

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 PPPs, for a comprehensive sample of 158 and 143 countries, respectively.

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.

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:

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 2013, general government investment grants averaged about ½ percent of GDP in the European Union, about half 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)

$$K_{it+1} = (1 - \delta_{it}) K_{it} + \left(1 - \frac{\delta_{it}}{2}\right) I_{it},$$

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 2005 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 1860-2014.

Data for the Organization for Economic Cooperation and Development (OECD) countries are taken from the August 2014 version of the OECD Analytical Database,⁵ and cover 26 countries for the period 1960-2013. 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 2005 international dollars using OECD purchasing power parities. Data is filled to the extent possible from the April 2014 vintage of the IMF World Economic Outlook (WEO) database⁶ whenever there are data patches in the OECD's database.

For non-OECD countries, data covering 132 countries for the period 1960-2011 are taken from version 8.0 of the Penn World Tables (PWT). The series retrieved consists of GDP (code Q_GDP) and total⁷ gross fixed capital formation (code Q_GFCF) in 2005 constant prices. These are then converted to 2005 international dollars using PWT purchasing power parities. In the next step, total investment from PWT is disaggregated into private and public investments by using the WEO's database. Specifically, public and private investment shares, as percents of total investment, are calculated from the WEO database, and these shares are applied to the total PWT investment series.⁸ Data is then extended to 2013 using the WEO database.

⁵ Data for six countries (Austria, Ireland, Italy, Mexico, Portugal, and Spain) are no longer published in the latest OECD version; earlier vintages of the database are used instead.

⁶ Specifically, annual growth rates from the WEO database are used for filling missing data. In addition, a few modifications are made to the WEO database to accommodate breaks or country-specific 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 PWT does not publish national accounts data with a breakdown of total gross fixed capital formation into private and public.

⁸ Modifications to the WEO database are made to accommodate breaks or country-specific data patches. These are explained in footnote 27.

- **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 artificial investment series is constructed between 1860 and the first available data point by assuming that investments grew by 4 percent a year to reach its five-year-forward moving average (first available) observed level.⁹ 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 4.6 percent in 2013, and from 4.25 percent to 10.4 percent for government and private assets, respectively (see Table 1).¹⁰ As shown in Table 1, different depreciation assumptions are made for middle-income and low-income countries following Gupta and others (2014).

	1860	1960	2013
Public Capital			
Low-income	2.50	2.50	2.50
Middle-income	2.50	2.50	3.51
High-income	2.50	2.50	4.59
Private Capital			
Low-income	4.25	4.25	4.25
Middle-income	4.25	4.25	8.10
High-income	4.25	4.25	10.41
Note: Income classifications are based on the World Bank's <i>World Development Indicators'</i> country groupings.			

⁹ 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.

¹⁰ These assumptions were made using evidence from historical data from the United States, Australia, and Canada.

- **Note.** All data series (public investment and capital stock, private investment and capital stock, GDP, etc.) are expressed in constant 2005 international dollars (purchasing power parity adjusted), using the corresponding component-specific deflators from OECD, PWT, and WB databases mentioned above. This is done to ensure that the series are economically meaningful over time and comparable across countries. Therefore, the public investment-to-GDP ratio is expressed in constant 2005 international dollars with different deflators for the numerator and denominator. This is not to be confused with the commonly-reported measure of the public investment-to-GDP ratio where both numerator and denominator are expressed in nominal terms. In fact there could be large historical differences between the two series in many countries where the price of investment have become much cheaper relative to other components of GDP, potentially explained by faster productivity growth in capital-goods sectors (see for example Buiter et al., 2014).

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 information; (ii) actual annualized PPP investment data are lacking for most countries; and (iii) there is no consistent publicly available framework to classify PPPs as public or private, such that 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 (Kappeler and Nemoz, 2010) for European countries and the World Bank Private Participation in Infrastructure (WB PPI) database for low- and middle-income countries.¹¹

Data from the EIB includes the total value of PPP projects¹² (in euro) for 18 countries covering the period 1990-2009. The project value measures total financing requirements at financial closure, meaning it is a stock variable. Similarly, information from the WB PPI

¹¹ Data on high-income or non-European countries such as the United States, Australia, Canada, China, Japan, etc. are not available.

¹² 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 their database.

database includes the total value of PPP investment commitments at contract signature or financial closure (in US dollars) for 125 countries covering the period 1984-2012.¹³ We exclude divestiture projects (i.e., asset sales or privatizations) from the WB database to make it comparable with EIB data.

Following the EIB approach, 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 2005 international dollars using the GFCF deflators and purchasing power parities taken from the OECD, PWT, and WEO, depending on data availability. Finally, data are extended to 2013 by assuming PPP investment to GDP (both in constant 2005 international dollars) remained, for each country, at its latest three-year average.

While there are a few caveats regarding the PPP's 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's database may be recorded on the governments' balance sheets, and therefore, in the public investment figures; (ii) total PPPs projects commitments may include financing or maintenance costs and may thus overestimate PPP's annual investment figures; (iii) PPP project commitments may include only a proportion of financing placed on the bond market, rather than total investment costs (i.e., ignoring any government subsidies), and therefore underestimate PPPs' annual investment figures; (iv) PPPs 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.

- **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 PPPs projects depreciation rates are the same as those of public investment projects (see Table 2).

¹³ See http://ppi.worldbank.org/resources/ppi_methodology.aspx for more details on the WB PPI database methodology.

Table 2. Data Sources

GDP and Public and Private Investment in 2005 International Dollars	OECD Analytical Database, August 2014 Version PWT, Version 8.0 WEO, April 2014 Version
PPP Investment in 2005 International Dollars	World Bank Private Participation in Infrastructure Database EIB (2010) OECD Analytical Database, August 2014 Version PWT, Version 8.0 WEO, April 2014 Version
Depreciation Rates	World Bank World Development Indicators Country Groupings

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