FAD Investment and Capital Stock Database 2019: Manual & FAQ - Estimating Public, Private, and PPP Capital Stocks

This document describes the measurement issues, data sources, methodologies, and assumptions used in constructing the series of public and private capital stocks, as well as capital stocks from public-private partnerships (PPPs), for a comprehensive sample of around 170 countries starting from 1960 until 2017.

A. Measuring Public Investment

Disentangling the private and public sectors' contribution to total investment is challenging in practice. We measure public investment using gross fixed capital formation (GFCF) of the general government (i.e., central plus subnational governments).[1][2]This approach allows for the use of the comparable data available for a large number of countries but ignores alternative modes by which governments support overall investment including: (i) investment grants, which are transfers from central and/or subnational governments to public and private entities outside the general government to support investment in fixed assets;[3] (ii) loan guarantees;[4] (iii) tax concessions, such as those for mortgage interest, research and development, and municipal bonds; (iv) the operations of public financial institutions, such as development banks, which provide long-term funding at subsidized rates; and (v) government-backed saving schemes. Similarly, some governments contract the private sector to provide infrastructure services (e.g., through PPPs), with annual payments for these services classified as public current spending and investment spending classified as private. In addition, some entities controlled by the public sector—but outside the general government—undertake infrastructure spending that is not recorded as public investment. Typical examples include SOEs, parastatals, and entities involved in social housing, whose investments can be large. Similarly, special purpose vehicles linked to PPPs contracts are typically classified as private, even if they are controlled by the public sector. The data are constructed with these caveats.

[1] Gross fixed capital formation is measured by the total value of acquisitions less disposals, of fixed assets during the accounting period plus certain specified expenditure on services that adds to the value of non-produced assets, such as the improvement of land (System of National Accounts 2008, Chapter 10, 10.32).

[2] Hemming and others (2006).

[3] These transfers are typically classified as current spending, rather than capital spending. In 2017, general government investment grants averaged about 0.7 percent of GDP in the European Union, about 70 percent of their 1995 level.

[4] In 2012-2013, government guarantees (including for investment) averaged about 12 percent of GDP in the EU, with considerable dispersion across countries (from 5.7 percent of GDP in France to 41.4 in Ireland).

B. Public and Private Capital Stocks

The methodology applied to the construction of public and private capital stocks draws, in large part, on that employed by Kamps (2006) and Gupta and others (2014). Specifically, the capital stocks are constructed following the perpetual inventory equation:

$$K_{it+1} = (1 - \delta_{it})\, K_{it} + (1 - {}^{\delta_{it}}/_{2})\, I_{it}\,,$$

where for each country i, K_{it+1} is the stock of (public or private) capital at the beginning of period $t + 1$; δ_{it} is a time-varying depreciation rate; and I_{it} is gross fixed (public or private) capital formation in period t, assuming that new investment is operational in the middle of the period.

The inputs required to apply this method are the investment flow series, the initial capital stock, and the size and time profile of the depreciation rate. All series (output, investment, capital stocks) are expressed in constant international 2011 prices (using purchasing power parity).

- **Investment series.** Several databases are used to ensure a comprehensive database of the public capital stock series covering the period 1860-2017.

  Data for the Organization for Economic Cooperation and Development (OECD) countries are taken from the July 2019 version of the OECD Analytical Database. Specifically, the series retrieved (in national currency and constant prices) is comprised of government GFCF (code IGV), private GFCF (code IPV), and real gross domestic product (code GDPV). The series are then converted to 2011 international dollars using corresponding OECD purchasing power parities. For countries with missing government GFCF series in constant prices (IGV), the total GFCF deflator (government + private) is used to convert the government GFCF series in current prices (IG) to constant prices. For countries with missing IGV and IG series, we used the code "IGAA", which is general government gross fixed capital formation from the appropriation account.

  For non-OECD countries, data are taken from version 9.1 of the Penn World Tables (PWT). The series retrieved consists of GDP (code Q_GDP) and total5 gross fixed capital formation (code Q_GFCF) in 2011 constant prices. These are then converted to 2011 international dollars using PWT corresponding purchasing power parities. In the next step, total investment from PWT is disaggregated into

[5] PWT does not publish national accounts data with a breakdown of total gross fixed capital formation into private and public.

private and public investments by using the WEO's database. Specifically, public and private investment shares, as percent of total investment, are calculated from the WEO database, and these shares are applied to the total PWT investment series.[6]

For countries lacking data on public and private gross fixed capital formation in the OECD and PWT/WEO databases, data are taken from Haver Analytics database and the World Bank Development Indicators Database.

- **Initial capital stock.** There is no official information on the magnitude of the initial capital stock for the vast majority of countries. Following Kamps (2006), the initial capital stock is set to 0 for all countries in 1860. Second, an aritificial investment series is constructed between 1860 and the first available data point by assuming that investment grew by 4 percent a year to reach its five-year-forward moving average (first available) observed level.[7] As for public and private investment, two artificial series are constructed between 1860 and the first available data point by assuming that public and private investment grew at the same rate as total investment to reach their five-year forward moving average (first available) observed levels, respectively.

- **Depreciation rates**. Country-specific depreciation rates are not typically available but they are likely to increase with income assuming that the share of assets with a shorter life spans (such as technology assets) rises with income levels. Following the arguments in Kamps (2006), it is assumed that the depreciation rate for high-income economies rises monotonically from 2.5 percent in 1960 to 4.55 percent in 2016, and from 4.25 percent to 7 percent for government and private assets, respectively (see Table 1).[8] As shown in Table 1, different depreciation assumptions are made for middle-income and low-income countries following Gupta and others (2014).

[6] Modifications to the WEO database are made to accommodate breaks or country-specific data patches. Such methods include using older vintages, correcting cases with negative values or cases where private and public investment do not add up to the total, replacing data with missing values when there are large breaks in the series, and filling in one-year patches by taking the average of the one-year forward and backward data points.

[7] This ensures an equal treatment of all countries since historical information on public investment is not available. Kamps (2006) and Gupta (2014) show that different assumptions on the initial capital stock series do not affect the dynamics of the series to a great extent.

[8] These assumptions were made using evidence from historical data from the United States, Australia, Japan, and Canada. In addition, the depreciation assumption for private capital has been revised relative to the 2017 update (see Section D. "What's New in the 2019 Update" below for more details).

Table 1. Depreciation Rates

(in percent)

	1860	1960	2016
Public Capital			
Low-income	2.50	2.50	2.50
Middle-income	2.50	2.50	3.52
High-income	2.50	2.50	4.55
Private Capital			
Low-income	4.25	4.25	4.25
Middle-income	4.25	4.25	5.40
High-income	4.25	4.25	7.00

Note: Income classifications are based on the World Bank's *World Development Indicators'* country groupings.

C. Capital Stock from PPPs

The methodology applied in the construction of the PPP capital stock is identical to the methodology described in Section B. Given an initial PPP capital stock, a depreciation rate series, and PPP investment flows, it is simple to compute the PPP capital stock following the perpetual inventory equation above.

- **Investment series.** It is difficult to compile a comprehensive comparable long time- series database for PPPs across countries since (i) project deals' databases do not always provide complete or comparable information; (ii) annualized PPP investment spending data are lacking for most countries; and (iii) there is no consistent standard framework to classify PPPs as public or private, since the treatment of PPPs in the national accounts varies across years and countries. In spite of these challenges, the approach followed here is to rely on data for total PPP projects commitments (rather than annualized investment flows) taken from the European Investment Bank for European countries and the World Bank Private Participation in Infrastructure (WB PPI) database for low- and middle-income countries.[9]

Data from the EIB includes the total value of PPP projects[10] (in euro) covering the period 1990-2017. The project value measures total financing requirements at financial closure, meaning it is a stock variable. Similarly, information from the WB PPI database includes the total value of PPP investment commitments at contract signature or financial closure (in US dollars) covering the period 1990-2018.[11] We exclude divestiture projects (i.e., asset sales or privatizations), rentals, and merchant projects from the WB database to make it comparable with EIB data.

Following the EIB approach (Kappeler and Nemoz, 2010), annual PPP investments are derived by spreading the value of PPP project commitments over five years. The PPP investment series is then converted to constant 2011 international dollars using the GFCF deflators and purchasing power parities taken from the OECD and PWT depending on data availability.

While there are a few caveats regarding the PPP database, it is still useful in providing an idea of the magnitude of PPP capital stock in comparison with the public capital stock. Caveats include: (i) some of the capital expenditures in the PPP database may be recorded on the governments' balance sheets, and therefore, in the public investment figures;[12] (ii) total PPP projects commitments may include financing or maintenance costs and may thus overestimate PPP's annual investment figures; (iii) PPP project commitments may be underestimated to the extent that PPP data is not comprehensive or includes only a proportion of financing, rather than total investment costs (i.e., ignoring any government subsidies; (iv) PPP commitment amounts represent commitments at the financial closure stage, not actual executed investments; and (v) the definition of what constitutes a PPP project may vary across countries and databases.

[9] Data on some high-income non-European countries are not available. This includes the United States, Australia, Canada, China, Japan.

[10] The EIB defines a PPP project as one that is "based on a long term, risk sharing contract between public and private parties based on a project agreement or concession contract." Investments made by regulated utilities, project refinancing, and privatizations are therefore excluded. Projects below 5 million Euros are also excluded from the EIB database.

[11] See http://ppi.worldbank.org/resources/ppi_methodology.aspx for more details on the WB PPI database methodology.

[12] PPPs are typically not properly reported in headline fiscal indicators, notably in countries with cash-based accounting. As countries move towards accrual accounting and implement international standards such as IPSAS32 (currently implemented in New Zealand, Australia, Canada, among others), PPP commitments in several projects and related assets would be included in the government's balance sheet.

- **Initial PPP capital stock.** Due to the lack of a long-time series on PPPs, the initial PPP capital stock for each country is assumed to be 0 the year prior to the first available data point.

- **Depreciation rates.** For ease of comparability with the public investment capital stock, it is assumed that PPP projects depreciation rates are the same as those of public investment projects (see Table 2).

Table 2. Data Sources

GDP and public and private investment	OECD Analytical Database, February 2019 PWT, Version 9.1 WEO, April 2019 Haver Analytics World Bank Development Indicators
PPP investment	World Bank Private Participation in Infrastructure Database European Investment Bank EIB, October 2018
Deflators and 2011 purchasing power parity for GDP and public and private and PPP investment/capital stock	OECD Analytical Database, February 2019 PWT, Version 9.1
Country income groupings	World Bank World Development Indicators Country Groupings, June 2019

D. What's New in the 2019 Update

The 2019 Update contains important new and revised data relative to the 2017 Version, namely (1) the use of the Penn World Table version 9.1 (compared to version 9.0 used earlier), (2) the use of the OECD Analytical Database, July 2019 (compared to 2016 earlier), (3) the use of updated PPP information from the World Bank Private Participation in Infrastructure Database and European Investment Bank, and (4) the revisions to the depreciation rate assumptions for private assets for high-income and middle-income countries.

- **Penn World Tables 9.1.** There are two main changes in this version relevant to the current data publication:[13] (i) the incorporation of new purchasing power

[13] For a detailed list and discussion of the PWT 9.1 revisions, see Inklaar and Pieter (2019).

parities data for a range of countries; and (ii) the incorporation of revised and extended National Accounts data, covering the period up to 2017.

- **OECD Analytical Database 2019.** The major change in the 2016 version and later is the shift of several European countries' National Accounts series from the European system of National and Regional Accounts (ESA) 1995 to ESA 2010, which has a similar treatment to SNA 2008 for R&D expenditure. Therefore, most European countries' public investment rates will increase.

- **World Bank PPI Database 2018.** As in the 2017 update, we exclude from the latest World Bank database, "divestitures", "rentals" and "merchant" types of projects (we had excluded only "divestitures" in the earlier data publication). This is because these projects are not truly PPPs as they do not involve any risk sharing between the private and public partner. The implication of this exclusion is a large reduction in the PPP capital stock in emerging and low-income countries, with most excluded projects in the telecommunication sector.

- **Depreciation rate assumptions.** In line with latest country level data from the United States, Australia, Japan, and Canada, the depreciation rate assumptions for private assets for high-income and middle-income countries in this data publication have been revised downwards (Table 1), which also makes the overall depreciation patterns more consistent with the latest assumptions from Penn World Tables.

E. Frequently Asked Questions

Why use real rather than nominal investment series?

From an economic standpoint, if we are interested in measuring the impact of investment and the capital stock on productivity growth in a given country over time, we should look at the ***real*** investment and capital stock series (i.e. in constant national prices). To make the ***real*** investment and capital stock series comparable across countries, the constant national prices series is converted to ***constant international dollars*** using constant (2011) PPP exchange rates. Note that the annual growth rates of the ***real national currency*** and ***real international dollars*** series will be identical for a given country. Therefore, the real international dollars series replicates exactly the relative movements of ***volume*** GDP growth (or investment) of each country.

This is relevant since nominal investment shares (i.e. nominal gross fixed capital formation as a percentage of nominal GDP) have been subject to a long-term decline in the advanced economies. However, the decline in ***nominal*** shares is largely due to a decline in the ***price*** of investment goods ***relative*** to other goods (see Citi Research 2014 and Grice 2016). This fall in the relative price of investment goods has been attributed to advances in information and communications technology leading to faster productivity growth in the capital-goods sector (see for example, Buiter et al. 2014 and Karabarbounis et al. 2014).

Why are depreciation rates assumed to rise over time in middle-income and advanced economies? One would expect fixed assets to be of a lower quality and therefore deteriorate faster as income falls.

Country-specific depreciation rates are not typically available but they are likely to increase with income assuming that the share of assets with a shorter life spans (such as technology assets) rises with income levels (see Kamps, 2006). For example, a concrete structure typically lasts 80-100 years as compared to IT assets with only a few years' lifespan (see Gupta et al.
2010, and Arestoff and Hurlin 2006). These depreciation assumptions are further refined in this data publication and consistent with evidence from historical statistics' offices data from the United States, Australia, Japan, and Canada.

Are state-owned enterprises (SOE) investments covered by the database?

The data coverage is the general government (i.e., central, states, local governments and social security funds). In reality, public infrastructure assets and services are also provided by public entities outside the general government, such as state-owned enterprises. Data limitations prevent the use of the consolidated public sector.

Is the capital stock from PPPs included in the estimated public capital stocks?

We did not consolidate PPP data either in public or private capital stocks. It is treated separately since existing databases of PPP projects do not easily allow us to classify projects as public or private. It should be noted that International Public Sector Accounting Standards (IPSAS) approved in 2011 prescribe the treatment of most PPPs as public (IPSAS 32), thus affecting headline fiscal indicators (public deficit and debt). Although the implementation of IPSAS32 will take time, it does set a precedent for public sector statistical standards (such as GFSM 2014, ESAS 210, and 2008 SNA) to converge to the same principles.

What is the assumption of 4 percent investment growth for years with no data based on?

Long historical information on investment for most countries (except the US) is not available. We have to make some comparable assumptions across countries to construct the capital stock (starting from 1860). We follow the literature (Kamps 2006 and Gupta et al. al. 2014) and assume 4 percent for all countries for the following reasons (i) investment grew by 4 percent on average in the period for which data is available (1960-2001 for OECD countries), and (ii) alternative assumptions (for growth rates prior to 1960) do not impact the profile of the series over time (for 1960-2001).

F. References

Arestoff, Florence, and Christophe Hurlin, (2006), "Estimates of Government Net Capital Stocks for 26 Developing Countries, 1970–2002," Policy Research Working Paper Series 3858, The World Bank.

Buiter, Willem H., Rahbari E., and Seydl J., 2014, "The Long-Run Decline in Advanced- Economy Investment," Citi Research, Economics, Developed Markets, Global, Global Economics View, June 11, 2014.

Citi Research, 2014, "The Long-Run Decline in Advanced-Economy Investment".

Feenstra, Robert C., Robert Inklaar and Marcel P. Timmer (2015), "The Next Generation of the Penn World Table" *American Economic Review*, 105(10), 3150-3182, available for download at www.ggdc.net/pwt

Inklaar, Robert, and Pieter Woltjer (2019), "What Is New in PWT 9.1?", available for download at www.ggdc.net/pwt

Government finance statistics manual 2014. – Washington, D.C.: International Monetary Fund, 2014.

Grice, Joe, 2016, "National Accounting for Infrastructure", Oxford Review of Economic Policy, Volume 32, Number 3, 2016, pp. 431-445.

Gupta, S., et al., 2010, "Public Capital and Growth", International Monetary Fund, WP/10/175.

Gupta, S., et al., 2014, "Efficiency-Adjusted Public Capital and Growth," *World Economic Development,* Vol. 57, Issue C: pp. 164–78.

Hemming, R. and others, 2006, "Public-Private Partnerships, Government Guarantees, and Fiscal Risk," (Washington: International Monetary Fund).

Kamps, C., 2006, "New Estimates of Government Net Capital Stocks for 22 OECD Countries, 1960–2001," *Staff Papers*, International Monetary Fund, Vol. 53, No. 1, pp. 120–50.

Kappeler, A., and M. Nemoz, 2010, “Public-Private Partnerships in Europe – Before and During the Recent Financial Crisis,” *Economic and Financial Report 2010/04* (European Investment Bank).

Karabarbounis, L. and Brent Naiman, 2014, “The Global Decline of the Labor Share”, *Quarterly Journal of Economics.*