GLOBAL MACRO DATABASE (GMD)

Technical Appendix

www.globalmacrodata.com

Version 2025-06

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1 Introduction

The Global Macro Database (GMD), introduced by Müller et al. (2025), is the world's most comprehensive open-source repository of cross-country macroeconomic statistics. Updated on a quarterly basis, the GMD currently contains 46 variables, spanning 243 countries and territories over the period 1086 to 2024 with projections up to 2030.

This technical documentation contains several parts. Sections 2-5 outline the terms of use, version history, acknowledgements, and ways of accessing the data. Sections 6-8 describe the data coverage, sources, and variable definitions. Section 9 and 10 discuss the process of prioritizing different sources and measurement issues. Section 11 outlines some planned further improvements.

2 Terms of Use

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For academic use, proper citation of the GMD is required. Please cite:

```
@techreport{GMD2025,
  title = {The Global Macro Database: A New International Macroeconomic Dataset},
  author = {M{\"u}ller, Karsten and Xu, Chenzi and Lehbib, Mohamed and Chen,
      Ziliang},
  institution = {National Bureau of Economic Research},
  type = {Working Paper},
  series = {Working Paper Series},
  number = {33714},
  year = {2025},
  month = {April},
  doi = {10.3386/w33714},
  URL = {http://www.nber.org/papers/w33714},
}
```

Proper citation of the Global Macro Database (GMD) is required for any use of the data. For licensing or usage inquiries, contact us at hello@globalmacrodata.com.

3 Version History

This section summarizes major updates to the Global Macro Database (GMD). For full release notes and version details, please visit www.globalmacrodata.com/data.

Version 2025_06 – *current*

- Data updated as of June 2025.
- Patched inflation data issues caused by CPI breaks; revised priority list.
- Added six new sources: Reinhart and Rogoff (2010b), International Institute of Social History (2024), United Nations Statistics Division (2025), Fortin-Gagnon et al. (2022), Cha et al. (2022b), National Bank of Belgium (2024).
- Updated source priority order for `nGDP`, `cons`, `inv`, `finv`, `imports`, `exports`
- Government finance variables now derived from GDP ratios. Then, we chainlink the estimated levels series with other series: `govdebt`, `govdef`, `govexp`, `govrev`, `govtax`.
- Improved data cleaning pipeline and resolved minor source inconsistencies.
- Fixed issues with the government deficit and current account balance data.

Version 2025_03

- Data updated as of March 2025.
- Added support for Python, R, and Stata packages.
- Updated data across all indicators.
- Extended historical coverage using Ferreres et al. (2005), Stuart (2018), and Taiwan Statistical Office (2025).
- Refined treatment of IMF WEO and improved source hierarchy.
- Fixed inconsistencies in a few long-run series (e.g., Australian GDP).

Version 2025_01 - Initial Release

- First release with date up-to-date as of January 2025.
- Coverage: 46 variables, 243 countries, annual data spanning from the 1800s to 2030 (including forecasts).
- Integrated data from 32 major contemporary sources and 78 historical datasets.
- Unified structure for macroeconomic indicators across countries and time.

4 Acknowledgments

The development of the Global Macro Database would not have been possible without the generous funding provided by the Singapore Ministry of Education (MOE) through the PYP grants (WBS A-0003319-01-00 and A-0003319-02-00), a Tier 1 grant (A-8001749-00-00), and the NUS Risk Management Institute (A-8002360-00-00). This financial support laid the foundation for the successful completion of this extensive project.

We would also like to thank the many people who have supported this project. For helpful feedback on data issues, we would like to thank Andrea Presbitero, Matteo Iacoviello, Xander Uyttenbroek, Flint O'Neil, Luis Libonatti, Jeroen Bouma, and Tom Hamburger. Shixuan Yuan and Cedric McKeever provided excellent research assistance.

5 Accessing the Data

The Global Macro Database (GMD) is available through multiple access methods:

Web Download

Visit www.globalmacrodata.com/data and submit your email to download the dataset in CSV, Excel, or Stata format.

Stata Package

Install the official SSC package and retrieve data using the `gmd` command:

```
ssc install gmd, replace
gmd
gmd rGDP, country(FRA)
```

Type `help gmd` in Stata for full documentation. Please make sure you use the most recently updated version.

Python Package

Install via pip and use the `gmd()` function to access data with filtering options:

```
pip install global_macro_data
from global_macro_data import gmd

df = gmd()
df = gmd(version="2025_01", country=["USA", "CHN"], variables=["rGDP", "CPI"])
```

R Package

Install the R package from GitHub and access data similarly:

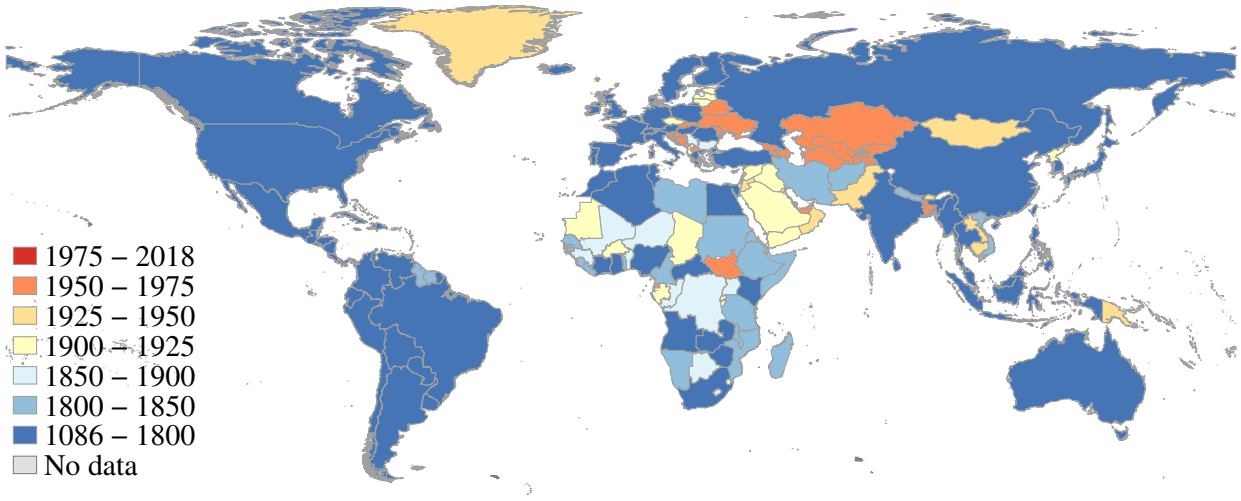
```
install.packages("devtools")
devtools::install_github("KMueller-Lab/Global-Macro-Database-R")

library(globalmacrodata)
df <- gmd(version = "2025_01", country = c("USA", "CHN"), variables = c("rGDP", "
    CPI"))
```

For full setup instructions and usage examples, see www.globalmacrodata.com/data.

6 Data Coverage

The Global Macro Database comprises a collection of 46 macroeconomic variables, spanning 243 countries and territories. The majority of countries have time series data extending to pre-1950 periods, with many reaching back to the early 20th century or even the 19th century, including several developing nations. Figure 1 presents a world map indicating the earliest year for which any macroeconomic statistic is available for each country (excluding population data).

Figure 1: First Year in Dataset, By Country



Note: This figure visualizes, for each country, the first year for which we have data on any macroeconomic variable other than population in the Global Macro Database (GMD). The map demonstrates that for the vast majority of countries, we have time series before 1950, with many series extending back to the 1800s for both advanced and developing economies. For some countries, such as the United Kingdom, data coverage begins as early as 1086.

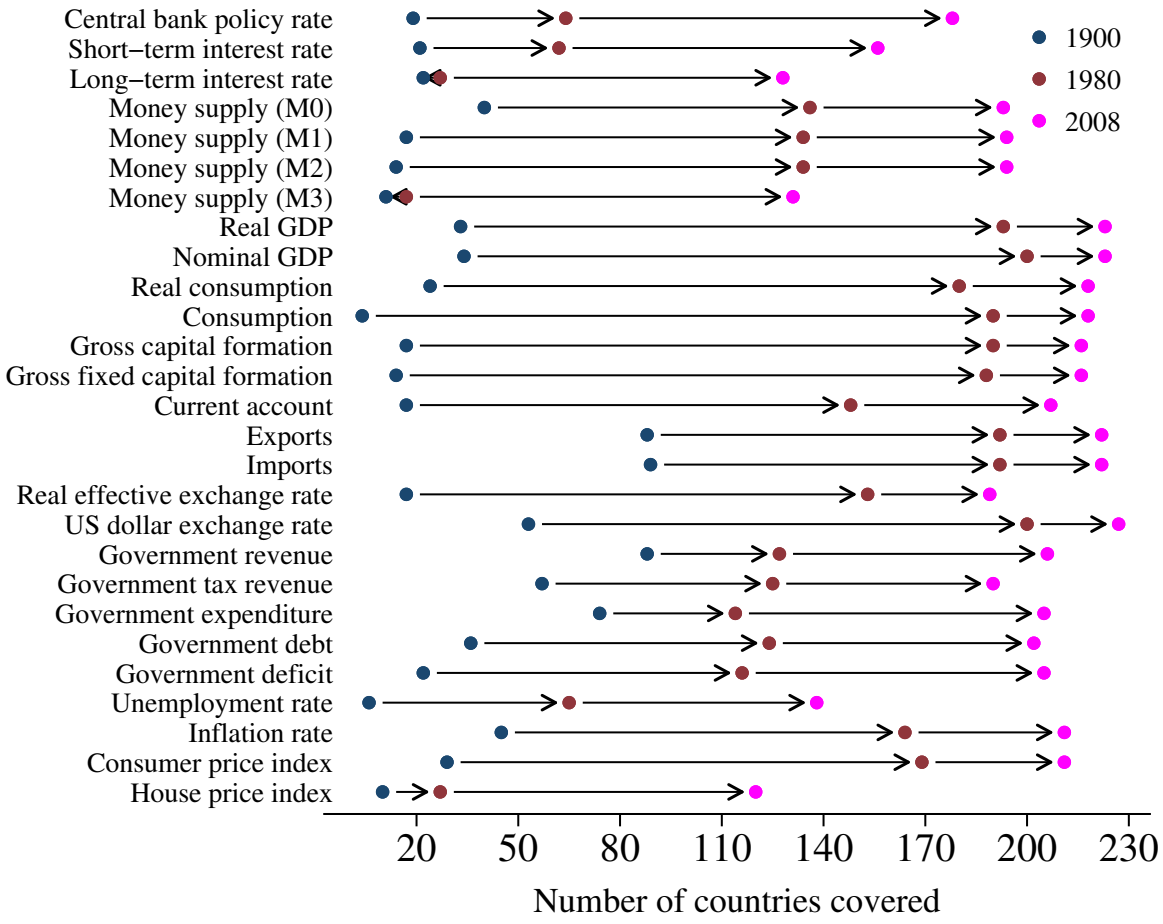
6.1 Dataset overview

The following tables provide an overview of the key variables, along with their respective time and country coverage, highlighting the dataset's extensive scope and usefulness for cross-country and panel analyses.

Table 1 shows the key variables included in the Global Macro Database (GMD). The table provides detailed information on each variable, including the variable name, the abbreviation used in the database, units of measurement, temporal coverage, forecast horizons, and country coverage. The variables are grouped into six categories: national accounts, consumption and investments, external sectors, government finances, money and interest rates, and prices and labor market. For detailed definitions and descriptions of each variable, please refer to Section 8.

Figure 2 illustrates the number of countries covered by the Global Macro Database (GMD) for each variable in the years 1900, 1980, and 2008. A significant proportion of the variables have coverage for over 20 countries since 1900, over 100 countries since 1980, and nearly 200 countries since 2008, reflecting the increasing scope and comprehensiveness of the database over time. Figure 3 depicts the share of GDP for which data is available on key variables in the GMD.

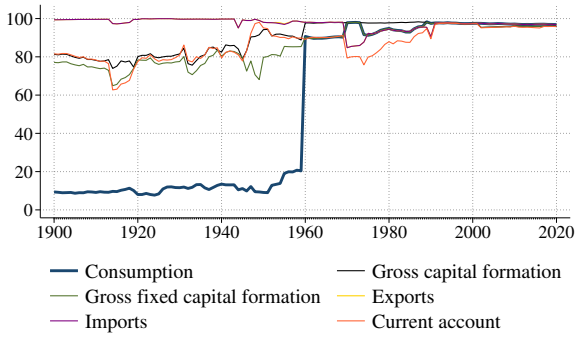
Figure 2: Number of Countries Covered, By Variable



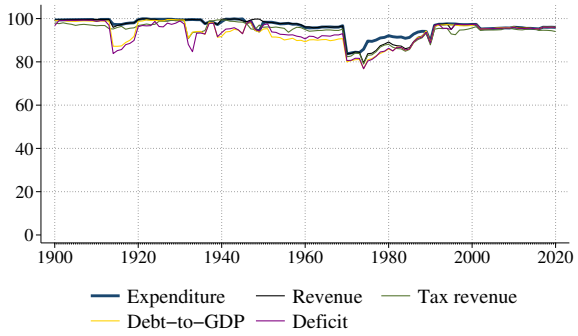
Note: This figure plots the number of countries with available data for all macroeconomic variables contained in the Global Macro Database (GMD) at three points in time: 1900, 1980, and 2008. Each line represents a variable, with dots indicating the coverage at these three dates. The graph reveals substantial variation in coverage across variables and time.

Figure 3: Share of GDP Covered Over Time, By Variable

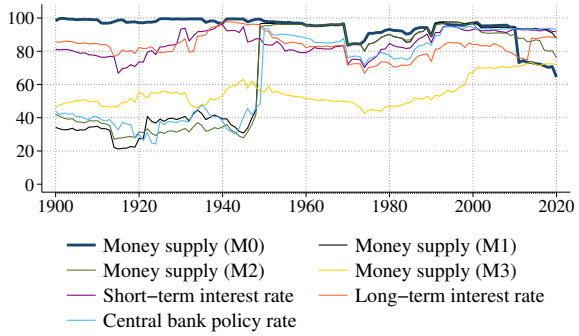
(a) National Accounts



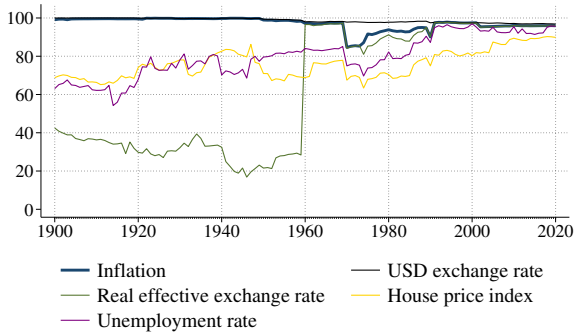
(b) Government Finances



(c) Money and Interest Rates



(d) Prices and Labor



Note: This figure plots the share of GDP covered by each variable in the Global Macro Database (GMD) between 1900 and 2020.

6.2 Comparison with other sources

By design, the coverage of our dataset surpasses that of all existing publicly available sources we are aware of, as these sources have been integrated into the Global Macro Database (GMD). Table 2 compares the coverage of key variables in the GMD with those offered by other widely-used data providers. Table 3 presents the number of country-year observations included in the GMD and the fraction covered by the major providers in percentage. Figure 4 compares the coverage of the Global Macro Database (GMD) with that of the next best source for each key variable.

In addition to publicly available sources, Table 2 also includes a comparison with the dataset provided by the commercial data provider Global Financial Data (GFD). Beyond surpassing the coverage of many commercial products, the Global Macro Database (GMD) offers more comprehensive and transparent documentation, supported by an open-source code base. For further details, please refer to our GitHub repository.

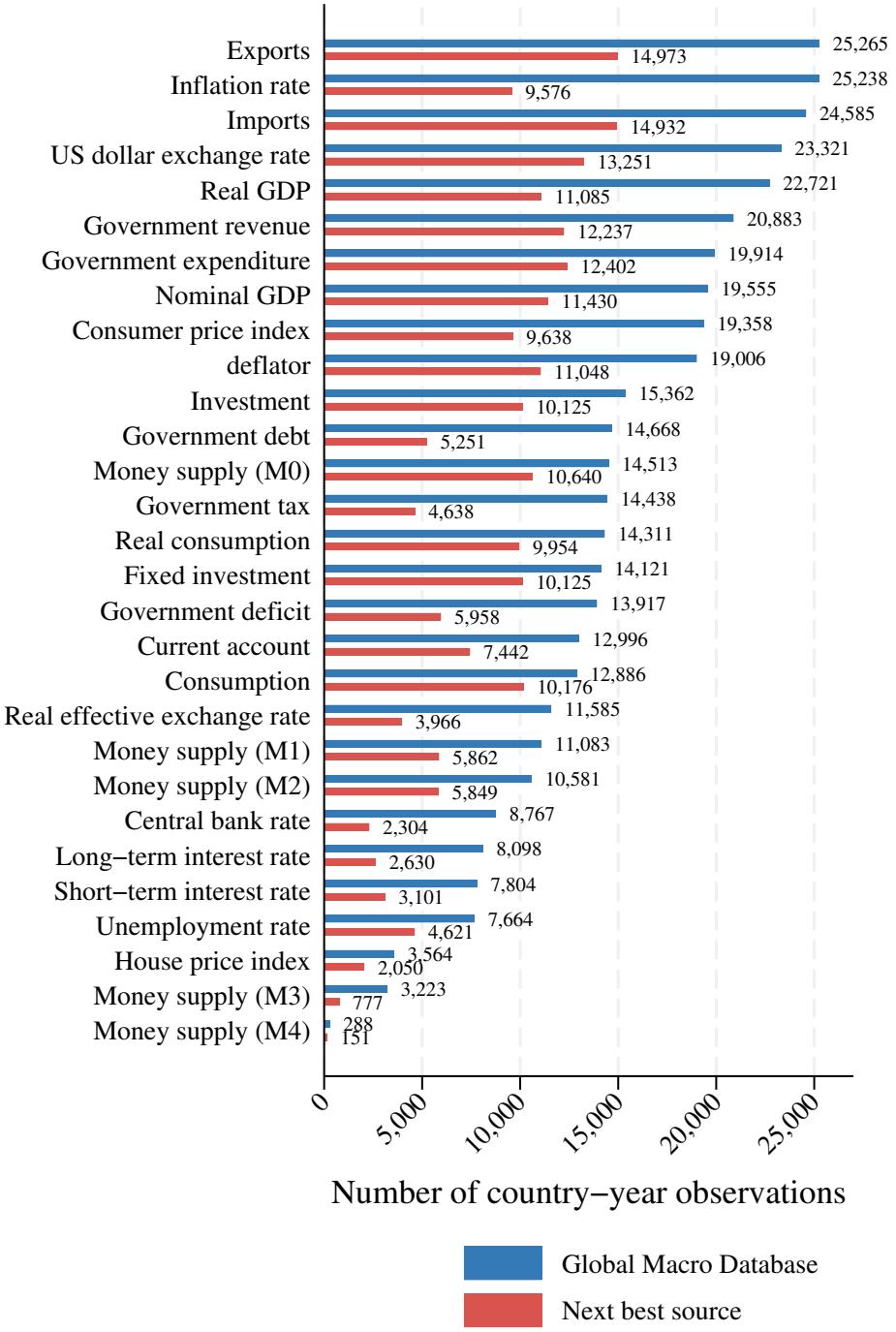
Table 3: Coverage of GMD Variables in Selected Sources

		Fraction of observations in the GMD covered in... (in %)							
Variable	**GMD**	IFS*	WEO	OECD EO	WDI†	UN	JST	Mitchell	GFD‡
Central bank policy rate	8,767	26	—	21	—	—	—	—	73
Short-term interest rate	7,804	40	—	27	—	—	32	—	53
Long-term interest rate	8,098	26	—	22	—	—	32	—	96
Money supply (M0)	14,513	47	—	—	—	—	3	73	93
Money supply (M1)	11,083	61	—	11	—	—	18	53	41
Money supply (M2)	10,581	64	—	—	—	—	14	55	—
Money supply (M3)	3,223	—	—	31	—	—	24	—	—
Money supply (M4)	288	—	—	—	—	—	52	—	—
Real GDP	22,721	23	33	10	49	44	12	29	87
Nominal GDP	19,555	30	38	12	58	52	14	39	83
Consumption	12,886	25	—	18	66	79	—	—	—
Real consumption	14,311	26	—	—	50	70	—	—	—
Gross capital formation	15,362	28	42	15	55	66	16	35	28
Gross fixed capital formation	14,121	32	—	16	56	72	—	31	28
Current account	12,996	35	55	16	57	—	19	—	21
Exports	25,265	19	34	9	35	40	10	59	73
Imports	24,585	19	35	9	36	41	11	61	75
Real effective exchange rate	11,585	34	—	8	34	—	—	—	38
US dollar exchange rate	23,321	57	32	11	52	—	11	—	97
Government revenue	20,883	19	28	6	22	—	12	59	70
Government tax revenue	14,438	28	—	7	32	—	—	31	1
Government expenditure	19,914	19	30	6	22	—	13	62	70
Government debt	14,668	80	36	10	13	—	17	—	13
Government deficit	13,917	27	43	9	—	—	—	40	92
Unemployment rate	7,664	60	51	26	38	—	25	—	66
Inflation rate	25,238	38	29	2	35	—	10	32	96
Consumer price index	19,358	50	39	3	47	—	14	43	96
House price index	3,564	—	—	—	—	—	58	—	31
Population	51,938	29	14	4	27	32	5	—	53

Note: This table shows the number of country-year observations in the Global Macro Database (GMD) and the fraction covered in major providers of macroeconomic data (in percent). Our dataset begins in the year 1086. * IFS includes data from both the IMF MFS and IMF GFS datasets. † Unemployment data from the World Bank is added from International Labour Organization (ILO). ‡ The GFD coverage is based on the

subset of data currently available to us and may not represent the entirety of the GFD dataset.

Figure 4: Comparing Dataset Coverage by Variable



Note: This figure compares, for each variable, the coverage of the Global Macro Database (GMD) with that of the next most comprehensive source. Blue bars show the number of country-year observations in the Global Macro Database, and the red bars shows the number of country-year observations for the next best source.

Table 1: Variable Overview

Variable	Abbreviation	Unit	From	To	Forecasts	Countries
A. National accounts						
Nominal GDP	nGDP	Millions of LC	1086	2029	5	229
Real GDP	rGDP	Millions of LC	1270	2029	5	227
Real GDP in USD	rGDP_USD	Millions of USD	1791	2025	1	215
Real GDP per capita	rGDP_pc	LCU per capita	1277	2029	5	227
GDP deflator	deflator	Ratio	1270	2029	5	226
Population	pop	Millions	1277	2030	6	239
B. Consumption and investments						
Real final consumption	rcons	Millions of LC	1800	2024	—	213
Final consumption	cons	Millions of LC	1800	2026	2	219
Final consumption in percent of GDP	cons_GDP	%	1800	2026	2	219
Gross capital formation	inv	Millions of LC	1830	2029	5	218
Gross capital formation in percent of GDP	inv_GDP	%	1830	2029	5	218
Gross fixed capital formation	finv	Millions of LC	1800	2026	2	216
Gross fixed capital formation in percent of GDP	finv_GDP	%	1800	2026	2	216
C. External sectors						
Current account	CA	Millions of LC	1772	2029	5	209
Current account in percent of GDP	CA_GDP	%	1772	2029	5	209
Exports	exports	Millions of LC	1280	2029	5	225
Exports in percent of GDP	exports_GDP	%	1280	2029	5	222
Imports	imports	Millions of LC	1560	2029	5	225
Imports in percent of GDP	imports_GDP	%	1560	2029	5	222
Real effective exchange rate	REER	Index, 2010 = 100	1870	2025	1	180
USD exchange rate	USDfx	1 USD in LC	1791	2025	1	236
D. Government finances						
Government debt	govdebt	Millions of LC	1670	2029	5	197
Government debt in percent of GDP	govdebt_GDP	%	1670	2029	5	197
Government deficit	govdef	Millions of LC	1689	2029	5	200
Government deficit in percent of GDP	govdef_GDP	%	1689	2029	5	200
Government expenditure	govexp	Millions of LC	1689	2029	5	203
Government expenditure in percent of GDP	govexp_GDP	%	1650	2029	5	199
Government revenue	govrev	Millions of LC	1689	2029	5	202
Government revenue in percent of GDP	govrev_GDP	%	1650	2029	5	198
Government tax revenue	govtax	Millions of LC	1750	2025	1	198
Government tax revenue in percent of GDP	govtax_GDP	%	1789	2024	—	190
E. Money and interests						
M0	M0	Millions of LC	1619	2025	1	187
M1	M1	Millions of LC	1841	2025	1	185
M2	M2	Millions of LC	1841	2025	1	183
M3	M3	Millions of LC	1819	2025	1	70
M4	M4	Millions of LC	1870	2020	—	4
Central bank policy rate	cbrate	%	1694	2025	1	167
Short-term interest rate	strate	%	1695	2025	1	143
Long-term interest rate	ltrate	%	1310	2025	1	86
F. Prices and labor market						
Consumer price index	CPI	Index, 2010 = 100	1209	2029	5	218
House price index	HPI	Index, 2010 = 100	1819	2025	1	59
Inflation	infl	%	1210	2029	5	218
Unemployment rate	unemp	%	1760	2029	5	220
G. Financial crises						
Banking crisis dummy	BankingCrisis	Dummy	1800	2020	—	163
Sovereign debt crisis dummy	SovDebtCrisis	Dummy	1800	2020	—	160
Currency crisis dummy	CurrencyCrisis	Dummy	1800	2019	—	160

Note: This table presents the variables included in the Global Macro Database (GMD), along with their abbreviations/variable names, units of measurement, temporal coverage, forecast horizons, and country coverage. "LC" refers to local currency units and "USD" to US dollars.

Table 2: Comparing the Coverage of Key Macroeconomic Variables

Source	Start Year		Latest		Countries		Variables
	First	Median	Actual	Forecast	Number	Year-Obs.	
GMD	1086	1800	2024	2030	243	57,559	46
GFD	1000	1820	2024	—	236	39,345	37
IFS	1920	1950	2024	—	219	14,234	25
WEO	1960	1970	2024	2029	208	11,149	23
JST	1870	1870	2020	—	18	2,666	29
MAD	1253	1876	2022	—	169	20,590	3
OECD EO	1960	1960	2024	2025	49	2,726	36
PWT	1950	1960	2019	—	183	10,399	3
UN	1900	1970	2020	—	215	11,179	15
WDI	1960	1960	2024	—	222	13,820	37

Note: This table compares the coverage of the key macroeconomic variables included in our dataset across a selected sample of widely-used data providers. See Table 1 for the list of variables, which also includes derived measures such as GDP-scaled variables. The number of variables refers to the subset of macroeconomic indicators we cover that are available in a given source, not the total number of variables available. The acronyms in the source column refer to the following datasets: GFD = Global Financial Data, IFS = IMF International Financial Statistics, WEO = IMF World Economic Outlook, JST = Jordà-Schularick-Taylor Macro History Database, MAD = Maddison Historical Statistics, OECD EO = OECD Economic Outlook, PWT = Penn World Table, UN = United Nations Statistics, WDI = World Bank World Development Indicators. "Year-Obs." under the "Countries" header refers to the total number of country-year observations with non-missing information on any of the variables. Note that, for the Maddison dataset, we keep only continuous observations which started in 1253.

7 Sources and Data Access

7.1 Types of data sources

Our dataset combines information from 118 distinct sources that can be categorized along two primary dimensions. The first dimension is update frequency, which distinguishes between current sources (31) that are continuously updated with regular release calendars, primarily from major international organizations and statistical agencies, and historical sources (87) that are either never or infrequently updated without a regular schedule. The second dimension is coverage, where we differentiate between 74 aggregators providing data for multiple countries (e.g., IMF, World Bank) and 44 country-specific sources focused on individual countries, often from national statistical offices or academic research.

Table 4: Types of Sources in the Global Macro Database

	Current	Historical	**Total**
Aggregators	23	51	**74**
Examples	*WEO*	*JST*	
Country-specific	8	36	**44**
Examples	*FRED*	*Thomas et al. (2010)*	
Total	**31**	**87**	**118**

Note: This table plots information on the number of sources used in the Global Macro Database. We differentiate sources along two dimensions: (1) whether they are continuously updated (*current*) or contain only historical data (*historical*), and (2) whether they report information on several countries (*aggregators*) or only a single country (*country-specific*). Note that we count as historical sources that have been updated on an ad-hoc basis but do not have a clear release calendar, such as the Jordà et al. (2017) Macro History Database.

Table 5 provides a comprehensive overview of all currently incorporated sources in the Global Macro Database (GMD), along with detailed information about each source. This includes the source reference, the abbreviation used in the GMD, the latest update date, an indication of whether the source is newly digitized, temporal coverage, variable coverage, country coverage, and whether it is classified as a historical source (i.e., a dataset that is not updated or is only infrequently updated).

Table 5: Dataset Overview

Source	Abbreviation	Updated	Digitized	From	To	Forecasts	Variables	Countries	Historical
Panel A: Aggregator Sources									
Asian Development Bank (2024)	ADB	2024-10-14	No	2000	2023	—	30	49	No
African Development Bank (2018)	AFDB	2025-06-29	No	1980	2020	—	14	53	No
African Union (2024)	AFRISTAT	2024-07-20	No	1990	2023	—	11	22	No
Institute of Economic Research, Hitotsubashi University (2020)	AHSTAT	2024-05-04	No	1860	2013	—	28	6	Yes
European Commission (2024a)	AMECO	2025-06-29	No	1960	2026	2	21	43	No
Arab Monetary Fund (2024)	AMF	2024-07-10	No	1971	2021	—	22	22	No
Barro and Ursúa (2012)	BARRO	2024-05-04	No	1800	2009	—	2	42	Yes
Banque Centrale des Etats de l'Afrique de l'Ouest (2024)	BCEAO	2025-06-29	No	1960	2024	—	29	8	No
Broadberry and Gardner (2022)	BG	2024-09-30	No	1885	2008	—	2	8	Yes
Bank for International Settlements (2024c)	BIS CPI	2025-06-29	No	1661	2024	—	1	62	No
Bank for International Settlements (2024f)	BIS HPI	2025-06-29	No	1927	2025	1	1	58	No
Bank for International Settlements (2024d)	BIS REER	2025-06-29	No	1994	2025	1	1	63	No
Bank for International Settlements (2024a)	BIS USDfx	2025-06-29	No	1791	2024	—	1	189	No
Bank for International Settlements (2024b)	BIS cbrate	2025-06-29	No	1945	2025	1	1	48	No
Bank for International Settlements (2024e)	BIS infl	2025-06-29	No	1662	2024	—	1	62	No
Banca d'Italia (2024)	BIT	2025-01-10	No	1955	2024	—	1	9	Yes
Bordo et al. (2001)	BORDO	2024-04-21	No	1880	1997	—	10	56	Yes
Darvas (2021)	BRUEGEL	2024-04-21	No	1960	2023	—	1	178	Yes
Baron et al. (2020)	BVX	2024-04-21	No	1870	2016	—	7	48	Yes
United Nations (2024a)	CEPAC	2024-07-11	No	1950	2023	—	26	36	No
International Institute of Social History (2024)	CLIO	2025-01-10	No	1500	2011	—	2	175	Yes
Mack and Martínez-García (2011)	DALLASFED	2024-04-21	No	1975	2023	—	2	26	Yes
University of California – Davis (2024b)	Davis	2024-06-01	No	1818	2012	—	1	55	Yes

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Source	Abbreviation	Update	Digitized	From	To	Forecasts	Variables	Countries	Historical
European Commission (2024b)	EUS	2025-06-29	No	1949	2024	—	31	43	No
Food and Agriculture Organization of the United Nations (2024)	FAO	2024-12-10	No	1970	2023	—	5	214	Yes
University of California – Davis (2024a)	FLORA	2024-06-01	No	1799	1975	—	2	12	Yes
Banque de France (2024b)	FRANC ZONE	2025-06-29	No	1991	2019	—	7	15	Yes
Flandreau and Zumer (2009)	FZ	2024-06-24	No	1880	1913	—	14	16	Yes
Smits et al. (2009)	GNA	2024-06-28	No	1800	2005	—	3	17	Yes
Gapminder (2024)	Gapminder	2024-08-14	No	1800	2030	6	1	197	Yes
Grimm (2024)	Grimm	2024-10-30	No	1945	2023	—	1	166	Yes
Schuler (2015)	HFS	2024-06-28	No	1800	2008	—	30	64	Yes
Homer and Sylla (1996)	Homer Sylla	2024-10-28	No	1798	1989	—	3	26	Yes
Ellison et al. (2024)	IHD	2024-10-07	No	1925	1936	—	7	39	Yes
International Labour Organization (2024)	ILO	2024-12-10	No	2000	2023	—	1	215	Yes
Mauro et al. (2015)	IMF FPP	2024-10-28	No	1800	2023	—	6	151	Yes
Mbaye et al. (2018)	IMF GDD	2024-04-21	No	1950	2018	—	3	185	Yes
International Monetary Fund (2024a)	IMF GFS	2025-06-29	No	1972	2024	—	16	158	No
International Monetary Fund (2010)	IMF HDD	2024-06-16	No	1800	2015	—	1	188	Yes
International Monetary Fund (2024b)	IFS	2025-06-29	No	1920	2024	—	25	221	No
International Monetary Fund (2024c)	IMF MFS	2025-06-29	No	1950	2024	—	7	162	No
International Monetary Fund (2024d)	WEO	2025-02-01	No	1960	2029	5	23	208	No
Albers et al. (2023)	JERVEN	2024-10-07	No	1890	2015	—	4	50	Yes
Jones and Obstfeld. (1997)	JO	2024-06-07	No	1850	1945	—	7	13	Yes
Jordà et al. (2017)	JST	2024-06-25	No	1870	2020	—	29	18	Yes
Ljungberg (2019)	LUND	2024-10-14	No	1870	2016	—	1	27	Yes
Laeven and Valencia (2013)	LV	2024-10-17	No	1970	2017	—	4	155	Yes
Inklaar et al. (2018)	MAD	2024-04-04	No	1253	2022	—	3	169	Yes

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Source	Abbreviation	Update	Digitized	From	To	Forecasts	Variables	Countries	Historical
Cox and Dincecco (2021)	MD	2024-06-20	No	1650	2010	—	6	31	Yes
Bértola and Rey (2018)	MOXLAD	2024-04-21	No	1870	2010	—	7	20	Yes
Officer and Williamson (2024)	MW	2024-10-02	No	1209	2024	—	10	41	Yes
Mitchell (2013)	Mitchell	2024-04-21	Yes	1750	2010	—	26	142	Yes
National Bank of Serbia (2024)	NBS	2024-06-24	No	1833	1950	—	26	8	Yes
Organisation for Economic Co-operation and Development (2024a)	OECD EO	2025-06-29	No	1960	2025	1	36	49	No
Organisation for Economic Co-operation and Development (2024b)	OECD HPI	2025-06-29	No	1960	2023	—	2	47	No
Organisation for Economic Co-operation and Development (2024c)	OECD KEI	2025-06-29	No	1914	2023	—	6	47	No
Organisation for Economic Co-operation and Development (2024d)	OECD MEI	2025-06-29	No	1935	2023	—	5	47	No
Organisation for Economic Co-operation and Development (1986)	OECD MEI ARC	2024-10-30	No	1955	1984	—	3	18	No
Organisation for Economic Co-operation and Development (2024e)	OECD QNA	2025-06-29	No	1947	2023	—	5	48	No
Organisation for Economic Co-operation and Development (2024f)	OECD REV	2025-06-29	No	1970	2022	—	1	38	No
Feenstra et al. (2015)	PWT	2024-04-21	No	1950	2019	—	3	183	Yes
Reinhart and Rogoff (2009)	RR	2024-04-21	No	1719	2016	—	5	72	Yes
Reinhart and Rogoff (2010a)	RR debt	2024-04-21	No	1719	2010	—	1	68	Yes
Schmelzing (2019)	Schmelzing	2024-07-10	No	1310	2018	—	1	8	Yes
Albers (2018)	TH ID	2024-10-07	No	1925	1936	—	2	27	Yes
Federico and Tena-Junguito (2019)	Tena	2024-09-25	No	1800	1938	—	6	150	Yes
United Nations (2024b)	UN	2025-06-29	No	1900	2020	—	15	239	No
United Nations Statistics Division (2025)	UN Trade	2025-06-25	Yes	1900	1960	—	2	22	No
Ha et al. (2023)	WB CC	2024-09-05	No	1970	2023	—	2	205	Yes
World Bank (2024)	WDI	2025-06-29	No	1960	2024	—	37	223	No
World Bank (1999)	WDI ARC	2024-07-24	No	1960	1997	—	38	209	Yes
Nakamura and Zarazaga (2001)	ARG 1	2024-06-24	Yes	1901	1935	—	1	1	Yes
Ministerio de Economia de la Republica Argentina (2024)	ARG 2	2024-06-24	No	1940	2023	—	6	1	Yes

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Source	Abbreviation	Update	Digitized	From	To	Forecasts	Variables	Countries	Historical
Ferreres et al. (2005)	ARG 3	2025-03-01	No	1810	2018	—	12	1	Yes
Hutchinson and Ploeckl (2024)	AUS 1	2024-04-21	No	1789	2020	—	6	1	Yes
Vamplew (1987)	AUS 2	2024-07-04	Yes	1788	1917	—	13	1	Yes
Schulze (2000)	AUT 1	2024-04-21	No	1870	1913	—	2	1	Yes
Instituto de Pesquisa Econômica Aplicada (2024)	BRA 1	2024-10-08	No	1872	2023	—	3	1	Yes
Statistics Canada (2024)	CAN 1	2024-10-02	No	1867	1977	—	24	1	Yes
Fortin-Gagnon et al. (2022)	CAN 2	2025-06-25	No	1914	2025	1	15	1	Yes
Swiss National Bank (2009)	CHE 1	2024-06-26	No	1907	2005	—	5	1	Yes
Historical Statistics of Switzerland (2012)	CHE 2	2024-10-02	No	1851	1992	—	7	1	Yes
National Bureau of Statistics of China (2024)	CHN 1	2024-12-18	No	1949	2023	—	16	1	No
Abildgren (2017)	DNK 1	2024-06-24	No	1487	2023	—	17	1	Yes
Bank of Algeria (2023)	DZA 1	2024-07-24	No	1974	2023	—	3	1	Yes
Instituto Nacional de Estadística (2024)	ESP 1	2025-06-29	No	1995	2023	—	11	1	No
Banco de España (2024)	ESP 2	2024-12-29	No	1277	2014	—	16	1	Yes
Banque de France (2024a)	FRA 1	2025-06-29	No	1970	2025	1	3	1	No
Levy-Garboua and Monnet (2016)	FRA 2	2024-09-30	No	1800	2015	—	3	1	Yes
Thomas et al. (2010)	GBR 1	2024-06-18	No	1086	2016	—	17	1	Yes
Bank Indonesia (2023)	IDN 1	2025-06-29	No	2008	2018	—	16	1	No
Stuart (2018)	IRL 1	2025-02-21	No	1933	2014	—	6	1	Yes
Statistics Iceland (1997b)	ISL 1	2024-04-21	Yes	1870	2016	—	3	1	Yes
Statistics Iceland (1997a)	ISL 2	2024-09-26	No	1625	1990	—	30	1	Yes
Baffigi (2013)	ITA 1	2024-07-04	No	1861	2011	—	9	1	Yes
Piselli and Vercelli (2023)	ITA 2	2024-07-04	No	1861	2016	—	14	1	Yes
Istituto Nazionale di Statistica (2024)	ITA 3	2025-06-29	No	1995	2023	—	13	1	No
Bank of Japan (2024)	JPN 1	2024-10-08	No	1882	2017	—	7	1	Yes

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Source	Abbreviation	Update	Digitized	From	To	Forecasts	Variables	Countries	Historical
Cha et al. (2022a)	KOR 1	2024-05-13	No	1911	2016	—	4	1	Yes
Cha et al. (2022b)	KOR 2	2025-06-20	No	1877	2015	—	21	1	Yes
Gardner (2022)	LBR 1	2024-09-30	No	1845	1979	—	9	1	Yes
Bank Al-Maghrib (2001)	MAR 1	2024-07-24	No	1985	2024	—	4	1	Yes
Grytten (2022)	NOR 1	2024-09-25	No	1816	2019	—	3	1	Yes
Eitrheim et al. (2023)	NOR 2	2024-07-08	No	1516	2022	—	17	1	Yes
Statistics Poland (2024)	POL 1	2025-06-29	No	1989	2020	—	18	1	No
Instituto Nacional de Estatística (2001)	PRT 1	2024-07-08	Yes	1549	1998	—	15	1	Yes
Saudi Central Bank (2024)	SAU 1	2025-06-29	No	1973	2020	—	9	1	No
Schön and Krantz (2017)	SWE 1	2024-04-21	No	1290	2020	—	22	1	Yes
Central Bank of the Republic of Türkiye (2024)	TUR 1	2025-06-29	No	1994	2024	—	1	1	No
National Statistics, Republic of China (Taiwan) (2024)	TWN 1	2024-05-13	No	1951	2021	—	4	1	Yes
Taiwan Statistical Office (2025)	TWN 2	2025-02-28	No	1951	2025	1	14	1	Yes
Federal Reserve Bank of St. Louis (2024)	FRED	2025-06-29	No	1929	2025	1	26	1	No
Carter et al. (2006)	USA 2	2024-09-26	No	1774	2003	—	19	1	Yes
South African Reserve Bank (2024)	ZAF 1	2025-06-29	No	1959	2020	—	22	1	No

7.2 How we update the data

Automated downloads

For current sources, we employ automated data collection through APIs and structured web queries. Our data downloading and processing pipeline has the following key functions:

- Automatic downloading and processing new data as it becomes available
- Data validation and harmonization
- Integration of new information into the existing dataset

Manual collection

Historical sources require careful manual processing. This involves the one-time collection of historical datasets, digitization of printed materials where necessary, standardization of formats and units, and integration with the automated updating system for current data. This meticulous process ensures that the historical data maintains the same quality standards as our automated collections.

7.3 Data storage and version control

Raw data storage

A critical feature for combining many dozens of historical sources with up-to-date recent data is to maintain a comprehensive archive of previous versions. For every source file, we always maintain the original data files in their native formats (csv, Excel, Stata, etc.) at the time they were downloaded. We also maintain any additional source documentation or meta data, as available. If the data is newly digitized or comes from an unusual source, we store the PDF files and archive the relevant web pages. In all cases, we always record the time stamp when a dataset was downloaded and the source URLs.

Version control

Our version control system tracks data vintages from each source. We store newly-downloaded incremental updates and always record whether data values are genuinely new information or represent revisions (i.e., updates of data points that were already previously available). As such, we maintain complete historical records of all data points, and document

all modifications and harmonization steps. This systematic approach ensures full traceability of every transformation made to the original data.

7.4 Data update process

Update monitoring and integration

Our update process begins with a continuous monitoring of current sources for new releases, supported by an automated notification system for new data availability and regular checks of historical sources for potential updates. The integration phase involves automated comparison with existing data, identification of revised values, integration of new data points, and maintenance of vintage data.

Quality control

Each update undergoes a rigorous quality control process consistent with the initial release of the Global Macro Database. Among others, we always run (a) a set of automated data validity checks, (b) unit and format verification checks, (c) consistency checks relative to previous versions, and (d) manually review all significant changes. This process is designed to make the resulting dataset as error-free as possible.

In addition to these initial checks, we always manually check the time series plot for each country and variable for potential issues.

8 Variable Definitions

8.1 Statistical framework

Wherever possible, our variable definitions follow the System of National Accounts 2008 (SNA 2008), the international statistical standard for national accounts adopted by the United Nations Statistical Commission. The SNA 2008 provides a comprehensive, consistent, and flexible framework for collecting and reporting macroeconomic statistics.

The SNA framework is reasonable starting point for our dataset because it provides internationally agreed-upon concepts, definitions, and classifications, ensures consistency and comparability across countries and time periods as much as possible, and offers standardized methodologies for data compilation.

For variables that are not reported as part of national accounts statistics, we try to adopt a consensus approach by surveying the meta data and best practices in existing work.

8.2 Nominal gross domestic product

Nominal Gross Domestic Product (GDP) measures the total market value of all final goods and services produced within a country's borders in a specific time period, typically a year. It reflects the economic output valued at the prices of that same year, often referred to as "current prices."

The international standard, the System of National Accounts (SNA), outlines three distinct yet equivalent approaches to calculating GDP. In theory, all three methods yield the same result.

- **Production Approach:** Calculates GDP as the sum of gross value added by all resident producer units, plus any taxes and less any subsidies on products (United Nations, 2009, Chapter 16, Section C).
- **Income Approach:** Sums the incomes generated by production. This includes compensation of employees (wages and salaries), gross operating surplus of enterprises (profits), and taxes on production and imports less subsidies.
- **Expenditure Approach:** Computes GDP by summing all final expenditures. It is calculated as the sum of final consumption (C), gross capital formation (investment, I), government spending (G), and net exports (exports (X) minus imports (M)). The formula is:

$$\text{nGDP} = C + I + G + (X - M)$$

Our `nGDP` series is constructed from sources that may use any of these methods. The expenditure approach can be constructed from our database which provides series for its main components, namely household and government final consumption, gross capital formation, and net exports. `nGDP` is measured in millions of local currency units at current market prices.

8.3 Real gross domestic product

Real GDP in Local Currency (rGDP) Real GDP measures a country's total economic output adjusted for the effects of price changes (i.e., inflation or deflation). It is valued using the prices of a fixed base year, thus providing a "constant price" series that reflects changes in volume. In our dataset, `rGDP` is measured in millions of constant 2015 local currency units (LCU).

Real GDP in U.S. Dollars (rGDP_USD) The construction of this series follows the methodology used by the World Bank to ensure that the real growth rates of the local economy are preserved accurately.[1]

The calculation proceeds as follows:

1. First, the nominal GDP for the base year (2015) is converted to U.S. dollars using the 2015 average market exchange rate ($E_{c,2015}$). This single value serves as the anchor for the entire series. The anchor value is calculated as:

$$\text{rGDP}_{\text{USD},c,2015} = \frac{\text{nGDP}_{c,2015}}{E_{c,2015}} \tag{1}$$

   For the reference year 2015, the values in current and constant prices are the same.

2. Second, the annual real growth rates ($g_{c,t}$) are calculated from the constant local currency series (`rGDP`):

$$g_{c,t} = \frac{\text{rGDP}_{c,t}}{\text{rGDP}_{c,t-1}} - 1 \tag{2}$$

3. Finally, these growth rates are applied forwards and backwards from the 2015 constant U.S. dollar value to generate the complete time series. The series is constructed recursively as follows:

$$\text{rGDP}_{\text{USD},c,t} = \begin{cases} \text{rGDP}_{\text{USD},c,t-1} \times (1 + g_{c,t}) & \text{if } t > 2015 \\ \frac{\text{rGDP}_{\text{USD},c,t+1}}{1+g_{c,t+1}} & \text{if } t < 2015 \end{cases} \tag{3}$$

This method ensures that the resulting series reflects the true volume growth of an economy, free from the distorting effects of both domestic inflation and exchange rate volatility.

GDP deflator (`deflator`)

The GDP deflator is defined as a price index derived by dividing nominal GDP by real GDP (United Nations, 2009, Chapter 15, Section C). `deflator` measures the overall price level of all domestically produced final goods and services. The deflator is set to 100 in the base year and expressed as an index.

[1] The methodology is detailed by the World Bank here: https://datahelpdesk.worldbank.org/knowledgebase/articles/114943-how-do-you-derive-constant-price-series-in-usd

Population (pop)

Population is the total number of persons present in the economic territory, including both nationals and foreigners (United Nations, 2009, Chapter 19, Section B). pop is measured in millions of persons.

8.4 Consumption and investment

Final consumption (cons)

Final consumption is the total expenditure on the consumption of goods and services (United Nations, 2009, Chapter 9, Section D). cons is measured in millions of local currency units. cons_GDP is in percent of nominal GDP (e.g., 100 means 100%).

8.5 Investment

Gross capital formation (inv)

Gross capital formation is measured by the total value of the gross fixed capital formation, changes in inventories and acquisitions less disposals of valuables. (United Nations, 2009, Chapter 10, Section B). inv is measured in millions of local currency units. inv_GDP is in percent of nominal GDP (e.g., 100 means 100%).

Gross fixed capital formation (finv)

Gross fixed capital formation is measured by the total value of a producer's 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. (United Nations, 2009, Chapter 10, Section B). finv is measured in millions of local currency units. finv_GDP is in percent of nominal GDP (e.g., 100 means 100%).

8.6 External sector

Exports (exports)

Exports are goods and services produced in one economy and sold to another economy, valued free on board (f.o.b.) at the border of the exporting country (United Nations, 2009, Chapter 15, Section B). exports is measured in millions of local currency units. exports_GDP is in percent of nominal GDP (e.g., 100 means 100%).

Imports (`imports`)

Imports are goods and services purchased by residents from nonresidents, originally valued cost, insurance, and freight (c.i.f.) but converted to f.o.b. (United Nations, 2009, Chapter 15, Section B). `imports` is measured in millions of local currency units. `imports_GDP` is in percent of nominal GDP (e.g., 100 means 100%).

Current account balance (`CA`)

The current account is defined as the sum of the balances on goods, services, primary income, and secondary income (United Nations, 2009, Chapter 16, Section B). It is considered a key indicator of an economy's saving-investment relationship with the rest of the world. `CA` is measured in millions of local currency units. `CA_GDP` is in percent of nominal GDP (e.g., 100 means 100%).

Real effective exchange rate (`REER`)

The real effective exchange rate, or REER, is the trade-weighted average of bilateral exchange rates adjusted for relative price levels. `REER` is expressed as an index equal to 100 in the base year and thus measures (changes in) international competitiveness.

USD exchange rate (`USDfx`)

The US dollar exchange rate is defined as the value of one U.S. dollar in terms of local currency units. Wherever possible we report end-of-period rates.

8.7 Government finance

Government debt (`govdebt`)

Government debt is the total liabilities of the government requiring future payments of interest and/or principal. It includes loans, debt securities, and other borrowings (United Nations, 2009, Chapter 22, Section D). `govdebt` is measured in millions of local currency units. `govdebt_GDP` is in percent of nominal GDP (e.g., 100 means 100%).

Government revenues (`govrev`)

Government revenue is the increase in net worth of the government resulting from incoming transactions; it includes taxes, social contributions, grants, and other revenue (United

Nations, 2009, Chapter 22, Section C). govrev is measured in millions of local currency units. govrev_GDP is in percent of nominal GDP (e.g., 100 means 100%).

Government tax revenue (govtax)

Government tax revenues are compulsory transfers to government units, including taxes on income, profits, goods and services, and international trade (United Nations, 2009, Chapter 22, Section C). govtax is measured in millions of local currency units. govtax_GDP is in percent of nominal GDP (e.g., 100 means 100%).

Government expenditure (govexp)

Government expenditure is a decrease in net worth of the government resulting from transactions, including from compensation of employees, use of goods and services, and transfers (United Nations, 2009, Chapter 22, Section C). govexp is measured in millions of local currency units. govexp_GDP is in percent of nominal GDP (e.g., 100 means 100%).

Government deficit (govdef)

Government deficit refers to net lending/borrowing by the government, i.e. the difference between revenue and expenditure (United Nations, 2009, Chapter 22, Section C). govdef is the primary measure of a country's fiscal position and measured in millions of local currency units. govdef_GDP is in percent of nominal GDP (e.g., 100 means 100%).

8.8 Money and interest rates

Money supply (M0)

M0 is defined as notes and coins in circulation outside depository corporations (International Monetary Fund, 2016, Chapter 6, Section IV). It is considered the most liquid monetary aggregate. M0 measured in millions of local currency units.

Money supply (M1)

M1 is defined as currency in circulation plus transferable (demand) deposits (International Monetary Fund, 2016, Chapter 6, Section III). It is the most liquid monetary aggregate including bank deposits. M1 is measured in millions of local currency units.

Money supply (`M2`)

M2 is defined as M1 plus time and savings deposits and includes less liquid monetary assets (International Monetary Fund, 2016, Chapter 6, Section III). `M2` is measured in millions of local currency units.

Money supply (`M3`)

M3 is defined as M2 plus marketable instruments issued by depository corporations (refer to (International Monetary Fund, 2016, Chapter 6, Section III)). It represents the broadest monetary aggregate measured within the banking system. `M3` is expressed in millions of local currency units.

Money supply (`M4`)

M4 is defined as M3 plus debt securities issued by the central government that are held by money holders (refer to (International Monetary Fund, 2016, Chapter 6, Section III)). It is the most comprehensive measure of the money supply. `M4` is also expressed in millions of local currency units.

Central bank policy rate (`cbrate`)

The central bank policy rate is the key interest rate used to implement or signal monetary policy stance (International Monetary Fund, 2016, Chapter 4, Section II). It usually applies to short-term liquidity operations. `cbrate` is measured in percent per annum (e.g., 5 means 5%).

Short-term interest rate (`strate`)

The short-term interest rate is the market rate on short-term government securities or interbank rates, usually referring to three-months maturity (International Monetary Fund, 2016, Chapter 4, Section II). `strate` is measured in percent per annum (e.g., 5 means 5%).

Long-term interest rate (`ltrate`)

The long-term interest rate is the market yield on long-term government bonds, usually referring to ten-year maturity (International Monetary Fund, 2016, Chapter 4, Section II). `ltrate` is measured in percent per annum (e.g., 5 means 5%).

8.9 Prices and labor market

Consumer price index (`CPI`)

The consumer price index (CPI) is a measure of the average change in prices paid by consumers, with the weights based on household consumption patterns (United Nations, 2009, Chapter 15, Section A). `CPI` is expressed as an index equal to 100 in the base year.

House price index (`HPI`)

The house price index (HPI) measures changes in residential property prices, where possible adjusted for quality (Eurostat, 2013). `HPI` is expressed as an index equal to 100 in the base year.

Inflation (`infl`)

Inflation is defined as the period-on-period percentage change in the consumer price index, which measures the rate of price level changes (United Nations, 2009, Chapter 15, Section A). `infl` is expressed in percent per annum (e.g., 5 means 5%).

Unemployment rate (`unemp`)

The unemployment rate is defined as the number of unemployed persons as a percentage of the labor force (United Nations, 2009, Chapter 19, Section D). Wherever possible, it is based on International Labor Organization standards. `unemp` is expressed in percent (e.g., 5 means 5%).

9 Priority Ordering of Data Sources

Our extensive experience working with macroeconomic time series has led us to develop a hierarchy for how different sources should be prioritized. This ordering reflects both the reliability of the data and the practical considerations of maintaining a comprehensive database. The hierarchy follows three main tiers:

9.1 Tier 1: Modern official sources

Modern official sources, particularly those from international organizations, national statistical offices, and central banks receive the highest priority. These institutions typically

have the most accurate and up-to-date information for their respective countries, along with detailed documentation of methodologies and regular revision schedules.

9.2 Tier 2: Country-specific historical sources

The second tier consists of country-specific historical sources, often compiled by economic historians or research institutions focusing on particular countries or regions. These sources frequently offer invaluable historical data that has been carefully reconstructed and have often been evaluated through the academic peer review process. Notable examples include the historical statistics for Australia compiled by Vamplew (1987), Portuguese historical statistics by Instituto Nacional de Estatística (2001), and Argentinian long-run series by Nakamura and Zarazaga (2001).

9.3 Tier 3: Other aggregators

International aggregators such as the IMF, World Bank, or OECD form the third tier. While these sources provide extensive cross-country coverage and standardized definitions, they sometimes sacrifice historical depth or country-specific accuracy.

This ordering has proven robust through extensive testing and practical application. It balances the trade-offs between data accuracy, historical coverage, methodological consistency, and maintenance feasibility. The hierarchy is not rigid, however, and we document any deviations from this general ordering in our detailed source notes for each country and variable.

10 Measurement Issues

10.1 Data quality

A key contribution of our dataset is the systematic approach to data quality control through comprehensive visual inspection of all time series. For each of our 46 variables and 243 countries/territories, we plot the data from every available source on a single graph, allowing for detailed comparison and anomaly detection. This results in over 4,000 individual plots that we manually inspect for data quality issues.

Visual inspection process

Our visual inspection process creates plots for each country-variable combination. These plots comprehensively display our final GMD estimates, a GMD forecast (where available), data points from all available sources, clear indication of splice points between different sources, and notes on major adjustments or concerns.

This visualization process allows us to identify several critical types of data quality issues. We detect level shifts, which appear as unexpected jumps in the series that might indicate currency changes, definition changes, or data errors. We also identify source discrepancies, where different sources report substantially different values for the same period. The process also reveals outliers that deviate significantly from the series trend, inconsistencies in the units or currency in which a data series is recorded, and splicing problems where different data sources are not correctly "stitched together."

Documentation and correction

After identifying a potential data quality issue, we implement a systematic correction procedure. We begin by thoroughly documenting the nature of the anomaly and cross-referencing it with other sources and historical events. This investigation helps us determine whether the issue reflects a genuine economic event, a definitional change, or a data error requiring correction. Based on this assessment, we apply the necessary corrections while maintaining a detailed documentation of all adjustments. Throughout this process, we carefully flag any remaining uncertainties in the dataset to ensure full transparency.

Quality control documentation

We maintain a comprehensive set of PDF documents containing plots for each country and variable, accessible at www.globalmacrodata.com/documentation. This documentation provides extensive details, including a complete source information, the time spans each data source is used for constructing our time series, notes on specific adjustments or concerns, and detailed explanations of any splicing procedures applied.

As an illustrative example, consider the case of government expenditure data in Argentina. We use the following sources:

- Mitchell (2013): 1864-1989
- International Monetary Fund (2024a): 1990-1992
- International Monetary Fund (2024d): 1993-2029

These plots serve dual purposes: they function as both a quality control tool and transparent documentation of our data construction process. This comprehensive approach allows users to evaluate the reliability of specific series and understand precisely how different sources were combined to create our final estimates.

10.2 Dealing with data revisions

A key challenge in maintaining a long-run macroeconomic database is the treatment of data revisions. Statistical offices and international organizations frequently revise their estimates as new information becomes available or methodologies improve. Without proper treatment, these revisions would propagate through the entire historical series when using standard chain-linking procedures, causing implausible changes to historical values.

Fixed year approach

To address the issue of data revisions, we implement a reference year approach that effectively separates historical data from contemporary revisions. We establish 2019 as our reference year for the current version of the dataset, with historical data (pre-2019) chain-linked backwards and contemporary data (post-2019) chain-linked forwards from this base year.

This approach creates a clear framework for handling new data and revisions:

- Values before 2019 remain unchanged
- Values after 2019 incorporate all new information and revisions
- The reference year serves as an anchor point between historical and contemporary data

Going forward, we will occasionally consider a change in the reference year to take into account possible data revisions to 2019 values of the data.

Example

To illustrate our approach of fixing the reference year, consider a hypothetical case for real GDP. We begin with a historical source providing data for 1850-1989 and a contemporary source (e.g., International Monetary Fund (2024d)) covering 1990-2024. When a new (International Monetary Fund, 2024d) release revises the values for the 2022-2024 period and adds 2025-2029 forecasts, the treatment of these revisions differs significantly under different approaches.

Under traditional chain-linking starting from the most recent data, revisions to recent years would affect the entire series back to 1850, meaning historical values would change despite no new historical information becoming available. In contrast, our reference year approach provides a more stable framework:

- 2019 serves as the fixed reference point
- Data for 1850-2019 is constructed by chain-linking backwards from 2019
- Data for 2020-2025 is constructed by chain-linking forwards from 2019
- Revisions to 2022-2024 and the addition of 2025 only affect post-2019 values

Implementation

For each variable, we implement a systematic procedure that begins with fixing the level of the series in 2019 using our preferred contemporary source. For earlier years ($t < 2019$), we use growth rates from historical sources to chain-link backwards from 2019, with these values remaining fixed unless errors are discovered. For later years ($t > 2019$), we employ growth rates from contemporary sources to chain-link forwards from 2019, allowing these values to update with each new data release.

This methodology ensures that our historical estimates remain stable while still incorporating all relevant contemporary revisions and updates. We plan to periodically update the reference year (e.g., to most recent years) in the next major releases of the dataset. At this point, the entire series will be recomputed to incorporate any important historical revisions.

10.3 Base years for index variables

Several variables in our dataset are expressed either in constant prices or as indices (e.g., Consumer Price Index, GDP deflator, real GDP). These variables require a common reference year for meaningful comparison. We implement a systematic approach to standardize reference years across all index variables.

Primary reference source

We use the IMF's World Economic Outlook (International Monetary Fund, 2024d) as our primary reference source for reference years. This choice is motivated by several key

advantages: the WEO offers wide country coverage, maintains a regular updating schedule, employs consistent methodological treatment, and enjoys broad usage in applied research.

10.4 Rebasing methodology

To ensure consistency across countries and time periods, we rebase real GDP series to a common reference year, set to 2010. The rebasing involves recalculating real GDP using country-specific GDP deflators. Formally, the deflator is computed as:

$$\text{Deflator}_{c,t} = \left(\frac{\text{nGDP}_{c,t}}{\text{rGDP}_{c,t}} \right) \times 100, \tag{4}$$

where $\text{nGDP}_{c,t}$ and $\text{rGDP}_{c,t}$ denote nominal and real GDP for country c in year t, respectively.

We then loop over each country separately to anchor each series to the base year 2010 deflator value:

$$\text{rGDP}_{c,t}^{\text{rebased}} = \text{rGDP}_{c,t} \times \frac{\text{Deflator}_{c,2010}}{100}, \tag{5}$$

where $\text{Deflator}_{c,2010}$ is the GDP deflator value for country c in the base year 2010. After rebasing, we update the GDP deflator to reflect the recalculated real GDP values:

$$\text{Deflator}_{c,t}^{\text{updated}} = \left(\frac{\text{nGDP}_{c,t}}{\text{rGDP}_{c,t}^{\text{rebased}}} \right) \times 100. \tag{6}$$

This rebasing method ensures temporal consistency and comparability of real GDP figures across different countries in our dataset.

10.5 Changes in currency

The long-run nature of our dataset requires careful handling of currency changes and redenominations. Historical sources often report values in currencies that were in use at the time of recording, while modern sources typically adjust historical values to current currencies. We identify and address two distinct types of currency changes:

1. **Adoption of new currencies:** Complete changes in the monetary unit, such as:
    - Introduction of new national currencies post-independence
    - Currency union adoptions (e.g., Euro)

- Post-hyperinflation currency reforms

2. **Redenomination of existing currencies:** Technical adjustments to the same basic monetary unit, typically:
    - Removal of zeros after hyperinflation periods
    - Technical currency reforms maintaining the same basic unit

For new currency adoptions, we apply the official conversion rate at the time of change. For example, in the case of Euro adoption, we use the irrevocable exchange rates set by the European Central Bank (e.g., 1.95583 Deutsche Mark = 1 Euro for Germany). All historical values are converted using these official rates, and we document the conversion rate and date in country-specific notes.

Currency redenominations, particularly following periods of hyperinflation, require special attention. For instance, Turkey removed six zeros from the Lira in 2005, requiring all pre-2005 values to be divided by 1,000,000 to maintain consistency. Brazil presents a more complex case, with multiple changes between 1942 and 1994:

- 1942-1967: Cruzeiro
- 1967-1970: Cruzeiro Novo, 1000:1 redenomination
- 1970-1986: Cruzeiro
- 1986-1989: Cruzado, 1000:1 redenomination
- 1989-1990: Cruzado Novo, 1000:1 redenomination
- 1990-1993: Cruzeiro
- 1993-1994: Cruzeiro Real, 1000:1 redenomination
- 1994-present: Real, 2750:1 conversion

For such complex cases, we implement a systematic procedure in four steps. First, we document the complete chain of currency changes. Second, we apply conversions sequentially using official exchange rates. Third, we cross-validate the results with multiple sources when available. Fourth, we record potential measurement uncertainties in periods of extreme inflation.

To ensure accurate currency conversions, we employ several quality control measures. These start with an automated detection of unusual jumps in series around known currency change dates and a cross-validation with multiple sources where available. Most importantly, we manually review all major currency changes.

For each country-year observation affected by currency changes, we maintain detailed documentation of the original currency and value, applied conversion rate(s), and final adjusted value. This information is available in the country-specific technical notes. In cases where sources disagree about the appropriate conversion rate, particularly during periods of high inflation, we use geometric averages of available estimates and flag these observations for higher uncertainty.

10.6 Accounting identities and internal consistency

Some variables in the dataset, such as nominal GDP, have several components that should in principle add up to the total. In the case of GDP, the expenditure approach implies that $Y = C + I + G + NX$. Ideally, this accounting identity should thus always hold in the data. In practice, data providers such as Eurostat include have an unexplained "statistical discrepancy" even for recent data points that would have to be incorporated for the components to add up to GDP.

Because we construct time series from many different underlying sources using ratio-splicing, accounting identities such as the one outlined above will not hold exactly. While we do not explicitly provide it, the statistical discrepancy in our data can be calculated as the difference between GDP and the sum of its underlying components.

The alternative to accepting a statistical discrepancy would be to use a hierarchical reconciliation method. These methods rescale the underlying components so that they exactly add up to the total. Because using a statistical discrepancy is the standard approach taken by almost all data providers, however, we do not use hierarchical reconciliation. To ensure the highest possible data quality, we instead manually investigate all cases where the statistical discrepancy is large to identify potential errors before each release.

10.7 Dealing with series breaks

Series breaks occur when the same variable exhibits a discontinuity due to methodological changes, redefinitions, or changes in source data. We identify a series break when either:

- There is an explicit documentation of methodological change

- There is an unexplained jump in the series that unambiguously cannot be attributed to economic events
- Other sources than the one in use report substantially different growth rates or values for the same period

We employ two distinct methodologies for addressing series breaks, depending on the availability of overlapping data.

Method 1: Overlapping data available

When we have overlapping observations between two sources at the break point t_0, we adjust the historical series using the ratio method:

$$\hat{y}_s = y_s^{next} \times \frac{y_{t_0}^{previous}}{y_{t_0}^{next}} \quad \text{for all } s < t_0 + 1 \tag{7}$$

where:

- $\hat{y}_s$ is the adjusted value for period s
- y_s^{next} is the value from the next series used in the chain-linking process
- $y_t^{previous}$ is the value from the previous series at the break point
- y_t^{next} is the value from the next series at the break point

Method 2: No overlapping data

Statistical breaks that occur at time t when chain-linking backwards are adjusted as following this methodology:

1. **Compute growth rates from the new source after the break:**

$$g_t^{\text{previous}} = \frac{y_{t_0}^{\text{previous}} - y_{t_0-1}^{\text{previous}}}{y_{t_0-1}^{\text{previous}}}, \quad \text{for } t \in \{t_0 + 1, t_0 + 2, t_0 + 3\} \tag{8}$$

2. **Compute growth rates from the old source before the break:**

$$g_t^{\text{next}} = \frac{y_{t_0}^{\text{next}} - y_{t_0-1}^{\text{next}}}{y_{t_0-1}^{\text{next}}}, \quad \text{for } t \in \{t_0 - 3, t_0 - 2, t_0 - 1\} \tag{9}$$

3. **Create a combined growth rate series:**

$$g_t = \begin{cases} g_t^{\text{previous}} \\ g_t^{\text{next}} \end{cases} \tag{10}$$

This series pools available growth rates from both sources to increase robustness.

4. **Compute the median growth rate:**

$$\bar{g} = \text{median}(g_t) \tag{11}$$

The median is used for robustness against outliers and to adjust the pre-break value:

5. **Adjust the pre-break value using the median growth rate:**

$$y_{t_0+1}^{break_adjusted} = \frac{y_{t_0+1}^{previous}}{1+\bar{g}} \tag{12}$$

6. **Compute the chainlinking ratio:**

$$\theta = \frac{y_{t_0+1}^{\text{break_adjusted}}}{y_{t_0}^{\text{next}}} \tag{13}$$

7. **Apply adjustment to historical series:**

$$\hat{y}_s = y_s^{next} \times \theta \quad \text{for all } s < t_0 + 1 \tag{14}$$

This approach ensures consistency and robustness when adjusting historical time series across structural breaks.

Implementation notes

We strictly give preferences to Method 1 whenever overlapping data is available. Method 2 is only used when no overlapping observations exist. When multiple breaks exist in a series, we apply these methods sequentially. Crucially, all series breaks and adjustment methods are documented in country-specific notes.

10.8 Doubtful data points

In compiling a comprehensive macroeconomic database, we systematically identify and address doubtful data points that may reflect measurement errors rather than genuine economic phenomena. We classify these into two main categories: outliers and definitionally impossible values.

Outliers

We define outliers as observations that exhibit implausible changes in the level of a series. Our identification process combines economic validation and source comparison. For economic validation, we cross-reference flagged observations with other sources, verify if large changes can be explained by known economic shocks, and compare with related economic variables for consistency. The source comparison involves checking alternative data sources for the same period and evaluating the reliability of different sources.

When outliers are identified, we follow a three-step protocol. First, we replace values with another source if a more reliable source is available. Second, if no reliable alternative exists, we set the observation to missing. Third, all adjustments are meticulously recorded in the country-specific notes.

Definitionally impossible values

Certain variables have natural constraints on their possible values based on economic definitions. We systematically check for and address two types of constraints. First, sign restrictions dictate that stock variables (e.g., money supply, population), price indices, and exchange rates must be positive, while flow variables (e.g., government deficit, current account) can be negative. Second, logical bounds require that percentages (e.g., unemployment rate) must lie between 0 and 100, and ratios (e.g., debt-to-GDP) must be non-negative.

When encountering impossible values, we implement a three-step verification process. First, we compare the values with alternative sources to identify correct values. Second, we check for potential unit or sign errors in the source data. Third, we investigate possible definitional changes or special circumstances that might give rise to unusual values.

Quality control process

For both types of doubtful data points, we implement a systematic review process:

1. Automated flagging of potential issues

2. Manual review of flagged observations
3. Cross-validation with multiple sources
4. Documentation of all adjustments
5. Regular review of flagging thresholds

All identified doubtful data points and their resolution are recorded in our technical documentation, allowing users to assess the reliability of specific observations and understand any adjustments made to the raw data.

11 Planned Improvements

We are currently working on:

- An article describing the `gmd` Stata command in detail, which we are also in the process of improving
- Improving the government finance statistics, especially to better take into account the different reporting of measures referring to central and general government
- Further harmonizing the definition of monetary aggregates across sources
- Adding measures of total factor and labor productivity
- Extending the coverage of exchange rate data, especially for former colonies

We always welcome additional suggestions. Just open an issue on our GitHub repo or reach out to us at hello@globalmacrodata.com.

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