This outlook provides a focused assessment of the state of public capital in the major European countries and identifies areas where public investment could contribute more to stable and sustainable growth.

A European Public Investment Outlook brings together contributions from a range of international authors from diverse intellectual and professional backgrounds, providing a valuable resource for the policy-making community in Europe to feed their discussion on public investment. The volume both offers sector-specific advice and highlights larger areas which should be prioritized in the policy debate (from transport to social capital, R&D and the environment).

The Outlook is structured into two parts: the chapters of Part I respectively explore public investment trends in France, Germany, Italy, Spain and Europe as a whole, and illuminate how the legacy of the 2008 Global Financial Crisis is one of insufficient public investment. Part II investigates some areas into which resources could be channelled to reverse the recent trend and provide European economies with an adequate public capital stock.

The essays in this outlook collectively foster a broad approach to and definition of public investment, that is today more relevant than ever. Offering up a timely and clear case for the elimination of bias against investment in European fiscal rules, this outlook is a welcome contribution to the European debate, aimed both at policymakers and general readers.

As with all Open Book publications, this entire book is available to read for free on the publisher’s website. Printed and digital editions, together with supplementary digital material, can also be found at www.openbookpublishers.com.

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Edited by Floriana Cerniglia and Francesco Saraceno
8. From Trans-European (Ten-T) to Trans-Global (Twn-T) Transport Infrastructure Networks. A Conceptual Framework

Paolo Costa,° Hercules Haralambides° and Roberto Roson°


Even before the Trans-European Transport Network (Ten-T) appeared formally in the Maastricht Treaty in 1992, European transnational transport flows have followed a pattern recalling this network.\footnote{Article 129 b), c) and d) of the Maastricht Treaty (European Union 1992) provides for the construction of both transport and energy and telecommunication networks.}

Ten-T networks (road, rail and inland navigation) have been, and still are, the beneficiary of a vast program of public investment, publicly funded by the European Union and Member States, and partly financed by the private sector. The network has been under planning, designing, improvement and realization ever since its inception in the mid-1990s. A new cycle of planning, designing and implementation of the network, foreseen by the EU guidelines for Ten-T’s development,\footnote{Council Regulation (EU) 1315/2013.} is currently underway, to be completed by 31 December 2023.

The need to transform a patchwork of national networks into a single European one, characterized by common standards and full interoperability, has been recognized since the preparatory work for the Treaty of Rome in 1957 (Bonnefous 1951).
Notwithstanding this, infrastructure policies aimed at guiding the post-Second World War reconstruction of Europe remained confined within each national box of policy tools, in the name of “keeping national” both the anticyclical role of the Keynesian multiplier (of public investment), and the pursuit of the objectives of economic integration of the then less developed areas (especially Southern Italy and, since the early 1970s, Ireland).

Ten-T reached the heart of European policy, and the “satisfaction of the common European interest” was added to the national criteria that filter all infrastructure development programs which derive their legal basis from the Maastricht Treaty. This has been the result of efforts to reconcile the need to accelerate the construction of the internal market and the EU policy objectives of growth and employment. Simply put, completing the internal market required the elimination of cross-border missing links and bottlenecks, so as to ensure access to the heart of the market from peripheral regions and to prepare transport networks and systems capable of competing globally. On the other hand, transport infrastructure investments, and their long construction periods, were seen by many Member States (in our view, often wrongly) as an ideal way of fighting unemployment, which, at the beginning of the 1990s, was hitting more than 17 million Europeans, one third of whom were young people. Of course, the positive effects on European competitiveness, in the medium- to long-term, did not escape the attention of any EU government.

The overarching goal was to combine a Keynesian approach to boost aggregate demand with the benefits of a substantial reduction in transport costs. The latter objective, it was correctly expected, would reduce unit costs of production; expand markets for outputs and inputs (including labour) and lead to higher international competitiveness of the single internal market, thus increasing growth capable of creating jobs (Haralambides 2019). These guiding principles permeated the whole development of the Ten-T Network and its implementation, and dictated the definition of its investment priorities in 1996, 2004 and 2013.

The above principles are still central on the eve of the new Ten-T policy revision, enriched, however, by the 2004 and 2013 objectives of environmental and energy sustainability, stressed by the need to combat climate change and contain energy costs. Among others, lowering the pollution intensity of transport (greenhouse gases in particular), as well as its energy intensity, is thought of as being able to encourage a modal shift towards rail, sea and inland navigation, instead of the dominant “road” and “air” transport modes. All along, the assumption has been that a more

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7 The questions here are: how is it possible to build a European single market without physically connecting any given point (A) with any given point (B), and how could we do this when the road, rail and inland navigation network presents so many missing links at old country border crossings, not to mention the bottlenecks still affecting many nodes and links in the network?

8 “Networks are the arteries of the single market. They are the lifeblood of competitiveness, and their malfunction is reflected in lost opportunities to create new markets and hence in a level of job creation that falls short of our potential” (European Commission 1993, p. 89).
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<th>TENT Corridors</th>
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<td>136,9</td>
<td>443,5</td>
<td>874,9</td>
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Fig. 1. Distribution of EU Ten-T funds by transport mode and core corridor

Source of data: Euro Commission, 2018. Figure created by Paolo Costa.
competitive performance of the “non-road” and “non-sky” modes, made possible by infrastructural and technological modernization and a fairer allocation of external costs through their internalization in transport prices, would favour the “modal split”: a modal shift that could lead to a more sustainable satisfaction of transport demand.9 Finally, the integration of the European economy into the world economy has also been a cited objective but, as we will see below, one of very low impact on policy formulation until now.10

The implementation of the Ten-T policy moved on accordingly. The current allocation of European Ten-T funds to different modes along the nine corridors of the core network is represented in Figures 1 and 2: 78.8% of the money goes to rail infrastructure, 8.4% to inland waterways and 6.7% to road infrastructure. Maritime transport, including ports, gets 4.3% of the EU funds, with only 1.45% going to the — currently most promising — Mediterranean ports.11

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9 In turn, the shift from road to rail would lead to greater sustainability in terms of safety, as a key to a zero-casualty transport strategy.

10 The “opening” of the Ten-T network to the world was suggested in the Final Report written by Expert Group no. 4, coordinated by Paolo Costa, working at the revision of the Methodology for Ten-T planning dedicated to the “Ten-T Extension outside the EU” (European Commission 2010).

11 This is occurring while rail transport performance in the EU is still unsatisfactory in terms of volume transported and modal share. On average, road transport accounts for 75% of the market, while rail has actually declined slightly since 2011 (European Court of Auditors 2017).
From 1994 to 2013 the geography of the Ten-T Network has been evolving, so as to address the progressive eastward enlargement of the Union, as well as the changing settlement patterns brought about by the long-term economic and social developments in Europe. Some nodes and links of the network were thus becoming technically or geographically obsolete, some less useful and others highly in-demand. There has been little consideration of the demands for change in the geography of the Ten-T networks, and in their modal structure, coming from both inside and outside Europe, due to new connectivity requirements deriving from the increasing integration of Europe into the global economy.

To be more precise, there has been no lack of attention given to the neighbouring countries bordering the European Union, both to countries which are candidates for EU enlargement and to those belonging to the “ring of friends”. All of them have been the subject of the neighbourhood policy launched in 2004 mainly with the objective of avoiding the emergence of new dividing lines, new Berlin walls, between the enlarged EU and its neighbours.

What was underestimated was the fact that international transport flows were and are changing in volume, and geographic patterns are changing with profound consequences particularly as regards, now, to the increasing importance of southern European ports as the gateways to the continent of Asian cargoes.

Equally underestimated is the disruptive impact of new transport technologies and their “digital twin” on infrastructure networks. The authors of this chapter believe that the major issue to take into consideration in designing the 2023 Ten-T revision will probably be the geographical and technological disruptions of the existing infrastructure network.

This consideration will have to be tackled, on top of dramatic disruptions coming from other sources, such as: e-commerce (leading to more freight transport and increasing the share of relatively carbon-intensive modes); increasing vehicle automation (pushing up demand for road freight and shifting freight from rail and inland waterways onto roads); manufacturing re-shoring and 3D printing (with a significant decrease in internationally traded goods that greatly reduces sea and air transport volumes); high capacity vehicles (HCV) (carrying bigger loads than regular trucks, limiting emissions and congestion, reducing overall costs, increasing safety, but causing a reverse modal shift from rail to road); and decarbonizing technologies for

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12 Five main transport axes linking the EU with its neighbours were identified by a High Level Group chaired by Loyola De Palacio and formalized in the “Guidelines for Transport in Europe and neighbouring regions (COM/2007/32)”. The interests and commitment of the neighbouring countries were then assessed by the communication “Progress of exploratory talks regarding cooperation in the field of transport with the neighbouring countries COM(2008)”. The Ministerial Conference — The Future of Trans-European Transport Networks: Bringing Europe Closer to its Neighbours — held in Naples on October 2009 paved the way to the transport neighbourhood policy still in operation.

13 Freight volumes will continue to grow strongly, with global freight demand projected to triple between 2015 and 2050 (ITF (2019)).
heavy-duty long-haulage — electric roads, hydrogen, batteries — (potentially capable of altering the relative convenience of different transport modes).\(^\text{14}\)

8.2. Demand for New Connectivity: Europe’s Economic, Social and Political Integration in a Global Context

The 2013 revision of Ten-T defined a “two layer” set of networks: the so-called *core network*, a set of only nine (core) corridors linking the major urban nodes among them and to major ports, airports and rail-road terminals and the *comprehensive network*, pervasively connecting all major European urban centres. The core network has been set to become *efficient, safe, green and smart* by the year 2030, while the completion of the comprehensive network is foreseen for 2050. The core network is also expected to cater for the growing relations between the EU economic space — assumed to remain the largest in the world for at least a few more decades — and the rest of the world. In this scenario, competition within the internal market will continue to be at the root of EU core business, under the understanding that growth in one Member State is inextricably linked to the growth in any other Member State.

In 2008 China acceded to the World Trade Organization (WTO) and in just over ten years at the time of writing (2019) China’s external trade has accounted for 50% of global trade. At the same time, multilateral trade negotiations opened up — to their benefit — the economies of many emerging markets, led by BRICS.

According to the OECD’s International Transport Forum, by 2030 the world trade is foreseen to have increased by a factor of 3.4 and this growth will come mostly from emerging economies and global markets (ITF 2019). In such a scenario, Europe’s dependence on trade will intensify, putting ports and airports under great pressure. Adjusting European ports and airports to the new level of activity becomes thus an absolute and immediate priority, particularly in view of the long gestation periods of large infrastructure investments. This priority was not neglected in the technical process of the 2013 revision of the Ten-T Network, and found its way through *de facto*, in the definition of the nine “core corridors”, all of which starting or finishing at a port city, or including major ports in their layout.

But the implementation strategy designed by each core corridor coordinator unfortunately did not reflect the importance of this priority: missing links and bottlenecks in the internal network seem still to be more relevant than creating effective gateways and doors to the world. The allocation of EU funds (Figures 1 and 2) reflects this “wrong” choice. We are convinced that it is time to move from “Europe as a single market” to “A single Europe in the global market”. The key question is how.

Demand for transport, especially for goods, is a function of the size and geography (spatial distribution) of production and consumption. With a given transport technology,
8. From Trans-European to Trans-Global Transport Infrastructure Networks

the flows that satisfy a certain transport demand are controlled by the capacity and geography of the networks (links and nodes) along which these flows run.

If the technology, the geography of flows/networks and capacity are given, then transport flows assigned to the network will move from any “origin” to any “destination” along the network, behaving “like water” that always follows the shortest (minimum cost) path. This will occur unless “deviations” — due to indivisibility, cumulative processes or market imperfections — take place, or because missing links or capacity bottlenecks in the network fail to be eliminated.

If a new geography of production and consumption areas produces a pattern of flows that significantly departs from the historical one, this will tend to retroact on the net, demanding investments in transport infrastructures aimed at transforming, à la Alfred Marshall, “existing plants”, which have become obsolete, into “adequate ones”. Disruptions in the geography of transport therefore tend to generate disruptions in the geography of infrastructures.

A distinctive feature of the world of transport is that its scenarios are characterized by recurrent geographical transitions, where we are confronted with radical changes in the geography of production, income and consumption. This is exactly what is happening now at the global and European scale: a change has already translated into a revolution in the geography of international trade, which is moving along routes that make increasingly evident the obsolescence of historical modal and intermodal networks.

8.2.1. The growing importance of the extra-EU markets

The reason why phenomena that are changing the geography of the world economy are of profound interest to the whole of the European Union is simple. Even if Europe remains the most economically integrated region in the world — much more than the USMCA (ex Nafta) and the East and Southeast Asian regions — it is nonetheless becoming increasingly open to the world, and the current US-China trade war is only slowing down this inevitable process.

From 2002 to 2008 the ratio of extra-EU to intra-EU exports has increased slowly but steadily in almost all European countries (Figure 3). On average, in the whole EU28, the ratio has risen from 0.464 to 0.478. Since 2009, in the midst of the Great Recession, the ratio has begun to grow even more significantly. The EU28 average rose from 0.494 (2009) to 0.612 (2015), an increase of 24%. The projection of the same ratio to 2030 suggests that, by that date, non-EU exports will be worth as much as 65% of intra-EU exports, with a clear difference between the behaviour of the countries of the “new Europe”, all still aiming at exploiting the potential of the internal market (ratio of extra-EU to intra-EU exports still less than 30% by 2030), and the countries of the “old Europe” whose extra-EU market will be worth 75% of the intra-EU one.

Until a few years ago, Europe believed it could safely neglect what was happening around it and focused almost exclusively, and in a rather introverted way, on the
completion of the internal market. So great was its preoccupation with, for example, such things as market shares and other aspects of competition law, that decisions and rulings of its Directorate-General for Competition penalized European companies in their global competitive strife. In effect, these decisions and rulings were instead “music to the ears” of Europe’s international competitors.

For years, Europe’s “proud” conviction that it was the world’s largest trading bloc reinforced its belief that everything could continue to be played “within the Union” or, at most, by just taking into account the only world economic powers relevant at that time: the USA and Japan which, together with the EU, formed the so-called “Triad” (Ohmae 1985) that dominated the world. For example, only twenty years ago, the geography of international trade was dominated by the “transatlantic relationship” between Europe and the United States, and between the latter and Japan; a triangle in which only China and South Korea began to fit.

![Fig. 3 Ratio of extra-EU and intra-EU exports, 2002-2016, and forecast to 2030](image)

Source of data: Euro Commission, 2018. Figure created by Paolo Costa.

The Great Recession of 2009, which, for some European countries, lasted until 2013 or beyond, suddenly made it painfully clear what was happening in the meantime in the rest of the world: a shift of the centre of gravity of the world economy outside the advanced countries of the OECD area, favoured by a formidable reduction in transport costs, as a result of competition and economies of scale in ocean transportation, and by advances in logistics and vertical integration, resulting from the fragmentation of the different phases of industrial production.
In a way, the Great Recession urged Europe to better study phenomena beyond economics, which are changing the geography of the world. Among others, the demographic dynamics of the world population.

Today, 60% of the world population lives in Asia (4.5 billion) and 17% in Africa (1.7 billion). Only the remaining 23% live in the rest of the planet (10% in Europe). Between now and 2050, half of the increase in world population (1.3 billion people) will manifest itself in Africa, while another 750 million will be added in Asia. By 2050, 80% of the world’s population will be living in Asia and Africa. Europe will be the only part of the world having a lower population in 2050 than in 2017. Obviously, demographic shifts such as these are already having their impact on the regional distribution of global income. Today, the Asian bloc represents more than a third of the global GDP, while North America is just under 28% and Europe is at 21.37%. Projections to 2050 reinforce pro-Asia shifts. If to these projections one adds the significant incremental differences in labour productivity, one can easily assume that every long-term scenario will be decisively characterized by a move in global demographic and economic weights towards a lasting Asian centrality.

Following OECD (2011), it seems reasonable to imagine the doubling of world GDP by 2030, driven by a sustained growth in the emerging economies. By the same year, the GDP of North America would increase by only 50% and that of Europe by 40%. On an even longer horizon (2050), and with a world population exceeding 9 billion people, world GDP could grow up to four times that of 2005 (almost ten times for China and India). The combined effect of the low growth of the European population, and the even lower growth of European GDP and disposable income, should however mean that the per capita income of Europe and of the other advanced countries remains — even in 2050 — higher than that of the rest of the world.

It is against this background that the economic geography of the world and, with it, that of its trade will be redrawn.

Accordingly, the demand for freight transport could increase by a factor of 2.5 to 3.5. In the case of emerging economies (non-OECD countries) this factor could be even higher, in the neighbourhood of 4 to 5. Demand for transport, now fulfilled over new, substantially different, transport networks, will inevitably result in heavy demand for new infrastructure which, in view of its long gestation period, should be planned now, so as not to hinder trade and world growth.

In summary, and according to the plausible scenarios above, the two ongoing processes that should convince the EU to shift its focus from an inward-looking viewpoint to the evolution of transport and transport infrastructure in a broader global view are:

1. The emergence and strengthening of Asia’s central role in the world economy;
2. The rapid development of the southern and eastern shores of the Mediterranean.
This picture, however, is not without further complications: the centre of gravity of the European economy will shift to the east, within and outside the current borders of the Union, driving a redefinition of the geography of production within Europe.

### 8.2.2. Asia’s central role in the global economy and trade

Emerging Asian economies will become central to the global economy, because they will be no longer just the place of origin of European, American and Japanese imports, but also increasingly crucial destinations of exports from OECD countries.

The Asian focus is particularly important for the European economy and its transport sector, as evidenced by actual maritime flows, which are clearly prevalent in Eurasian relations and, more generally, on a global scale. According to the UNCTAD surveys of containerized ocean traffic between the world’s macro-regions since 1996, there is a growing disproportion in traffic flows along the three main global routes. By far, the most important exchange for Europe today is the Europe-Asia-Europe one (23 million TEU traded in 2017) which, although slightly lower than the transpacific flows between Asia and America (26 million TEU), is now three times more important than the transatlantic route (7 million TEU).

In short, trends in regional growth (GDP) and world commerce show that, even if the market of North America will continue to remain the most important extra-European one (as far as Europe is concerned), the affirmation of Asia as a final market, as well as the centre of the world manufacturing production, makes the Europe-Far East relationship the most important interregional relationship for the economy of the European continent.

This is the reason why both researchers and traders are exploring new ways of fuelling this relationship, possibly through routes that had been neglected so far. For instance, the polar route from China to the North Sea via the Bering Strait and the Arctic Ocean: a route that is expected to be open soon all year round, because of the effects of global warming on polar ice. Other cases are the rail route from China to Germany via Russia or ex-Soviet Eurasian republics, the sea route that from China reaches the North Sea circumnavigating Africa, and the maritime one that crosses the Pacific and the Atlantic from China to the North Sea via the Panama Canal. This is also the reason why China has addressed its most important international policy strategy — the Belt and Road Initiative — to the Eurasian region.

All routes that can acquire some meaning on their own, but always without contesting the primacy of the “Royal Road”, i.e. the route between Europe and the Far East via Suez. Its superiority lies in its reduced transit times, as well as in its ability to intercept, on its way to the Mediterranean and Northern Europe, cargoes from such routes.
countries and territories as Malaysia, Indonesia, Philippines, Thailand, India, the Persian Gulf and East Africa. The organization of shipping traffic along this route, and its best exploitation, is crucial for the European economic growth.

8.2.3. The potential of “MENA (Middle East and North Africa) shores” and the Mediterranean Sea basin

The development of the countries surrounding the Mediterranean Basin (Southern Europe, North Africa and the Near East) will add significant volumes of intra-Mediterranean maritime flows to those connecting Asia and Europe. The modernization and reform of ports in Greece, Italy, France and Spain, will offer the “southern gates” to the Asian cargo. The role of Mediterranean ports in serving the European “heartland”, and their increasing market share in Europe-Asia’s trades, now challenges the so far unquestionable dominance of the Hamburg-Le Havre range of ports of the European North, with Spain’s Valencia expected to overtake Bremerhaven in 2019. A “rebalancing” of European gateways that will call for a corresponding adaptation of the intra-European land transport infrastructure network (rail, road and inland waterways) has to be connected to the next steps of Ten-T planning.

In the long run, however, something will be added by the economic growth of Africa and the Middle East. This phenomenon has unfortunately been recently overshadowed by political turbulence. The political instability in Libya and Syria, and the political and economic instability in Turkey, is stunting the growth of their economies, which were reaching rates not very different from those of the emerging Asian economies. It is reasonable to expect that the growth processes will soon recover in these areas, making these markets of great significance to European development. The most obvious example is Turkey, which, before the recent political and economic-financial crisis, was growing at a Chinese pace and, for European exports, has constituted a market of the same size as China.

8.2.4. The shift of the European economy’s centre of gravity to the East

If what is happening beyond Suez and the Mediterranean is affecting the economic geography of Europe on the sea side, on the land side too change no longer passes unnoticed — consider, in particular, the progressive shift of Europe’s centre of gravity towards the east. The 2004 enlargement that brought the “new Europe” into the Union started a process of geographical rebalancing of the European economy. And although today sees the “old Europe” still accounting for almost 90% of the EU’s gross domestic product, the “new Europe” is experiencing growth rates permanently higher than those of the “old Europe”. If one projects these processes at a 2020 and 2030 horizon, one could safely foresee at least a doubling of the share of the “new Europe” in the European gross product, with a proportional growth of the share of the European
domestic market, represented by countries and regions located to the east (and south) of the old centre of gravity.

The European centre of gravity is bound to move further to the east in view of the expected economic growth of the neighbouring former Soviet republics (Moldova, Ukraine and Belarus), as well as Russia, despite, also here, the political interferences of the Ukrainian crisis and the consequent Western sanctions on Russia. Finally, one should note that the area of continental Europe that has most successfully overcome the Great Recession (with an unemployment rate in 2017 lower than 3.8%), perhaps with the exception of Greece, is the one that runs, eastward, from Southern Germany to Southeast Europe. These results are also explained by a shift to the east of the European manufacturing industry.

8.2.5. Consequences for the EU transport infrastructure policy

The centrality of Asia, the development of the southern and south-eastern shores of the Mediterranean, and the shift of Europe’s manufacturing centre of gravity to the east are all long-term trends whose consequences in terms of road, rail, inland waterway and port infrastructure policy should be obvious.

The adjustment of Europe to these trends should consequently move along three parallel lines: i) maintain efficient access to Europe’s historical, productive and consumptive heart; ii) increase the accessibility of regions that were less central yesterday, but are soon bound to increase their economic centrality, possibly becoming an engine of development for the entire continent; iii) link Europe’s infrastructural plans to similar developments taking place outside its borders, most notably China’s Belt and Road Initiative (BRI).

Even if there is still a lot of ground to cover to bridge a decades-long infrastructural gap\(^{18}\) between Northwest and Southeast Europe, some of the above processes are already underway, as evidenced by the substantial amount of investments in transport infrastructure made in Central and Eastern European countries. Less coherent is the European transport infrastructure policy, implicit in the construction of Ten-T networks: little attention is paid to adapting the node-ports, acting as global gateways, and the connected internal links.

The relative obsolescence of historical ports, built over the past decades in response to a geography of traffic that no longer exists today and, in turn, the low capacity of many port nodes — together with the inadequacy of the networks connecting them to the internal market — that today would ensure the minimum cost path to freight, is evident. In addition, the state of many port-nodes is today in crisis (technical obsolescence) because of the technical progress that fuels the oligopolistic competition

\[^{18}\text{Investments in internal transport infrastructures (roads, railways and canals) in Western Europe have been at around 0.8\% of GDP since 2000; the same investments, on the other hand, passed in Central and Eastern Europe from 1\% of GDP in 2002 to 2\% in 2009, a phenomenon that can be explained by the efforts made to reduce the initial infrastructural sub-endowment (ITF 2011).}\]
between shipping companies, using ever larger ships, capable of carrying ever growing mega-cargoes demanding new adequate port and land infrastructure.

Adapting the capacity of the port-node gates to the networks of “minimum cost path” would achieve the double result of reducing both the higher direct transport and logistic costs — paid by market operators — and those indirect negative externalities from pollution, congestion and accidents, that, even if not yet fully appreciated by the market, are nevertheless a burden on the collectivity. For instance, it has been demonstrated (Cappelli, Libardo and Fornasiero 2011) that the transport of a container that goes from China to Germany (Munich) via Rotterdam, instead of Venice, produces at least 78 kg of additional CO2 per TEU (up to 600 tons of CO2 for a containership of 8,000 TEU). In enabling, for instance, Venice to handle one million TEUs more per year, from the Far East and on its way to Europe, roughly 125,000 tons less of CO2 per year would be emitted, in addition to time savings and lower fuel costs. Unfortunately, this evidence has not produced results yet.

The geography of European ports has not changed much. On the contrary, in the face of the changing geography of the origins and destinations of traffic, the historical ports have reacted by trying to achieve economies of scale that could compensate, at least in part, the higher transport costs due to the lengthening of distances by sea and land. The rest of the higher costs due to longer distances were instead passed on to the port users, taking advantage of the considerable market power enjoyed by the historical ports. Distracted or conniving infrastructure policies have so far favoured such inefficiencies to the detriment of traffic receivers. This is why many of them, actually close to the Mediterranean ports, have continued to be served by the North Sea ports, for traffic to and from “beyond Suez”, despite at least five more days of navigation and a few hundred more kilometres by land.

This is a situation that the European transport infrastructure policy has been hoping to correct before 2030, the date at which the construction of the Core Trans-European Transport Network and its core corridors, finally taking into proper account the heightened significance of the Mediterranean maritime routes, should be completed. Crucial to this aim is the review of the Union guidelines that the Commission has to carry out by 31 December 2023. In evaluating which “amendments” are needed in order to take care of the “changes in passenger and freight transport flows”, as well as the “developments in national transport infrastructure investments”, it is advisable to identify ways and means for tackling the geographical and technological obsolescence of all current networks.

Some ideas for addressing “geographical obsolescence” are those discussed above. Some thoughts on tackling “technological obsolescence” are discussed in the next paragraph, dedicated to the disruption of the worldwide maritime freight transport network and its infrastructure. On this issue, we believe that the key nodes to be connected should be the global ports, i.e., those connecting seaborne global flows. This

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is because of their role in consolidating/deconsolidating mega-cargoes moving from (to) ports to final destinations (origins) by rail, HCV or, why not, hyperloop.

A further final paragraph is dedicated to the fact that moving from Ten-T to Twn-T, from the “European” to the “Global”, demands global agreements. The novelty is the necessary interlocution with foreign counterparts, in dovetailing European and global networks. The Chinese Belt and Road Initiative is possibly the most relevant strategy to be considered in this context.

8.3. Dealing with the Disruption of the Worldwide Maritime Freight Transport Network and its Infrastructure

One major disruption reshaping the whole world of freight transport, both services and the links and nodes of their infrastructure networks, is that regarding global supply chains that comprise at least one ocean leg, i.e., the vast majority of international trade flows (UNCTAD 2017).

Ships, ports, rails, roads, warehouses, etc. are under disruption all over the world, confronted with a clear-cut choice: either to undergo a process of upgrading or to put themselves under the risk of being abandoned, because of technical or geographical obsolescence, and replaced by new, state-of-the-art pieces of infrastructure, or private capital assets.

The gigantic process of global “infrastructural change”, estimated to amount to trillions of US dollars, is currently taking place without any comprehensive assessment of its efficiency, sustainability or fairness. That is, without any alignment of private and public objectives or, in the case of Europe, only partially achieving the Union’s overarching policy objective of economic convergence and greater economic and social cohesion. No one actually knows if citizens and businesses are getting the best value out of infrastructure networks and related investments, existing or under disruptive adjustment, as there is no international cooperation, or at least consistent dialogue, on this matter.

On the contrary, donor countries and organizations such as the European Investment Bank (EIB), the European Bank for Reconstruction and Development (EBRD), the World Bank and International Finance Corporation (WB/IFC), the Asian Infrastructure Investment Bank (AIIB), etc. appear to be competing on infrastructure, lending or granting funds to cash-hungry countries in an uncoordinated fashion, without sound, sophisticated, cost-benefit analyses that, when applied, rarely goes beyond a case by case partial and biased exercise. There is an urgent need for assessing the systemic impact of whole transport infrastructure network. Some novel analytical tools and approaches are now available and are reviewed below. The alternative reliance on the mere criterion of the amount of lending, the latter being often also the criterion of success of lending policies or promotion of lending officers is not leading to the best use of scarce financial resources.
However, one should not forget that infrastructure investments have long gestation periods until they yield fruit, while many loans need to be repaid in the meantime. In this regard, it should also not be forgotten that world debt is exceeding the GDP of the United States, while China’s Non-Performing Loans represent 25% of that country’s GDP. A new global economic meltdown cannot therefore be excluded, bearing in mind that the cause of the 2009 crisis was precarious — not to say conniving — lending to aspiring homeowners.

What follows, summarized in Table 1, is a brief description of certain recent trends. Growth in trade (UNCTAD 2018), oligopolistic market structures, and often misplaced business expectations regarding the illusionary benefits of economies of scale (EoS) in shipping, all encourage a seminal, disrupting innovation: the construction of ever larger containerships. This is a development which has already started to manifest significant diseconomies in ports, along the supply chain, and among many disgruntled shippers, particularly in Europe, where shipping industry concentration (alliances) is higher, and the contestability of the market lower than in Asia and North America.

<table>
<thead>
<tr>
<th>Disruptive innovation</th>
<th>Infrastructure disruption</th>
<th>Capital asset disruption</th>
<th>Market structure disruption</th>
<th>Business model disruption</th>
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<tr>
<td>Panamax</td>
<td>Route disruption</td>
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<tr>
<td>Suezmax</td>
<td>Further route disruption</td>
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<tr>
<td>Megaships</td>
<td>Port disruption/obsolescence</td>
<td>Ship fleet disruption</td>
<td>Oligopolistic competition</td>
<td>Ship sharing (alliances)</td>
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<tr>
<td>Megaports/port systems</td>
<td>Rail infrastructure disruption/obsolescence</td>
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<td>Road infrastructure disruption/obsolescence</td>
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<td></td>
<td>Inland waterways disruption/obsolescence</td>
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<tr>
<td>Mega cargoes</td>
<td>Consolidation/deconsolidation points</td>
<td>Warehouses, logistic equipment</td>
<td>Ship/port/Logistic integration</td>
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<tr>
<td>Supply chain digitalization</td>
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<td>Ship/port/Logistic digital integration; platformed services</td>
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</tbody>
</table>
(for a comprehensive analysis of “gigantism” in container shipping, see Haralambides (2019)). It might be interesting to also mention at this junction that, due to the new Asian centrality in global manufacturing, seaborne trade of manufactures has been carried principally along two main routes: the transpacific one, connecting China to the USA, and the Asia-Europe one. It is mainly along these two routes where repeated rounds of replacement of existing ships with new bigger ones takes place. Those replaced are either scrapped, or deployed as feeders to secondary markets and ports (a practice known as cascading) many of which have neither the trade volumes nor the technology to receive them.

The progressive substitution of existing ships with larger ones is producing much more profound consequences on port facilities.

Only few of the existing ports can accommodate containerships of the latest generations, and even for those which do, serving such ships is becoming an increasing headache. A further increase in ship size can only be achieved by increasing the beam of the ship beyond the current 60 metres, something that would however render useless the latest generation of ship-to-shore cranes. Complying with carrier requests for the “same” turnaround times, irrespective of ship size, causes significant diseconomies in cargo handling operations. It is not so difficult to understand why: as crane productivity cannot be stretched much beyond 30 moves/hour (it actually declines after a certain crane density), the only way to serve a larger ship in the same time (e.g. 48 hours) is by adding more and bigger (in terms of air draft and outreach) cranes. However, increasing crane density reduces crane productivity, nullifying the advantages of having bigger hatches (Haralambides 2019).

Furthermore, big ships impose substantial demands on port capacity, without however paying commensurately for this demand. For instance, where before one could accommodate three Panamax vessels (i.e. three berths) along one kilometre of quay-wall, today, in the same space, one can only host two mega-vessels of the latest generation (about 400 metres long). Berth utilization obviously goes down and so does the utilization of Ship-to-Shore (StS) cranes, since bigger ships mean lower call frequency (Haralambides 2019). All this would be fine, however, as long as carriers were bringing more traffic to the port with their larger vessels. But this doesn’t happen either. Call size, it has been proven, is only moderately correlated with vessel size.

Therefore, ports eligible to handle the megaships of today and tomorrow are those rich both in adequate nautical accessibility (deep waters) and large spaces on land and efficient and sustainable connections via rail and road (and inland waterways) to large markets. Since all three conditions can in most cases be modified by adequate investments, the choice of the megaports of tomorrow is a delicate one and can lead to substantial port disruption, with two opposite potential risks:

1. Creation of port overcapacity, when too many ports are trying to stay on the contestable global markets and/or

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20 Crane density is defined as the number of cranes per 300 metres of quay length.
2. Rail, road and inland waterways infrastructure under-utilization when a lack of port capacity acts as a crucial “missing link” in the networks (rail, road, etc. disruption).

In conclusion, the coordinated use of all transport infrastructure, to be used along the routes followed by global supply chains, is crucial for “getting the best value for citizens and businesses” from existing or disrupted infrastructure. By definition, here is a delicate “governmental” role at stake at all levels: national, regional (European) and global.

But the economic usefulness of megaships does not depend only on a sufficient level of capacity utilization, something increasingly difficult to attain were it not for carrier cooperation in global shipping alliances, but also on spending most of their time at sea. The capital intensity of these ships obliges them to limit their ports of call at each end to just a few hub ports or load centres such as Shanghai, Singapore, Hong Kong, and currently in Europe, Rotterdam and Hamburg, from where huge surges of containers are consolidated or further forwarded (feedered) with smaller vessels, rail or road, to regional and local ports. Complex hub-and-spoke networks have thus evolved whose logistical fine-tuning and optimization bears directly on consumer pockets.

The consolidation/deconsolidation of mega-cargoes passes through successive steps, dealing with sub-consolidation/deconsolidation phases. Mega-cargoes call for supply chain integration. That is why the choice of megaports will decide which links and nodes of the land multimodal transport infrastructure network will have to be constructed, or further developed, to cope with the new freight consolidation/deconsolidation trends, along each supply chain route (land leg and port node on the departing country; maritime leg, and port node and land leg on the receiving country).

The choice (competitively, when possible) among different routes is somehow in the hands of governments — in the case of Europe, both at European and national levels — because of their final say about infrastructure provision. The choice, however, is also controlled by the potential “private” investor in port infrastructure, as well as by the supply chain user, the latter being mostly the freight forwarder or the logistics service provider, who combine the maritime leg, the ports, and land transport. If, as in the current situation, no regulator “supervises” this process, the only agent not controlling the cost and the quality of the service provided would paradoxically be the final consumer who pays the bill.

It is worth noting that the complexity of the mega-cargo consolidation/deconsolidation process, and the necessity of dealing with sub-consolidated/sub-deconsolidated cargo lots, make the value added generated in this logistics phase greater than that generated by the pure maritime transport service. A new business model is consequently emerging: the one that foresees the vertical integration, under the same firm roof, of the maritime and port services, and/or of the maritime, port and logistics services (integrated physical business model). This integration is eligible for
being digitally operated in a suitable platform, run by one of the operators controlling one leg of the supply chain or, preferably, by a specialized, independent third party (digital business model) (Costa et al. 2018).

The overall European transport network disruption taking place because of this “maritime driven” revolution assigns a primary role to those Ten-T nodes characterized as megaports: they become the most important missing links (missing nodes) to deal with, in the amendment of the Ten-T Guidelines of 31 December 2023. But EU megaports are also the missing links across the external EU border: they are connecting the EU with the rest of the world. In terms of Eurasian relations, this means dovetailing them with the Belt and Road Chinese Initiative.

8.4. Dovetailing the EU Ten-T Infrastructure Policy with the Chinese Belt and Road Initiative (BRI)

Until 2013, the evolution of the Ten-T Network was a phenomenon entirely controlled by the European Union.

Extending the Core Ten-T Network outside the EU was until recently only a matter of “closing” the EU infrastructure system, i.e. extending Ten-T to accession candidate countries, as well as to potential ones in the ring of neighbouring friends, in order to enlarge or deepen the internal market: a policy defined in Brussels and, of course, gladly accepted by her counterparts.

“Opening” and connecting the EU infrastructure system to the rest of the world is a totally different story, however. The physical dovetailing of the EU network with external networks is bound to be influenced by preceding policies and strategies, and the dovetailing of the EU Ten-T with the Eurasian land (belt) and maritime (new silk road) networks, supported by the Chinese BRI, is today the most relevant case.

To many, BRI is above all a brilliant manifestation of China’s renewed presence on the world stage. The “initiative” constitutes a great diplomatic strategy, many believe, based on a refined exercise of soft power, that considers “power with others” as more effective than power “over others” (Nye 1990).

To quote China’s president Xi Jinping (2017),

[…] BRI aims to replace estrangement with exchanges between different civilizations, replace clashes with mutual learning and replace a sense of superiority with coexistence; it aims to boost mutual understanding, mutual respect and mutual trust among different countries. In this light, the BRI is seen as a path towards global peace [...].

And on BRI and the new economic order, President Xi continues:

[…] BRI is guided by the principles of consultation and cooperation, aiming at shared benefits. The initiative represents an approach to international cooperation featuring mutual respect, justice, equity and cooperation for win-win outcomes. BRI is committed to multilateralism and an open global economy. As such, BRI will help move economic globalization toward greater openness, inclusiveness and balance [...].
The stated objective of BRI — a one trillion US dollar program — is to achieve greater economic integration and development through better connectivity, the latter being the main enabler of trade growth and trade-driven prosperity. Ongoing research by authors of this chapter shows that a 10% improvement in connectivity between countries along the “Maritime Silk Road” would deliver a 3% decrease in Chinese trade costs which would, in turn, boost China’s imports and exports by around 6% and 9%, respectively. The latest studies by the World Bank and other international institutions also suggest that BRI cooperation could cut the costs of global trade by 1.1 to 2.2%.

Chinese investments of transport relevance in the EU, not necessarily always under the BRI umbrella, are impressive. Bloomberg calculates them to be in excess of €300 bn in the past ten years. Ports — the gates of Chinese exports to Europe — score prominently among these investments, with the port of Piraeus, Greece, showcasing second place (after Valencia, Spain, also, presently, under Chinese interest) in the Mediterranean; 7th in Europe; and 36th (from 93 in 2010) in the world.

As mentioned above, and according to many observers and researchers on BRI, China has adopted a refined version of projecting “soft power”, in the sense that it appears to be exercising a type of “multiple bilateralism”, building relations, individually, or in groups (e.g. 16+1), with different countries in Europe, Central- South- and Southeast Asia, East and West Africa and even Oceania and Latin America. But, is it really so?

In Europe, feelings are mixed, in spite of President Xi’s reassurances during his recent visit to Europe, according to which it is not China’s aim to play one country against the other, neither to advance ad hoc and uncoordinated investments, nor to proliferate an understandable initial “vagueness” in geographically defining BRI. On the contrary, at this point in time, China would welcome a joint effort in dovetailing BRI with the Ten-T Network going forward.

EU Member States are not as unequivocal, however, when it comes to Europe’s openness to Chinese investments. A new core-periphery divide appears to have emerged, with Germany and France pushing for an EU-wide investment screening mechanism, while governments in Greece, Portugal and Cyprus are sceptical of such a move, arguing that it would hamper their countries’ ability to attract much-needed capital. In parallel, however, it is the EU Member States themselves who, in their anxiety to compete for Chinese funds, or to accredit themselves as marine terminals on the “silk road”, or as land facilities along the “belt”, visit China on an almost daily basis. This gives Chinese interlocutors enormous room for manoeuvre in their effort to penetrate the European markets.

It is true that the sale of the majority stock of the Piraeus Port Authority A.S. to COSCO, and especially certain activities that took place thereafter, including Greece’s vetoing a UN resolution on human rights, has left a somehow bitter aftertaste in Brussels. Moreover, the Union looks also with some concern at the Chinese penetration into the Western Balkans which, after having acquired the port of Piraeus, are concretely applying their soft power for the construction of a “Balkan Silk Road” which
should ideally connect Beijing to Athens and from there reach Skopje, Tirana, Sarajevo, Belgrade and Budapest.

In spite of, or even thanks to, all the above, and copying similar procedures of the US Senate, a screening mechanism was proposed by the European Commission in 2017 and approved by the Parliament in February 2019. The “mechanism” aims to ensure that “critical infrastructure”, such as those relating to energy, transport, communications and data storage (but also those that concern “critical technologies”, such as artificial intelligence, robotics, semiconductors and nuclear and space technologies) is not predatorily targeted by foreign investors. The “mechanism” is seen as a coordinating tool at the EU level, which does not intend to replace national mechanisms, nor challenge Member States’ prerogative to decide on investments. With regard to transport investments in particular, the European Commission has initiated a discussion on Europe-China, within a so-called “EU-China Connectivity Platform”.

Confronted with BRI, each country — and the EU too — is faced with a deliberately complex proposal, whereby it is up to each interlocutor, along BRI, to find their place on one or the other of the global logistical routes, within a wide spectrum of alternative options, relatively indifferent from the Chinese point of view. “Choice”, naturally, has always an objective, and alternative options ought to be guided by it. Some logistics chains, for instance, are better than others because they guarantee shorter and more efficient paths. Often, however, sound economics is sacrificed in the altar of unfolding strategies, or as a result of the will, ability and bargaining power of either party.

The strategic game is evident in the continuous redesign of BRI’s land routes, but also in the maritime silk road, which, from 2014 to 2017, has made its western landing more uncertain: as far as the Mediterranean Basin is concerned, in 2014 just the ports

![Diagram](image_url)

Fig. 4 Potential Ten-T/BRI dovetailing nodes

*Source: Paolo Costa, 2019.*
of Piraeus and Venice were considered as the possible southern gates to Europe. In 2017, China’s interests were also manifested in the Italian ports of Trieste, Genova and Palermo; Spain’s Valencia; France’s Marseilles; but also in ports outside the Union, such as Suez, Haifa, Istanbul (Kumport), Gibraltar and more (Costa 2017).

Among the many potentially involved nodes, those on the “Belt” (land) are “dictated” by geography while those on the “Road” (sea) are, so far, “suggested” by China (Figure 4).

8.5. Assessing the Systemic Impact of Transport Infrastructure: Some Novel Analytical Tools and Approaches

The key message emerging from the discussion above is the need to elaborate transport and infrastructural policies, considering the broader, systemic impact on the economy, or on the society at large, as well as the compatibility with policies undertaken by other global players. Therefore, when it comes to considering alternative policies in the allocation of public (and private) investment funds, one would like to base the choice on (or at least start with) rational comparisons, based on facts and scientifically accepted theories and models.

Unfortunately, the typical tools such as cost-benefit analysis, multi-criteria analysis, input-output or computable general equilibrium models, etc., all fall short in completely assessing the systemic consequences of (large) infrastructure investments. This is clearly due to two main reasons:

1. The extreme complexity and interplay of the effects;
2. The lack of reliable data.

However, it may be worthwhile to briefly mention here two recent contributions and methodologies, which promise to provide a more useful support for decision-making in this context.

One is illustrated in a recent paper by Treb Allen and Costas Arkolakis (2019). They develop a general equilibrium geographic framework to characterize the welfare effect of transportation infrastructure investments, tackling three distinct but conflating challenges. First, an analytical characterization of the routing problem, where infrastructure investment between any two connected locations decreases the total trade costs between all pairs of locations. Second, a general equilibrium geography setup where market inefficiencies arise due to agglomeration and dispersion spillovers. Third, a framework that admits analytical characterizations of traffic congestion. Allen and Arkolakis apply this model to calculate the welfare effects of improving each of the thousands of segments of the US national highway network.

This research work paves the way for the construction of a global transportation general equilibrium model, which could be of fundamental importance for the assessment of transport infrastructure policies, such as those discussed throughout
this chapter. For sure, this would be a very challenging venture, in terms of data and computational power, which would require the collaboration of different research centres around the world. However, there are examples of successful consortia of this kind, managing complex data bases and sophisticated global models, like the Global Trade Analysis Project (GTAP), based at Purdue University.

GTAP-based computable general equilibrium models are being used for policy assessment exercises, such as effects of trade agreements, the impact of Brexit, and long-run implications of economic growth on natural resources and climate change. Therefore, we believe that the development of a new generation of global transportation network models is not an impossible dream. These models could provide the scientifically sound assessment of the policies, trends and phenomena considered in this chapter.

Another, albeit very different, approach has been explored by Franz Hubert and his co-authors (Hubert and Ikonnikova (2011); Roson and Hubert (2015); Csercsik, Hubert, Sziklai and Kóczy (2019)). In these works, a methodology is used for analyzing bargaining games on network markets, which are markets where transactions occur by means of distribution and transportation networks. The overall economic surplus obtained in the market is distributed among all network agents on the basis of their bargaining power, which in turn depends on a variety of factors: position of each agent (e.g., a country) in the network, reliability in the cooperation scheme (e.g., geopolitical stability), existence of market distortions and availability of outside options. From this perspective, who controls critical links or nodes in the network extracts the highest surplus. An interesting implication is that building/improving new links or nodes may be justified in terms of bargaining power, rather than in terms of narrow social net benefits.

The typical example here is the one of gas pipelines in Europe. It may not be universally known that the total carrying capacity of the existing pipeline network, in Europe, far exceeds its actual utilization. The construction of large new infrastructure such as North Stream or TAP would not be necessary, therefore, at least in terms of economic logic. However, geo-political considerations, for instance, associated with bypassing some critical countries, are rather evident.

The principle carries over to other transportation networks, and may help in explaining some choices which are made, for example the ones taken in designing the BRI initiative.

Trade is based on cooperation, but trade needs transport infrastructure, where cooperation is, consequently, also necessary. If cooperation generates some mutual benefits, the pie of surplus has to be split in some way. This is where cooperative game theory, when applied to transport infrastructure, can shed some light.

Admittedly, research on network cooperative games, as well as the one on global transportation general equilibrium models, is still in its infancy. We can therefore conclude that the radically changing scenario of global trade flows poses new
challenges not only in terms of management and policies, but also in terms of the supporting applied economic research and modelling.

8.6. Some Concluding Remarks

Ten-T has been evolving from 1996 to 2013 trying to cope with the enlargement of the European Union and to encourage modal shifts from road and air to rail, inland navigation and short-sea shipping. However, during these notable efforts, little attention has been paid to the global dimension of European connectivity, which now demands a European contribution towards building a Trans-Global network, Twn-T.

Together with addressing a number of technical disruptions affecting transport and its infrastructure, the new wave of Ten-T revision — due by December 2023 — must depart from what has thus far been an introverted view of Europe as a single market (something that has often penalized European competitiveness) to an extroverted orientation of the Union as a key player in a global market.

The growing economic centrality of Asia since China’s accession to WTO; China’s strong interest in the Mediterranean Basin as the “super-hub” that connects four continents; and the eastward shift of the European economic barycentre: all of these developments indicate possible solutions for addressing the “geographical obsolescence” of the current Ten-T.

In parallel, innovation-driven disruption of the worldwide maritime freight transport network and its infrastructure necessitates the streamlining of port nodes and rail networks around the world, in a way that at the same time addresses efficiently the current “technological obsolescence” of big parts of European infrastructure, predominantly of ports.

But the new Ten-T Network evolving into a Twn-T one will not anymore be the product solely of European decisions: dovetailing Ten-T with China’s Belt and Road Initiative will be unavoidable.

Any dovetailing of Ten-T and BRI networks into a possible Twn-T network would profit a lot from the availability of sound methodologies for assessing the systemic consequences of changes in the Twn-T Network due to large infrastructure investments. Such methodologies do exist even if they are in their infancy. The construction of a global transportation general equilibrium model that could, among others, tackle the routing problem is within reach. The same can be said of methodologies used for analyzing bargaining games on network markets where the bargaining power of each agent (e.g., China or the EU) depends on its position in the network and its reliability in a cooperation scheme.
References


