

# IMFDataPy: A Python Package for IMF Data Discovery and Extraction

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## Abstract

The IMF’s RESTful APIs for retrieving international economic data series are technically involved. The structure of the returned JSON datasets varies from one series to another. It is too complex for an unprepared or non-technical user to download or use the data.

We have created an installable Python package, **IMFDataPy**, for discovering and extracting IMF data series. It serves to mask or wrap the complexities of the IMF JSON RESTful API so that the users would not need to handle JSON data or its underlying metadata. It provides an intuitive way for users to search through the series or indicator names.

**IMFDataPy** is designed with an extensible software architecture and simple APIs. It contains comprehensive and searchable documentation; as well as unit tests that ensure the functionality of the package as designed. The package also contains robust input parsing; provides summaries of the downloaded IMF time series data and metadata; and last but not least, gives a number of economic and financial use cases of **IMFDataPy**.

The current work is released as a Python package on Python Package Index, **IMFDataPy** PyPI page and the source code is available at the GitHub repository, **IMFDataPy** GitHub page.

## 1 Introduction

The International Monetary Fund (IMF) is an international organization that provides financial assistance and advice to its 190 member countries out of 195 countries in the world. Apart from advising services, the IMF periodically collects large amounts of data on various economic indices from its member countries.

An IMF data **series** (e.g., International Financial Statistics) is a dataset containing multiple economic indicators. An economic **indicator** (e.g., Gross Domestic Product) is a set of time-indexed numeric values that represents an economic index or metric. **Dimension** refers to the metadata that pertains to all indicators within a specific IMF series. Here, metadata is defined as a collection of information that provides descriptive and structural details about the data itself. The dimension most commonly include the following items:

- Area (e.g., the US) — or in some datasets called Country — may refer to a territorial entity of a state understood by international law, a territorial group (e.g., Eurozone), or a non-sovereign territory for which statistics are maintained;
- Frequency (e.g., quarterly);

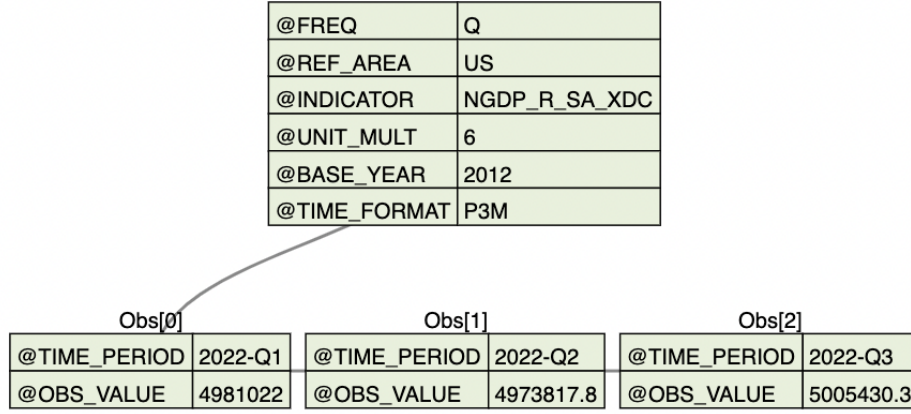


Figure 1: Data Structure of Quarterly Real Gross Domestic Product observations for the US in 2022.

- Period (e.g., from 2020 to 2022).

Table 1 lists some of the more than 30 monthly, quarterly, or annual data series for 190 member countries from the 1960's to present available from IMF (IMF 2023a).

There are four main data extraction methods, which we summarize below. For their detailed IMF help and documentation, see (IMF 2020a).

- **Web Query Interface** allows user interactions and customization of data tables and graphs online.
- **Bulk Download** allows downloading a zip file containing csv files for data and metadata for each dataset (IMF 2023c).
- **IMF Data Mapper** and **IMF Mobile App** provides data lists, summaries, and visualization for some of the IMF indices. Data such as real GDP trends can be accessed through a web browser or the IMF mobile app on a phone or a tablet (IMF 2023b, 2015).
- **JSON RESTful Web Service API** can be programmatically accessed using Python, R, or other programming languages to download JSON files automatically. Briefly, **JSON** is a file format for data storage and transmission that consists of attribute-value pairs and arrays. It is readable by machines, but not readily comprehensible by people. **RESTful API** is an interface that enables clients (programs or devices) to interact with server resources using the **REpresentational State Transfer** design pattern. This design pattern is based on the exchange of client requests and server responses as described in Chapter 5 of (Fielding 2000).

While powerful and flexible, the RESTful API is however not exactly intuitive for first-time or less technical users. The main issue is that the data is stored in datasets called series, with each series associated with multiple dimensions. For example, to find a country's Consumer Price Index (CPI) or Gross Domestic Product (GDP), one would need to first discover the correct names of the containing series and dimensions, followed by a text search of well-selected keywords. (Dew 2016, 2018) illustrate the complexity well. Additional examples are available in our [IMFDataPy Github repository](#) (in the folder 'demo').

**Example 1.** *Real Gross Domestic Product (RGDP)* is the inflation-adjusted monetary value of goods

Table 1: Examples of IMF data series and indicators.

Series	Series Name	Examples of Indicators
IFS	International Financial Statistics	Gross Domestic Product, Interest Rates, Unemployment Rates, Consumer Price Index, Industrial Production, Exchange Rates, Export and Import, Government Revenues and Expenditures
GFS	Government Finance Statistics	Financial assets and liabilities classified by sector, Government Revenue, Government Cash Flow
HPDD	Historical Public Debt Database	Debt To GDP Ratio
PCPS	Primary Commodity Price System	Indices of market price for fuel and non-fuel commodities
DOTS	Direction of Trade Statistics	Value of Imports and Exports, Value of Trade Balance
FDID	Financial Development Index Database	Financial Development Index, Financial Market Index
CPI	Consumer Price Index	CPI for various goods and services groups

and services in a country during a specific time period. *Quarter-on-quarter (QoQ)* is a change in value between one quarter and the previous quarter. To access QoQ RGDP data using the JSON RESTful API, we need to follow two steps:

- First, understand or look up the information of its containing series by using the `DataStructure` method, and specify the necessary dimensions.
- Second, request the data using the `CompactData` method.

Description of the above and other methods can be found in our GitHub demo and the IMF website (IMF 2020b). We refer readers to our [Python Jupyter Notebook Example](#) for step-by-step implementation details.

## 2 Existing Software Packages

**IMFDataPy** is our Python package that allows users to retrieve data directly from the IMF’s servers. In Table 2, we compare **IMFDataPy** with other R or Python software packages that have similar functionality.

Table 2: Existing packages to explore and extract the IMF data from IMF’s servers.

Name (Language)	Functionality	Available Series	Limitations
<b>IMFData</b> (Lee 2019) (R)	Search through series and index codes and output data, given series name, index codes and other parameters	All	Not actively maintained. Removed from CRAN. An archive version can be installed.
<b>imfr</b> (Gandrud 2020) (R)	Load data given series name, index code and other parameters	All	Not actively maintained. Removed from CRAN. An archive version can be installed.

Name (Language)	Functionality	Available Series	Limitations
<b>datapungi</b> (Otterson 2020) (Python)	Load data & metadata given series name, index code and other parameters	All	Some series (other than IFS) resulted in errors. Little documentation was provided. No information on unit tests. Source code was not available.
<b>imfpy</b> (Kearney 2021) (Python)	Search through the datasets, download data into a Pandas DataFrame, visualize data	DOTS	Only one IMF series.
<b>PyIMF</b> (Eggers 2022) (Python)	Search through datasets and indices and output data, given index codes and other parameters	All	Installation using pip results in error. No source repository found. Documentation was not provided. No unit tests.
<b>IMFDataPy</b> (Choi and Klein 2022) (Python)	Search through series names. Download data & metadata given series name and index <b>search terms</b> into Pandas DataFrames and CSV files	AFRREO, BOP, DOT, FSI, GFSR, HPDD, IFS	Limited number of series (more to be added). Limited built-in visualization of the results.

DBnomics (DBnomics team 2023) is another noteworthy service that collects and stores economic data from the IMF (and some other 88 providers at the time of writing) on its own servers that is not associated with IMF. It also provides a user-friendly web interface for analyzing essential indices with detailed information on the data sources. Moreover, there are R and Python clients available that enable users to retrieve the data automatically.

### 3 IMFDataPy Package

**IMFDataPy** is designed with an object-oriented architecture, in which child objects may inherit or override the behavior of the parent object. Each of the IMF’s datasets is a child of the parent class, **IMF** object, which in turn is a child of the abstract class, **Series** (Figure 2).

All data is downloaded into a Pandas DataFrame, which is a two-dimensional tabular data format with columns of various data types that come with the Python package, Pandas. In order to produce

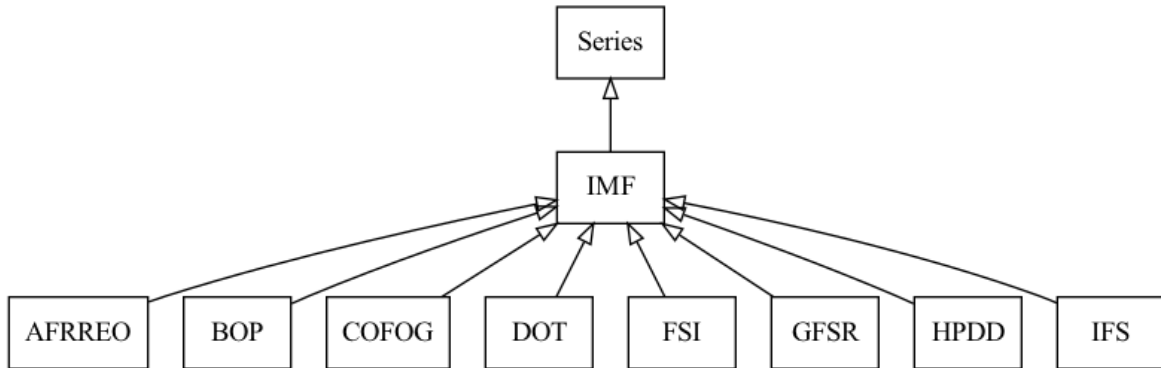


Figure 2: Object-oriented design of **IMFDataPy**.

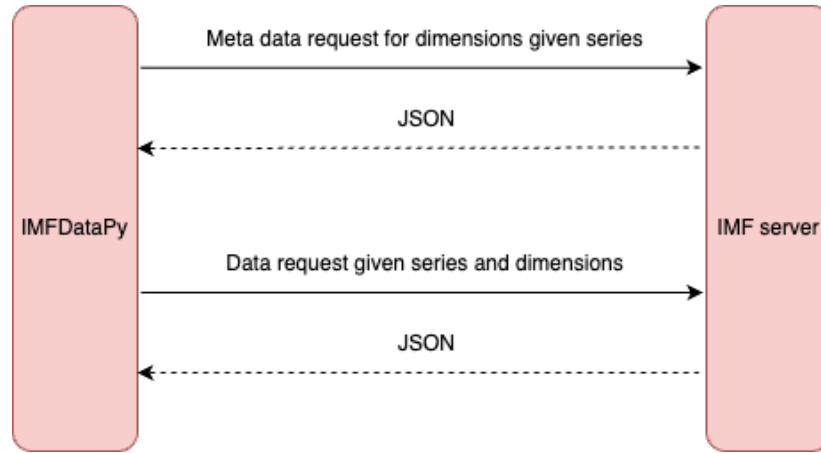


Figure 3: Sequence of requests from **IMFDataPy** to IMF’s server

the final DataFrame, the package first sends a request to the IMF’s server to get the dimensions for a specific series and then, having analyzed which of the indicators match the search terms given by the user, the **IMFDataPy** package sends a request to load the data given the dimensions, including the names of the indicators (Figure 3).

Having received the JSON file with the data, the package then transforms it into a more readable Pandas DataFrame and provides additional summary statistics and visualization.

To install the package, a user may simply run the command:

```
pip install imfdatapy
```

**Example 2.** For the example of quarterly RGDP change using the **IMFDataPy** package, the essential Python code is shown below. For details, we refer readers to our [Python Jupyter Notebook Example](#) for details.

```
from imfdatapy.imf import *

ifs = IFS(search_terms=["gross domestic product"], countries=["US"],
          period='Q', start_date="2010", end_date="2023")

df = ifs.download_data()
```

We trust with **IMFDataPy**, more people, especially beginning or non-technical users, are able to access IMF data more readily.

## Acknowledgements

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