



Infrastructure Investment and Growth

A Policy Report

Introduction

Decisions on public spending on transportation and communication infrastructure are widespread political dilemmas. On the one hand, it is commonly accepted that critical infrastructures such as transportation and communication networks are key drivers of economic prosperity, growth and job creation, which is an argument few politicians can resist. On the other hand, the lists of investment proposals coming from various sources are never-ending and frequently contain projects that are exorbitantly expensive (and even more so when operations and maintenance costs are considered). The aim of this policy report is to give policy makers some background and recommendations on aspects that should be considered in infrastructure planning, especially in times and/or places where economic growth is a strong political priority.



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It is not in doubt that transportation and communication are essential to most economic activities and that there therefore is a close association between infrastructure capacity and economic performance. However, it can be questioned whether infrastructure investment is a lead or a lag variable in relation to economic growth. In the former case, infrastructure projects wholly or partly “pay for themselves” as they create economic value that would not exist in their absence, for instance by widening product and labour markets and thereby opening new market opportunities for firms or improving labour-markets’ matching of competences and skills. This idea can motivate giving infrastructure construction and renewal a prominent role in growth-promotion strategies in stagnant regions. In the latter case, infrastructure planning may be given a less pro-active role among other ways to advance economic growth, such as human-capital building, support for entrepreneurship, venture-capital markets and R&D, with more focus on planning in order to prevent bottlenecks, congestion and crowding becoming a drag on growth. While the distinction between these two perspectives may be vague it can have major implications for how much investment risk that is accepted, especially in times or regions undergoing persistent slow economic growth.¹ Another implication of this distinction is that it raises questions as to what extent benefit-cost assessments (BCA) of investment projects include effects on growth and whether there is a need to include benefits from wider economic impacts. The latter refers to the additional benefits (or disbenefits) that may arise from transport improvements due to ‘distortions’ or market failures in non-transport markets, which implies that the full welfare effect of a transport investment is not reflected in the transport market.

¹ An example, to illustrate this point, of a failure of a large strategic investment for the purpose of promoting economic and population growth in such a region is the Swedish Inland line, a 1288 km railway line running north-south through the interior of the northern half of Sweden. It was built from 1907 and never became profitable until it was mothballed in 1992.

A typical feature of infrastructure is economies of density, i.e., cost savings from spatial proximity of users and operators, which therefore set rural and remote regions with low economic activity and/or low population density at a disadvantage compared to more prosperous or populated areas (although, on the other hand, construction costs may be lower). This may lead decision-makers to give priority to projects in densely populated areas or areas that already experience high economic growth, especially where density leads to congestion and crowding (diseconomies of density).

These economies of density have two roots. One is that infrastructure requires considerable investment in fixed and sunk costs: assets such as railways, airports or fibre-optic networks. This creates economies of scale and scope that can be utilised better in regions with large and dense populations. Another root is network externalities, i.e., complementarities across users and operators, raising the quality or diversity of services, as when more passengers make possible more frequent train departures. Economies of density are and have for a long time been prevalent characteristics of transport and communication networks, but their nature and significance have sometimes been dramatically changed by the information and communication technology (ICT) developments, as for instance when wireless electronic communication has replaced communication in fixed-line networks. But it remains a fact that insufficient access to transportation and communication facilities and services, such as a nearby airport, in some locations may be a major difficulty to economic operations (Zhang & Graham 2020).

There are two circumstances that may lead the political system to exaggerate the importance of infrastructure investment as a means for promoting economic growth, in particular when economic assessments show low benefit-cost ratios. The first is that most infrastructure facilities are site-specific and therefore have site-specific local and regional effects, while tax funding is mostly national. This gives rise to the so called 1/n-effect, i.e. the "importance of the geographic incidence of benefits and costs owing to the geographic basis for political representation" (Weingast et al. 1981, p. 642), which means that political decision-makers with a local electorate have incentives to deviate from the common (national) good when benefits are local and funding is spread over a larger population. A second reason for bias is the difficulty in disentangling effects on total growth from spatial redistribution. Local effects resulting from for instance a new metro line are often clearly visible in the form of increasing population and new business establishments in the vicinity of stations, while negative re-allocation effects are less salient as they are spread over many places and may result instead from slowing growth rates (compared to an often unmeasurable counterfactual development) than outright shutdowns.²

It is therefore not unusual that there is a fierce ongoing discussion in many countries over the role of infrastructure investments in enhancing economic growth in economically challenging regions or times. As an example, the following section provides a short background on such discussions in Sweden,

² This often sets BCA at a credibility disadvantage as policy makers have to choose whether they should trust results from models more than what they can see with their own eyes.

on macroeconomic and microeconomic perspectives that have not been easy to reconcile. The report then proceeds with a brief review of research on whether infrastructure boosts growth. In the fourth and final section, concluding recommendations for policy makers are drawn together based on both research and on the infrastructure planning debate.

Swedish debate 1990-2021

An intense debate on infrastructure's contribution to growth raged among Sweden's economists in the early 1990s. At that time, Sweden was in deep economic crisis and, as often in bad times, it was necessary to consider whether government investment projects could be brought forward to stimulate the economy. The crisis had followed a series of crises in the 1970s and 1980s, and it was obvious to many that, this time, structural growth-enhancing measures were needed. Attention was therefore directed to research findings. Based on data from the United States, Aschauer (1989) and Munnell (1990) showed that the infrastructure investments made there, especially in the 1950s and 1960s in the construction of an interstate highway system linking the entire country, had increased business sector productivity and hence growth. The Swedish Productivity Delegation took note and, based on a commissioned study, proposed vigorous investments in the main road network, high-speed train between major cities and expansion of the capacity of the airport at Arlanda.

The report from the Productivity Delegation clearly made a large impact on the Swedish political debate. However, the empirical basis for its conclusions with respect to the role of infrastructure came soon under heavy criticism in academic circles. A study by Berndt and Hansson (1992) pointed out that the models developed by Aschauer and Munnell have a number of serious drawbacks. When estimating these models with Swedish data, Bendt and Hansson obtained results that did not make much sense. Using an alternative approach, they found that reduced infrastructure capital investment in Sweden since 1974 had only modestly contributed to the productivity growth slowdown. In another study, Wibe (1992) tore the Productivity Delegation's own study on the association between regional differences in infrastructure capital and productivity to shreds, claiming that the analysts had misunderstood both theory and data, yielding results that were nonsense.

After the economic crisis in the early 1990s, Sweden had a period of good economic growth until the financial crisis of 2008-09. Gross investment in national road and rail declined as a share of GDP during the 1990s, from 1.3% of GDP to 0.7% at the turn of the century, but then bounced back, returning to the previous level around 2010. The new crisis set the stage for a new round of intense discussions on the role of infrastructure. The growth-enhancing effects of infrastructure were emphasised but the main argument was that the infrastructure investments had not kept up with the relatively strong economic growth since the mid-1990s. All parties in the Swedish Parliament and many stakeholder organisations expressed that the transportation infrastructure was in a state of neglect.

This message was also made in some macro-economic reports³, but did not receive any explicit support from the economists working with transport and infrastructure planning. In the preparation of the national transport plan 2010-21, benefit-cost assessments were made of 479 proposed rail and road projects.⁴ Just a little less than 60% of these were found to have benefits exceeding the costs, with no explicit consideration of cost overruns and investment risk⁵, and only 20% were “convincingly” profitable (Eliasson & Lundberg 2012, Lundberg et al. 2012). A common opinion among transport economists was that several of the main concerns over capacity constraints and dysfunctions of the national transportation infrastructure were related to inadequate pricing of usage, neglect of maintenance, re-investment needs, and minor investment targeting bottlenecks.

Still, these economists have emphasised that in analysing urban and regional infrastructure there is a need to consider possible synergy or interaction effects that affect the overall economy and that may be absent in the economic evaluations of specific investment objects. Such effects arise out of agglomeration in close environments where consumers and/or producers can interact easily. That makes the sharing of essential facilities, improved learning/knowledge overspill and better matching on the labour market possible (Duranton and Puga 2004). Infrastructure investments can have a role in supporting such effects for example by making commuting possible within a large area.

Agglomeration effects are thought to affect labour productivity and can therefore be measured by wage-income statistics. Based on Swedish data, Börjesson et al. 2019 found that the wage sum increases by 3-6% when the average travel cost is reduced by 1%, where the lower value is for the whole country and the higher value for high-income individuals in the extended Stockholm metropolitan area. Other studies with Swedish data of productivity or employment effects are Anderstig et al. (2012), Norman et al. (2017) and Håkansson & Isacsson (2018). The latter showed that the impact of increased accessibility on economic growth is local and exists only at distances shorter than 25 km.

A new national transport plan for 2022-33 is now underway. This plan is said to make possible for Sweden to “continue to develop as a competitive economy with growth and also become the world’s first fossil-free welfare country” (prop. 20/21:151, p. 27, my transl.). Possibly, this could be apprehended as an indication of a shift of emphasis from “growth” to “sustainability”, or at least the transition to a greenhouse-gas-neutral economy, as an overarching goal of the plan. However, echoing the “new green deal” discourse at both sides of the Atlantic, it can also be seen as a desire to promote economic growth under the conditions imposed by the climate-policy regime.

3 In a report to the Ministry of Finance, Vredin (2013) and Nyström (2013) scrutinised the arguments in the macroeconomic reports. Both authors agreed that key aspects of the statistics need to be improved.

4 An overview of the role of economic analysis in Sweden’s transportation infrastructure planning and discussion of various validity issues is Andersson et al. (2018).

5 Nilsson et al. (2019) found overruns by, on average, between 32% and 20% for railway and road contracts, respectively. Nilsson & Jäderholm (2021) studied seven mega-size objects and found a total cost increase of 208%.

Does infrastructure investment boost growth?

“On his journeys he experienced how well the grace of providence has ruled, placing rivers at all places where large cities strike out” (Kellgren 1791, my transl.). This satirical verse from the late 18th century by one of the founders of the Swedish Academy on “the holy Fool’s way of life”, catches part of the problem of understanding the direction of the causal relationship between facilities for transportation and communication, and economic development. At that time it was obvious to all, except to “the holy Fool”, that the causality worked from the river-transportation routes to the economic activity in cities. But the joke is on them; in the coming century, railway lines, as the new major means for transportation, were drawn to “the places where large cities strike out”. And, indeed, the chicken and egg problem (or the “endogeneity problem”) is still one of the major difficulties to our understanding of the relation between transportation and communication infrastructure and economic growth.

A study that illuminates this issue in a historical perspective is Krüger (2012). He used annual national account data for Sweden over two centuries starting from 1800. This period covers the roll-outs of the national railway, road and telecommunications networks. Using a time-series (wavelets) decomposition of the time-series and searching for leads and lags in the correlation between investments and GDP, he found that public investments in infrastructure boosts GDP in the short term (in a couple of years), but that long-term causality works in the opposite direction. A possible interpretation of this pattern is that there are “Keynesian” short-term effects on GDP from public spending (a lead), but the long-term relationship is dominated by the need to adapt infrastructure to the developments of the economy (a lag).

As mentioned in the previous section, the policy debate in the 1990s was much influenced by the study by Ashauer (1989) on how investment in public capital during the first decades after WW2 had affected the US economy. This study ignited much discussion among economists on the causal relationship of the empirical association he had found. Subsequent studies (e.g. Fernald (1999)) did however corroborate his claim, which was based on data from the period when the federal highways system was constructed, connecting large parts of the country into an integrated network for automobile transportation. However, they also pointed out that there are diminishing returns to the establishment of new networks; a second federal highways network would not achieve the same results as the first.

Over the years that have passed, there have been numerous econometric studies estimating productivity effects (often measured as elasticities) of various kinds of transport infrastructure on various industries and in various countries. In recent years some researchers have tried to overview this line of work by meta-analysis. A seminal study of this type was Melo et al. (2013), concluding that the results of the underlying studies were widely dispersed. It also observed extensive methodological problems of unobserved heterogeneity, spurious associations and omitted variable bias. Later, Garcia et al. (2017), came to similar conclusions

based on a wider sample. They summarised their findings by stating that there are “very different results that suit everyone’s tastes”. In particular, they cautioned that there may be a substantial publication-bias (leading to a selection of studies that find significant effects). When attempting to control for such bias the estimated positive elasticity of infrastructure to growth was reduced to a low number.

Another meta-analysis the same year (Holmgren & Merkel 2017) estimated elasticities varying from negative to positive numbers depending on the type of infrastructure in which the investment is made as well as between industries. Intriguingly, they found that “the estimated effects exhibiting high precision are clustered around zero. This is to say that the higher the reliability of the estimate, the closer it is to zero.” (Holmgren & Merkel 2017, p. 17).

Several explanations for this dismal finding were suggested by Vällilä (2020), commenting that infrastructure by its very nature is a difficult object for econometric studies, leading to model inaccuracy. There are issues concerning heterogeneity in sampling, empirical model specification, and estimation. Also, there is no commonly accepted definition of infrastructure, several measurement problems, insufficient theoretical understanding of the complex and possibly unstable links between infrastructure and growth, and last but not least a lack of relevant high-quality data. Facing this long list of difficulties he concluded with a prediction that “the progress in tackling the root causes of model inaccuracy will likely remain slow” (Vällilä 2020, p. 48).

A possible remedy to some of the problems that arise in econometric studies of observational (macro-level) data is to use quasi-experimental micro-level data. The latter is a route that some recent studies have taken. For instance, a few studies have exploited the opening of the Öresund Bridge between Sweden and Denmark constructing a counter-factual from large sets of micro-level (firm-level) data from public records. For example, Achten et al. (2019) employed a synthetic control method and found positive effects of the bridge on the local and supra-regional economy, but only the effects at a larger regional level were robust. Ferguson and Forslid (2016) estimated effects in southern Sweden from the enhanced access by the bridge to direct international flight connections at the Copenhagen Airport. They used a “triple differences approach” by estimating the impact from (i) before and after differences in export and import performance of industries that (ii) depend more or less on international travel and (iii) between the Skåne region and the two other metropolitan regions of Sweden (Gothenburg and Stockholm). They concluded that the improved access to direct flight connections had a considerable impact on trade, in particular for knowledge-intensive services.

Another field of research on the effects of infrastructure on the economy concerns the impacts of the roll-out of networks for electron communications. As long as large-width communication required fixed-line access, such as old-copper DSL or optic fibre, such studies could exploit regional differences in the pace of roll-out. For instance, a study by De Stefano et al. (2014) exploited a natural

experiment setting in north-eastern England and found no significant differences in turnover, employment, employment growth or shutdowns of firms in different areas. A similar study on employment in rural communities in Germany (Fabritz 2013) found small but significant positive effects. Another study of firms in Italy found an impact on sales growth but no effects on employment (Canzian et al. 2015). Using Norwegian data, a study by Akerman et al. (2015) found small effects on productivity growth, but that DSL-access favoured high-skilled labour and disfavoured less skilled labour.

A tentative summary of the large amount of research in this area is therefore that there are cases where infrastructure investment leads to increased macro-economic productivity, in particular when it radically reduces the cost of transportation or communication, like the federal highways network, the Öresund bridge, DSL access (and possibly other networks linked to new technologies), but that the evidence for more general positive effects is weak.

Advice to policy makers

The overall conclusion from research is thus that the role of infrastructure as a way to boost economic growth is limited. An important policy implication is that every investment proposal should be judged on its own merits, usually summarised as its cost benefit-ratio. This suggestion is probably in many cases a hard sell, as there is a widespread scepticism towards benefit-cost assessments. Studies of investment-planning decisions in Sweden and Norway suggest that there are only weak associations between the outcome of such evaluations and actual priorities made (Nilsson 1991, Eliasson & Lundberg 2012, Eliasson et al. 2015). Jussila-Hammes & Nilsson (2017), who studied political and economic determinants of national road and rail investment projects in Sweden in three consecutive national transport plans in a model with municipality-level data, found that projects with an economic assessment have a better chance to be included than projects that do not, but this so even if the outcome shows that costs exceed benefits.

Although decision-makers can have many valid reasons for making priorities on other grounds than socio-economic assessments, a common argument, at least in the Swedish political debate, is that there is something missing in these assessments. It appears that, to some extent, this simply reflects a misunderstanding of what is included in the assessments and what explains the results. First, the main benefits from investments are usually improvement of access, which is basically captured by reduction of travel time and other costs of travel. It is sometimes not clear to decision-makers that this basically is a measure that encompasses GDP effects (and more than that since value of leisure is included). Second, this measure is a measure of a primary effect. This is often partly transferred to other subjects than the road users, leading to indirect secondary effects, for instance a surge of real-estate prices. In these cases, analysts responsible for economic assessments often have to explain that project benefits can only be counted once (Andersson et al. 2018). Third, policy makers are sometimes surprised to see that effects from reduced emissions and pollution or improved traffic safety

do not contribute more to the total economic benefits, even though they relate to main policy objectives. The reason for that, however, is not (necessarily) that these items are undervalued, but that emissions, pollution and accidents result from usage of the whole existing infrastructure. Therefore, while for instance road tolls and speed limits may have first-order effects on these variables, effects from investments, i.e., increments to the capital stock, often are of second order (Hultkrantz et al. 2003).

“... a positive benefit-cost ratio is a valid sign of the positive effects on economic growth and overall social welfare.”

A first take-home message to policy makers is therefore that a positive benefit-cost ratio is a valid sign of the positive effects on economic growth and overall social welfare. A decision-maker that wants to maximise the welfare effects from infrastructure investment should first of all study the benefit-cost evaluations of investment objects. As a rule, the relevant effects on GDP growth are included in these assessments. In fact, the main link between a transportation infrastructure investment and the overall economy, irrespective of whether it is a lead or a lag relationship, is accessibility.

Of course, this is not to say that decisions should be based on one criterion only. Economic models are imperfect, there are many uncertainties surrounding investments⁶ and distributional issues need to be addressed. Also, ongoing research shows that there are indeed wider economic impacts of agglomeration that in some cases are not fully captured with standard models (Graham & Gibbons 2019), although perhaps mainly in small local areas (Håkansson & Isacsson 2018). However, complete ignorance of benefit-cost assessments is difficult to reconcile with an overall objective to boost economic growth and welfare.

A second advice is that decisions should be based on economic evaluations that reflect as close as possible the cost and benefits of the objects that actually will be built. Flyvjerg & Bester (2021) show, based on a sample of more than 2000 projects, that there is a fallacy of ex ante benefit-cost estimates because costs are systematically underestimated and benefits overestimated. A substantial part of the problem is that these economic assessments are made very early in the planning process. Here, the Swedish experience is telling. Nilsson & Jäderholm (2021) study cost increases during different stages for seven mega-size projects. The cost of these projects in real prices increased by 147% from the start of the process, but just by 12% from the time when the project was tendered. They suggest that it seems that “the political price of proceeding with ever more costly projects seems to be lower than sending them back to the drawing table to look for cheaper solutions or stopping them altogether.” (Nilsson & Jäderholm 2021, p. 19).

⁶ This does not make benefit-cost assessments pointless, see Asplund & Eliasson (2016).

A third advice is that more attention should be paid to how existing infrastructure is used than to how it can be augmented. As noted above, measures for improving efficiency of usage of existing capacity can be expected to have first order effects on overall efficiency of transport and communication systems. In fact, for this reason it has long been the overarching principle of transport policy in the EU that transport should be priced according to its social marginal cost. However, at least in Sweden, considerable evidence suggests that truck and rail transport is severely under-priced. Capacity problems could therefore be rectified relatively quickly through increased and differentiated taxes and charges.

A fourth advice concerns the need to analyse traditional infrastructure jointly with information and communications technology (ICT) infrastructure. This can be seen as a new twist to the “prices before investment” argument that emerges from the continued developments of “smart transport” and intelligent transportation systems (ITS) that can assist travellers and make more efficient use of transport networks. As an example, more efficient use of railroad capacity could be accomplished not just by differentiated track-use charges but also by use of market-based mechanisms for allocating both track capacity and wagon-load capacities (Hultkrantz & Lunander 2013, Isacson & Nilsson 2003, Lusby et al. 2011) to make better use of existing capacity, for instance by loading otherwise empty wagons and allowing larger train sets.

One imminent aspect of this issue is that transportation and ICT infrastructure are often handled in different planning systems, both at national and local levels, and are subject to different business models and different regulatory regimes. Another such aspect is that “smart technologies” often require sharing of information. This raises several complex problems related to information security, integrity and competition neutrality that need to be sorted out, for instance by political decisions on which organisational bodies (infrastructure manager, port authorities, etc.) must shoulder the overall responsibility for ensuring compatibility and security of collaborating systems and agents.

In conclusion, the main message of this report is that policy makers should trust the information they in many cases already have in assessing to what extent infrastructure investment contributes to economic growth.

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ISBN: 9782390670216

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