International Transport Forum

# Understanding the Value of Transport Infrastructure

## Guidelines for macro-level measurement of spending and assets


Task Force Report, 2013

OECD

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**Task Force on Measuring Transport Infrastructure Spending and Assets**

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## THE INTERNATIONAL TRANSPORT FORUM

The International Transport Forum at the OECD is an intergovernmental organisation with 54 member countries. It acts as a strategic think-tank, with the objective of helping shape the transport policy agenda on a global level and ensuring that it contributes to economic growth, environmental protection, social inclusion and the preservation of human life and well-being. The International Transport Forum organises an annual summit of Ministers along with leading representatives from industry, civil society and academia.

The International Transport Forum was created under a Declaration issued by the Council of Ministers of the ECMT (European Conference of Ministers of Transport) at its Ministerial Session in May 2006 under the legal authority of the Protocol of the ECMT, signed in Brussels on 17 October 1953, and legal instruments of the OECD.

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## TASK FORCE RECOMMENDATIONS

- Decisions on transport infrastructure spending should be based on quantitative data and analysis. Improving international comparability of such data should be one of the key goals of the international statistical community.

- While macro-level analysis can inform policy makers about the relationship between transport infrastructure and economic growth, decision-making on individual projects should be based on cost-benefit and financial analyses.

- A concerted effort should be made to improve harmonization of definitions, data collection and dissemination of macro-level transport infrastructure spending and asset data.

- National statistics offices should provide, at minimum, data on investment and maintenance spending by asset type. Efforts should also be made to estimate data on capital stock (asset value).

- In order to improve international comparability of transport infrastructure spending data, statistical data collection and reporting should follow the guidance provided in this report and, in particular, provide detailed metadata on definitions, methods and coverage of data (Chapter 2.4).

- The International Transport Forum, in co-operation with national statistics offices and other international bodies, should play a key role in fostering dialog between statistics providers and users on data related issues.

- It is also recommended that the International Transport Forum database would act as a reference point to aggregate international data on transport infrastructure spending and related output data.

## KEY MESSAGES

- The quality of transport infrastructure is a key determinant of performance in the transport sector and development of transport infrastructure supports economic growth.

- Countries spend considerable amounts of money each year to build, maintain and improve their transport infrastructure in response to the growing passenger and freight mobility needs and the need to renew aging infrastructure. Decision-makers need information on spending and the outputs achieved from infrastructure spending in order to prioritize investment. This is critical under tight budget constraints.

- Despite the importance of the transport sector, there is a lack of cross-country comparison of inputs, outcomes and efficiency. This reflects the lack of an analytical framework for comparisons, and significant problems relating to data availability, definitions, coverage, quality and comparability.

- The lack of clear definitions and common practices to measure transport infrastructure spending hinders accurate measurement of how spending relates to economic growth, leading to less-informed decisions.

- Better and more comparable data can lead to more robust macroeconomic analysis for supporting decision-making. The first objective is to establish how much transport infrastructure is in place and how stocks evolve over time, how close to the optimum the current stock is, and what determines investment.

- The System of National Accounts (SNA) provides a useful conceptual framework for the improvement of transport infrastructure spending data. The classifications and definitions used are a useful starting point for international comparability.

- For analytical purposes, it is essential not only to have data on the additions to the stock (spending) but also the size and value of the existing network (stock). Therefore, collection and estimation of capital stock data is highly recommended, and the report proposes ways of doing this.

- A key aim of this report is to provide detailed guidance for the uniform collection of data on transport infrastructure spending and assets, ultimately leading to better decision-making.

# 1. INTRODUCTION

Transport infrastructure is a critical ingredient in economic development at all levels of income. It supports personal well-being and economic growth.

Transport infrastructure plays a role as a capital input into production and wealth generation. The economic impact can be transformative, especially at lower levels of income. Examples include transcontinental railways or canals linking oceans. At higher levels of income the direction of causality between infrastructure development and income growth becomes increasingly complicated. However, the two remain correlated even in the most developed economies.

The indirect contribution of infrastructure to economic development arises through a multitude of channels, including the enabling of productive private investment, the creation of new activities (supply chains), or the reshaping of economic geography.

Transport infrastructure is a necessary input into the production of transport services which, in turn, are necessary to allow for the market exchange of final goods and inputs (including labour) – or for broader welfare benefits (e.g., travel time savings). Given its central economic role, transport infrastructure is often referred to as the backbone of a modern economy.

But how much, exactly, does transport infrastructure support economic development and wealth creation? What determines the magnitude of that impact?

Public policymakers need high-quality and internally consistent data on transport investment (as well as spending on operations and maintenance) for a number of uses. Most importantly, they need the data to assess the affordability and sustainability of public budgets and funding needs at all levels of government. The data are also needed to assess (e.g. by benchmarking) the long-term costs of strategic infrastructure development plans. There is little point in focusing on measuring inputs without being able at the same time to measure and evaluate outputs.

Infrastructure investments are a key determinant of performance in the transport sector. However, the sector lacks standardized definitions and methods for measuring investment and – *a fortiori* – assets. The increasing mix of public and private investors and operators in the transport sector adds to the complexity of measuring investments and outcomes. Transport infrastructure has to be maintained and measurement of maintenance costs and outcomes differs widely across modes and countries. The lack of clear definitions and common practices hinders meaningful analysis and comparison, and this may lead to inaccuracy in decision making.

While this report focuses on *ex-post* measurement of transport infrastructure spending and asset data at macro level, it is equally important to recognize that public policy decisions pertaining to transport infrastructure concern individual projects. Whereas macro-level analysis can inform us about the relationship between transport infrastructure and economic development, it is crucial that decision-making on individual projects is based on its costs and benefits, so that the best projects are carried out and the non-viable ones are eliminated. Macro-level analysis evaluates the overall impact of transport infrastructure investments on economic growth and development in a country. Micro-level analysis is used to evaluate the specific impacts of individual transport infrastructure projects *ex-ante* in terms of resource allocation efficiency, and identifies the socio-economic return of the project. Micro-level analysis can also be used *ex post*, for example, for the evaluation of spending resources on transport infrastructure.[1]

The International Transport Forum at the OECD convened a Workshop in Paris on 9-10 February 2012, to discuss issues concerning the measurement of investment in transport infrastructure.[2] The objective of the workshop was to serve as a platform for statisticians and stakeholders to discuss and better understand transport infrastructure investment and maintenance data, by bringing together data providers and users to share their experience with the methodology, interpretation and limitations of transport investment data. While transport investment data are an important component of sector planning and operations, there are significant gaps in supplying the information needed or significant differences and ambiguities in the definition of common terms. Moreover, while there is general agreement on the criticality of transport in underpinning economic development, there is less confidence that either the adequacy of the sector's capacity, or its quality, can be determined from available datasets. Major investment decisions may potentially be made with incomplete or erroneous data. The stakes in getting better and more complete data are thus very high.

The workshop identified a number of clear problems with current measurement of transport infrastructure spending. These include:

1. Lack of clear and commonly agreed definitions for a number of critical terms used;
2. Lack of critical data;
3. Absence of methods to estimate missing data;
4. The lack of clear definitions and common practices to measure transport infrastructure spending hinders meaningful comparison between countries and across spending options, leading to less-informed decisions.

To address the above issues, the workshop concluded that there is a need to develop a "best practices" manual for measuring spending on transport infrastructure that would eventually become a manual for data collection and reporting both for national data producers and for international bodies. Following the workshop recommendations, the International Transport Forum at the OECD formed a Task Force consisting of selected experts around the world.

The Task Force was assigned with a task to:

- Review existing sources of data along with definitions and coverage;

1 For methodology on micro-level analysis on expenditures, see Carlevaro, F. and C. Gonzalez (2011).

2 Presentations made at the workshop, the results of the discussions, along with a summary report with a set of tentative suggestions for further work, are available at: http://www.internationaltransportforum.org/Proceedings/InfrastructureInv/index.html

- Identify critical data gaps and highlight the importance and usefulness of filling the gaps;
- Set priorities for filling the gaps;
- Develop improvements in data definitions where appropriate; and
- Develop a methodology for moving forward in improving the data available for measuring assets and their value in addition to the investment and maintenance of transport assets.

This report summarizes the deliberations and recommendations of the Task Force. Specifically, the recommendations focus on how to improve the international collection of statistics on transport infrastructure spending and assets.

The report is divided into two main parts. Chapter 2 explores issues in measuring spending on infrastructure. It discusses existing definitions and methods used to collect data, and identifies critical data needs. The chapter concludes with recommendations on and practices for arriving at these critical statistics. Chapter 3 focuses on the use of these data in impact analysis and benchmarking. Chapter 4 concludes the report.

# 2. MEASURING TRANSPORT INFRASTRUCTURE SPENDING

## 2.1 Introduction

Data on infrastructure investment and maintenance are collected at an international level by a number of institutions. The International Transport Forum at the OECD collects statistics on investment and maintenance in transport infrastructure based on an annual targeted survey sent to 54 member countries. The survey covers total gross investment in road, rail, inland waterways, maritime ports and airports, including all sources of financing. It also covers maintenance expenditures financed by public administrations. The World Road Statistics, published annually by the International Road Federation (IRF), includes the latest available road expenditure figures broken down nationally by administrative level (e.g. central or regional/local government) and nature of outlay (investment, maintenance, other recurrent costs) as well as private sector expenditures. The International Union of Railways also collects and disseminates data on rail infrastructure while the International Civil Aviation Organization (ICAO) and Airport Council International have information on airport infrastructure. These data, derived in turn from national sources, are marked by significant gaps, differences in definitions, methods and classifications. This hinders meaningful comparisons or analysis of the results internationally. Also, problems may arise even at the national level regarding methods between different modes of transport.

The System of National Accounts 2008 (SNA 2008) is a worldwide standard for the compilation of national accounts statistics. It has been produced under the auspices of the United Nations, the European Commission, the Organisation for Economic Co-operation and Development, the International Monetary Fund and the World Bank Group. The European equivalent, the European System of Accounts (ESA) 2010, is similar when it comes to the conceptual framework but more prescriptive in the definition of transactions, is an obligatory regulation within the European Union.

National accounts include statistics and data on total gross fixed capital formation (investment) with the classification for land transport, water transport, air transport as well as warehousing and support activities for transportation. Despite the conceptual benefits of the SNA, it does not recognise transport infrastructure as a major asset class and lumps together transport and communications industries as well as infrastructure and other constructions. That is, there is no breakdown of data, neither by mode nor by asset type.

Despite some deficiencies as regards classification of transport, the System of National Accounts is used as a conceptual starting point in this paper. The practical challenges to achieve perfectly harmonized data are well understood, and implementation may differ from this conceptual starting point.

## 2.2 Definitions and classifications

In discussing transport infrastructure, three definitions are of particular importance: 1) investments (or gross fixed capital formation), 2) maintenance, and 3) capital stock.

### *2.2.1 The recording and measurement of investments and maintenance*

*Definitions*

According to the System of National Accounts 2008, gross fixed capital formation consists of the "*purchase of goods (and services) that are used in production for more than one year*" (SNA, para. 10.33). As such, they should align to the definition of an (economic) asset as being "*a store of value representing a benefit or series of benefits accruing to the economic owner by holding or using the entity over a period of time. It is a means of carrying forward value from one accounting period to another*" (SNA, para. 3.5). Investments can be distinguished from the purchase of goods and services which are directly used up in a production process (intermediate consumption)[3].

When it comes to the delineation of transport infrastructure spending, the distinction between fixed capital formation and intermediate consumption is very relevant. While the production and purchase of a new structure clearly constitutes investment, the delineation of expenses made for maintenance is less clear. Ordinary maintenance and repairs should be recorded as intermediate consumption[4], whereas major renovations, reconstructions and enlargements are to be recorded as investments. This difference between investment and maintenance is useful and defined as follows:

"Ordinary maintenance and repairs are distinguished by two features:

a. They are activities that owners or users of fixed assets are obliged to undertake periodically in order to be able to utilize such assets over their expected service lives. They are current costs that cannot be avoided if the fixed assets are to continue to be used. The owner or user cannot afford to neglect maintenance and repairs as the expected service life may be drastically shortened otherwise;

b. Maintenance and repairs do not change the fixed asset or its performance, but simply maintain it in good working order or restore it to its previous condition in the event of a breakdown. Defective parts are replaced by new parts of the same kind without changing the basic nature of the fixed asset" (SNA, para. 6.228).

"On the other hand, major renovations or enlargements to fixed assets are distinguished by the following features:

a. The decision to renovate, reconstruct or enlarge a fixed asset is a deliberate investment decision that may be undertaken at any time and is not dictated by the condition of the asset. Major renovations of equipment, buildings or other

3 For reasons of convenience, the purchase of goods and services which may be temporarily stored as part of inventories is disregarded. Also the purchase of goods which are primarily held as stores of values, so-called "valuables", is not further discussed.

4 Note that some of the ordinary maintenance may be done in-house. In that case, the relevant expenses will not be recorded as intermediate consumption; they simply will be part of cost components such as compensation of employees, other expenditures on goods and services recorded as intermediate consumption, etc.

structures are frequently undertaken well before the end of their normal service lives;

b. Major renovations or enlargements increase the performance or capacity of existing fixed assets or significantly extend their previously expected service lives. Enlarging or extending an existing building or structure obviously constitutes a major change in this sense, but a complete refitting or restructuring of the interior of a building also qualifies" (SNA, para. 6.229).

*Time of recording*

Apart from the delineation between investments and current expenditures, the 2008 SNA also provides more detailed guidance on the time of recording, the valuation of transactions, and the ownership of transport infrastructure.

As transport infrastructure typically takes more than a year to complete, the issues regarding the time of recording is quite relevant for this type of investment. "*The general principle for the time of recording of acquisitions … of fixed assets is when the ownership of the fixed assets is transferred to the institutional unit that intends to use them in production*" (SNA, para. 10.53). This is also true for fixed assets that take more than a year to produce. However, "*… when stage payments are made, these are regarded as purchase of (part of) a fixed asset or as a trade advance if the value of the stage payment exceeds the value of the work put in place. In the latter case, work is recorded as fixed capital delivered to the final owner as work proceeds until the trade credit is exhausted*" (SNA, para. 10.55). The recording of stage payments as capital formation, including the addition of these investments to the capital stock is somewhat disputable, as the relevant incomplete structures cannot yet be used in the production of goods and services. An alternative could be to distinguish these structures from the capital stock of completed assets used in production.

*Valuation*

In relation to the valuation of the purchases of assets, the "costs incurred on the acquisition of an asset are treated as an integral part of the value of that unit's gross fixed capital formation" (SNA, para. 10.49). More specifically, these so-called costs of ownership transfer consist of the following cost categories:

a. All professional charges or commissions incurred by both units acquiring or disposing of an asset, such as fees paid to lawyers, architects, surveyors, engineers and valuers, and commissions paid to estate agents and auctioneers;

b. Any trade and transport costs separately invoiced to the purchaser;

c. All taxes payable by the unit acquiring the asset on the transfer of ownership of the asset;

d. Any tax payable on the disposal of an asset;

e. Any delivery and installation or de-installation costs not included in the price of the asset being acquired or disposed of; and

f. Any terminal costs incurred at the end of an asset's life such as those required to render the structure safe or to restore the environment in which it is situated.

*Ownership*

Regarding ownership of assets, the SNA applies the principle of economic ownership, not legal ownership: “The economic owner of … assets … is the institutional unit entitled to claim the benefits associated with the use of the entity in question in the course of an economic activity by virtue of accepting the associated risks” (SNA, para. 3.21). So, the decisive criterion is who will get the risks and rewards associated with the use of the relevant transport infrastructure. Normally, this will also be the unit that is the legal owner of the structure. However, in the case of public infrastructure, the situation has become less clear with the establishment of private finance initiatives (PFIs), sometimes also described as public-private partnerships (PPPs) or a build, own, operate and transfer (BOOT) scheme. In each of these cases, the actual economic owner of the structure under consideration has to be established. Detailed practical guidance has been developed by the European Commission (Eurostat), because of the need to have more explicit rules under the Excessive Deficit Procedure, in order to arrive at internationally comparable data for government deficit and debt. The basic principle is to establish who “owns” the relevant risks and rewards (for more detailed discussion, see ESA95 Manual on Government Deficit and Debt, 3rd Edition).

Another situation where economic ownership may differ from legal ownership may be the case of financial lease and similar arrangements. “*A financial lease is a contract between a lessor and a lessee whereby the lessor legally owns the good but the terms of the lease are such that the lessee takes over both the economic risks and rewards of using the asset in production. … In these cases, the asset is recorded as being acquired by the lessee in return for a loan extended by the lessor to the lessee*” (SNA, para. 10.57).

Finally, it has to be noted that in case the owner of a building or other structure is a non-resident, by convention a national resident unit is created which owns the structure. The non-resident owner is thus treated as a foreign direct investor in the notional resident unit.

*Other sources*

Another international standard for measuring and defining investments is the International Public Sector Accounting Standards (IPSAS). They are an elaboration of the International Accounting Standards (IAS) for corporations, but targeted at government (related) units. It is acknowledged that the implementation of the European System of Accounts 2010 (ESA), which should replace ESA1995 as from September 2014, could also be marked by the launching of a major project for the implementation of EU harmonized public accounting standards for all public entities of the EU based on the IPSAS standards. However, like the SNA and the IAS, the IPSAS standards use “accrual accounting” as a basic underlying principle and do not deviate much from the existing definition used in the SNA. They do deviate from “cash accounting” which at the moment is still the usual practice in government administrations. An important difference between the two types of accounting, cash versus accrual, relates to the accounting for investments, depreciation and the concomitant recording of non-financial assets. Cash accounting records revenue when cash is received, and records expenses when cash is paid, while accrual-based accounting records income items when they are earned and records deductions when expenses are incurred. In this respect, IPSAS and the standards for national accounting are rather similar, although some differences may exist, for example, in respect of the valuation of assets (see Annex 2 for more details).

### *2.2.2 The recording and measurement of capital stocks*

From an analytical perspective, it is interesting to also have data on the total capital stocks of transport infrastructure, both in monetary and physical terms. This section will only deal with the recording and measurement of stocks of assets, or capital stocks, in monetary terms. A lot of information exists on infrastructure capacity in physical terms. However, the challenge often is to include quality into measurement. For example, it is extremely difficult to have internationally comparable data on road infrastructure capacity at different service levels due to different standards in different countries. In principle, however, value of capital stock should reflect quality.

According to the 2008 SNA, every item on the balance sheet has to be valued "… as if it were acquired on the date to which the balance sheet relates. This implies that when they are exchanged on a market, assets and liabilities are to be valued using a set of prices that are current on the date to which the balance sheet relates and that refer to specific assets" (SNA, para. 13.16). One has to take into account that the value of a certain asset will decrease while ageing and having been more used/depleted, as a consequence of which the future benefits that can be derived from such an asset will decrease as well.

To adequately value assets using (equivalent) market prices, one would need prices from second-hand markets on which the items in question are regularly, actively and freely traded. This may be the case for e.g. cars and residential dwellings, but certainly not for transport infrastructure. In the absence of market equivalent prices for the relevant assets, two alternatives are available:

1. Net present value method: the value of an asset is approximated by the present (discounted) value of future economic benefits expected from a given asset;

2. Perpetual Inventory Method (PIM): the value of the capital stock is approximated by accumulating and revaluing acquisitions less disposals of the type of asset in question over its lifetime and adjusted for changes such as depreciation, destruction by natural disasters, etc.

In compiling national accounts, the PIM usually is the preferred method. In the case of transport infrastructure, it also seems the only viable method, given the absence of market prices from trading in second-hand items, and given the difficulties in estimating the future benefits that can be derived from a particular asset. A major advantage of the PIM is also that it basically resembles the "current replacement cost" or "depreciated replacement cost", as often applied in business accounting, where one also often applies the historical cost method (before and after depreciation). The main difference between the two approaches relates to the prices at which the asset is valued. Whereas the first method tries to revalue the assets in question in line with present/current prices (often by using a general price index for the relevant asset), the second method retains the valuation at the prices at which the assets in question were acquired in the past.

Box 1. **Perpetual Inventory Method (PIM)**

The Perpetual Inventory Method (PIM) is a method of accounting for stocks (or inventory) of assets that records the sale or purchase of assets in near real-time, through the use of computerized point-of-sale and enterprise asset-management systems. Perpetual inventory provides a highly detailed view of changes in inventory and allows real-time reporting of the amount of inventory in stock, hence, accurately reflecting the level of goods on hand.

Basically, the measurement of stocks of assets using PIM resembles the current replacement cost method, often applied in business accounting. The stock of assets is set equal to the sum of past years' investments. The assets acquired in past periods will need to be revaluated to current price levels, to arrive at the appropriate value. Also depreciation of the assets in place needs to be taken into account, to reflect the decrease in value due to the use of the relevant assets. Finally, one needs to account for the disposal of the relevant assets, either as a result of a sale or because the asset is scrapped at the end of its economic life cycle.

In relation to the use of PIM, two points may be noted here. Especially relevant for transport infrastructure is its long service life, often over and above 50 years. As a consequence, one would need a long time series of acquisitions less disposals to arrive at an estimate of the total stock. Often this is circumvented by making a level estimate for a certain benchmark year in the past. The impact of this benchmark estimate on the quality of the value estimates for current capital stocks in recent years may be less significant if the benchmark estimate is further in the past.

The goal of the PIM is to arrive at a valuation in prices of the year for which the value of the stocks is calculated. Usually, one adjusts the investments in past years by applying an appropriate price index. In business accounting, one often uses an historic price, i.e. the price levels for past investments are not (frequently) adjusted. In the case of transport infrastructure, this does not seem justified, mainly because of the long service life of these assets and the significance of price level changes over these longer periods of time.

To estimate the total capital stock, the following data and assumptions, broken down by type of asset, are required:

- A sufficiently long time series of data on gross fixed capital formation;
- A sufficiently long time series of price indices (deflators);
- An estimate of the capital stock for a certain year in the past;
- Guestimates or assumptions regarding the average service lives of the relevant assets;
- Assumptions regarding the depreciation function, or “age-price profile”, of the relevant assets;
- Assumptions regarding the mortality function, or “retirement function”, of the relevant assets.

Some of the issues related to these data and assumptions are discussed below. More details on methodology and practices of measuring capital stocks can be found in the second edition of the OECD Manual, *Measuring Capital* (OECD, 2009).

The preferable breakdown into different types of asset will mainly depend on three factors: (i) the analytical needs; (ii) the availability of detailed data, and (iii) the required quality of the results. In relation to the latter element, apart from the length of time-series data, the most critical element in the estimation of capital stocks is the service life of the various types of asset. For the depreciation and mortality functions, applied to the service life of transport infrastructure, one would probably use the same set of assumptions for the various types of asset, and if one would want to choose assumptions that differ across the various types of infrastructure it likely does not affect the results dramatically.

"Sufficiently long time series" in the above means that one would prefer the longest possible and consistent time series, preferably surpassing the service life of the asset. In that case, the estimates of capital stock for more recent years would be based on actually measured data on gross fixed capital formation and/or the "rough estimates" for the starting stock would have a relatively low weight. It may be clear that the availability of long time series is especially demanding in the case of transport infrastructure which typically has a rather long service life.

The age at which the relevant asset is put out of service, because it has reached the end of its service life, is typically referred to as the "retirement" of the asset. Usually, some kind of retirement of the mortality function is assumed. This can be a "simultaneous exit", i.e. all assets are retired at the moment when they reach the average service life of the asset in question. Other retirement patterns assume a certain bell-shaped function around the average age of retirement (see OECD, 2009, section 13.2.).

Box 2. **Service life by asset type in Germany**

The service life of infrastructure is the period of time that the infrastructure (road, bridge, rail or other) is expected to be in operation. For example, the source for service lives of assets in Germany are depreciation rules for companies as set by the German Ministry of Finance. Depreciation tables provide, by detailed asset type, information on the length of service lives for tax purposes. As these fiscal service lives reflect a principle of prudence, they tend to underestimate the true economic service lives and hence, the Statistisches Bundesamt for purposes of depreciation measurement, adjusts them upwards by between 20 and 100%. Adjustment factors are based on expert opinions from enterprises and industry associations. To a small extent, service lives are differentiated by industry. For example, it is assumed that lorries have a shorter service life in the construction industry than elsewhere.

Service lives for structures, in particular for dwellings and non-residential buildings, and service lives for intangible assets such as software are based on a series of other sources, and are typically differentiated between different industries. For every type of investment, there is a different average service life, because every year the product, industry and sectorial composition of service lives may change. The table below shows examples of average service lives for types of assets as well as the spread of service lives for particular products within each asset category.

Table. **Service life by asset type in Germany**

| **Type of asset** | **Average service life** | **Minimum and maximum service life of products within asset type** |
|---|---|---|
| Buildings | 66 | 15 – 150 |
| Residential buildings | 74 | 40 – 95 |
| Streets | 57 | 35 – 116 |
| Equipment | 12 | 5 – 30 |
| Transportation equipment 11 | 11 | 8 – 25 |
| Machinery and equipment 12 | 12 | 5 – 30 |
| Metal products 18 14 – 22 | 18 | 14 – 22 |
| Data processing equipment | 5 | 5 – 9 |

Source: OECD (2009) and Schmalwasser and Schidlowski (2006).

The depreciation function, or “age-price profile”, reflects the decrease in value of an asset during its service life. As for transport infrastructure this information usually is not available from directly observable market prices, assumptions will have to be made. Leaving apart the information on the service life, there are two basic possibilities. Either one directly assumes a certain age-price profile, for example, a linearly-declining function, giving rise to constant absolute values of depreciation over an asset’s lifetime; or one makes assumptions regarding the “age-efficiency profile”. The latter reflects the productive capacity of an asset over its service life. This information can then be used to construct an age-price profile. The geometric age-efficiency profile is the one most commonly used (for more details on different methodologies for individual assets and for cohorts of assets, including the pros and cons of these methods, reference is made again to the OECD Manual, *Measuring Capital*).

A final remark in relation to the 2008 SNA standards concerns the measurement of the depreciation costs, or "consumption of fixed capital" according to SNA-terminology. These costs should include "… *the decline, during the course of the accounting period, in the current value of the stock of fixed assets owned and used by a producer as a result of physical deterioration, normal obsolescence or normal accidental damage*" (SNA, para. 10.25). Unforeseen elements, e.g. obsolescence due to unforeseen technological developments, are to be accounted for as "other changes in the volume of assets", as a kind of revaluation.

### *2.2.3 Scope of the term "transport infrastructure" by asset type*

The scope and coverage of the term "transport infrastructure" by asset type differs significantly from one country to another, depending on national definitions and data availability. This is one of the major obstacles for obtaining comparable data on spending on infrastructure in the transport sector (see also Chapter 2.3. below).

The European Commission has taken steps to define the scope of the term "infrastructure" in the framework of the transport policy for charging for the use of infrastructure (EEC Regulation No. 1108/70). This regulation introduced an accounting system for expenditure on infrastructure in respect of transport by rail, road and inland waterways. The regulation has been amended several times and, in the interest of clarity, the European Commission has further defined the scope of the term "transport infrastructure" in a more recent regulation (EC Regulation No. 851/2006). This regulation sets a useful conceptual framework to be used for collecting statistics on transport infrastructure.

Similar regulations or definitions of scope for airport and seaport infrastructure do not exist at the international level. However, the Glossary of Transport Statistics gives a general definition of airport and seaport infrastructure. These definitions are still crude and a number of issues remain unsolved. For example, in the case of air transport infrastructure, only infrastructure serving aviation should be included, while non-flight-related activities (e.g. tax-free shopping) should be excluded from the scope. In addition, decisions should be made in terms of what types of airport should be included in the data collection (only commercial airports serving scheduled flights, or all including private airports).

According to the European Commission definition, "transport infrastructure" means "all routes and fixed installations of the three modes of transport being routes and installations necessary for the circulation and safety of traffic" (EC Regulation No. 851/2006). More specifically, the regulation gives the following definitions by mode.

*Rail*

Railway infrastructure consists of the following items, provided they form part of the permanent way, including service sidings, but excluding lines situated within railway repair workshops, depots or locomotive sheds, and private branch lines or sidings:

- Ground area;
- Track and track bed, in particular embankments, cuttings, drainage channels and trenches, masonry trenches, culverts, lining walls, planting for protecting side slopes etc.:

  passenger and goods platforms;

  four-foot way and walkways;

  enclosure walls, hedges, fencing;

  fire-protection strips;

  apparatus for heating points, crossings, etc;

  snow protection screens;
- Engineering structures:

  bridges, culverts and other overpasses, tunnels, covered cuttings and other underpasses;

  retaining walls, and structures for protection against avalanches, falling stones, etc.;
- Level crossings, including appliances to ensure the safety of road traffic;
- Superstructure, in particular:

  rails, grooved rails and check rails;

  sleepers and longitudinal ties, small fittings for the permanent way, ballast including stone chippings and sand;

  points, crossings, etc.;

  Turntables and traversers (except those reserved exclusively for locomotives);
- Access way for passengers and goods, including access by road;
- Safety, signalling and telecommunications installations on the open track, in stations and in marshalling yards:

  including plants for generating, transforming and distributing electric current for signalling and telecommunications;

  buildings for such installations or plants;

  track brakes;
- Lighting installations for traffic and safety purposes;
- Plants for transforming and carrying electric power for train haulage: sub-stations, supply cables between substations and contact wires, catenaries and supports; third rail with supports;
- Buildings used by the infrastructure department, including a proportion in respect of installations for the collection of transport charges.

*Road*

Road infrastructure consists of the following items:

- Land;
- Road works prior to paving:
- cuttings, embankments, drainage works, etc.;
- support and back filling;
- Pavement and ancillary works:
- pavement courses, including waterproofing, verges, central reserve, gullies and other drainage facilities, hard shoulders and other emergency stopping areas, lay-bys and parking places on the open road (roads for access and parking and traffic signs), car parks in built-up areas on publicly owned land, planting and landscaping, safety installations, etc.;
- Engineering structures:
- bridges, culverts, overpasses, tunnels, structures for protection against avalanches and falling stones, snowscreens, etc.;
- Level crossings;
- Traffic signs and signalling and telecommunications installations;
- Lighting installations;
- Toll collection installations, parking meters;
- Buildings used by the infrastructure department.

*Inland waterway*

Inland waterway infrastructure consists of the following items:

- Land;
- Channel (earthworks, canal basins and linings, sills, groynes, berms, tow-paths and service roads), bank protection, canal-carrying aqueducts, siphons and conduits, canal tunnels, service basins used exclusively for sheltering vessels;
- Works for waterway shut-off and safety, spillways for the discharge by gravity of impounded water, basins and reservoirs for storing water for feeding and regulating water level, water control structures, flow gauges, level recorders and warning devices;
- Barrages or weirs (works constructed across the bed of a river to maintain sufficient depth of water for navigation and to reduce the speed of flow by creating pounds or reaches), associated structures (fish ladders, relief channels);

- Navigation locks, lifts and inclined planes, including waiting basins and basins for water economy;
- Mooring equipment and guide jetties (mooring buoys, dolphins, mooring bitts, bollards, rails and fenders);
- Movable bridges;
- Installations for channel buoying, signalling, safety, telecommunications and lighting;
- Installations for controlling traffic;
- Toll collection installations;
- Buildings used by the infrastructure department.

*Airport*

The Glossary of Transport Statistics defines airport infrastructure as "a defined area of land or water (including any buildings, installations and equipment) intended to be used either wholly or in part for the arrival, departure and surface movement of aircraft and open for commercial air transport operations". The definition includes, in more detail:

- *Airport terminals* as a self-contained facility for handling passengers and/or freight. Passenger terminal is further defined as an airport terminal with facilities for the handling of passengers, including passenger check-in, baggage handling, security, immigration passenger boarding and disembarkation. Freight terminal, in turn, is an airport terminal designed solely to handle freight shipments, including freight acceptance and release, secure storage, security and documentation.
- *Airport runways* as a defined rectangular area on an airport prepared for the landing and take-off of aircraft.
- *Airport taxiways* as a defined path on an airport established for the taxiing of aircraft and intended to provide a link between one part of the airport and another.
- *Check-in facilities* including conventional check-in facilities where airline staff handle ticket processing, luggage labelling, including fast bag drops, and issue of boarding cards directly as well as self-service check-in kiosks providing check-in facilities and offering automatic ticket processing, boarding cards and, in some cases, luggage label printing.
- *Passenger gates* defined as a passenger terminal where passengers gather prior to boarding their Aircraft both with finger bridges (a gate with a finger bridge connecting to the aircraft to allow boarding without descending to ground level and using steps to board or other gates.
- *Airport car parking facilities* provided at the airport both for short, medium and long stay with the exception of remote parking facilities only those served by airport buses should be included.

- *Intermodal freight facilities* within the airport with connections to modes other than road on its landside.

- *Connections to other modes* of transport provided within the airport for connection to other modes of surface transport, including access to high speed rail services, access to main line rail services, access to city metro and underground services, access to express and inter urban coach services and access to local bus services.

*Sea port*

The Glossary of Transport Statistics defines a port as a place having facilities for merchant ships to moor and to load or unload cargo or to disembark or embark passengers to or from vessels, usually directly to a pier. The definition of a port includes port land-side facilities such as storage and stacking areas, port cranes, port repair facilities, navigation aids and services as well as hinterland links.

### 2.3 Critical data needs and availability of data

To invest efficiently in transport infrastructure, policy and decision makers need to have, at minimum, key information on:

- Infrastructure inventory - the type, amount (i.e., stock), location, and condition of transport infrastructure, categorized by mode;

- Use and performance - the effectiveness and efficiency of the transport infrastructure in moving people and goods, as well as the undesirable consequences (e.g., accidents);

- Factors affecting the performance of the transport infrastructure - such as the aging of, and the increasing demand on, the infrastructure;

- Economic drivers - trends and developments that affect economic growth;

- Investment impacts and trades-off - the costs and impacts of competing investment choices.

Unfortunately, the available information is often extremely limited.

This section identifies minimum data requirements to carry out the macroeconomic analysis where the relationship between transport infrastructure investment and economic development will be developed. The minimum data requirements include investment flows by mode and by asset type as well as operation and maintenance (routine and periodic) expenditure by mode and by asset type. Furthermore, there is a need for breakdown of data by asset types. For example, productivity, determinants and financing of roads are very different from that for rail (and rail track from rolling stock), so there is a need to report and analyse different types of infrastructure assets separately.

To estimate the productivity of, say, road infrastructure, one needs information not only on the size and the use (traffic flow) of the road network (stock) but also on the marginal productivity. This information is needed also in monetary terms to be able to: (1) add them up (1 km of road can have very different values in different locations); and to (2) account for its quality. As infrastructure reduces production and transaction costs, its geographical location is also a key. At the micro (project) level there is a need to know which points on the map a piece of infrastructure connects. If you wish to study whether a road is “productive”, it is not really enough to know that it is in Paris or France.

As this list of necessary information can become exhaustive, a more pragmatic approach can be chosen by defining a list of common critical data needs. These critical data are meant to be the information required for carrying out meaningful analysis on the macro level. The critical data needs are presented in Box 3 below.

Box 3. **Critical data needs**

Tier 1. Minimum data requirement

1. Infrastructure investment and maintenance *separately and by asset type*
2. Capital stock *by asset type*
    2.1. In monetary (gross and net) values
    2.2. In physical units
3. Deflators (cost indices for relevant spending categories)

Tier 2. Additional information

4. Spending broken down by general government and by private ownership
5. Total spending by asset type on transport equipment
6. Spending broken down by urban and non-urban area.

In order to understand the availability of these data for different modes (road, rail, inland waterways, maritime ports and airports) in the member countries, a short survey was carried out among the data providers. Overall, twenty countries (out of total 54) completed the questionnaire. A summary table of answers from questionnaires is presented in Annex 1.

Results of this short survey indicate that due to a lack of commonly agreed definitions and classifications, the scope of the term “transport infrastructure” differs significantly from one country to another, depending mainly on national definitions and data availability. In many cases, countries do not provide any information on the coverage of data. For nearly all countries data on total investments on road and rail infrastructure are available while coverage for seaport and airport investments is less common. For maintenance data results are even less promising. Data on road maintenance is available in most of the countries (95%), while statistics on maintenance for other modes are less detailed (63%-78%).

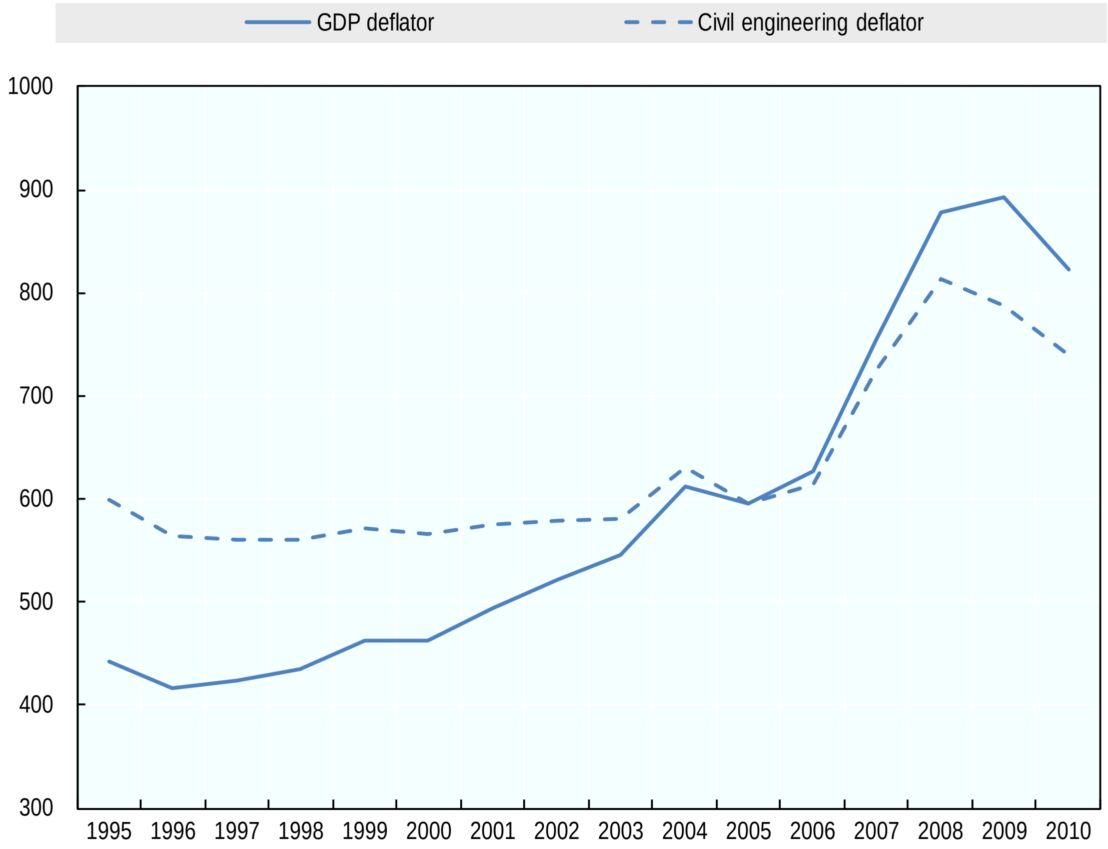
Data on capital stock are available for 60% of countries that responded the questionnaire. The International Transport Forum at the OECD has not collected these data before and this result is encouraging for incorporating capital stock into future questionnaires, especially noticing that most of the countries have these data available both in physical units and values.

Countries have more difficulties for providing data with more detailed breakdown of the investment and maintenance. In countries where investment and maintenance data are available, information on central and local government data are available for 70% of respondents. However, less than half of the countries can report private investment. The availability of data on private maintenance is even more difficult – only two countries out of twenty report statistics on private maintenance expenditure for roads.

Also, the breakdown of urban and non-urban data seems very difficult for data providers. Only one third of respondents can do some kind of breaking down of these items for road investments. These results may be affected by the difficulty of defining urban area – something which may differ significantly from country to another. Further, data on associated investments (rolling stock, ICT and transport services) are more difficult to obtain with data availability ranging from only 13% to 61% of countries, depending on variable.

Finally, the short questionnaire also included a question on the availability of a possible deflator to be used for calculating spending in constant prices. Based on responses, a variety of deflators are currently in use. However, the most commonly used was the cost index for land and water construction (or civil engineering). If this has not been available, most countries used a general GDP deflator as one that is easily accessible and available. However, choosing a right deflator may be crucial for interpreting data on investment spending. As following graph on volume of investment in Finland illustrates the choice of the deflator affects the trend observed. The cost of land and water construction has increased more than costs at manufacturing industry, resulting with more moderate growth in volume of road investment.

Figure 1. **Volume of road investment in Finland 1995-2010**
(at constant 2005 prices)



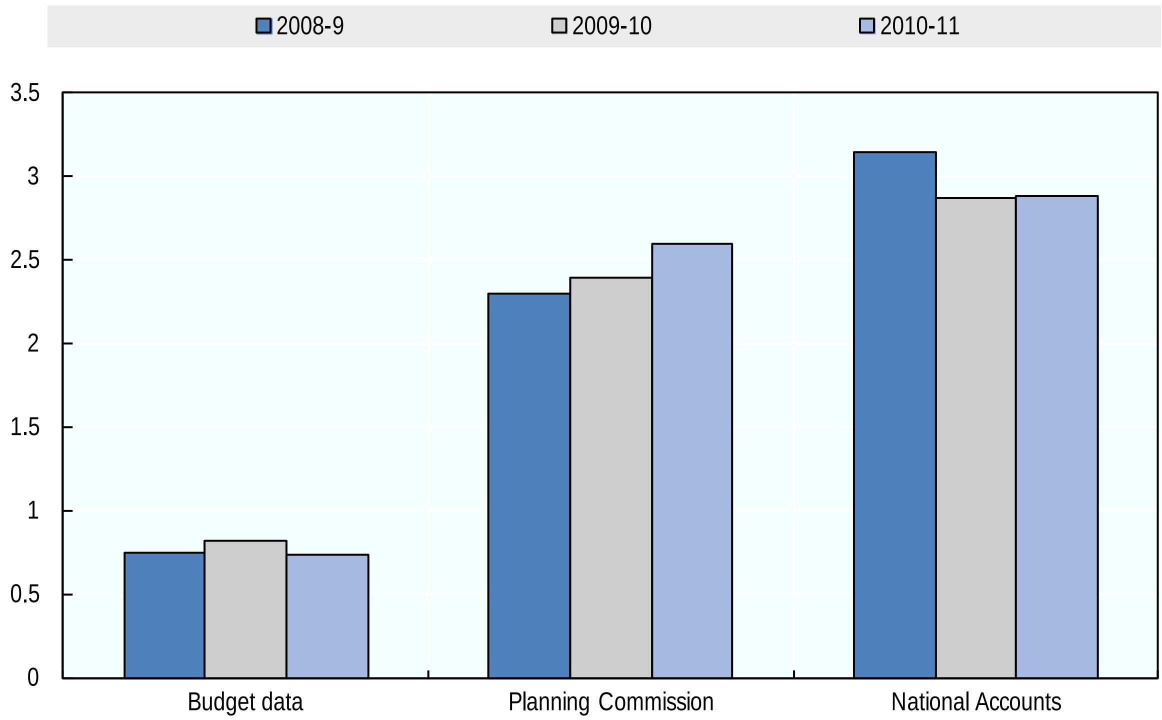

Source: International Transport Forum at the OECD.

Similarly, for international comparisons, economic analysis of time-series data almost always entails some form of correction for price changes. International cross-sectional comparisons frequently involve currency conversions and Purchasing Power Parity (PPP) adjustments but civil engineering related PPP deflators are currently not available. In relation to investments, the OECD currently collects and publishes these data for total investments, construction, and equipment. More detailed and targeted PPPs would be an advancement for creating better comparability for transport infrastructure spending at the international level.

Finally, the example below from India illustrates how different approaches to estimate investment in transport infrastructure affect the overall results. Kumar and Sankar (2012) present three alternative estimates for investment in transport infrastructure in India. The first estimate is based on the combined capital expenditure of central and state governments. These are budget based estimates and exclude both private expenditure and capital expenditure incurred by autonomous organizations, statutory bodies and public sector companies. Therefore, the estimates do not fully cover the capital expenditure incurred by the public sector as a whole.

The second estimate is based on the data compiled by the Indian Planning Commission obtained from different Ministries/Departments and the State Governments. The investment data from the Planning Commission in respect of public sector is Plan expenditure data as reported by various Transport Ministries (Railways, Road Transport & Highways, Shipping, Civil Aviation, Rural Roads) or Departments of central government and State governments against approved plan allocation. It incorporates also private investment, including under public-private partnership.

Figure 2. **Investment in transport infrastructure in India**
(alternative estimates, % of GDP)




Source: Kumar and Sankar (2012).

The third estimate largely follows basic concepts, definitions and methodology given in the System of National Accounts. National accounts have two different sets of estimates on gross fixed capital formation. One estimate is in terms of industry of use which covers railways and other transport (comprising road transport and waterborne transport) and includes expenditure on all types of transport equipment and the rolling stock across all tiers of the government and the private sector. However, investment related to construction under transport is subsumed under distinct asset class – construction. The other estimate of gross fixed investment is in terms of assets and institutions and it covers two distinct asset classes, machinery and equipment (covering all types including transport) and construction across public, private and the household sector. It does not give investment break down in terms of machinery and construction separately for the transport sector. However, capital formation for the asset class construction is available for the public sector roads only and not for construction related to other modes of transport.

In summary, an attempt is made below to classify data gaps into the following three categories: (a) data not available; (b) data exists but with different coverage; and (c) data exists but coverage unknown.

*Data not available*

Most of the time missing information is simply due to the fact that a specific mode of transport does not exist in the reporting country. There are two other possible cases for a country reporting non-available data. First, the information is classified confidential. This is the case of rail, seaports and airport data in Australia, for example. Second, the information might exist but is not collected because it is not required at the national level or there is a lack of resources for collecting it and national statistical offices do not have any collecting system in place to gather this information (for example, Montenegro, Slovakia, Latvia).

*Data exist but with varying coverage*

The lack of internationally agreed definitions makes data comparisons difficult between countries. Data collected by the International Transport Forum is generally reported as they are defined and collected within the national statistical systems. Ideally, a detailed metadata would be incorporated into the responses. However, it is currently not possible to indicate comparability of coverage since there has not been, until now, recommendations for internationally agreed definitions. Some countries provide descriptions of the coverage of their data, which form the basis for defining best practices to improve data collection.

Another reason for varied coverage is the treatment of private spending. Confidential data, data protection laws, the Code of Practice of Eurostat and internal statistical rules do not always permit tracking down or dissemination of private spending information. This is the case of Australia, for example, which only reports data for roads. In Sweden, also, no private investment data are available. In addition to these differences, there is a problem when investment and maintenance spending cannot be separated.

*Data exist but the coverage is unknown*

The last type of data gap occurs when countries provide data on spending on transport infrastructure but there is no clear knowledge on what is included in data. Although this seems a rather unlikely reason for a gap, it seems that in several countries this is a real problem as information is aggregated and compiled from several sources.

## 2.4 Task Force recommendations for improving data collection

As discussed above, national data sources provide information on transport infrastructure spending according to their own national definitions and the data coverage reflects national needs making international comparisons difficult. To ensure the quality and the comparability of data, it is crucial that statistics providers have a clear and consistent understanding of the definitions and coverage used for collecting data on infrastructure spending.

In order to improve international comparability and analytical use of statistics on transport infrastructure spending and assets, the Task Force therefore makes the following recommendations:

***Recommendation 1. National statistical offices should provide, at minimum, data on investment and maintenance separately by asset type.***

Based on data availability and minimum data requirements for carrying out macroeconomic analysis on the impact of infrastructure investment on economic development, the very minimum statistics needed are investment and maintenance separately with breakdown by road, rail, inland waterways, ports and airports.

***Recommendation 2. It is highly recommended to provide estimates of capital stock by asset type***.

From an analytical perspective it is essential not only to have data on additions to stock (spending) but also the size and value of the existing network (stock). Therefore, collection and estimation of capital stock data is highly recommended. These data are likely to be available better in physical units but collection of data in monetary values is also encouraged. To estimate capital stock in values, the Perpetual Inventory Method (PIM) described in Chapter 2.2.2 is a preferred approach.

***Recommendation 3. The definition and recording of investment and maintenance should follow as closely as possible that used in the System of National Accounts***.

Despite some deficiencies as regards classification of transport in the System of National Accounts, the definitions used are a useful conceptual starting point for international comparability. The definition between investment and maintenance, according to which ordinary maintenance and repairs do not change the capacity or performance of the infrastructure whereas major renovations, reconstruction and enlargements increase performance or capacity of infrastructure and are to be recorded as investments, is especially useful.

**Recommendation 4. The European Commission regulation on the scope of transport infrastructure is a useful conceptual framework for classification of infrastructure by asset type. Development of more accurate definitions for all asset types should be considered as a priority item for future work.**

As demonstrated earlier, the lack of a commonly agreed framework and of classification of infrastructure by asset type is a major problem for comparability of international transport infrastructure spending data. The European Commission regulation on the scope of the term “transport infrastructure” for road, rail and inland waterway infrastructure is a useful conceptual starting point for improving comparisons and analysis of the results internationally (see Chapter 2.2.3). The development of similar and more accurate definitions for the scope should be considered as a priority for future work at an international level (e.g. International Transport Forum/Eurostat/UNECE).

***Recommendation 5. National statistical offices should produce or distribute specific transport infrastructure construction cost indices for use as deflators in calculating spending in constant values***.

The importance of using accurate deflators (cost index) for calculating spending in constant values was demonstrated above. Choosing a wrong deflator may significantly affect the results of analysis. Various cost indices are used to deflate each component of the GDP. For the construction of transport infrastructure, it is recommended to use an index which reflects as specifically as possible the cost structure of the industry. If they are not available, the production of such indices is highly recommended.

**Recommendation 6. The OECD and ITF countries are invited to explore possibilities to have more detailed and targeted Purchasing Power Parities for transport infrastructure.**

Purchasing Power Parities (PPPs) reflect price level differences between countries. As such they enable international comparisons of expenditures that are adjusted for differences in price level. In this respect, specific PPPs related to civil engineering would improve international comparability and analytical use of transport infrastructure spending data. In relation to investments, the OECD currently collects and publishes these data for total investments, construction, and equipment. It would be useful to have more detailed and targeted PPPs made available.

***Recommendation 7. Data should always include detailed metadata on methods, definitions and classifications used***.

To foster international comparability of statistics regarding transport infrastructure spending and assets, information on methods, definitions and classifications should always be provided with data. Preferably this should include information about how they differ from recommendations given in this report.

# 3. USING DATA FOR BETTER POLICIES

## 3.1 Introduction

Transport is critical to many aspects of economic life. Transport infrastructure is a necessary input into the production of transport services which, in turn, are vital for the market exchange of final goods and inputs– or for broader welfare benefits. But how much, exactly, does transport infrastructure support economic development and wealth creation? What determines the magnitude of that impact?

Lack of (comparable) data limits the quality of macroeconomic analysis. Concerns for policy-relevant analysis can be summarized as:

a. Finding out how much (in monetary terms) transport infrastructure there is in the first place;

b. Estimating how the stocks evolve over time (i.e. do annual investment flows cover depreciation?);

c. Estimating how close to the optimum (growth-maximizing level) the current stock is (i.e. should more or less be invested?); and

d. What determines investment (e.g. does fiscal decentralization boost local and regional government infrastructure investment?).

Based on this, analysts can support policymaking by assessing the impact of changes of direction. The important caveat remains that project selection should still be based on cost-benefit assessment because even if the stock of transport infrastructure assets is close to its optimum, there may still be a number of welfare-enhancing individual projects.

In addition to these macroeconomic analysis, statistics on transport infrastructure are useful for assessing the condition of the existing assets, evaluating the extent to which the infrastructure meets current demand, assessing whether infrastructure is likely to be able to meet demand in the future and benchmarking – to compare infrastructure availability in one country with other countries.

For assessing the existing assets and generating meaningful information, the infrastructure statistics can be classified into five broad categories:

- Accessibility indicators measuring the availability of infrastructure over geographic area and as proportion of population;

- Quality indicators, i.e. whether the available infrastructure is of use or not;

- Fiscal costs and revenue indicators, including budget outlay, expenditure, investments and revenues generated;
- Utilization indicators measuring whether the infrastructure is being utilized to its full capacity or not; and
- Affordability indicators showing whether the infrastructure can be afforded by users.

These types of indicators are specifically useful for benchmarking: to compare infrastructure availability and performance internationally.

Despite the potential value, there is a lack of cross-country comparisons of outputs, inputs and efficiency. As a recent OECD study on the performance of road transport infrastructure points out, this may partly reflect the lack of analytical or empirical framework but, more importantly, significant problems relating to data availability, coverage, quality and comparability (Braconier *et al.,* 2013). Benchmarks for the transport sector and infrastructure performance are hampered by a complete lack of data on some dimensions (e.g. connectivity), partial coverage (e.g. travel time) or limited comparability (investment and maintenance).

The following sections will discuss macroeconomic research and the use of data on transport infrastructure for benchmarking. Few examples are also shown to illustrate the possible policy use.

## 3.2 Macroeconomic research

Transport infrastructure assets and networks have very special economic characteristics. They are associated with multiple market failures, including public good characteristics and externalities (both positive and negative). Transport infrastructure assets tend to be costly to construct but relatively cheap to operate and maintain, giving them characteristics of natural monopolies. The assets are specific, long-lived and generate benefits for users over long time periods. The economy-wide benefits of such assets depend on how well they have been combined into networks. For example, a sparse network connecting critical hubs may be more efficient than a dense network with key missing links.

Countries spend considerable amounts of money each year to maintain and improve their transport infrastructure in response to growing passenger and freight mobility needs. Given the level of funding requirements and budgetary constraints, it is important for decision-makers to understand the relationship between these expenditures and policy objectives. Decision-makers need reliable information and appropriate analytical tools to prioritize projects according to the benefits they provide. The same is true for the costs of operation, maintenance and reconstruction during service life, which tends to follow the costs of constructing a new infrastructure.

The direct impact – or productivity – of investment in transport infrastructure has been the subject of a body of empirical literature over the past decades. In this context "productivity" simply refers to the relationship between transport infrastructure and some measure of income/growth/wealth or welfare, most often measured as Gross Domestic Product or value added at the appropriate level of aggregation. Considering transport infrastructure as an input variable in an aggregate production function and measuring the empirical relationship between transport infrastructure input and aggregate output allows for a direct effect and an indirect effect (transport infrastructure boosting total factor productivity and thereby output). Ideally, one would consider the relationship between components of the transport network and growth, in order to assess how close the existing network is to its growth-maximizing (or optimal) level.

It is important to note that the policy target for the policy maker is the optimality of the network (i.e. a stock of assets). The annual investment (flow) into that network is just a short-term decision variable meant to serve the broader policy target.

Transport infrastructure is part of the broader concept of public capital. The empirical literature on the productivity of public capital has been summarized in Kamps (2005), Jong-A-Pin and de Haan (2008), and Crafts (2009). The early empirical literature in the late 1980s, using mostly US data, suggested that the growth impact of public capital was very high. The econometric methodology of these early studies was subsequently questioned, and the application of more appropriate methods led to lower estimates.

It is important to recognize that public capital is often used in these studies as a proxy for infrastructure or, more specifically, transport infrastructure, given that a large share of government investment (capital) comprises transport infrastructure, specifically roads. However, as emphasized in Gonzalez-Alegre *et al.* (2008), these concepts are empirically unequal, so conclusions based on data for overall government investment (capital) are not immediately applicable for investment in transport infrastructure. The heterogeneity of public capital across countries and time periods also explains why the results of empirical analyses tend to vary significantly.

Box 4. **Impact of road infrastructure on productivity of manufacturing in Finland**

Uimonen and Tuovinen (2006) have estimated the impact of the road infrastructure on costs and productivity of the manufacturing industry in Finland. The study uses new data on the asset value (capital stock) of road infrastructure and applies an econometric model to estimate the impact of the road network on manufacturing productivity.

According to the study, road infrastructure has had a significant impact on the productivity of the manufacturing industry. A 1% increase in investment in road infrastructure resulted in 0.3% savings in the short-term costs for manufacturing industries. In addition, investments in infrastructure were clearly more productive than investments in private capital.

As more time-series data have become available, it has also become possible to estimate how the productivity of public capital may have changed over time. While this branch of literature is still young, there is some evidence that the productivity of public capital has been declining over time in advanced economies, notably in Europe. This tentative conclusion is intuitively appealing insofar as one would indeed expect the growth impact of, say, motorway construction to be large in the early phases of network development as key hubs are connected. The more complete the network becomes, the lower the average impact of yet another segment is likely to become. However, it is important to point out again that even if the average impact may be low, individual projects may still have a very high economic rate of return and may be worth pursuing even in the context of well-developed networks.

Apart from estimating the productivity of, or need for, transport infrastructure (investment), empirical researchers have also sought to understand its drivers. One driver is clearly the size of investment needs, or the difference between the existing stock of assets and its optimal value – underdeveloped networks warrant more investment than mature ones. Other factors that drive the amount of investment considered include the type of basic macroeconomic characteristics mentioned above: fiscal sustainability considerations, the cost of financing as well as the system of fiscal federalism and devolution of power to lower levels of government. All these factors have been found to impact investment in transport infrastructure but, interestingly, their impacts are different from other types of government investment.

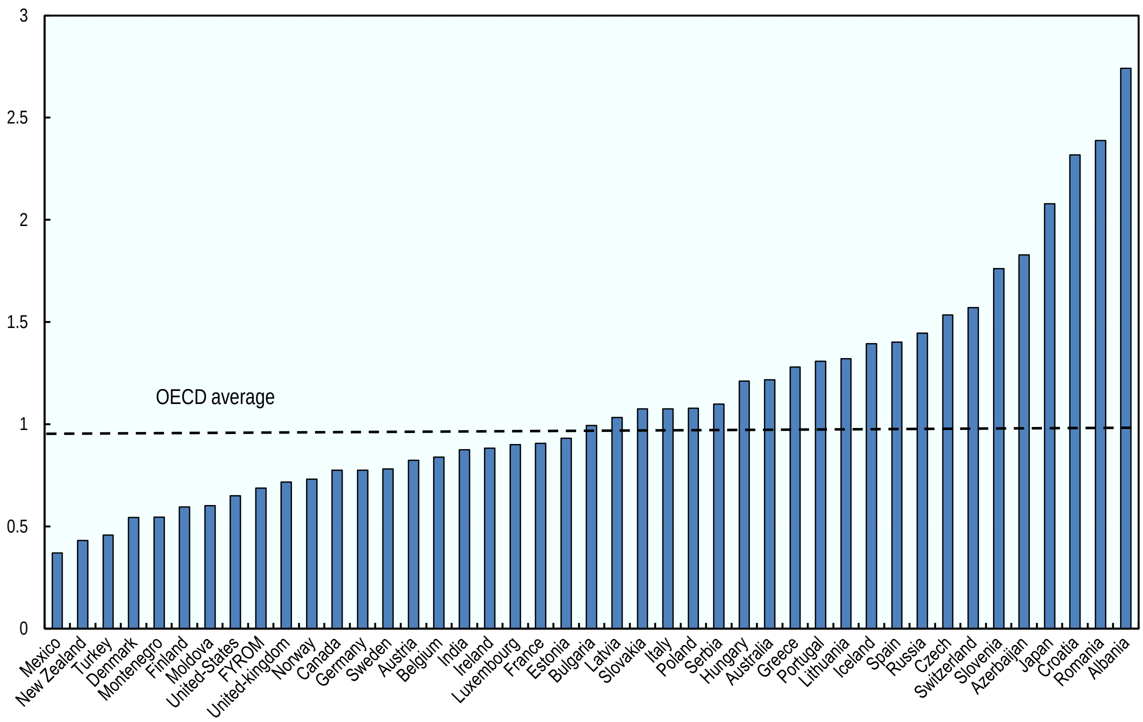
As part of the discussion on sustainable development and green growth, one of the main new concerns of transport economics is extending the scope of research to include externalities – especially calculating the contribution of the transport sector to the green growth.

### 3.3 Infrastructure data for benchmarking

Figure 3 presents data on investment in road and rail transport infrastructure as a share of GDP in several countries. Although the investment needs for transport infrastructure depend on a number of factors, such as the quality and age of the existing infrastructure, geography of the country and transport-intensity of the country's productive sector, this type of benchmarking may provide a useful starting point for analysis, raising questions such as:

- Why is the level of investment lower in country A compared with country B?
- What role do institutional arrangements play in determining investment levels among different countries?

Figure 3. **Investment in road and rail infrastructure as a share of GDP**
(average 2000-2010)




Source: International Transport Forum at the OECD.

The point of investment and maintenance is ultimately the production of a good or service – in the case of transport, the movement of people and goods from one place to another. Thus, there is thus little point in focusing on measuring inputs (investment, maintenance and operating costs) without being able at the same time to measure and evaluate outputs and to relate the outputs to the inputs functionally.

Outputs are, however, measured in a number of dimensions, only some of which are easily collected and reported. The first dimension – quantity – has been the starting point of most transport databases. Freight outputs in tonnes originated, tonne-km transported and freight revenue generated are accepted measures. Even at this physical level, though, there are imbalances between modes, with information about railways and air typically more detailed than for roads because railways and airports/operators are sufficiently limited to permit a full description of assets whereas roads are often of necessity reported on a sampled basis. For example, the International Transport Forum database presents annual physical output of the transport systems by mode and by country. Relating physical outputs to specific commodities, origins, destinations and routes has been much harder, though some programs (TENtec and Freight Analysis Framework) are attempting to construct such databases in support of the EU- and US-wide transport systems, respectively.

Another aspect of output quantity measurement – matching costs to revenues – has been much less available, and yet this is the real basis of calculation of net benefits of investment and maintenance. Some efficiency proxies (annual tonne-km/truck, tonne-km/employee, etc.) can aid in establishing this relationship, but they typically do not involve monetary relationships, and are only partial measures of the effectiveness of the use of resources. There are very few datasets linking trucking or water (or airline) reports of outputs with the costs specific to those outputs.

The second dimension of output measurement is quality. Quality of service measures are complex, and can include on-time reports, cleanliness, customer complaints, and loss and damage, among many others. Quality measures can be specific to each mode and to the types of service provided by the mode in a particular country (rail commuter versus intercity passengers versus high-speed rail, for example). Despite the complexity of the measurements, the level of quality of service is an inherent assumption in decisions about where and how much to invest in transport and it is directly related to maintenance decisions as well. In the case of public support provided to franchises, quality serves as a part of the compensation calculation. The productivity of a given investment and priority decisions across modes can hardly be assessed without at least some connection to quality of outputs as well as quantity and cost.

Complementary data for improved policy analysis are available from several different sources. These include:

- Physical size (km), density (km/km$^2$) and technical information of network (how many lanes, design speed, etc.);
- Output measures (tonne-km, pass-km, quality);
- Emissions;
- GDP, population, country size;
- Costs (labour and capital); and
- Vehicle stock.

Although these data exist, there is a general lack of linkage between transport data and related measures of transport impact. For example, most transport databases do not directly provide information about energy consumption, emissions (CO2 and pollution) and other social impact data, nor do they provide information as to how to find such information that is consistent with the definitions and assumptions in the original database. As a result, data users trying to evaluate a transport investment in the context of its broader impacts must either possess high familiarity with all sources of data, or proceed piecemeal by consulting a number of unconnected sources.

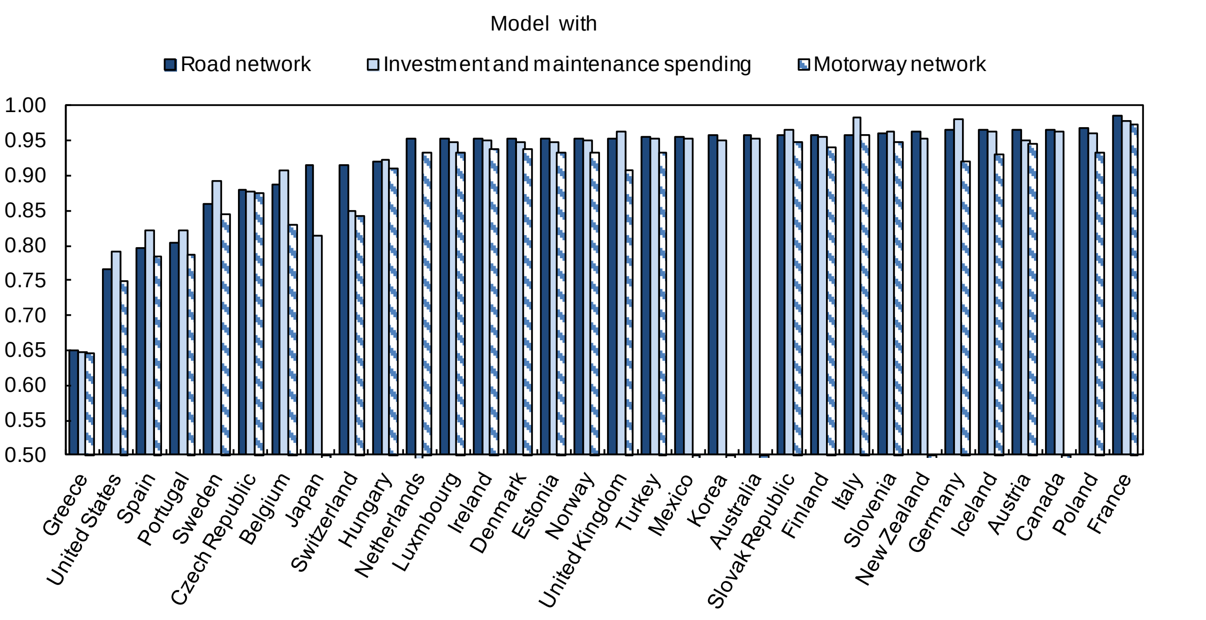
In defining data or indicators that can effectively support the decision-making process, certain criteria must also be considered. First, the availability and ease of assembling data are important factors to take into account. Indicators need to be easily replicable and consistently measurable through time. Furthermore, indicators need to be easily interpretable for policy evaluation. In empirical work the sample analysed must be big enough to render statistical tests sufficiently powerful. Finally, the more one aggregates (the more “macro” the level of analysis is), the more critical it is that the aggregation is consistent across (geographical) units and over time.

To the extent possible, then, transport datasets should be constructed so as to show both quality and indirect effects, or should at least make the reference to all output impacts as effective as possible. If this can be achieved, one of the concerns – that the overall linkages between transport investment and economic development are hard to quantify – can be alleviated.

Box 5. **DEA efficiency scores for road infrastructure**

Braconier *et al.* (2013) estimate the efficiency (defined as the ratio of output to inputs) of the road transport sector using Data Envelopment Analysis (DEA).While there are several ways of analysing efficiency, the DEA is a method to estimate efficiency accommodating multiple outputs and inputs. DEA is a non-parametric programming technique that develops an efficiency frontier by optimizing the weighted output/input ratio of each provider. The potential efficiency gains for any country depend on their distance from the frontier. Countries below the frontier (1.00) are inefficient and can increase outputs for given inputs or decrease inputs for given outputs. The baseline model consists of three inputs: number of motor vehicles, the length of the road network and energy consumption. Passenger-kilometres and tonne-kilometres are used as proxies for transport volumes while the number of road injury accidents as an undesirable output. Investment and maintenance data has been used as an alternative proxy for road network. This type of analysis can provide guidance on the scope of potential efficiency gains and help to analyse linkages between policy and performance. Figure 3 presents results of the DEA analysis for several OECD countries. The results show that differences in efficiency between the best and worst performing countries are significant. For example, Greece could simultaneously reduce energy consumption and injuries and increase freight and passenger traffic by 35% (efficiency score 0.65).

Figure 4. **DEA efficiency scores**




Note: Efficiency scores vary from zero (the lowest level of efficiency) to on (the highest). Data are averaged over the 2000s. All variables are scaled by GDP in 2005 PPP dollars.

Source: Braconier *et al.* (2013).

## 4. CONCLUSIONS

This report has highlighted the importance of macro-level data for a better understanding of the relationship between transportation expenditures and policy objectives. Infrastructure investments are a key determinant of performance in the transport sector.

Past investment decisions and research have been restricted by the lack of appropriate data. Better data are needed to carry out policy-relevant research at the macro level. Such policy-relevant research would include better estimates of the value of transport infrastructure, the productivity of transport infrastructure investment and a better understanding of determinants (or lack thereof) of investment in transport infrastructure.

The report has identified the lack of clear and commonly-agreed definitions and methods for a number of critical terms used as a key barrier to the advancement of internationally comparable data on spending in transport infrastructure and assets. There are also major gaps in the available data, used to carry out macroeconomic analysis on the impact of transport infrastructure investment in economic development. These include investment flows by mode and by asset type, as well as operation and maintenance (routine and periodic) expenditure as separate items. One needs information not only on the spending but also on the value of the existing stock (assets).

The report provides guidance on definitions and coverage used for collecting data on infrastructure spending. In order to improve international comparability and analytical use of statistics on transport infrastructure spending and assets, the report also makes a number of practical recommendations.

The ultimate challenge will be adopting uniform methods and definitions for each mode and all geographical areas. This report hopefully is a first step towards better comparability and coverage of statistics on transport infrastructure spending and assets.

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## ANNEX 1. DATA AVAILABILITY

Total number of responses: 20

Data availability by asset type and spending category (% of responses)

| | Investment | | | | |
|---|---|---|---|---|---|
| Asset type | Total | General government | Private ownership | Urban | Non-urban |
| **Road** | 100 | 80 | 35 | 15 | 30 |
| **Rail** | 94 | 76 | 41 | 12 | 24 |
| **Inland waterways** | 75 | 50 | 50 | 0 | 17 |
| **Sea ports** | 88 | 71 | 71 | | |
| **Air ports** | 89 | 53 | 41 | | |

| | Maintenance | | | | |
|---|---|---|---|---|---|
| Asset type | Total | General government | Private ownership | Urban | Non-urban |
| **Road** | 95 | 84 | 11 | 21 | 37 |
| **Rail** | 78 | 86 | 29 | 14 | 29 |
| **Inland waterways** | 63 | 40 | 20 | 0 | 20 |
| **Sea ports** | 56 | 78 | 56 | | |
| **Air ports** | 68 | 54 | 38 | | |

| | Capital stock | | | Other | | |
|---|---|---|---|---|---|---|
| Asset type | Total | Physical units | Values | Rolling stock | ICT | Transport services |
| **Road** | 70 | 64 | 64 | 45 | 25 | 25 |
| **Rail** | 67 | 67 | 67 | 61 | 33 | 28 |
| **Inland waterways** | 50 | 25 | 75 | 38 | 13 | 0 |
| **Sea ports** | 56 | 56 | 89 | 25 | 25 | 25 |
| **Air ports** | 63 | 50 | 67 | 32 | 26 | 21 |

## ANNEX 2. INTERNATIONAL PUBLIC SECTOR ACCOUNTING STANDARDS

The International Public Sector Accounting Standards (IPSAS) are an elaboration of the International Accounting Standards (IAS) for corporations, but then targeted at government (related) units. As the (2008) SNA and the IAS, the IPSAS-standards use "accrual accounting" as a basic underlying principle. In that respect, they deviate from "cash accounting" which at the moment still is the usual practice in government administrations. An important difference between the two types of accounting relates to the accounting for investments, deprecation and the concomitant recording of non-financial assets.

"IPSAS 17 – Property, plant and equipment" deals with the recording and measurement of investments and capital stocks. Property, plant and equipment includes infrastructure assets (IPSAS 17, para. 4). Below, the main accounting rules, as prescribed by IPSAS 17 will be addressed. Doing so, differences with the SNA-standards will be highlighted.

*The recording and measurement of investments*

The general definition of (investments in) non-financial assets according to IPSAS is very similar to the one applied in the 2008 SNA: "Property, plant and equipment are tangible items that:

a. Are held for use in the production or supply of goods or services, or rental to others, or for administrative purposes; and

b. Are expected to be used during more than one reporting period" (IPSAS 17, para. 13).

The costs related to these items should "… be recognized as an asset if, and only if:

a. It is probable that future economic benefits or service potential associated with the item will flow to the entity; and

b. The cost or fair value of the item can be measured reliably" (IPSAS 17, para. 14).

IPSAS 17, para. 21, also gives a more precise definition of "infrastructure assets", of which transport infrastructure:

"*Some assets are commonly described as infrastructure assets. While there is no universally accepted definition of infrastructure assets, these assets usually display some or all of the following characteristics:*

*a. They are part of a system or network;*

*b. They are specialized in nature and do not have alternative uses;*

 

c. *They are immovable; and*

d. *They may be subject to constraints on disposal.*

*Although ownership of infrastructure assets is not confined to entities in the public sector, significant infrastructure assets are frequently found in the public sector. Infrastructure assets meet the definition of property, plant and equipment and should be accounted for in accordance with this Standard. Examples of infrastructure assets include road networks, sewer systems, water and power supply systems and communication networks".*

Furthermore, also the issue of maintenance is addressed in IPSAS 17. In para. 23, it is stated that "… *an entity does not recognize in the carrying amount (the amount at which an asset is recognized, addition PvdV) of an item of property, plant and equipment the costs of the day-to-day servicing of the item*". On the other hand, para. 24 states that the replacement of parts at regular intervals, for example a road that needs resurfacing every few years, should be recognized according to the criteria in para. 14 (see above). It also states that the carrying amount of those parts that are replaced should be derecognized.

Disregarding textual differences, and a consequence differences in interpretations, one can say that the 2008 SNA and IPSAS use the same kind of concept for defining investments in general and transport infrastructure in particular.

IPSAS does not seem to include specific rules in relation to the time of recording of large infrastructural investments, the production of which involves several years and payments are done in stages. On the other hand, there are quite specific standards for the valuation of the costs of investment:

*"The cost of an item of property, plant and equipment comprises:*

a. *Its purchase price, including import duties and non-refundable purchase taxes, after deducting trade discounts and rebates.*

b. *Any costs directly attributable to bringing the asset to the location and condition necessary for it to be capable of operating in the manner intended by management.*

c. *The initial estimate of the costs of dismantling and removing the item and restoring the site on which it is located, the obligation for which an entity incurs either when the item is acquired or as a consequence of having used the item during a particular period for purposes other than to produce inventories during that period" (IPSAS 17, para. 30).*

*"Examples of directly attributable costs (which are not part of the investment costs, PvdV) are:*

a. *Costs of employee benefits (as defined in the relevant international or national accounting standard dealing with employee benefits) arising directly from the construction or acquisition of the item of property, plant and equipment;*

b. *Costs of site preparation;*

c. *Initial delivery and handling costs;*

d. *Installation and assembly costs;*

e. *Costs of testing whether the asset is functioning properly, after deducting the net proceeds from selling any items produced while bringing the asset to that location and condition (such as samples produced when testing equipment); and*

f. *Professional fees" (IPSAS17, para. 31).*

Comparing the above IPSAS-definitions with the relevant parts of the 2008 SNA, it becomes apparent that the latter standards include more costs into the "price" of the relevant asset. Most of the costs which are explicitly excluded for the value of the asset, are included according to the 2008 SNA standards. In practice, however, the differences may be less significant, as the national accounts data will be based on survey data from the relevant (government) units, and it may be difficult to separate out, for example, installation costs from current expenses, if the unit has not included them in investments.

Another difference may relate to the valuation of own-account production, or self-constructed assets. Whereas IPSAS recommends a valuation according to the internal costs of construction, the 2008 SNA suggests a valuation at (equivalent) market prices, i.e. including a net return on the fixed capital used in production, which comes down to adding a profit margin as observed in the market.

Regarding ownership, IPSAS provides specific details for the recording of financial lease. IPSAS 13 on leases requires a unit "… *to evaluate its recognition of an item of leased property, plant and equipment on the basis of the transfer of risks and rewards*" (IPSAS 17, para. 6). This is fully in line with the SNA standards.

The recording and measurement of capital stocks

On valuation of assets on the balance sheets, IPSAS 17, para. 43 states the following: "*After recognition as an asset, an item of property, plant and equipment shall be carried at its cost less any accumulated depreciation and any accumulated impairment losses*". Para. 44 goes on with saying that, for assets whose fair value can be measured reliably, revaluations should be made with sufficient regularity. For items with significant and volatile changes in fair value, an annual revaluation is recommended; for other items, a revaluation every three to five years is considered sufficient. "*The fair value of items of property is usually determined from market-based evidence by appraisal. The fair value of items of plant and equipment is usually their market value determined by appraisal. An appraisal of the value of an asset is normally undertaken by a member of the valuation profession, who holds a recognized and relevant professional qualification*" (IPSAS 17, para. 45).

If market (equivalent) prices are not available, IPSAS 17 provides alternative valuation methods in para. 47 and 48. One alternative is valuing an item by reference to other items with similar characteristics, in similar circumstances and location, whereas in the case of specialized buildings and other man-made structures, depreciated replacement costs, or the restoration cost or service unites approaches are recommended (for more details, reference is made to IPSAS 21).

 

When it comes to measuring (accumulated) depreciation, IPSAS requires significantly more detail than the more aggregated estimation procedures in the area of national accounts: "*Each part of an item of property, plant and equipment with a cost that is significant in relation to the total cost of the item shall be depreciated separately*" (IPSAS 17, para. 59). An example for roads is provided in para. 60: "*For example, in most cases, it would be required to depreciate separately the pavements, formation, curbs and channels, footpaths, bridges and lighting within a road system*". Doing so, the residual value (after depreciation) and the useful life, or service life, shall be reviewed at least at each annual reporting date (IPSAS, para. 67).

Furthermore, IPSAS 17 (para. 72) states, rather similar to the 2008 SNA, that *"… all the following factors are considered in determining the useful life of an asset:*

*a. Expected usage of the asset. Usage is assessed by reference to the asset's expected capacity or physical output.*

*b. Expected physical wear and tear, which depends on operational factors such as the number of shifts for which the asset is to be used and the repair and maintenance program, and the care and maintenance of the asset while idle.*

*c. Technical or commercial obsolescence arising from changes or improvements in production, or from a change in the market demand for the product or service output of the asset.*

d. *Legal or similar limits on the use of the asset, such as the expiry dates of related leases*".

IPSAS 17 (para. 71) also recommends that "… depreciation of an asset begins when the asset is available for use i.e., when it is in the location and condition necessary for it to be capable of operating in the manner intended by management". In this respect, it may deviate from the SNA-standards that state that stage payments have to be recorded as investments, which also means that depreciation begins, at least in practice although in theory the considerations may be less diverging.

Regarding the depreciation method, IPSAS (para. 76) states the following: "The depreciation method shall reflect the pattern in which the asset's future economic benefits or service potential is expected to be consumed by the entity". In para. 78, different methods are suggested: the straight-line method, the diminishing balance method and the units of production method". Apart from the terminology used, IPSAS and SNA are fully compatible.

A final remark in relation to the IPSAS-standards concerns the disclosure requirements for property, plant and equipment. IPSAS 17, para. 88, includes a very detailed list of items that needs to be disclosed in the financial statements. This list includes, amongst others, the measurement bases for determining the value of the asset, the depreciation method applied, the useful life, the "carrying amount" at the beginning and the end of the period (including specific details on the change between these two values). It goes without saying that this kind of information would also be extremely useful for improving macro-economic estimates.

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# Understanding the Value of Transport Infrastructure

## Guidelines for macro-level measurement of spending and assets

Transport infrastructure is a critical ingredient in economic development at all levels of income. It supports personal well-being and economic growth. Countries spend considerable amounts of money each year to build, maintain and improve their transport infrastructure.

But how much, exactly, does transport infrastructure support economic development and wealth creation? What determines the magnitude of that impact?

Despite the importance of the transport sector, the lack of clear definitions and common practices to measure macro-level transport infrastructure spending hinders accurate measurement of how spending relates to economic growth, leading to less-informed decisions.

This report provides detailed guidance for the uniform collection of data on transport infrastructure spending and assets. It concludes with recommendation and practices for arriving at these critical statistics. The report also discussed the use of these data in impact analysis and benchmarking, ultimately leading to better decision-making.

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