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Determinants of Inflation in Iran and Policies to Curb It

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Determinants of Inflation in Iran and Policies to Curb It
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ABSTRACT: High and volatile inflation has been an endemic economic and social issue in Iran that has contributed to rising poverty and social tensions. For policymakers to effectively address the inflation problem, it is critical to understand its causes. This paper seeks to contribute to this endeavor by applying a vector error-correction model to study the short- and long-term determinants of inflation in Iran over the past two decades and identify policy options to curb it. Using quarterly data spanning 2004-2021, it finds that money growth drives inflation only in the long term, while currency depreciation, fiscal deficits, and sanctions (proxied by oil exports) drive inflation both in the short- and the long term. In the absence of a removal of US trade and financial sanctions that could significantly boost the rial, budget deficits will have to be adjusted to contain inflation, albeit gradually to avoid hindering the recovery. Over the medium term, strengthening the inflation targeting framework could help improve monetary transmission and contain inflation durably.

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WORKING PAPERS

Determinants of Inflation in Iran and Policies to Curb It

Prepared by H. Elif Ture and Ali Reza Khazaei [1]

[1] H. Elif Ture (IMF) and Ali Reza Khazaei (IMF summer intern June-September 2021 and Shahid Beheshti University).

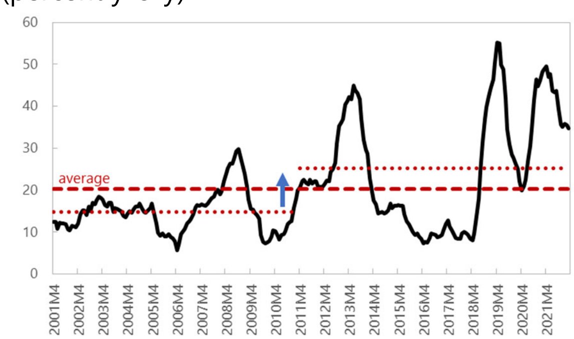
Contents

1. Introduction

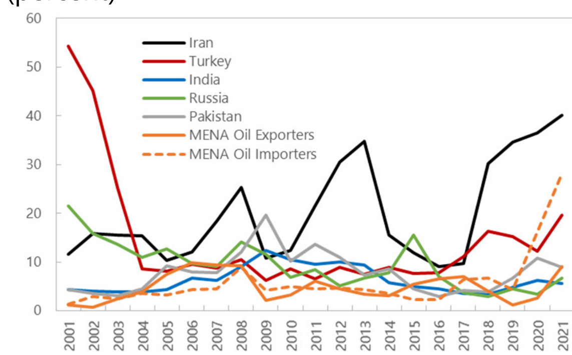
High and volatile inflation has been an endemic economic and social issue in Iran that has contributed to rising poverty and social tensions. Iran's CPI inflation has fluctuated sharply over the past two decades around its annual average of 20 percent (Figure 1.a.), and has been much higher than that of Iran's emerging market and regional peers (Figure 1.b.). With the COVID-19 pandemic hitting Iran's economy on top of preexisting U.S. trade and financial sanctions and exacerbating the supply constraints, annual CPI inflation reached nearly 50 percent at the end of FY 2020/21 (Iranian year 1399 that ended on March 20, 2021) and averaged 40 percent during FY 2021/22 (Iranian year 1400). Coupled with low economic growth and high unemployment, rising inflation has fueled widespread protests in the country amid a significant erosion in purchasing power.[1] The new government that took office in August 2021 identified tackling inflation as a key economic priority.[2]

Figure 1. Inflation in Iran and Its Peers

a. CPI inflation in Iran, 2001/2-21/22
(percent y-o-y)



b. CPI inflation in peers, 2001-21
(percent)



Source: Central Bank of Iran, Statistical Center of Iran, and IMF World Economic Outlook Database, April 2022.
MENA: Middle East and North Africa; Oil Exporters: Algeria, Bahrain, Iraq, Kuwait, Libya, Oman, Qatar, Saudi Arabia, United Arab Emirates, Yemen; Oil Importers: Egypt, Jordan, Lebanon, Morocco, West Bank and Gaza, Tunisia.

For policymakers to effectively address the inflation problem, it is critical to understand its causes. This paper studies the determinants of inflation in Iran to identify effective policies to fight it. Using a Vector Error Correction Model (VECM), the paper quantifies the short- and long-term impact of various domestic and external factors on inflation and illustrates alternative inflation scenarios using conditional forecasts. Using quarterly data between 2004Q2 (1383Q1) and 2021Q1 (1399Q4), it finds that whereas base and broad money growth drive inflation only in the long-term, nominal exchange rate depreciation vis-à-vis the US dollar, current (operating) budget deficits, and oil export volumes (a proxy for sanctions intensity) are the main drivers of inflation in the short term. Under the baseline (unconditional) forecast informed by historical data, inflation would continue rising in the next two years along with elevated deficits and continued depreciation of the rial. Under conditional forecasts with fiscal and monetary restraint, however, inflation would decline below 20 percent in the next two years, albeit at a modest cost to non-oil GDP. A stabilization in the exchange rate or an

[1] See, for instance, https://www.reuters.com/world/middle-east/soaring-bread-prices-spark-protests-shop-fires-iran-irna-2022-05-13/
[2] See, for instance, https://www.aljazeera.com/economy/2021/8/2/iran-president-raisi-fix-economy

increase in oil export volumes (e.g., doubling within the next year), for instance though some sanctions relief, would also lower inflation significantly, while supporting non-oil GDP.

There is an extensive literature on the drivers of inflation in Iran and results vary widely depending on the model used,[3] the time period covered, and explanatory variables included:

- Earlier studies include i) Liu and Adedeji (2000), ii) Celasun and Goswami (2002), and iii) Bonato (2007), who estimate a long-run equilibrium for the money market using quarterly data and find using error correction mechanisms that i) inflation is a monetary phenomenon both in the short- and long-term, ii) the disinflation during 2000/01 stems from the relative stability of the parallel market exchange rate, and iii) the disinflation during 2002/06 is due to the lagged impact of the deceleration in money growth.

- Among recent empirical work, Mohammadi (2020) uses a structural VAR and also finds that inflation is a monetary phenomenon both in the short- and long term; Hemmati and others (2018) use a VECM and find that external determinants of inflation along with money supply are: the exchange rate, import prices, and intensification of sanctions in the long run, and exchange rate and tariffs in the short run; Sadeghi and Tayebi (2018) use an Autoregressive Distributed Lag (ARDL) model and find that along with monetary policy, sanctions have also impacted inflation through the exchange rate and the budget deficit; and Majdzadeh and others (2015) use Bayesian Model Averaging (BMA) to measure the impact of thirteen demand and supply factors on inflation and find that energy prices, money supply (as a share of GDP), money growth, and market exchange rate occupy the first four ranks.

Following the literature on Iran, this paper also uses a VECM to estimate the long- and short-term impact of various domestic and external factors on inflation. Contributing to the literature, this paper focuses on a larger set of factors (fiscal deficits and expenditures, base and broad money supply, oil and non-oil GDP, sanctions proxied by oil exports, global oil and food prices, market exchange rate vis-à-vis the US dollar, and non-oil imports) and covers more recent periods (following the reimposition of US sanctions in 2018), making use of the Central Bank of Iran's (CBI) recently published CPI and budget data after a three-year suspension.

In the remainder of the paper, Section 2 reviews the inflation trends in Iran over the past two decades, Section 3 presents the empirical model and estimates of inflation determinants, Section 4 presents the forecasts for inflation under alternative scenarios, and Section 5 concludes with a discussion of policy options.

2. Inflation in Iran: Historical Trends

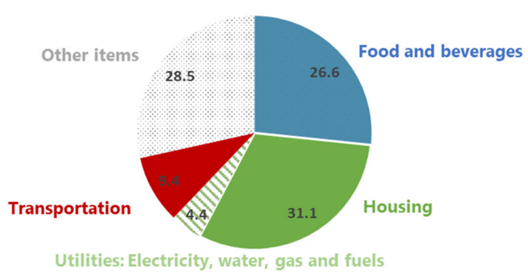
As common in emerging market and developing economies, the consumption basket in Iran has been largely comprised of food and housing. In FY 2021/22, for instance, food and beverages, utilities (electricity, water, and gas), and transportation comprised 40 percent of the consumption basket, while other "core" items comprised the remaining 60 percent, half of which was housing (Figure 2.a.). Although many food and energy items have

[3] Inflation is typically modeled in the literature in two ways: through a Phillips Curve relationship between output gap and inflation (often augmented with other factors); or through a money market equilibrium relationship between money demand and money supply. Given the weak relation between output gap and inflation in Iran, in part due to the difficulties in measuring output gap in an oil exporting economy under sanctions, the money market equilibrium approach has been used more widely for Iran.

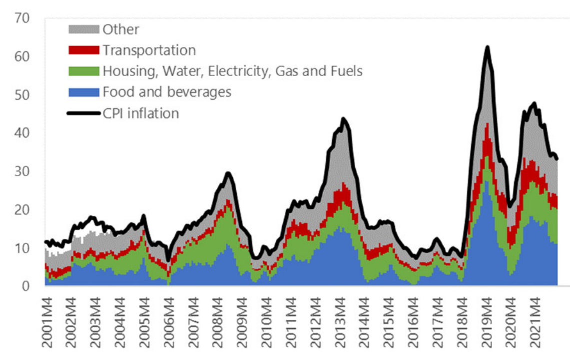
been heavily subsidized in Iran,[4] food and beverages and housing and utilities have been the largest contributors to inflation (Figure 2.b.). Food price inflation in Iran has markedly surpassed that in the rest of the world, especially when economic sanctions intensified during the early and late 2010s (Figure 2.c.). Housing rental prices have spiked in recent years, along with housing sale prices, as consumers hedge against inflation investing in housing, but also feeding inflation by raising rents (Figure 2.d.).

Figure 2. Components of Inflation in Iran

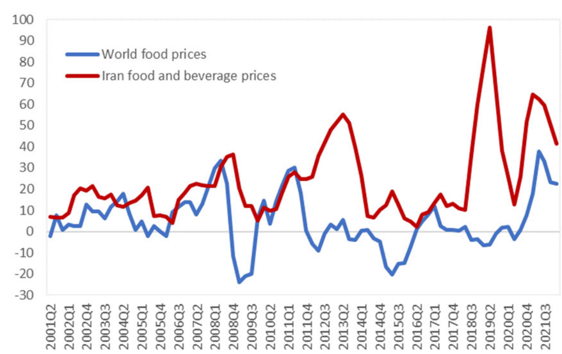
a. Consumption basket, 2021/22
(percent)



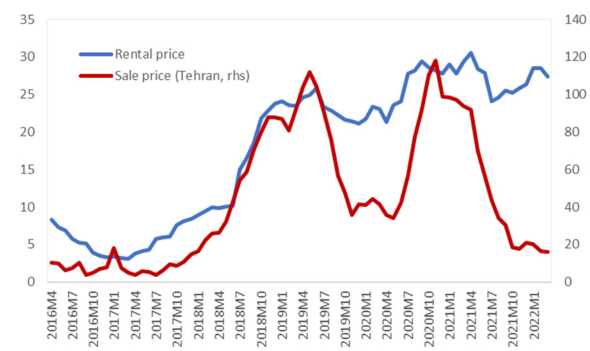
b. Contributors to inflation, 2001/2-21/22
(percent y-o-y)



c. Food prices, 2001/2-21/22
(percent change y-o-y)



d. Housing prices, 2016/17-21/22
(percent change y-o-y)



Sources: Central Bank of Iran, Statistical Center of Iran, and IMF World Economic Outlook Database, April 2022.

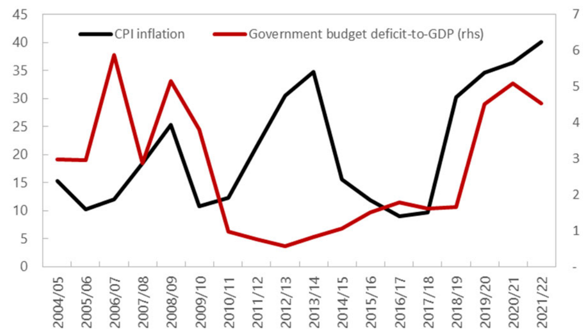
Domestic factors, such as loose fiscal and monetary policies, have been positively associated with inflation. Large fiscal deficits and rapid liquidity growth were associated with high inflation particularly during the mid-2000s due to expansionary government policies, during intensified sanctions in the early and late 2010s, and recently due to the COVID-19 crisis (Figures 3.a. and 3.b.). Negative real interest rates enabled by financial repression have likely added to inflationary pressures during intensified sanctions and the COVID-19 pandemic as well (Figure 3.c.). While non-oil output gap, computed using the HP filter, has not been clearly associated

[4] See, for instance, https://financialtribune.com/articles/energy/110377/iran-world-s-largest-energy-subsidy-provider-in-2020 and https://en.radiofarda.com/a/subsidies-will-cost-iran-63-7-billion-in-12-months/29890040.html

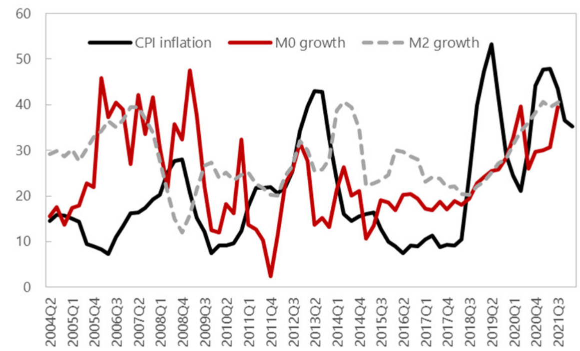
with inflation,[5] non-oil output growth seems to have been positively associated with inflation, albeit at a one-year lag (Figure 3.d.).

Figure 3. Domestic Drivers of Inflation in Iran

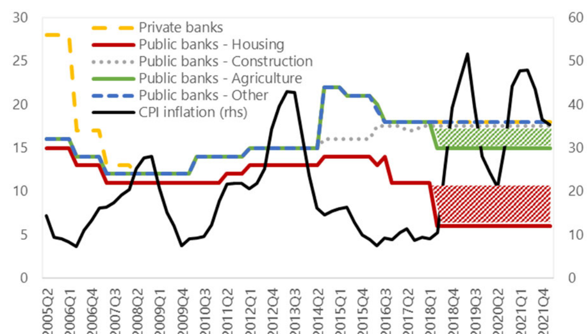
a. Fiscal deficit and inflation, 2004/5-21/22 (percent)



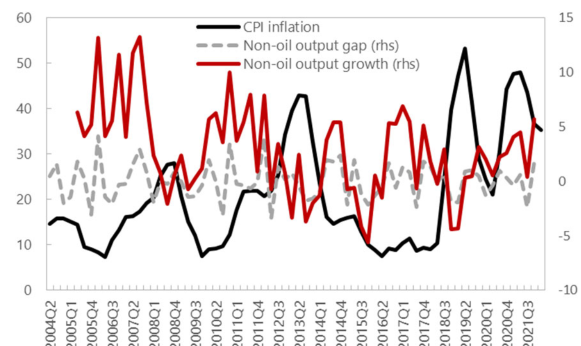
b. Money supply and inflation, 2004/5-21/22 (percent y-o-y)



c. Lending rates and inflation, 2005/6-21/22 (percent y-o-y)



d. Output and inflation, 2004/5-21/22 (percent y-o-y)



Sources: Central Bank of Iran, Statistical Center of Iran, Iranian Ministry of Finance, and IMF staff estimates.
Note: Shaded areas in panel c depict interest rate intervals. Output gap in panel d is estimated using the HP filter.

On the external side, exchange rate depreciation has been highly associated with inflation. Renewed sanctions and the COVID-19 crisis, in particular, have led to a sharp depreciation in the market exchange rate,[6] which in turn raised import prices and passed through to domestic inflation (Figures 4.a. and 4.b.).[7] Import volumes also seem to be negatively correlated with inflation, particularly during intensified sanctions in the early and late 2010s that likely led to import shortages (Figure 4.c.). Sanctions have also decreased export volumes, which

[5] The weak relationship between the output gap and inflation in Iran partly reflects the difficulties in measuring output gap in an oil exporting economy under trade and financial sanctions.

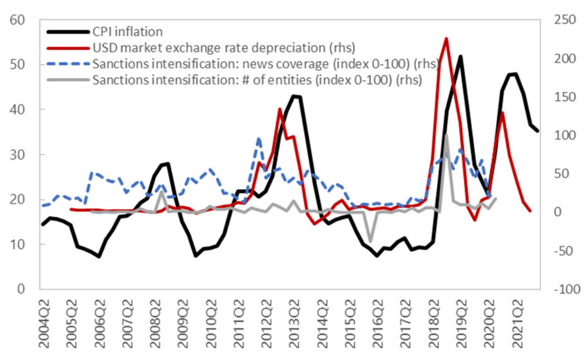
[6] Currently, Iran operates a system of three different exchange rates: (i) an official rate used to subsidize imported essential goods; (ii) the NIMA rate at which exporters are required to sell their FX proceeds; and (iii) a parallel market rate.

[7] Barrett (2019) finds that an unexpected one percent depreciation of the market exchange rate in Iran leads to a 0.4 percent permanent increase in the price level within the five months after the shock.

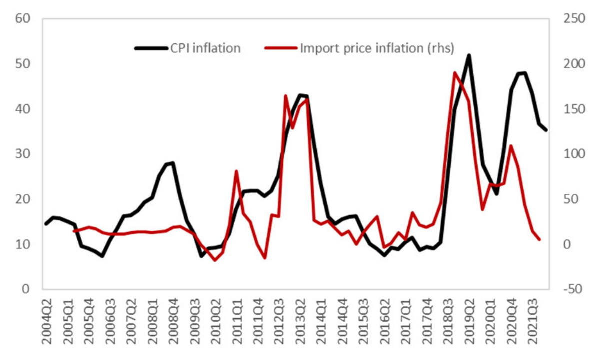
have been negatively associated with inflation (Figure 4.d.). Oil prices, however, have been positively associated with inflation in the short term (Figure 4.d.). Nevertheless, the decline in oil prices accompanying the COVID-19 crisis was not enough to curb inflation fueled by a large currency depreciation, and expansionary fiscal and monetary policies amid ongoing sanctions.

Figure 4. External Drivers of Inflation in Iran

a. Sanctions, exchange rate, and inflation, 2004/5-21/22 (percent y-o-y)

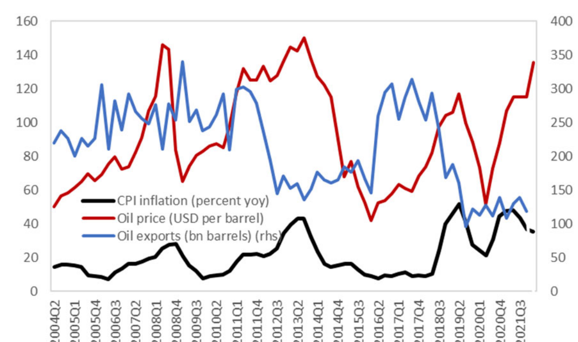


b. Import prices and inflation, 2004/5-21/22 (percent y-o-y)



c. Import volumes and inflation, 2004/5-21/22 (percent y-o-y)

d. Oil trade and inflation, 2004/5-21/22



Sources: Central Bank of Iran, Statistical Center of Iran, Laudati and Pesaran (2021) for sanctions data, IMF World Economic Outlook Database April 2022, and IMF staff estimates.
Note: Import prices in panel b are computed as the ratio of nominal over real imports of goods and services. Oil export volumes in panel d are computed as the ratio of oil export values over oil prices.

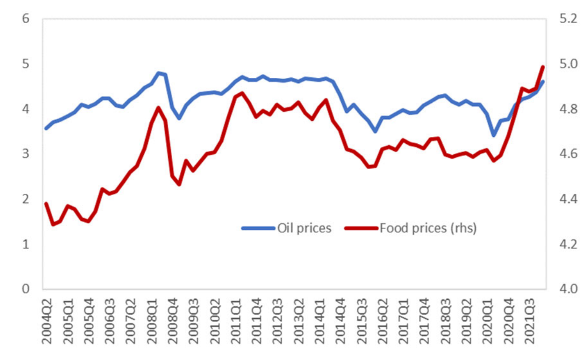
The rise in the global oil and food prices since the beginning of 2021 and supply chain disruptions are also likely to add to inflationary pressures. Although the analysis focuses on the period before 2021Q1, the rise in commodity prices and shipping costs, as well as supply shortages following the global demand recovery from the COVID-19 pandemic and the impact from the war in Ukraine are a source of continued inflationary pressures, especially for emerging markets with weak monetary frameworks and unanchored inflation expectations like Iran.

3. Inflation in Iran: Model Estimates

This paper uses a VECM to estimate the long- and short-term impact of various domestic and external factors on inflation. A VECM is type of a VAR model with cointegration restrictions, used to handle nonstationary (i.e., I(1)) variables whose linear combination is stationary. This stationary combination is called the cointegrating equation, which is interpreted as the long-term (equilibrium) relationship among the variables. VECM also allows for short term relations to be estimated using OLS as in a VAR.

The analysis is based on quarterly data between 2004Q2 and 2021Q1 (Appendix Table A1). It uses CBI's newly launched national accounts data in 2021Q3 based on 2016/17 prices and newly released CPI and budget data in 2022Q2 following a 3-year suspension. The baseline model includes consumer price index (CPI) as the dependent variable,[8] real non-oil gross value added (RGVAno) to capture the demand side effects,[9] base money (M0) to capture the impact of monetary policy, current (operating) budget deficit (CD) to capture the impact of fiscal policy,[10] nominal market exchange rate vis-à-vis the US dollar to account for external factors, oil export volumes (OilX) to proxy for sanctions,[11] and oil prices (OilP) to account for the oil sector. The latter also proxies food inflation in the world, given their high positive correlation during the sample period (Figure 5). Current budget expenditures (CEX), broad money (M2),[12] real exchange rate (RER=NER/CPI*CPI_US), real oil gross value added (RGVAo), global food prices (FoodP), and real imports of goods and services (IMP) are also included in alternative specifications. All variables except for the deficit (which can be positive or negative) are expressed in logarithms. Current fiscal deficit is expressed in trillion rials.

Figure 5. Global oil vs food prices, 2004/5-21/22
(in natural logarithms)



Source: IMF World Economic Outlook Database, April 2022.

First, the existence of a long-run relationship (cointegration) between inflation and its potential determinants is established. To do so, the first step is to test for stationarity. Augmented Dickey-Fuller (ADF) unit root tests verify that all variables are difference stationary (Appendix Table A2). The second step is to choose the lag length. Optimal lag of the baseline VAR model is set at p=5, which is the maximum of the lag lengths chosen by various criteria (Appendix Table A3). This implies an optimal lag of p-1=4 for the VECM. The last step is to test for cointegration. Johansen cointegration test implies that there is at least 1 cointegrating vector in all model specifications (Appendix Table A4). Table 1 presents the normalized cointegration coefficients for the

[8] Non-administered consumer prices would have been a more appropriate dependent variable, but we lack data on the share of administered prices in the consumption basket.

[9] Real non-oil GDP at basic prices (i.e., gross value added), instead of non-oil output gap, is used in the baseline specification because the latter is i) a short-term phenomenon only, ii) stationary in level rather than difference, and iii) seems to be associated less with inflation (Figure 3.4).

[10] Current (operating) budget deficit, instead of overall budget deficit, is used in the baseline specification because the latter is stationary in second rather than first difference.

[11] Oil export volumes, instead of various sanctions indices (e.g., by Laudati and Pesaran (2021)), are used in the baseline specification because the latter are stationary in levels rather than difference.

[12] M2, instead of M1, is used in the alternative specification because the latter is stationary in second rather than first difference.

default model with intercept and no trend and 1 cointegrating equation—the long-term equilibrium (Appendix Table A5).

Table 1. Normalized Cointegrating (Long-term) Coefficients

(standard errors in parentheses)

ln CPI:	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
ln RGVAno	0.91 ***	0.44 ***	-2.13 ***	0.40	1.06 **	0.28	1.17 ***
	(0.31)	(0.12)	(0.44)	(0.31)	(0.60)	(0.38)	(0.25)
ln M0	0.47 ***	0.25 ***		0.48 ***	0.56 ***	0.55 ***	0.37 ***
	(0.06)	(0.02)		(0.05)	(0.06)	(0.05)	(0.05)
CD/1000	0.21% ***		0.19% ***	0.27% ***	0. 24% ***	0.22% ***	0.14% ***
	(0.03%)		(0.02%)	(0.03%)	(0.04%)	(0.03%)	(0.03%)
ln NER	0.16 ***	0.01	-0.35 ***	0.12 ***		0.15 ***	0.26 ***
	(0.04)	(0.03)	(0.07)	(0.04)		(0.04)	(0.04)
ln OilX	-0.35 ***	-0.28 ***	-0.51 ***		-0.42 ***	-0.37 ***	-0.18 ***
	(0.04)	(0.02)	(0.04)		(0.05)	(0.04)	(0.04)
ln OilP	0.04	0.01	0.19 ***	-0.14 ***	0.04		
	(0.04)	(0.01)	(0.04)	(0.04)	(0.05)		
ln CEX		0.69 ***					
		(0.04)					
ln M2			1.05 ***				
			(0.09)				
ln RGVAo				-0.58 ***			
				(0.06)			
ln RER					0.19 **		
					(0.08)		
ln FoodP						0.08	
						(0.14)	
ln IMP							0.11
							(0.08)
Adj. coef.	-0.25 ***	-0.39 **	-0.30 ***	-0.16 ***	-0.20 ***	-0.21 ***	-0.33 ***
	(0.04)	(0.17)	(0.07)	(0.04)	(0.03)	(0.04)	(0.05)
R^2	0.93	0.87	0.90	0.90	0.93	0.93	0.93
(adj. R^2)	(0.87)	(0.76)	(0.81)	(0.82)	(0.88)	(0.86)	(0.87)

Source: Author's estimates.

Note: 63 observations (2005Q3 – 2021Q1) after adjustments. *** (**) [*] means significance at 1 (5) [10] percent level.

In the long term, money supply, nominal exchange rate, and budget deficit have a significant positive impact on inflation, whereas oil exports have a negative one. According to the baseline cointegrating equation (Table 1, column 1), an increase in base money (nominal exchange rate) of 1 percent increases inflation by 0.5 (0.2) percent in the long term. Likewise, an increase in the current fiscal deficit of 100 trillion rials (about 25 percent of 2020/21 quarterly mean) increases inflation by 0.2 percent. Oil exports (sanctions), on the other hand, have a significant negative impact on long-term inflation: an increase in oil export volume of 1 percent decreases long-term inflation by 0.35 percent. Whereas the long-term impact of oil prices on inflation is insignificant, likely resulting from offsetting effects of oil prices on inflation through oil export receipts vs non-oil import bill,[13] the long-term impact of real non-oil GDP on inflation is positive, likely reflecting low capacity-utilization under sanctions amid low investment, for instance in imported technology. Such positive long-term correlation between inflation and output is also reported by Esfahani and others (2013), who attribute it to the inefficiencies in the Iranian economy that lower investment.

Long-term relationships remain largely unchanged under alternative model specifications. Table 1 shows that the sign and significance of long-term coefficients remain largely unchanged when using current expenditures (CEX) instead of current deficit (CD) in column (2);[14] when using real oil gross value added (RGVAo) instead of oil exports (OilX) in column (4);[15] when using real exchange rate (RER) instead of nominal exchange rate (NER) (in column 5); when using global food price (FoodP) instead of global oil price (OilP) (in column 6); and when using real non-oil imports of goods and services (IMP) instead of oil price (OILP)—the only insignificant term in model 1—to account for potential supply constraints (e.g., import compression due to the pandemic or sanctions). Including broad money (M2) instead of base money (M0) in column (3), however, results in a reversal of the positive long-term relationships of non-oil output and nominal exchange with inflation,[16] and yields a positive long-term relationship between oil prices and inflation.[17] Nevertheless, the positive (negative) long-term relationship of fiscal and monetary policy variables (oil exports) with inflation remains unchanged in all specifications.

The following VECM is estimated to combine the long-term and short-term dynamics:

$$\Delta Y_t = AY_{t-1} + \sum_{l=1}^{p-1} B_l \, \Delta Y_{t-l} + C + u_t$$

where $Y_t = [\ln CPI_t \ln RGVAno_t \ln M0_t \; CD_t \ln NER_t \ln OilX_t \ln OilP_t]'$ is the vector of variables in quarter t; $\Delta Y_t = Y_t - Y_{t-1}$ is the vector of first differenced variables; A is the 7x1 coefficient matrix of the cointegrating relationship, B_l is the coefficient vector of the lag l of differenced variables, C is the vector of constants, p is the lag order of the model in its VAR form, and u_t is the vector of error terms with zero mean and constant variance. Appendix Table A6 reports the detailed estimates.

In the short term, only the nominal exchange rate, current budget deficit, and sanctions have a significant positive impact on inflation. Figure 6.a. (Appendix Figure A1) shows the responses of inflation to innovations in the independent variables in the baseline specification (1).[18] While inflation has a positive response to all explanatory variables but oil exports, only the nominal exchange rate, current deficit, and sanctions significantly raise inflation in the short term. For instance, a one standard deviation innovation in the nominal exchange rate and current deficit would increase inflation in the next 4 quarters by 3.8 and 3.0 percent. Figure 6.b. shows the

[13] Fuel subsidies may also mask the impact of higher oil prices on domestic consumers.

[14] Including current expenditures instead of deficit (i.e., excluding non-oil revenues) renders the long-term inflationary impact of nominal exchange rate insignificant, likely due to current expenditures (which is positively correlated with nominal exchange rate) partly picking up the positive correlation between nominal exchange rate and inflation.

[15] Excluding oil exports results in a negative correlation between oil prices and inflation, likely due to oil prices partly picking up the negative correlation between oil exports and inflation.

[16] The reversal in the signs of non-oil output and nominal exchange rate might be due to their positive correlation with bank credit to the economy, which is included in M2 but not in M0. Bank credit may boost both domestic and external demand (imports), raising output and depreciating the currency.

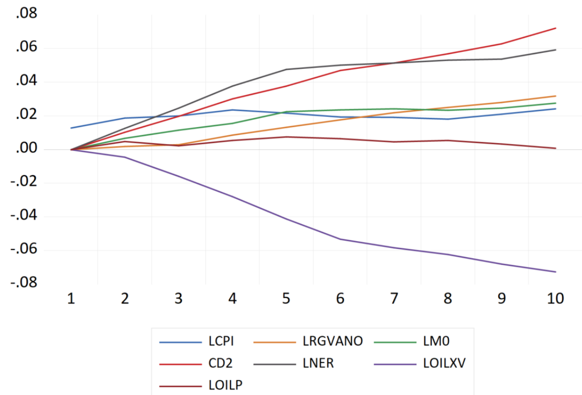
[17] The positive correlation of oil prices and inflation may also be due to bank credit in M2, with import channel offsetting oil export channel for oil prices to affect inflation.

[18] See Appendix Figure A2 for the impulse responses and variance decompositions of Models (2) - (7), which show similar results.

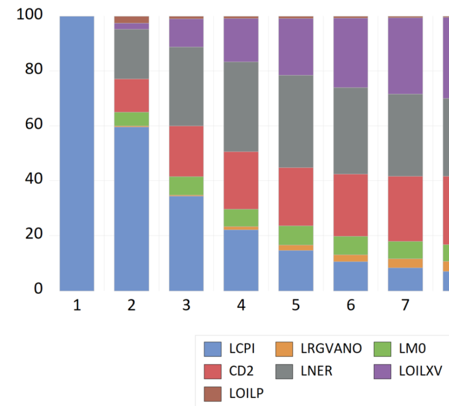
variance decomposition of model (1) and confirms that the nominal exchange rate strongly predicts variation in inflation, along with current deficits, and sanctions (oil exports). Around 70 percent of the variation in inflation is explained by these 3 variables by quarter 4. Base and broad money, however, do not strongly predict variation in inflation in the short term. Even so, monetary policy could affect inflation indirectly through the changes in the exchange rate, aggregate demand, and adjustment to the long-term equilibrium.

Figure 6. Impulse Responses and Variance Decompositions: Model (1)

a. Response of ln CPI to Innovations



b. Variance Decomposition of ln CPI



Source: Author’s estimates.

The error correction term and the model fit for inflation, and the residual diagnostic tests lend support for the model specification. The error correction (adjustment) term for inflation in the cointegrating equation is both negative and significant in all model specifications, implying a stable equilibrium (Table 1 and Appendix Table A6). Previous quarter’s deviation from long-run equilibrium inflation is corrected at a speed of 25 percent in the baseline model (1). The baseline model also has an R^2 (adjusted R^2) of 0.93 (0.87) for the inflation equation. Autocorrelation LM test (Appendix Table A7) and White heteroskedasticity test (Appendix Table A8) point to no autocorrelation and no heteroskedasticity, and the Jarque-Bera test points to normality of residuals (Appendix Table A9).

4. Inflation in Iran: Alternative Scenarios

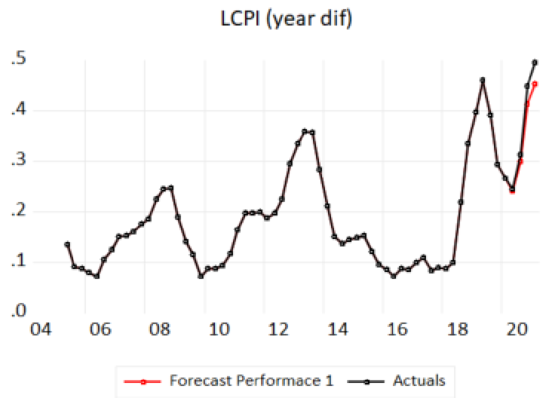
Predicted inflation closely tracks the main trends in actual inflation. While inflation is perfectly matched over the last 4 quarters of the sample period (Figure 7.a.), it is underestimated over the last 8 quarters (Figure 7.b.) along with expansionary fiscal and monetary policies ensuing the COVID-19 shock in 2020Q1.[19] The CBI has not published inflation data for FY 2021/22 (Iranian year 1400). Using inflation data published by the Statistical Center of Iran (SCI) for FY 2021/22, Figures 7.c. and 7.d. also show that the predicted inflation closely follows the actual inflation in the past 8 and 12 quarters from 2022Q1.[20]

[19] See Appendix Figure A3 for the forecast performance of other variables.

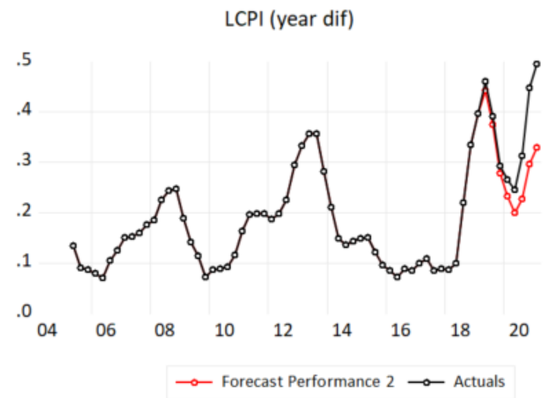
[20] Note that the CBI’s inflation data have on average been higher than the SCI’s in the past few years.

Figure 7. Forecast Performance of Model (1): Actual vs Predicted Inflation

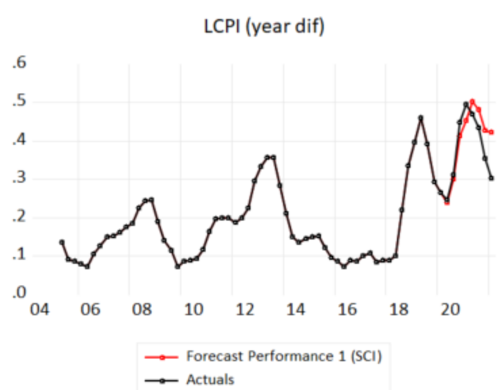
a. Over the last 4 quarters: 2020Q2-2021Q1



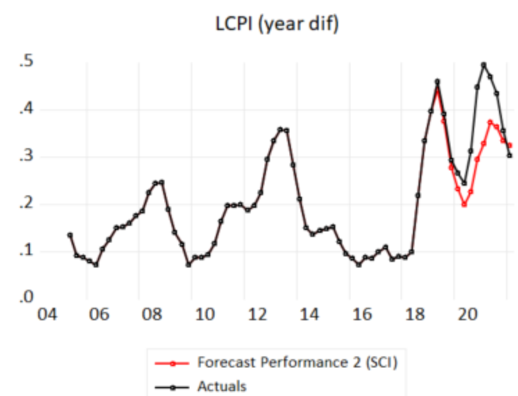
b. Over the last 8 quarters: 2019Q2-2021Q1



c. Over the last 8 quarters: 2020Q2-2022Q1



d. Over the last 12 quarters: 2019Q2-2022Q1



Under the baseline (unconditional) forecast informed by historical trends, inflation would keep rising in the next two years. For the next 8 quarters, the model predicts inflation to remain high at over 50 percent, along with elevated deficits and continued exchange rate depreciation (Figure 8). Inflation would be very similar to the baseline forecast under a scenario with higher oil prices—as predicted in the IMF forecast prepared for the April 2022 WEO—along with non-declining oil exports (or no intensification in sanctions) (Figure 9.a.).

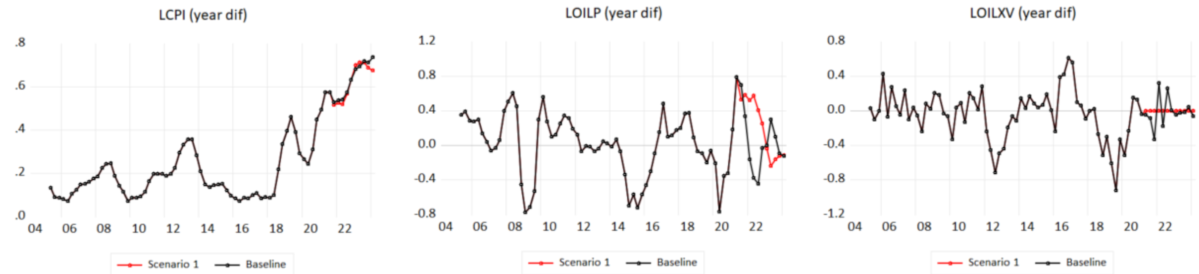
Under conditional forecasts with fiscal restraint, however, inflation would decline below 20 percent in the next two years, albeit at a modest cost to non-oil GDP. Figure 9.b. shows conditional forecasts under fiscal restraint, with no increases in the deficit in nominal terms. In that case, inflation would fall below 20 percent in the next 2 years, albeit at a modest cost to non-oil GDP. Figure 9.c. shows conditional forecasts under both fiscal and monetary restraint, with only 10 percent growth in the monetary base. In that case, inflation would decline below 20 percent more quickly (and even reach single digits), but the cost to non-oil GDP would be higher.

Under conditional forecasts with a stronger rial or with some sanctions relief, inflation would drop significantly amid a rise in non-oil GDP. Figures 9.d. and 9.e. show conditional forecasts with no nominal depreciation and higher oil exports (e.g., oil exports grow by 20 percent each quarter, doubling the oil exports from 1mbpd to over 2mbpd in a year, which would be possible through some sanctions relief). In those cases, inflation would drop by about 10 percentage points compared to the baseline, while non-oil GDP would remain unchanged or even increase.

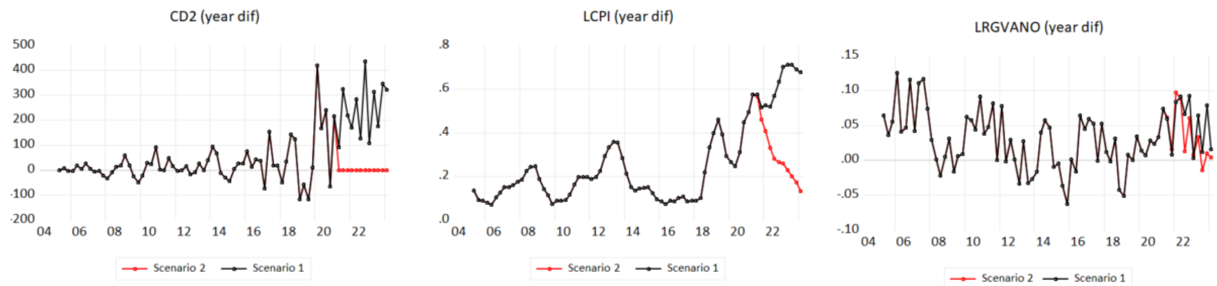
Figure 8. Baseline (Unconditional) Forecasts for 2021Q2-2024Q1 Using Model (1)

Figure 9. Conditional Forecasts for 2021Q2-2024Q1 Using Model (1)

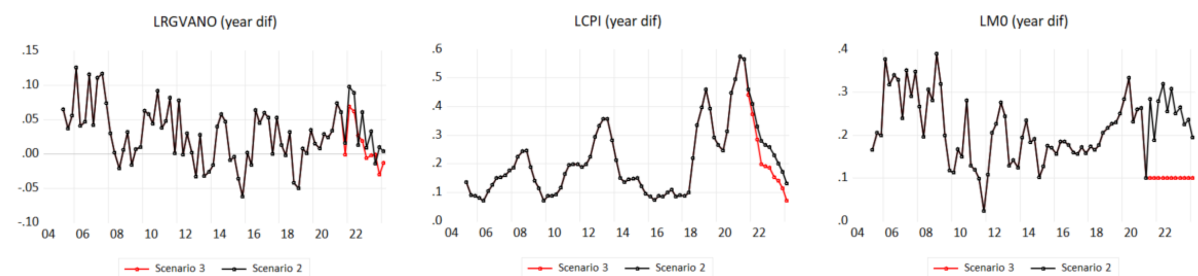
a. Under higher oil prices and constant oil exports



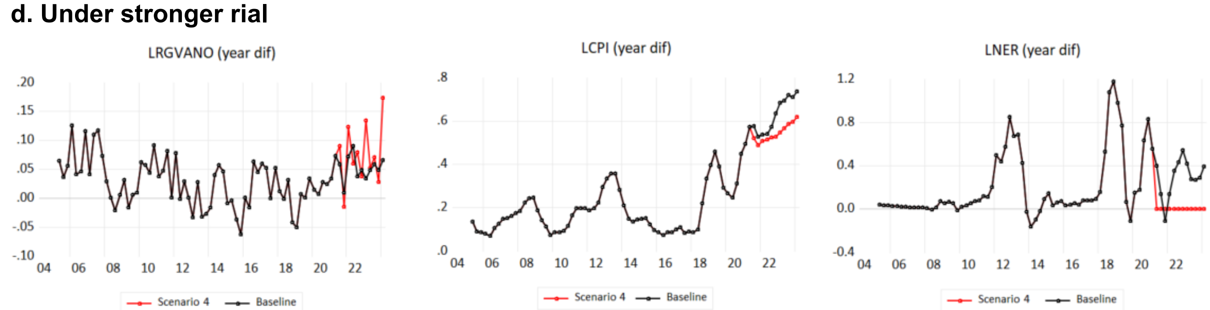
b. Under fiscal restraint



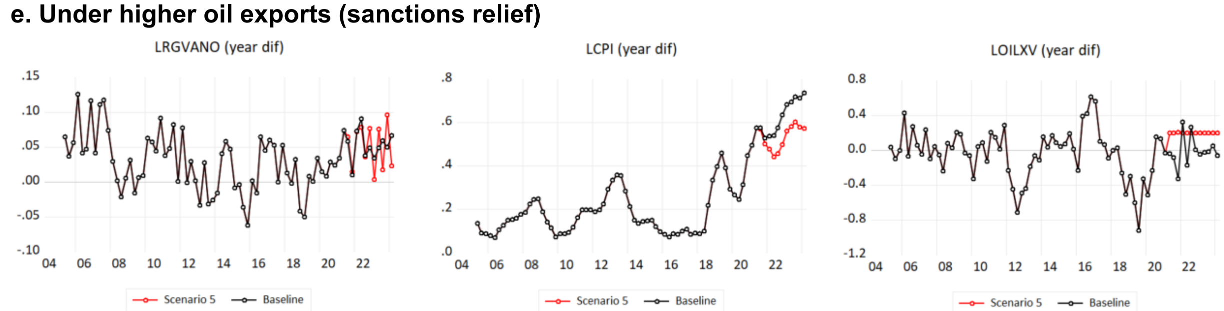
c. Under fiscal and monetary restraint



d. Under stronger rial



e. Under higher oil exports (sanctions relief)



5. Policy Implications

The high inflation rates in Iran can be explained by both external and domestic factors that are hard to disentangle and that feed one another. Sanctions contribute to inflation directly through import shortages and supply constraints, and indirectly through depreciating exchange rates and higher government deficits resulting from lower oil exports and foreign exchange receipts. Lack of external funding in turn means that fiscal deficits are increasingly financed by lending by banks and Iran's sovereign wealth fund (NDFI), which in turn expand the supply of money. Expansionary monetary and fiscal policies on top of sanctions, such as through cheap private credit and higher government spending, fuel inflation further, and in turn feed back into depreciating exchange rates.

The policy mix in Iran has relied too heavily on distortive price controls, which can contain inflation only temporarily, albeit with negative long-term consequences. Iran has employed price controls on various goods and services, including energy (such as electricity and petroleum products), foodstuffs (such as wheat, through a guaranteed price to producers and a subsidized exchange rate for importers that was recently scaled back), and financial services (through interest rate ceilings). While used as a tool for socioeconomic policy (such as protecting consumers and workers, supporting producers, and promoting targeted sectors), price controls often undermine investment and growth, worsen poverty and inequality, impose large fiscal burdens, and weaken the effectiveness of monetary policy (World Bank, 2020). Replacing price controls with expanded and better-targeted social safety nets would be more effective and less costly in achieving social protection objectives.

A sustained reduction in inflation will require a fundamental shift in the policy mix involving fiscal, exchange rate, monetary, and structural reforms. While sanctions relief would promote a faster decline in inflation by helping stabilize the exchange rate and facilitate the implementation of difficult reforms, these reforms are needed even more urgently in the absence of sanctions relief and should be implemented gradually.

Short-term priorities

In the short term, reducing budget deficits and tightening monetary policy, including by eliminating the distortive energy price, foreign exchange, and interest rate controls, supported by strategic communication and better targeted transfers to affected lower income households, would be the most effective policy to reduce inflation.

Budget deficits will have to be reduced to contain inflation—albeit gradually to avoid undermining the recovery if sanctions remain. This would include cutting wasteful energy subsidies that largely benefit the richer segments of the population through a carefully devised public communication strategy to secure broad acceptance. While this could add to inflationary pressures in the short term, the poorer segments of the population could be compensated directly through better targeting the existing cash transfers. Improving public spending efficiency, including through corruption control and governance reforms, would also help contain excessive deficits. Mobilizing non-oil revenue, through broadening the tax base, eliminating tax exemptions, improving taxpayer compliance, and better managing public assets, would create fiscal space for priority spending while ensuring debt sustainability.[21] Ture (2022) shows that spending part of the mobilized tax revenue on much needed investments, such as on greening and digitalizing the economy, would offset its output and distributional costs.

[21] See Benedek and others (2021) for tax policy, Jenkins and others (2022) for revenue administration, and De Clerk and others (2022) for state asset management reform recommendations for Iran to improve its budget financing capacity.

Physical and human capital spending (such as investment in infrastructure, education, and health) would be largely noninflationary as it would boost productivity.

Lending and deposit rates should be increased to stabilize the market exchange rate and reduce inflation, while multiple exchange rates should be unified to remove distortions. The current multiple currency practice should be discontinued as it creates rent seeking, erodes competitiveness, and puts pressure on reserves. In this regard, the government's plan to eliminate the official subsidized currency is a welcome first step to unify all exchange rates and remove such distortions. Its inflationary impact could be limited as currency subsidies only partially reach end-consumers through large importers, and could be alleviated by compensating those impacted directly through existing transfer policy. The unification should be accompanied by a sizeable increase in the lending and deposit rates to stabilize the foreign exchange market and contain excessive credit growth. Caps on lending and deposit rates far below inflation erode bank profitability and fuel inflation, and should be removed to address financial sector weaknesses and strengthen control over inflation.

Medium-term reforms

Over the medium term, strengthening the inflation targeting framework could help improve the effectiveness of monetary policy to reduce inflation durably. Although not covered in this study, structural reforms to promote private sector participation and diversification through enhanced competition and regulation in the business environment would also help address the long-term (structural) causes of inflation.

CBI's governance and operations should be strengthened to better fight inflation. The fight against inflation is complicated by the absence of a clear and credible nominal anchor for inflation expectations, the prevalence of fiscal dominance, the CBI pursuing multiple objectives and not being independent, and the weaknesses in the financial system. As such, and given the lack of exchange rate flexibility and prevalence of high dollarization, the introduction in 2020 of a new monetary policy framework focused on inflation targeting (IT) has so far not been effective in lowering inflation.[22] Over the medium term, the institutional setup of the CBI needs to be strengthened to facilitate successful implementation of IT. This will require a political commitment to reduce fiscal dominance, coupled with steps to ensure CBI's operational and financial autonomy, and improve CBI accountability and transparency in achieving its inflation target. Banking sector weaknesses also need to be addressed, starting with an asset quality review of the largest banks, and strengthening bank resolution and supervision frameworks. In the meantime, however, making the monetary policy framework more market oriented by facilitating the active use of interest rates, targeting monetary aggregates, developing government bond markets, and using macroprudential tools (e.g., to limit excessive credit growth) would help improve monetary transmission and control over inflation (Mazarei 2020).

Private sector development and diversification should be promoted to help address long-term (structural) inflation. Inflation has been structurally high—averaging 20 percent in the last two decades—reflecting not only the entrenched fiscal and financial imbalances, but also the state and oil dependent structure of the economy. Some non-oil sector development has taken place in response to periodic sanctions. Nevertheless, much of the

[22] In 2020, the Central Bank of Iran adopted inflation targeting as its new monetary policy framework. This is achieved through open market operations (OMO) to control the interest rate and manage liquidity in the interbank market. The instruments for OMO include trading government securities, conducting repurchase agreements backed by foreign currency and government bonds, collateralized lending, and banks' depositing with the CBI. During the gradual transition to the new regime, banks still need to abide by the ceiling on deposit and lending rates approved by the Money and Credit Council.

consumption basket in Iran is still either imported or produced using imported goods, such as various foodstuffs that are produced using imported fertilizers and animal feed, which makes domestic prices vulnerable to external price and exchange rate movements.[23] For the private sector to emerge as a driver for diversification, business climate needs to be improved, not only by removing price distortions, but also by leveling the playing field with state enterprises and foundations. This will require strengthening the rule of law and promoting competition and innovation to increase productivity and reduce import dependence.

[23] According to the World Bank's World Integrated Trade Solution (WITS), three quarters of Iran's imported products (in USD) were non-consumer goods, including capital goods (33 percent), intermediate goods (28 percent), and raw materials (15 percent) that are used for domestic production.

Appendix

Table A1. Data Variables and Sources

Variable	Definition	Unit	Source	Date
CPI	Consumer price index	2016/17=100	CBI; SCI	2000Q1 – 2021Q1; 2021Q2 – 2022Q1
RGVAno	Nonoil GDP at 2016/17 basic prices	billion rial	CBI	2004Q2 – 2021Q4
RGVAo	Oil GDP at 2016/17 basic prices	billion rial	CBI	2004Q2 – 2021Q4
M0	Base money	billion rial	CBI	2000Q1 – 2021Q4
M2	Broad money	billion rial	CBI	2000Q1 – 2021Q4
CD	Current (operating) deficit	billion rial	CBI	2002Q2 – 2021Q1
CEX	Current budget expenditure	billion rial	CBI	2002Q2 – 2021Q1
NER	Nominal market exchange rate	rial/USD	CBI; Bonbast	2000M4 – 2022M2; 2018M5-M8, 2022M3
CPI_US	Consumer price index of the US	1982-84=100	BLS	2000Q1 – 2022Q1
OilP	Global oil price	USD/barrel	IMF	2004Q1 – 2022Q1
FoodP	Global food price index	2016=100	IMF	2004Q1 – 2022Q1
OilX	Oil exports	billion USD	CBI	2004Q2 – 2021Q4
IMP	Imports of goods and services at 2016/17 market prices	billion rial	CBI	2004Q2 – 2021Q4

Note: Data are retrieved from Haver or CBI in May 2022 unless otherwise stated. Global oil and food price data are retrieved from the April 2022 vintage of the IMF WEO database. Missing market exchange rate data for 2018M5-M8 and 2022M3 are obtained from Bonbast.com.

Table A2. Augmented Dickey-Fuller (ADF) Unit Root Tests

2004Q2-2021Q1	Level			1st Difference		
Variable	**Lag**	**t-Stat.**	**Prob.**	**Lag**	**t-Stat.**	**Prob.**
ln CPI	1	1.536	0.999	0	-2.797	0.064
ln RGVAno	7	-2.599	0.099	6	-3.872	0.004
ln RGVAo	0	-2.330	0.166	0	-9.244	0.000
ln M0	4	-1.217	0.662	3	-3.698	0.006
ln M2	9	0.683	0.991	8	-3.037	0.037
CD2=CD/1000	6	1.696	1.000	2	-12.038	0.000
ln CEX	3	1.679	1.000	2	-8.913	0.000
ln NER	4	1.466	0.999	0	-4.935	0.000
ln RER	1	-1.558	0.498	0	-5.265	0.000
ln OilP	0	-2.537	0.111	0	-6.757	0.000
ln FoodP	1	-2.770	0.068	1	-6.409	0.000
ln OilX (value)	0	-2.104	0.244	0	-9.300	0.000
ln OilXv (volume)	1	-1.271	0.638	0	-11.911	0.000
ln IMP	3	1.468	0.999	2	-7.355	0.000

Note: All variables are difference stationary, that is I(1), at 10 percent significance level (5 percent significance level except for CPI).

Table A3. Optimal VAR Lag Length: Baseline Model (1)

VAR Lag Order Selection Criteria
Endogenous variables: LCPI LRGVANO LM0 CD2 LNER LOILXV LOILP
Exogenous variables: C
Date: 05/24/22 Time: 13:52
Sample: 2004Q2 2021Q1
Included observations: 63

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-328.0391	NA	9.82e-05	10.63616	10.87429	10.72982
1	86.64608	724.0535	9.00e-10	-0.972892	0.932117	-0.223642
2	188.7461	155.5809	1.76e-10	-2.658605	0.913286*	-1.253763*
3	242.4557	69.90776	1.76e-10	-2.808117	2.430656	-0.747682
4	305.2390	67.76611	1.55e-10	-3.245683	3.659974	-0.529654
5	384.1521	67.63977*	1.06e-10*	-4.195304*	4.377235	-0.823682

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Table A4. Johansen Cointegration Test Summary: Baseline Model (1)

Date: 05/24/22 Time: 13:53
Sample: 2004Q2 2021Q1
Included observations: 63
Series: LCPI LRGVANO LM0 CD2 LNER LOILXV LOILP
Lags interval: 1 to 4

Selected (0.05 level*) Number of Cointegrating Relations by Model

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	5	3	3	3	3
Max-Eig	3	3	3	2	1

*Critical values based on MacKinnon-Haug-Michelis (1999)

Table A5. Johansen Cointegration Test: Baseline Model (1)

Date: 05/24/22 Time: 13:55
Sample (adjusted): 2005Q3 2021Q1
Included observations: 63 after adjustments
Trend assumption: Linear deterministic trend
Series: LCPI LRGVANO LM0 CD2 LNER LOILXV LOILP
Lags interval (in first differences): 1 to 4

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.728172	206.9398	125.6154	0.0000
At most 1 *	0.532892	124.8770	95.75366	0.0001
At most 2 *	0.454865	76.92181	69.81889	0.0121
At most 3	0.249117	38.69837	47.85613	0.2724
At most 4	0.145215	20.64852	29.79707	0.3799
At most 5	0.130606	10.76346	15.49471	0.2265
At most 6	0.030417	1.946046	3.841465	0.1630

Trace test indicates 3 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.728172	82.06280	46.23142	0.0000
At most 1 *	0.532892	47.95522	40.07757	0.0053
At most 2 *	0.454865	38.22344	33.87687	0.0142
At most 3	0.249117	18.04985	27.58434	0.4910
At most 4	0.145215	9.885062	21.13162	0.7554
At most 5	0.130606	8.817411	14.26460	0.3017
At most 6	0.030417	1.946046	3.841465	0.1630

Max-eigenvalue test indicates 3 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

LCPI	LRGVANO	LM0	CD2	LNER	LOILXV	LOILP
26.37616	-23.99381	-12.41777	-0.055313	-4.291859	9.154609	1.036728
-12.02146	33.17076	-1.254982	0.032245	5.220229	2.731767	-2.047881
-1.161905	13.74384	-2.404915	0.008814	2.576480	3.722696	4.653342
-11.10154	-45.09559	9.899747	-0.004724	7.110046	2.175729	7.045657
-1.962497	-18.60936	6.083043	0.008415	-4.758677	-5.253228	0.475969
-10.51252	53.32781	-4.850400	1.45E-05	7.892127	-3.279064	-2.581726
-36.23338	42.93909	14.61256	-0.041837	17.46206	-1.527795	-5.837869

Unrestricted Adjustment Coefficients (alpha):

D(LCPI)	-0.009291	-0.000131	0.003250	0.000464	-0.001458	0.001409	-1.81E-05
D(LRGVANO)	-0.011266	0.006399	-0.005282	0.008529	0.001710	-0.002723	-0.001644
D(LM0)	0.007533	0.010713	-0.012702	0.004159	-0.005000	0.007001	-0.001972
D(CD2)	-14.95562	-12.69137	-17.23479	-1.405147	-11.18360	-3.986701	0.262976
D(LNER)	-0.035831	0.010393	0.019203	-0.008816	-0.017932	-0.005552	-0.006297
D(LOILXV)	0.002109	-0.026859	-0.036202	-0.022016	0.014112	0.014151	-0.014612
D(LOILP)	-0.064208	0.064834	-0.029931	-0.029325	0.003263	-0.003174	0.003952

1 Cointegrating Equation(s): Log likelihood 321.7136

Normalized cointegrating coefficients (standard error in parentheses)

LCPI	LRGVANO	LM0	CD2	LNER	LOILXV	LOILP
1.000000	-0.909678	-0.470795	-0.002097	-0.162717	0.347079	0.039305
	(0.31359)	(0.05521)	(0.00031)	(0.04113)	(0.04375)	(0.04028)

Adjustment coefficients (standard error in parentheses)

D(LCPI)	-0.245056
	(0.04262)
D(LRGVANO)	-0.297166
	(0.11646)
D(LM0)	0.198691
	(0.16782)
D(CD2)	-394.4718
	(206.972)
D(LNER)	-0.945082
	(0.34231)
D(LOILXV)	0.055626
	(0.58272)
D(LOILP)	-1.693561
	(0.57187)

Table A6. VECM Estimates: Baseline Model (1)

Vector Error Correction Estimates
Date: 05/24/22 Time: 14:08
Sample (adjusted): 2005Q3 2021Q1
Included observations: 63 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
LCPI(-1)	1.000000
LRGVANO(-1)	-0.909678
	(0.31359)
	[-2.90090]
LM0(-1)	-0.470795
	(0.05521)
	[-8.52745]

CD2(-1)	-0.002097
	(0.00031)
	[-6.72432]
LNER(-1)	-0.162717
	(0.04113)
	[-3.95610]
LOILXV(-1)	0.347079
	(0.04375)
	[7.93364]
LOILP(-1)	0.039305
	(0.04028)
	[0.97580]
C	15.80170

Error Correction:	D(LCPI)	D(LRGVANO)	D(LM0)	D(CD2)	D(LNER)	D(LOILXV)	D(LOILP)
CointEq1	-0.245056	-0.297166	0.198691	-394.4718	-0.945082	0.055626	-1.693561
	(0.04262)	(0.11646)	(0.16782)	(206.972)	(0.34231)	(0.58272)	(0.57187)
	[-5.74944]	[-2.55164]	[1.18394]	[-1.90591]	[-2.76086]	[0.09546]	[-2.96147]
D(LCPI(-1))	0.040678	-0.371242	1.201113	-821.8889	-2.962620	1.891157	-2.841315
	(0.14761)	(0.40334)	(0.58122)	(716.808)	(1.18554)	(2.01813)	(1.98054)
	[0.27557]	[-0.92042]	[2.06654]	[-1.14660]	[-2.49897]	[0.93708]	[-1.43462]
D(LCPI(-2))	-0.021667	-0.373105	-0.938570	-628.8917	0.059682	0.668242	-0.638975
	(0.16083)	(0.43945)	(0.63326)	(780.990)	(1.29169)	(2.19883)	(2.15788)
	[-0.13472]	[-0.84902]	[-1.48212]	[-0.80525]	[0.04620]	[0.30391]	[-0.29611]
D(LCPI(-3))	0.304081	0.603165	0.751470	2839.536	-0.005165	-2.246401	-1.493882
	(0.16621)	(0.45415)	(0.65444)	(807.109)	(1.33489)	(2.27236)	(2.23004)
	[1.82949]	[1.32812]	[1.14827]	[3.51816]	[-0.00387]	[-0.98857]	[-0.66989]
D(LCPI(-4))	-0.094375	-0.288081	-0.395937	-742.7103	0.800585	-0.863792	0.520647
	(0.13559)	(0.37048)	(0.53387)	(658.413)	(1.08896)	(1.85372)	(1.81920)
	[-0.69603]	[-0.77759]	[-0.74164]	[-1.12803]	[0.73519]	[-0.46598]	[0.28620]
D(LRGVANO(-1))	-0.264440	-1.007570	0.106865	-578.5482	-1.633492	-0.231205	-0.576445
	(0.07477)	(0.20431)	(0.29442)	(363.101)	(0.60054)	(1.02229)	(1.00325)
	[-3.53649]	[-4.93152]	[0.36297]	[-1.59335]	[-2.72005]	[-0.22616]	[-0.57458]
D(LRGVANO(-2))	-0.239461	-0.826939	0.365248	-642.7846	-1.262694	-0.197528	-0.372302
	(0.06854)	(0.18729)	(0.26988)	(332.843)	(0.55049)	(0.93710)	(0.91965)
	[-3.49355]	[-4.41536]	[1.35335]	[-1.93119]	[-2.29375]	[-0.21079]	[-0.40483]
D(LRGVANO(-3))	-0.112471	-0.825185	0.065561	-157.4165	-1.316193	0.168299	0.691709
	(0.06748)	(0.18438)	(0.26570)	(327.680)	(0.54195)	(0.92256)	(0.90538)
	[-1.66672]	[-4.47542]	[0.24675]	[-0.48040]	[-2.42860]	[0.18243]	[0.76400]
D(LRGVANO(-4))	-0.110422	0.177905	-0.039227	267.5329	-0.731610	-0.915718	1.208716
	(0.06150)	(0.16804)	(0.24215)	(298.645)	(0.49393)	(0.84082)	(0.82516)
	[-1.79545]	[1.05868]	[-0.16199]	[0.89582]	[-1.48119]	[-1.08908]	[1.46483]
D(LM0(-1))	-0.004971	-0.047501	-0.133825	183.6553	-0.164239	-1.017247	-0.939269

	(0.04669)	(0.12758)	(0.18385)	(226.734)	(0.37500)	(0.63835)	(0.62647)
	[-0.10647]	[-0.37232]	[-0.72792]	[0.81000]	[-0.43797]	[-1.59355]	[-1.49932]
D(LM0(-2))	0.007945	0.136694	0.031278	-402.9951	-0.240936	0.178661	-0.208996
	(0.04491)	(0.12271)	(0.17683)	(218.086)	(0.36070)	(0.61401)	(0.60257)
	[0.17691]	[1.11392]	[0.17688]	[-1.84787]	[-0.66798]	[0.29097]	[-0.34684]
D(LM0(-3))	0.021412	0.114049	-0.035140	131.8852	0.079631	-0.749874	-0.446957
	(0.04399)	(0.12018)	(0.17319)	(213.589)	(0.35326)	(0.60135)	(0.59015)
	[0.48680]	[0.94895]	[-0.20290]	[0.61747]	[0.22542]	[-1.24699]	[-0.75736]
D(LM0(-4))	0.090379	-0.206698	0.023168	-2.650801	-0.114437	0.527773	-0.021915
	(0.04403)	(0.12031)	(0.17336)	(213.806)	(0.35362)	(0.60196)	(0.59075)
	[2.05268]	[-1.71810]	[0.13364]	[-0.01240]	[-0.32362]	[0.87676]	[-0.03710]
D(CD2(-1))	-0.000396	-0.000640	0.000385	-1.557466	-0.001859	0.001037	-0.003864
	(9.5E-05)	(0.00026)	(0.00038)	(0.46338)	(0.00077)	(0.00130)	(0.00128)
	[-4.15216]	[-2.45422]	[1.02346]	[-3.36107]	[-2.42528]	[0.79469]	[-3.01818]
D(CD2(-2))	-0.000296	-0.000571	0.000294	-0.908315	-0.001344	0.000573	-0.002549
	(7.5E-05)	(0.00020)	(0.00029)	(0.36261)	(0.00060)	(0.00102)	(0.00100)
	[-3.96438]	[-2.79675]	[1.00011]	[-2.50491]	[-2.24155]	[0.56151]	[-2.54420]
D(CD2(-3))	-0.000215	-0.000445	0.000172	-1.035993	-0.001159	0.000390	-0.002100
	(5.8E-05)	(0.00016)	(0.00023)	(0.28119)	(0.00047)	(0.00079)	(0.00078)
	[-3.71466]	[-2.81048]	[0.75378]	[-3.68436]	[-2.49299]	[0.49297]	[-2.70357]
D(CD2(-4))	-7.45E-05	-0.000202	0.000197	-0.393753	-0.000339	0.000775	-0.001696
	(4.0E-05)	(0.00011)	(0.00016)	(0.19398)	(0.00032)	(0.00055)	(0.00054)
	[-1.86376]	[-1.84852]	[1.25527]	[-2.02986]	[-1.05527]	[1.41857]	[-3.16493]
D(LNER(-1))	0.101450	-0.128162	-0.043759	87.78369	0.663232	-0.874857	-0.292595
	(0.02487)	(0.06796)	(0.09794)	(120.786)	(0.19977)	(0.34007)	(0.33373)
	[4.07858]	[-1.88572]	[-0.44680]	[0.72677]	[3.31998]	[-2.57261]	[-0.87674]
D(LNER(-2))	0.001390	0.109729	-0.123777	-30.53985	-0.230201	-0.302683	0.304340
	(0.03126)	(0.08541)	(0.12307)	(151.786)	(0.25104)	(0.42735)	(0.41939)
	[0.04448]	[1.28475]	[-1.00570]	[-0.20120]	[-0.91698]	[-0.70829]	[0.72568]
D(LNER(-3))	0.058339	-0.101154	-0.035624	-68.84273	0.471994	-0.194973	0.288961
	(0.03144)	(0.08590)	(0.12379)	(152.663)	(0.25249)	(0.42981)	(0.42181)
	[1.85565]	[-1.17755]	[-0.28778]	[-0.45094]	[1.86935]	[-0.45362]	[0.68505]
D(LNER(-4))	-0.036102	-0.019544	-0.073318	-252.2913	-0.414611	-0.378485	0.746864
	(0.02841)	(0.07764)	(0.11187)	(137.973)	(0.22819)	(0.38845)	(0.38122)
	[-1.27061]	[-0.25173]	[-0.65536]	[-1.82856]	[-1.81692]	[-0.97434]	[1.95915]
D(LOILXV(-1))	0.061301	0.129911	-0.113850	114.6485	0.204365	-0.331774	0.578186
	(0.01637)	(0.04474)	(0.06447)	(79.5061)	(0.13150)	(0.22384)	(0.21968)
	[3.74405]	[2.90388]	[-1.76602]	[1.44201]	[1.55416]	[-1.48216]	[2.63200]
D(LOILXV(-2))	0.025234	0.089099	-0.093482	92.10819	0.079425	-0.368282	0.465779
	(0.01650)	(0.04508)	(0.06497)	(80.1220)	(0.13251)	(0.22558)	(0.22138)
	[1.52935]	[1.97630]	[-1.43892]	[1.14960]	[0.59937]	[-1.63261]	[2.10401]
D(LOILXV(-3))	0.025723	0.004941	-0.089937	-26.60638	0.020223	-0.156129	0.402288
	(0.01387)	(0.03790)	(0.05462)	(67.3575)	(0.11140)	(0.18964)	(0.18611)

	[1.85443]	[0.13037]	[-1.64670]	[-0.39500]	[0.18153]	[-0.82329]	[2.16157]
D(LOILXV(-4))	0.008672	0.052680	-0.004275	100.8622	0.087774	-0.138117	-0.082369
	(0.01282)	(0.03503)	(0.05048)	(62.2610)	(0.10297)	(0.17529)	(0.17203)
	[0.67635]	[1.50369]	[-0.08467]	[1.61999]	[0.85239]	[-0.78792]	[-0.47881]
D(LOILP(-1))	0.038722	0.034957	-0.046078	-89.63313	0.010979	0.016220	0.111630
	(0.01094)	(0.02988)	(0.04306)	(53.1026)	(0.08783)	(0.14951)	(0.14672)
	[3.54089]	[1.16990]	[-1.07015]	[-1.68792]	[0.12501]	[0.10849]	[0.76083]
D(LOILP(-2))	0.020585	0.051317	-0.005932	228.4858	0.196549	-0.100363	0.019028
	(0.01362)	(0.03722)	(0.05363)	(66.1385)	(0.10939)	(0.18621)	(0.18274)
	[1.51138]	[1.37893]	[-0.11061]	[3.45466]	[1.79682]	[-0.53898]	[0.10413]
D(LOILP(-3))	0.035590	0.062141	0.008050	-27.56694	0.155659	-0.215215	0.012578
	(0.01356)	(0.03705)	(0.05339)	(65.8417)	(0.10890)	(0.18537)	(0.18192)
	[2.62480]	[1.67728]	[0.15078]	[-0.41868]	[1.42942]	[-1.16098]	[0.06914]
D(LOILP(-4))	0.009843	0.009456	0.033016	-72.37706	0.086295	0.247857	0.010551
	(0.01489)	(0.04069)	(0.05863)	(72.3051)	(0.11959)	(0.20357)	(0.19978)
	[0.66106]	[0.23242]	[0.56314]	[-1.00099]	[0.72162]	[1.21755]	[0.05281]
C	0.038203	0.063720	0.030048	31.90102	0.216341	0.131849	0.316480
	(0.00946)	(0.02584)	(0.03723)	(45.9166)	(0.07594)	(0.12928)	(0.12687)
	[4.04015]	[2.46627]	[0.80707]	[0.69476]	[2.84877]	[1.01991]	[2.49457]
R-squared	0.931342	0.960222	0.710713	0.850610	0.609410	0.591033	0.521055
Adj. R-squared	0.871006	0.925266	0.456491	0.719327	0.266164	0.231637	0.100163
Sum sq. resids	0.005429	0.040531	0.084165	128013.7	0.350172	1.014726	0.977280
S.E. equation	0.012826	0.035046	0.050502	62.28326	0.103011	0.175355	0.172089
F-statistic	15.43596	27.46944	2.795640	6.479228	1.775432	1.644518	1.237979
Log likelihood	205.4202	142.0945	119.0775	-329.3210	74.16953	40.65514	41.83954
Akaike AIC	-5.568897	-3.558555	-2.827858	11.40702	-1.402207	-0.338258	-0.375859
Schwarz SC	-4.548356	-2.538015	-1.807318	12.42756	-0.381667	0.682282	0.644682
Mean dependent	0.049577	0.005266	0.054193	8.064494	0.052585	-0.011669	0.002444
S.D. dependent	0.035712	0.128198	0.068502	117.5631	0.120250	0.200048	0.181414

Determinant resid covariance (dof adj.)	8.00E-12
Determinant resid covariance	8.65E-14
Log likelihood	321.7136
Akaike information criterion	-3.324240
Schwarz criterion	4.057669
Number of coefficients	217

Table A7. Autocorrelation LM Test: Baseline Model (1)

VEC Residual Serial Correlation LM Tests
Date: 05/24/22 Time: 14:16
Sample: 2004Q2 2021Q1
Included observations: 63

Null hypothesis: No serial correlation at lag h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	36.93335	49	0.8975	0.713921	(49, 106.0)	0.9056
2	52.04200	49	0.3564	1.069981	(49, 106.0)	0.3794
3	49.12500	49	0.4681	0.997962	(49, 106.0)	0.4914
4	48.66905	49	0.4865	0.986851	(49, 106.0)	0.5096
5	28.13765	49	0.9927	0.524987	(49, 106.0)	0.9935

Null hypothesis: No serial correlation at lags 1 to h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	36.93335	49	0.8975	0.713921	(49, 106.0)	0.9056
2	110.2225	98	0.1877	1.123610	(98, 91.1)	0.2871
3	169.2904	147	0.1006	1.019320	(147, 51.0)	0.4818
4	NA	196	NA	NA	(196, NA)	NA
5	NA	245	NA	NA	(245, NA)	NA

*Edgeworth expansion corrected likelihood ratio statistic.

Table A8. White Heteroskedasticity Test: Baseline Model (1)

VEC Residual Heteroskedasticity Tests (Levels and Squares)
Date: 05/24/22 Time: 14:17
Sample: 2004Q2 2021Q1
Included observations: 63

Joint test:

Chi-sq	df	Prob.
1646.274	1624	0.3443

Individual components:

Dependent	R-squared	F(58,4)	Prob.	Chi-sq(58)	Prob.
res1*res1	0.899710	0.618695	0.8176	56.68172	0.5244
res2*res2	0.892298	0.571373	0.8486	56.21479	0.5420
res3*res3	0.947155	1.236098	0.4755	59.67079	0.4147
res4*res4	0.974714	2.658472	0.1753	61.40699	0.3549
res5*res5	0.887347	0.543229	0.8667	55.90286	0.5537

res6*res6	0.914050	0.733421	0.7422	57.58512	0.4907
res7*res7	0.860058	0.423849	0.9361	54.18364	0.6180
res2*res1	0.955388	1.476944	0.3894	60.18947	0.3965
res3*res1	0.938003	1.043438	0.5627	59.09420	0.4353
res3*res2	0.948822	1.278599	0.4586	59.77579	0.4110
res4*res1	0.904277	0.651506	0.7959	56.96946	0.5136
res4*res2	0.929066	0.903278	0.6380	58.53113	0.4558
res4*res3	0.978134	3.085079	0.1393	61.62246	0.3478
res5*res1	0.960807	1.690659	0.3299	60.53082	0.3846
res5*res2	0.850418	0.392089	0.9514	53.57632	0.6403
res5*res3	0.950656	1.328695	0.4396	59.89136	0.4069
res5*res4	0.980178	3.410361	0.1188	61.75124	0.3436
res6*res1	0.886910	0.540861	0.8682	55.87531	0.5547
res6*res2	0.983184	4.032291	0.0903	61.94061	0.3374
res6*res3	0.955232	1.471538	0.3911	60.17961	0.3968
res6*res4	0.909399	0.692234	0.7691	57.29213	0.5016
res6*res5	0.916196	0.753971	0.7290	57.72034	0.4857
res7*res1	0.862098	0.431139	0.9324	54.31217	0.6132
res7*res2	0.982611	3.897086	0.0955	61.90450	0.3386
res7*res3	0.942425	1.128871	0.5218	59.37277	0.4253
res7*res4	0.935037	0.992643	0.5888	58.90732	0.4421
res7*res5	0.959818	1.647378	0.3408	60.46856	0.3868
res7*res6	0.986235	4.941385	0.0639	62.13283	0.3312

Table A9. Normality Test: Baseline Model (1)

VEC Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
Null Hypothesis: Residuals are multivariate normal
Date: 05/24/22 Time: 14:18
Sample: 2004Q2 2021Q1
Included observations: 63

Component	Skewness	Chi-sq	df	Prob.*
1	0.155656	0.254401	1	0.6140
2	0.862879	7.817887	1	0.0052
3	0.171753	0.309740	1	0.5778
4	0.389870	1.595989	1	0.2065
5	-0.011034	0.001278	1	0.9715
6	-0.390019	1.597207	1	0.2063
7	-0.101024	0.107162	1	0.7434
Joint		11.68366	7	0.1115

Component	Kurtosis	Chi-sq	df	Prob.
1	2.548312	0.535558	1	0.4643
2	3.897442	2.114181	1	0.1459
3	3.224870	0.132737	1	0.7156
4	2.546825	0.539089	1	0.4628
5	3.038792	0.003950	1	0.9499
6	3.561321	0.827089	1	0.3631
7	3.079578	0.016623	1	0.8974

Joint	4.169227	7	0.7601

Component	Jarque-Bera	df	Prob.
1	0.789960	2	0.6737
2	9.932068	2	0.0070
3	0.442477	2	0.8015
4	2.135078	2	0.3439
5	0.005228	2	0.9974
6	2.424296	2	0.2976
7	0.123785	2	0.9400
Joint	15.85289	14	0.3224

*Approximate p-values do not account for coefficient estimation

Figure A1. Impulse Response Functions: Baseline Model (1)

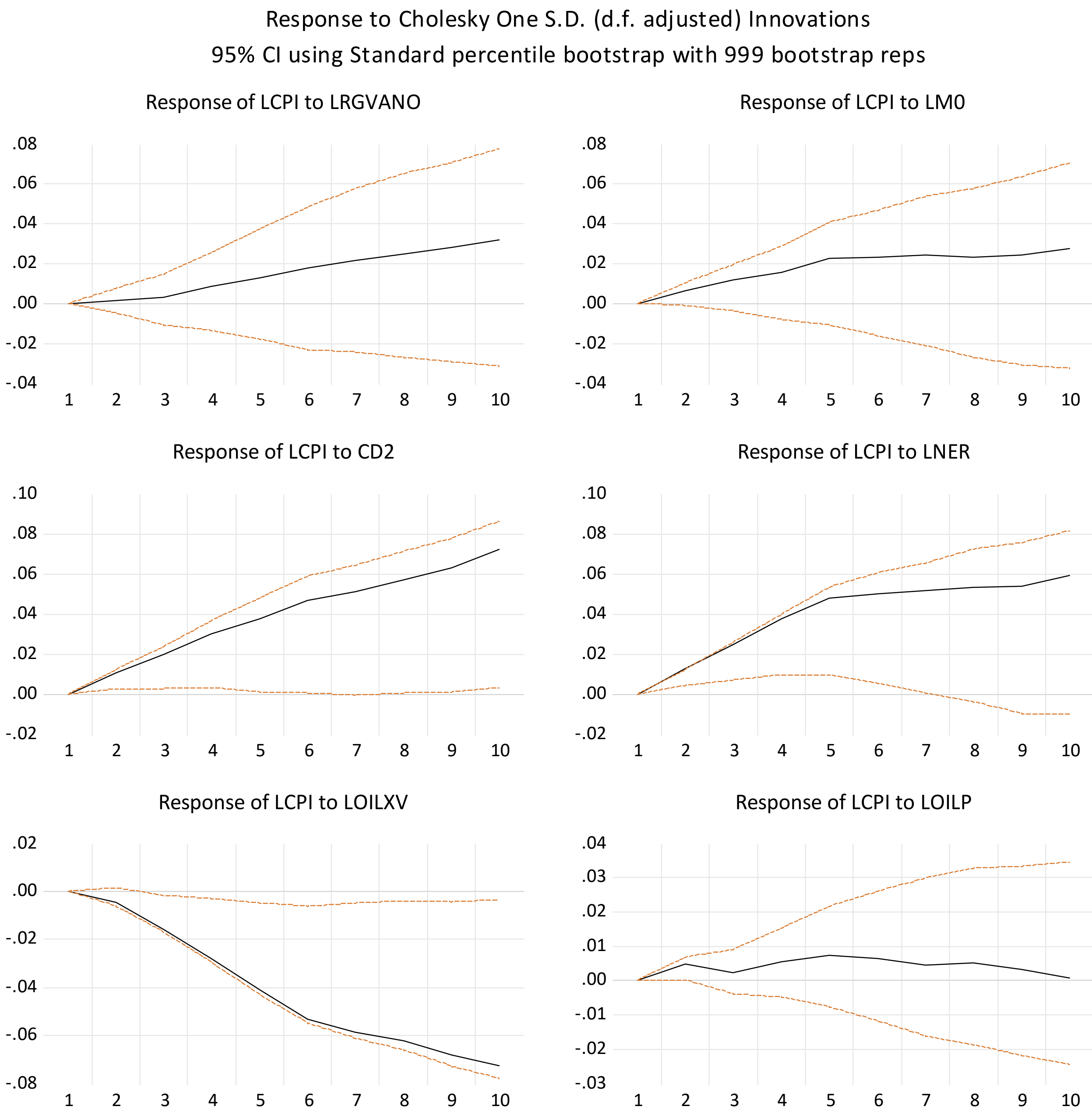
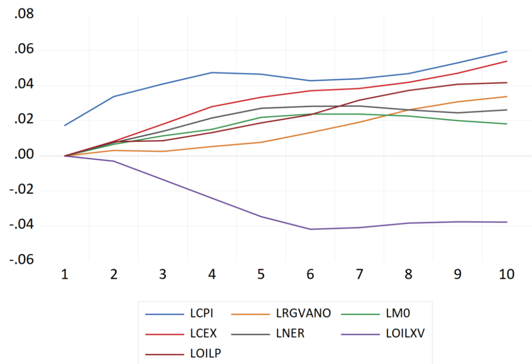
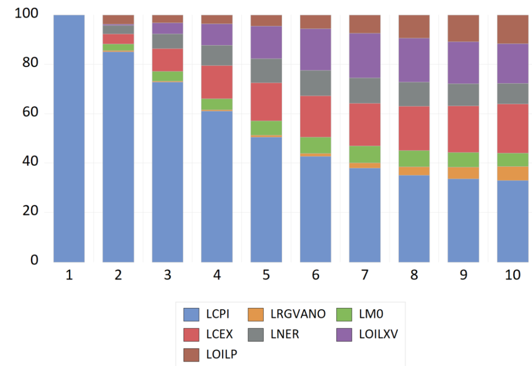


Figure A2. Impulse Responses and Variance Decompositions: Models (2) – (7)

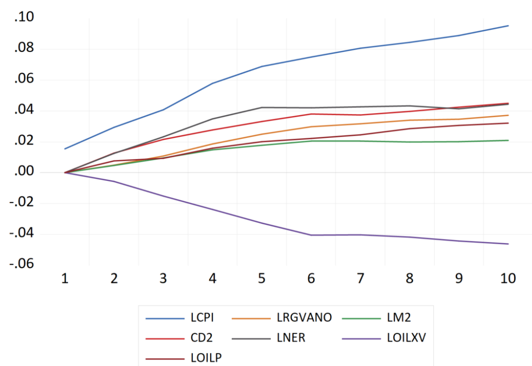
Impulse Responses of ln CPI **Variance Decompositions of ln CPI**

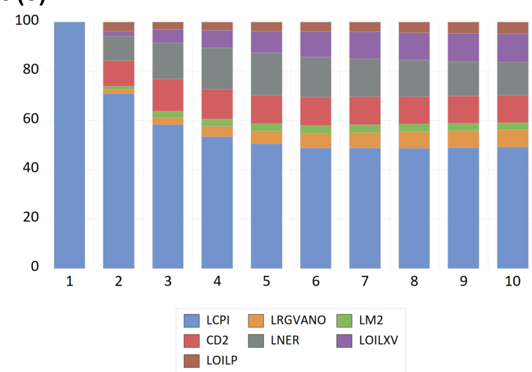
Model (2)



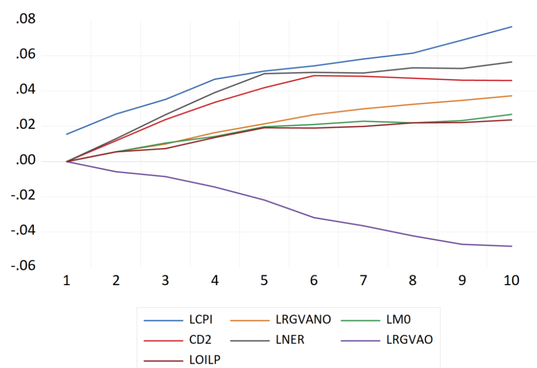


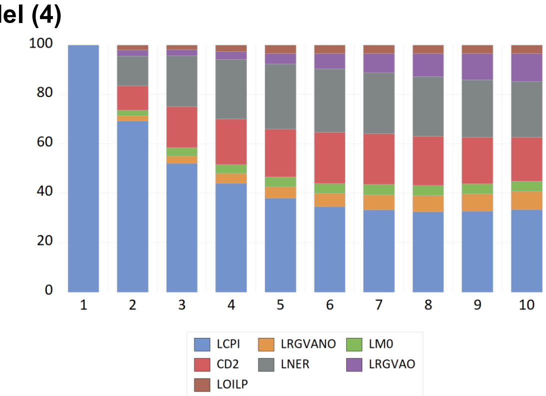
Model (3)





Model (4)





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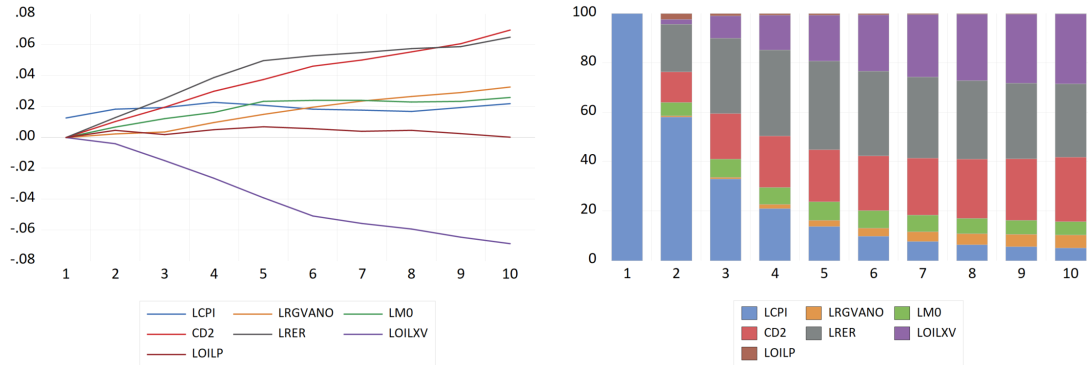
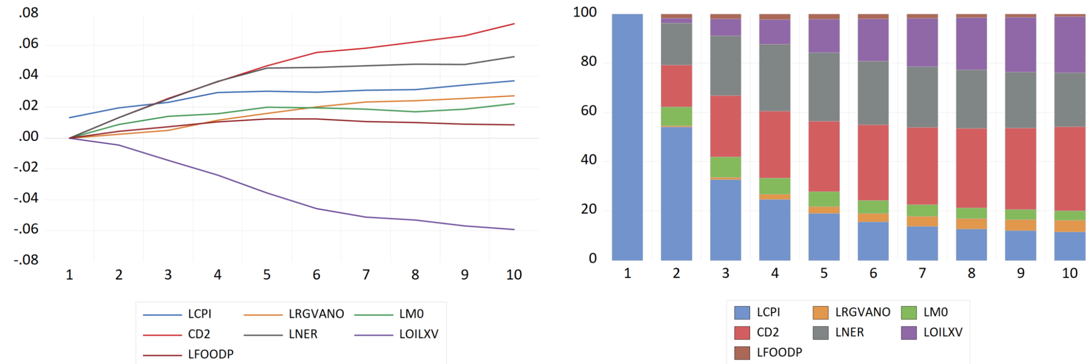
Model (5)



Model (6)



Model (7)

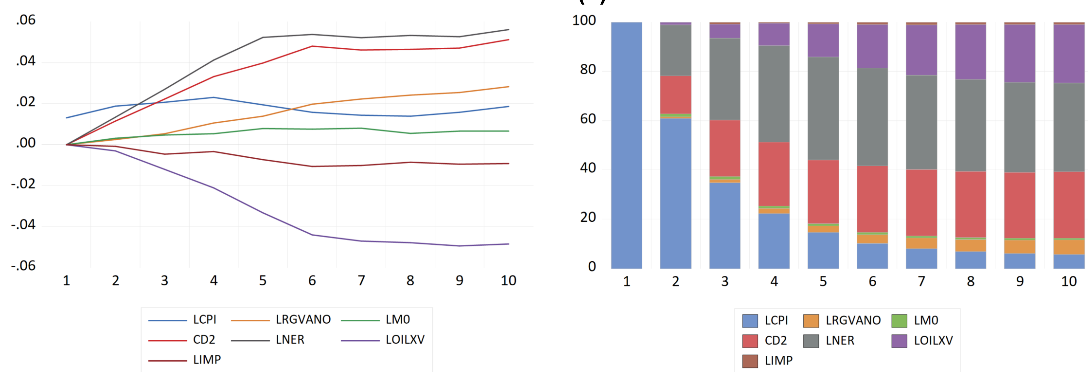
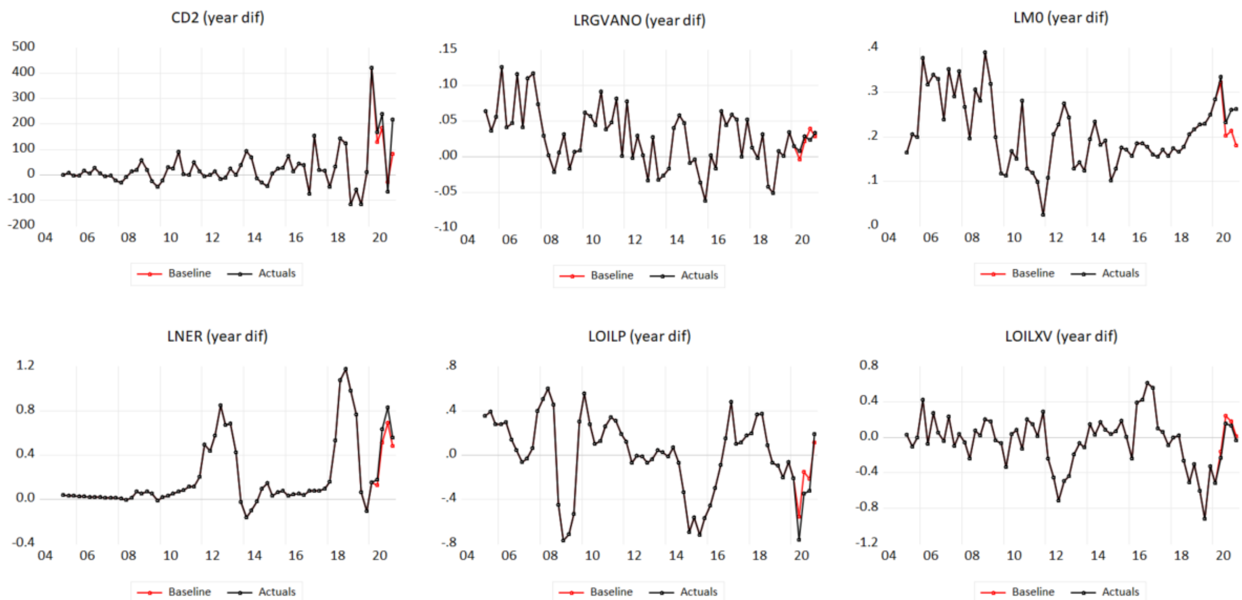
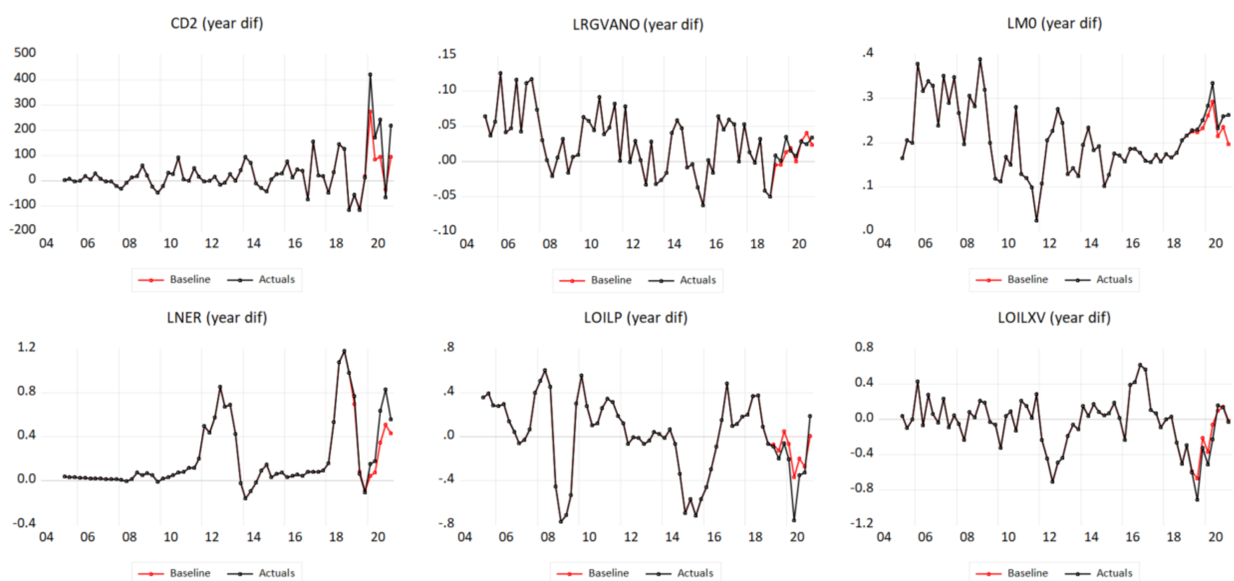


Figure A3. Forecast Performance of Baseline Model (1)

a. Over the last 4 quarters (2020Q2-2021Q1)



b. Over the last 8 quarters (2019Q2-2021Q1)



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