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**Article**

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# Transport Infrastructure: Higher Investments Needed to Preserve Assets

by Uwe Kunert and Heike Link

A quantitatively and qualitatively efficient transport infrastructure is a fundamental requirement for the success and prosperity of the German economy, with its high degree of labor division, its many exchange relationships, and its central European location. The transport infrastructure represents a considerable economic capital stock with gross fixed assets of 778 billion euros. This corresponds to six percent of the gross fixed assets of all economic sectors in Germany. Despite the importance of this sector for the economy, there is a serious lack of investment in the maintenance and quality assurance of the transport infrastructure.

Against this backdrop, a brief survey on the transport sector has been developed for this article based on an ex-post comparison of replacement demand and replacement investment made from 2006 to 2011. The analysis shows that, in the past, there has been an investment shortfall of almost four billion euros for the maintenance of the transport infrastructure. Assuming that this investment gap will need to be closed in order to maintain the transport infrastructure in coming years, and if the cumulative result of years of neglect is also taken into account, the additional annual investment requirement is likely to be at least 6.5 billion euros. There are also additional investment requirements for vehicles and selective network and capacity expansion that are difficult to estimate.

The internationally recognized benchmark for investment in transport infrastructure is roughly one percent of GDP.<sup>1</sup> The actual demand for transport infrastructure and suitable measures for its financing, however, cannot really be derived from international comparisons, since country-specific characteristics, such as the level of infrastructure development, topography or the transport intensity of the economy vary too greatly. One percent of GDP may be too low for countries in an expansion phase and too high for countries with a highly developed infrastructure.

Germany, with its central European location and its international economic diversification, needs an efficient transport system. A comparison of the transport infrastructures of western European countries shows that Germany is well positioned with its advanced rail transport, but its road network is only mediocre.<sup>2</sup> This is reason enough to secure the quality of transport supply and enable the networks for an environmentally compatible traffic management.

## Development of Investments and Capital Stock

Each year the public and private sectors invest nearly 35 billion euros in traffic routes, nodes, and vehicles (see Table 1). This represents approximately seven percent of gross fixed capital formation in all economic sectors. Investment in transport infrastructure plays a particularly important role since it is essential for a spatially differentiated economy based on the division of labor. This sector is highly dependent on government invest-

<sup>1</sup> See OECD/ITF, *Spending on Transport Infrastructure 1995-2011* (Paris: 2013).

<sup>2</sup> See K.H. Hartwig et al., *„Verkehrsinfrastruktur-Benchmarking Europa“ ifmo-studien* (Berlin: 2007).

Box

### Definitions and Methods of Calculation

Replacement investments include replacing worn parts of infrastructure installations as part of major repairs and renewal measures. A distinction is made here between simple restoration to its original form and a qualified securing of its asset value, which takes into account the quality standards of the replacement applicable at the time of the renewal and modified construction standards. The expansion of the network to include new lanes or tracks are net investments which are not part of replacement demand. Replacement and net investments together constitute gross investments.

The methodological basis for calculating the demand for replacement investment is the investment and fixed assets calculation by DIW Berlin for the transport sector. This uses a perpetual inventory model to determine fixed assets, asset disposals (monetary equivalent of physical asset losses no longer on inventories) and write-downs (imputed depreciati-

on), in which fixed assets are updated through the accumulation of individual annual investments, taking depreciations and disposals into account. Gross fixed assets represent the replacement value of traffic systems created over time on a uniform price basis, while net fixed assets represent present value.

The disposals of assets calculated by the perpetual inventory model can be considered the requirement needed to restore assets to their original construction. Additional demand for the qualified securing of asset value was derived from previous studies by DIW Berlin which compared model results for asset disposals and funds used in the past for replacement or renewal measures.

ment.<sup>3</sup> In 2011, 20 billion euros, or almost 60 percent of all transport investment, was spent on infrastructure. This represents nearly 0.8 percent of GDP. Approximately 40 percent was spent by passenger and freight transport service providers on vehicles and equipment which corresponds to a total of approximately 14 billion euros.

### Transport Infrastructure Represents Large Capital Stock

Compared internationally, Germany's transport infrastructure is well developed. Germany has 12,800 km of highways, 39,700 km of major national roads (more than 2,000 km of which are of freeway standard), about 600,000 km of state, district, and municipality roads, 33,600 km federal railroads, 4,200 km non-federal railroads, 7,300 km federal waterways, and about 3,400 km of railroads for suburban trains and trams. According to calculations by DIW Berlin (see box), the transport infrastructure (routes and nodes, such as the 5,600 passenger stations) represents a significant economic capital stock with gross assets of 778 billion euros and net fixed assets of 511 billion euros (as at 2011, at 2005 prices) (see Table 1), which amounts to around six percent of the

gross assets of all sectors of the economy.<sup>4</sup> Nearly half of

<sup>4</sup> The gross assets of the entire transport sector amount to approximately seven percent of the assets of all economic sectors.

Table 1

#### Plant and Equipment Investment and Fixed Assets of the Transport Infrastructure 2011

In million euros

	Gross fixed investment <sup>1</sup>	Gross fixed assets <sup>2</sup>	Net fixed assets <sup>2</sup>
Transport infrastructure	20,166	777,960	511,362
Including:			
Transport routes	16,448	695,711	460,512
Including:			
Federal transport routes	9,092	362,852	240,330
Including:			
Federal highways	5,110	195,610	133,572
DB infrastructure	3,032	126,678	82,300
Federal waterways	950	40,564	24,458
Transport nodes <sup>3</sup>	3,718	82,249	50,850
Transport sector, total	34,540	952,016	610,277

<sup>1</sup> Excluding land acquisition. Nominal.

<sup>2</sup> Year-end stock. Excluding land acquisition. At 2005 prices.

<sup>3</sup> Transport nodes include DB stations, airports, inland ports and seaports.

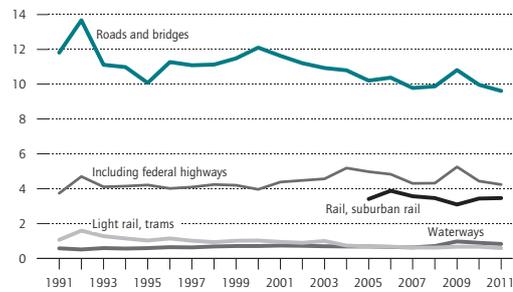
Source: Calculations by DIW Berlin.

<sup>3</sup> Only 15 percent of gross fixed capital formation went in airports, river ports, sea ports, and pipelines, where the private sector also invested in infrastructure.

The transport infrastructure represents considerable national economic capital stock.

Figure 1

**Gross Investments in Transport Infrastructure**  
In billion euros at 2005 prices



Source: *Transport in figures for 2012*, calculations by DIW Berlin.

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Investments have fallen in recent years.

this capital stock is transport infrastructure that falls under the responsibility of central government (freeways, major national roads, Deutsche Bahn AG railroads, federal waterways).

**Investment Recently Declined**

This high level of fixed assets is the result of continuous investment activity up until the end of the 1980s, especially in West Germany, and investments made since 1991 to meet backlog demand for the renovation and modernization of the transport infrastructure in eastern Germany. From 1991, annual gross fixed capital investment in the road network in real terms remained virtually constant at 11 to 12 billion euros (at 2005 prices).<sup>5</sup> In recent years, however, this figure fell to less than ten billion euros (see Figure 1). This includes annual federal government investment of four to five billion euros in the federal highway network. In contrast, since the completion of the service and financing agreement (Leistungs- und Finanzierungsvereinbarung, LuFV),<sup>6</sup> the provision of replacement investments in Deutsche Bahn (DB) railroads has been constant or even slightly increased. In

<sup>5</sup> All figures given here refer to 2005 prices and have been recalculated using the asset-specific price indices of the Federal Statistical Office. They therefore differ from information about investments in the Commission's "Future of Transportation Infrastructure Finance" report which were calculated using a less precise procedure (GDP as a deflator). Certainly this less precise method has led to differing statements on the development of investment. See Bundesrat, Commission report „Zukunft der Verkehrsinfrastrukturfinanzierung“ from December 2012.

<sup>6</sup> In 2009, central government and DB concluded a service and financing agreement (LuFV) to maintain the rail infrastructure which contained the maintenance standards and financing for the railroads.

real terms, between 2.3 and 2.7 billion euros has been invested annually in the railroad infrastructure since 2005. Including the hubs (passenger and freight stations), annual investment has been close to 3.5 billion euros. After the unification-related increase in funds, annual investment in federal waterways in the early 1990s fluctuated between 0.6 and 0.8 billion euros.

In particular, infrastructure sectors that fell under the financial remit of other government authorities (Länder, districts, municipalities) recorded declines in real investment. This affected not only roads but particularly regional public rail transport (urban railroads, tramways). Taking into account declining investment in local roads, which also had an impact on local bus transport, it can be concluded that there was declining investment particularly in all areas of regional public transport.<sup>7</sup>

**Fixed Capital Consumption in Road and Rail Infrastructure**

The development of both fixed assets in terms of monetary value and of the technical condition of the transport infrastructure over time shows that investment activity in recent years has not been sufficient to maintain the desired infrastructure quality. Accordingly, there was a slight decrease in net assets in these areas (see Figure 2).

In addition, the condition of the infrastructure has deteriorated significantly. Consequently, an assessment of the condition of federal highways showed that around 20 percent of highways and 41 per cent of major national roads have exceeded the 3.5 score considered a warning value; 46 percent of highway bridges exceeded their respective warning value receiving a score of 2.5.<sup>8</sup> The deterioration of municipal roads is obvious in many places, but documentation for minor roads is neither adequate nor uniform.<sup>9</sup> Since the LuFV is in effect, reports published annually have shown that the condition of DB's rail infrastructure does indeed meet all the quality indicators, so it cannot be concluded that investment has been neglected here.<sup>10</sup> However, according to the infrastructure condition report, the scores awarded to railroad bridges have deteriorated, and are currently

<sup>7</sup> More than two-fifths of public transport passengers traveled on buses. This makes it clear that public transport needs a high quality road network in cities.

<sup>8</sup> See Bundesrat "Zukunft der Verkehrsinfrastrukturfinanzierung" (2012) and Deutscher Bundestag, Verkehrsinvestitionsbericht für das Berichtsjahr 2011, Bundestag printed paper, no. 17/12230 (2013).

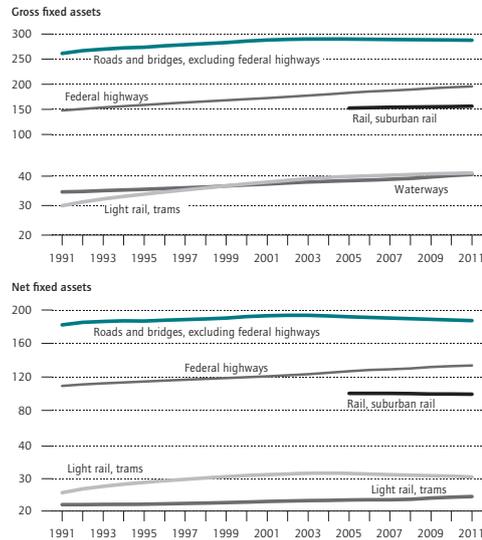
<sup>9</sup> A. Grossmann, R. Roos, and D. Wenzel, "Systematik für eine objektive Dringlichkeitsreihung im Rahmen der Straßenerhaltung in Kommunen, Straße und Autobahn 59", no. 10 (2008): 641-647.

<sup>10</sup> See Deutsche Bahn AG, Infrastrukturzustands- und -entwicklungsbericht 2011 (2012).

Figure 2

**Transport Infrastructure Fixed Assets**

In billion euros at 2005 prices



Source: *Transport in figures for 2012*, calculations by DIW Berlin.

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There has been an erosion of assets on some routes in recent years.

averaging 2.05, implying a need for improved modernization in future. Fixed capital consumption has also occurred in non-state-owned railroads (NE railroads). This is the result of financial bottlenecks in the Länder and due to the acquisition of decommissioned DB routes by NE railroads for which there was no longer any government funding.

**Greater Demand For More Investment**

The development of net assets described above implies a need for more investment which will be estimated in this section. Basically, we can distinguish between the following investment areas: replacement and backlog investment in transport infrastructure, network and capacity expansion, and investment in vehicles.

In 2001, in a report for the Federal Ministry of Transport, DIW Berlin highlighted that the maintenance of national transport routes was being neglected, that there was a correspondingly significant need to implement overdue and replacement investment, and called for repair and replacement to take priority over new const-

ruction.<sup>11</sup> The now updated comparison of replacement demand with the volume of maintenance investments for the period of 2006-2011 includes national transport routes, state, district, and municipality roads, and the infrastructure of railbound public passenger transport, ÖSPV (see box).<sup>12</sup>

Accordingly, replacement demand in these infrastructure sectors during the period mentioned amounted to approximately 13.2 billion euros annually at 2005 prices (see Table 2). Of this amount, only 9.4 billion euros were actually invested leading to an annual investment gap of 3.8 billion euros, or nearly one-third. The largest gap between demand and actual replacement investment is for state, district, and municipality roads (almost 40 percent).<sup>13</sup> In absolute terms smaller, but in relative terms larger gaps are found in the infrastructure of railbound public transport (over 50 percent), and the waterways (over 60 percent).

Assuming that an investment gap of this size also occurs in the coming years, given the external conditions remain unchanged, and that this underfunding, which has existed for a number of years, results in corresponding pent-up demand, then the annual investment deficit calculated here of 3.8 billion euros can be considered the minimum level of additional reinvestment required.<sup>14</sup> Using a comparable definition, the “Transport Infrastructure Funding” commission estimates the additional backlog due to lack of replacement investment at 2.65 billion euros which would take a period of 15 years to work off. Consequently, annual replacement and backlog investment of around 6.5 billion euros would be required.<sup>15</sup>

Given the favorable state of Germany’s transport infrastructure and the high demand for maintenance invest-

<sup>11</sup> See, U. Kunert, H. Link, “Bundesverkehrswege: Neubau auf Kosten der Substanzerhaltung künftig nicht mehr vertretbar”. Wochenbericht des DIW Berlin, no. 42 (2001). For the forecast period up to 2020, replacement demand was calculated to be two-thirds of total planned investment.

<sup>12</sup> This definition counts for 90 percent of transport infrastructure assets. It does not include NE railroads, airports, inland ports, seaports, and pipelines. In addition to the analysis period mentioned above, comparison calculations for the period 2000-2011 were also made, leading to annual demand figures on a comparable scale.

<sup>13</sup> The German Institute of Urban Affairs (das Deutsche Institut für Urbanistik) calculated similarly high replacement demand for municipal roads, see Difu, *Investitionsrückstand und Investitionsbedarf der Kommunen* (Berlin: 2008).

<sup>14</sup> In addition, the fixed asset account for individual aggregate investment identifies future increases in asset disposals, including, in particular, for the railroad’s engineering structures (mainly bridges).

<sup>15</sup> This is essentially derived from ex-post analyses. Additional ex-ante studies would be required with projected investment lines and according to calculations differentiating between the investment aggregates (bridges, superstructure, etc.)

Table 2

**Annual Replacement Demand According to DIW's Fixed Assets Calculation for 2006-2011**

In million euros at constant 2005 prices

	Replacement demand <sup>1</sup>	Replacement investments <sup>2</sup>	Outstanding replacement demand	Proportion of outstanding replacement demand in percent
Federal highways	2,700	2,200	500	19
State, district, and municipality roads	6,400	3,900	2,500	39
DB infrastructure	3,110	2,910	200	6
Infrastructure of public rail passenger transport	480	220	260	54
Federal waterways	520	190	330	63
Total	13,210	9,420	3,790	29

1 Calculated from physical disposals according to DIW asset model plus a surcharge for the qualified securing of asset value.

2 Data on replacement investments: for federal highways, DB, and federal waterways, nominal data from the Federal Ministry of Transport, Building and Urban Development, were deflated to 2005 prices using sector-specific price indices to make them comparable with replacement demand. For other roads: estimate by DIW. For public rail passenger transport information: Association of German Transport Companies. Source: Calculations by DIW Berlin.

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The investment gap is particularly large for roads in Länder, districts, and municipalities.

ment in all transport modes, extensions to the network and capacity of the transnational network are limited to the removal of bottlenecks and the development of important connections, especially in freight transport. Examples of this are German rail routes that feed transalpine traffic and the hinterland connections of seaports. Both the former and the present governments have acknowledged a structural under-financing of the transport infrastructure. The current investment framework for the period 2011 to 2015 has set aside 50 billion euros for the national transport infrastructure. However, due to the advanced planning stages of many economically viable infrastructure projects, the additional investment potential of transport routes under the responsibility of the federal government alone would total over five billion euros more than the available budget.<sup>16</sup>

In regional and urban transport, passenger numbers in public transport have risen by a tenth in the past decade despite some poor quality services. Since increased

<sup>16</sup> See Federal Ministry of Transport, Building and Urban Development, Investitionsrahmenplan 2011-2015 für die Verkehrsinfrastruktur des Bundes (Berlin: 2012). The viability of the individual projects is demonstrated using cost-benefit analyses as part of federal transport infrastructure planning.

transport in urban areas cannot be absorbed by road transport for environmental and road capacity reasons, public transport services should be expanded and the quality improved. The Association of German Transport Companies (Verband Deutscher Verkehrsunternehmen) reported investment demand up to 2025 of at least 12 billion euros for the public rail passenger transport infrastructure alone.<sup>17</sup>

The quality and scope of transport services depend not only on the infrastructure, but also on the vehicles. Thus, investment by transport providers in passenger and freight vehicles plays an important role. In public passenger transport, the type of vehicles available to customers also determines the quality of the service and can therefore have a positive or negative effect on demand. In this transport sector, similar volumes of rail and road vehicles have been procured. The problems with the quality of rolling stock in regional and long-distance transportation that have repeatedly arisen over recent years imply that more investment is needed. New low-noise rolling stock is now imperative for rail freight.<sup>18</sup>

Overall, for the necessary replacement investment in the transport sector, the pent-up demand for neglected replacement measures, and new investments beyond the current investment lines, an estimated additional annual requirement of at least 10 billion euros is needed to maintain and improve installations and rolling stock.<sup>19</sup>

**Financing Concepts Needed for Infrastructure Investment**

The bulk of investment in the aforementioned infrastructure sectors must be financed by the government. There are separate regulations at each level of government for assessing the financial viability of investment projects, for the legal and planning conditions, and with regards to financial instruments. Consequently, at federal level, federal transport route planning is used as an instrument for project assessment and planning that functions across all transport modes. It is essentially funded from the federal budget through taxes (including

<sup>17</sup> Excluding regional passenger rail transport (SPNV), based on 2007 prices, Association of German Transport Companies (Verband Deutscher Verkehrsunternehmen), ed., Finanzierungsbedarf des ÖPNV bis 2025 (Cologne: 2009). The ÖPNV plans, inter alia, to introduce new suburban trains, to improve wheelchair access and new information systems. For regional passenger rail transport, there are plans for additional suburban railroad lines and the expansion of regional railroads, such as the Rhein-Ruhr-Express.

<sup>18</sup> See "Quiet Freight" pilot and innovation program, Federal Ministry of Transport, Building and Urban Development.

<sup>19</sup> The volume of investment included in this figure for expansion is more difficult to assess because it depends on the transport demand, the economic evaluation of individual projects, and the development funding available.

duties paid by users, such as car and energy taxes) and revenues from the toll roads. The LuFV, which is currently being renegotiated, has been available as an instrument for financing replacement investment in DB railroads and stations since 2009. As a result, there are various sources of funding for the different transport routes,<sup>20</sup> though the percentage of financing coming directly from fees paid by users and contributions from transport-specific taxes varies dramatically.

Funding for infrastructure is significantly less regulated, less secure, and less transparent at Länder, district, and municipal level than at central government level. Only a small number of specific instruments are regulated in the Regionalization Act (Regionalisierungs-gesetz), such as financing of public transport from federal funds and the partial financing of municipal roads and the local rail passenger transport through revenues from the central government's energy tax, regulated in the (expiring) Municipal Transport Financing Act (Gemeinde-verkehrsfinanzierungsgesetz, GVFG). Thus, given the figures presented in this report, investment deficits at municipal level are hardly surprising.

### Conclusion and Policy Recommendations

An efficient transport infrastructure is a basic prerequisite for the German economy. However, insufficient investments have been made in the transport infrastructure in recent years. According to calculations by DIW Berlin, there is an annual investment gap of around 3.8 billion euros for the necessary reinvestment in infrastructure alone. In addition, there are pent-up replacement investment needs, and a need for investment in rolling stock and the expansion and extension of the network. In total, this results in an investment gap of at least ten billion euros per year.

Although the problem of financing transport infrastructure has been acknowledged in political circles for some time, and has led to various proposals for generating the required revenue (for example, extending the existing toll to include other vehicle classes or extending the network of toll roads), there is still no solid, self-contained or feasible concept for financing the infrastructure.<sup>21</sup> A concept of this kind should clarify the primary purposes of charging user fees, such as rail track charges,

road tolls and waterway duties. For example, the goal of generating revenue might compete with achieving environmental targets, such as the reduction of pollution and noise emissions. User fees can also help to reduce infrastructure congestion (congestion charges). In addition, the scope and aim of transport-specific taxes, such as energy and road taxes, need to be defined (for example, energy taxation as an instrument for pricing CO<sub>2</sub> emissions) and how a practically implementable policy path can be determined for such instruments.<sup>22</sup> Furthermore, it would also be necessary to clarify the use of revenues for transport infrastructure, compensatory measures for burdened users and, not least, EU compatibility of the measures.

There is a lack of a balanced approach, not only at federal level, but in particular, for infrastructure financing which is the responsibility of the Länder, districts, and municipalities. Interesting international examples here are the commuter tax in France and the mutual fund schemes in Swiss municipalities. Considering the financial deficits shown in this report, particularly in areas of non-federal infrastructure, the need for action is especially urgent here.

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<sup>20</sup> Federal highways: financed from federal budget and toll revenues, DB: financed by revenues from fees for the use of routes and stations, and the LuFV from the federal budget, waterways: financed by the federal budget and revenue from duties charged for using the waterways.

<sup>21</sup> The work carried out by the „Future of Transport Infrastructure Financing“ Commission was continued by another Commission of the Conference of Ministers of Transport, recommendations are presented in October 2013.

<sup>22</sup> So, for example, in the current debate on passenger vehicle tolls, the issues are whether to levy tolls on vehicles with a total weight of 3.5 t to 12 t, on what roads tolls should be levied, and how this is to be achieved in technical terms. The suitability of the TOLLCOLLECT system to deal with the correspondingly high number of transactions appears to be in doubt.

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