

DRIVERS AND IMPACTS OF INFLATION: A LOOK AT ENERGY PRICES, EXCHANGE RATE VOLATILITY, AND STOCK MARKETS

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Abstract: *In the last decade the world has experienced a number of global crises which triggered economic downturns. Impacts from the global financial crisis, the global COVID pandemic, and Russia's invasion of Ukraine trigger instability in financial markets. This paper explores similarities and differences between these crises based on inflation and its energy-related components. A Vector Autoregressive (VAR) model is used to analyze both EU-level trends, as well as data for Romania. The findings indicate idiosyncratic shifts in the relationships between variables. The changes are often specific to individual shocks and the policy context. How policy makers respond to these shocks will also impact the fiscal space, the borrowing costs of countries, and the cost of servicing debt, which risks a return to the type of austerity policies that slowed down the post-financial crisis recovery. There is a need for more detailed research and investigations in policy responses designed to respond to ongoing events.*

Keywords: *economic crises, energy prices, exchange rate volatility and stock markets.*

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Introduction

In less than two decades, the European Union (and the global economy, have been hit by two major economic crises. Following the Global Financial Crisis (GFC) that started in 2008, the EU economy shrunk by 4.2 percent in 2009 and only reached its pre-crisis output level by 2014 (International Monetary Fund, 2023). In 2020, an initial shock triggered by the onset of the Covid-19 pandemic was followed by a one-year decline in real GDP of 5.6 percent. A strong initial policy response and generous stimulus measures supported a rapid recovery and output levels recovered above their pre-Covid levels by 2022 (International Monetary Fund, 2023). However, the crisis that started with the onset of the pandemic continues to reverberate through the economy, as the impacts persist and there are signs of a renewed slowdown and risks of another recession. This is due to additional shocks, such as Russia's invasion of Ukraine in 2022, and the economic repercussions and instability that it triggered. This ongoing economic context has been dubbed the "polycrisis" (PC), with developments that continue to impact the supply of goods and commodities globally, exacerbate capital market and exchange rate volatility, and present threats to global financial stability (Tooze, 2022).

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The EU, with a prior dependence on Russian gas, has to navigate an energy crisis and is coming out of a winter throughout which energy prices reached record highs. The energy shock came at a time when supply-chain bottlenecks from the pandemic were already creating inflationary pressure, with overall inflation persisting within the EU and globally. After over a decade of low and even negative interest rates in advanced economies, central banks are responding to higher inflation through rapid and aggressive monetary tightening. Debates within policy and academic circles reflect growing concerns and questions over the effectiveness of this approach, as well as the possible negative consequences to the economic and financial stability of continued interest rate hikes and monetary tightening (Grubb, 2022; European Central Bank, 2023a; de Mendoca & Garcia, 2023; Weber et al., 2022).

The response of EU institutions and its member states to the initial pandemic shock distinguishes itself positively from how the response to the GFC unfolded. Studies highlight a more firm and rapid response in support of financial stability and stimulus policy following the onset of the pandemic (Quaglia & Verdun, 2022). The EU set up a facility for the issuance of joint debt instruments in support of recovery programs, as well as projects to accelerate the energy transition and support energy independence (European Commission, 2023b). These efforts however risk being hampered by a slowdown or recession caused by excessive monetary tightening and by the increased cost of capital and investment, a concern echoed by European Central Bank (ECB) officials (European Central Bank, 2023a).

It is within this context that this paper aims to explore and better understand the similarities and differences between how select macroeconomic variables interact. The paper looks at variables such as inflation, represented by the harmonized consumer price index and its energy-related component, the harmonized consumer price index for energy and the relationship to exchange rates, as well as the return of the stock market. The macroeconomic variables represent energy price related variables that are directly or indirectly influenced by the events. Through constructing a Vector Autoregressive (VAR) model, the analysis focuses on both EU-level trends, as well as data for Romania, as a case study for a non-euro area EU member, in order to identify whether EU-wide trends are reflected at the country-level, especially for members at the EU periphery.

The findings identify idiosyncratic shifts in the relationships between variables. The changes are often specific to individual shocks and the policy context. This reinforces concerns and questions over the current policy response and whether a singular policy tool, in this case rapid monetary tightening and increases in interest rates, is an appropriate policy for tackling inflation.

These moves are expected to continue despite the acknowledgment from within the institutions that the consequences of this move are alarming while the causes of inflation remain unaddressed (European Central Bank, 2023a). It is also important to note that the increase in the policy rate means an increase in the interest rates paid by governments on their debt as the yields on their bonds have moved with the policy rate (Eurostat, 2023).

In a context where dependence on energy imports and a shock to energy prices was undoubtedly a significant factor in the onset of inflationary pressures, the relationship

between higher interest rates and investments toward a green energy transition suggests the current policy response does not address and might even increase the vulnerabilities let to the energy price shock.

1. Literature review

In the aftermath of the POLYCRISIS shocks, persistent inflation has been a problem globally, as well as for the EU, where the overall inflation rate reached 9.3 percent in 2022 and is expected to average 6.3 percent in 2023 (International Monetary Fund, 2023). The response to inflation from the ECB is a continued increase in interest rates, which have increased from close to zero to over 4 percent in less than one year (Eurostat, 2023). This move has also brought up interest rates and yields overall, increasing borrowing costs for governments and their costs of servicing debts. High inflation is a problem that advanced economies last encountered in the 1980s (International Monetary Fund, 2023).

The response of the ECB, to increase interest rates follows the old-time established playbooks of central banks, which aim to reduce economic activity and dampen demand with higher unemployment through higher interest rates (Ireland, 2010). Not all members of the EU are part of the euro area and subject to the policy decisions of the ECB, however, given their open capital accounts countries outside of the euro area must follow the ECB and increase interest rates as well in order to avoid large capital outflows (de Paula et al., 2017).

This type of response is aimed at the issue of a possible wage-price-spiral-led inflationary episode. There is mounting evidence to counteract the idea that wages are currently the main driver of inflation in the eurozone. While a debate over what the largest drivers of inflation are continues, there is general agreement, including from ECB and International Monetary Fund (IMF) research that rules out wages, and identifying energy prices, import prices, as well as increased mark-up and profits as the main drivers of inflation (European Central Bank, 2023b; Giri, 2022; Hansen et al., 2023; Weber et al., 2022). Similar methods and impact analysis of macroeconomic variables in the region have been used by Aursulesei 2020, Benea-Popușoi 2021, and Diavor, M., 2021.

Previous research from the ECB has shown that energy price increases rapidly pass through to other prices and the non-energy components of inflation (European Central Bank, 2016). The spill-over effects of Russia's invasion of Ukraine brought to the forefront the EU's energy dependence on Russian gas and underscored the urgency of a transition to green energy which also weans the EU off dependence on gas imports, and the European Commission has put forth a plan and proposal for each member state to make large scale investments towards this transition (European Commission, 2023a).

The countries that are EU members are far from a monolith, with distinct economies. Countries outside of the euro area, which are predominantly Eastern European countries at the periphery face additional concerns due to capital flow and exchange rate volatility. The EU overall is currently a net importer of energy but certain members, such as Romania are large energy producers and less dependent on imports (Eurostat, 2023). These differences highlight how the context of each member state is distinct, and the specific characteristics of

each economy further suggest that distinct types of shocks would not have the same impact, as well as how specific policies would result in different impacts depending on the context.

2. Data and Methodology

We build a dataset using the following databases: Eurostat, European Central Bank, and Refinitiv. The data downloaded is compiled into a new dataset, which includes monthly data for a number of indicators. The variables included show the annual changes in inflation, both overall, as well as for energy and excluding energy, exchange rate fluctuations, and the changes in representative stock market indices. The dataset starts in January 2008, to capture the impact of the GFC and continues until the most recent available data at the time of this analysis, using monthly data for all variables. The analysis is carried out by dividing the data into three periods: GFC - the global financial crisis and its aftermath from January 2008 until December 2012; PC - the polycrisis triggered by Covid, Russia's war in Ukraine and beyond from February 2020 until June 2023. The period in between crises, from January 2013 until January 2020 is labeled NC - the non-crisis period - and used as a reference point. The NC dataset includes the largest number of observations and allows for an indicative analysis of how variables interact outside of the crises. For each of the variables and timeframes, the data set includes series for the EU, comprising its current 27 members, as well as for Romania. The series of variables that show the totals for all EU countries are contrasted with data for Romania specifically in order to examine the relationship between inflation, exchange rate, and stock market volatility between the EU overall, and an Eastern European member of the union still outside the eurozone. The list and description of variables are shown in Table 1.

Table 1. Variables in the model

Variable	Description
hicp_all_eu	Harmonized Index of Consumer Prices (HIPC), annual rate of change, monthly series, all items, EU 27
hicp_all_ro	HIPC, annual rate of change, monthly series, all items, Romania
hicp_e_eu	HIPC, annual rate of change, monthly series, energy, EU27
hicp_e_ro	HIPC, annual rate of change, monthly series, energy, Romania
hicp_excle_eu	HIPC, annual rate of change, monthly series, excluding energy, EU27
hicp_excle_ro	HIPC, annual rate of change, monthly series, excluding energy, Romania
xr_eur_leu	Euro to Leu exchange rate, monthly average
xr_eur_us	Euro to USD exchange rate, monthly average
em_bet_ro	BET Romanian Stock Market Index
em_stoxx_euro	Euro STOXX 50 Index, composed of 50 blue-chip stocks from 11 countries in the Eurozone

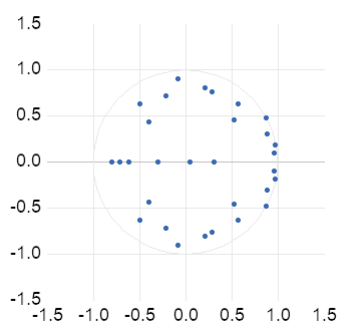
Source: Author's compilation

We construct a Vector Autoregressive (VAR) model for each period in EViews which we use as the basis for further analysis. For each period we test the stability of the model and proceed with further tests. The variables in the model are not stationary but following (Sims, 1989; Watson, 1994) we proceed to test for cointegration using the Johansen test for cointegration using both the trace and eigenvalue test. Results from EViews find that the variables are cointegrated and thus the VAR model is stable regardless of variables meeting the stationary condition. As we are looking to examine the

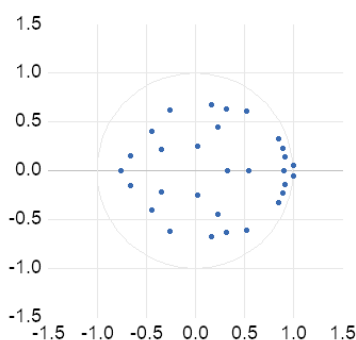
relationships between variables and how they shift during specific periods, we proceed to not differentiate the variables to avoid the loss of information (Sims, 1989).

The selected variables present a strong cointegration relationship for the entire period examined, confirmed through performing the Johansen cointegration test, as well as a test performed for each of the shorter timeframes examined through VAR models (Johansen, 1991). The inverse roots of the AR characteristic model for each period are shown in Figure 1, and confirm the stability of the chosen model for each period, with all points within the circle (Lütkepohl, 1991).

Inverse Roots of AR Characteristic Polynomial



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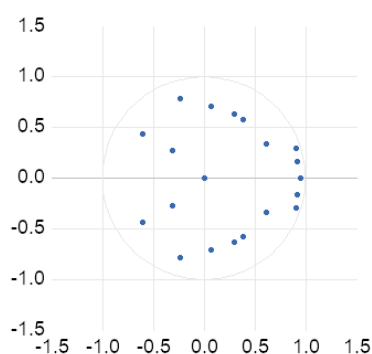


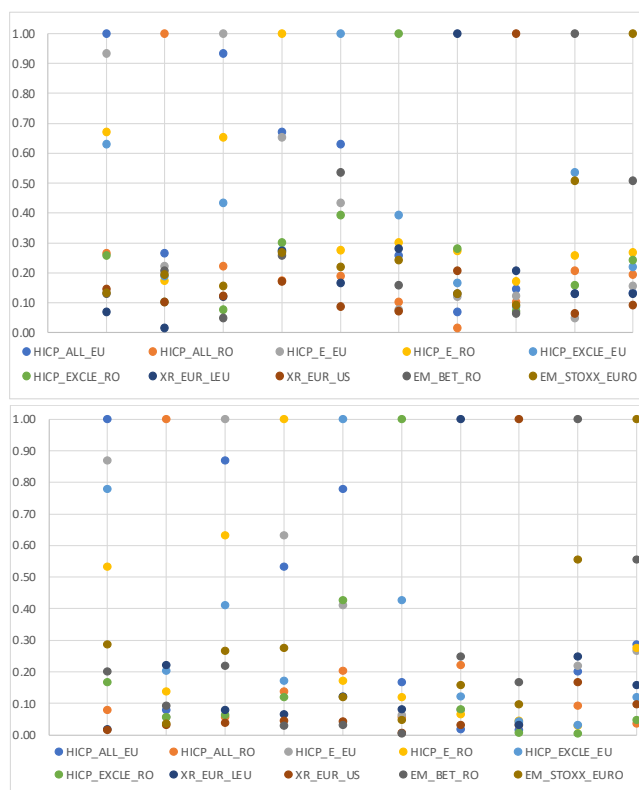
Figure 1. Inverse Roots of Characteristic AR Polynomial (top to bottom: GFC, non-crisis, polycrisis)

Source: Author's calculation

The VAR model is then used to perform a series of tests to examine the shifts in the relationships between the selected variables in each of the three periods examined. The results are presented to highlight the similarities and changes between the crisis and non-crisis periods, as well as between the two crises in this timeframe. For each period we obtain the correlation matrix and covariance matrix, examine pairwise Granger causality relationships, as well as test the impulse response functions to energy price and exchange rate shocks. The following section provides an overview of the results and discusses their possible implications.

3. The Model and Finding

The results from the model show that many of the relationships between variables shift in the crisis periods. Furthermore, relationships between variables at the EU level are not always consistent with those observed for Romania, which highlights the need for more granular analysis and the different contexts of countries within the EU. The components of inflation included in the sample are more volatility during the POLYCRISIS which included an energy shock price, than for example during the GFC. Overall, in the examined sample, the POLYCRISIS exhibits the most changes in relationships and volatility in the indicators. Figure 2 illustrated the correlation matrix for each period, showing the absolute values of the relationships. The correlation is weaker in the past period examined. However, since this is an ongoing crisis, it should be noted that these relationships could stabilize and revert to their historical norm as the crisis unfolds.



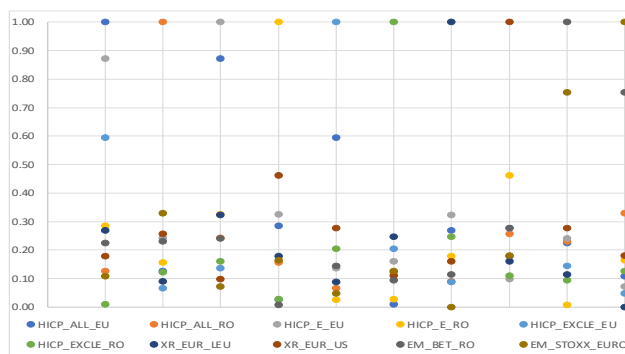


Figure 2. Correlation matrix, absolute values (top to bottom: GFC, non-crisis, Covid).

Source: Author's calculation

The pairwise Granger causality tests that identify causality relationships between variables show significant shifts for the different periods. The pairs for which the null hypothesis of no causality can be rejected with a 0.05 confidence level are unique in each period. Looking at inflation and its decomposed element as the possible dependent variables, the relationships with a causality relationship in at least one period, as well as the reported p-values for each period, are shown in Table 2.

Table 2. Variables with at least one pairwise Granger causality relationship

Dependent variable	Variables	GFC	NC	POLYCRISIS
HICP_ALL_EU	HICP_E_EU	0.046	0.138	0.962
	HICP_EXCLE_RO	0.024	0.774	0.737
HICP_ALL_RO	HICP_ALL_EU	0.658	0.459	0.003
	HICP_E_EU	0.333	0.548	0.003
	HICP_EXCLE_EU	0.046	0.095	0.005
HICP_E_EU	EM_BET_RO	0.806	0.030	0.711
	HICP_ALL_RO	0.405	0.025	0.104
	HICP_E_RO	0.038	0.141	0.208
HICP_E_RO	HICP_EXCLE_RO	0.012	0.604	0.353
	HICP_ALL_EU	0.446	0.003	0.666
	HICP_ALL_RO	0.301	0.004	0.183
	HICP_E_EU	0.925	0.010	0.842
HICP_EXCLE_EU	HICP_EXCLE_EU	0.265	0.001	0.931
	HICP_EXCLE_RO	0.005	0.121	0.021
	EM_BET_RO	0.596	0.004	0.481
	EM_STOXX_EURO	0.241	0.000	0.923
	HICP_EXCLE_RO	0.039	0.063	0.094
HICP_EXCLE_RO	XR_EUR_US	0.229	0.013	0.927
	EM_BET_RO	0.043	0.207	0.531
	EM_STOXX_EURO	0.005	0.447	0.877
	XR_EUR_LEU	0.393	0.886	0.007
XR_EUR_US	XR_EUR_US	0.075	0.472	0.014
	EM_BET_RO	0.581	0.546	0.008
	EM_STOXX_EURO	0.686	0.020	0.005

Source: Author's compilation

The pairwise Granger tests identify multiple causality relationships between the energy price index in the EU and in Romania and other variables. In the case of Romania's energy only price index, causality is identified with the price index that excludes energy, suggesting second order contagion for all other prices through this polycrisis period. A similar relationship is not identified within the same confidence interval for the EU overall, however, as noted

priorly, data for this period is still limited and the relationship should be examined further at a later date. Indicators for Romania have a larger number of identified relationships as the dependent variables, which is not a surprising result, as developments within the EU are more likely to drive those in a smaller Eastern Europe member than vice versa.

The impact of two types of shocks – energy price and exchange rate on inflation and stock markets are examined through impulse response (IR) functions for each period. A similar pattern is observed: the impact of the shocks shifts depending on the period, as well as when looking at EU and Romania data. In the case of Romania, exchange rate shocks are consistently more impactful for inflation and stock market shifts, a result consistent with Romania’s overall position in global capital markets. Given space limitation, we present the more pronounced responses to the IR functions for both the EU and Romania for the polycrisis period, which is also of relevance to current policy discussions. These results are shown in Figures 3 and 4.

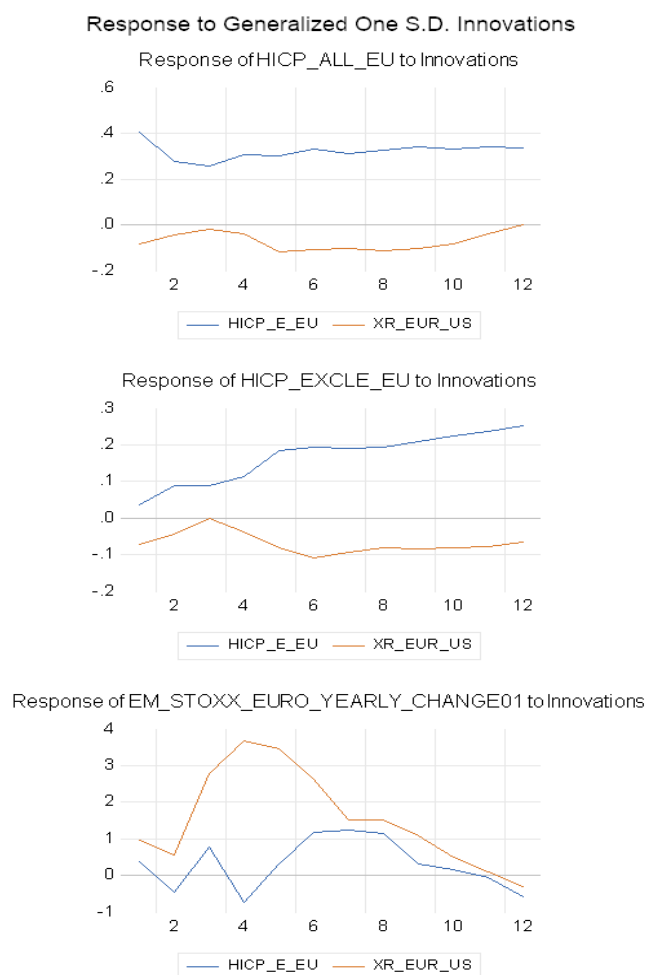


Figure 3. Impulse response function to generalized shock for energy price index and exchange rate, POLYCRISIS

Source: Author’s calculation

Looking at the POLYCRISIS period, for the EU, exchange rate shocks for the euro vis-à-vis the US dollar, its main trading currency outside the euro, have a limited impact on inflation. The exchange shock leading to a pronounced positive reaction from capital markets that continues for several periods is a result unique to the polycrisis period. During the GFC a similar exchange rate shock had a negative impact on the stock index. In the case of the EU, exchange rate shocks for all periods and the energy price shocks during the GFC and in the non-crisis period tend to revert to the previous trend within a few periods. During the polycrisis period, the energy price shocks signal a persisting impact on inflation, with a stronger initial impact on the overall price index, and then a second-order impact on the price index which excludes direct energy prices. The persistence of the shocks on inflation in this period could be related to the policy responses and tightening of monetary conditions, which are not captured by the model.

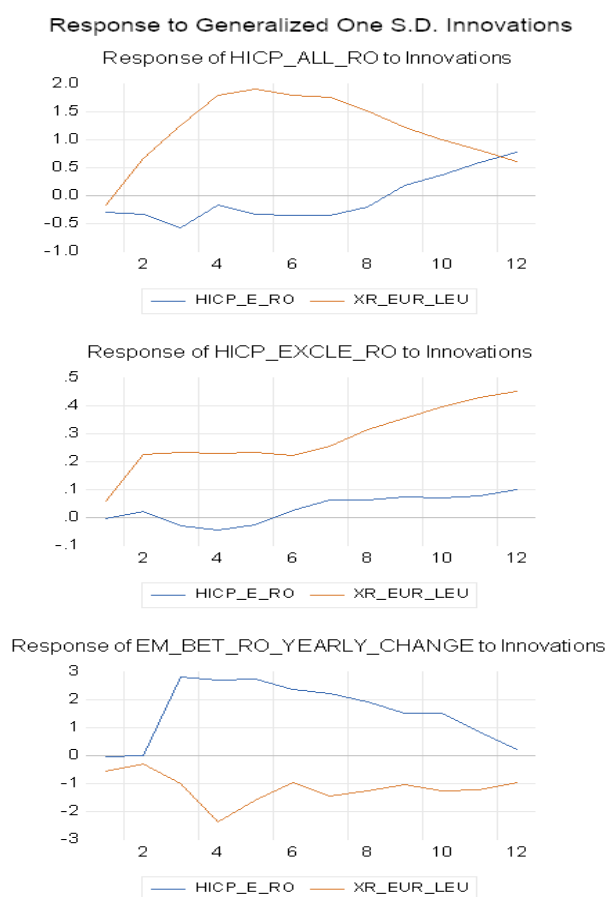


Figure 4. Impulse response function to generalized shock for energy price index and exchange rate, POLYCRISIS

Source: Author's calculation

In the case of Romania, a shift emerges in the variable with a larger and more persistent impact on inflation and on the stock market. A shock to the exchange rate has a negative albeit small effect on the stock index, which is a departure from the impact of a

similar shock during the period from the GFC and preceding the pandemic. For Romania, in the polycrisis period, the most persistent shock for inflation is due to the exchange rate. Shifts in domestic energy prices have a lesser impact on inflation indicators, leading first to a negative response and in later periods to increases in the overall price index and the price index which excludes energy through second-order effects. This resonates with the finding illustrated in Table 2, which suggests that EU-wide price shifts have a stronger causal relationship with price levels within Romania.

Conclusions

Continuing monetary tightening and persisting inflation dominate policy discussion in Europe and there is no sign the ECB will slow down on interest hikes. Thus, the monetary policy response will also impact fiscal space, the borrowing costs of countries, and the cost of servicing debt, which risks a return to the type of austerity policies that slowed down the post-financial crisis recovery.

As highlighted in this article, it is important to better understand the drivers of inflation, the interactions of components, and their impacts. The results caution on the risks of looking at EU-wide trends, which are on occasion very different than what is experienced at the country level, as well as way as not recognizing the peculiarities in how variables respond depending on the overall macroeconomic context, with variables responding differently in times of crises, as well as in response to specific shocks. This finding points to the need for more granular research and investigations and policy responses designed to respond to ongoing events.

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