Online Annex 2.1. International Practices with Inflation Indexation[1]

This Online Annex summarizes the survey of indexation practices discussed on the chapter's subsection "*International Practices with Inflation Indexation.*" The cross-country review of inflation indexation practices focused on major budget items that are commonly impacted by indexation—personal income tax thresholds, public wages, pensions, and social benefits (Figure 2.1). It relied on a variety of sources described in a summarized manner below:

Data Description

- *Personal income tax threshold indexation*—The cross-country analysis was done using the data from Beer, Griffiths, and Klemm (2023). The data was verified and updated using official websites and IMF desk inputs, based on availability. The sample has 158 countries and classifies countries based on whether the prevailing personal income tax bracket adjustments are automatically tied to inflation, regularly adjusted but with an unclear process (de facto), or not adjusted regularly.

- *Pension indexation*—The first source was OECD (2021) and Checherita-Westphal (2022). For most LIDCs and EMs, the data was collected from the "Social Security Programs Throughout the World" published by the United States Social Security Administration (SSA) in collaboration with the International Social Security Association (ISSA). The "benefits adjustments" of old-age benefits were first analyzed to identify if the adjustments are regular—in which case, they are considered as indexed and then, as a second step, categorized whether they are indexed to prices, wages or mixed/other factors such as GDP growth. In the case that "benefits adjustments" is missing or not mentioned to have "regular adjustments", they were classified as "no indexation". The data was verified and updated using official websites and IMF desk inputs, based on availability. The sample has 176 countries.

- *Social assistance programs indexation*—Social assistance programs include all major fixed cash transfer programs, such as disability benefits, child benefits, family allowances, minimum income guarantees, income support for working-age population, and others. The first source was the detailed database of 31 countries from Mutual Information System on Social Protection (MISSOC). Special focus was given to the "benefits adjustments" of family allowances and guaranteed minimum income. For the rest, the data was collected from the 2018/19 "Social Security Programs Throughout the World" published by the United States Social Security Administration (SSA) in collaboration with the International Social Security Association (ISSA), based on desk research and country responses. Here, special importance was given to analyze the "benefits adjustments" of family and household benefits. If a country was identified to have regular adjustments for most of its social benefits programs, the country is coded as indexed. Further, the type of indexation, i.e., to prices or other variables such as expenditure surveys of low-income households was identified. In the case that "benefits adjustments" was missing or not mentioned to have regular adjustments for majority of the social assistance

[1] This Online Annex was prepared by Vybhavi Balasundharam with assistance from Arika Kayastha. More details can be found in Balasundharam, Kayastha, and Poplawski-Ribeiro (Forthcoming).

programs, the country is classified as having no indexation. The data was verified and updated using official websites and IMF desk inputs, based on availability. The sample has 132 countries.

- *Public sector wages indexation*—The primary source was IMF (2016) on pay setting systems including indexation practices. This survey contains 77 countries. The dataset was updated and expanded using multiple sources, including Tamirisa and Duenwald (2018), in which the survey question was "Are base wages indexed" and complied from national authorities and IMF country desks inputs, Checherita-Westphal (2022), official websites and IMF desk inputs, based on availability. The sample has 116 countries.

A. List of Countries and Indexation Practices

Country	Group	Pension Benefits Indexation *p - Automatic Indexation to prices* *w - Automatic Indexation to wages* *m - Automatic Indexation to a combination of prices, wages etc.*	Social Assistance Benefits Indexation *0 - No Automatic Indexation* *p - Automatic Indexation to prices* *m - Automatic indexation to other variables*	Wage Indexation *0 - No Automatic Indexation* *p - Automatic Indexation to prices* *m - Automatic Indexation to other variables*	Personal Income Tax Threshold Indexation *No - Ad hoc adjustment* *Automatic adjustment - By law* *Unclear process - De facto Regular adjustment but no law*
Afghanistan	LIDC			0	No
Albania	EME	p	m	0	No
Algeria	EME	0	0		
Andorra	AE	p	0		
Angola	EME	0	0	0	No
Antigua and Barbuda	EME	0			No
Argentina	EME	m	m		Unclear process
Armenia	EME	0	0		
Aruba	EME	0			No
Australia	AE	p	p	0	No
Austria	AE	0	p	0	Automatic Adjustment
Azerbaijan	EME	w	0		
Bahamas, The	EME	p	p		
Bahrain	EME	0			
Bangladesh	LIDC	0	0	0	No
Barbados	EME	p			No
Belarus	EME	w	m		
Belgium	AE	p	p	p	Unclear process
Belize	EME	0			
Benin	LIDC	0	0		
Bhutan	LIDC	w	0		
Bolivia	LIDC	p	0	0	
Bosnia and Herzegovina	EME	m	m	0	
Botswana	EME	0	0	0	No
Brazil	EME	m	0	0	No
Brunei Darussalam	EME	0	0		
Bulgaria	EME	m	0	0	
Burkina Faso	LIDC	0	0	0	

Burundi	LIDC	0	0	0	No
Cabo Verde	EME	0	0		No
Cambodia	LIDC		0		No
Cameroon	LIDC	0	0	0	No
Canada	AE	p	p	0	Automatic adjustment
Central African Republic	LIDC	0			
Chad	LIDC	0	0	0	No
Chile	EME	p		0	Automatic adjustment
China	EME	m	p		No
Colombia	EME	m			Unclear process
Comoros	LIDC	0	0	0	No
Congo, Democratic Republic of	LIDC	0			No
Congo, Republic of	LIDC	0	0	0	No
Costa Rica	EME	m	0	p/m	Automatic adjustment
Côte d'Ivoire	LIDC	0	0	m	No
Croatia	EME	m	0	m	No
Cyprus	AE	m	p	p	No
Czech Republic	AE	m	0	0	No
Denmark	AE	w	m	0	Automatic adjustment
Djibouti	LIDC				No
Dominica	EME	p			No
Dominican Republic	EME	0	0	0	Unclear process
Ecuador	EME	p	0	0	Automatic adjustment
Egypt	EME	0		0	No
El Salvador	EME	0		0	No
Equatorial Guinea	EME	0			No
Estonia	AE	m	0	0	
Eswatini	EME	0	0	m	No
Ethiopia	LIDC	0	0	0	No
Fiji	EME		0		No
Finland	AE	m	p	0	Unclear process
France	AE	p	p	0	Unclear process
Gabon	EME	0	0	0	No
Gambia, The	LIDC	0			No
Georgia	EME	0	0	0	
Germany	AE	w	m	0	Unclear process
Ghana	LIDC	0	0	0	No
Greece	AE	m	p	0	No
Grenada	EME	0			
Guatemala	EME	0		0	No
Guinea	LIDC	0	0		No
Guinea-Bissau	LIDC	0	0	0	No
Guyana	EME	0	0		No
Haiti	LIDC	0			
Honduras	LIDC	0	0	0	Automatic adjustment
Hong Kong SAR	AE	p			No
Hungary	EME	m	0	0	
Iceland	AE	m	0	0	Automatic adjustment

India	EME	p	0	p	No
Indonesia	EME	0	0	0	No
Iran	EME	p	p		Unclear process
Iraq	EME				No
Ireland	AE	w	0	0	No
Israel	AE	p	p	m	Automatic adjustment
Italy	AE	p	0	0	No
Jamaica	EME	0	0		No
Japan	AE	m	m	0	No
Jordan	EME	m		0	No
Kazakhstan	EME	p	p		No
Kenya	LIDC	0	0		No
Kiribati	LIDC	0	0		No
Korea	AE	p	0	0	No
Kosovo	EME	0	0	0	No
Kuwait	EME	0		0	
Kyrgyz Republic	LIDC	0	0	0	
Lao P.D.R.	LIDC	w	m		No
Latvia	AE	m	0	0	No
Lebanon	EME			0	No
Lesotho	LIDC	w	0	0	No
Liberia	LIDC		0	0	No
Libya	EME	w	0		No
Lithuania	AE	w	0	0	No
Luxembourg	AE	m	p	p	No
Macao SAR	AE	m			No
Madagascar	LIDC	w	0	0	No
Malawi	LIDC	0		0	No
Malaysia	EME	0		0	No
Maldives	EME	p	0		No
Mali	LIDC	0	0	0	No
Malta	AE	p	m	p	No
Marshall Islands	EME	0			
Mauritania	LIDC	p	0	0	
Mauritius	EME	p	p		No
Mexico	EME	p	0	p	No
Micronesia	EME	0			
Moldova	LIDC	m	p	0	No
Mongolia	LIDC	0	0	0	No
Montenegro, Rep. of	EME	m	m	m	No
Morocco	EME	0	0	0	No
Mozambique	LIDC	0			No
Myanmar	LIDC		0		No
Namibia	EME	0	0	0	No
Nepal	LIDC	0	0		No
Netherlands	AE	w	p	0	Automatic adjustment
New Zealand	AE	m	m	0	No
Nicaragua	LIDC	p			No

Niger	LIDC	0	0	0	No
Nigeria	LIDC	0		0	No
North Macedonia	EME				No
Norway	AE	w	p	0	Unclear process
Oman	EME	0		m	
Pakistan	EME	0	0	0	No
Palau	EME	0			
Panama	EME	0			No
Papua New Guinea	LIDC	0			No
Paraguay	EME	p			Unclear process
Peru	EME	0		0	Automatic adjustment
Philippines	EME	m	0	m	No
Poland	EME	m	m	0	No
Portugal	AE	m	m	0	No
Qatar	EME	0	0	0	
Romania	EME	m	p		No
Russia	EME	p	m	p/m	No
Rwanda	LIDC	0	0	0	No
Samoa	EME	0			No
San Marino	AE	p	p	0	No
São Tomé and Príncipe	LIDC	p			No
Saudi Arabia	EME			0	
Senegal	LIDC	0	0	0	No
Serbia	EME	m	p	m	Automatic adjustment
Seychelles	EME	p	p		No
Sierra Leone	LIDC	0			No
Singapore	AE	0		0	No
Slovak Republic	AE	p	0	m	No
Slovenia	AE	m	p	0	No
Solomon Islands	LIDC	0			No
Somalia	LIDC				
South Africa	EME	0	0	0	Unclear process
South Sudan	LIDC				No
Spain	AE	p	0	0	No
Sri Lanka	EME	0	0		No
St. Kitts and Nevis	EME	0			
St. Lucia	EME	p			No
St. Vincent and the Grenadines	EME	p			
Sudan	LIDC	p		0	No
Suriname	EME	w	0		No
Sweden	AE	w	0	0	Unclear process
Switzerland	AE	p	p/m	0	No
Syria	EME	0			No
Taiwan Province of China	AE	p	p		Automatic adjustment
Tajikistan	LIDC	p	p	0	No
Tanzania	LIDC	m	0	m	No
Thailand	EME	0	0		No
Timor-Leste	EME				No

Togo	LIDC	0	0		No
Tonga	EME				No
Trinidad and Tobago	EME	0			No
Tunisia	EME	w		p	No
Turkiye	EME	p	0	p	Unclear process
Turkmenistan	EME	w	w	0	
Uganda	LIDC	0	0	0	No
Ukraine	EME	m	m	p	Unclear process
United Arab Emirates	EME			0	
United Kingdom	AE	m	p	0	No
United States	AE	p	p	0	Automatic adjustment
Uruguay	EME	w	p	0	Unclear process
Uzbekistan	LIDC	p	w		Unclear process
Vanuatu	EME	0			
Venezuela	EME	w			Automatic adjustment
Vietnam	LIDC	m	0		No
West Bank and Gaza	EME			p	No
Yemen	LIDC			0	
Zambia	LIDC	w/0	0	0	No
Zimbabwe	LIDC	0	0	0	No

Source: IMF staff analysis and Balasundharam, Kayastha, and Poplawski-Ribeiro (Forthcoming).

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Online Annex 2.2 Estimating Dynamic Net Effects of Inflation Shocks on Fiscal Variables[2]

This Online Annex summarizes the data and methodology of the econometric exercises performed in the subsection "*Effects of Inflation on Public Finances Over the Medium Term*" of Section II.

Regression Model

To determine the *net* effect of inflation on public finance variables over the near and medium term in advanced and emerging market economies, the chapter estimates local projections of various inflationary shocks on fiscal aggregates (Jordà, 2005). The general estimation model is:

$$\hat{g}_{i,t+h} = \sum_{l=0}^{L} \beta_{l,h}\pi_{i,t-l} + \sum_{l=0}^{L} \beta_{L+l+1,h}x_{i,t-l} + \delta_{i,h} + \delta_{t,h} + \epsilon_{i,t,h}, \qquad \hat{g}_{i,t+h} \stackrel{\text{def}}{=} g_{i,t+h} - g_{i,t-1}$$

where g is a given fiscal outcome, π the inflation rate (either CPI or deflator), x other controls, δ fixed effects, and ϵ a potentially autocorrelated independent error term. Index i denotes countries, t time, $h = \{0, \dots, H\}$ the time horizon of the dependent variable, and l the lag on the regressors.

The fiscal outcomes considered are the overall balance, primary balance, cyclically-adjusted primary balance, tax revenue, primary expenditure, the interest bill, and debt, all in ratios to GDP, as well as the long-term outstanding sovereign bond rate in percent. In addition, the model is also estimated for revenue and expenditure sub-items in log nominal terms, which permits to compare the growth rates of variables with different GDP shares.

The regression is estimated using both FE-OLS regressions, which are useful at capturing all sources of inflation, as well as instrumental variable regressions, which allow to better isolate the direct effects of a given inflationary shock. Instrumenting also mitigates reverse causality, such as fiscal policy affecting inflation. The main instrument used for CPI inflation shocks is the change in the price growth of the commodity import basket, further interacted with an exchange rate peg dummy (lagged). The intuition is that commodity price shocks tend to pass through to overall inflation, but more so in more flexible exchange rate regimes, where the exchange rate tends to depreciate when commodity import prices rise. This instrumental variable approach filters out domestic shocks.

The first stage of the IV regression is given by:

$$\pi_{i,t} = \beta_1 c_{i,t} + \beta_2 c_{i,t} * peg_{i,t-1} + \beta_3 peg_{i,t-1} + \epsilon_{i,t},$$

where peg is a dummy variable equal to one if the country's exchange rate is fully pegged, and c is the growth in the commodity import price index weighed by GDP:

$$c_{i,t} = \sum_{j=1}^{J} \left(\Delta p_{j,t} \, \frac{1}{3} \sum_{l=1}^{3} \frac{m_{i,j,t-l}}{y_{i,t-l}} \right),$$

[2] This Online Annex was prepared by Daniel Garcia-Macia, based on Garcia-Macia (Forthcoming), with assistance from Zhonghao Wei.

where p_j is the global price of commodity j, $m_{i,j}$ the imports of commodity j by country i, and y_i is country i's GDP. The commodity weight is calculated based on the average commodity import GDP shares over the previous 3 years (Gruss and Kebhaj 2019).
Local projections are in addition estimated decomposing inflation (GDP deflator growth) into surprise and expected components. Expected inflation is defined as the one-year-ahead forecast made as of one year ago. Surprise inflation equals realized minus expected inflation. The two inflation components (surprise and expected) are included as regressors in the same local projection regression, and their respective coefficients analyzed.

Data

The estimation uses long-ranging annual data (1962–2019) from FAD's Public Finances in Modern History database, as well as highly disaggregated quarterly data from the first quarter of 1999 to the fourth quarter of 2019 from International Financial Statistics. Data for inflation forecasts and surprises are obtained from the World Economic Outlook.[3]

The annual sample includes 85 advanced and emerging market economies (after excluding economies with a population below 1 million people). Observations where inflation is above 30 percent in absolute terms, or where the original data source complied in the FAD database changed, are also excluded. The quarterly sample includes 28 advanced economies (Online Annex Table 2.2.1). Online Annex Table 2.2.2 presents summary statistics for the variables included in the regression analysis with quarterly and annual data, respectively.

While the annual data permit to study medium-term responses and extend the analysis to advanced economies before the Great Moderation period—when inflation was higher, more volatile, and more persistent—, as well as to emerging market economies, the quarterly data allow to capture the immediate or automatic effects of inflation on fiscal variables before policies have time to react.

Online Annex Table 2.2.1. List of Countries in the Sample

Group	Countries	Frequency	
		Annual	Quarterly
Advanced Economies	Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Portugal, Slovak Republic, Slovenia, Spain, Sweden, United Kingdom, United States	X	X
	Hong Kong SAR, Israel, Japan, Korea, New Zealand, Switzerland	X	
	Cyprus, Iceland, Latvia, Lithuania, Luxembourg, Malta		X
Emerging Market Economies	Albania, Algeria, Angola, Argentina, Azerbaijan, Bahrain, Bolivia, Brazil, Bulgaria, Chile, China, Colombia, Costa Rica, Croatia, Dominican Republic, Ecuador, El Salvador, Equatorial Guinea, Gabon, Georgia, Guatemala, Hungary, India, Indonesia, Iran, Jamaica, Jordan, Kuwait, Lebanon, North Macedonia, Malaysia, Mexico, Mongolia, Morocco, Namibia, Oman, Pakistan, Panama, Paraguay, Peru, Philippines, Poland, Qatar, Romania, Russia, Saudi Arabia, South Africa, Sri Lanka, Eswatini, Thailand, Trinidad and Tobago, Tunisia, Türkiye, United Arab Emirates, Ukraine, Uruguay, Venezuela	X	

Source: IMF staff calculations.

[3] A few additional variables are obtained from other sources, including the commodity price index (Gruss and Kebhaj 2019), exchange rate regime (Ilzetzki and others 2019), and country income groups (World Economic Outlook).

Online Annex Table 2.2.2. Summary Statistics

Quarterly Data (1999–2019)

Variables	Mean	Median	Standard deviation	25th percentile	75th percentile	Obs.
CPI inflation (annualized, percent)	2.3	2.0	3.6	0.2	4.0	2,508
Overall balance (percent of GDP)	-2.4	-2.0	6.1	-5.4	0.9	2,508
Primary balance (percent of GDP)	0.2	0.4	5.9	-2.7	3.2	2,508
Cyclically-adjusted primary balance (percent of GDP)	0.0	0.3	4.8	-2.2	2.7	2,417
Tax revenue (percent of GDP)	27.0	25.3	8.9	21.2	29.6	2,508
Primary expenditure (percent of GDP)	43.0	41.5	12.2	36.8	47.2	2,508
Interest Expense (percent of GDP)	2.6	2.2	2.0	1.3	3.3	2,508
Long-term Sovereign Bond Effective Rate (percent)	3.8	3.9	2.3	2.2	4.8	2,056
Real GDP growth (quarterly, percent)	0.5	0.6	2.2	0.1	1.1	2,508
GDP Deflator growth (annualized, percent)	2.4	2.0	4.5	0.4	4.0	2,428
Tax Revenue (nominal growth, quarterly, percent)	1.1	2.0	16.2	-6.5	10.2	2,508
Income and Profit Tax Revenue (nominal growth, quarterly, percent)	1.1	2.0	26.6	-12.1	13.5	2,479
Total Expenditure (nominal growth, quarterly, percent)	1.1	1.3	13.6	-4.7	7.9	2,508
Compensation of Employees (nominal growth, quarterly, percent)	1.1	1.0	13.2	-3.1	5.9	2,508
Expenditure in Goods and Services (nominal growth, quarterly, percent)	1.1	2.0	23.1	-7.7	11.7	2,508
Capital Expenditure (nominal growth, quarterly, percent)	1.1	0.8	6.6	0.1	1.6	2,508
Subsidies (nominal growth, quarterly, percent)	1.4	0.7	41.2	-9.1	12.6	2,493
Social Benefits and Transfers (nominal growth, quarterly, percent)	1.2	1.1	10.3	-2.1	4.9	2,508
Interest Expense (nominal growth, quarterly, percent)	-0.1	0.0	29.8	-5.4	5.0	2,506
Commodity Import Price Index Growth (quarterly, percent)	0.1	0.1	1.1	-0.2	0.5	2,508
Exchange Rate Regime Dummy (Peg=1)	0.7	1.0	0.5	0.0	1.0	2,508

Annual Data (1962-2019)

Variables	Mean	Median	Standard deviation	25th percentile	75th percentile	Obs.
Overall balance (percent of GDP)	-2.8	-2.3	16.5	-4.4	0.0	3,178
Government debt (percent of GDP)	47.8	41.1	33.5	23.7	62.3	3,136
Interest bill (percent of GDP)	2.7	2.1	2.4	1.0	3.5	3,178
Primary expenditure (percent of GDP)	30.1	28.9	19.8	19.5	39.1	3,178
GDP Deflator Growth (percent)	6.1	4.3	6.7	1.9	8.7	3,178
Real GDP growth rate (percent)	3.8	3.5	5.4	1.8	5.6	3,178

Source: IMF staff calculations.
Note: Quarterly data covers the period from the first quarter of 1999 to the fourth quarter of 2019.

Estimation

The preferred approach varies for the quarterly and annual datasets. The regressions with annual data are estimated using FE-OLS, since all instruments are weak at the annual frequency, and use GDP deflator growth as the inflation measure, since it is better at capturing the denominator channel, key for debt dynamics. Real GDP growth is added to control for the business cycle. The number of lags included for inflation is based on statistical significance, resulting in $L = 0$ for the quarterly sample and $L = 1$ for the annual sample.

The regressions decomposing inflation into surprise and expected components (Figure 2.4) are based on one-year-ahead GDP deflator growth projections from the World Economic Outlook as of the October vintage of the preceding year. The surprise is the difference between the historical deflator growth recorded in the October 2022 vintage and the projection.[4]

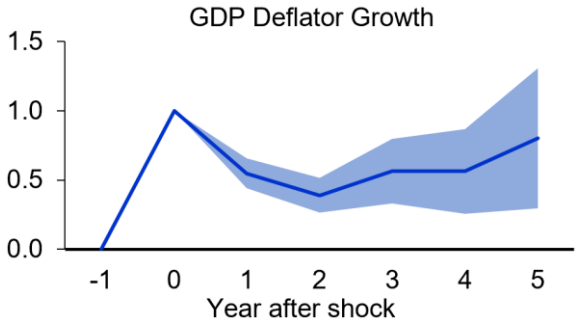
Robustness and Additional Tests

Below are additional figures whose results are referenced in the main text. Online Annex Figure 2.2.1 shows the average path of GDP deflator growth after a 1 percentage point increase in the same variable

[4] As a robustness check, the regressions are also run using CPI inflation instead of deflator growth projections. While in general the reduction in debt is smaller from shocks to CPI growth than to deflator growth (because CPI inflation is less correlated with the nominal GDP denominator), the result that inflation surprises are the only component reducing debt in the medium term remains.

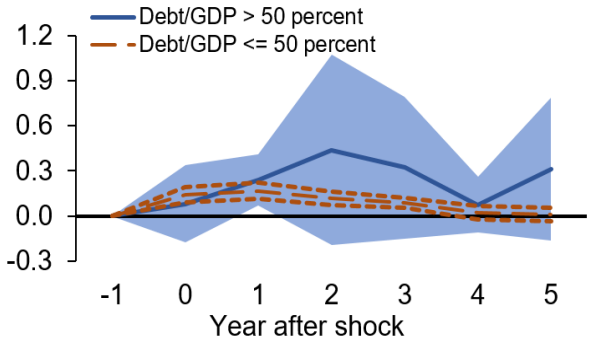
(reference in the main text Footnote 9). Online Annex Figure 2.2.2 replicates Figure 2.3 (b) splitting the sample by initial debt level. It shows that the response of the overall balance is statistically similar regardless of the debt level. Online Annex Figure 2.2.3 also uses the same regression approach as Figure 2.3 (b) but comparing advanced and emerging market economies and showing other key fiscal variables. The debt and overall balance responses are similar between the two groups, with slightly more positive effects of inflation in advanced economies. However, the interest bill does not climb with inflation in emerging markets, as interest payments on foreign currency debt (more common in emerging markets) decline as a share of domestic GDP in countries with fixed exchange rates. Online Annex Figure 2.2.4 confirms that inflation reduces debt more in countries with a fixed exchange rate, as they avoid an increase in the domestic value of foreign-currency debt. Finally, comparing advanced economies before and during the implementation of inflation targeting by many central banks in advanced economies (1962-1991 and 1992-2019, respectively) shows that inflation helped reduce debt less in the earlier period, when inflation came less as a surprise (not plotted, but available upon request).[5]

Online Annex Figure 2.2.1. Spike in the GDP Deflator Growth Rate, 1962–2019
(Percentage points)



Source: IMF staff estimations using data from Public Finances in Modern History database and World Economic Outlook.
Note: FE-OLS regressions using the GDP deflator as inflation indicator and including 85 countries. Countries with population below 1 million in 2019 are excluded, as well as observations with annual GDP deflator inflation higher than 30 percent in absolute terms, or where the original data source changes. The chart plots a 90 percent confidence band, with standard errors clustered at the country level.

Online Annex Figure 2.2.2. Response of Overall Balance to a 1 Percentage Point GDP Deflator Shock, 1962–2019
(Percent of GDP)



Source: IMF staff estimations using data from Public Finances in Modern History database and World Economic Outlook.
Note: FE-OLS regressions using the GDP deflator as inflation indicator and including 85 countries. Countries with population below 1 million in 2019 are excluded, as well as observations with annual GDP deflator inflation higher than 30

[5] Results are also robust to excluding country-year observations of debt restructurings with face value reductions, using the dating from Asonuma, Niepelt, and Ranciere (2023) and April 2023 *World Economic Outlook*, Chapter 3.

percent in absolute terms, or where the original data source changes. The chart plots a 90 percent confidence band, with standard errors clustered at the country level.

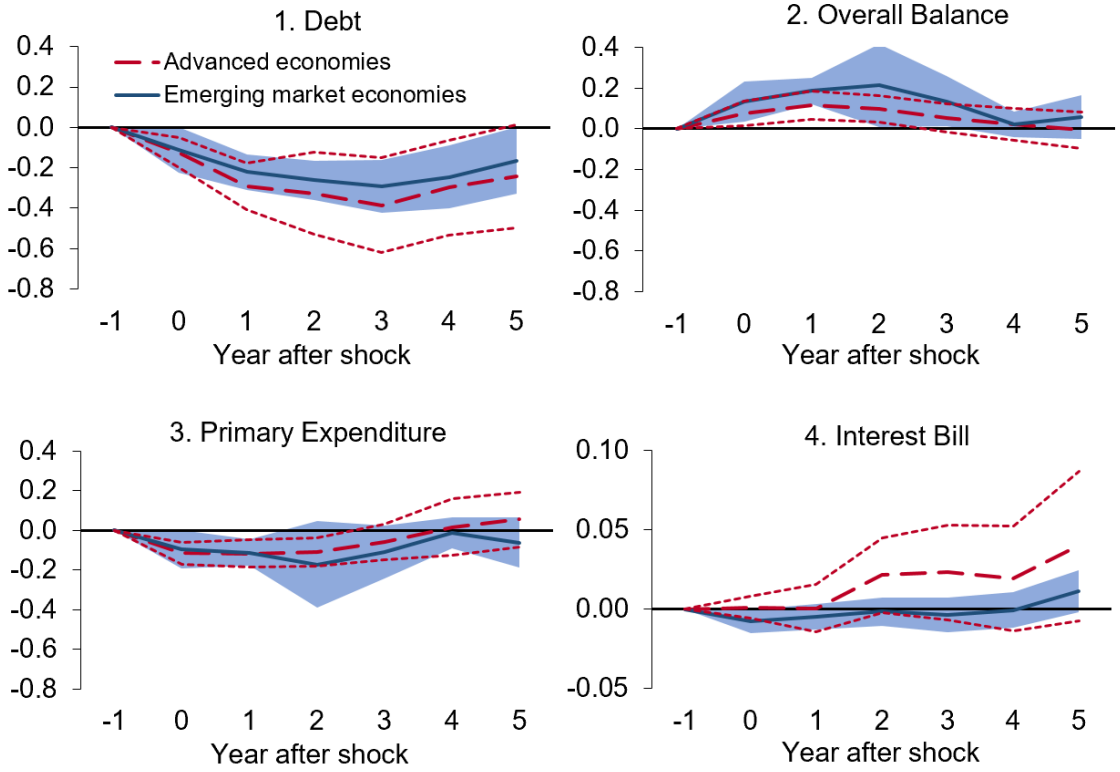
Online Annex Table 2.2.3. Impact of CPI Inflation Spikes in Initial Quarter, 1999–2019

	CPI inflation		Overall Balance		Primary Bal.		Revenue		Primary Exp.		Interest Expense	
	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS
Slope Coefficient	0.73	1.04	0.37	-0.23	0.37	-0.18	-0.08	-0.07	-0.53	0.18	0.00	0.05
p value	0.00	0.00	0.09	0.10	0.10	0.22	0.68	0.33	0.02	0.09	0.97	0.15

Sources: IMF staff estimations based on data from Gruss and Kebhaj (2019), Ilzetzki and others (2019), International Financial Statistics, and World Economic Outlook database.
Note: Fiscal variables are in percent of GDP. The data cover the period from the first quarter of 1999 to the fourth quarter of 2019, excluding the COVID-19 period. Both regressions control for quarter indicator variables (to absorb seasonality) and country and year fixed effects. OLS regressions also control for real GDP growth. P values below 0.10 indicate significant results at the 10 percent confidence level.

Online Annex Figure 2.2.3. Response to a 1 Percentage Point GDP Deflator Shock

(Percent of GDP)



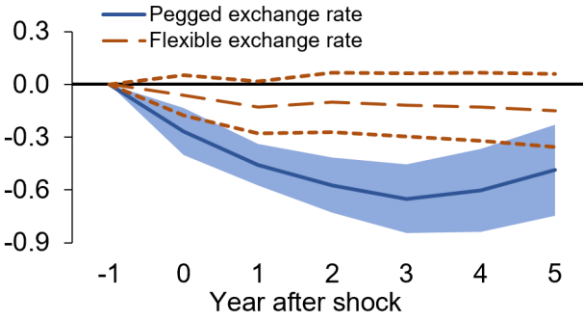
Sources: Public Finances in Modern History and World Economic Outlook.
Note: Fixed effects-ordinary least squares (FE-OLS) regressions. Observations with annual inflation higher than 30 percent in absolute terms (representing about 5 percent of the sample), or where the original data source changes, are excluded. Controls include real GDP growth, lagged inflation, and country and year fixed effects. The charts plot 90 percent confidence bands (blue shaded areas and short-dashed lines), with standard errors clustered at the country level.

Quarterly regressions instead are estimated with the instrumental variable approach described above, with CPI as the inflation measure. Comparing IV and OLS estimates for the quarter of the CPI inflation shock shows that the latter might suffer from reverse causality in the quarterly data, as primary expenditure is positively associated with inflation in the OLS regressions, but negatively in the IV regression (Table 2.2.4). The instrument is found to be strong and not significantly correlated with real GDP growth.

Moreover, global commodity prices do not appear to be driven by domestic developments in individual advanced economies—excluding the three largest advanced economies does not significantly alter the results. Yet, direct effects of commodity import price changes on fiscal variables (e.g., through import tariffs) cannot be fully ruled out, and so the results are also presented for disaggregated budget components.[6] Quarterly regressions include quarter indicator variables to control for seasonality.

Online Annex Figure 2.2.4. Response of Debt to a 1 Percentage Point GDP Deflator Shock

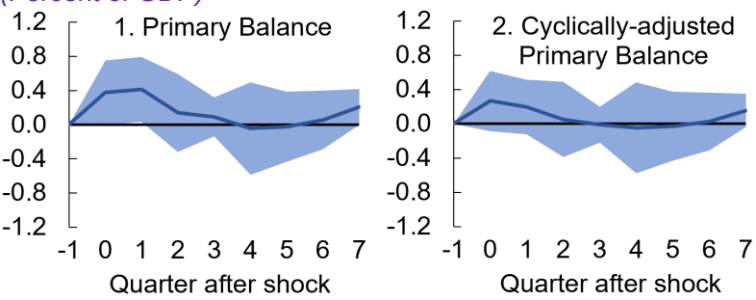
(Percent of GDP)



Sources: Ilzetzki and others (2019), Public Finances in Modern History, and World Economic Outlook.
Note: Fixed effects-ordinary least squares (FE-OLS) regressions. Observations with annual inflation higher than 30 percent in absolute terms (representing about 5 percent of the sample), or where the original data source changes, are excluded. Controls include real GDP growth, lagged inflation, and country and year fixed effects. Pegged exchange rate regimes include de jure and de facto pegs (Ilzetzki and others, 2019). The charts plot 90 percent confidence bands (blue shaded areas and short-dashed lines), with standard errors clustered at the country level.

Online Annex Figure 2.2.5. Estimated Initial Gains in Fiscal Balances from CPI Inflation Spikes, 1999–2019

(Percent of GDP)



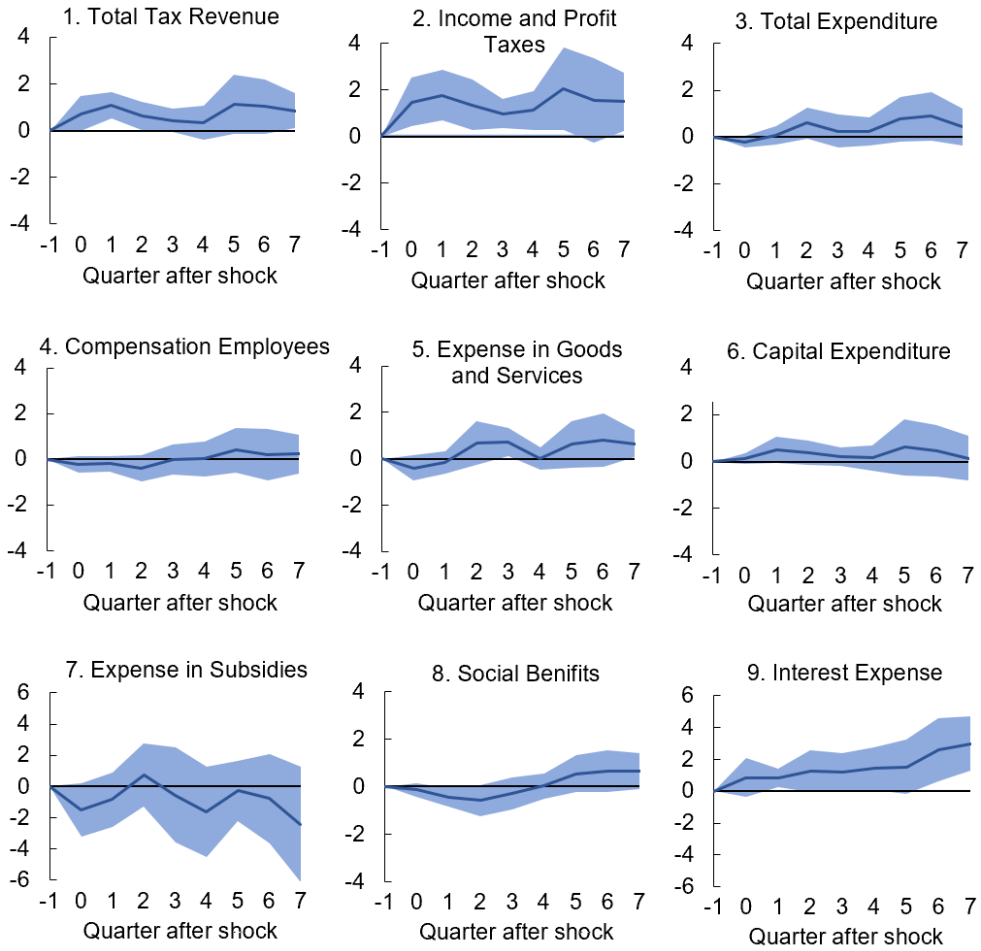
Sources: IMF staff estimations based on data from Gruss and Kebhaj (2019), Ilzetzki and others (2019), International Financial Statistics, and World Economic Outlook database.
Note: The data cover the period from the first quarter of 1999 to the fourth quarter of 2019, excluding the COVID-19 period is excluded. IV regressions, controlling for quarter indicator variables (for seasonality), and country and year fixed effects. The charts plot the average impulse response (solid blue lines) and the 90 percent confidence bands (blue shaded areas), with standard errors clustered at the country level.

[6] Other instruments have been tested, such as trading partner demand growth—an instrument associated with domestic demand growth. Although the results are qualitatively similar, they turned out to be highly correlated with real GDP. US inflation (interacted with countries' trade exposure to the *United States*) turned out to also be a valid instrument, yielding similar fiscal responses but less precisely estimated. Global value chain distress (Federal Reserve Bank of New York, Global Supply Chain Pressure Index, https://www.newyorkfed.org/research/gscpi.html) was also tested, but proved to be a weak instrument once included simultaneously with commodity import prices. Carrière-Swallow and others (2023) obtain a significant and persistent impact of global shipping costs on inflation in a regression without time fixed effects.

Online Annex Figure 2.2.5 extends Figure 2.5 to show the response of the primary and cyclically adjusted primary balances. Like with the overall balance, inflation spikes lead to an initial improvement in both measures of the balance, but the response is slightly attenuated for the cyclically adjusted primary balance. Online Annex Figure 2.2.6 also uses the same sample and estimation approach as Figure (2.5) but shows sub-components of revenue and spending. Unlike in Figure 2.5, the subcomponents are shown in log nominal terms, so the cumulative impulse response functions show percentual growth rates relative to period $t-1$.

Online Annex Figure 2.2.6. Estimated Initial Gains in Fiscal Balances from CPI Inflation Spikes, Sub-Items, 1999–2019

(Percent)



Sources: IMF staff estimations based on data from Gruss and Kebhaj (2019), Ilzetzki and others (2019), International Financial Statistics, and World Economic Outlook database.
Note: All variables are in log nominal terms. The data cover the period from the first quarter of 1999 to the fourth quarter of 2019, excluding the COVID-19 period. Fixed effects-two stage least squares (FE-2SLS) using instrumental variables and controlling for quarter indicator variables (to absorb seasonality), and country and year fixed effects. The charts plot the average impulse response function (solid blue lines) and the 90 percent confidence bands (blue shaded areas), with standard errors clustered at the country level.

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Online Annex 2.3. The Redistributive Impact of Inflation[7]

This Online Annex summarizes the methodology employed in the analyses of the chapter section entitled "*Distributive Effects of Inflation and Fiscal Policy Support*." The sharp increase in inflation could have important distributional aspects, potentially affecting medium term economic growth.

Building on existing literature, the annex identifies the effect of inflation on household financial resources through three channels: consumption basket, income, and wealth. The *consumption basket channel* captures how inflation influences households' consumption baskets, comparing the basket specific inflation with the economy wide inflation. The *income channel* and the *wealth channel* capture the changes in the real values of income and wealth respectively, accounting for the effect that inflation has on these variables. Following the approach of Cardoso and others (2022), this annex examines the distributional impact of inflation in six countries chosen among LICs (*Kenya* and *Senegal*), emerging economies (*Colombia* and *Mexico*) and advanced economies (*Finland* and *France*). The selected countries also represent a mix of countries with respect to past inflation histories, commodity exporter/importer status, and availability and use of mortgage and other household credit markets.

Formally, the consumption basket, income, and wealth channels can be identified as follows. C_0^h, Y_0^h and W_0^h are respectively household expenditures, income and wealth at the beginning of the observation period. $C_{1,\pi>0}^h$, $Y_{1,\pi>0}^h$ and $W_{1,\pi>0}^h$ are the real value (inflation discounted) of these variables at a subsequent point in time in the event of an inflationary shock of size $\pi > 0$. $C_{1,\pi=0}^h$, $Y_{1,\pi=0}^h$ and $W_{1,\pi=0}^h$ are the values of household consumption, income and wealth at the same at point time, in absence of inflation. π_h is the rate of inflation faced by household *h* keeping its consumption basket constant, and α and i are the nominal growth rate of income and wealth. We can show that:

$$W_{1,\pi>0}^h = Y_{1,\pi>0}^h - C_{1,\pi>0}^h + \frac{W_0^h(1+i_{\pi>0})}{1+\pi}$$
$$= \frac{Y_0^h(1+\alpha_{\pi>0})}{1+\pi} - \frac{C_0^h(1+\pi_h)}{1+\pi} + \frac{W_0^h(1+i_{\pi>0})}{1+\pi} \quad (1)$$
$$W_{1,\pi=0}^h = Y_{1,\pi=0}^h - C_{1,\pi=0}^h + W_0^h(1+i_{\pi=0})$$
$$= Y_0^h(1+\alpha_{\pi=0}) - C_0^h + W_0^h(1+i_{\pi=0}) \quad (2)$$

Combining (1) and (2) allow to quantity the effect of inflation on household net wealth.

$$W_{1,\pi>0}^h - W_{1,\pi=0}^h$$
$$= \left[\frac{Y_0^h(1+\alpha_{\pi>0})}{1+\pi} - Y_0^h(1+\alpha_{\pi=0})\right] - \left[\frac{C_0^h(1+\pi_h)}{1+\pi} - C_0^h\right]$$
$$+ \left[\frac{W_0^h(1+i_{\pi>0})}{1+\pi} - W_0^h(1+i_{\pi=0})\right] \quad (3)$$

[7] This Online Annex was prepared by Julieth Pico Mejia and Alberto Tumino with support from Kardelen Cicek.

$$= \left[\frac{Y_0^h(\alpha_{\pi>0} - \alpha_{\pi=0} - \pi(1+\alpha_{\pi=0}))}{1+\pi}\right] - \left[\frac{C_0^h(\pi_h - \pi)}{1+\pi}\right] + \left[\frac{W_0^h\left(i_{\pi>0} - i_{\pi=0} - \pi(1+i_{\pi=0})\right)}{1+\pi}\right] \quad (4)$$

The effect of inflation on the household well-being is given by the sum of the income, consumption basket, and wealth effects. Changes in real wealth equal to the sum of changes in the real value of savings (income minus consumption) and in the real value of pre-existing wealth. The term in the first parenthesis captures the income effect. If the change in income is greater than the headline inflation, the income effect will be positive. The term in the second parenthesis captures the consumption basket effect. This effect is negative for those households for which household inflation is greater than the headline inflation. Finally, the third parenthesis captures the wealth effect. This effect is positive for net debtors, as inflation decreases the real value of the debt, and for assets whose value grow enough to overcome the loss in real value due to inflation.

The exercise focuses on the observed inflation from the second quarter of 2021 to the second quarter of 2022. It considers two scenarios, one in which financial resources remain constant in nominal terms, and another in which inflation can cause changes in income and wealth. At one extreme, we analyze a scenario in which $\alpha_{\pi>0} = \alpha_{\pi=0} = 0$ and $i_{\pi>0} = i_{\pi=0} = 0$.[8] Keeping constant income and wealth in nominal term at their observed baseline value, the scenario provides a "day after" assessment of a surprise inflationary shock, i.e., before income and wealth could react to the shock. In this scenario, equation (4) would take the following form:

$$W_{1,\pi>0}^h - W_{1,\pi=0}^h = \left[-\frac{Y_0^h\pi}{1+\pi}\right] + \left[\frac{C_0^h(\pi-\pi_h)}{1+\pi}\right] + \left[-\frac{W_0^h\pi}{1+\pi}\right] \quad (5)$$

The second scenario assumes that $\alpha_{\pi>0} \neq 0, i_{\pi>0} \neq 0, \alpha_{\pi=0} = 0, i_{\pi=0} = 0$, i.e., that the entire change in income and wealth observed from the second quarter of 2021 to the second quarter of 2022 is solely due to the reaction of these variables to inflation shocks. With positive growth rates of income and wealth, this is a scenario which minimize the effect of inflation on household financial resources.

$$W_{1,\pi>0}^h - W_{1,\pi=0}^h = \left[\frac{Y_0^h(\alpha_{\pi>0} - \pi)}{1+\pi}\right] + \left[\frac{C_0^h(\pi-\pi_h)}{1+\pi}\right] + \left[\frac{W_0^h(i_{\pi>0} - \pi)}{1+\pi}\right] \quad (6)$$

In both scenarios, labor supply and consumption preferences of agents remain constant. The analyses draw on a rich set of statistics and household microdata to simulate the effect of the inflation observed from the second quarter of 2021to the second quarter of 2022 on household financial resources. Data from the OECD and from the National Statistical Offices (NSOs) of non-OECD countries provide information on price changes by the Classification of Individual Consumption by Purpose (COICOP) consumption category occurred in the period of interest. Applied to household level microdata on consumption and households' financial circumstances, the price increases data allows to simulate the impact of inflation on household expenditures. In particular, the analysis employs data from the

[8] For small enough values of $\alpha_{\pi=0}$ and $i_{\pi=0}$, this scenario can be generalized to any case in which $\alpha_{\pi>0} = \alpha_{\pi=0}$ and $i_{\pi>0} = i_{\pi=0}$.

Colombia National Household Budget Survey 2016-2017; and the Financial Inclusion Module of the Colombia Great Integrated Household Survey (GEIH), 2017; Mexico National Survey of Household Income and Expenditure, 2018; Harmonized Survey on Household Living Standards 2018-2019 for *Senegal*. For *Kenya*, the study uses data from the Kenya Integrated Household Budget Survey 2016, while for *France* and *Finland* data from 2018 and 2017 the European Statistics on Income and Living Conditions (EU-SILC) respectively, used with the tax-benefits microsimulation model EUROMOD, the 2015 EU Household Budget Survey as well as the 2017 Household Finance and Consumption Survey (HFCS) are used, jointly with tabulated data on income, consumption, and net wealth available on the EUROSTAT website (experimental statistics).[9]

To assess the changes on the different income and wealth components, we use the changes observed in the period from the second quarter of 2021 to the second quarter of 2022. Statistics from EUROSTAT and NSOs of non-EU countries provides the growth rates of wages from the second quarter of 2021 to the second quarter of 2022, by industry ($\alpha_{\pi>0}$)[10]. The analysis assumes that the nominal value of social transfers remains constant, and for all countries except *Kenya* and *Senegal*, old-age pensions are indexed to inflation. The face values of old-age pensions in *Kenya* are held constant, and for *Senegal*, since old-age pensions are indexed to wage bill growth rather than inflation, we assume an increase of 1.8 percent corresponding to the growth rate of the wage bill. For financial data, the analysis employs statistics from the national central banks on return of fixed term deposits at various level of maturity for updating the monetary values of financial assets, while statistics on housing prices are used for changes in real estate values ($i_{\pi>0}$).[11] Mortgages and loans are assumed to keep their nominal value constant. The assumption of a fixed interest rate seems realistic for *France* and *Colombia*, where 96 and 90 percent of mortgages, respectively, are fixed-rate. For *Finland*, 98 percent of mortgages are variable-rate usually linked to the 12-month Euribor, whose variation during the period analyzed was only 0.8 percentage point.

Important to mention some caveats. First, when applying price increase to household consumption microdata, the analysis assumes that the consumption microdata reflects household consumption in the second quarter of 2021 and that the quantity of goods consumed is not affected by price changes (constant quantity). Second, this application focuses on liquid wealth rather than total net wealth given the challenges to obtain data on real assets and to map them with other household data and characteristics. Consistent with Cardoso and others (2022), liquid wealth is defined as liquid financial assets (e.g., deposits, stocks, bonds) minus all debt, including collateralized loans. (Yet, this annex also tries to overcome the second caveat and performs an analysis including real assets.). Third, data limitations do not allow to assess the wealth channel for *Mexico*, *Senegal*, and *Kenya*. Calculations will only focus on the income and consumption channels for these countries. Fourth, welfare quintiles for the distributional analysis are based on income in *Colombia*, *Mexico*, *Finland*, and *France*, and on consumption

[9] For EU countries, budget shares of COICOP categories are estimated by quintile of household disposable income and age of the household reference person and matched to EUROMOD output data based on the EU-SILC. The values of consumption are then adjusted uniformly to match the average propensity to consume by disposable income quintile derived from the EUROSTAT experimental statistics, published in its website. A similar procedure is applied to the wealth components, matching the EUROMOD output microdata to HFCS. Quintile points of market income rather than disposable income are used for the matching.

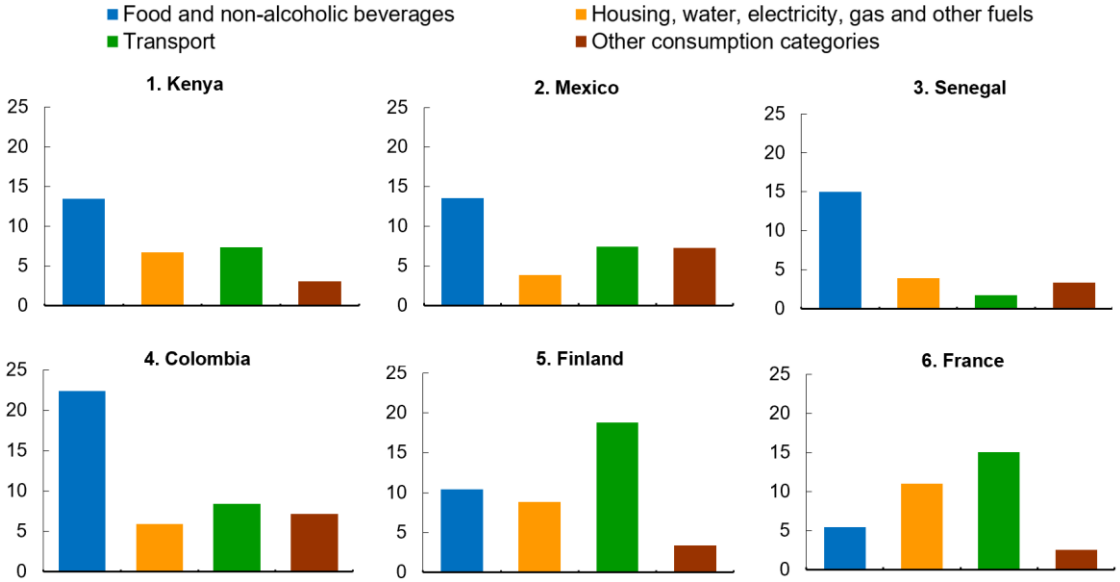
[10] For *Kenya*, we use the average wage growth for all employed people, as information about the industry in which each employed person works is not publicly available in the microdata.

[11] Changes in house prices are used in the scenario in which total net wealth is used to identify the wealth channel (See Online Annex Figure 2.3.3). In this analysis we focus on spending and not on consumption, so we do not include imputed income or own production as part of the consumption basket.

in the other countries. Fifth, for simplicity the analysis does not consider changes to personal income tax brackets (fiscal drag). Therefore, the results of the income channel could be slightly overestimated for the households jumping to the following tax bracket because of income change. Sixth, the analysis does not take into accounts the role of newly introduced/enhanced social benefits implemented in response to inflation.

All the analyzed countries experienced significant inflation from the second quarter of 2021 to the second quarter of 2022, although its composition and incidence varied across the income distribution. General inflation varied from 6.1 percent in *France* to 9.2 percent in *Colombia*. Prices of food-related products increased the most in *Colombia*, *Kenya*, *Mexico*, and *Senegal*, while energy products (COICOP categories "Transport" and "Housing, gas, water, and electricity") experienced the highest price increases in *France* and *Finland* (Online Annex Figure 2.3.1). The household level inflation, i.e., the increase in expenditures faced by households to keep unvaried their consumption basket, declines with income in *Colombia*, *Kenya*, *Mexico*, and *Senegal*, ranging from 9-10 percent at the bottom of the income distribution to 6-8 percent at the top.

Online Annex Figure 2.3.1. Changes in Prices Across Countries 2021–2022
(Percent)



Source: IMF staff calculations
Note: The period of analysis is from the second quarter of 2021 to the second quarter of 2022.

Online Annex Figure 2.3.2 shows that in *Kenya*, *Mexico*, and *Senegal*, the poorest households allocate 40 to 50 percent of their budget to food-related expenses, while these expenses represent 15 to 30 percent for the richest quintile. *Colombia* shows a similar, albeit smaller, pattern. The budget share of food products is almost constant across the different quintiles, around 10-15 percent, in *Finland* and *France*. In *Colombia*, *Finland*, and *France*, households dedicate a greater part of their budget to energy products. The poorest households dedicate around 40 percent of their budget to the consumption of products in the "Transportation" and "Housing, gas, water, and electricity" categories, while the richest dedicate only between 20 and 35 percent of their budget.

Combining the information from Online Annex Figures 2.3.1 and 2.3.2, we obtain the results presented in Figure 2.6. There, for example, the analysis shows that household level inflation is similar across income groups in *Finland* and *France* at 7 and 8 percent respectively (see Figure 2.6).

Moreover Cravino, Lan, and Levchenko (2020) show using measures of price stickiness derived by Nakamura and Steinsson (2008) that prices for goods and services making up a large share of the consumption basket of US middle-income households as of 2021 are usually less sticky and, during periods of general inflation, rise faster than the ones consumed by higher-income households (Table 2.3.1).

Online Annex Table 2.3.1. Expenditure Share Differences and, Frequency of Price Adjustment across Income Groups in the United States

Category	Income percentile		Difference	Regular price change
	40–60	Top 5		
Middle-class: Difference in the share of expenditures on the top five items in the consumption basket				
Gasoline (all types)	0.084	0.049	-0.035	87.71
Electricity	0.050	0.028	-0.022	38.14
Motor vehicle insurance	0.039	0.023	-0.016	8.16
Wireless telephone services	0.032	0.019	-0.013	13.00
Limited service meals and snacks	0.037	0.025	-0.012	6.13
Top 5 percent: Difference in the share of expenditures on the top five items in the consumption basket				
College tuition and fees	0.012	0.052	0.041	5.77
New vehicles	0.048	0.065	0.017	18.89
Club dues and fees for participant sports and group exercises	0.006	0.020	0.014	8.57
Other lodging away from home including hotels and motels	0.007	0.022	0.014	41.73
Airline fare	0.008	0.022	0.014	59.84

Source: IMF staff analysis based on Cravino, Lan, and Levchenko (2020); Nakamura and Steinsson (2008); and US Bureau of Labor Statistics.
Note: Price change frequency is the mean probability of price change in a month over 1988–2005.

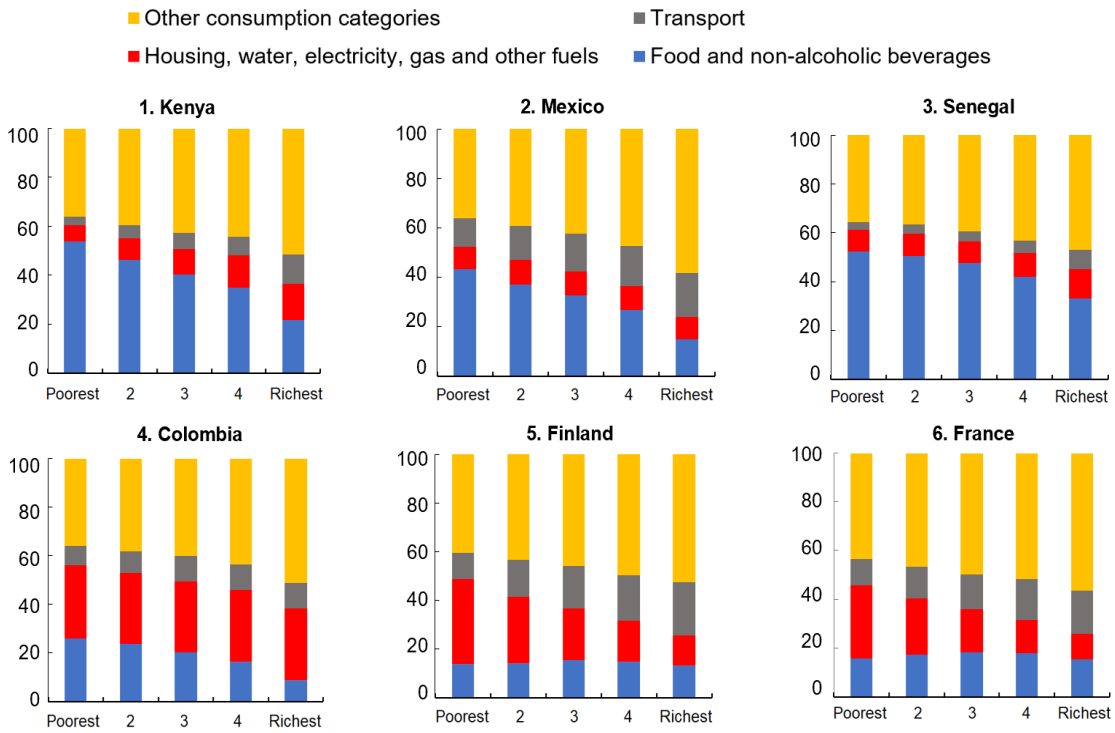
Online Annex Figure 2.3.3 shows the calculation of the wealth channel including not only liquid assets but also real assets, such as dwellings. The effects of changes in prices in real assets follow the same dynamics indicated in Equation (6) above. Moreover, since real assets, notably dwellings, correspond to a large share of assets for many households, the dynamics of their price may amplify the wealth effects for some countries. This is the case for *Finland* in our data. For that country, housing prices did not increase in the same pace as the overall inflation in the country, leading to a significant negative wealth effect on this exercise when real assets are considered.

Figure 2.8 in the main text reports the expected impact of inflation (observed baseline) on the poverty headcount, prior to new compensatory measures implemented by governments. To enhance country comparability, poverty rates are computed as the share of each country population whose household per capita income falls below the internationals poverty lines computed by the World Bank (LICs and emerging economies) and by Jolliffe and Beer Prydz (2016) for advanced economies. A poverty line of USD 3.65, expressed in 2017 Purchasing Power Parities (PPP), is used for *Kenya* and *Senegal*, a value of USD 6.85 in 2017 PPP is used for *Colombia* and *Mexico*, and a value of USD 21.7 in 2011 PPP is used in *France* and *Finland*. These values are converted into local currency and brought to values consistent with the year of the surveys by correcting for cumulative inflation. The income definition used for poverty

assessment includes labor income, public and private transfers (monetary and in-kind), pensions, investment income and rent (including imputed rents).[12]

Online Annex Figure 2.3.2. Budget Share in Microdata

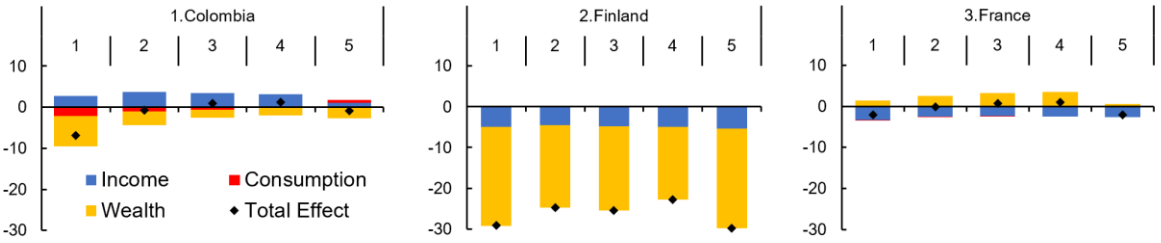
(Percent)



Source: IMF staff calculations

Online Annex Figure 2.3.3. Income, Consumption, and Wealth Channels Including Real Assets in 2021–2022

(Percent of household income)



Source: IMF staff calculations.
Note: The period of analysis is from the second quarter of 2021 to the second quarter of 2022.

[12] The process described is applied to all the countries analyzed and differs from the methodology commonly used by Eurostat for computing the at-risk-of-poverty rates in European countries. In Eurostat methodology, the at-risk-of-poverty rate is computed as the share of the population with an equivalized disposable below a threshold set at 60 percent of the median equivalized disposable income. The equivalized disposable income is computed as the total income of a household, after tax and other deductions, divided by the household size expressed in terms of equivalent adults according to the modified OECD equivalence scale. For more details, see https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:At-risk-of-poverty_rate.

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Online Annex 2.4. Disinflating and Distributing[13]

This Online Annex summarizes the methodology employed in the analyses of the chapter section entitled "*Disinflating and Distributing*."

A. Bayesian Panel Vector Autoregressive Model (VAR)

This subsection of Online Annex 2.4 discusses the first empirical exercise of that chapter section more in depth. A Bayesian Panel VAR encompassing 17 countries is estimated using sign restrictions.[14] We compare the average response of inflation in two sub-samples: before and after the mid-1980s to reflect changes in the economic and policy environment happening in many economies.

Methodology and Data

The Bayesian Panel VAR model is featured as follows:

$$A_{i0}\, X_{it} = B_{i0} + \sum_{l=1}^{q} B_{il}\, X_{it-l} + \epsilon_{it}, \quad (1)$$

where X_{it} is the vector of four endogenous variables for country i: log of real primary government expenditure, log of real GDP, CPI inflation, and log of real revenue. The framework is similar to Blanchard and Perotti (2002) with the addition of inflation. For other notations: q is the lag length;[15] B_{i0} represent deterministic terms; B_{il} is a 4×4 matrix of parameters; A_{i0} is a 4×4 matrix of parameters, capturing the contemporaneous relationships between the endogenous variables; and ϵ_{it} is a 4×4 vector of orthogonal structural shocks with a Gaussian distribution of mean zero and identity covariance matrix.[16]

The reduced-form representation implied by the structural model (1) is

$$X_{it} = C_{i0} + \sum_{l=1}^{q} C_{il} X_{t-l} + u_{it},$$

where $C_{i0} = A_{i0}^{-1} B_{i0}$, $C_{il} = A_{i0}^{-1} B_{il}$ and $u_{it} = A_{i0}^{-1} \epsilon_{it}$. The VAR model is estimated for different countries separately and then the estimates across them are averaged (see Pesaran and Smith 1995). For each country, Gibbs Sampling is used to draw the posterior distribution of VAR coefficients using the Normal-Wishart prior. There are 30,000 draws, out of which the first 20,000 are for burning. It is known that the reduced-form estimation does not provide enough information to identify even one column of A_{i0}, so additional restrictions/information are needed to identify the shock of interest. To overcome this,

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[13] This Online Annex was prepared by Anh Dinh Minh Nguyen and Carlos Eduardo Gonçalves with assistance from Zhonghao Wei.

[14] *Australia*, *Belgium*, *Canada*, *Finland*, *France*, *Germany*, *Italy*, *Ireland*, *Japan*, *Netherlands*, *Norway*, *Portugal*, *Spain*, *Sweden*, *Switzerland*, *United Kingdom*, and *United States*. *Denmark* is not included because it misses the revenue data from 1950–1953.

[15] The Panel VAR model uses two lags of endogenous variables. However, the results are robust with different lag structure.

[16] Deterministic terms and exogenous regressors are omitted from Equation (1) for notational brevity.

the chapter follows Canova and De Nicolo (2002), Uhlig (2005) and Rubio-Ramirez, Waggoner, and Zha (2010) and apply sign restrictions to identify a government expenditure shock.[17]

The main assumptions for the sign restrictions are standard, according to the literature (for example, Smets and Wouters 2007). Importantly, only sign restrictions on the contemporaneous responses are imposed and thus the data are left free to decide the size on impact as well as both the sign and the size in the following periods. A positive government expenditure shock leads to an increase in primary government expenditure and non-negative responses in output and prices. Aggregate demand and supply shocks are standard: the former leads to the same signs in the response of output and CPI as the expenditure shock, whereas the latter results in prices and quantities moving in opposite directions (similar to Gambetti and Musso 2017; and Barauskaite and others 2022).

Data

The main sources are the Jordà-Schularick-Taylor (henceforth, JST) Macrohistory database (Jordà, Schularick, Taylor, 2017), the IMF's Public Finances in Modern History, and WEO database. The sample for the baseline analysis is from 1950–2019. Primary government expenditure is not available from the JST database, so it is calculated using the additional information from the WEO database and Public Finances in Modern History. In one exercise, the sample is extended to include the 2020–2022 period in which the data for 2022 is the projected data from the WEO database (the October 2022 vintage). In the extended model with interest rate, the shadow rates from Bloomberg are used to capture unconventional monetary policy (covering *United States*, *Euro area*, *Japan*, *New Zealand*, *Canada*, and *Australia*).

Results and Robustness Tests

The baseline results for each sub-sample are presented in Figure 2.10. Different robustness checks are performed. First, extending the sample to cover the post-2019 period (2020–2022) leads to similar results, if anything the response is slightly larger when 2022 is included (Online Annex Figure 2.4.1). Second, the baseline model is extended to include short term interest rate to control for the endogenous response of monetary policy to fiscal shocks as well as to consider the monetary policy shock (Online Annex Figure 2.4.2.A). The latter is identified by assuming that a positive monetary policy shock raises interest rates while reduces output and inflation. Third, the identification is extended to control for a revenue shock by assuming that a positive revenue shock contemporaneously leads to an increase in revenue while a decrease in GDP, leading to a similar result (Figure 2.4.2.B). Regarding the impact of a revenue shock, the response of inflation is statistically insignificant in both sub-samples, echoing the results of Mertens and Ravn (2013).

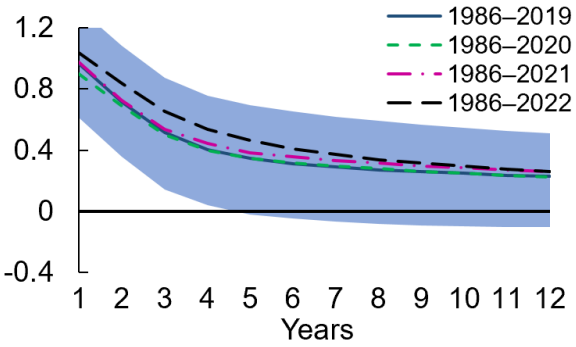
The results are also similar with different specifications: different lag structure (one lar or three lags), using price (instead of inflation), using growth instead of level in primary expenditure, GDP, and revenue, and using variables in per capita term for primary expenditure, GDP, and revenue. The similarity of the results of these robustness checks corroborates the findings.

[17] The Blanchard-Perotti identification is an alternative popular identification. However, it is not suitable for annual data while quarterly fiscal variables are not available for many countries over a long sample. The Ramey news military spending captures anticipated measures and is limited in term of country coverage. The narratives are available from the late 1970s and reflects mainly fiscal consolidation measures (see Guajardo and others 2014 or Alesina and others 2019). Having said that, extending the narratives further back to 1950 is a potential extension for future analysis.

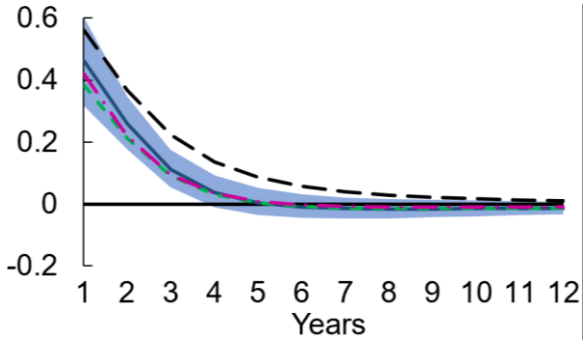
Online Annex Figure 2.4.1. Including the Post-2019 Period

(Percent for output; percentage point for inflation)

1. Output



2. Inflation

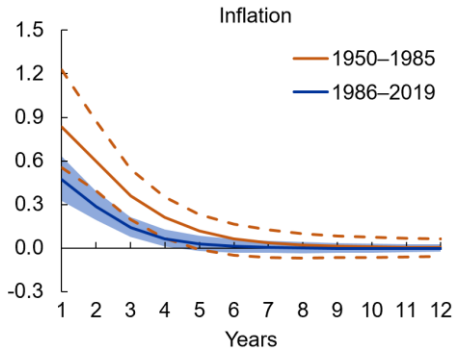


Source: IMF staff estimations based on data from the Public Finances in Modern History database; and Jordà, Schularick, and Taylor (2017).

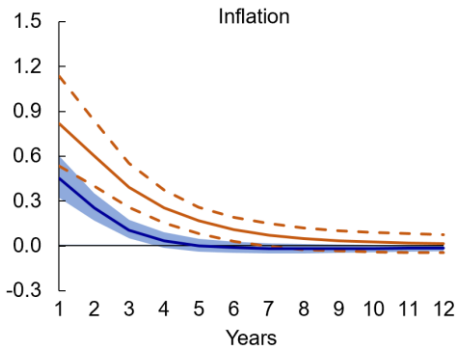
Online Annex Figure 2.4.2. Selected Robustness Checks, 1950–2019

(Percentage point)

1. Controlling for a monetary policy shock



2. Controlling for a revenue shock



Source: IMF staff estimations based on data from the Public Finances in Modern History; and Jordà, Schularick, and Taylor (2017).

B. Military News Shocks and Inflation in the US

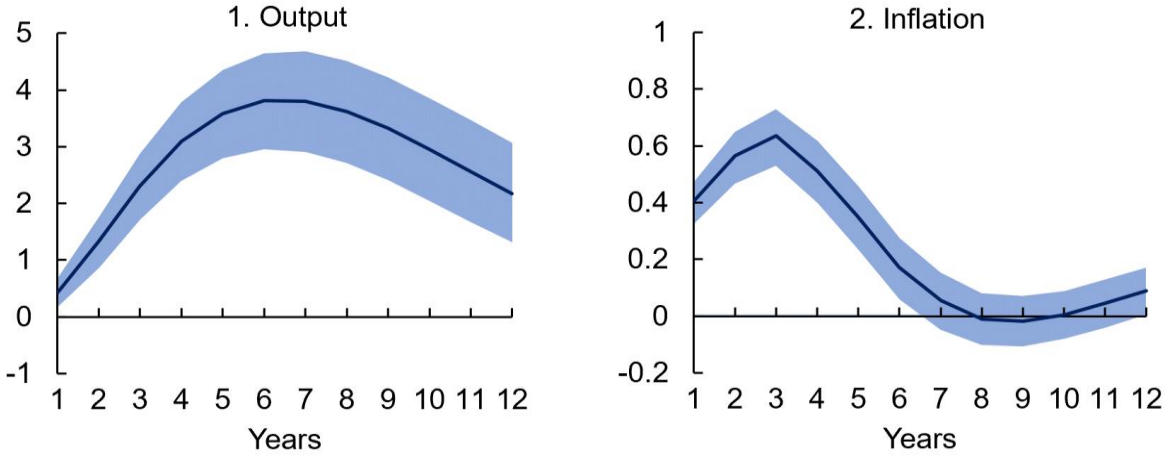
Figure 2.11 in the main text orders military spending news (as percent of nominal potential GDP) first, since shocks to that variable are the exogenous shock in a VAR (using Cholesky Decomposition as identification strategy), as in Ramey (2019). The intuition is that military spending increases are not directly associated with the state of the U.S. economy. Still, those expenses may push aggregated demand up leading to higher output (i.e., the fiscal multiplier) and inflation if there is no slack in the economy.

In addition to the Cholesky identification, another approach is to use a proxy (Bayesian) structural VAR (SVAR) in which the military news is used as an instrument to identify the government expenditure shock. The advantage of this method is that while it exploits the rich information set behind the narrative accounts, it is also robust to potential measurement errors (about the size and the timing of shocks). That is because it does not require a perfect correlation between the narrative measures and the latent structural tax shocks (see, Mertens and Ravn 2013; and Nguyen and others 2021).

The results from the proxy SVAR model are presented in Online Annex Figure 2.4.3. They again indicate an inflationary impact following an increase in government expenditures.

Online Annex Figure 2.4.3. Impact of Government Spending Shock on Inflation: A Proxy Bayesian SVAR, 1939–2015

(Percent for output; percentage point for inflation)



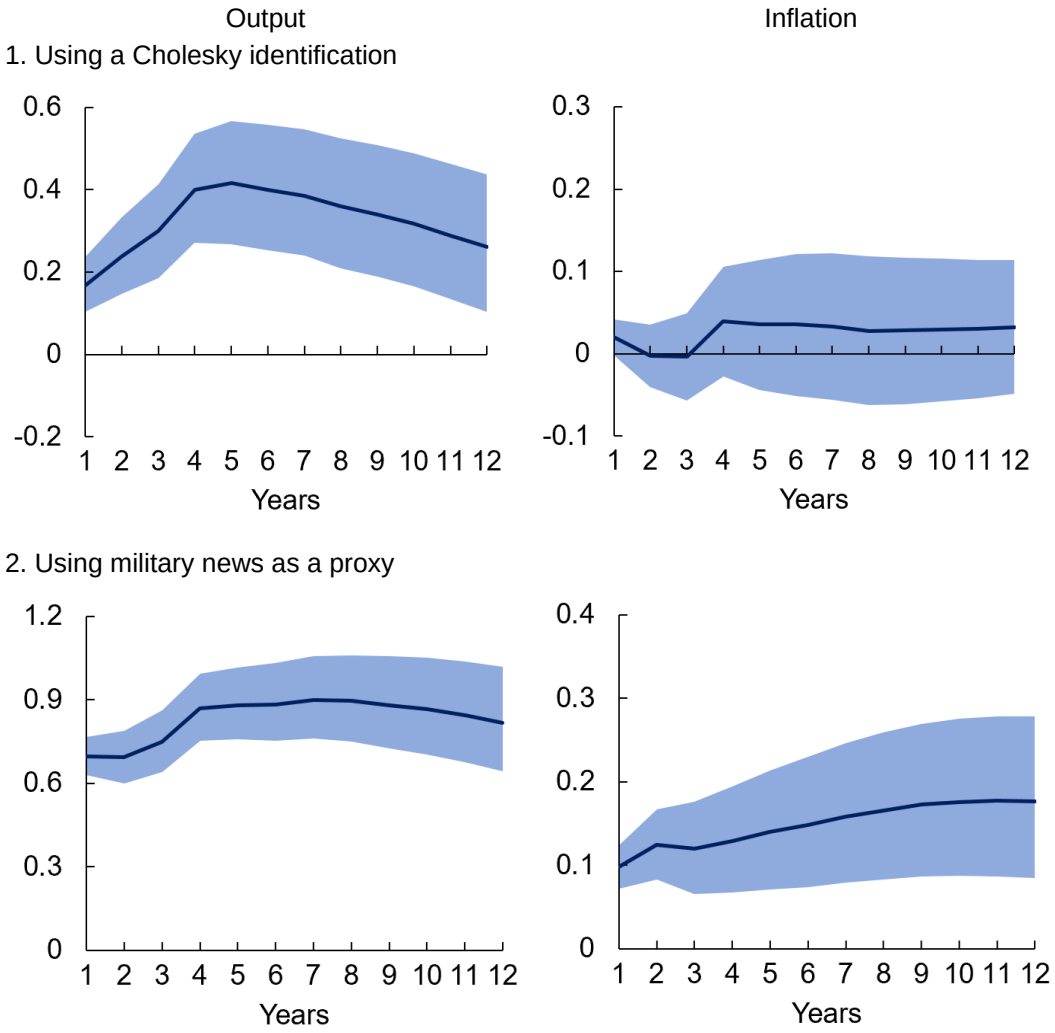
Source: IMF staff estimations. Notes: 68-percent credible intervals are plotted.
Note: The data cover the period from the first quarter of 1939 to the fourth quarter of 2015.

The proxy-SVAR specification treats the narrative dataset as imperfect measures of the latent government expenditure shocks. To evaluate how much information the narrative dataset contains about the latent structural shocks, we use a reliability measure as in Mertens and Ravn (2013). In the baseline benchmark specification, this passes significance levels. The correlation between the military news and the latent government spending shocks is 0.48. Such value indicates that the proxies contain useful information for the identification of the structural government expenditure shocks, and that there is a strong relation between the SVAR government spending shocks and the narrative military spending news.

A recent study suggests that prices do not increase in response to a positive government spending shock (Jørgensen and Ravn 2022), particularly in the post-Korean war sample. Estimations using Bayesian SVAR for the post-Korean war sample from the first quarter of 1960 to the fourth quarter of 2015 do **not** corroborate such findings. When the Cholesky identification by ranking the narrative on military spending news first is used, indeed the effect on prices vanishes. But using the proxy-based approach, which again is more robust to potential measurement errors, positive government spending shocks cause inflation to rise, as predicted by standard New Keynesian models (Online Annex Figure 2.4.4).

Online Annex Figure 2.4.4. Impact of Government Spending Shock on Inflation from a Proxy Bayesian SVAR, 1960–2015

(Percent for output; percentage point for inflation)



Source: IMF staff estimations.
Notes: 68-percent credible intervals are plotted. The sample covers the period from the first quarter of 1960 to the fourth quarter of 2015, so it excludes the World War II, and the Korean war from the analysis.

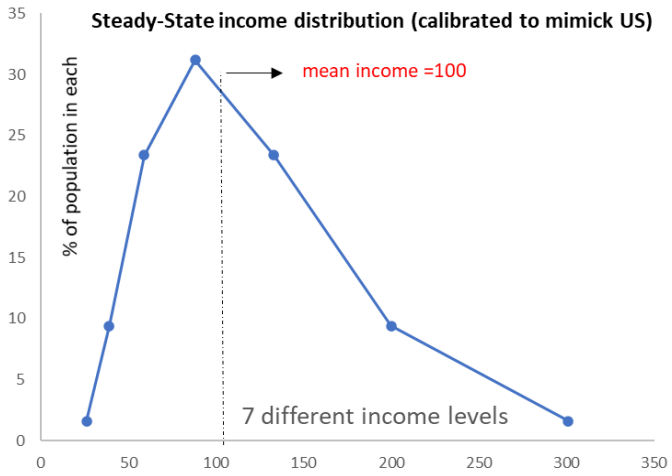
C. The Heterogeneous-Agents New Keynesian (HANK) model

The chapter also uses an heterogenous agents New Keynesian (HANK) model to analyze how fiscal policy could interact with monetary policy in the disinflation effort. This state-of-art class of models include a richer description of the households' income and wealth distribution. HANK models have been around at least since Aiyagari (1994), but only recently they have incorporated the typical features of the New-Keynesian tradition, as price and wage rigidities, which rendered them suitable to also analyze the implications of fiscal and monetary policy to the business cycle.

Beyond the richer illustration of households' income distribution (here calibrated for the United States; Online Annex Figure 2.4.5), the main ingredients of the standard HANK model are the following:[18] (i) *idiosyncratic income shocks that are not diversifiable*, with economic agents accumulating distinct levels of wealth; (ii) *incomplete markets*, leading to the rise of precautionary savings motive; (iii) *Taylor principle in the monetary policy*, with nominal interest rates increasing by more than inflation to bring it back to the central bank's target; (iv) *imperfect nominal adjustments in economic variables* and *imperfect competition*, implying that monetary and fiscal policies affect the business cycle; and (v) *no debt default*, with the government in the model acting to steer public debt back to its long-term level after large deviations.[19] The main conclusions are that inequality not only play an important role when trying to understand the impact of monetary policy; it also is greatly affected by it.

Another key feature of the model is the *no Ricardian equivalence*. Households with higher income hold assets that can be used during bad times to smooth out consumption. In the simplest version of the model (used in this Fiscal Monitor), these assets are government-issued bonds. Poor households hold only a tiny share of assets and would like to accumulate debt when the economy tanks; but they lack access to capital markets. The government always repays its maturing debt by taxing all individuals, but proportionally to their income. Since the well-off are the only ones carrying assets (bonds), they manage to smooth out their consumption better and indeed suffer the least when monetary policy is tightened.[20] Targeted transfers are very powerful in propping up demand because the lack of Ricardian Equivalence means the agents with higher marginal propensity to consume receive funds financed mostly by taxes paid by the rich (which have lower marginal propensity to consume)

Online Annex Figure 2.4.5. Income Distribution in the Economic Model Analyzed



Source: IMF staff calculations based on Auclert and others (2021).

[18] For all details of the model used with its equations, calibration and solution see Ghini, Nguyen, and Gonçalves (Forthcoming).

[19] In these models, variables always converge back to their steady state. So, there is no de-anchoring of inflation expectations, for example, since the monetary authority follows a Taylor rule. Yet, the dynamics of the convergence process and who ends up paying for it in terms of foregone consumption, for instance, does depend on the interaction of monetary and fiscal policy.

[20] In the model taxes are also transferred to bond holders who gain more when interest rates go up. In the real world, however, as interest rates rise, access to credit becomes even more difficult for the poor given the asymmetric information about bonds.

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