Data Appendix to "Global Reform of Personal Income Taxation, 1981-2005: Evidence from 189 Countries"

by Klara Sabirianova Peter, Steve Buttrick, and Denvil Duncan

Abstract
This appendix includes notes on and references to data sources, summary statistics, and discussion of the sample to accompany "Global Reform of Personal Income Taxation, 1981-2005: Evidence from 189 Countries" by Klara Sabirianova Peter, Steve Buttrick, and Denvil Duncan

Note: The appendix is intended solely for use in the refereeing process and is not expected to be a part of the published paper. It will be posted on the website when the review is completed.

1. Notes on Data Sources

The personal income tax dataset was built using raw data that was assembled from more than 100 distinct reference books and data sets. Of these, perhaps the most important source for PIT data are the tax anthologies published at international accounting firms such as Deloitte, Haskins and Sells, Coopers and Lybrand, and PricewaterhouseCoopers. These publications offer comprehensive coverage of PIT structure for 90-120 countries beginning in 1981 and provided the preponderance of our data.

An equally essential reference for acquiring data was found in international organization publications. There are several references here that deserve attention. One specialized publication, the International Bureau of Fiscal Documentation's European Tax Handbook series, offers comprehensive in depth coverage of European national tax systems beginning in 1990. Another specialized source is the OECD's Tax Benefit Position of Employees and their numerous online personal income tax data sets that reports income tax data going back to the 1970's for OECD countries. Helpful PIT data on developing countries was found at the World Bank, European Bank of Reconstruction and Development, and the International Monetary Fund. With these references,

we were able to achieve a broader coverage of poorer developing countries as well as to fill in missing data on the high and middle income countries.

In addition to tax anthologies and international organization publications, public policy centers served as a ready reference for both developed and developing country tax data. The most important of these are the University of Michigan's World Tax Database, a source that publishes online tax data as far back as 1975, and the Economist Intelligence Unit, whose online tax database covers approximately sixty to seventy countries beginning in 1995. Other policy center data sets that were regularly consulted are the Heritage Foundation, the Fraser institute, and the Brookings Institute's Tax Policy Center. These resources filled a more limited role in the research process, either serving as a starting point in our data collection or more frequently to confirm other data that had already been collected from other sources. Overall, these online datasets tended to have more errors than the other two sorts of references.

Not surprisingly, acquiring clean and consistent panel data from multiple references can be a difficult task as one is required to reconcile contradictory information reported in various sources. This problem is especially true in our case given the scope of the dataset; 25 years with over 145 countries per year. In this connection there are three broad categories of data problems that we had to pay particular attention to: definitional errors, country-specific problems, and editorial omissions and errors.

Definitional errors are referring to cases where different numbers are quoted for the same variable because of differences in definition or reporting style. A common example of this type of errors is where the top statutory rate is quoted inclusive of a national surtax in one source, while another source excludes the national surtax and accounts for the local tax. Still yet another quote will aggregate all three taxes. Although all three definitions are correct, they can cause

inconsistency in the series. In this case the reported numbers must be broken down into their component parts to identify the value of interest in order to create consistent series.

Country specific reporting problems generally arise due to differences between income year (year when income is earned) and assessment year (year when income is taxed). The question we have to answer in cases like these is should the reference year for a given tax schedule be the year in which income is earned or the year in which income is taxed. A related problem case exists when a country's fiscal year differs from the Gregorian calendar year. Such countries may have two tax schedules for a single calendar year, thus requiring us to make a choice about which schedule to report for that year. A similar reporting problem exists when countries enact tax laws that are made retroactive or become effective on a date other than January 1st. These problems are further compounded by the fact that not every data source distinguish among the various years.

The following rules are used to address the highlighted reporting complications. Where the income year differs from the tax year, we use the tax year as our year of reference. We use the tax schedule in effect on January 1st of a given year as the tax schedule for that year. This implies that if a tax change is enacted in July of a particular year, we assume it is effective on January 1 of the next year. For example, while the Clinton tax cut was enacted in August 1993 and applied to 1993 income, in our data set the new rates are recorded as of January 1st, 1994 because the new rates did not exist as of January 1, 1993. However, whenever possible, we identify the year of the income to which new tax rates are applied (in this case, it is 1993). Our solution, while admittedly artificial, enabled us to organize the data in a simple panel format without sacrificing too much accuracy.

An unrelated but equally important country specific cause for errors is the use of multiple tax schedules. There are a number of cases where the tax schedule varies across employment status,

type of employment, sector or residential status. As a general rule, we use the tax schedule applicable to a single individual resident earning wage income in a country's dominant sector.

The last source of inconsistency is based on editorial errors, editorial practices, and decisions that are publication specific. In addition to outright reporting errors, this category encompasses a broad variety of other troublesome issues such as tardy updating, missing data, breaks in publication series, and changing presentation formats. Examples of missing data include abbreviated tax brackets, missing tax rates, unreported or partially reported deductions and tax credits and unreported tax changes. The incidence of publication specific errors and random editorial changes left crucial breaks in the data that had to be filled in by other reputable sources.

Despite the myriad problems working with multiple tax references, there were workable solutions to these predicaments. Usually these solutions required tedious calculations or detailed comparison of two or more data sources to confirm a particular number or fact. In some obvious cases, a reasonable assumption could be made about the data in question. Usually, however, the solution to these problems required learning the fundamental details of one tax system or another. Not surprisingly, finishing the data ultimately required some familiarity with over one hundred and fifty individual tax systems going back to 1981.

That said, through careful cleaning of the data we have assembled a valuable consolidated personal income tax resource for scholars doing empirical research.

2. Summary Statistics

Table A1 below documents the trend in annual mean and standard deviation of the top PIT rate, number of tax brackets, and two measures of structural progressivity (Marginal Progression 1 and Average Progression 1).

Table A1. Summary Statistics of Main PIT Variables by Year

	Unweighted	Weighted			
	Top PIT Rate	Top PIT Rate	Number of Brackets	MRP1	ARP1
1981	46.775	62.009	14.674	0.110	0.084
	(23.775)	(14.006)	(6.570)	(0.042)	(0.032)
1982	48.192	57.265	13.245	0.096	0.080
	(23.364)	(13.796)	(6.340)	(0.034)	(0.029)
1983	47.913	57.918	12.984	0.098	0.079
	(23.219)	(13.440)	(6.477)	(0.034)	(0.028)
1984	45.930	56.736	12.503	0.098	0.078
	(23.469)	(12.289)	(6.256)	(0.034)	(0.027)
1985	45.102	56.503	12.413	0.099	0.080
	(22.959)	(12.234)	(6.199)	(0.035)	(0.027)
1986	44.083	56.280	12.246	0.097	0.078
	(22.511)	(12.183)	(5.994)	(0.033)	(0.027)
1987	41.307	50.635	8.732	0.088	0.073
	(21.851)	(13.054)	(5.631)	(0.031)	(0.026)
1988	40.323	47.153	6.760	0.079	0.066
	(21.135)	(15.881)	(3.806)	(0.031)	(0.024)
1989	39.238	44.139	6.104	0.077	0.065
	(20.771)	(15.195)	(3.740)	(0.033)	(0.024)
1990	37.372	42.345	5.818	0.078	0.065
	(19.527)	(13.471)	(3.646)	(0.034)	(0.023)
1991	36.139	42.937	5.534	0.078	0.062
	(19.105)	(12.807)	(3.712)	(0.035)	(0.022)
1992	34.977	41.566	5.260	0.078	0.061
	(18.234)	(12.714)	(3.747)	(0.033)	(0.024)
1993	34.047	40.689	5.108	0.076	0.060
	(17.306)	(12.223)	(3.528)	(0.034)	(0.025)
N	3613	3613	3143	3082	3082

Notes: Standard deviations are in parentheses. Weight is GDP in constant 1990 U.S. dollars. MRP1 and ARP1 are marginal and average tax rate progressions up to an income level equivalent to four times GDP per capita. All variables are described in the text.

Table A1. Cont'd Summary Statistics of Main PIT Variables by Year

	Unweighted	Weighted			
	Top PIT Rate	Top PIT Rate	Number of Brackets	MRP1	ARP1
1994	33.401	42.830	5.333	0.076	0.060
	(16.709)	(10.800)	(2.758)	(0.030)	(0.024)
1995	33.024	42.786	5.554	0.067	0.052
	(16.198)	(10.478)	(2.765)	(0.024)	(0.023)
1996	32.813	42.894	5.362	0.072	0.058
	(16.257)	(10.331)	(2.715)	(0.026)	(0.023)
1997	32.785	42.463	5.195	0.074	0.058
	(15.954)	(10.370)	(2.091)	(0.027)	(0.024)
1998	32.657	41.972	5.052	0.073	0.058
	(15.875)	(10.367)	(1.910)	(0.028)	(0.024)
1999	32.335	40.271	4.907	0.072	0.057
	(15.627)	(9.589)	(1.876)	(0.027)	(0.024)
2000	31.910	39.936	4.851	0.070	0.058
	(15.463)	(9.331)	(1.855)	(0.023)	(0.024)
2001	31.224	39.346	5.049	0.069	0.055
	(15.159)	(9.328)	(1.883)	(0.023)	(0.022)
2002	30.593	38.727	5.103	0.070	0.058
	(14.772)	(9.225)	(1.864)	(0.024)	(0.024)
2003	29.914	37.353	5.073	0.070	0.055
	(14.720)	(9.106)	(1.853)	(0.025)	(0.023)
2004	29.825	37.062	5.050	0.072	0.054
	(14.611)	(9.085)	(1.862)	(0.028)	(0.024)
2005	29.011	36.434	5.031	0.068	0.052
	(14.492)	(8.815)	(1.869)	(0.024)	(0.022)
N	3613	3613	3143	3082	3082

Notes: Standard deviations are in parentheses. Weight is GDP in constant 1990 U.S. dollars. MRP1 and ARP1 are marginal and average tax rate progressions up to an income level equivalent to four times GDP per capita. All variables are described in the text.

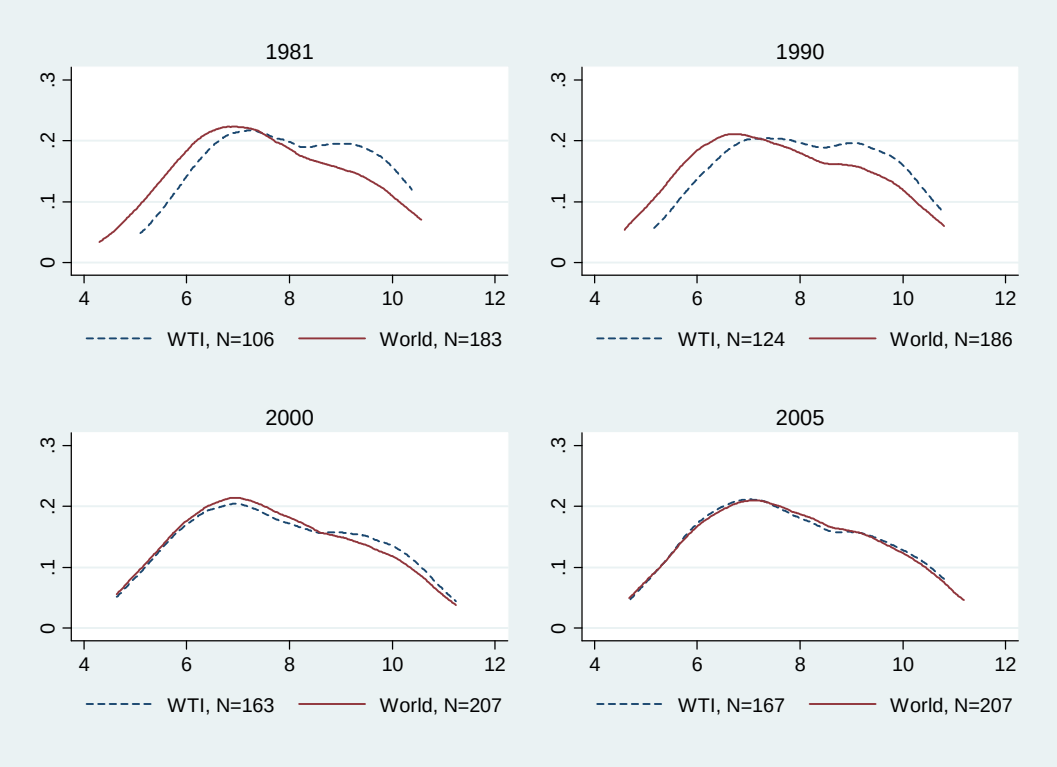
3. Data Representativeness

We believe that one of the primary advantages of our consolidated dataset is that it provides a level of world representation that has not been attained in previous studies of tax structures.[1] Our full sample includes 3613 top statutory PIT rates for 189 current and former countries from 1981 to 2005. This is an average of 145 countries per year. Even in the case of highly data-demanding

[1] Some of the largest samples in earlier studies include 51 marginal PIT rates from developing countries in 1984-1985 (Sicat and Vermani 1988) and 66 top PIT rates in 1980-1989 (Lee and Gordon 2005).

variables such as tax progressivity measures which require the complete tax schedule, we have non-missing values for 175 countries, or an average of 123 countries per year. The countries in our tax data are located in all populated geographic regions and continents,[2] and they represent approximately 94% of the world population and 98.5% of the world output (or more precisely, 86% of the world GDP in current U.S. dollars in 1981, 89% in 1982, 97% in 1983-1988, and 98-99% in all subsequent years).[3]

Figure A1: Distribution of Countries by Income



Notes: Reported are the kernel densities of the log of GDP per capita in 1990 U.S. dollars. The "WTI" denotes countries with non-missing tax and GDP measures in the World Tax Indicators database. The "world" includes all countries with available GDP measure.

Source: World Tax Indicators, United Nations Data, World Development Indicators, national statistical offices, and others.

[2] The regional breakdown is as follows: Africa – 48 countries, Asia and Oceania – 31, Central and South America – 35, Eurasia – 16, Europe – 43, Middle East – 12, and North America – 4.
[3] The major economies with missing PIT rates in the early 1980s are former USSR in 1981-1982 and Italy in 1981.

Further evidence in support of the representativeness of our sample is presented in Figure A1 above, which compares the distribution of countries by income level in the "general population" with the distribution in our estimation sample. For the "general population", we use a consistent sample of GDP per capita measures for most countries of the world from various sources including the United Nations Data and the World Development Indicators, among others. Figure A1 above shows that the coverage of our data set (WTI) matches the world distribution fairly well even in the early years of the sample. It is also apparent that the representativeness of our data improves over time.

Having a data set as representative as the WTI is crucial for empirical research. Equally as important is its longitudinal dimension. Sabirianova Peter (2008), for example, demonstrates that using panel data methods on a sample of 170+ countries switches the sign of the effect of various tax variables on the size of the shadow economy from negative in OLS to positive and highly statistically significant in fixed effect models. In this paper, we illustrate the importance of large representative samples in the context of a simple GDP growth model.[4] We estimate the effect of the top PIT rate on the growth of GDP using several alternative data sources (University of Michigan WTD, Heritage Foundation, OECD, World Bank, and the Economist Intelligence Unit) and compare the estimates with the estimates from our data (World Tax Indicators). The results from this exercise are reported in Table A2. We first note that alternative data sources are smaller in size and typically under-represent low-income countries (see Panel A). Panel B reports the trend coefficient on the top PIT rate and shows the large variation in sign, size and significance by data source. For example, Heritage Foundation and Economist Intelligence Unit databases show no

[4] The growth model includes the top PIT rate, annual change in the share of government consumption expenditures in GDP, annual change in the share of gross fixed capital formation in GDP, population growth rate, the share of industrial production in value added, year dummies, and country fixed effects to control for a country's endowment in human and physical capital and other time-invariant characteristics. We use the top PIT rate for comparability with other data sources.

trend in the top PIT rate, OECD and World Bank data sources produce a large downward bias in the estimated trend while the WTD shows a relatively steep descending trend in top rates. From Panel C, we see that only our dataset shows a negative and statistically significant relationship between the top PIT rate and GDP growth rate. The estimates of the tax rate effect on growth from other data sources are all statistically insignificant.

These results make it clear that reliance on small unrepresentative samples may lead to incorrect inferences and thus affect policy prescriptions. In this respect, we believe that our dataset is superior to most of the existing data on PIT rates.

Table A2: Sensitivity of Estimates to Different Data Sources

	World Tax Indicators	**Univ. Michigan WTD**	**Heritage Foundation**	**OECD**	**World Bank WDI**	**Economist Intelligence Unit**
Panel A: Composition of Countries, %						
Low income	15.31	12.26	13.78	0.00	8.41	1.53
Lower middle	25.05	25.11	20.51	0.00	17.29	14.80
Upper middle	24.63	25.58	27.88	6.78	28.04	23.47
High income	35.01	37.05	37.82	93.22	46.26	60.20
N (observations)	3613	1892	312	177	647	196
Panel B: Trend Coefficient for Top PIT Rate						
Trend	-0.876**	-1.220**	-0.528	-0.658**	-0.520**	0.159
	(0.063)	(0.099)	(0.496)	(0.134)	(0.114)	(0.495)
N (observations)	3613	1892	312	177	647	196
N (countries)	189	134	158	30	127	58
N (years)	25	23	2	6	6	4
Panel C: Effect of Top PIT Rate on GDP Growth						
Top PIT rate	-0.076**	-0.016	-0.016	0.076	-0.060	0.016
	(0.025)	(0.021)	(0.067)	(0.064)	(0.052)	(0.048)
N (observations)	3018	1619	297	177	588	196
N (countries)	168	119	152	30	114	58
N (years)	24	22	2	6	6	4

Note: Country-clustered robust standard errors in parentheses; ** significant at 1% level, * significant at 5% level. Panel B reports the unweighted estimates of the slope coefficient from regressing top PIT rates on the trend variable using the data sources indicated at the top of each column. Estimation is done by OLS with country fixed effects. Panel C presents the estimates of the relationship between the top PIT rate and real GDP growth rate using data from different sources. The growth model controls for the annual change in the share of government consumption expenditures in GDP, the annual change in the share of gross fixed capital formation in GDP, the population growth rate, the share of industrial production in value added, and year dummies.

An important question to ask at this stage is whether the changing sample composition played any role in the trends observed in the text. We test for any such effects by estimating the trend coefficient on tax variables using only the initial set of countries and comparing the results with those obtained using the full sample. Any compositional effect should show up as the difference between these two trend coefficients. The results in Table A3 show that there is no statistically significant difference at the 5% level in the estimated trend coefficients and hence no compositional effect.[5] These findings imply that we can be confident that the results we document are not influenced in any significant way by changes in the number of countries over time.

Table A3: Sensitivity of Trend Estimates to Changing Composition of Countries

	OLS		**FE**	
	All Countries	**1981 Sample**	**All Countries**	**1981 Sample**
Top PIT rate	-0.796**	-0.867**	-0.876**	-0.849**
	(0.080)	(0.067)	(0.063)	(0.068)
	[189/3613]	[108/2612]	[189/3613]	[108/2612]
Chi^2 test for difference between coefficients	*p*-value=0.128		*p*-value=0.322	
Marginal PIT rate at $4 \cdot y$	-0.308**	-0.289**	-0.307**	-0.299**
	(0.087)	(0.074)	(0.060)	(0.066)
	[175/3082]	[105/2353]	[175/3082]	[105/2353]
Chi^2 test for difference between coefficients	*p*-value=0.667		*p*-value=0.621	
Average PIT rate at $4 \cdot y$	-0.204**	-0.216**	-0.226**	-0. 224**
	(0.069)	(0.056)	(0.044)	(0.049)
	[175/3082]	[105/2353]	[175/3082]	[105/2353]
Chi^2 test for difference between coefficients	*p*-value=0.731		*p*-value=0.832	

Notes: Country-clustered robust standard errors are in parentheses; ** significant at 1% level, * significant at 5% level. Number of countries/observations is reported in brackets. Table reports the unweighted estimates of the slope coefficient from regressing selected tax variables on the trend variable using the sample indicated at the top of each column; *y* is a country's GDP per capita. The 1981 sample includes countries with available data in 1981.

[5] For MTR and ATR at $4 \cdot y$, we find that the trend slopes estimated on the 1981 sample (108 countries) are not statistically different (at the 5% level) from the trend slopes estimated when all countries are included. The results for other marginal and average tax rates are similar and not reported.

PIT Rates and PIT Revenue

We investigate the relationship between the PIT/GDP ratio and selected tax variables, including the top rate, average and marginal rates, and PIT progressivity measures and report the results in Table A4. The estimated model is

$$(1) \qquad r_{it} = \beta\tau_{it} + \gamma X_{it-1} + \theta Z_{it} + \alpha_i + \varepsilon_{it},$$

where r_{it} is the PIT/GDP ratio in country *i* and year *t*; τ_{it} is a tax variable of interest (either PIT rate or progressivity slope); X_{it-1} is a vector of one-year lagged covariates that include the log of GDP per capita,6 a 3-year moving average inflation rate, a 3-year moving average growth rate, a budget deficit indicator, and government expenditures as percent of GDP; Z_{it} is a vector of contemporaneous controls such as the difference between personal and corporate income tax rates, an indicator for cash vs. accrual base of the revenue measure, and a time trend; α_{it} is country fixed effects; and ε_{it} is the *iid* error term.

Predictably, we find that the PIT revenue share is negatively related to higher inflation, slower economic growth, deficit in the government budget, and a smaller size of the government. However, we do not find statistically significant association of the PIT revenue share with GDP per capita (after controlling for the income group) and with the difference between personal and corporate rates. The estimated coefficients on tax measures and interaction terms are not sensitive to omitting all or some of the *X* and *Z* variables. We also estimate the model separately for OECD and non-OECD countries and find the estimated *β's* to be relatively large, positive, and statistically significant in more developed OECD countries and positive, but not different from zero in non-OECD countries.

[6] To address the concern about possible division bias when using GDP per capita on the right hand side, we have also experimented with other measures of economic development such as life expectancy and the share of services in GDP. The results do not change in any significant way.

Table A4
PIT Revenue Function, FE

	Baseline	Main	OECD	Non-OECD	Notes/Sources
	(1)	(2)	(3)	(4)	
Top PIT rate	0.046**	0.061***	0.058**	0.020	World Tax Indicators v.1
	(0.018)	(0.021)	(0.026)	(0.014)	
Upper middle income	-0.032*	-0.036*			World Bank country classification based on historical income thresholds
× Top PIT rate	(0.017)	(0.019)			
Lower middle income	-0.041*	-0.043**			
× Top PIT rate	(0.021)	(0.021)			
Low income	-0.041*	-0.042**			
× Top PIT rate	(0.021)	(0.021)			
Top PIT – Top CIT		-0.017	-0.023	-0.009	World Tax Indicators v.1
		(0.014)	(0.022)	(0.013)	
Log (GDP per capita $_{t-1}$)		0.287	0.191	0.754	GDP in PPP international dollars; IMF WEO, UNCD
		(0.554)	(1.671)	(0.484)	
Annual inflation rate $_{t-1}$		-0.013***	-0.821*	-0.011***	3-year moving average; IMF IFS, IMF WEO, ILO Laborsta, EIU
		(0.004)	(0.467)	(0.003)	
Annual growth rate $_{t-1}$		-0.024*	0.056	-0.027**	3-year moving average; IMF WEO, UNCD
		(0.013)	(0.041)	(0.013)	
Budget deficit $_{t-1}$		-0.248*	-0.252	-0.346***	=1 if the government budget has deficit; IMF GFS, UNCD
		(0.127)	(0.227)	(0.127)	
Government size $_{t-1}$		0.055**	0.287**	0.046*	General gov't final consumption expenditures as percent of GDP; IMF IFS, WB WDI, EIU
		(0.028)	(0.106)	(0.024)	
Cash vs. accrual	0.230	0.216	-0.090	0.322	=1 if the revenue base is cash; IMF GFS
	(0.286)	(0.269)	(0.394)	(0.339)	
Trend	0.009	0.003	-0.028	0.005	
	(0.017)	(0.028)	(0.080)	(0.027)	
Constant	2.614***	-1.088	-2.289	-5.514	
	(0.709)	(4.951)	(16.619)	(3.978)	
N (observations)	1479	1479	657	822	
N (countries)	100	100	29	71	
R-squared	0.08	0.11	0.20	0.09	

Notes: Country-clustered robust standard errors are in parentheses; *** significant at 1% level, ** significant at 5% level, * significant at 10% level. Dependent variable is PIT revenue as percent of GDP. All estimates include country fixed effects. In addition to the variables listed in the table, estimates in columns 1 and 2 also include a set of country category indicators (upper middle, lower middle and low income countries). The omitted category is high income countries. Estimates in columns 2 through 4 also include a dummy variable for missing information on budget deficit (less than 5% of the sample).

Sources: Economist Intelligence Unit (EIU), International Labor Organization (ILO) Laborsta, IMF World Economic Outlook (IMF WEO), IMF International Finance Statistics (IMF IFS), IMF Government Finance Statistics (IMF GFS), United Nations Common Database (UNCD), World Bank World Development Indicators (WB WDI), World Tax Indicators v.1, reports of national statistical offices, and IMF country reports.

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