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Article

Beyond the Socio-Economic Impact of Transport Megaprojects

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Abstract: For more than two decades, scholars have been escalating asymmetric information issues in megaproject management linking them to enhanced public debt concerns. Most megaprojects turn out to be a burden on economy when constructions are completed. Authorities, meanwhile, continue to promote the advancement of megaprojects with overly optimistic public messages on expected socio-economic benefits. A combination of expertise in the topic, in-depth literature analysis, independent cost-benefit reassessment, and empirical survey of related documentation of three EU transport megaprojects shows political implications to be the essential causes of information asymmetries in megaproject management. Socio-economic over-estimations imply to be useful for obtaining and securing funding commitments at the political level, but then the real project value is often omitted from the assessment. This work takes a wider, strategic approach beyond the usual socio-economic reasoning. The article argues that socio-economic assessment practice is too narrow to grasp the full potential impact of a megaproject. Therefore, a strategic assessment should be performed by public authorities along with an appropriate funding mechanism. This work contributes to science by suggesting a direction to more constructive discussions between scholars and politicians that could lead to more effective future decisions on the overall sustainability of economies.

Keywords: megaprojects; asymmetric information; optimism bias; strategic misrepresentation; escalating commitments; cost overruns; project delays; public debt

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1. Introduction

Efficiency and effectiveness of public spending is an important property of sustainable public finance and overall growth of economy. Public spending as a significant part of fiscal policy package is a crucial topic from a project level to a fiscal package level. Scholars ([1–5]) have been intensively and openly analyzing asymmetric information issues (in particular optimism bias, strategic misrepresentation and escalating commitment) in megaproject management, linking them to enhanced public debt concerns. Literature often points out that most megaprojects have a negative impact on economies after completion of construction, thus confirming the concerns of scholars. However, public investment dedicated to megaprojects keeps on increasing. Public authorities and project promoters, despite warnings, keep on advancing with megaproject implementation persistently communicating overly optimistic information to the public on expected socio-economic benefits. The worldwide sustainability of economies has been seriously threatened by the recent economic shock due to the COVID-19 pandemic as it presented itself as the largest since the Great Depression of the 1930s [6]. Pre-crisis high public debt and, naturally, the quality of public investment issues stand herein at the center of discussions of politicians and economists [7].

Megaprojects, being major determinants of public investment quality, have become the center of attention in economic literature. Most scholars define megaprojects as the public investment projects with a total capital cost from EUR 1 billion ([5,8]) up to a national GDP [9] implying their significant share in public spending packages. Despite their risky nature [5], megaprojects have been very popular amongst politicians. Various information sources (for example, [10]) show demand for global infrastructure investments amounting to billions of euros. The European Commission (EC), in a struggle to reach its goals of a sustainable transport network, has allocated EUR 24 billion for transport sector projects alone through the Connecting European Facility (CEF) in the 2014–2020 funding period [11].

This work is a combination of the long-term expertise in the topic, in-depth scholar literature analysis, independent socio-economic reassessment of megaprojects, and empirical survey of related decisions of public authorities.

First of all, the article analyzes the causality chain from the roots of the megaprojects' failing nature to their impact on economic sustainability. The work takes into account the following economic literature, which suggests questionable socio-economic outcomes of megaprojects. The "iron law of megaprojects", documented by [12], states: *"over budget, over time, over and over again"*. Related scholar literature accordingly elaborates on persistent use of overly optimistic misleading information on forecasted benefits of megaprojects by promoters, which creates optimism bias, strategic misrepresentation, and escalating commitments in project management. Eventually, these issues lead to going over-budget and economically unjustifiable megaproject completion, which naturally converts into an additional burden of increased public debt while the public is kept at a substantial distance from the megaproject decision-making [3]. Expectations in the medium and long run are related to the additional public benefits deriving from the exploitation of the object, which has been delivered to the economy. In reference to medium- and long-term project benefits, construction and operation of infrastructures are activities with very significant social impact [10]. Literature notes that, in reality, the world of policy and project preparation and implementation is a highly stochastic one where things happen only with a certain probability and rarely turn out as originally intended [2]. Finally, in line with the widely-elaborated opinion of distinguished scholars [2,3], this work raises the hypothesis:

> *The root of the asymmetric information issues in megaproject management comes from the enhanced enthusiasm of project promoters, directed towards successful advancement in project implementation.*

Next, this work takes a strategic approach of analysis, which is wider and beyond commonly-accepted socio-economic reasoning. Three megaprojects-*Øresund Bridge*, *Brenner–Base tunnel* and *Rail Baltica*—similar in scope, objective, and governance, differing in their implementation phase are selected for independent reassessment from today's perspective and cross-referenced comparison of their social-economic impact results under *Cost–Benefit Analysis (CBA) guidelines*. Publicly available evidence reveals that funding decisions, which enabled these projects to be launched, were made on the basis of positive CBA results in each megaproject. Analysis shows that over-estimations of CBA results in all three projects, while just *Øresund Bridge*, with its initial clear commercial purpose, confirms to be beneficial to the economy under the estimated pessimistic scenario. Robust political implications of two other projects-*Brenner–Base tunnel* and *Rail Baltica* reveal other strategic purposes beyond socio-economic. In particular, the first implies to be solving long-term environmental issues in line with the EU's sustainable mobility goals under the European Green Deal [13], while the latter-NATO's military mobility issues in the Baltic region according to the EU Action Plan on Military Mobility [14]. The purposes of the two megaprojects are highly-welcomed among the public. However, they turn out to negatively impact the economy meaning that they are being delivered at the expense of the integrated and sustainable growth of the whole EU economy.

Finally, an empirical survey of publicly available documentation reveals two important points in this context. First, sensitive political decisions may raise public concerns; therefore, they tend to be covered with socio-economic impact asymmetric information. The hypothesis is therefore rejected due to implications on the root of over-optimism at the political rather than the project management level. Second, megaprojects, which are dedicated to deliver on certain strategic purposes, may include some factors that are omitted from commonly-performed socio-economic assessments. Therefore, the usual practice is too narrow to grasp the full potential impact of a megaproject. As shown in this work, a strategic perspective helps to find the logic of political reasoning, which often cannot be justifiable from a purely socio-economic point of view. The work emphasizes that strategic megaproject assessment in a combination with the establishment of appropriate funding mechanisms dedicated for solving particular strategic questions would clarify many currently-raised issues on the economic burden of megaprojects.

This work contributes to science by suggesting a direction for more constructive discussions on this topic. Better understanding of political reasoning consequently may lead to more constructive discussions between scholars and politicians, thus leading to more effective future decisions on the overall economic sustainability. Nevertheless, the socio-economic impact of a megaproject remains an increasingly important issue. The main unanswered question remains *what level of additional economic burden deriving from a megaproject is acceptable for the society in exchange for its strategic value?* Elaborations on this aspect promote further studies on searching for more appropriate megaproject assessment methodology through a strategic perspective, beyond the socio-economic. Strategic megaproject assessment approaches could therefore contribute to defining the components for the resilience of economies against economic shocks.

The structure of the analysis is the following: Section 2 provides literature analysis on the influence of asymmetric information in the context of the risks of megaproject implementation and elaborates the European Commission's widely used *Cost–Benefit Analysis (CBA) guidelines* project socio-economic impact evaluation mechanism. Section 3 explains the methodology, used for cross-evaluation of socio-economic impact of the three selected megaprojects. Section 4 provides the independent CBA reassessment results of three megaprojects (Øresund Bridge, Brenner–Base tunnel, and Rail Baltica) under the CBA guidelines, updated to today's perspective. This section also elaborates on the issues that might have significantly impacted the derivations of socio-economic results from the original ones. Section 5 cross-evaluates the projects between each other and against the publicly available decisions of authorities related to the projects. This section also provides the detailed analysis of parallel EU strategic initiatives, which imply significantly contributing to the project promotion at the political level. Section 6 discusses the political implications on the megaproject impact at the strategic level, ousting the importance of possible negative socio-economic affects.

2. Literature Analysis

2.1. Affects of Over-Estimation in Megaprojects

While many economists usually recommend government investment in infrastructure policy as a reliable and effective fiscal tool (especially to fight economic downturns), Ref. [15] points out the associated risk of significantly increasing public debt levels. Economists jointly underline high public debt levels of high-income countries before the COVID-19 crisis. Ref. [7] notes that, in general, the global debt, private plus public, stood at a record high of around 225% of world GDP pre-COVID-19, some 12% higher than before the Great Financial Crisis of 2009. Statistical evidence of [10] on infrastructure investment commitments to fight the global financial crisis of 2008 shows that this instrument is commonly exploited by governments of both developed and emerging markets. Ref. [15], however, reveals statistical evidence that government investments in infrastructure alone are insufficient measures in reduction of public debt levels. When elaborated further, the discussion on the effectiveness of public investments within a package of fiscal measures naturally evolves into a consideration on the separate impact of these investments on the economic development. A frequently published 'whatever it takes' fiscal mindset of various policymakers can easily translate to "spend like there's no tomorrow" [7]. Analyses of fiscal actions of governments worldwide in response to the economic shock caused by the COVID-19 pandemic, however, reveal that the economy's credit rating, not the public debt level, to be an essential challenge in developing expansionary fiscal policy ([7,16,17]). Looking from a broader perspective, increased public debt levels naturally lead to creditworthiness downgrades, which will naturally put an upward pressure on borrowing rates and threaten an outbreak of unstoppable pressure for inflation [7].

Efficiency and effectiveness of public spending is a crucial topic. Ref. [1,18,19] and others discuss it at a project level, while Ref. [7,15] and others at a fiscal package level. Ref. [5] notes an increased attention to the public investments in the form of megaprojects—the new animals on the European policy-making scene [20]. Most scholars associate megaprojects with the public investment projects with a total capital cost of more than EUR 1 billion ([5,8], others). Ref. [2,3] labels the Øresund Bridge project as one of them. Ref. [9] finally proposes a strikingly realistic comparison of the scale of some megaprojects that level up to a national GDP.

Many scholars ([3,5,8,21], etc.) elaborate on size, complexity, urgency, local institutional behavior, multilevel and multi-actor governance, lack of project planning management competences, high uncertainties and other pathological issues of megaprojects that eventually lead to cost overruns, implementation delays, and derivations from predefined specifications ([3,5]). Ref. [8] concludes a widely-elaborated message in economic literature that megaprojects are extremely risky ventures, notoriously difficult to manage, and often fail to achieve their original objectives. Ref. [12] concludes the "iron law of megaprojects": over budget, over time, and over and over again. Despite increasing warnings coming from scholars worldwide, a common practice of project promoters and related authorities has been evolving to feed the public through various media channels with an overly optimistic misleading information on project progress showing only their successful actions. Ref. [4,5,18] and others underline the issues of strategic misrepresentation and optimism bias have been given considerable attention during the planning process of infrastructure projects by many public agencies in developed economies. Ref. [8] adds escalating commitment—the third predominant concept—according to which executives continue to follow the pattern of behavior leading to unsuccessful outcomes rather than following an alternative course of action. Ref. [2], meanwhile, describes the root of these issues being the expectations of project promoters who would have an interest to lie and represent costs and benefits in a manner that would maximize the chances of the project winning public funding. Ref. [3] additionally suggests this behavior coming either out of ignorance or because they see such practices as counterproductive to getting projects started. Ref. [3] observes that citizens are typically kept at a substantial distance from megaproject decision-making. These factors, together with persistent feed of 'fake news' to the public by project promoters on project implementation [4], sum up to an alerting social and economic environment, where information flows, fully controlled by megaproject promoters, significantly influence overall economic environment, and public interest eventually becomes ignored.

A conclusion of [7] from several studies on a range of countries shows that a 10% increase in public debt is associated with a decrease in economic growth by around 0.3%. The perception implies that megaproject promoters persistently feed the general public with over-estimated and misleading information on project progress, triggering strategic misrepresentation and optimism bias issues in the decision-making process at a political level, which eventually leads to public debt increases and therefore eventually has to be covered by taxpayers. This implication is consistent with the elaboration of [5,12] and others stating that short political mandates further encourage misrepresentation, as does the fact that the costs of overruns and failed benefits would fall upon taxpayers and society at large rather than on the project developers.

Taking into account the above-described stressing picture, this analysis hereon raises **the hypothesis**, which is in line with the concerns of [2,3], widely escalated by many other scholars.

2.2. Cost–Benefit Analysis of Megaprojects

The EU public authorities use *Cost–Benefit Analysis (CBA) guidelines* to determine quantified expression of economic results of the European projects. *The European Commission* selects projects to be financially supported based on the economic results of their CBA. Ref. [22] describes CBA as a convenient tool for evaluation of infrastructure programs in which total social benefits of an infrastructure project are evaluated, set against the total social costs, and discounted back to the present at a social discount rate. However, there are many conceptual concerns in practical application of this methodology. Ref. [22] elaborates on the commonly-stressed concerns over the *ex-ante* evaluation method.

Despite its conceptual concerns and issues with practical applicability, the CBA evaluation methodology provides an opportunity to look at all of Europe's most important projects from the same angle of economic effectiveness. Every project is naturally a distinct one. Implications of every CBA developer on project effects are even more distinct. Section 4 nevertheless enables us to evaluate the same key determinants based on which all the social-economic impact is calculated in all selected projects. Ref. [18] shows that a large share of the 'claimed' benefits of infrastructure projects or programs are based on unrealistic assumptions and stresses the importance of the rarely performed *ex-post* project CBA assessment. Ref. [8] argues that early estimates and forecasts are used deceptively to inform decision-making and achieve the necessary alignment and support from stakeholders (including the taxpayer) to proceed with that preferred project. Section 4 highlights over-estimation practices in both ex-ante and ex-post CBA evaluation methods. The difference is that the ex-post evaluation eliminates the 'over budget' and 'over time' risks of [12] (as depicted in Section 2.1) out of the equation, and the remaining estimations on the project benefits are way more realistic. Ref. [20], for example, basing his estimation of rail and tunnel projects, calculates an average of 45% and 34% of cost overruns, respectively. This estimation is indeed optimistic compared to the vision of [2], according to which cost overruns of 50% to 100% in fixed prices are common in infrastructure megaprojects. The results of Section 4 are consistent with the elaborations of Section 2.1, consequently revealing capital cost overly optimistic estimations in ex-ante evaluations to have the greatest impact on a project's socio-economic impact results.

3. Data and Research Methodology

This section presents a cross-reference empirical analysis on the publicly available evidence about the economic sustainability of public investments committed to three *EU's Priority transport infrastructure development projects*.

3.1. Main Characteristics of Megaprojects

The descriptions of the megaprojects are available by clicking on the links provided in in the left column of Table 1 "EU Priority project". The main characteristics of the projects are shown in the other columns of Table 1.

The three projects, presented in Table 1, have been selected for independent reassessment from today's perspective and cross-comparison because of their similarities in terms of total capital cost, governance scheme, expected socio-economic effects, and, most importantly, that they are currently in different stages of the economic life-cycle. If considering an average annual inflation rate around 2% in the Eurozone between 2000 and 2021 on the basis of the official Eurostat data presented in Figure A1, the total amount of Øresund Bridge project investment in current prices of around EUR 5.9 billion would put the project on the same capital cost level with the remaining two projects. International joint ventures established by the member states to promote and implement each of these projects in a similar format (Project promoters in Table 1 include the links to their websites, where governance structures are explained). Adding to that, all three projects are dedicated to a more efficient passenger and freight logistics connection between distinct regions. Apart from similarities, Table 1 reveals the distinction of the three projects in terms of stages of their implementation. While the Øresund Bridge has been in an operations phase for

20 years, the Brenner–Base tunnel is currently well-advanced in the construction phase. Rail Baltica, meanwhile, is in the pre-construction phase.

Table 1. EU's Priority projects for comparison.

EU Priority Project	Public Investment Granted	Scope	Project Construction Phase	Project Promoter	Financial Commitment by Stakeholders *
Øresund Bridge	EUR 3.7 billion	15.9 km of bridge + tunnel (road and rail)	1995–2000	*Øresundsbro Konsortiet*	1991 (Denmark & Sweden)
Brenner–Base tunnel	EUR 8.1 billion **	64 km rail tunnel system	2011–2025 (xx)	*BBT SE*	2009 (Austria), 2010 (Italy)
Rail Baltica	EUR 5.8 billion **	870 km rail infrastructure	2022 (x)–2025 (xx)	*RB Rail AS*	2014 (o) (Estonia, Latvia, Lithuania)

*—Year of decisions by public authorities of the EU member states to permit constructions and grant funding; ** including a risk reserve (EUR 1144 billion); (x)—Project promoter publishes start of constructions in *2019*, but no official announcements have been made on the beginning of construction works of the main rail line yet. This analysis therefore estimates a likely 2022 year for launch of constructions on the main line based on publicly available information on *the project's public tenders*; (xx)—year of construction completion estimated by project promoters; (o)—year when the project promoter-joint venture 'RB Rail AS'-was established by Estonia, Latvia and Lithuania.

3.2. Cost–Benefit Indicators of Megaprojects

The analysis proceeds with the cross-evaluation of the data provided in Table 2 against external evidence, related scholar literature, and the values of Table 1. External evidence in this context is any legal, procedural, or other similar documentation published by the EU, national authorities, and project promoters, relevant to the selected projects. References of specific cases provided in Section 4. Related scholar literature herein refers to the information presented in Section 2 of this article. Sections 3.8 (Economic analysis. Transport) and 3.9 (Risk assessment. Transport) of the *CBA guidelines* are used as the basis methodology for evaluation of the socio-economic impact of the selected megaprojects. Section 3.7 (Financial Analysis. Transport) is not considered in this evaluation because it relates to the calculation of the amount of external EU contributions for projects. The abbreviations and economic terms are taken from the CBA guidelines in this analysis as well. Despite many conceptual issues, elaborated on in Section 2.2, CBA guidelines is the main commonly-accepted document in practice at the EU political level based on which a somewhat standardized view on the impact of megaprojects can be captured. Usually, the economic impact of projects is evaluated by ENPV (economic net present value), showing the total value of total quantified economic benefits throughout the project life-cycle at the current price level. In this analysis, however, the goal is to capture the level of sustainability of economic effectiveness, i.e., how robust the positive values of ENPV in the selected projects are. For this exercise, the economic internal rate of return value (ERR) by definition is a measure that shows the flipping point of the economic result, i.e., at which rate of inflation the economic net present value (ENPV) of the project flips from positive to negative and vice versa. Elaborations on sensitivity issues, noted by CBA developers, are taken into account for the reference on possible fluctuations of the main project economic factors, which determine the final socio-economic impact results.

Table 2. Comparison of the original CBA analyses of the selected projects.

EU Priority Project	Total Investments Considered by CBA	OPEX	ERR	Disc. Rate	B/C	Reference CBA (Year)	CBA Type	Sensitivity Issues Stressed by CBA
Øresund Bridge	EUR 3.824 billion	50 years	9%	3.5%	2.2	[18] (2010)	ex-post 10 years of OPEX	ERR 6% and B/C 1.4 in case of no traffic growth
Brenner–Base tunnel	EUR 6 billion	50 years	4.7%	0%; 2.5%; 8%	4.2; 1.9; 0.5	Ernst&Young Financial Business Advisors S.p.A (2007)(v)	*ex-ante*	25% investment increase reduces ERR to 3.91%
Rail Baltica	EUR 5.788 billion	30 years	6.32%	5%	1.19	Ernst&Young Baltic Ltd. (2017)(o)	*ex-ante*	26% investment increase drops ERR below 5%

OPEX = Operations and maintenance period; Disc.rate = Discount rate considered by relevant CBA; B/C = Benefit/cost ratio; ERR = Economic internal rate of return-definition from *CBA guidelines*; (v)-CBA results replicated by [23]; (o)-*Rail Baltica Global Cost–Benefit Analysis. Full Report.*

3.3. Research Methodology

The independent reassessment and cross-evaluation steps are the following for each megaproject:

1. Exposure to potential cost overruns (Table 2) evaluated by applying the relevant information from scholar literature, external evidence, the sensitivity benchmarks stressed by CBA developers, and the CBA type.
2. A combination of ERR, discount rate, B/C value, and sensitivity results of each megaproject's CBA (in Table 2) cross-evaluated to define a combination of conditions, which turn the overall project's economic results into negative:
   - ERR larger than the discount rate, together with a B/C ratio of more than 1, show the positive socio-economic impact estimation of a megaproject. The sensitivity issue column of Table 2 shows the main findings of the CBA developers that might lead the project socio-economic impact results to turn negative from positive. It also suggests the discount rate, assumed by CBA developers, in case it was not presented clearly in the CBA results.
   - Check whether the OPEX period that was taken into account in the CBA assessment is rational in the context of the operational lifetime of constructed assets elaborated in the scholar.
3. The validity of estimated forecasts in comparison with the currently-available actual statistical data.
4. Main benefits of each megaproject retrieved from their CBAs. Their extent within the project's overall socio-economic impact and their determinants identified.
5. The economic impact evaluated by cross-comparing their determinants against the same determinants of the other megaprojects.

4. Results

4.1. Øresund Bridge

4.1.1. Total Investments

As shown in Table 2, the *Øresund Bridge* project presents a very robust positive economic return on the public investment, completed in 2000 by Sweden and Denmark. The investments have been completed and no risk can be associated with investment cost increase, which is usually one of the largest factors to determine economic results of a project ([5,20] and others). However, Ref. [2] notes that this megaproject experienced a 10% cost overrun before the construction began, and an additional 38% cost overrun occurred on the Danish side alone during the construction phase. From the operation and maintenance costs (OPEX) point of view, the high-quality concrete structures are designed of the bridge to be exploited without essential maintenance for at least 100 years, whereas the replaceable concrete components can be serviced after 50 years [24]. The bridge constructions are moreover equipped with the continuous monitoring equipment that provides a continuous structure monitoring availability [25]. According to [26], the general rule of thumb of a 20% preventive maintenance share is usually achieved in infrastructure projects. This continuous monitoring of bridge structures together with all other innovative engineering decisions [27] imply a significantly larger portion of preventive maintenance and thus it is expected to cause significant OPEX reductions.

4.1.2. Socio-Economic Results of CBA

As visible in Table 2, the ERR is significantly higher than the discount rate at which the economic effect was calculated. Note that Ref. [18] considers all prices, discounted to the level of 2000 by applying 3.5% social discount rate according to the recommendations of the Danish Ministry of Transport. The CBA guidelines, on the other hand, recommend the application of 5% social discount rate to transport infrastructure projects. The ERR results of [18] assessment are larger than both recommended benchmarks (3.5% and 5%) in case of both medium traffic growth (ERR 9%) and no traffic growth (ERR 6%). This EUR 3.8 billion structure presented by [18] as a role-model public investment decision, which, in 10 years of operation, generated EUR 2 billion (discounted at 3.5% rate to the price level of 2000), or 53% of the construction cost.

4.1.3. Main Benefits

Ref. [18] present all the benefits, related to this project, directly or indirectly deriving from the passenger and freight traffic volumes, which are taken over from the ferry lines. Higher prices for bridge crossing in comparison to the ferry lines [27] were overwhelmed by the comfort and travel efficiency. Comfortable traveling over the bridge caused a significant number of re-settlements between Denmark and Sweden. Ref. [18] therefore depicts the largest part of benefits to be driven by increased effectiveness for business traveling and commuting (a total of 11.110 daily car trips).

Traffic flow official statistics of the time period between 2010 and 2020, published by the project promoter *Øresundsbro Konsortiet*, reveal the results, which could be generally evaluated as confirming the “no growth” traffic estimates of [18] back in 2010. Figure A2 shows the actual road traffic volumes by car and motorcycles (MC) between 2010 and 2019 at roughly the same level as estimated by [18] in 2010. There is a significant drop of traffic volumes recorded in 2020 due to mobility restrictions in response to the COVID-19 pandemic. Referring to estimations of [28], this article assumes a quick recovery of volumes to the pre-pandemic levels. Other, less significant freight traffic volumes on the road and rail (Figures A2 and A4) show, on average, up to about 10% increases from the forecasted trends of no growth. Benefits from freight transportation over the bridge amount to about 27% of total benefits in the estimations of [18]. Hence, a rough implication could be made that the better actual results of freight transportation are enough to compensate the overestimation of (around 20%) rail passenger volumes, forecasted by [18], as shown in Figure A3. Despite the fact that the assessment of [18] needs to be renewed to see the real picture of the *Øresund Bridge* economic effect after 20 years, it is very suitable as a benchmark for cross-comparison of the other two projects.

4.2. Brenner–Base Tunnel

4.2.1. Total Investments

Economic effect results of *Brenner–Base tunnel* raise questions from the very beginning. Total project cost in Table 1 is EUR 8.1 billion whereas Table 2 shows only EUR 6 billion of investment costs evaluated in the project’s CBA. The difference between these amounts is 35%. *CBA guidelines* indeed allow the contingencies to be excluded from the total investment amount. When implementing a project, on the other hand, contingencies (if they occur) have to be included into total project costs and therefore have to be funded by the public authorities.

4.2.2. Socio-Economic Results of CBA

The ERR value of 4.7% for this project is of concern. This value is just slightly higher than the presumed benchmark (discount rate) of 4% by CBA developers, suggesting that (even if all contracts are signed and completed ideally according to project design documentation) there is a high risk of project economic results to turn negative during the 50 years of the operations period of the tunnel. Note the stressed sensitivity issue by CBA developers (Table 2), which clearly indicates that this project would turn negative if the investment costs exceed EUR 7.5 billion (the 25% increase). For comparison purposes, Ref. [20] calculates an average of 45% cost overruns for tunnel projects, whereas Ref. [2] generalizes the estimated cost overruns of 50% to 100% in fixed prices. A highlighted sensitivity issue reveals that the CBA developers had indirectly stressed to the project promoters about this project's obviously negative social-economic impact prior to all the financial commitments being taken. The project's CBA calculations were made based on capital cost estimations of EUR 6 billion (excluding contingencies) with a predicted 35% expected unforeseen costs due to various unknowns that may arise while implementing the project. Decisions to grant funds (Table 1) were made despite these warnings. Looking back to 2009–2011, Austrian, Italian, and European Commission authorities should have based their decisions on granting funds to this project on anything but economic grounds, concluded in the project's CBA. The updated investment amount gives a negative economic effect in the frame of CBA, but the project works continue to move on with all the funding commitments of all the stakeholders.

The construction works were well advanced in the end of 2014 when a group of members of the European Parliament officially questioned the legitimacy of the above-mentioned economic assessment results [29] by naming them: *"marred by the use of obsolescent data, various methodological errors, over-estimation of benefits, and under-estimation of costs"*. The EC [30] published a purely procedural reply with no disagreement about incorrect cost–benefit assessment and confirmed the increased total project cost of EUR 9.8 billion (63% investment cost increase compared to the investment cost estimate in the project's CBA).

4.2.3. Main Benefits

Brenner–Base tunnel is purely a railway infrastructure construction project. Due to high capital and operations costs, railway projects generally are dedicated to addressing social comfort rather than commercial purposes. Differently from *Øresund Bridge*, the benefits of the *Brenner–Base tunnel* are expected to appear indirectly through passenger and cargo transportation time savings and reduction of environmental costs (e.g., damage produced by air pollution, climate change, electromagnetic fields), road accident costs, noise costs, etc. [23]. All of these project benefits are derivative benefits from modal shift (from road transport to rail) when the project is completed, i.e., when freight shippers and passengers have a quicker connection by train between Austria/Germany and Italy through the Alps, they will choose a train over a car/truck and:

- will save travel time on their trips;
- less cars/trucks on the roads of Alps will cause less car accidents;
- less cars/trucks on the roads will cause less environmental pollution due to reduced emissions;
- trains traveling through the tunnel do not produce noise, whereas cars/trucks on the roads do.

There is a number of publications about the engineering challenges along the tunnel construction progress, especially in the excavation process ([31,32] and others), causing numerous implications on project delays and increase of project costs. Some articles, such as [33], publish innovative design solutions, which, applied within this project, lead to significant optimization of project investment and operation costs. Ref. [23], however, outlines slow progress of this project due to institutional and financing problems despite serious coordination efforts from EU's heavyweight politicians.

From the current perspective of the evaluated socio-economic estimations, the only way this project may show some positive socio-economic impact on the European society is if the tunnel, when operating:

1. takes over and maintains a large portion of freight and passenger transportation through the Alps, and
2. the society will value the green (less polluting) transport mode significantly more than today.

Initiatives of shifting passenger and freight flows from road towards rail are becoming increasingly popular in the context of *the Paris Agreement*. Figure A5 shows the current volume of freight flows through the Alps accumulating to more than 40 million tons per year with the tendency to grow significantly. As an example, Ref. [1] proposes a series of measures to achieve more optimistic benefits that could derive from this project in the form of CO_2 reductions by inverting the modal balance on the Alpine corridor from current 71% road–29% rail) to 29% road–71% rail by 2035 This expected transformation of economic environment in freight transportation is further expected to contribute to the main policy objective of the EU, defined in the *Transport White Paper*, i.e., to transfer 30% of freight currently carried out by road to other transport modes, such as rail and inland waters by 2030 and 50% by 2050.

Suggestion of [1] estimates about EUR 262 million from 2026 to 2035 from freight transport pollution costs savings alone. In addition, the structures of *Brenner–Base tunnel* are designed to serve at least a lifetime of 200 years [33], meaning that the project should serve significantly longer than it is evaluated in the economic lifecycle of the project's CBA. If the estimated passenger and freight flows through the tunnel confirm in the future, unitary values of greenhouse gas (GHG) emissions costs and traffic volumes on the *Scandinavian-Mediterranean TEN-T corridor* would become the main factors according to estimations of [1].

4.3. Rail Baltica

4.3.1. Total Investments

Looking back at Table 2, the economic results of the *Rail Baltica* CBA are similar to the results of *Brenner–Base tunnel*-total public investment cost estimated at EUR 5.788 billion (including contingencies). The CBA developers, again, stress that increased investment costs by 26% or more would turn the project economic results into negative. The project is currently in the planning and documentation preparation phase. The concern, deriving from scholar literature on potential project cost overruns, is revealed in Section 2.2, and the examples from investment evaluations of the previous two projects show expected cost overruns from roughly 45% to 100% in this project.

4.3.2. Socio-Economic Results of CBA

The ERR value is 6.32%, slightly more than the benchmark 5% social discount rate. The concern on the beginning of project delivery of expected benefits complements the concern over potential cost overruns. The following information reveals the expected delays in delivery of project benefits.

The project promoter *RB Rail AS* forecasts to complete an 870 km long double-track electrified 1435 mm gauge railway line with the design speed of 240 km/h, fully equipped with *ERTMS* in just four years (by 2025). The following evidence from the previous stage of the Rail Baltica project could be linked to such project promoter's unrealistic estimation [18]. Ref. [23] identifies two stages of the Rail Baltica project. The first was related to the reconstruction of the existing railway infrastructure in Lithuania (from Polish/Lithuanian (PL/LT) state border to Kaunas completed in 2015, please see Figure 1 the green route). The second ("the new Rail Baltic project", according to [23]) was foreseen to be constructed with the design speed of 240 km/h (249 km/h according to the project promoter) along the red route of Figure 1.

Figure 1. The first part of Rail Baltica (green line) vs the new Rail Baltica project (red lines). Source: [23].

The first part of a 120-km long Rail Baltica line infrastructure in Lithuania (as identified by [23]) was constructed in the period between 2010–2015 (six years). The scope of works completed is equivalent to the construction of around 120 km of double track railway line with a full construction of embankment and railway structures and excluding installation of electrification and signaling systems on the line. For this scope, the vast majority of railway construction resources from Lithuania and surrounding neighbors were attracted to work on site. The scope of "The new Rail Baltica project" is more than seven times larger, but the workforce resources in the region have not increased in the region 2015. It also includes the installation of railway systems (electrification and *ERTMS*), which are time-consuming due to the necessity of thorough design, system configuration works, and, most importantly, development of interfaces with the systems of local electricity providers, etc. Additionally, having in mind long-lasting public procurement procedures on large-scale public purchases, this environment implies that the construction works on the *Rail Baltica* (or "the new Rail Baltica project") will be significantly extended and therefore the economic benefits from the project will be postponed.

With the upcoming tenders for the construction works (see Table 2), there is a significant risk of construction costs increasing. After the evaluation of 258 sample transport projects, Ref. [20] concludes average cost overruns in the railway infrastructure projects being 45%, whereas Ref. [2] has less optimistic estimates of 50–100% cost overruns during the construction phase. If all other project's CBA estimates remain unchanged, *Rail Baltica* economic results would turn negative as ERR would end up significantly lower than a 5% discount ratio benchmark, and the B/C ratio would be less than 1 after the main construction contracts signed.

4.3.3. Main Benefits

The enhanced will of project promoters to present the project to the public as better than reality is also clearly visible on *the project promoter's website*, where the promoter compares the investment costs (EUR 5.8 billion) with the quantifiable benefits in non-discounted prices (EUR 16.2 billion). At first glance, the numbers look very attractive; however, the comparison is incorrect from an economic point of view. The investment costs (EUR 5.8 billion) are calculated at a recent price level (2017) based on price levels of previously-completed projects. The benefits, on the other hand (EUR 16.2 billion), reach the price levels of 2055 with the estimated annual inflation of 5%. *Rail Baltica Global CBA (2017)*, however, reveals that the project promoter's published EUR 16.2 billion quantifiable benefits in fact are worth only EUR 4.581 billion EUR when prices are calculated at the same price level as project investment costs (Figure 2).

Table 94 Cost-benefit summary by countries

			Split by Rail Baltica track distance		
			Estonia	Latvia	Lithuania
		Total	EE allocation	LV allocation	LT allocation
			25%	30%	45%
Funding needs	CAPEX, M EUR	5 788	1 346	1 968	2 474
	National investment, M EUR (undiscounted)	1 155	268	393	493
	National investment, M EUR (discounted)	776	179	266	331
	Initial cash needed for cash balance, M EUR	29	7	9	13
	Additional financing needed for renewable investments, M EUR	534	131	161	242
Socio-economic cash flows	Total net benefits, M EUR (undiscounted)	16 226	3 978	4 895	7 354
	Total net benefits, M EUR (discounted)	4 581	1 123	1 382	2 076
Financial cash flows	Infrastructure manager revenues (undiscounted)	2 613	641	788	1 184
	Infrastructure manager revenues (discounted)	703	172	212	319
	Infrastructure manager OPEX (undiscounted)	2 543	623	767	1 153
	Infrastructure manager OPEX (discounted)	693	170	209	314
	Investment expenses (undiscounted)	5 788	1 346	1 968	2 474
	Investment expenses (discounted)	3 889	896	1 334	1 659
	Other net financial benefits (undiscounted)	1 684	413	508	763
	Other net financial benefits (discounted)	178	44	54	81
Ratios	Undiscounted B/C	2.80	2.96	2.49	2.97
	Discounted B/C	1.19	1.26	1.07	1.25

190

Figure 2. Rail Baltica Global project CBA results Source: : *Rail Baltica Global CBA (2017)*, accessed on 25 July 2021.

Similarly to *Brenner–Base tunnel*, the *Rail Baltica* project is also purely a railway infrastructure construction project, implying that the financial benefits should not be expected from the operations of the newly-built infrastructure. As highlighted by the *Rail Baltica Global CBA (2017)*, the project is dedicated to address social comfort and climate change benefits instead. Therefore, the following key benefits indicated by *Rail Baltica Global CBA (2017)* are:

- Air pollution reduction;
- Climate change mitigation benefits;
- Freight travel time savings;
- Passenger travel time savings;
- Additional personal transport savings;
- Freight carrier operating profit;
- Safety improvement;
- Noise reduction;
- Additional freight transportation savings/expenses.

All above-indicated benefits are mainly dependent on the ability of the newly-built railway infrastructure to attract freight and passenger flows to shift onto rail from other local modes of transport (road, air). Similar to the case of the *Brenner–Base tunnel,* the unitary values of time and green house gas emissions savings, indicated by [1], play an important role here too.

From the first glance at the passenger flow forecasts (Figure A8), questionable benefits reveal themselves on the sections Vilnius-Kaunas and Kaunas-PL/LT border. Furthermore, the dotted lines between these particular sections in Figure 3 reveal that there is no track alignment defined for these sections yet, meaning that these sections are not yet prepared for land acquisition, design, and construction tenders, and, therefore, their estimated benefits would have to move further to the future.

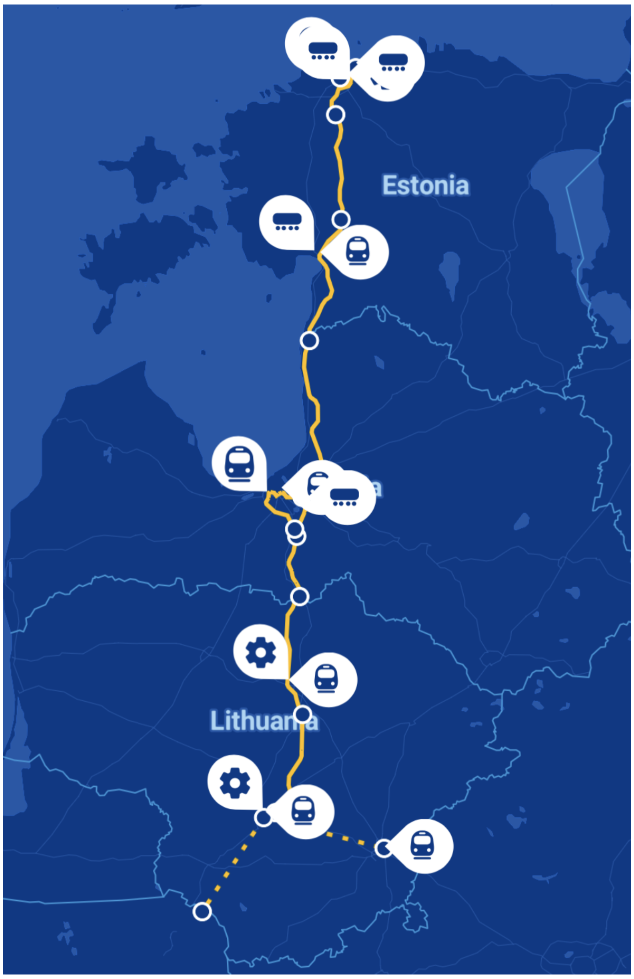

Figure 3. The new Rail Baltica Global project routing, published by project promoter Source: *Rail Baltica interactive map*, accessed on 25 July 2021.

Currently, in section Vilnius-Kaunas (the existing 1520 mm gauge double track railway line), 15–16 passenger train pairs per day are in operation (*Vilnius-Kaunas official train schedule as of 28 March 2021*). According to the assumptions of the *Rail Baltica Global CBA (2017)*, the new railway connection Vilnius-Kaunas will be faster than the existing one and will offer parallel daily operations of 11–12 passenger trains (Figure A6). This, first of all, implies a competition between parallel railway lines on this 100 km long Vilnius-Kaunas section, and, therefore, the passenger flows will be shared between these lines based on whichever service would be more convenient. The travel time savings would not be significant in any case because of a very short distance for a train ride. In the end, the taxpayers are the ones paying for maintenance of both parallel railway infrastructures no matter which is used more (this question is not evaluated in the CBA). This picture consequently implies a robust implication of overestimated rail passenger volume-related economic benefits on the Vilnius-Kaunas (the busiest, according to estimations in Figure A8) line throughout the project lifecycle.

A brief evaluation of estimated freight traffic flows on the same railway Vilnius-Kaunas and Kaunas-PL/LT lines, estimated by *Rail Baltica Global CBA (2017)* (Figures A7 and A9) and, again, cross-checking with the dotted lines between these particular sections in Figure 3 suggests the same concern as with the economic benefits from passenger flow estimations. Currently, the track alignment of the new Rail Baltica infrastructure on the Vilnius-Kaunas and Kaunas-PL/LT border is not defined, so the land acquisition procedures, preparatory technical documentation, and construction works are yet to be launched. Meanwhile, the existing Vilnius-Kaunas (1520 mm gauge double track) and Kaunas-PL/LT (1435 mm single track—the first part of Rail Baltica identified by [23]) railway sections are currently in operation. Construction of the new rail infrastructure in the scope of *Rail Baltica*, parallel to the existing rail sections, would create competition between two lines with similar train travel times because of short distances between stations. Therefore, the freight volumes would be shared between the parallel competitors, causing no environmental costs savings. Again, in the very end, the taxpayers are the ones paying for maintenance of both parallel railway infrastructures no matter which is used more (this question is not evaluated in the CBA). Further to this, freight logistics by nature are not as sensitive to time savings as they are to punctuality. This implies that the more convenient organizational and operational setup between the currently operational infrastructure and foreseen Rail Baltica infrastructure on sections Vilnius-Kaunas and Kaunas-PL/LT border will prevail and overtake the freight flows, while the taxpayers will be paying for operations and maintenance of two parallel railway infrastructures instead of one.

There are several other concerns regarding the overestimation of freight flows in *Rail Baltica Global CBA (2017)*:

1. Ref. [23] concluded a concern over export/import figures. For example, the fact that trains may be full from east to west (from Russia to Germany or to the Baltic countries) or north to south, but not on their return journeys because it is not cost-effective. This implies a large portion of empty freight trains running upwards as shown in Figure A7 with less foreseen possible revenues for the undertakers.
2. Figure 4 reveals the potential sources of freight flows streaming either from trans-Siberian Railway, Northern Russia, or Finland. Russia recently has been developing the operating capacities of the Ust Luga port (in the Gulf of Finland, close to St. Petersburg). Statistics show that, in 2020, Ust Luga port handled 102.6 million tons of freight (*Statista.com* accessed on 25 July 2021). This implies that the northern part Russia is bound to use its own port for logistics activities instead of giving up freight flows to the ports in the Baltic states. Finland, meanwhile, has been successfully completing the country's railway infrastructure development projects on the Scandinavian-Mediterranean TEN-T corridor (Figure 5). Finland's road and rail infrastructure is also included in the scope of the European Union's *Nordic Triangle railway/road axis*, which extends through the *Øresund Bridge* down to the Southern Europe along the Scandinavian-Mediterranean TEN-T corridor to Italy via the *Brenner–Base tunnel*. By using the EU funds, the Nordic countries have been intensively developing the infrastructure on the *Nordic Triangle railway/road axis* since 2007. As visible in Figure 5, the Scandinavian-Mediterranean TEN-T corridor with its upgraded rail and road infrastructure is the prevailing direct competitor over freight flows from the Nordic countries against the Rail Baltica line, which is a part of the North Sea-Baltic TEN-T corridor. This implies that the Nordic countries have stronger interest in exploiting their own transport infrastructure along the Scandinavian-Mediterranean TEN-T corridor rather than to use the Rail Baltica line. An implication concludes that the freight flow source from Finland would be questionable to travel through the Rail Baltica line in the future.

To conclude, the main benefits of the Rail Baltica project could appear significantly later than forecasted by project promoters and public authorities. The socio-economic impact is over-estimated in the project's CBA because the main determinants of the project's socio-economic benefits—expected passenger and freight volumes—are estimated unrealistically with important current business environment factors left out.

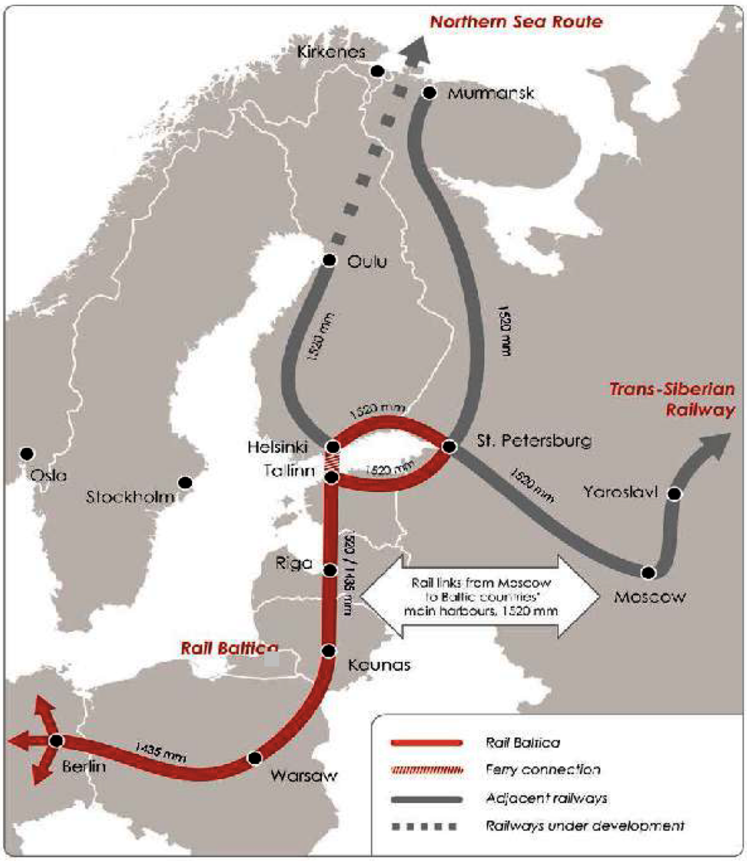

Figure 4. Directions of freight flows between Russia and Central Europe. Source: [23].

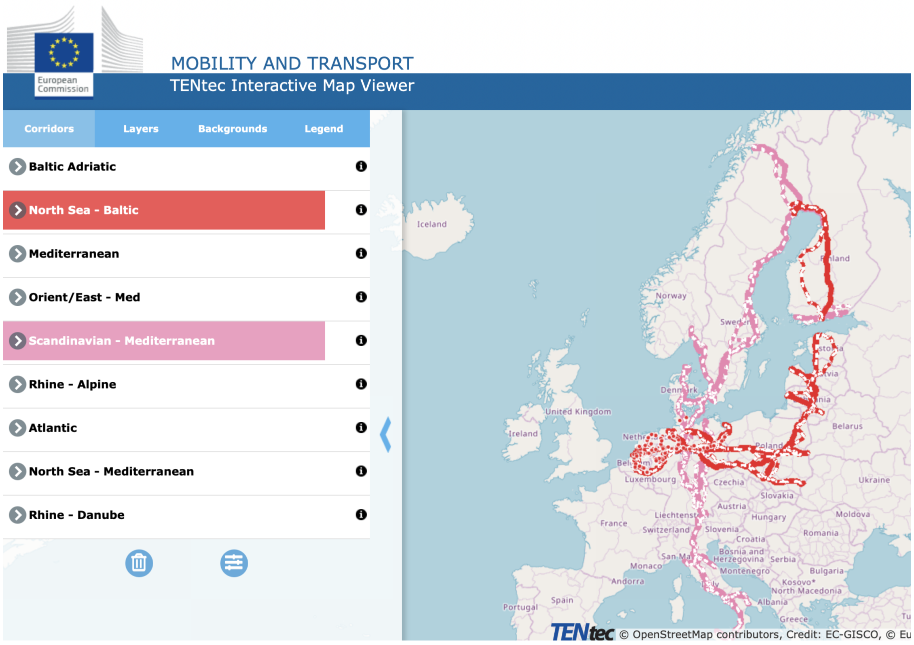

Figure 5. Scandinavian-Mediterranean and North Sea-Baltic TEN-T corridors. Source: *TENtec*, accessed on 25 July 2021.

5. Comparative Analysis

After the update of the CBA analyses of each megaproject to today's perspective, the results are revealed in Table 3. Concluding comparisons of the main socio-economic results of Section 4 in the context of the methodology of CBA guidelines is the following.

Table 3. Comparative analysis of socio-economic results under the commonly-accepted CBA framework, updated to today's perspective.

Essential Points	Øresund Bridge	Brenner–Base Tunnel	Rail Baltica
Investment cost overruns	±50% concluded after constructions	63% confirmed so far. Construction ongoing	50–100% estimated. Constructions yet to start
Project purpose identified in CBA	New fixed link transport connection (15.9 km) replacing ferry line services	New rail link across the Alps (64 km) to shift traffic volumes from road to rail	Fast rail service across the Baltic region (870 km) to shift traffic volumes from other transport modes
Key socio-economic determinants	Road passenger (commuter) traffic volumes/ service charges	Passenger and freight traffic volume shift from road to rail/ GHG emission cost unitary prices	Passenger and freight traffic volume shift to rail/ GHG emission cost unitary prices
Occurrence of over-optimism in CBA estimations	Passenger and freight volumes from 2010 over-estimated in the main scenario	Underestimated investment costs and construction term	Underestimated investment costs and construction term. Over-estimated freight and passenger flow forecasts.
Key conclusions of results under the CBA framework	**Positive CBA result** confirmed under pessimistic 'No growth' scenario-estimation confirmed by 2010–2020 actual data. Steady volumes of commuter travels since 2010, consumer willingness to pay higher costs for services	**Negative CBA result** due to significant investment cost overruns. Unrealistic, significantly higher than estimated freight traffic needed throughout 50 years of tunnel operation to turn CBA result into positive.	**Negative CBA result** due to expected investment cost overruns and unrealistically estimated traffic volumes

The Øresund Bridge project is definitely a 'role-model' project. Table 3 does show this project to confirm the estimations of its positive socio-economic impact under the CBA guidelines. The reason for this compliance implies to be the project's purely commercial nature. The benefits of this project are incoming from the tariffs of rail and road traffic flows that essentially disrupted the market of ferry line services between Denmark and Sweden. Section 4.1.3 reveals the essential socio-economic impact determinants to be road/rail passenger and freight traffic flow forecasts, together with transportation service tariffs, collected from crossing the bridge. Ref. [27] notes higher pricing policy applied for using the bridge due to previous public agreements with the ferry line businesses on compensation in case ferry line services are disrupted. Despite this, the relatively steady traffic volumes imply the current pricing levels to be acceptable for the public.

As elaborated in Section 4.1, the finalized post-construction total investment amount of the Øresund Bridge project can not influence the project socio-economic impact results in the future. The project did experience investment cost overruns of around 50% during the planning and construction phases, thus confirming the general trends of megaprojects presented by [2,20]. The reassessment traffic flows based on the actual figures from 2010 to 2020 reveal the over-estimation of the [18] CBA results. The traffic volume estimations of the main scenario 'medium growth', proposed by [18] back in 2010, were overly optimistic, and a 'no growth' scenario revealed itself as very close to the actual statistics. This implies that the public adaptation (in this case, the inter-regional resettlement of commuters) to the new levels of comfort, created with the project, finalized in about 10 years of project operation. The estimates of a 'no growth' scenario in 2010 were overly optimistic for rail passenger volumes, but the underestimated forecasts for all freight volumes could be considered as complementing the former. Finally, the largest portion of socio-economic benefits in 'no growth' scenario, in the context of commuting transportation volumes, confirms the trend today. Having in mind that the 'no growth' scenario traffic volume estimates, together with unchanging investment cost value and relatively stable operations costs, produced a B/C ratio of 1.4 (at 3.5% discount rate) and an ERR of 6%, today's estimations could be drawn at a similar level as these figures, still positive in terms of socio-economic impact. The results described above conclude a fragile, but positive Øresund Bridge project socio-economic impact.

Despite the revealed over-optimism in CBA estimations of all three megaprojects (Table 3), the CBA results from today's perspective show the Brenner–Base Tunnel and Rail Baltica projects to be having a negative socio-economic impact. Table 4 summarizes the key aspects of the exploitation of asymmetric information by megaproject stakeholders.

Table 4. Comparative analysis of the exploitation of asymmetric information by the megaproject stakeholders along the project implementation.

Essential Points	Øresund Bridge	Brenner–Base Tunnel	Rail Baltica
Publicly available warnings on expected project negative socio-economic outcomes	-	2007 (CBA sensitivity analysis), since 2014 (multiple sources)	Since 2014 (multiple sources), 2017 (CBA sensitivity analysis)
Financial commitments confirmed	Completed in 2000	Since 2009–current	Since 2014–current
Current public communication on positive socio-economic results by Project promoter (European Commission)	Yes (Yes)	No (Yes)	Yes (Yes)

Taking into account the information from Tables 2–4, implications of asymmetric information issues, such as optimism bias and strategic misrepresentation, elaborated by [4,5,18] can be drawn in both the Brenner–Base Tunnel and Rail Baltica projects. The analysis provided in Sections 4.2 and 4.3 reveals the risks, associated with investment cost overruns in both cases. Over-optimistic public announcements (examples: *rail-technology.com publication* accessed on 25 July 2021 , *ec.europa.eu* accessed on 25 July 2021) in the pre-construction project phase were based on the misleading information from the project's CBA (Table 2 and explanation in Section 4.2.1). This picture is consistent with the implication of theory [2] on the expectations of project promoters who might have an interest in presenting project costs and benefits in a way to maximize the chances of winning public funding being a root of the optimism bias issue. Indeed, project promoters are hired to run the project. If the project shows a negative socio-economic impact, it will be cancelled and the promoters will lose their jobs. Project promoters persistently feed the public with positive project results, even if they are incorrect (as shown by the incorrect investment costs at current prices vs. undiscounted benefits comparison in *railbaltica.org/finances* accessed on 25 July 2021 or *railbaltica.org/cost-benefit-analysis* accessed on 25 July 2021 and explained in Section 4.3.3) to collect popularity credits and thus evolve the optimism bias. Public authorities in charge of decision-making are willing to follow the popularity trend; therefore, they tend to decide accordingly on project implementation and funding. As the project advances into the construction phase, optimism bias issue evolves, and the strategic misrepresentation issue emerges [5] because the decision-makers are not willing to risk to change their previously made decisions on significant funding due to irreversible project progress achieved.

These implications, representing **the hypothesis** of this work, are consistent with the following situation in the Brenner–Base Tunnel project, when evaluated purely from the project management point of view. However, the external evidence shows rather political implications, which prevail over the ones described above.

The construction works were well advanced in the end of 2014 when a group of members of the European Parliament officially questioned the legitimacy of the above-mentioned socio-economic assessment results [29] by naming them:

"marred by the use of obsolescent data, various methodological errors, over-estimation of benefits, and under-estimation of costs."

The EC [30] published a purely procedural reply with no disagreement about incorrect cost–benefit assessment and confirmed the increased total project cost of EUR 9.8 billion (63% investment cost increase compared to the investment cost estimate in the project's CBA). This reply of [30] in a formalistic way strongly suggests several important factors on the expressed position of the EC:

1. The EC fully supports this project with all the previous financial commitments;

2. The EC may base its decisions on financial commitments not necessarily in line with the formally accepted basis of CBA guidelines (strategic misrepresentation, as elaborated in Section 2.1).

As the investment cost overrun of 63% has already occurred during the construction phase, the Brenner–Base Tunnel project appears to currently have no legitimate socio-economic impact justification under the commonly-accepted CBA methodology.

The socio-economic impact of the Rail Baltica project at this point of implementation is even more risky. As highlighted in Section 4.3.2 and Table 3, current total investment costs are exposed to a risk of high cost overruns due to the revealed optimism bias issue, escalated by project promoters, which are expected to trigger possible strategic misrepresentation and escalating commitments practices of relevant decision-makers. The empirical evidence, concluded in Table 4, reveals that the project management situation in the case of Rail Baltica is in line with the "iron law of megaprojects", documented by [12]: *"over budget, over time, over and over again"*. An estimation of exceptionally quick completion of construction works of fully functional 870 km long railway infrastructure in just four years (as explained in Section 4.3.2) implies significant postponement of the full completion of the construction stage of the project as a whole. Implication of overestimated passenger and traffic flows is explained in Section 4.3.3. The upcoming public procurement, land acquisition, design documentation development, and other pre-construction long-lasting activities imply that high estimates of freight and passenger flows on Vilnius-Kaunas and Kaunas-PL/LT border sections would be significantly postponed. The explanation in Section 4.3.3 also reveals incorrect traffic volume estimate forecasts in the medium- and long-run on Vilnius-Kaunas and Kaunas-PL/LT border sections due to currently existing railway operations on parallel lines, which, after the Rail Baltica project completion, would compete for traffic volumes with the newly built Rail Baltica infrastructure. Relatively short distances and technical/environmental aspects of Vilnius-Kaunas and Kaunas-PL/LT sections suggest no significant train speed or other kind of performance-related benefits on the new Rail Baltica line over the current competitor. North–South freight traffic volume estimates from Tallinn to Poland, as stressed by [23] and described in Section 4.3.3, suggest significant over-estimations because the flows from Russia are being diverted to Russia's own Ust Luga port near St. Petersburg and expected Finnish freight has a significant potential to travel on newly modernized road and rail infrastructure along the parallel Scandinavian-Mediterranean TEN-T corridor.

All the implications above suggest highly questionable estimated volumes of freight flows on Rail Baltica. The megaproject's socio-economic impact (keeping in mind capital costs with a tendency of significant increase) cannot be justified with the current publicly-elaborated assumptions. Without additional purposes and therefore additional external benefits assigned, this project is at risk of becoming just a financial burden on taxpayers in the medium- and long-run, unless this project is designed to serve some other external purposes.

The two megaprojects with negative CBA results, shown in Table 3, are investigated through a wider perspective, beyond the usual socio-economic framework. Table 5 presents external (strategic) values of these projects, documented and published by the EU authorities from parallel ongoing EU's initiatives. These external values are either omitted or undervalued in the previous CBA practices (Table 2).

Table 5. Analysis of the external megaproject values in the context of EU's parallel ongoing strategic initiatives.

Essential Points	Brenner–Base Tunnel	Rail Baltica
EU's parallel ongoing strategic initiatives	EU sustainable mobility goals within the European Green Deal [13] to reduce the GHG emissions by 90% by 2050	EU Action Plan on Military Mobility [14]. Commitment to have a fully-fledged European Defense Union by 2025
External factors, significantly improving the socio-economic value of the project	1. World's efforts to reduce the effects of global warming significantly raise the unitary values of GHG emission costs. 2. Tunnel construction lifecycle is around 200 years (150 years of project benefits omitted in 2007 CBA assessment).	Critical missing link for NATO military mobility—absence of EU standard gauge rail infrastructure on the major part of the Baltic region.
Pending questions for application of strategic approach	Construction works are close to completion with currently-granted funding. No current public necessity for socio-economic assessment. It should arise several years after completion of construction works when ex-post CBA will be required under EU's legislation. Actual freight volumes transported through the tunnel would be possible to evaluate together with enhanced unitary values of GHG emission costs	Project mainly funded from EU Cohesion fund and national budgets of Estonia, Latvia, and Lithuania. Current funding model reduces economic growth potential in the Baltic region, jeopardizes the initial purpose of the EU Cohesion policy. Sensitive public issue in the Baltic region. Military mobility funding possible up to 10% only, but should fully fund the project.

Section 4.2.3 and Table 3 show the main determinants of socio-economic benefits of the Brenner–Base Tunnel project to be the freight and passenger transportation volumes across the Alps (along the Scandinavian-Mediterranean TEN-T corridor) and the unitary values of greenhouse gas (GHG) emissions cost. Freight volumes alone on this corridor accumulate to the level of more than 40 million tons per year and have a reasonable tendency to grow on Europe's main transport axis. Table 5 shows the socio-economic impact of the Brenner–Base Tunnel project could still be positive in the very long run (i.e., 200 years, considering the tunnel operation lifecycle) if the rail passenger services through the tunnel are capable to take over a significant portion of the passengers from the current road transport volumes and freight capacity estimate growth across the Alps confirms and (at least) stays on the rail as shown in Figure A5. Justification on increased unitary values of GHG emissions cost increase could also result in additional project benefits. Both factors, traffic volumes and unitary values, should become more popular in the future in the context of promoting green policy support worldwide. This overall environment implies that the project promoters have a decent chance to make this project acceptable to the public, if this expensive purchase is publicly presented as an investment in substantial reduction of global warming effects. The recent EU's strategy on sustainable mobility goals within the European Green Deal [13] to reduce the (GHG) emissions by 90% by 2050 suggests the primary goal of the Brenner–Base Tunnel to significantly contribute to the environmental changes. This perception ultimately rejects **the hypothesis** because, despite the contribution of the project to the strategic environmental sustainability goals, it implies to be the root of asymmetric information in project management, arising from imperfections of EU legislation.

The strategic purpose of Rail Baltica is being documented and published by the EU authorities in parallel to the project implementation. The Warsaw declaration of 2016 [34] between the European Commission, European Parliament, and the NATO defined the framework for the development of the EU's Action Plan on Military Mobility [14]. The European Commission President, Jean-Claude Junker, in his State of The Union address (September 2017, [35]) introduced the EU's initiative of creating a fully-fledged European Defense Union by 2025. A follow-up of this speech, the Action Plan on Military Mobility of March 2018 [14], was a follow-up EC communication. It identified the necessity to develop the EU transport infrastructure for dual civilian–military purposes with sufficient technical parameters for effective military movement.

The critical missing link for the NATO military mobility is the absence of EU standard gauge railway infrastructure on the major part of the Baltic region (from Kaunas (Vilnius) up to Tallinn). The difference between the width of EU and Russian standard rail track gauges is 8.5 cm. This legacy technical barrier, imposed as a measure of military strategy of the Russian army against Germany in the beginning of the 20th century, does not allow the trains of the EU standard to travel on the currently-existing Russian gauge railway networks in the major part of the Baltic states. The rail track gauge difference had proven useful during Russia's war with Turkey back in 1877, as it could slow the enemy's military advances [36]. The difference in track gauges is presented in Figure A10.

In particular, the Action Plan on Military Mobility escalates the necessity of the infrastructure on the North Sea-Baltic Corridor (page 4 of [14]). The Importance of Rail Baltica to the Military Mobility initiative was expressed in the media as well (*By NATO commander*, accessed on 25 July 2021, *EURACTIV*, accessed on 25 July 2021). On 21 July 2020, the European Council reached an agreement on the new long-term EU budget, allocating EUR 1.69 billion EUR (in current prices) for military mobility, dedicated to construction of missing links within the CEF 2021–2027 [37] and a significant amount of this funding could be allocated to Rail Baltica. This evidence, together with the unjustifiable socio-economic impact potential of Rail Baltica, leads to an implication that the project is primarily dedicated to the military mobility purposes, while an availability for public transport operations will be created as well.

The current estimation of the Rail Baltica capital costs is around EUR 5.8 billion with a rough probability to increase by 50% to 100% during construction (up to EUR 11.6 billion). With the current military mobility funding allocations, this project could receive up to 10% of its cost only. From the socio-economic perspective, the Rail Baltica project concludes to be at risk of becoming a huge financial burden on taxpayers in the medium- and long-run. The project funding consequently would be covered mostly from the national budgets of Estonia, Latvia, and Lithuania, including the EU's contributions through the *Connecting Europe Facility (CEF)* funding instrument. According to [38], CEF allocates the funds, transferred from the Cohesion fund, which are dedicated primarily for the regional economic cohesion with the economic level of the EU [39]. Despite the highly-encouraging initial purpose of Rail Baltica, the decision of public authorities on project funding therefore implies that these military mobility developments are being delivered at the expense of the economic development of the Baltic states and therefore jeopardizes the notion of balanced, integrated, and sustainable growth of the whole EU economy.

This picture, once again, ultimately rejects **the hypothesis** since the root of misleading information on socio-economic impact, persistently published by the promoters of Rail Baltica, implies to be the initiative of the public authorities with other than socio-economic goals in mind. However, sensitive decisions, especially on funding allocation, which may raise public concerns, suggest to be covered with asymmetric information, such as overly optimistic socio-economic impact estimations. It shows up as a convenient tool for public authorities to score popularity credits and to keep the public away from decision-making.

6. Discussion

The original CBA assessments of the analyzed megaprojects (Table 2) all show positive socio-economic results. All of these assessments include overly optimistic estimations on future economic development (Table 3), leading to political decisions on securing the necessary funds under the EU legislative requirements. The independent CBA reassessment from today's perspective (performed within this research), meanwhile, shows two of three megaprojects to actually cause a significant burden on the economy (Table 3). Analysis of the decisions of public authorities shows robust financial commitments and persistent public communication on positive project outcomes despite numerous warnings on economic threats coming from scholars, independent politicians, and even from the CBA developers all throughout the megaproject development (Table 4).

The empirical survey of parallel EU's strategic initiatives, however, suggests additional external strategic values for the economically-failing megaprojects (Table 5). On one hand, these external strategic values are omitted from the commonly-accepted CBA practice, while, on the other, they imply to be ousting the whole concept of socio-economic assessment of megaprojects. In particular, if a megaproject is dedicated to achieving a certain strategic goal of the EU, it will be strongly supported by the EU authorities all the way through its implementation, despite a possibility of negative socio-economic consequences. This results in a notion that **every megaproject**, promoted by the EU, is of a high public value either from an economic or other strategic point of view. However, then, commonly-performed socio-economic assessment practice implies to be too narrow to evaluate the full potential impact of a megaproject. In this case, a wider perspective needs to be applied to find the logic of political reasoning, which cannot be justifiable from a purely socio-economic point of view.

Several captivating questions arise herein. The first question is *why would the public authorities need to persistently use asymmetric information on project benefits to cover the negative socio-economic impact if the megaproject actually has a higher strategic value, which is omitted from the socio-economic assessment?* Despite high strategic value, the socio-economic impact of a megaproject remains an increasingly important issue because society eventually has to pay for the implementation and operation of the newly-created structures. The second question therefore is *what level of additional economic burden deriving from a megaproject is acceptable for the society in exchange for its strategic value?*

As shown in this analysis, all three projects are dedicated to solving specific issues in certain regions. While the Øresund Bridge project, with its clear commercial purpose, is definitely bringing in new opportunities to the economic well-being of the local society (i.e., Sweden and Denmark), the other two projects, Brenner–Base Tunnel and Rail Baltica, are causing challenges to the local economies instead (i.e., Austria/Italy and Estonia/Latvia/Lithuania, respectively). All three projects are, meanwhile, extremely important to the EU from a strategic point of view.

The current EU practice to fund strategic projects (independently of their initial dedication) through the EU's structural funds package is a sensitive public issue, and it turns out to be significantly contributing to the discussions on the first above-mentioned question. Persistent use of asymmetric information by public authorities conveniently helps to avoid public concerns and to score popularity credits from high hopes on expected megaproject outcomes. The EU structural funds (in particular, the Cohesion fund) are initially dedicated to achieving socio-economic equality in every EU region (this issue is elaborated in Section 4). Political decision-making to solve strategic issues with particular regional funding consequently raises many questions on the region's later ability to meet the public expectations of economic development and social well-being.

This analysis emphasizes that the projects should be funded from the appropriate funding packages, dedicated for specific strategic purposes. Separate assessment of all EU's initiatives dedicated towards environmental sustainability should be completed and, consequently, an adequate joint funding package for these initiatives should be identified. Similarly, the military mobility initiatives throughout the EU should be collected, jointly assessed, and included into one funding package from military funding sources without mixing it with the funding dedicated for regional socio-economic development. This approach would create less discussions and more trust between authorities, scholars, and the public in general.

Better understanding of political reasoning and more clarity in political actions related to megaproject developments may consequently lead to more constructive discussions between scholars and politicians, thus leading to more effective future decisions on the overall sustainability of the economy. Elaboration on the second above-mentioned question should lead to the search for more appropriate megaproject assessment methodology through a wider, strategic perspective, beyond the socio-economic. Strategic megaproject assessment approaches consequently could contribute to defining the components for resilience of economies against economic shocks.

7. Conclusions

The economic literature, analyzed in this work, is consistent with the CBA results evaluated in this analysis in the context of over-estimations. Despite their ex-ante or ex-post status, all three CBA reassessments show over-optimism in estimations of socio-economic forecasts. The in-depth empirical study of publicly available documentation, related to the megaprojects, ultimately rejects the hypothesis, raised from the overview of the related scholar literature, stating:

The root of the asymmetric information issues in megaproject management comes from the enhanced enthusiasm of project promoters, directed towards successful advancement in project implementation.

Robust political implications reveal other strategic (not necessarily socio-economic) purposes of some megaprojects. The study shows that commonly-performed socio-economic assessment practice is too narrow to grasp the full potential impact of a megaproject. Therefore, a strategic perspective in many cases needs to be applied to megaprojects instead of commonly-accepted socio-economic assessment.

The study shows a high value of all three megaprojects to the society, but not necessarily from a socio-economic point of view. Øresund Bridge, in line with the CBA assessment results, has a clear commercial purpose. Faster and more comfortable transport connection between Sweden and Denmark comes at a higher cost, but is accepted by public over disrupted ferry services. Significant construction cost overruns in the Brenner–Base tunnel show unjustifiable socio-economic impact according to the CBA guidelines. However, the project tackles the long-term environmental issues in line with the EU's sustainable mobility goals under the European Green Deal, which are bound to be more valued by the public than up to now. In light of the current trends of the worldwide policy to meet the objectives of *the Paris Agreement*, the project intends to stand firmly as publicly acceptable. Rail Baltica shows unjustifiable socio-economic impact according to the CBA guidelines. However, it intends to be solving primarily the EU's military mobility issues in the Baltic region. Despite the highly-encouraging initial purpose of Rail Baltica, the decision of public authorities on project funding therefore implies that these military mobility developments are being delivered at the expense of the economic development of the Baltic states and therefore jeopardizes the notion of balanced, integrated, and sustainable growth of the whole EU economy.

Sensitive decisions, which may raise public concerns, suggest to be covered with asymmetric information, such as overly optimistic socio-economic impact estimations. It shows up as a convenient tool for public authorities to score popularity credits and to keep the public away from decision-making. The current EU's practice, to fund all strategic projects (independently of their initial purpose) through the EU's structural funds package, initially dedicated to achieving socio-economic equality in all EU's regions, should be revised as it jeopardizes balanced, integrated, and sustainable growth of the entire EU economy. The projects, therefore, should be funded from the appropriate funding packages, dedicated for specific strategic purposes, not mixing them with the funds dedicated to region-specific economic growth. This would create less discussions and more trust between the authorities, the public, and scholars.

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Abbreviations

The following abbreviations are used in this manuscript:

MDPI	Multidisciplinary Digital Publishing Institute
DOAJ	Directory of Open Access Journals
TLA	Three Letter Acronym
LD	Linear Dichroism

Appendix A

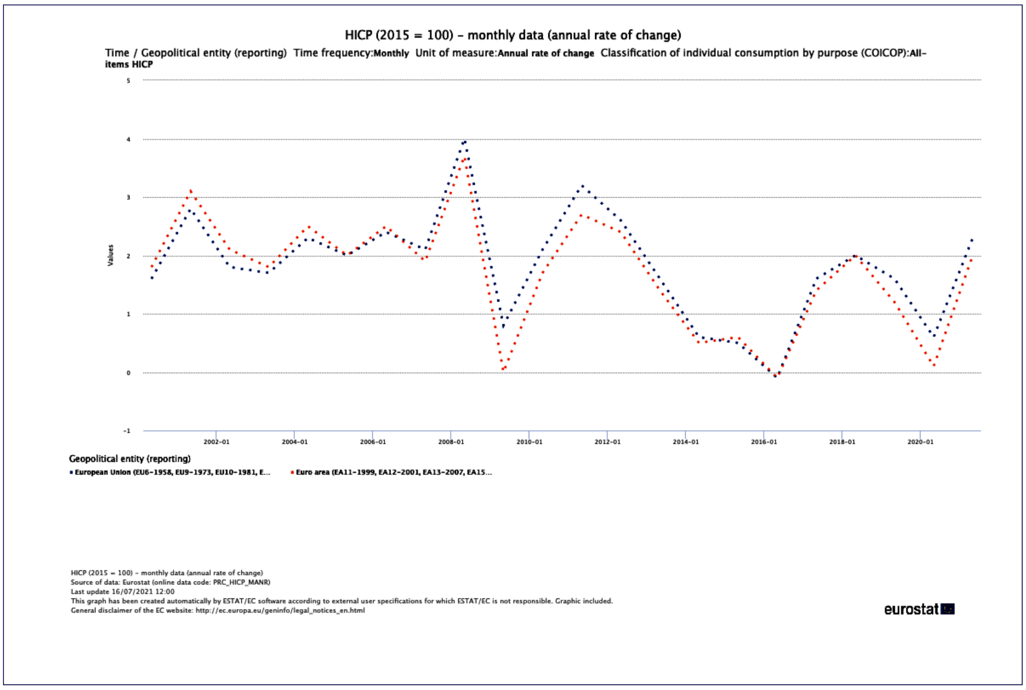

Figure A1. *Inflation rate in the Euro area 2000–2021*, accessed on 25 July 2021.

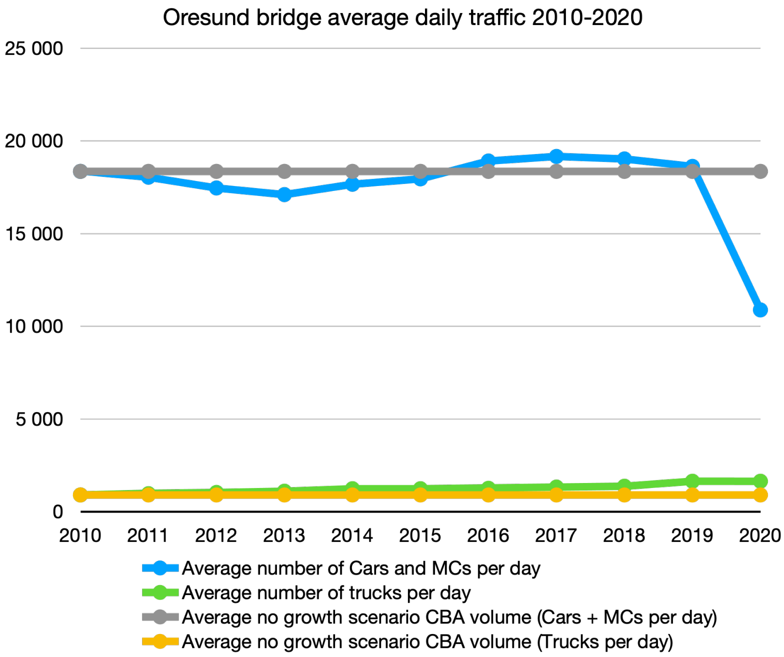

Figure A2. Road traffic volumes on Øresund Bridge between 2010 and 2020 in comparison to the "no growth" estimate of [18].

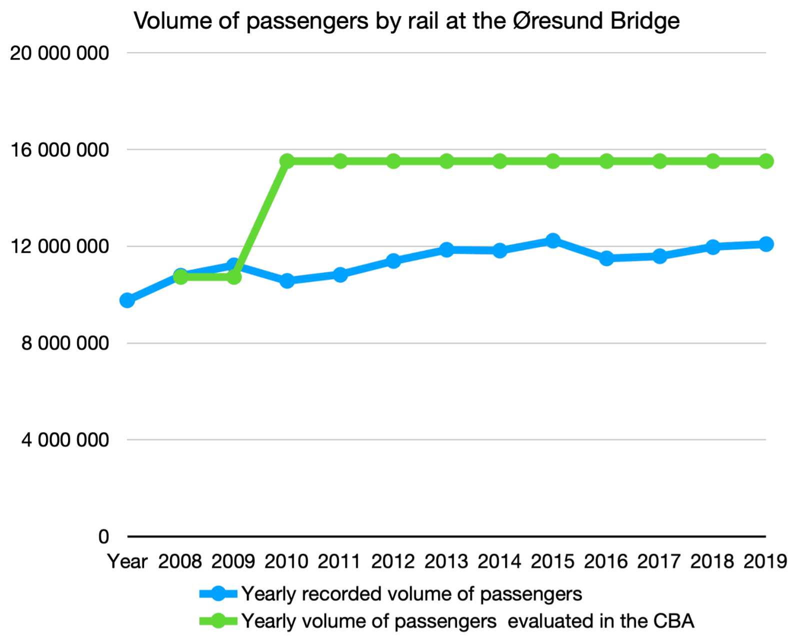

Figure A3. Rail passenger traffic volumes on Øresund Bridge between 2008 and 2020 in comparison to the "no growth" estimate of [18].

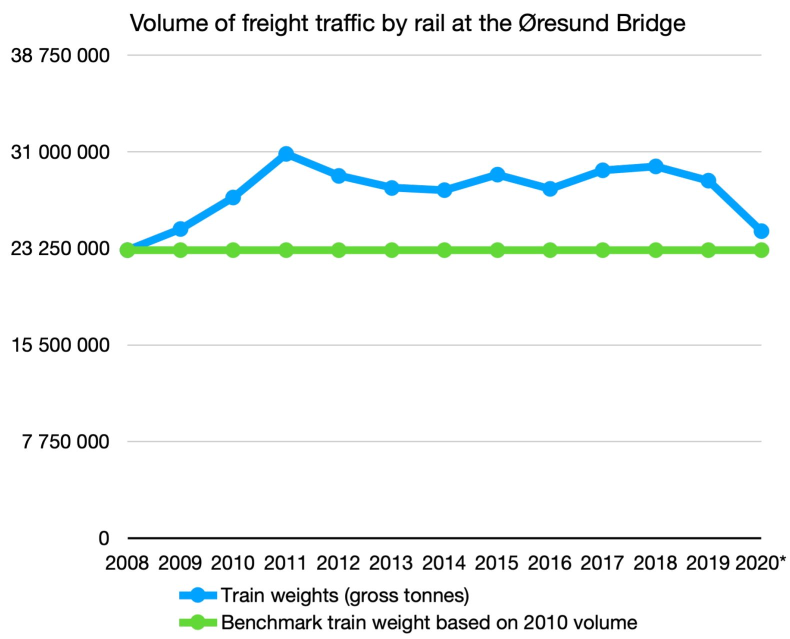

Figure A4. Rail freight traffic volumes on Øresund Bridge between 2010 and 2020 in comparison to the "no growth" estimate of [18]. *—estimate.

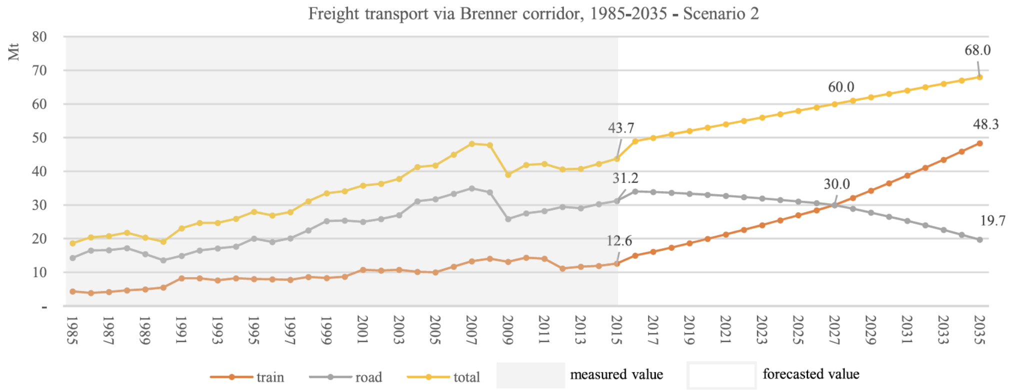

Figure A5. Freight transport forecast via Brenner corridor after implementation of *Brenner–Base tunnel* project. Source: [1].

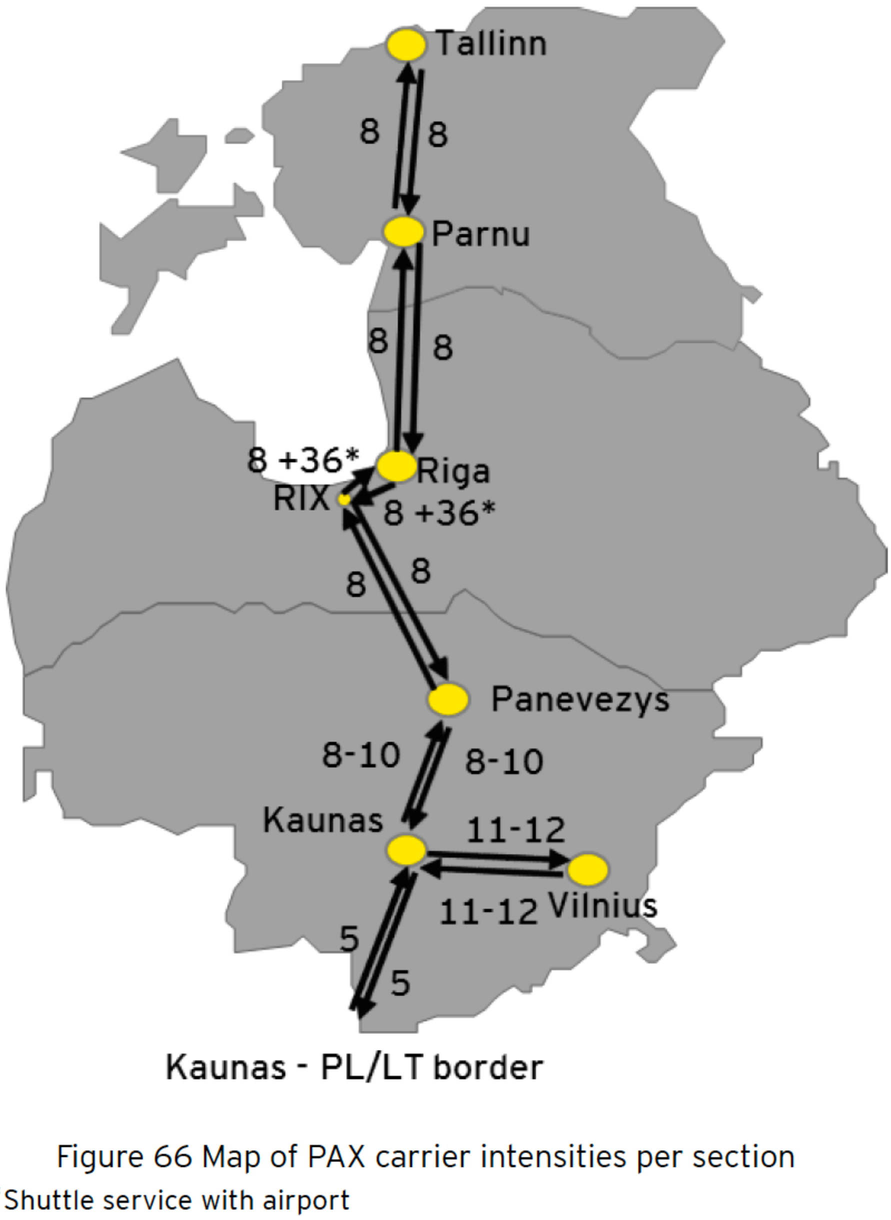

Figure A6. Passenger train forecast. Source : *Rail Baltica Global CBA (2017)*, accessed on 25 July 2021.

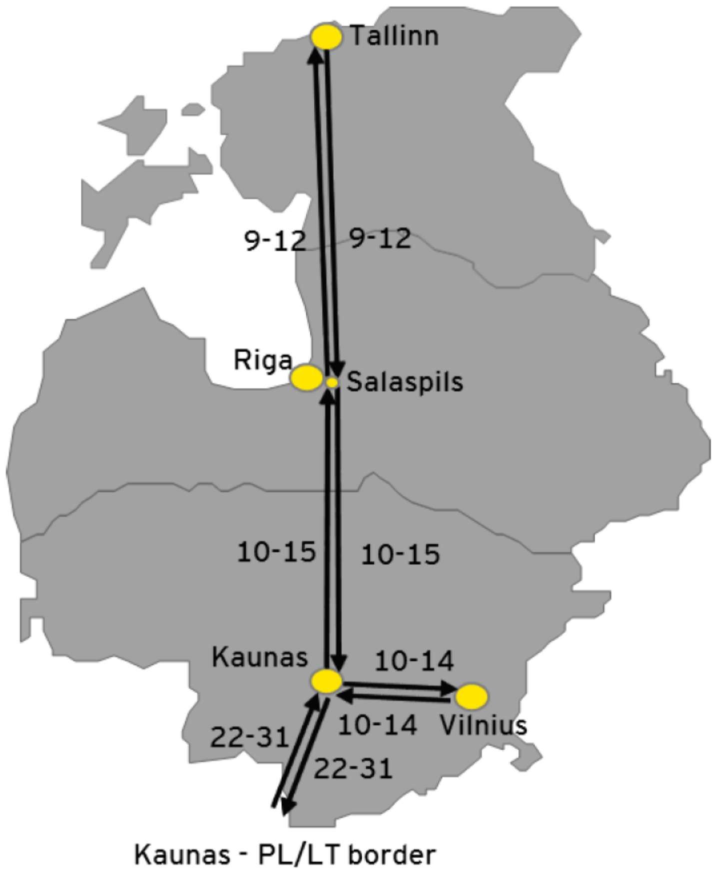

Figure 77 Map of freight carrier intensities per section (Base case)

Figure A7. Freight trains forecast. Source: *Rail Baltica Global CBA (2017)*, accessed on 25 July 2021.

Table 37 Passenger forecasts summary for the first 10 years of operation (thous. passengers)

		2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Base case	Tallinn-Parnu	0	428	733	910	970	1 031	1 115	1 122	1 129	1 136	1 144
	Parnu - Riga	0	354	606	752	800	850	920	926	932	938	943
	Riga-RIX	0	794	1 366	1 702	1 819	1 940	2 107	2 127	2 148	2 168	2 189
	RIX-Panevezys	0	392	668	826	875	925	997	1 000	1 003	1 006	1 009
	Panevezys - Kaunas	0	680	1 159	1 431	1 515	1 601	1 725	1 728	1 732	1 735	1 738
	Kaunas - Vilnius	0	887	1 510	1 864	1 972	2 082	2 243	2 247	2 251	2 254	2 258
	Kaunas - PL/LT border	0	358	610	752	795	839	904	906	907	909	910
	Trips	0	1 920	3 288	4 081	4 343	4 612	4 990	5 018	5 047	5 076	5 105

Figure A8. Passenger traffic forecast. Source: *Rail Baltica Global CBA (2017)*, accessed on 25 July 2021.

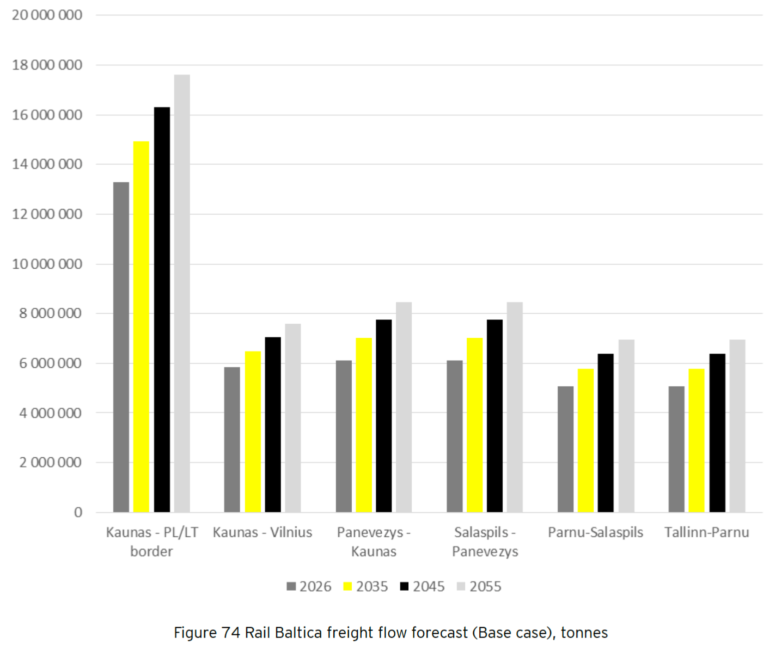

Figure A9. Freight traffic forecast. Source: *Rail Baltica Global CBA (2017)*, accessed on 25 July 2021.

Figure A10. Difference in the width of EU and Russian rail tracks.

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