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A 'European Silk Road'

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Abstract

- In this study we argue for a 'Big Push' in infrastructure investments in greater Europe. We propose the building of a European Silk Road, which connects the industrial centres in the west with the populous, but less developed regions in the east of the continent and thereby is meant to generate more growth and employment in the short term as well as in the medium and long term.

- After its completion, the European Silk Road would extend overland around **11,000 kilometres** on a northern route from Lisbon to Uralsk on the Russian-Kazakh border and on a southern route from Milan to Volgograd and Baku. Central parts are the route from Lyon to Moscow in the north and from Milan to Constanţa in the south. The southern route would link Central Europe with the Black Sea area and the Caspian Sea littoral states.

- A state-of-the-art motorway and high-speed railway line with a string of logistics centres, seaports, river ports and airports shall set new European standards, among others in e-mobility. The full extension would constitute around **EUR 1,000 billion** or approximately **8% of the gross domestic product** of the countries situated along its two routes. The costs relative to the EU's economic output amount to about 7%.

- According to a conservative estimate, the European Silk Road could lead to an **economic growth of 3.5% on average** and an **increase in employment of around 2 million** along its routes in the course of an investment period of 10 years. Under favourable circumstances and at continued low interest rates, an employment creation of over 7 million can be expected in greater Europe.

- The improved infrastructure of the key route could yield significant **time savings of over 8%** in road transport on the northern route into the central region of Russia alone. On average this would save approximately 2.5 hours, for instance from Vienna. Thus the countries along the northern route would be able to **increase their exports to Russia by more than 11%**. This would imply additional exports of over EUR 12.5 billion.

- The Austrian export industry would particularly benefit from these infrastructural measures. **Austria's exports to Russia would rise by over 14%**. This corresponds to about EUR 330 million. The **construction projects would create 34,000 jobs in Austria**. Under favourable conditions, up to 121,000 new jobs could be created in Austria.

Keywords: infrastructure, transportation, Europe, China, Silk Road, growth, industrialisation, international trade

JEL classification: H54, O18, R41, R42, L92

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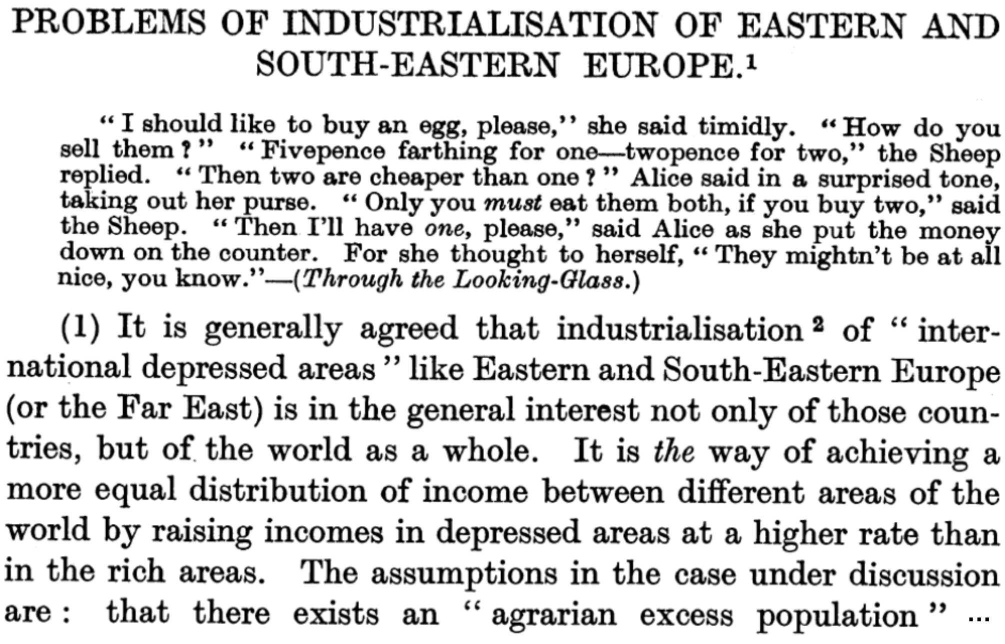
1. Introduction

The article of the Austrian economist Rosenstein-Rodan on the problems of industrialisation of Eastern and Southeastern Europe in the *Economic Journal* in 1943 is a ground-breaking economic publication about the economic advantages of large-scale infrastructure investments for the development of poorer countries in particular (Figure 1), because it became the basis for the so-called Big Push theory. The underlying idea is that a coordinated strong investment push, for example in the field of transport infrastructure, enables the simultaneous industrialisation of wide economic sectors (e.g. Rosenstein-Rodan, 1961; Sachs and Warner, 1999; Easterly, 2006). Such coordinated investments normally have a high economic benefit. Due to the high external effects, there are few incentives for the individual company looking for profits to invest in network infrastructure. An increasing number of empirical studies supports these ideas in the historical (Donaldson, 2018; Donaldson and Hornbeck, 2016) as well as the current context for developed as well as developing countries (Galiani et al., 2017; Baum-Snow et al., 2016; Holl, 2016).

Figure 1 / Rosenstein-Rodan's article as a basis for the Big Push theory



PROBLEMS OF INDUSTRIALISATION OF EASTERN AND SOUTH-EASTERN EUROPE.[1]

"I should like to buy an egg, please," she said timidly. "How do you sell them?" "Fivepence farthing for one—twopence for two," the Sheep replied. "Then two are cheaper than one?" Alice said in a surprised tone, taking out her purse. "Only you *must* eat them both, if you buy two," said the Sheep. "Then I'll have *one*, please," said Alice as she put the money down on the counter. For she thought to herself, "They mightn't be at all nice, you know."—(*Through the Looking-Glass.*)

(1) It is generally agreed that industrialisation [2] of "international depressed areas" like Eastern and South-Eastern Europe (or the Far East) is in the general interest not only of those countries, but of the world as a whole. It is *the* way of achieving a more equal distribution of income between different areas of the world by raising incomes in depressed areas at a higher rate than in the rich areas. The assumptions in the case under discussion are: that there exists an "agrarian excess population" ...

Source: Rosenstein-Rodan (1943).

Rosenstein-Rodan proposed the establishment of an Eastern European Industrial Trust (E.E.I.T.) to finance the Big Push. The capital of the fund was meant to be provided by the governments of Western and Eastern Europe. Creditor countries would have to be paid after 20 years. However, Rosenstein-Rodan emphasised that his article was less about the 'how' rather than the 'what' of a strong and coordinated investment push: 'Attention is confined here to what ought to be done rather than how it is to be done' (1943: p. 209). Our contribution to a European Silk Road should be understood as a follow-up to Rosenstein-Rodan's observations: as an initial intellectual proposal for a coordinated initiative relating to infrastructure development in greater Europe.

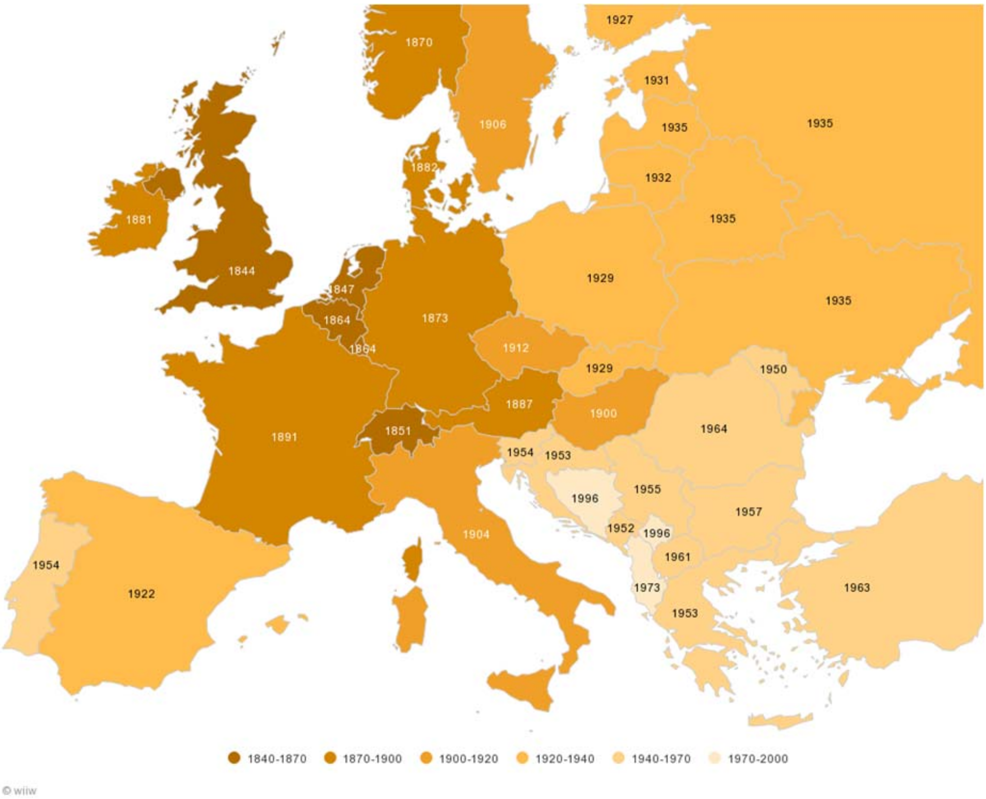
In the following, we first examine the significance of infrastructure investments in terms of economic history and then compare it with the present situation. This is followed by a short analysis on the Chinese initiative of the New Silk Road and then our own proposal for a European Silk Road. In section 5 we present calculations on current gaps in infrastructure in the EU and EFTA countries, as well as on infrastructure requirements in the other countries of greater Europe. In section 6 we estimate the investment costs of both the European Silk Road and the closing of the gap in the infrastructure in EU, EFTA and greater Europe. Subsequently, the effects of infrastructure investments on the short-, medium- and long-term growth are discussed, and then the effects of the construction of a European Silk Road on economic and employment growth are estimated. In addition, potential trade effects are calculated as well. The study ends with a short section on conclusions.

2. On the significance of infrastructure investments in terms of economic history

The provision of infrastructure has always played an important role in economic history to promote development, not least in the course of the (gradual) Industrial Revolution (Berend, 2012). Originating in the United Kingdom this new prosperity was able to spread only slowly from the northwest to the southeast of the European continent from the middle of the 19th century (Figure 2). Countries like Bosnia and Herzegovina or Kosovo were able to reach an income level of USD 4,000 GDP per head at purchasing power parities (PPP) only just before the turn of the millennium – 150 years after the United Kingdom, the motherland of the Industrial Revolution.

Figure 2 / The slow expansion of the Industrial Revolution

The year in which the GDP of USD 4,000 per head (at PPP and prices of 2011) was exceeded



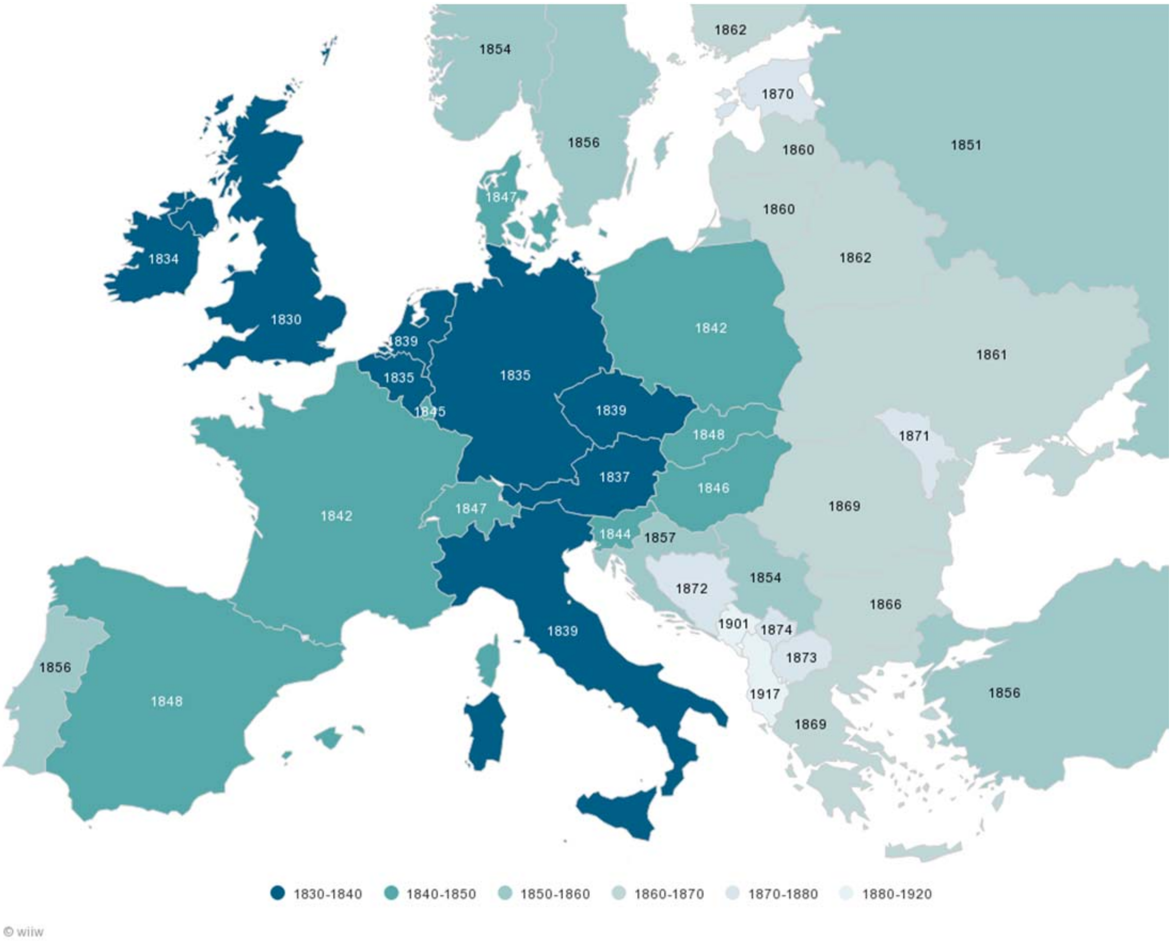
Note: Kosovo estimate based on wiiw data, Belgian observation for Luxembourg, Soviet observation for Russia, Latvia, Belarus and Ukraine, average of Czechoslovakia and Hungary for the Czech Republic, average of Czechoslovakia and the USSR for Slovakia, average of Finland and the USSR for Estonia, average of Poland and the USSR for Lithuania, average of Romania and the USSR for Moldavia.
Source: Maddison Project (rgdpnapc) January 2018, wiiw, own estimates, own visualisation.

Therefore, the geographical distance from London seems to have been an essential determinant of the industrialisation of Europe. A possibility to bridge the distance to London was the investment in transport infrastructure. Railway construction has decisively contributed to industrialisation. Even in this aspect, the development began in the United Kingdom (Figure 3).

The Liverpool and Manchester Railway was the first exclusively steam-powered railway line, which was opened on 15 September 1830. Similar to the development in productivity, the railway development across the European continent also took place gradually – from the northwest to the southeast. Albania was the last European country where a railway was built (by the Austrian-Hungarian army) in 1917. Nonetheless, some countries were able to counter their disadvantages caused by the geographic location through an early introduction of the railway. In the territory of today's Republic of Austria and Italy for instance, the first railway lines were constructed as early as the 1830s.

Figure 3 / Late introduction of the railway time in the Balkans

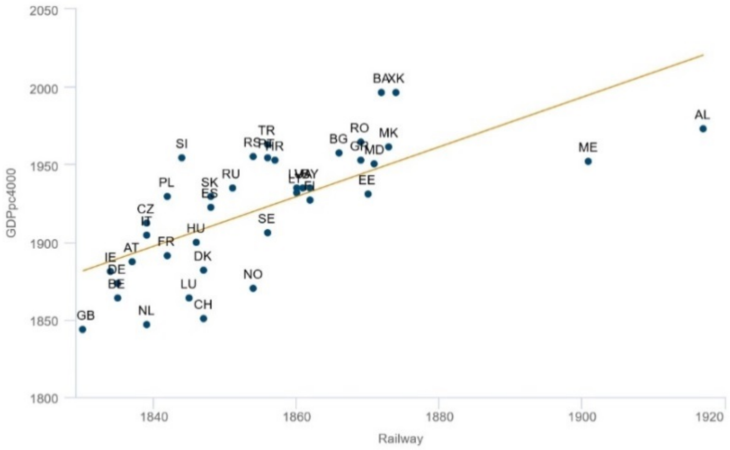
The year in which the first steam-powered railway line was opened



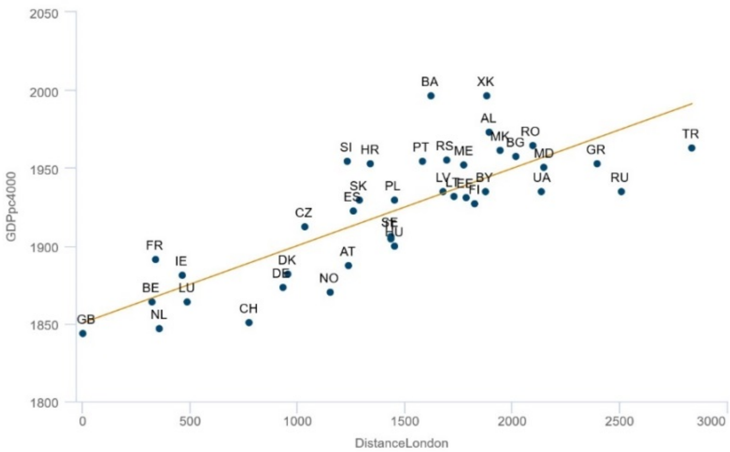
Source: Wikipedia, Wikimedia, FDV, own visualisation.

Figure 4 / The relationship between railway construction, industrialisation and geography

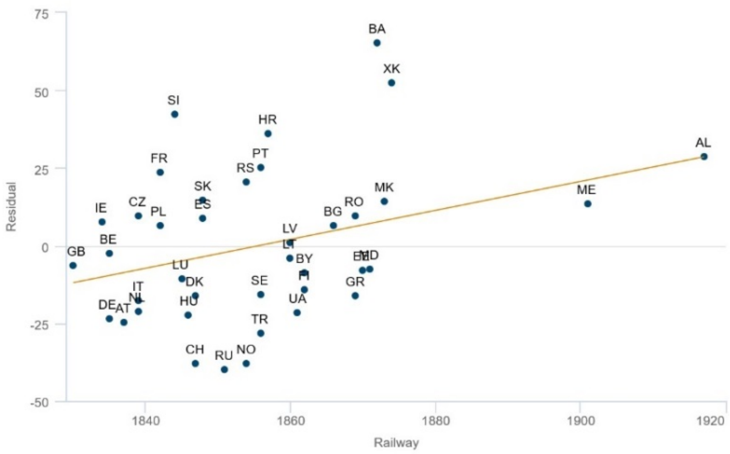
X-axis: year of introduction of the railway, y-axis: year of industrialisation



X-axis: distance from London in km, y-axis: year of industrialisation



X-axis: year of introduction of the railway, y-axis: delayed industrialisation in years with given distance from London



Note: Cross-sectional regressions for European countries, least squares method.
Source: Maddison Project (rgdpnapc) January 2018, wiiw, Wikipedia, Wikimedia, FDV, own estimates, own visualisation.

The causality between GDP development and railway construction surely went both ways – the construction of railway infrastructure increased economic performance, and a higher economic output encouraged further expansion of infrastructure. However, there are good reasons to assume that railway construction had a significant impact on the process of industrialisation and led this process (Berend, 2012). A range of descriptive scatter diagrams (Figure 4) is intended to substantiate this. In the upper part of Figure 4 one can see a strong positive connection between the time of the first railway construction and the crossing of an income level of USD 4,000 at PPP. In the middle part of the figure, one can see the closer and statistically highly significant linear relation between the year of industrialisation and the distance of the respective capital city from London.

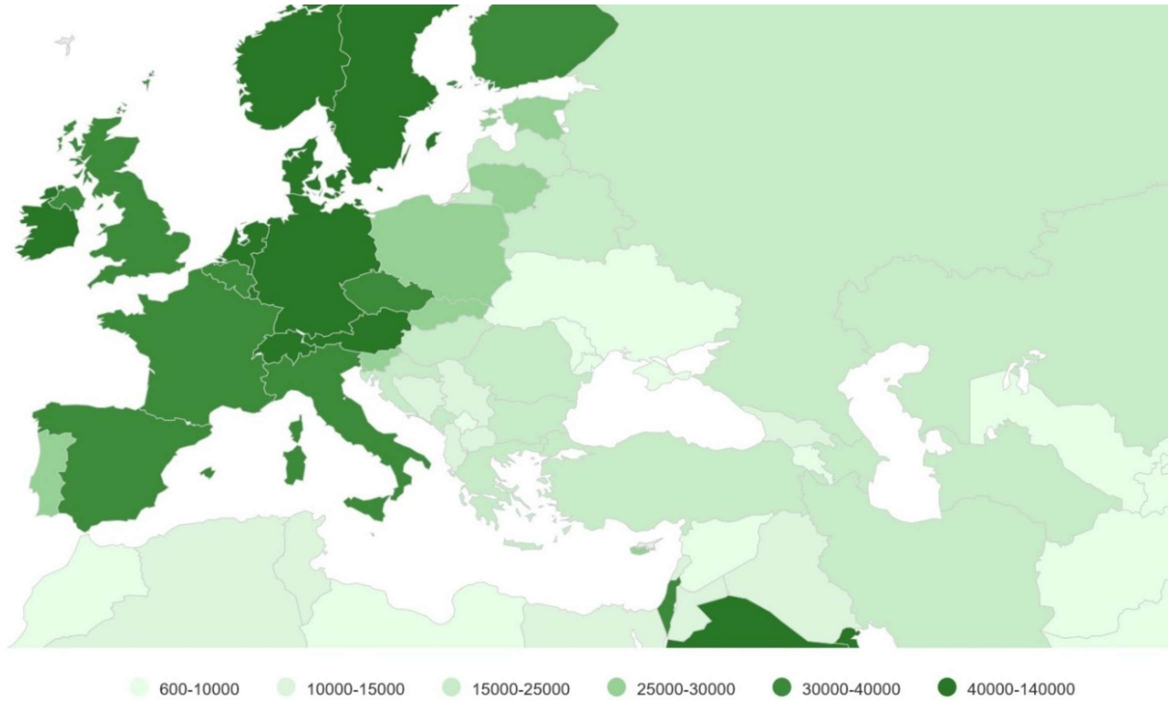
The question that arises, therefore, is whether both the year of industrialisation and the year of the introduction of the steam-powered railway can be described as a function of the geographic distance from London. In the following, we therefore want to clarify if the effect of the railway on industrialisation still has an impact after the effect of distance is deducted. For that, we take the residuals of the regression (that is, the vertical distance between point of observation and estimated regression line) of the previous link between time of industrialisation and distance and put them in relation to the time of introduction of the railway on the horizontal axis in the lower part of Figure 4. The vertical axis of the residuals can now be interpreted as years of delayed industrialisation (with given geographic distance to London). On average the 'early industrialisers' built their first railway line around 1850 and were able to industrialise two decades earlier than their distance from the United Kingdom would have suggested. The 'late industrialisers' had introduced the railway around 1860 and took two decades longer for their industrialisation than the distance of their capital to London would have led one to expect. Infrastructure is thus an opportunity to counteract the determinism of, generally speaking, an unfavourable geographic location.

Even more than 200 years after the beginning of the Industrial Revolution the significant income differentials between Europe's northwest and southeast largely remain as such. Even though Communism initially pushed industrialisation, decades of economics of shortage (Kornai, 1980) in the east of Europe eventually hindered the economic development and the expansion of a modern infrastructure.

While Northwestern Europe shows annual income levels of (way) beyond USD 30,000 per head at purchasing power parities, the majority of Southeastern Europe has to make do with a level of (clearly) below USD 25,000 (Figure 5). Some countries of the Western Balkans and in the Black Sea area often register only less than USD 10,000 or 15,000 GDP per head at PPP. Only a few countries of Eastern Central Europe (e.g. Slovenia, Slovakia, Poland), with a GDP per head of USD 25,000 to 30,000 at purchasing power parities, were able to catch up with the northwest of the continent.

Figure 5 / Large income disparities that exist in greater Europe even today

GDP per head in USD (at PPP and prices of 2011), 2016



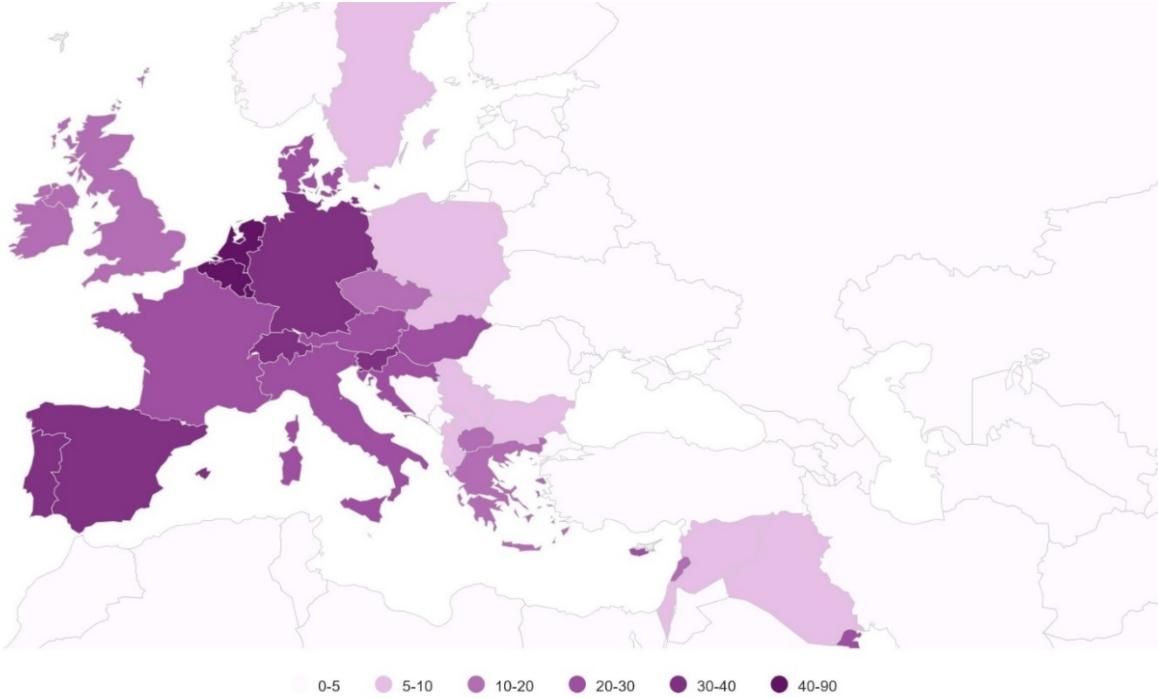
Source: Maddison Project (cgdppc) January 2018, wiiw, own estimates, own visualisation.

Similar to the previous development in steam trains, the distribution of modern infrastructure (e.g. high-speed trains or motorways) in greater Europe today is also characterised by a strong northwest-southeast divide. In many Member States of the European Union a motorway density of 20-30 kilometres per 1,000 km² land area can be observed (Figure 6). In the Benelux countries there are actually values far beyond 40 kilometres. In recent years even in individual countries of the Balkans a large extension of the motorway network partially caught up with the network density of Northwestern Europe. Along and to the east of the line from Tallinn to Bucharest, however, the motorway density decreases drastically to less than 5 kilometres per 1,000 km² land area. Some countries of Central Asia and Southeastern Europe have no motorways at all or have just started to build motorway sections.

Today, as 150 years ago, infrastructure investments, especially in the transport sector, have the potential to help reduce the differences of huge economic disparities in Europe and also facilitate more political integration. The construction measures can raise the economic growth in the short and medium term and strengthen productivity and market access in the long term (e.g. IMF, 2014). Cross-border infrastructural measures demand a cooperative behaviour of the governments involved and against this background, could moreover lead to more trust and political cooperation even in other fields. Last but not least, there exists a possibility to set new common standards in infrastructure development, which might gain supra-regional significance later on.

Figure 6 / Hardly any motorway in Eastern Europe

Kilometres of motorway per 1,000 square kilometres land area, last year of available data



Source: NationMaster, CIA World Factbook, World Development Indicators, Eurostat, Wikipedia, own estimates, own visualisation.

3. The Chinese 'New Silk Road'

The Chinese leadership has recognised the many advantages of large infrastructure investments for quite some time. Since 2013 and under the project name Belt and Road Initiative (BRI) or New Silk Road, it pursues the ambitious project to connect China with its neighbouring states, the Asian continent in general, and Africa and Europe with enhanced infrastructure by land and sea (Figure 7). The BRI routes are not described very precisely. But rather a variety of construction projects is carried out under the umbrella term 'New Silk Road', financed by Chinese banks, designed by Chinese construction companies and to a large part executed by Chinese workers with Chinese building materials. Accordingly, the cost estimates vary immensely; they range from around USD 1,000 billion up to USD 8,000 billion (Hurley et al., 2018). Admittedly, one should mention that even the highest estimations of, for instance, the BRI infrastructure investment costs amount to only a fraction of Asia's investment requirements, which according to the Asian Development Bank (ADB, 2017) amount to USD 26,000 billion between 2016 and 2030. Europe's reaction to the Chinese initiatives has so far been rather cautious.

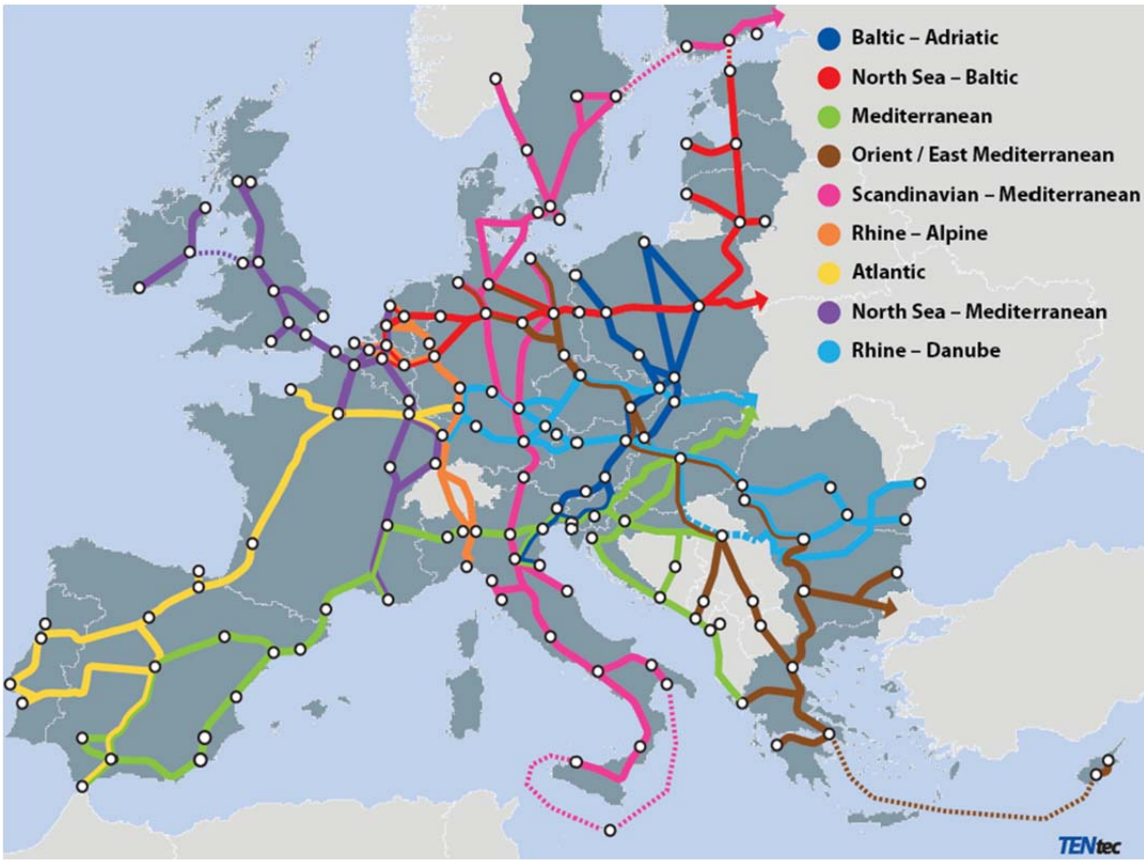
Figure 7 / China's Belt and Road Initiative – New Silk Road

Source: China Files.

The EU Parliament has identified opportunities as well as challenges in this regard (Steer Davies Gleave, 2018), and the European Commission has presented a new EU strategy for China (EC, 2016a; Council, 2016). It basically advocates cooperation with China, also within the framework of the BRI. The 'EU-China Connectivity Platform' shall take up synergies with EU initiatives. An expert group of the platform (2017) has for instance presented a short list of projects that are complementary to the BRI in the scope of the Trans-European Transport Networks (TEN-T). It contains for example seaport projects in Italy, inland waterway projects in Poland, intermodal terminals in Slovakia and motorways in Bulgaria. Altogether, however, the EU seems to still owe a concrete and comprehensive response to the BRI.

In addition, they also failed to do their homework with regard to the mentioned TEN-T networks within the EU. The initial plans for the TEN-T programme existed as early as 1990. Since then, a range of infrastructure corridors were defined (Figure 8) and infrastructure bottlenecks identified. The financing is largely borne on a national level, and accordingly the budget for infrastructure development along the TEN-T core networks is regularly cut, particularly in times of crisis. Relatively small allocations are received for the expansion of the TEN-T networks from the various EU coffers. In the current financial framework 2014-2020, subsidies[1] of EUR 22.4 billion are available from the Connecting Europe Facility (CEF), approximately 70 billion from the European Structural and Investment Funds (ESIFs) and around 21 billion in loans from the European Fund for Strategic Investments (EFSI) by the EU and the European Investment Bank (EIB). As measured by the estimated costs of the TEN-T core networks of EUR 750 billion, the current European efforts to improve the infrastructure in the EU will remain fragmented.

Figure 8 / EU: Slow expansion of the TEN-T networks since 1990



Source: European Commission.

Further east, the member states (Russia, Belarus, Kazakhstan, Kyrgyzstan, Armenia) of the Eurasian Economic Union (EAEU), have so far also expressed a willingness to cooperate.[2] Russia's President

1 https://ec.europa.eu/transport/themes/infrastructure/ten-t-guidelines/project-funding_en [24/06/2018]

2 http://greater-europe.org/archives/5464 [last accessed on 24/06/2018]

Putin even launched the idea of a Greater Eurasian Partnership in 2016.[3] But only little concrete progress has been made, and most of the projects have so far remained in the planning stage. Since a large part of the BRI projects are to go through the Central Asian and East European region, the transport corridors of the New Silk Road have been addressed in a somewhat more concrete manner.

A detailed study of the Eurasian Development Bank (EDB, 2018) is available on this topic. It assumes increased transit railway container traffic between China and the EU through the EAEU. The annual doubling of container trains happened in particular between 2013 and 2016, thanks to the immense subsidisation of this mode of transport by the Chinese authorities. In 2016, China's total transport subsidies in this sector were USD 88 million. The freight rate is almost zero. One can expect that an extension of transport subsidies through Chinese provinces will further increase the container traffic. The tenuous capacities of the Polish-Belarusian border crossing point have been identified by the EDB as one of the main obstacles for freight traffic on the trans-Eurasian transport corridors (Figure 9).

Figure 9 / The most important trans-Eurasian transport corridors

Source: EDB.

[3] http://russiancouncil.ru/en/blogs/frankywongk/a-comparative-study-of-the-greater-eurasian-partnership-the-chinese-an/ [last accessed on 24/06/2018]

4. Proposal of a European Silk Road

It should be noted that Europe has so far been rather passive with regard to China's large infrastructure initiative and had little to counter (Steer Davies Gleave, 2018). But major infrastructure gaps need to be filled and income disparities compensated, particularly in the east of the continent. Moreover, it would also be in Western Europe's interest to expand its eastern neighbourhood markets with the aid of modern transport infrastructure. The market potentials of this neighbourhood are huge. The wider region is home to roughly 480 million people, which are almost as many inhabitants as in the EU (510 million). However, they have only about half the income of the Member States of the European Union. These include the inhabitants of the Western Balkans and the European Free Trade Association (EFTA) with approximately 30 million people; the population of the former European republics of the Soviet Union with around 200 million; the inhabitants of the Central Asian and Caucasus republics with almost 90 million; and the remaining Black Sea and Caspian Sea littoral states – Turkey and Iran – with 80 million respectively.

To link the industrial centres of Western Europe with these populous, but underdeveloped regions in the near neighbourhood in a better way should also be of mutual interest and lead to a more widespread economic integration and enhanced political cooperation in greater Europe, independent of China's BRI initiative[4]. Further, a European Silk Road could also define the future access points to East Asia and thereby rather complement China's New Silk Road instead of competing with it.

Such a European Silk Road could possibly have two main routes, which in essence will connect the centres of Western European industry with the eastern neighbourhood in greater Europe (Figure 10). A northern route could reasonably start from Lyon. Lyon is an old French industrial centre, as well as an important transport and logistics hub. The route could go via Paris, Brussels and the southern Netherlands directly to the most densely populated metropolitan region of Germany in the Rhine-Ruhr area. It is also home to the port of Duisburg, which is one of the world's largest inland ports and one of the most significant logistics centres in the northwest of the continent. The key course of the northern route could then go via Berlin, Warsaw and Minsk to Moscow. In the southwest, extensions could go from Lyon via Barcelona to Madrid and Lisbon and in the east from Moscow via Nizhny Novgorod and Samara to the Russian-Kazakh border town of Uralsk.

A southern route of the European Silk Road could have its starting point in the Milan metropolitan region, the largest Italian urban agglomeration and economic centre of the country. The southern route on its key stretch could continue via Zurich and the industrially developed southern German region along the Danube valley via Vienna and Budapest to Bucharest and the port of Constanta on the Black Sea. From there, two extensions could on the one hand lead by sea via the Russian port of Novorossiysk to Volgograd and on the other hand via the Georgian port of Poti and Tbilisi to Baku on the Caspian Sea.

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4 Even though not fully understood, there exists a significant theoretical and empirical literature which substantiates that trade minimises the risk of conflicts (Philippe et al., 2008, 2012; Håvard et al., 2010; Han and Ward, 2010).

Figure 10 / Proposal of a European Silk Road on a northern and southern route

Source: GEOATLAS.com, own route design.

As can be seen in the comparison of Figure 10 with Figure 9, the northern route of the European Silk Road would connect to the northern and central Eurasian corridor, while the southern route would link the international north-south corridor and the trans-Asian corridor. In the bottom branch of expansion the route would also overlap with the Europe-Caucasus-Asia transport corridor (TRACECA) supported by the EU since the beginning of the 1990s. The route crossing the Caucasus has been identified as being particularly in need of expansion (TRACECA IDEA, 2008).

The key course of the northern route is about 3,400 kilometres, and together with the expansions 6,700 kilometres. The southern stretch is shorter: it essentially covers 2,500 kilometres, and along with the extensions on land comes to 4,300 kilometres. The total distances on land come to around 11,000 kilometres in greater Europe. It would be reasonable to equip these routes with both high-speed rail links and efficient motorways, which, in contrast to the existing system, will bypasses the local traffic and run in an express system on a higher level and would indeed be European. For that, a string of logistics centres, seaports, river ports and airports would have to be constructed to ensure a contemporary multimodal traffic. The project would also help to set new pan-European standards in technology and environmental protection along the route and beyond. Solutions for future e-mobility and driverless vehicles, especially for the motorway and related areas would have to be found.

5. Further infrastructure potentials

Apart from the visionary Silk Road projects, Figure 6 has shown that the existing infrastructure in Europe is very unequally distributed. There exist major gaps in infrastructure. In the following, we identify and present them, first for the countries of the EU and EFTA and subsequently for the other countries of greater Europe situated further east.

5.1. INFRASTRUCTURE GAPS IN AUSTRIA, THE EU AND EFTA

In order to clarify which areas of public infrastructure are potentially in need of investment, this section focuses on the examination of the existing infrastructure based on available (physical) data for the sectors rail, road, telecommunications, energy and health. The selection of the country group includes the EU-28 countries plus Norway and Switzerland, for which comparable indicators are available. The used set of data therefore contains the following countries: Belgium, Bulgaria, Denmark, Germany, Estonia, Finland, France, Greece, UK, Ireland, Italy, Croatia, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Austria, Poland, Portugal, Romania, Sweden, Slovakia, Slovenia, Spain, Czech Republic, Hungary, Cyprus, Norway and Switzerland. Even though, in contrast to all other countries, the two latter countries are not EU members, they have been integrated in the data set of the following analysis due to their high level of development and their geographic proximity.

Table 1 / Infrastructure data

Infrastructure variable	Unit	Data source	Number of countries
Rail			
High-speed railway lines[5]	Kilometres	IUR	30
Electrified railway lines	Kilometres	Eurostat	27
Road			
Total road sections	Kilometres	Eurostat	28
Motorway sections	Kilometres	Eurostat	27
Telecommunications			
Broadband (from 100 MBit/s)	Fixed connections	Digital Scoreboard (Commission)	28
Energy			
Power lines (400 kV)	Kilometres	ENTSOE	23
Net electricity generation capacity	Megawatts	ENTSOE	28
Health			
Hospital beds	Number	OECD	28

Notes: ENTSOE – European Network of Transmission System Operators for Electricity. IUR – International Union of Railways.

5 According to the data by the IUR, high-speed tracks are characterised by the fact that trains can run on them at a speed of more than 250 km/h.

Table 1 contains the infrastructure data included in the analysis. The data set provides a cross-sectional analysis; the development of the listed infrastructure variables is not compared over time, but between the countries based on the data point existing for the last available year (as a rule 2015). It is evident from Table 1 that data is not available in all five categories for each of the 30 European countries. While, for instance, comparable data is only available for 23 countries for the length of the power lines, there is data available on the total length of road in kilometres for 28 countries.

The methodological approach is based on measuring the potentials in subsections of the infrastructure as a distance from the European average (using linear regressions). The average of the used country group, consisting of 30 countries, is therefore set as a standard by which the existing infrastructure of the respective European country can be compared. Obviously, another benchmark could be set – for example by taking the top performers in a particular infrastructure category as an orientation – to determine the infrastructural potential. Taking the countries with the quantitatively most developed infrastructure in the respective area as an orientation would generally entail a greater need for public investment than the comparison with the average of the country group.

Here, a regression approach is adopted as a method. For example, the length of the high-speed railway line (in kilometres) is first divided by the area of the respective country in order to make the data comparable across different countries. This variable is then explained by means of three factors. First, the gross domestic product per capita is used as an indicator of the level of development; second, demographic and geographical differences are checked on the basis of population density; and third, an indicator is used to display the ruggedness of the terrain in each country[6], so that topographical differences are also checked. Therefore, the equation to be estimated generally has the following form:

$$INFRA_i = GDP\ per\ capita_i + population\ density_i + terrain\ conditions_i + residual_i$$

Here, $INFRA_i$ is the respective infrastructure variable (e.g., high-speed railway line or broadband connections) that is related either to the area of the country (e.g., high-speed railway) or to the population (e.g., broadband connections) to ensure comparability between countries. The sub-index i refers to the data of the respective country i.

The displayed equation is estimated for all infrastructure variables listed in Table 3. The estimate yields a residual value for each country – that part of the infrastructure data that cannot be explained by the regression and that indicates the distance from the linear regression line. The residual for the respective European country resulting from the estimates is then used for the respective infrastructure variable to assess whether, for example, the existing Austrian infrastructure shows a gap in the European comparison, which would appear as a negative residual value. The residual value can thus be interpreted as an indicator of the infrastructure investment potential.

Subsequently, the results for Austria are discussed in detail, and then additional results for other European countries are presented. A summary of the relevant infrastructure potentials for Austria can be seen in Table 2. Negative residual values indicate that Austria shows investment potential in the

6 For a country such as Austria, characterised by a mountainous and rugged terrain, this ruggedness indicator has a significantly higher value than for countries like the Netherlands or Germany. The data is available at: http://diegopuga.org/data/rugged/

respective infrastructure category, because the existing infrastructure falls short of the average calculated by the regression analysis.[7]

Using the same method, infrastructure potentials can be observed in three areas: high-speed railway lines, motorways and net electricity generation capacity. Here, the Austrian values are below the estimated regression line (compared to the EU/EFTA average and at the given economic stage of development, population density and terrain conditions). In high-speed railway lines, the estimation results indicate an investment gap amounting to approximately 170 kilometres. In the motorways field the gap is around 460 kilometres. And in the area of net electricity generation capacity, Austria's intermittent distance from the regression line amounts to about 3,600 megawatts. In all other areas – electrified railway kilometres, total road sections, broadband, power lines (400 kV) and hospital beds – the used method did not reveal any investment gaps for Austria.

Table 2 / Estimated infrastructure potentials in Austria (rounded)

Infrastructure variable	Residual	Unit
Rail		
High-speed railway lines	-170	Kilometres
Electrified railway lines	990	Kilometres
Road		
Total road sections	500	Kilometres
Motorway sections	-460	Kilometres
Telecommunications		
Broadband (from 100 MBit/s)	42,950	Fixed connections
Energy		
Power lines (400 kV)	40	Kilometres
Net electricity generation capacity	-3,600	Megawatts
Health		
Hospital beds	23,250	Number

Note: negative value = infrastructure potential
Source: own estimates.

In the same way as for Austria, the infrastructure potentials can also be calculated for the other 29 European countries in the data set from the linear regressions on the basis of residual values. Table 3 shows the results for all countries. Negative residual values that indicate investment potential in the respective infrastructure sector are marked in green. Prima facie it is obvious that the number of areas with a gap in investment differs significantly in inter-country comparison. Therefore the regression results shown here point to investment potentials, in Poland for instance for six variables, whereas in Germany only in one field. If adopting the country typology by Gräbner et al. (2018), which groups 26 EU countries based on their macroeconomic reaction to the rising economic and financial openness due to EU integration, we find that the peripheral EU countries on average show investment potentials in approximately 3.7 of eight variables, followed by the catching up national economies in Eastern and Southeastern Europe (3.5 variables), the core EU countries (3.2 variables) and the financialised countries (2.5 variables), where the financial sector plays a special role (see Figure 11 that also lists in the figure footer text which EU countries are allocated to which of the four groups of countries).

7 Positive residual values can be interpreted in such a way that Austria is above the average of the country group determined by means of regression.

Table 3 / Estimated infrastructure potentials in 30 European countries (residual values, rounded)

Country	HR (km)	ER (km)	TR (km)	MW (km)	BB (connect.)	PL (km)	NE (mW)	HB (number)
Belgium	100	750	-1	220	144,810	-410	4,980	14,220
Bulgaria		1,630	-1,310	-410	-102,080	-260	2,950	11,430
Czech Republic		1,130	-220	-670	-172,600	1,120	5,050	11,010
Denmark		-1,050	-170	170	-196,290	210	-2,940	-11,780
Germany	370	22,670		820	-1,661,590	5,310	14,670	262,580
Estonia		-250	1,190	2	-36,300		670	-560
Ireland		-900	270	290	72,900		1,600	-13,590
Greece		-2,150			-30,180	550	-4,030	-11,420
Spain	1. 610	-2,580	-5,130	6,650	34,600	6,680	4,850	-103,600
France	470	-4,400	880	-1,500	-364,900	2,060	-33,700	76,440
Croatia		160	-500	690	-104,210	-150	-1,930	1,940
Italy	70	-1,330	-1,790	-3,300	-522,650	-2,700	5,190	
Cyprus			40	50	-6,060		8	-1,530
Latvia		-210	730		109,410		-280	440
Lithuania		-520	730	8	-30,400	-1,120	-830	5,330
Luxembourg		70	-20	40	-11,210		-750	630
Hungary		1,210	350	620	-228,510	520	-4,440	14,680
Malta			2		3,050			-260
Netherlands	-60	-1,700	-220	-90	328,690		15,570	
Austria	-170	990	500	-460	42,950	40	-3,600	23,250
Poland	-570	5,050	-1,820	-2,880	-1,147,630	-2,730	-7,590	42,010
Portugal		-550	-1,210	1,520	357,520	-120	790	-20,800
Romania		420	-2,490	-2,060	600,490	-1,170	-6,470	23,750
Slovenia		20	150	390	3,700	20	-330	-1,550
Slovakia		480	-280	-410	-9,980	150	-560	2,010
Finland		-2,360	500	-1,280	80,650	-600	960	-2,250
Sweden	-240	-1,510	2,300	-2,320	708,350	3,170	5,380	-21,880
UK	-680	-8,340	-1,920	-5,440	-1,453,390	550	-48,570	-148,660
Norway		-9,010	2,400	-6,050		-4,770	8,970	-2,380
Switzerland	10		210					3,830

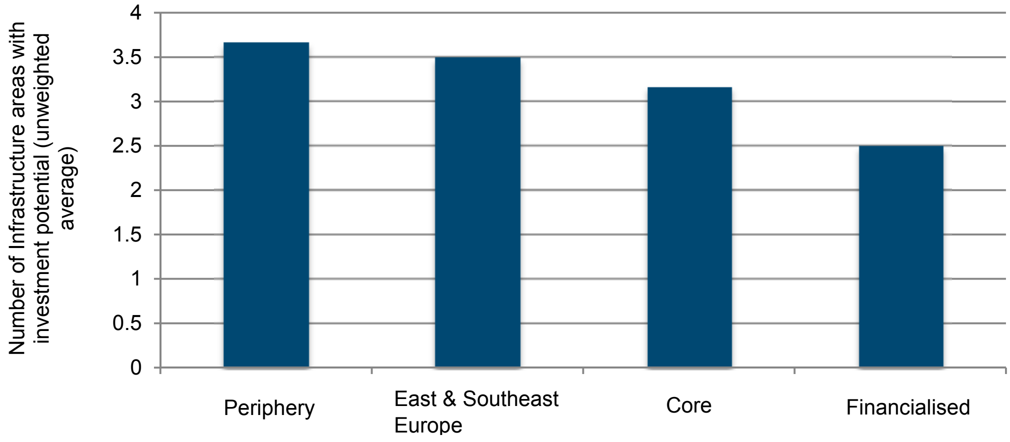
Data: See Table 1; own calculations. HR – high-speed rails (in kilometres), ER – electrified railway lines (in kilometres), TR – total road sections (in kilometres), MW – motorway sections (in kilometres), BB – broadband (fixed connections), PL – 400 KV power lines (in kilometres), NE – net electricity generation capacity (megawatts), HB – hospital beds (number). Negative values (in green) show investment potential.

To enable a better overview of the differences in investment potential when comparing the groups of countries, Table 4 compares the average of residual values for the respective country group – considering the population figures or the land area respectively to achieve comparability between the countries.[8] It is clearly evident that the investment need is the lowest in the core countries. In fact, a negative investment gap can only be seen in the scope of motorways in the average of residual values of this country group. This result seems plausible, considering that investment potentials are measured here by means of deviations from the European average. As the core countries belong to the

[8] Here, the respective infrastructure variable (e.g. high-speed lines) is related to the underlying regressions, either to the surface area of the country or to the number of inhabitants in order to ensure comparability between the countries (e.g. high-speed line kilometres in relation to the area of the country; broadband connections in relation to the population).

economically most advanced countries with well-developed infrastructure compared to other European countries, the averages of the residual values for the core countries naturally only refer to minor gaps in investment.

Figure 11 / Number of infrastructure variables with investment gap (negative residual)



Data: Analysis based on the results in Table 3. Periphery: Cyprus, France, Greece, Italy, Portugal and Spain. East and Southeast Europe: Bulgaria, Romania, Czech Republic, Estonia, Latvia, Lithuania, Hungary, Poland, Slovenia, Slovakia. Core: Austria, Belgium, Denmark, Finland, Germany, Sweden. Financialised: Luxembourg, the Netherlands, Malta, Ireland.

The investment gaps are most substantial in the periphery, as well as in Eastern and Southeastern Europe. In the periphery, the major negative residuals appear in the areas of electrified railway lines, total road sections and hospital beds. This implies that public investments in the road and rail infrastructure, as well as in the hospital sector could close gaps in these countries compared to the European average. In Eastern and Southeastern Europe the infrastructure potentials in the high-speed rail, motorway, broadband and power line areas are particularly marked. These figures indicate that in Eastern Europe public investments in the infrastructure sectors of rail (high-speed), road (motorways), telecommunications and energy would be most constructive to achieve the European average. In the financialised countries the results in Table 4 mainly show potentials in the field of rail infrastructure.

Table 4 / Residual values (considering population figures or land area respectively to achieve comparability between the countries)

Area	Periphery	East and Southeast Europe	Core	Financialised
HR	1.378	-1.830	0.397	-1.382
ER	-7.723	5.381	10.880	-8.546
TR	-4.665	2.334	1.693	-0.765
MW	4.274	-1.374	-0.133	5.862
BB	1.883	-3.630	8.289	5.591
PL	2.062	-1.167	1.981	
NE	-0.100	-0.028	0.068	-0.017
HB	-1.191	0.771	0.405	-0.793

Data: See Table 2; own calculations. HR – high-speed rail (km / 1,000 km² area), ER – electrified railway lines (km / 1,000 km² area), TR – total road sections (km / 1,000 km² area), MW – motorway sections (km / 1,000 km² area), BB – broadband (connections / 1,000 inhabitants), PL – power lines (km / 1,000 km² area), NE – net electricity generation capacity (MW / 1,000 inhabitants), HB – hospital beds (number / 1,000 inhabitants). Negative values (in green) show investment potential. Periphery: Cyprus, France, Greece, Italy, Portugal, Spain. East and Southeast Europe: Bulgaria, Romania, Czech Republic, Estonia, Latvia, Lithuania, Hungary, Poland, Slovenia, Slovakia. Core: Austria, Belgium, Denmark, Finland, Germany, Sweden. Financialised: Luxembourg, the Netherlands, Malta, Ireland.

5.2. INFRASTRUCTURAL NEEDS IN GREATER EUROPE

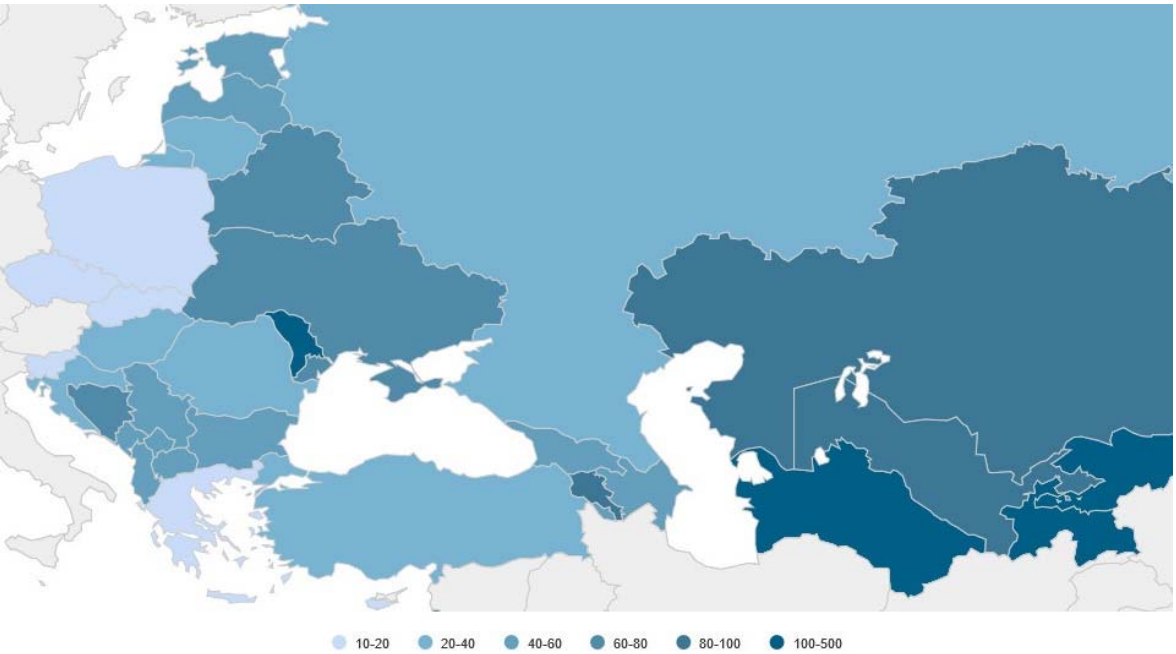
As the previous analysis has shown, the requirement in new infrastructure increases when advancing to the east of the European continent. This is also corroborated by estimates by the European Bank for Reconstruction and Development (EBRD). Here, the infrastructural needs both for replacement investments and investments for future growth as well as the catch-up investments were calculated for a number of countries in Eastern Europe and the European neighbourhood. The catch-up investments on average comprise more than half of the estimated infrastructure requirements. This is followed by replacement and maintenance investments with more than a third and by those investments that are necessary in the coming years to maintain the growth of the gross domestic product and population with around 15%.

Figure 12 shows the annual total infrastructure investment need for the years ahead in percentage of gross domestic product as estimated by the EBRD. There are high infrastructural requirements in the range of annually 40% to 80% of the GDP in the Balkans, in the western regions of the former Soviet Union and in the Caucasus. In the Central Asian republics of the former Soviet Union the infrastructural needs are especially high with over 80%, sometimes even crossing 100% of the GDP.

A breakdown of the infrastructural requirements by sectors (Figure 13) provides a good understanding. The largest gaps in infrastructure are seen in the transport sector, followed by the power sector. The requirements are relatively low in the ICT, as well as water and waste water infrastructure. In the entire region, except for Kyrgyzstan, Belarus, Tajikistan, Albania and Turkey, the need for transport infrastructure greatly exceeds 50% of the total need. Therefore, a Big Push in infrastructure investments would be particularly advantageous in this field.

Figure 12 / Very high infrastructure investment potential in the east of Europe and beyond

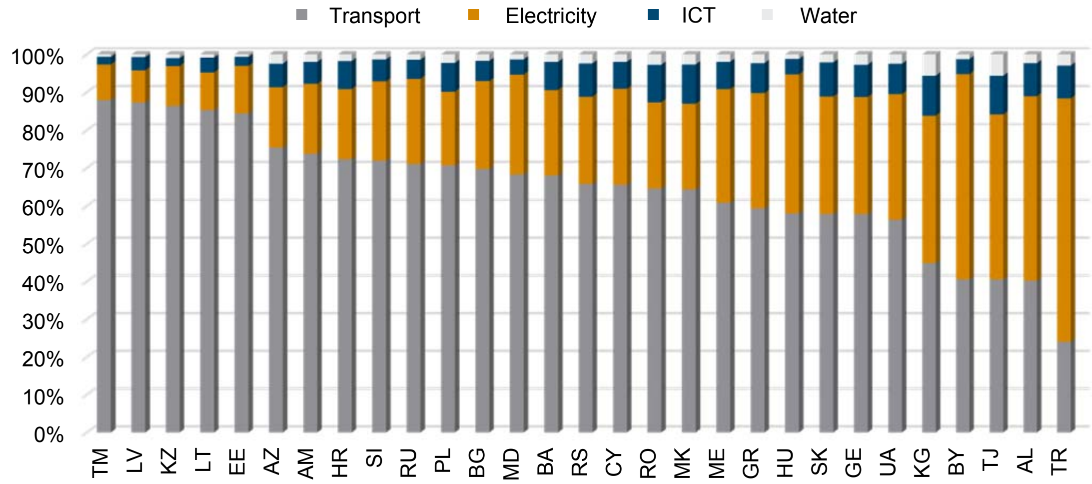
Estimated annual infrastructural requirements for the period 2018-2022, in % of the GDP 2015



Note: Slovakian value for the Czech Republic, Macedonian value for Kosovo, Kazakh value for Uzbekistan.
Source: EBRD (2017), own estimates, own visualisation.

Figure 13 / Largest infrastructure gaps in the transportation sector

Estimated infrastructural needs by sector for the period 2018-2022, in % of the total requirement



Source: EBRD (2017), own visualisation.

6. Estimation of the investment costs

In the following we try to estimate the potential investment costs of both the European Silk Road and the investment gaps in EU and EFTA, as well as of investment requirements in the other countries of greater Europe. In this connection, it is worth noting that due to the variety of the different infrastructure investment projects and the diverse calculation methodologies for average project costs, the comparative values on an international level are not very useful. We therefore base the majority of the following calculations on the very detailed unit costs of the so-called SP-V guidance of the Austrian Ministry of Transport, Innovation and Technology (BMVIT, 2006: p. 51).

We have converted these values for several kinds of rail and road infrastructure construction into prices for 2017 with the aid of the building price index for civil engineering of the Austrian Office for Statistics. Compared to other European projects (ECA, 2013) these yield very high unit costs, for example EUR 33 million for the new construction of a motorway with a tunnel section of less than 50%, or EUR 67 million for each constructed kilometre for a new two-track railway line with tunnel system. These are quite conservative cost estimates on the upper margin. The costs of similar projects in other countries are often only half or a quarter of those in Austria. The terrain and pricing level play a decisive role in the cost differences. We can check the latter and apportion the Austrian unit cost rates to the other examined countries. For that, we use the price level indices for civil engineering works published by Eurostat.

Table 5 shows the resulting costs in EUR million depending on the section of the 'European Silk Road'. Furthermore, a rough cost estimate was carried out for 5 seaports, 10 river ports, 6 airports and 12 logistics centres along the route. To enable a conservative estimation, we deliberately assumed very high cost rates here as well. Seaports were calculated with a unit rate of EUR 7 billion[9], river ports with half. Airports were estimated with EUR 10 billion[10]. The cost of the logistics centres was based on the area of the Duisburg logistics centre with the German unit costs for large warehouses and distribution centres according to Turner & Townsend (2017) and estimated with EUR 2.12 billion. The total cost of both routes of the European Silk Road thus add up to an investment volume of approximately EUR 1,000 billion or almost 8% of the gross domestic product of the concerned countries. If the costs are allocated to the EU's GDP, we get around 7%. With EUR 1,000 billion, the European Silk Road would be at the lower end of cost estimates of the Chinese New Silk Road.

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9 Approximately the costs for the new Doha harbour according to: http://www.constructionweekonline.com/article-9412-top-10-port-projects/8/

10 Current estimates for the Berlin airport.

Table 5 / Cost estimate of the European Silk Road

	(Rounded to 100)	Distance km	Motorway EUR mill.	Railway EUR mill.
Northern route	Lyon-Moscow	3,400	98,500	200,400
	Extension Lisbon	1,900	49,800	101,000
	Extension Uralsk	1,400	26,100	53,700
	Total northern route	6,700	174,300	355,200
Southern route	Milan-Constanta	2,500	69,900	141,800
	Extension Volgograd	900	17,100	35,300
	Extension Baku	900	14,600	30,100
	Total southern route	4,300	101,600	207,200

North & south	Total distance km	Motorway EUR mill.	Railway EUR mill.	Road & railway EUR mill.
	11,000	275,900	562,400	838,200

North & south	5 seaports EUR mill.	10 river ports EUR mill.	6 airports EUR mill.	12 logistics centres EUR mill.
	35,000	35,000	60,000	25,400

TOTAL EUR mill.	TOTAL in % of the GDP of concerned countries	TOTAL in % of the EU's GDP
993,700	**7.6**	**6.7**

Source: Own calculations.

Similar to the European Silk Road, the unit costs for the estimated gaps in infrastructure in the EU as well as Norway and Switzerland were estimated and used to calculate the total costs for closing the gap in the (Western) European infrastructure. In addition to the previous estimates for the unit costs of motorway and high-speed railway lines, the unit costs of the SP-V guidance for the two-track extension of the existing railway lines and the new construction of a bypass road with a tunnel section of approximately 50% were assumed to be EUR 13 million per kilometre for the electrified railway lines and the entire road network at current prices. The costs for fixed broadband connections in the range from 100 Mbit/s were based on information by WIK-Consult and WIFO (2017). The highest ever investment costs per newly provided residence in Lower Austria South with almost EUR 4,000 were used here. For the costs of one kilometre of 400 KV power lines, the high average costs of about EUR 5 million per kilometre were used according to APG (2015) for erecting this infrastructure in the Vienna region. In the net electricity generation capacities per megawatt, costs of around EUR 4.5 million were calculated according to Energie Steiermark (2014) for the River Mur power plant. Based on the current estimates[11] for hospital beds, the average values of approximately EUR 2 million per hospital bed were estimated for the Vienna North Hospital. With the help of the Eurostat price level index for civil engineering, all Austrian values were in turn applied to the examined countries.

[11] https://www.krone.at/1676064

Overall, the total costs for closing the gaps in infrastructure amount to EUR 2,900 billion, or almost 18% of the GDP of EU, Norway and Switzerland. The total costs for Austria would be about EUR 43 billion or slightly lower than 12% of the GDP. These investment volumes would enable all EU countries (plus Norway and Switzerland) to come near the current average in the various infrastructure sectors. An ambitious goal, which is certainly not strictly necessary in many cases on account of national peculiarities, because other, better solutions have been found, for instance in network organisation, which can compensate for drawbacks in quantity through quality. Therefore, these estimates are indicative and need to be considered as a potential ceiling for reasonable infrastructure investments in this area.

Table 6 / Cost estimate of closing infrastructure gaps in the EU, Norway and Switzerland

High-speed railway line	**Electrified railway line**	**Total road length**	**Motorway section**
EUR mill.	EUR mill.	EUR mill.	EUR mill.
112,500	515,800	154,500	900,600

Fixed broadband connection	**400 KV power line**	**Net electricity generation capacity**	**Hospital beds**
EUR mill.	EUR mill.	EUR mill.	EUR mill.
23,400	66,400	516,900	609,400

TOTAL	**TOTAL**
EUR mill.	**in % GDP EU + NO & CH**
2,899,400	**17.8**

Source: Own calculations.

Finally, if we take the EBRD estimates for non-EU and EFTA Europe and for the Caucasus and Central Asian countries as a base for their infrastructural requirements in the transportation, energy, ICT and water areas, these result in investment costs of EUR 1,147 billion for the coming years (2018-2022). With 43% of the GDP of the concerned countries, these are quite high. When adding the costs of the European Silk Road to the costs of closing the infrastructure gaps in the EU and the infrastructure investment requirement in the other countries of greater Europe, one gets a total sum of around EUR 5,000 billion. But even this high amount is still far below the highest estimates for the Chinese BRI initiative with approximately EUR 7,000 billion.

7. Economic effects of the infrastructure investments

The first part examines the effects on GDP and employment growth with regard to the economic effects of the discussed infrastructure investments and the second part assesses possible trade effects.

7.1. SHORT- AND MEDIUM-TERM GROWTH EFFECTS

This section presents empirical estimates and provides answers to the question of short-, medium- and long-term growth effects of public investments. We first focus on the short- and mid-term growth effects of changes in public investment activities. Distinctions are also made with regard to economic cycles and the interest rate environment. This is followed by an evaluation of the long-term (supply-side) effects of public infrastructure on the aggregated output to enable qualified assessments of the social benefits of public investments.

A wide range of expert literature deals with the effects of public investments on economic growth and employment (e.g. Pereira and Andraz, 2013; IMF, 2014; EC, 2016b; Revoltella et al., 2016). The existing studies are based on different country groups comprising developed and developing countries in varying periods (Pereira and Andraz, 2013: pp. 13-28). The estimates presented below concentrate on the EU-15 country group: Belgium, Denmark, Germany, Ireland, Greece, Spain, France, Italy, Luxembourg, the Netherlands, Austria, Portugal, Finland, Sweden and UK. Most of the EU-15 Member States have a similar level of development as Austria. Even though this country group is not homogenous, it seems most appropriate to include the EU-15 as a group of developed national economies in the study, which means the exclusion of 'less developed' countries that can barely be compared with Austria. The examined period covers the years 1970-2015, where the availability of data specifies the time limitation; for the used series of data go back only till 1970 for most countries included in the data set.

To assess the macroeconomic effects of public investments, the methodology initially applied by the International Monetary Fund in the World Economic Outlook (2014) can be used.[12] The basic idea is to estimate the effects of changes in public investments (measured in relation to the gross domestic product) on the real economic output by modelling the 'investment shock' on future changes in the GDP that originates from changes in the public investment activities with the aid of the following equation:

$$y_{i,t+k} - y_{i,t} = \alpha^k{}_i + \gamma^k{}_t + \beta^k PINV + \varepsilon^k{}_{i,t}$$

Here, y stands for the natural logarithm of the real GDP; $y_{i,t+k} - y_{i,t}$ is then defined as the cumulative change from time *t* to time *t+k* of the natural logarithm of the real GDP multiplied by 100; α_i are fixed effects at national level that are included to check for country-specific peculiarities; γ_t are fixed effects with regard to time that enable the control of global shocks that affect all the countries in the same way; β represents the estimated coefficient that maps the severity of the effect on the economic performance

12 See also Abiad et al. (2015).

if there is a change in public investments (PINV); and $\varepsilon_{i,t}$ is the error term.[13] The regression equation is estimated here for *k=5* (future) years.

From a methodological point of view, the estimation of the regression equation (3) is based on so-called ‘local projections’ (Jorda, 2005). The method relies on estimating a series of *k* regressions to capture the effect of a ‘shock’ (in this case, the variable for public investments) on the future change of a dependent variable (here, the real GDP).[14] The specification of five years (k=5) allows for the assessment of the dynamic influence of public investments on economic performance in the short and medium term.

The data included in the analysis originates from the European Commission AMECO database. The economic output (y) is measured by means of the real GDP (at constant prices of 2010). The variable PINV measures public investments based on annual changes of real gross fixed capital formation of the public sector in relation to the GDP (at constant prices of 2010). The data set here contains time series for the EU-15 countries for the period 1970-2015.

The above equation can be used to estimate ‘impulse response functions’, which enable a graphical illustration of the dynamic effects of changes in public investments on economic performance (Jorda, 2005). The local projection assumes year 0, when the ‘investment shock’ is announced, but its initial impact on the GDP becomes visible only in year 1. The path of the effect is then constructed until year five; the deviations from the level in year 0 are then illustrated graphically. The cumulative effect is the sum of the annual deviations from the initial year 0 (cf. Jorda and Taylor, 2016, p. 223), but is not explicitly shown in the figure.

Figure 14 shows how a rise in public investment activities by one percentage point of the GDP will affect the economic performance for the EU-15 in the years after this ‘shock’. The grey area maps the uncertainty in the form of the one-standard error band around the estimated PINV coefficient (β). It is clearly evident from the results in Figure 14 that public investments have distinctive positive effects on the economic performance. The most significant growth effect, though, appears only after several years. While economic performance increases in year two by 0.8%, the effect enhances continuously afterwards and is 1.3% in year four. This result is congruent with the IMF (2014) estimates, which also identified a positive growth effect of public investments of 1.3% in the fourth year for a larger group of OECD countries (cf. IMF, 2014: p. 96). The cumulative growth effect within the first four years that can be calculated as the sum of the coefficients from year one to year four displayed in Figure 14 is 3.8% of the GDP.

The estimates contained in Figure 14 illustrate the average effect of a change in public investments on economic performance in the examined data set of the EU-15 countries. The empirical literature, however, points out that the effects of fiscal policy in general (e.g. Gechert, 2015; Qazizada and Stockhammer, 2015) and of public investments in particular can markedly differ depending on the position in the economic cycle (Pereira and Andraz, 2013; IMF, 2014; Gechert, 2015).

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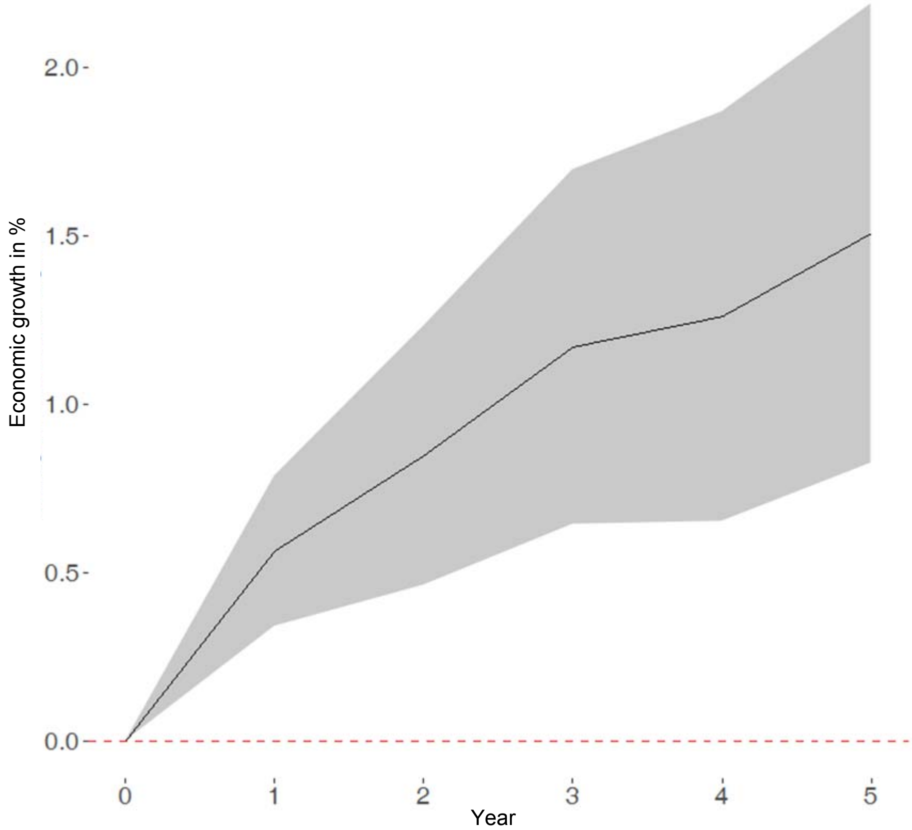
13 Cf. IMF (2014: pp. 94-96).

14 The advantages of this estimation method compared to alternative approaches (VAR, ARDL) are described by Gupta et al. (2017: pp. 18-19).

Figure 14 / Effect of a change in public investments on economic performance (EU-15)

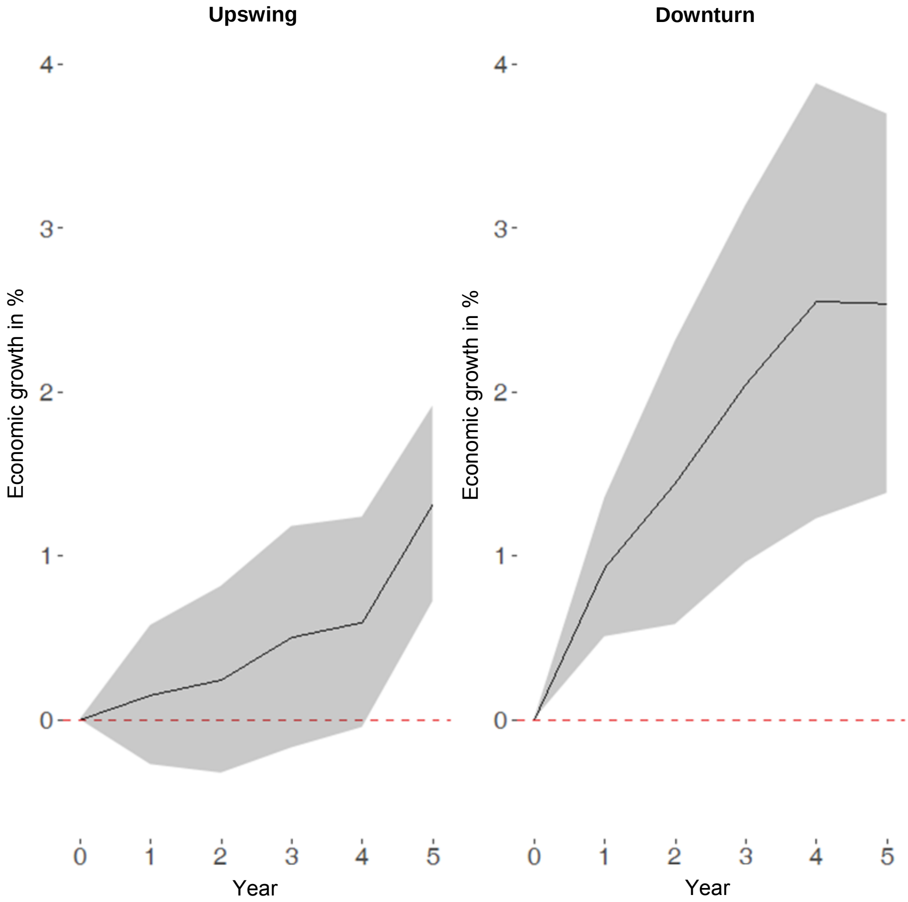


Source: AMECO; own calculations. The estimates are based on 639 observations in year 1 (k=1). The grey area maps the uncertainty in the form of the one-standard error band around the estimated coefficient for public investments (β).

Therefore, the effects of public investments in in economic upswings and downturns are estimated below. We can fall back on Jorda and Taylor (2016) in this regard. They separate the cyclical component of the GDP from the trend component by using the HP filter[15] in order to achieve an assessment of the respective national economy's position in the economic cycle. The output gap is the deviation of the real GDP from the trend estimated by the HP filter. Observations with negative output gap form the basis of the data for estimates in 'downturns', observations with positive output gap are allocated to the other category, 'upswing' (cf. Jorda and Taylor, 2016: p. 223). Based on this rough distinction between two economic cycles, the equation above is estimated separately for upswings and downturns.

15 See Hodrick and Prescott (1997).

Figure 15 / Effect of a change in public investments on GDP growth in upswings and downturns

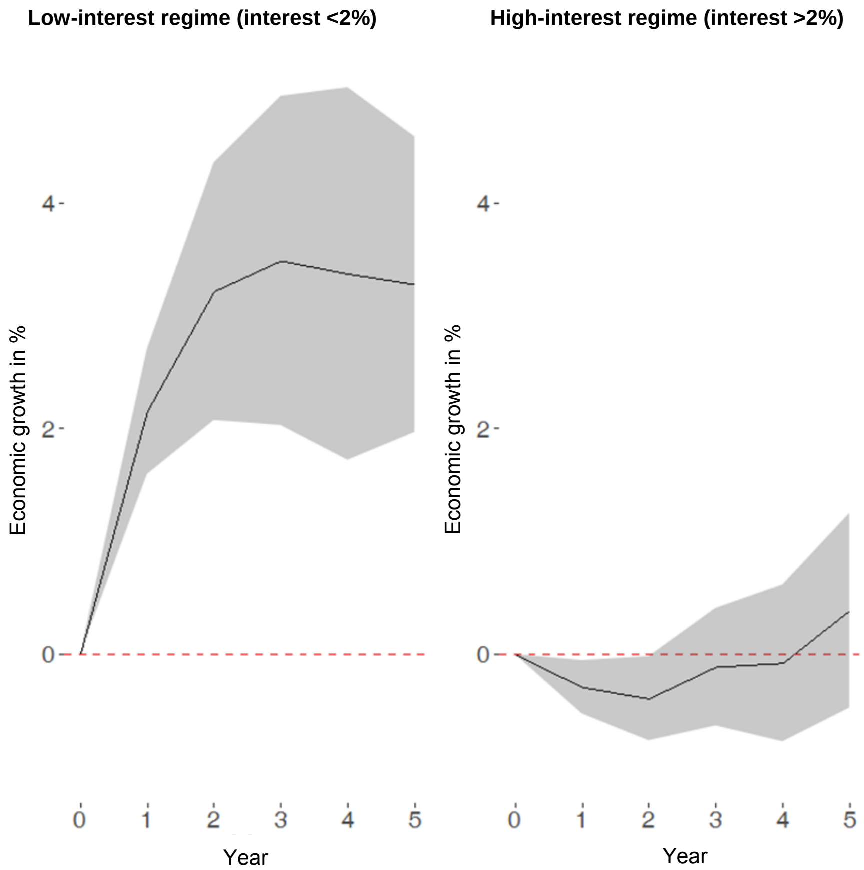


Source: AMECO; own calculations. In year 1 (k=1) the estimates are based on 303 observations in the upswing and 334 observations in the downturn. The grey area maps the uncertainty in the form of the one-standard error band around the estimated coefficient for public investments (β).

Figure 15 illustrates that the effects of a change in public investment activities on the economic performance in downturns (characterised by a negative output gap, i.e. economic underutilisation) is significantly stronger than in upswings. In the upswing the economic output rises by only 0.6% after a public investment shock amounting to one percentage point of the GDP in year four; cumulatively, the effect in the first four years is 1.5%. In comparison, with 2.6% the increase is more than four times higher in the downturn in year four; with 7.0% in the downward swing, the cumulative effect is even almost five times more than in the upswing. This result is consistent with the current empirical literature, which shows particularly high fiscal multiplier effects in downswing periods (e.g. IMF, 2014; Abiad et al., 2015; Gechert, 2015; Heimberger, 2017).

Moreover, several studies in academic fiscal multiplier literature that deals with the effects of discretionary changes in fiscal policy on output show that the interest rate environment plays a prominent role with regard to the effectiveness of fiscal measures. Particular attention is being given to the so-called *Zero Lower Bound (ZLB)*, the zero minimum level for nominal interest rates. The argument is essentially based on the fact that fiscal policy is more effective, if the central bank operates close to the ZLB and thus is not (or no more) able to stimulate the economy by further interest rate cuts. In various macroeconomic models (e.g. Christiano et al., 2011; Farhi and Werning, 2016), as well as by reference to macroeconometric estimates (Blanchard and Leigh, 2013; Heimberger, 2017) it can be shown that fiscal multipliers can be markedly higher with interest rate close to 0 than in an economic environment characterised by higher interest.

Figure 16 / Effect of a change in public investments on GDP growth in low-interest and high-interest environments



Source: AMECO, OECD; own calculations. In year 1 (k=1) the estimates are based on 105 observations in the low-interest environment (nominal, short-term interest rate below 2%) and 371 observations in the high-interest environment. The grey area illustrates the uncertainty in the form of the one-standard error band around the estimated coefficient for public investments (β).

Against this background, a distinction is subsequently to be made between two regimes with regard to the estimation of dynamic effects of changes in public investment activities: The observations of the macro data set used for the previously shown estimates are either allocated to a ‘high-interest regime’ that is characterised by a short-term interest at more than 2%, or a ‘low-interest regime’ distinguished by a short-term interest lower than 2%.[16] The interest rates originate from the OECD database and relate to short-term interest, which are normally measured based on money market interest rates.[17]

16 The estimation results are qualitatively robust, if this interest rate limit between “high-interest” and “low-interest environment” is more stringently drawn by setting the limit for instance at 1%.

17 Cf. the OECD website (last accessed on 12/06/2017): https://data.oecd.org/interest/short-term-interest-rates.htm

The estimates depicted in Figure 16 show that changes of public investment activities in the low-interest environment exhibit significantly larger effects. While the change of economic output in the high-interest environment is cumulatively even slightly negative after four years, the cumulative increase in the low-interest environment is 12.2% of the GDP. This result indicates that public investments can expect clearly more positive economic growth effects at low interest rates. This correlation is consistent with the argument that fiscal multipliers close to the ZLB can be markedly higher than one (e.g. Woodford, 2011).

7.2. LONG-TERM GROWTH EFFECTS

While the previously presented calculations enabled an assessment of the growth effects of public investments in the short and medium term, the subsequent section deals with the question of longer-term social benefits of public infrastructure. In this context the long-term effects of public infrastructure (investments) can be evaluated by means of their effect on the aggregated output (e.g. Andrews and Swanson, 1995; Pereira and Andraz, 2013).

Methodologically, the subsequent estimates are based on the works by Canning and Bennathan (2000), as well as Holzner (2011). Both studies determine the long-term benefit of infrastructure variables[18] by estimating aggregated production functions for a panel consisting of larger groups of countries. The contribution of infrastructure to the aggregated economic production can then be depicted by the following equation:

$$y_{i,t} = a_i + b_t + f(k_{i,t}, h_{i,t}, x_{i,t}) + \varepsilon_{i,t}$$

Thereby $y_{i,t}$ is the natural logarithm of the real economic output per employee (in country *i* at the time *t*); a_i are fixed effects with regard to country-specific peculiarities, which also allows for checking cross-country differences concerning the total factor productivity; b_t are fixed effects in terms of time, which controls global shocks that affect all countries in the same manner; $k_{i,t}, h_{i,t}$ and $x_{i,t}$ represent the natural logarithm of physical capital, human capital and/or infrastructure capital; and $\varepsilon_{i,t}$ is the error term.[19]

Table 7 summarises the data included in the analysis of the long-term infrastructure effects. It should be noted that all capital variables, as well as the variable (y) are measured per employee. Data on physical capital stock are from the European Commission AMECO database. Just like in Holzner (2011), the natural logarithm of the gross enrolment rates in the secondary school level serves as a proxy for human capital (h). Here, two different infrastructure variables x are applied, whose effect on the output is of particular interest. The first infrastructure variable is the railway infrastructure (RI), measured as number of electrified railway kilometres per employee. The second infrastructure variable is the motorway infrastructure (MI), measured as number of motorway kilometres per employee. Data was not available for all countries and variables over the entire period 1970-2015.[20] Just like in the estimates on the short-term effects of public investments, the considered country group is limited to the EU-15 to ensure the comparability of most of the countries (with Austria).

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[18] Holzner (2011) uses revenues from tourism as a proxy for tourism-relevant infrastructure.

[19] Cf. Canning and Bennathan (2000: pp. 5-6).

[20] The estimates are consequently based on an unbalanced panel data set.

Table 7 / Data to estimate growth effects of public investments in the EU-15 in the period 1970-2015

Variable	*Description*	*Data source*	*Period*
y	Natural logarithm of the real GDP per employee	AMECO	1970-2015
k	Natural logarithm of the real physical capital stocks per employee	AMECO	1970-2015
h	Natural logarithm of gross enrolment rates in the secondary school level	World Bank	1970-2015
RI	Natural logarithm of electrified railway kilometres per employee	Eurostat	1970-2015
MI	Natural logarithm of motorway kilometres per employee	Eurostat	1970-2015

Source: wiiw illustration.

In principle, the production function can have various forms. Following Canning and Bennathan (2000), as well as Holzner (2011), a so-called translog production function shall be used subsequently, the main benefit of which is that it permits different extents of substitutability and complementarity between the included types of capital. The translog production function has the following form:

$$f(k_{i,t}, h_{i,t}, x_{i,t}) = \alpha_1 k_{i,t} + \beta_1 h_{i,t} + \gamma_1 x_{i,t} + \alpha_2 k^2{}_{i,t} + \beta_2 h^2{}_{i,t} + \gamma_2 x^2{}_{i,t} + \delta_{kh} k_{i,t} h_{i,t} + \delta_{kx} k_{i,t} x_{i,t} + \delta_{hx} h_{i,t} x_{i,t} + \varepsilon_{i,t}$$

This equation shows that the production function does not assume the classic Cobb-Douglas form (cf. Canning and Bennathan, 2000: p. 6), but is expanded by the squared terms of the capital variables k, h and x, as well as by interaction terms between all capital variables. This is the basis for the subsequently presented econometric estimates on the long-term effects of infrastructure investments.

The central problem in estimating an aggregated production function as presented in the equation above lies in the question of reverse causality. In this specific application, it means that an increase in income (more output) leads to a higher demand for infrastructure. Therefore, a positive correlation between infrastructure shocks and output levels can also be simply due to increased demand. If this potential bias is not factored in, one has to assume an overestimation of the coefficients in the production function. However, Kao and Chiang (1999) have proposed an approach that allows the estimation of the long-term relationship between the variables presented, based on consistent t-statistics. Thereby, 'lags' (temporally delayed values) and 'leads' (temporally leading values) of the explanatory variables are included in the estimation. The resulting method of estimation is referred to as 'dynamic OLS' and makes it possible to solve the problem of reverse causality and potentially inconsistent estimates.

Table 8 displays the econometric estimates based on the trans-log-production function defined in the equation above.[21] All estimates contain 'fixed effects', as well as two 'lags' and one 'lead' of the explanatory variables; the parameter estimations on these variables are however not shown in Table 8 due to lack of space. In collumn (1) k and h are first introduced as control variables. It is clearly evident that both k and h are positive; this means that they have a positive effect on the aggregated output in the

[21] Before the execution of the panel estimates, tests regarding the non-stationarity of the used variables were carried out based on the Im-Pesaran-Shin tests (Im et al., 2003). This requires balanced panel data; accordingly, the time series had to be partially shortened. The Im-Pesaran-Shin test was conducted for each variable individually. As it turned out, the variables y, k and h have a root of unity, i.e. are I (1). For the infrastructural variables MI and RI, however, the null hypothesis of non-stationarity can be discarded. As Canning and Bennathan (2000), as well as Holzner (2011) pointed out, the parameter estimates by means of the dynamic OLS estimator by Kao and Chiang (1999) are consistent, if cointegrative relations don't exist between the variables.

long term.[22] Of particular significance is the interpretation of the results in the squared terms and interactions. The squared terms are negative both for k and h, which indicates decreasing marginal profits of these two types of capital. The interaction term is positive, which points to the fact that k and h are complements, not substitutes.

Table 8 / Long-term effects of infrastructure investments on the aggregated output

		Dependent variable: *GDP per employee*	
	(1)	*(2)*	*(3)*
k	*0.348****	*0.644**	*0.141*
	(0.059)	*(0.352)*	*(0.096)*
k^2	*-0.010*	*-0.005*	*0.008*
	(0.007)	*(0.012)*	*(0.014)*
h	*0.006*	*1.587****	*0.066*
	(0.077)	*(0.291)*	*(0.070)*
h^2	*-0.038****	*-0.052****	*-0.025****
	(0.007)	*(0.009)*	*(0.005)*
RI		*0.304*	
		(0.361)	
RI^2		*-0.016*	
		(0.010)	
MI			*0.182****
			(0.052)
MI^2			*-0.036****
			(0.005)
k * h	*0.045****	*-0.058****	*-0.028****
	(0.010)	*(0.012)*	*(0.010)*
k * RI		*-0.031*	
		(0.019)	
h * RI		*-0.087****	
		(0.017)	
k * MI			*0.022*
			(0.015)
h * MI			*0.042****
			(0.006)
Countries	*15*	*15*	*15*
Observations	*453*	*453*	*453*
R^2	*0.337*	*0.745*	*0.573*
Adjusted R^2	*0.225*	*0.697*	*0.493*

Note: * p<0,1; ** p<0,05; *** p<0,01.
The estimates contain 'time-fixed effects' and 'country-fixed effects', as well as two lags and one lead of the explaining variables respectively (dynamic OLS estimator; see Kao and Chiang, 1999). Standard errors in brackets.

In collumn (2) of Table 8, the railway infrastructure variable (RI) is then introduced as an additional explanatory variable. In the process, investments in the railway infrastructure will have two effects: first,

[22] It should be noted that the h coefficient is not statistically significant. However, Canning and Bennathan (2000) point out that the statistical significance due to the non-linearities in the specification should not be over-interpreted when estimating a translog production function, because the t statistics could be asymptotically inconsistent in case of non-linearity (see Canning and Bennathan, 2000, p. 9).

an increase in the capital stock and second, an increase in the existing infrastructure of railway tracks. Canning and Bennathan (2000: p. 12) explain that the coefficient of the additionally included infrastructure variable (RI in line (2)) can be interpreted as the effect of the infrastructure assets increased through infrastructure investments, while the remaining capital stock remains constant. In general, a positive coefficient demonstrates that the movement of resources for generating additional infrastructure assets has positive output effects in the observed infrastructure variable. Variable RI is positive, thus suggesting above-average long-term investment effects.[23] The direction of the results remains unchanged for k and h by the inclusion of RI, but h now has a clearly stronger positive influence. The interaction term of RI and h is negative and statistically significant; thus, h and RI seem to be rather substitutes than complements.

Collumn (3) in Table 8 finally introduces the motorway infrastructure variable MI as an explanatory variable. MI is positive and statistically highly significant, which indicates long-term investment effects on the output that lies above the average. The negative squared term in turn points to decreasing marginal returns, while the positive signs in the interaction terms k*MI and h*MI suggest that motorway infrastructure constitutes a complement to physical capital and human capital.

7.3. ECONOMIC AND EMPLOYMENT GROWTH EFFECTS OF THE EUROPEAN SILK ROAD

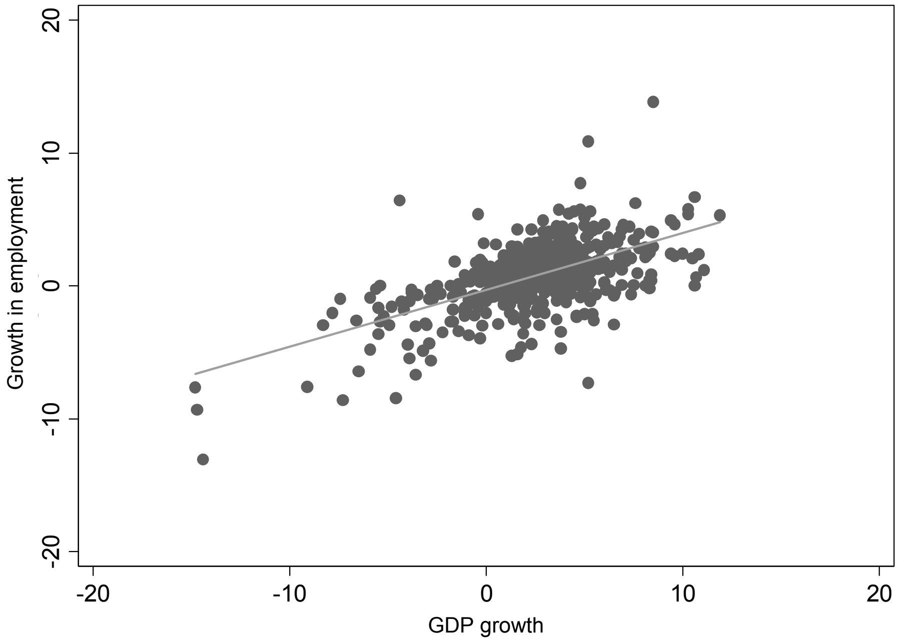
For our calculations on the growth effects of investments in the European Silk Road, we will focus on the short to medium-term effects based on the low GDP investment multiplier of 1.3 calculated in the baseline scenario (Figure 14) for year 4, which is consistent with the relevant literature (IMF, 2013). Further, we assume an investment period of one decade in infrastructure investments in the European Silk Road. We moreover assume that the GDP employment coefficient is 0.52. We were able to calculate this value for the data set available from Eurostat for EU and EFTA countries on employment growth and GDP growth between 1996 and 2017. Figure 17 indicates the estimated relation between economic and employment growth in a scatter diagram (details on the estimation procedure can be found in the note to the figure).

Therefore, if we take the previously calculated investments in the European Silk Road and use the conservative cost assumptions described before, we arrive at a GDP effect of 3.5% for the average of the involved countries and an associated average employment effect of 1.8%; an increase in employment of over 2 million people ensues as a sum of the national results. These results can be understood as a short to medium-term level effect for the investment period. If one assumes a higher GDP-employment-coefficient of 0.70, as found under favourable conditions (ECB, 2016), and the previously estimated results for the low-interest periods of an investment-GDP-multiplier of approximately 3.5, then we obtain much stronger employment effects of over 7 million people in greater Europe. For Austria, the construction projects in the baseline scenario result in an additional economic growth of 1.5% and additional 34,000 jobs. Under favourable circumstances, up to 121,000 new jobs could be generated in Austria. Again, it should be noted that this is a level effect over an investment period of one decade.

[23] Although RI is not statistically significant, Canning and Bennathan (2000: p. 9) once again point out that the statistical significance needs to be relativised due to the non-linearities in the specification.

Figure 17 / Positive relationship of economic and employment growth

Real GDP growth and growth of employed persons, EU and EFTA countries, 1996-2017



Note: Partial relation. The used model is a robustly estimated fixed effects model including a dummy variable for crisis for 2008, 2009, 2012, 2013.
Source: Eurostat, own estimates, own visualisation.

Table 9 / Effects of the European Silk Road on economic and employment growth

	Employment in 1,000	GDP EUR mill.	Investments in % GDP	GDP effect in %	Employment effect in %	Employment effect in 1,000
AT	4,185	369,686	11.8	1.5	0.8	34
AZ	4,760	36,034	55.2	7.2	3.7	178
BE	4,587	437,204	5.7	0.7	0.4	18
BY	4,352	48,183	58.4	7.6	3.9	172
CH	4,454	601,016	8.6	1.1	0.6	26
DE	40,482	3,263,350	5.6	0.7	0.4	152
ES	18,649	1,163,662	8.2	1.1	0.6	103
FR	26,512	2,291,705	7.4	1.0	0.5	133
GE	1,707	13,419	189.0	24.6	12.8	218
HU	4,373	123,495	19.4	2.5	1.3	57
IT	22,444	1,716,935	1.4	0.2	0.1	22
NL	8,376	733,168	2.2	0.3	0.2	13
PL	16,079	465,605	12.5	1.6	0.8	136
PT	4,515	193,072	7.2	0.9	0.5	22
RO	8,363	187,868	22.1	2.9	1.5	125
RU	72,393	1,397,361	12.6	1.6	0.8	615
Total	**246,231**	**13,041,763**	**7.6**	**3.5**	**1.8**	**2,022**

Note: Effects of the northern and southern route. GDP and employment effects in % as an average of national effects, employment effect in 1,000 inhabitants as a sum of the national effects.
Source: Eurostat, WDI, own estimates.

7.4. TRADE EFFECTS

Finally, we also evaluate the rough trade effects of the European Silk Road construction. Here, we will concentrate on the core stretch of the northern route between Lyon and Moscow and estimate the potential export growth for the European countries trading with Russia, which could benefit from this construction project. Since Russia is the dominant national economy in the east of greater Europe, the calculations with regard to Russia are a good approximation for the eastern region. For that, a one-country gravity model for Russia is estimated according to the following equation, as was also done, for example, in Summary (1989) or Depken and Sonora (2005):

$$\ln(M_i) = \beta_0 + \beta_1 \ln(GDP_i) + \beta_2 \ln(dist_i) + \varepsilon_i$$

In this specific case, the natural logarithm of the average values of Russia's imports M with over 170 partner countries *i* in the period of 2012-2016 was selected as a dependent variable of cross-sectional regression. The five-year average was selected to balance cyclical fluctuations, and because Russia is a member of the WTO since 2012. The data for goods imports was taken from the UN COMTRADE database and is stated in nominal US dollars. The import of goods is on the one hand explained by means of the average of the partner countries' GDP over the same period (in nominal US dollars according to WDI database), as well as the time in hours currently required on the northern route to travel by car from the capital of the respective country to Moscow ($dist$). Both explanatory variables were logarithmised as well.

In the baseline scenario, this results in a negative coefficient for the logarithmised hours driven of 1.336. The estimated value is close to those of other gravity model estimations (Bachetta et al., 2012), and it can be assumed that the estimator is unbiased. Since the estimation is carried out in logarithms, one can interpret the value as elasticity between the volume imported and the distance between the countries. If the current distance is reduced by 1% in hours driven, the import value would increase by 1.336%. Together with the results of the calculations of the time saved on the northern route of the European Silk Road to be built averaging over 8% or 2.5 hours (assuming an increase in speed on existing motorways of 10 km/h and on existing main roads of 30 km/h), it was possible to calculate the corresponding effects on the exports to Russia for the countries with time savings.

Consequently, the countries along the northern route could boost their exports to Russia by more than 11% (Table 10). This would be equivalent to over EUR 12.5 billion in additional exports. Austria's exports to Russia would increase by over 14%, equivalent to about EUR 330 million.

Table 10 / Effects of the core northern route of the European Silk Road on trade with Russia

		RU exports (average 2012-2016)	Distance to Moscow	Current, without northern route	Current, without northern route	With northern route	With northern route	Time change	Estimated effect on the exports to Russia	Estimated effect on the exports to Russia
Code	**City**	**in mill. EUR**	**km**	**hours**	**km/h**	**hours**	**km/h**	**in %**	**in %**	**in mill. EUR**
PL	Warsaw	4,976	1,259	15	83	13	98	-14.8	19.8	983
DE	Berlin	23,961	1,819	21	86	18	100	-13.3	17.8	4,268
FR	Paris	8,352	2,855	30	95	27	107	-11.7	15.6	1,305
BE	Brussels	2,636	2,551	28	92	24	104	-11.5	15.3	403
NL	Amsterdam	3,739	2,541	28	90	25	102	-11.2	15.0	562
LU	Luxembourg	130	2,552	29	89	25	100	-11.1	14.8	19
BY	Minsk	9,196	717	9	84	8	94	-10.6	14.2	1,302
AT	Vienna	2,308	1,957	23	87	20	97	-10.6	14.1	326
UK	London	5,067	2,894	33	89	29	98	-9.7	13.0	656
SI	Ljubljana	920	2,330	26	89	24	98	-9.2	12.2	113
CZ	Prague	3,412	1,933	27	73	24	80	-9.0	12.0	410
DK	Copenhagen	1,217	2,262	27	84	25	92	-8.8	11.8	143
CH	Zurich	2,153	2,582	28	92	26	100	-8.5	11.4	245
ES	Madrid	3,147	4,155	42	99	39	108	-8.4	11.2	352
IE	Dublin	937	3,476	41	86	37	93	-7.8	10.4	97
PT	Lisbon	430	4,572	47	98	43	106	-7.6	10.1	43
IT	Rome	9,156	3,071	34	91	31	98	-7.1	9.5	870
SK	Bratislava	2,170	1,948	22	89	21	94	-5.5	7.4	160
HU	Budapest	1,981	1,825	22	82	21	86	-5.4	7.2	143
AL	Tirana	11	2,923	36	81	34	86	-5.2	7.0	1
HR	Zagreb	265	2,311	26	89	25	94	-4.7	6.2	17
RS	Belgrade	790	2,189	26	85	25	89	-4.7	6.2	49
BA	Sarajevo	56	2,388	29	83	28	86	-4.2	5.6	3
MK	Skopje	68	2,622	30	86	29	90	-4.0	5.3	4
GR	Athens	354	3,282	37	89	36	92	-3.3	4.4	16
	Average			**29**	**88**	**26**	**96**	**-8**	**11**	
		Total								***12,492***

Source: UN COMTRADE, WDI, distancecalculator.net, own estimates.

8. Conclusions

In this study we argue for a 'Big Push' in infrastructure investments in greater Europe. We propose the construction of a European Silk Road that links the industrial centres in the west with the densely populated, but less developed regions in the east of the continent and thereby provide for more growth and employment in the short, medium and the long term. This initiative should not be viewed as a competition to the Chinese New Silk Road, but as a complementary project. Besides economic benefits, this would also entail important political advantages, when more cooperation would ensue due to transnational, joint infrastructural measures. Moreover, this study identifies substantial gaps in infrastructure in the west of the continent and even larger infrastructural needs in the east. Our cost estimates yield an investment volume of around EUR 1,000 billion for the European Silk Road, and for the further closure of infrastructure gaps in the west and east of the continent, costs of about EUR 2,900 and EUR 1,100 billion, which in total are far below the highest estimations for the Chinese New Silk Road of up to EUR 7,000 billion. The investment costs are set off by potential positive growth effects in the gross domestic product, employment and trade. In a baseline scenario, our calculations show that the European Silk Road would have the potential to improve the GDP of the involved countries by 3.5% over an investment period of 10 years and increase employment by 2 million people. Under particularly favourable circumstances and with interest rates remaining low, even an employment effect of over 7 million in greater Europe can be expected. Savings in transport time, for instance on the northern route of the European Silk Road averaging 8%, could enable the countries along the northern route to raise their exports to Russia by more than 11%. To expand the pan-European market the potentials of an enhanced economic integration are substantial. Similar to Rosenstein-Rodan's proposal 75 years ago to establish an Eastern European Industrial Trust to finance a Big Push, whose capital was to be provided by the governments of Western and Eastern Europe, today we also would like to propose such a trust fund, which sets out to bridge the gaps in infrastructure in greater Europe and construct a European Silk Road with the aid of an infrastructure investment push. With the currently extremely low interest rates and in view of the anticipated immense economic effects, a 'self-financed' investment can be expected (IMF, 2014). Otherwise, there exist other opportunities that are not debt-financed to enable these infrastructure investments. For example, the annual losses from tax evasion and tax avoidance in the countries of the European Union are estimated at approximately EUR 1,000 billion (Murphy, 2012). The additional resources made available by the fight against tax evasion and tax avoidance could, at least in part, flow into the expansion of long-term infrastructural measures.

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