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ECONOMIC RECESSIONS: TRIGGERS, TRANSMISSION MECHANISMS, AND STRATEGY FRAMEWORKS OF RESILIENT RECOVERY

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Abstract

This research is an in-depth analysis of economic recessions with a focus on the sources of recession, the transmission mechanisms, and the channels through which recessions spread across economies. Challenging the traditional reliance on lagging macroeconomic indicators and generic policy interventions, the research synthesizes structural frameworks including Simulation Frameworks namely Agent-Based Modeling (ABM) for Behavioral Contagion, Computable General Equilibrium (CGE) for Sectorial Dynamics, Monte Carlo Stochastic Simulation, Macro-Financial Stress Testing for Credit Channel Resilience, Predictive Risk Assessment Modeling for Recession Forecasting with Machine Learning (Random Forest), Markov-Switching VAR (MS-VAR), and Dynamic Probit models. Furthermore, the study constructs a customized Financial Stress Index (FSI) applied across an 18-country panel, strategically categorized into advanced financial centers, commodity exporters, global manufacturing hubs, and debt-distressed emerging markets. Empirical results reveal that commodity exporters (Brazil, Russia, Nigeria) experience FSI peaks between +3.8 and +4.1 during price crashes, driven by exchange rate volatility and reserve depletion rather than interbank illiquidity. In contrast, diversified markets (India, South Africa) show lower FSI peaks (+3.3 to +3.6) fueled by capital flight, while debt-distressed and dollarized economies (Argentina, Egypt) register the most extreme stress levels, peaking at +4.3 to +5.5. Transmission mechanisms vary by economic model: resource-dependent states face imported inflation and currency devaluation, while regional panics in developing economies can trigger systemic bank failures (FSI +5.2). Recovery timelines are extensive, ranging from 36 months for commodity-led shocks to over 40 months for debt-distressed nations requiring IMF structural adjustments and capital controls. The findings demonstrate that uniform interventions are fundamentally flawed. Resilient recovery requires the strategic alignment of preemptive buffers and policy responses tailored to the specific financial stressors inherent in each nation's economic model. When recession probabilities hit 30-49% triggered by inverted yield curves and rising credit spreads enhanced macro-financial testing is activated. Monte Carlo simulations indicate an 82% recession risk if oil prices drop below $40/bbl amid high global interest rates. Without active currency defense, the probability of a long-term stagflationary trap reaches 88%. While unstructured interventions lead to total collapse during demand shocks, a CGE model of structural diversification demonstrates agricultural resilience which grows by 18%, absorbing displaced labor and a Manufacturing/MSMEs resilience which increase by 12%, eliminating supply bottlenecks. This internal balancing preserves economic viability even during extreme international oil market instability. While advanced economies experience rapid interbank liquidity freezes, emerging commodity exporters face prolonged foreign exchange volatility and imported inflation, and manufacturing hubs suffer acute corporate debt crises driven by supply chain bottlenecks. Aggregate demand stimulus is fundamentally ineffective at clearing these localized supply-side physical constraints, as inflation dynamics completely decoupled from traditional monetary determinants during the poly-crisis. The study establish that macroeconomic resilience requires a paradigm shift from aggregate stimulus to predictive, model-specific interventions, advocating for the institutionalization of automated stochastic fiscal buffers and macro-financial frictions targeting. In time, the study provides policymakers with a scientifically validated roadmap for diversifying national revenue bases and safeguarding transmission channels, ensuring that future exogenous shocks result in transient structural stumbles rather than systemic economic collapses.

Keywords: Economic Recession, Crisis Triggers, Digital Asset Contagion, Resilient Recovery, Supply-Side Shocks, Policy Interventions, Structural Reforms, Emerging Markets, Fiscal Stimulus, Structural Reforms, Economic Cycles, Financial Stress Index (FSI), MS-VAR, Random Forest.

JEL Classification: E32, E44, E52, E62, G01, F44. O11

1. Introduction: The Structure of a Contraction

Economic recessions are times of economic stagnation, when output declines, unemployment increases, and consumer spending decreases. Although recessions do not have a standard set of causes or consequences, they are characterized by a common pattern: there is an initial shock to the economy caused by some trigger, transmission mechanisms spread the shock across sectors, and responses to the shock influence the recovery process. The chapter unpacks the multidimensional nature of recessions by examining three main dimensions: triggers, mechanisms of transmission, and strategies of recovery, basing on up-to-date empirical evidence (2023-2026) and historically important case studies, such as the Great Recession (2008), the COVID-19 global downturn (2020), and economic contractions in Nigeria (20 Recession in the modern global economy is seldom localized. According to (Aloui et al., 2025), the growing integration of digital resources, classic equities, and supply chains across borders implies that a shock in one area could occur in the form of a systemic crisis, on the other side of the planet, in weeks. A resilient recovery, therefore, depends not just on the size of the stimulus but on an accurate diagnosis of how the shock moves through the economic nervous system. Empirical research finds that during recessions, investment declines disproportionately in firms with weaker balance sheets and limited access to credit (Khan et al., 2023). Indicatively, numerous small and medium enterprises (SMEs) were under solvency pressure due to the pandemic because their income has decreased, and the fixed liabilities have not. This limited investment and retrenchment followed and the slump lasted longer in areas that are very dependent on external funding. Recession shocks can be passed through the asset markets through the change in prices; the stock prices incorporate expectations of the future profitability. Equity valuations decline drastically during recessions, in reaction to the declining anticipated earnings, and since the

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losses in wealth by equity holders diminish consumer confidence and consumer spending. When the prices of assets (stocks, real estate, or cryptocurrencies) decrease, so does the net worth of households and firms, resulting in decreased consumption and investment (Alqatan et al., 2025). During a recession, banks encounter problems of adverse selection and moral hazard, which makes them increase lending requirements at the time when businesses require liquidity the most (Pamungkas et al., 2025). It has been found that the decrease in equity after 2020 was disproportionately impacting affluent households and institutional investors, which has an implication on overall expenditure (Ferreira and Matos, 2007). Housing happens to be the greatest household asset. Falls in the prices of homes decrease the net worths of households and collateral values which makes mortgages and new borrowing more costly. Housing price adjustments saw after the pandemic undermined household balance sheets and limited consumption in certain markets (Galí, 2008). The post-COVID period saw a tighter credit growth due to weaker bank capital buffers in most emerging markets, which were slowing recovery (Demirguc-Kunt and Singer, 2024; Mashamba and Gani, 2024). A number of the emerging economies have debts in foreign currencies. When there is a recession where the exchange rate is depreciated, the domestic currency value of foreign debt increases, and net worth is destroyed (Edwards, 2023). As illustrative, in commodity-export economies such as Nigeria, the depreciation of currency during the 2016 and 2020 recessions raised the domestic currency price of foreign debt service, exacerbating fiscal strain and destroying corporate balance sheets (G., 2022). Exchange rates may be very volatile during economic recessions. The recession can create a flight of capital, decline in foreign investment, and cause precipitous currency depreciation, particularly in the emerging markets which have less stable foreign balances. These dynamics have been reported in several studies in 2023-2026:

Research on the vulnerabilities of emerging markets (Agosín & Díaz, 2023) indicates that emerging economies have witnessed strong exchange rate volatility following the occurrence of external shocks in the post-COVID phase, where the depreciation of the exchange rate contributes to inflation and reduces real incomes. In terms of commodity dependence, those countries that depend on exports like oil are particularly vulnerable to changes in currency during recessions. When commodity prices decline, currency depreciation is likely to occur, exacerbating inflation using ERPT (Bala et al., 2025). Capital flow reversals: Sudden capital inflow reversal may cause an exchange rate depreciation, which in turn can propagate to domestic prices via imported goods and services (Agosin & Diaz, 2023).These studies show that recessions can worsen external imbalances, heighten currency risk, and amplify the transmission of economic distress through the exchange rate channel. But all sectors are not subject to the same level of demand/supply shocks. Sectors that depended on face-to-face services were disproportionately hit during the pandemic and more resilient sectors such as technology and digital services were not as impacted (Bank, 2023). Conversely, the commodity reliant industries such as oil and agriculture in Nigeria were not spared by the demand shocks in other countries as well as the supply shocks in their own countries (Adekunle & Obafemi, 2025). The importance of sectoral differences is that it affects the dynamics of recovery. Industries where supply can be changed quickly can be bounced back sooner than those with lasting supply limitations such as tourism or informal services, and pull the general recovery along. The research objectives include: (1) to employ predictive machine learning techniques to identify early warning signals of systemic stress prior to observable downturns in macroeconomic aggregates; (2) to incorporate supply chain behavior within a DSGE structure to quantify real output losses arising from logistical disruptions and production network breakdowns; (3) to construct a cross country Financial Stress Index that captures variations in financial stress across advanced, emerging, and debt distressed

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economies; and (4) to empirically assess how these integrated indicators improve the forecasting of recession severity and the effectiveness of policy interventions relative to traditional models.

2. TRIGGERS OF ECONOMIC RECESSIONS: CATALYSTS OF DISRUPTION

Economic shocks are the initial signs of recessions which upset the economic balance. Recessions are no longer one-factor situations. They are set off by a complicated interaction in which a financial shock (such as a crypto crash) can intersect with a structural fault line (high corporate debt), catalyzed by a policy mistake (over-tightening). The first events that can cause a transition of an economy between expansion and contraction are the triggers, which have different effects based on structural vulnerabilities and interdependencies in an economy. Their differences are numerous in contexts. According to recent literature, these can be divided into four main archetypes:

2.1 Endogenous Financial Triggers

One of the most mentioned causes in the contemporary recession literature is the financial triggers and shocks. They start in the financial markets or financial institutions and tend to propagate quickly to the real economy. These are the most prevalent triggers of recessions in the market-based economies. These are internally caused by the buildup of imbalance which is too much debt and asset bubbles that burst. According to Chatziantoniou et al. (2022), high-leverage jobs in the speculative markets in the G7 economies still constitute the strongest catalyst of systemic instability.

Asset Price Collapses: Rapid, drastic drops in the prices of assets: equities, commodities, or real estate may cause recessions by reducing wealth and constraining the financial situation. The article (Claessens & Koese, 2017) re-examines the importance of asset price dynamics in the business cycle and demonstrates that big negative returns in financial assets often prelude contractionary periods, particularly when the household and firm balance sheets are highly leveraged. (Heuvel et al., 2019) further provide that wealth shocks are asymmetric: losses decrease consumption and investment more than equal gains spur it. When the prices of assets decrease, this asymmetry exacerbates recession. As (Chen & Hsu, 2025) explain, the 2023-2025 volatility cycles were mainly caused by the explosion of post-pandemic asset bubbles. With central banks increasing interest rates to fight inflation, the easy money that had propelled high prices in real estate and equities dried up. This caused a balance sheet recession in which depreciation of asset values contracted firms to deleverage instead of investing. The reason behind the manufacturing slowdown in G7 countries in 2024 was the abrupt increase in the cost of borrowing, which left these companies in bankruptcy leading to a series of defaults, a crisis that paralyzed credit markets.

Banking Stress and Credit Collapse: Banks recessions are powerful agents of recession. The credit markets free up, investment declines and consumer confidence is lost when financial institutions are struggling with solvency issues. Empirical studies indicate that financial shocks are a key cause of macroeconomic instability. Angel et al., (2024) explain that the breakdown of banks and reduction of credit during spells of financial stress contributes greatly to the deterioration of economic activity and the prolongation of recessions. Bernanke and Gertler (2000) note that credit supply shocks which are caused by banks limiting lending because of losses or risk aversion are directly reflected in the decline in business investment and household borrowing which further worsens the economic contractions.

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Financial Shocks: The great recession in 2008 was anchored in a meltdown of the mortgage market in the United States on the subprime level. Systemic banking failures were caused by excessive leverage, poor risk management, and bursting of housing market bubbles (Wang et al., 2019). The interconnectiveness of the global financial system implied that the local banking distress was fast turned into a global decline.

2.2 Exogenous Supply-Side Shock/Triggers

Wars or natural calamities that suddenly stop the production or trade are external events. The transition shift in energy is emerging as a new kind of exogenous stimulus of resource-dependent countries. Indicatively, the energy transition risk has presented a new volatility trigger; abrupt declines in fossil fuel demand as a result of green policy changes in the EU and China. This is a short-term revenue shock on the sovereign balance sheet.

Volatility of Commodity Price Shocks: The economy of the emerging economies that are highly dependent on oil and commodities is susceptible to price volatility. The 2016 and 2020 recessions in Nigeria were caused by sudden drops in oil prices; its main export and source of revenue exacerbated by the lack of foreign exchange and limited fiscal room (IMF, 2021). The economies that rely on exports are very vulnerable to commodity price fluctuations. In Nigeria, the recessions of 2016 and the COVID-19 recessions were precipitated, in part, by drastic declines in oil prices. Adekunle and Obafemi (2025) record the erosion of government finances, decline in foreign exchange inflows, and the ensuing currency depreciation were caused by lower oil revenue and it had a direct effect of causing a contracting economy. These results are also observed in Latin America and Sub-Saharan Africa where exports of commodities dominate: a fall in prices in minerals, oil, or agricultural goods can rapidly constrain fiscal positions and slow down investment (Edwards, 2023; Gupta et al., 2023). Commodity price shocks are especially powerful since they have both demand and supply impacts: the decline of global demand makes commodity prices lower, which, in turn, decreases export revenues and investment. In the case of the resource-dependent economies such as Nigeria, the trigger is perennial.

Health Crises: The COVID-19 pandemic in 2020 was an exogenous health shock that forced lockdowns and widespread disruption of economic activities. In contrast to the normal business cycle recessions, the worldwide recession was driven by the social health actions limiting movements and spending (Bank, 2023). According to the (Kose & Ohnsorge, 2023), (2025) the effect of a pandemic is a labor supply shock.

Geopolitical Interruptions: Akadirir and Olasehinde-Williams (2025) distinguish the trade weaponization as one of the major causes. Export embargo, sanctions, or blocking vital maritime choke points (such as the Red Sea or Strait of Hormuz) produce shortages to inputs immediately. This will result into stagflationary recessions, where output decreases and inflation increases- the hardest to control recession.

Global Demand Shifts and Trade Contraction: Forbes and Warnock (2023) point out that the negative impacts of the global economy directing a major economy to contract their demand sharply in the global market, like after the pandemic or during periods of monetary tightening, can soon cut into export markets of smaller economies, causing recessions in foreign markets, and, therefore, are prone to trigger global downturns through international Trade integration implies that recessions can spread across borders, as less orders, investment flows and financial pressures are made.

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2.3 Policy-Induced Triggers

Contractionary effects may also be caused by a sudden shift in monetary or fiscal policy, or external demand shock. Recent studies emphasize the potential to trigger a decline in small and open economies by sudden capital flow reversals and exchange rate volatility (Ahmed and Zlate, 2023). The reason is that even the instruments employed in stabilizing the economy may cause a recession when they are miscalibrated. The recent studies emphasize the role of sudden changes in the reversal of capital flows and exchange rate instability in triggering a decline in small and open economies ().

Monetary Tightening: Monetary tightening used to fight hyperinflation by aggressive methods may accidentally lead to a hard landing, such as the late 2023-2024 global interest rate cycles. Intensive or sudden tightening of the monetary policy particularly when undertaken in conjunction with poor macroeconomic fundamentals can cripple growth. The most notable one is the aggressive interest rate increases of 20222024. The IMF (2024) analysis indicates that central banks in their eagerness to kill inflation normally overdo it, which causes a liquidity crisis. High rates suck the money out of the banking sector and lead to a sudden credit stop, which strangles viable businesses. According to research studies (Romer and Lucas, 2024) sudden changes in interest rates without corresponding stabilization of financial markets may decrease investment and consumption, which will push the economies into recession. The tightening/easing trade-off is common between central banks and their control over inflation and growth respectively. Wrong decisions in this balance may unwittingly lead to recessions.

Fiscal Contraction/Triggers: A major decrease in government expenditure or a sudden increase in taxes may be enough to cause a recession, particularly in a government where government expenditure is a high proportion of GDP. Some countries were too fast in their fiscal tightening in the aftermath of the pandemic, which resulted in poor recovery performances. According to (Levine, 2023), in most cases, premature austerity actions tend to undermine the demand when the economic fundamentals have not stabilized. The Fiscal Cliff trigger, described by (Ahmed & Hassan, 2023), is when the government support (e.g., the pandemic stimulus) suddenly goes away and the underlying strength of the private demand becomes apparent. In emerging markets, it currently appears in the form of an Austerity Trigger, with the compelled reduction of budgets on service debts resulting in a breakdown of investment in government infrastructure.

2.4 Digital Asset Contagion as a Transmission Mechanism of Economic Recessions

Digital assets, particularly, cryptocurrencies and other decentralized financial products, have become a prominent means of transmission during economic downturns in the years 2024-2026. Compared to conventional channels (e.g., financial markets, exchange rates, supply/demand shocks), the digital asset contagion takes place via distinct channels, which are based on the nature of blockchain-based systems, high volatility, speculative behavior of investors, and growing inter-linkages of digital and traditional financial markets. Recent studies have started to map the ways in which stress in digital asset markets may enhance downturns in the economy, spread shocks across classes, and how it interacts with financial stability risks.

Crypto-Volatility: The high volatility of digital assets is a hallmark of these products and their leverage mix to exacerbate declines. According to Popescu and Spulbar (2025), cryptocurrencies have ceased to be fringe assets that are speculative in nature to becoming vectors of systemic risk. Their analysis of the emerging markets (such as Nigeria and Vietnam) shows that a crash in the crypto market is now also a Wealth Shock, similar to a crash in the stock market. In contrast to the conventional assets, crypto-triggers are digital in nature. It has been suggested that there

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was greater crypto volatility before there was greater volatility in small cap and risk-factor equities, which implies that there is a contagion channel through investor risk sentiment. The collapse of a large stablecoin or exchange (a la the FTX collapse, on a macro scale) leads to instantaneous hoarding of liquidity by retail investors, which results in an instantaneous arrest of consumption (Loang, 2024).

Algorithmic Contagion: Algorithms used in crypto and traditional markets to trade and manage risk may generate a feedback loop where a downturn is reinforced by the algorithmic sell signal across systems. These dynamics are similar to those of contagion in financial network theory except that they act on compressed time scales because of 24/7 trading and intensive participation of algorithms. The fact that it is a high-frequency, high-leverage environment implies that digital downturns can spread distress quicker and more severely than most traditional financial shocks.

Depegging Events: Stablecoins, cryptocurrencies that aim to keep a fixed value (usually to the U.S. dollar) are becoming a more central feature of decentralized finance (DeFi). Financial contagion is the phenomenon that arises when stablecoins lose their dollar peg and, therefore, cause a run on DeFi protocols and liquidation of larger crypto positions, decreasing liquidity in markets (Popescu and Spulbar, 2025). The stablecoin depegging also happened along with the instability of the local currency and led to decreased liquidity and increased exchange rate pressures (Adekunle & Obafemi, 2025). The large involvement of retail in digital assets implied that massive losses lowered consumer spending and remittances, which contributed to the contraction of domestic demand. In that manner, digital contagion is able to play with underlying structural weaknesses to exacerbate downturns.

Asset Price Wealth Effects: Digital asset contagion is not independent but it interacts with traditional sources of transmission. As a result, wealth effects among retail and institutional investors have been growing as a result of cryptocurrency market surges. On the other hand, sudden decreases in the prices of cryptocurrencies may cause the loss of the perceived wealth. Dwivedi et al. (2022) note that the downward trend in the high visibility digital asset valuation can decrease the confidence of investors and the risk appetite in the asset classes. This resembles impacts of wealth in equity market losses, but can be even stronger since retail crypto owners are younger and can be more behavioral to losses.

Credit and Counterparty Exposure: Although direct bank exposure to digital assets in most jurisdictions is small, indirect exposures have been on the rise: Banks, hedge funds, and asset managers are increasingly engaging with digital markets via custodial services, structured products, and derivative exposure. As digital asset markets get stressed, institutions can shift risk or constrain credit, which has indirect impacts on the overall credit conditions (Ahmed and Zlate, 2023). In other situations, the companies that use digital assets as security to finance their businesses might be compelled to sell traditional assets to cover margin calls, which passes the strain to the equity market or fixed income markets. In the sell-offs, researchers reported large positive changes in the correlation between large cryptocurrencies and equity indices, with larger increases observed in technology-heavy indices (Popescu and Spulbar, 2025). These interactions demonstrate a path between digital asset contagion into traditional financial contagion, in which behavior and risk pricing in one area are influenced by stress in the other.

Liquidity Transmission: Stablecoins are commonly used as a base asset to trade and lend on digital asset exchanges and decentralized finance (DeFi) platforms. The decline in trust in stablecoins leads to a decrease in the depth of the market and a rise in bid-ask spreads, which

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spreads the stress to other markets and even short-term funding conditions. Digital markets leverage (e.g., the borrowing of stablecoins against crypto collateral) is used by many participants. In times of rapid price declines, automatic liquidations can create cascades of forced sales, which further drive down prices in other related digital assets and spread to other markets (Loang, 2024).

Table 1: Summary of Triggers (2023-2026 Perspective)

Trigger Category	Specific Catalyst	Mechanism of Onset
Financial (Endogenous)	Asset Bubble Burst / Debt Crisis	Rapid repricing of assets destroys net worth.
Digital (Modern)	Crypto-Market Collapse	Instantaneous liquidity freeze & wealth shock.
Supply (Exogenous)	Geopolitical Fragmentation / Climate Event	Physical shortage of inputs halts production.
Policy (Induced)	Aggressive Monetary Tightening	Credit Crunch starves the economy of capital.

2.5 Transmission Mechanisms: How Shocks Travel

A trigger only becomes a recession if it is successfully transmitted through the economy. When an economic recession is induced, be it by financial crisis, health emergency, policy change or price shock of a commodity, the initial shock is rarely contained in isolation. Rather, it is transmitted through the economy via a set of transmission mechanisms. These are the channels by which the effects of a shock are spread and they affect output, employment, investment, prices, and financial stability. The intensity of a recession, (Kose and Ohnsorge, 2023) note, is hardly dependent on the magnitude of the initial shock but the effectiveness of channels used in the transmission of the shock. With the hyper-connected economy of the mid-2020s, these channels are no longer the physical trade routes that move slowly, but instead become a digital and financial network almost instantaneous. The macroeconomics and financial stability research between 2023 and 2026 has made the processes of these transmission mechanisms clearer, with a particular focus on the aspect of interconnectedness, feedback mechanism, and time-varying dynamics. The main mediums are:

2.6 Financial Sector Linkages in the Transmission Mechanisms

The financial sector is very important in passing the impacts of economic recessions to an entire economy. Financial sector linkages are defined as the interrelations of financial institutions, markets and instruments, which enable the movement of capital, credit and liquidity in the economy. These connections are the transmission channels in which the external and internal economic shocks spread, increasing the effects of recession. The financial sector is usually affected by economic recessions and hence, contributes to the aggravation of the adverse effects on the overall economy. The credit markets collapsed during the Great Recession, limiting the lending to households and companies, further worsening the output deterioration. The depression further slowed down investment by bank deleveraging and stricter credit conditions (Bernanke and Gertler, 2000). The financial market transmission is manifested in equity, bond and real estate valuation. Contractionary forces were strengthened as asset prices fell and wealth and consumer confidence were eroded (Fama, 2023). Financial sector is the key place where the economic recessions spread and multiply. The interdependent nature of the banking institutions, financial markets and central bank policies dictate the level of impact of recession and whether economies would recover. With these financial sector linkages, policymakers can develop specific interventions to stabilize the financial system, keep credit flowing, and develop a robust recovery.

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The solution to the weaknesses in the financial sector especially regarding the enhancement of regulatory frameworks, liquidity, and access to credit is critical in reducing the adverse impact of economic recessions and attain economic stability in the long term. The international financial markets become very interdependent in an integrated global economy. The ripple effects of a recession in a single major economy may be felt in other economies via a range of mediums, such as stock markets, bond markets, and currency markets.

*Stock Market Decline***:** When the economy is in recession, stock markets tend to fall drastically due to investor response to low economic outlook and company profits. Reduction in stock market value impacts on the wealth of the investors and this impacts consumer spending and corporate investment. Also, the declining stock prices may weaken consumer and business confidence, resulting in additional decreases in spending and investment. The effect on the prosperity of the individuals and institutions may create a feedback loop, deteriorating the recession.

Bond Markets and Yield Spreads: In the case of a recession, the government bonds demand normally goes up as investors tend to invest in safer investments, causing a reduction in the bond yields. Nevertheless, corporate bonds yields, and in particular, the yield of firms whose credit rating is lower, increase. The reason behind this is that investors view more risk of default by corporations during a downturn. The increasing yield premiums between government bonds and corporate bonds may pose a great challenge to businesses trying to refinance their debts because the cost of borrowing will be increased.

Currency Markets and Exchange Rate Volatility: Exchange rates can fluctuate considerably as a result of a recessionary shock in a given country, and it has an impact on the competitiveness of exports and imports. As an illustration, when a large economy such as the United States or the European Union goes into a recession, the currency may be devalued, thus, exports will be cheap, and imports expensive. This, in its turn, influences balances of trade and may cause the imbalances in the countries with the high trade relations. In the case of emerging economies, the financial situation may be aggravated because of the exchange rate devaluation as the service burden of foreign-denominated debt increases, and the inflationary pressure may increase.

2.7 Credit Market and Banking Sector Channels

One of the most effective transmissions of the shocks into recessionary effects is a contraction in the supply of credit. Financial institutions restrict lending practices or decline new lending when they experience losses or when there is uncertainty. This leads to a decrease in investment as companies are not able to fund new projects and expansions (Bernanke and Gertler, 2000); consumer borrowing decreases, and spending on homes, durable goods and services is cut. Demirguc-Kunt and Singer (2024) note that in stress post-pandemic, banks in emerging markets raised risk premiums and cut loan supply, further decreasing economic recovery by limiting the financing of the private sector.

Credit Squeeze: The shocks in the banking sector are one of the major ways in which the economy is impacted during a recession. Banks serve as the go between and credit flows to households, businesses and governments. But when the economy is in recession, banks are usually directly affected by the slowdown in economic activity in terms of rising loan losses, falling asset prices and decreased profitability. This forms a vicious circle of low lending and high cost of borrowing. The losses that result may weaken the balance sheets of banks, which result in a restrictive credit supply. The net worth of borrowers decreases when a trigger like increase in policy rate or a decrease in the price of an asset takes place. Fearing being pushed out of business, banks stop functioning as go-betweens. They end up not lending even to healthy firms

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not because the firms are not viable, but due to hoarding by banks. With the banks being more wary of lending, businesses have difficulty getting credit to invest in, and households may have a tougher time securing a loan to spend, whether it be on a mortgage or a car loan, or on a student loan. This credit crunch further worsens the recession by cutting down consumption and investment. In their African banking industry study, Ahmed and Hassan (2023) show that this is a nonlinear channel. Credit freezes not gradually when liquidity goes below a particular level. There is the multiplier effect whereby according to the Financial Accelerator theory, when the price of assets falls slightly, lending falls significantly, which results in the investment falling significantly. This process transforms what would be a small adjustment in the market to a Great Recession. In their revised study of monetary policy, (Bernanke and Gertler, 2000) confirm this observation.

Asset Value Decline and Collateral Effect: Recessions usually result in drastic fall in asset values, especially in the real estate and the stock market. As prices of assets fall, the collateral value that borrowers can obtain to borrow funds is diminished. This is likely to cause banks to be unwilling to lend or lend at a greater rate or with more collateral or lending requirements. The fact that businesses and consumers are unable to get credit further degrades economic activities as they spend less, invest less and the economy grows less.

Bank Insolvency and Systemic Risk: When the losses incurred by defaults and falling asset value are so high, banks can run into insolvency thereby reducing the overall capacity of the financial system. This, in severe instances, causes a banking crisis, that is, the collapse of several financial institutions and the collapse of the credit system. The insolvency of entire banks can cause systemic risk that in turn can cause a credit freeze, worsening the recession. This was experienced during the 2008 Global Financial Crisis (GFC) during which the collapse of key banks as a result of exposure to subprime mortgages caused a liquidity crisis to hit the globe and a major economic depression to be experienced.

Asset Price Channels: Households and firms rely largely on financial markets as a source of wealth. Declines in equity, real estate or fixed income asset prices lead to a decrease in net worth, which subsequently influences economic behavior: Households decrease consumption when they feel poorer (Lopez & García, 2025) and businesses reduce investment when capital gains no longer appear on the balance sheet. After the severe initial sell-offs in the COVID-19 downturn, asset prices remained volatile in 2023 and 2024, which further helped to depress consumption and corporate confidence (Bank, 2023).

2.8 Investment and Consumption Linkage

Real economy is influenced by financial sector linkages as it affects investment and consumption choices. Credit availability, interest rates and the mood of the investors are critical determinants of the business decision and consumer behavior.

Investment Decisions and Business Confidence: When the economy is in a recession, companies tend to have trouble accessing affordable credit, whether that is because of the credit squeeze due to tightening of lending policies, or because the cost of borrowing is increased. Economic growth is slowed when businesses are unable to access the capital required to invest in new projects, expand operations or maintain current operations. In addition, companies can decrease investment since they are not quite sure of what demand will be in the future and this worsens the decline. This was mostly witnessed in the 2008 financial crisis when the uncertainty in financial markets resulted in a colossal decline in corporate investment, thus extending the recession.

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Consumption Channel: The biggest constituent of GDP is generally consumption. Consumption decreases will reduce output of goods and services. Job losses or uncertainty to the income will decrease household spending (Friedman and Savage, 1948) and even constant employment will be translated into decreased spending when the households anticipate worsening of economic conditions. Consumer spending is also affected by the financial sector in terms of the availability of credit. In a recession, where banks grow more risk-averse, consumer credit supply is likely to contract resulting in low household expenditure. This is particularly important in economies that have a major contribution of consumption in GDP. There is also the wealth effect in which a decline in asset prices (e.g. housing or stock prices) causes a decline in consumer wealth which causes a decline in spending because households become poor. This tightening of consumer spending further exacerbates the recession, because businesses will see less and less demand to goods and services, causing layoffs and a vicious cycle of economic contraction.

2.9 Wealth and Balance Sheet Channels in the Transmission Mechanism

Balance sheet channel and the wealth channel is one of the main transmission channels in which recessions spread and intensify in an economy. This channel connects alterations in asset prices and financial states to the actual economic action upon consumption, investment, borrowing, spending and stability of firms. The resulting worsening of balance sheets by households, firms, and financial institutions with a decrease in asset prices or increase in liabilities can significantly decreases economic activity. The latest studies (2023-2026) emphasize the impact of this channel in large-scale downturns, such as the global recession of 2021-2022, commodity-driven declines, and episodes of financial market stress. It is through this mechanism of transmission that financial markets are connected to the real economy, making the losses of wealth to result in wider economic contraction. The COVID recession caused the world stock markets to initially fall and real estate markets of most countries to soften (Bank, 2023). Experience reveals that households reduce discretionary expenditures very quickly after such losses (Friedman, 2009). It has been also found in research that wealth effects are asymmetric, in that, the decline in asset values shrinks consumption more than the rise in consumption by the same amount (Lopez & Garcencia, 2025). This asymmetry intensifies recessions since the negative effects of decreases in wealth generate greater negative effects in household expenditures compared to the same positive effects in recoveries. This process is particularly significant in developed economies where financial assets represent significant proportions of households’ portfolios.

2.10 Aggregate Demand and Supply Channel Interactions

The relationship between demand and supply channels is at the core of the discussion of the dissemination of economic recessions within an economy. The interaction of demand and supply channels is core to the way recessions occur and to the extent of their economic impact. Demand shocks lower household and firm spending, whereas supply shocks limit the production capacity and raise costs. The interactions between these forces can form self-reinforcing cycles that exacerbate economic downturns. As opposed to financial shocks that are mainly directed to the financial system, demand and supply interactions are directly related to the real economy, which causes an immediate production, consumption, employment, and investment to be affected. These channels are not separate; they interact, support, and even enhance the effects of each other and may be very deep and long-lived in a recession. The COVID-19 crisis caused both supply and demand shocks in the commodity based economies at the same time. The decline in household consumption and investment, along with the impact on the supply chain, spread the recession between the countries and industries (Galí, 2008).

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2.11 Aggregate Demand Shocks and Economic Contraction

Aggregate demand is the total expenditure by households, firms, governments and net exports. One of the transmission mechanisms of recessions is a fall in aggregate demand.

Consumption and Income Effects: Consumption is generally decreased when economic conditions are worsened by job loss, falling wages or increasing uncertainty. In most economies, consumption is the biggest portion of GDP thus contraction here is immediately transferred to the overall economic contraction (Friedman and Savage, 1948). The COVID-19 recession led to concurrent supply and demand shocks in commodity-based economies. Declines in household consumption and investment, and disruptions in supply chains, spread the recession among nations and industries (Galí, 2008). In the COVID-19 recession, e.g. lockdowns and mobility limits had a drastic impact on the consumption of services (in particular hospitality, travel, and retail). This was a contraction in demand which was immediate and cross-country based (Bank, 2023). Not only was the output reduced but also mass layoffs, which led to a consumption- employment feedback loop.

Investment and Business Sentiment: Business investment is very responsive to demand. Firms delay or abort investment projects when they regard weaker demand prospects. This became apparent during the post-Great Recession period, but similar trends were observed during the pandemic recession: the unpredictability of future demand caused companies to reduce capital expenditures, slowing down recovery and shrinking productive capacities in the medium term (Galili, 2008). Recent empirical studies indicate that a lower demand in both developed and developing economies may lower investment by tightening credit and decreasing the expected returns on capital (Gupta et al., 2023). This impact was multiplied in commodity-dependent economies such as Nigeria: the decrease in the global demand of oil decreased exports, decreasing government spending and business investment simultaneously.

2.12 Aggregate Supply Shocks and Production Disruptions

Aggregate supply is used to show the amount of output that firms can and will produce at various levels of price. Supply shocks not only decrease productive capacity but also increase costs, which spreads recessionary pressures via higher prices or scarcity.

Supply Chain Disruptions: The COVID-19 pandemic made the global supply chains vulnerable. The closure of the borders, factory shutdowns, and overcrowding in ports resulted in massive shortages in inputs of semiconductors to the medical supplies. Such shocks limited production when companies still had demand (World Bank, 2023; Galí, 2024). Recent estimates suggest that the continuous dislocations in supply chains throughout 2020-2023 slowed down the world manufacturing and uneven recovery trends across regions (Findlay, 2024). To illustrate, import-reliant industries suffered more recessions whereby the supply shocks were the worst.

2.13 Labor Market Adjustments

The labor market is an important transmission mechanism in recessions as it affects the level of employment, income distribution, and the development of human capital. The consequences of job losses, wage stagnation, and labor force participation may spill over into the economy and influence the recovery process. The policymakers should acknowledge the importance of the labor market and put in place measures that will help the workers by educating them, retraining, and the social safety nets. Recovery frameworks should also be resilient and contain specific interventions to offset social and economic impacts of recessions on the workforce so that a more equitable and sustainable recovery process is achieved. The increasing unemployment increases

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the recessions by decreasing consumption and human capital loss. In the case of the Great Recession and the COVID-19 recession, the trend of continuing to lose jobs had permanent consequences in terms of participation in the labor market (Dornbusch and Fischer, 2023). The COVID19 pandemic decreased the supply of effective labor because of illness, caregiving duties and limitations of workplace activities. These restrictions increased wage expenses in certain industries and left others idle. This duality was especially apparent in economies that had informal labor markets, including most of those in Africa: a part of the economy was unable to work effectively, and other parts ceased to exist at all (Hermes and Lensink, 2024). Pandemics are not the only examples of supply-side shocks. The oil supply was reduced, which restricted the supply of commodities such as Nigeria to the world, leading to a deeper contraction of the economy. What it caused was a concomitant decrease in supply and demand intensifying the impact of recessionary effects (Adekunle & Obafemi, 2025).

2.14 Exchange Rate Pass-Through in the Transmission Mechanisms

Exchange rate pass-through (ERPT) is a transmission channel which is critical and through which exchange rate developments impact the real economy in recessions. It is defined as the extent and rate at which fluctuations in the nominal exchange rate translate into domestic prices of imported goods and services, inflation, firm costs and eventually output and consumption. ERPT can enhance the effect of recession during the economic stress, by affecting inflation, competitiveness, trade balances, and monetary policy. Later studies as of 2023-2026 have outlined the importance of ERPT in developed and new market downturns especially where sudden capital flows, currency fluctuations and external shocks meet. Exchange rate pass-through is a concept that is used to explain the conversion of exchange rate fluctuations to domestic prices of traded goods and services. In case of depreciation of the domestic currency, the prices of imports are likely to increase and this puts inflationary pressure. On the other hand, appreciation has the ability of reducing the cost of imports and reducing inflation. ERPT differs with the size of different countries, sectors and economic statuses and is determined by the level of trade openness, inflation expectation, market structure and credibility of the monetary policy. ERPT is especially relevant during recessions when depreciation of currencies is usually accompanied by other methods of transmission, including the reduction in demand, capital movements, and the restriction of credit facilities. Under these conditions, ERPT may exert exasperating inflationary stress, squeeze real incomes, and complicate the policy responses.

Import Price Inflation: Among the immediate effects of depreciation of exchange rates is the rise in the domestic price of imported commodities. When the currency is weak, the companies that depend on imported raw materials or intermediate goods or consumer products have to spend more, which is usually transferred to consumers as more expensive prices:

- Increasing consumer prices: Domestically, inflation speeds up as import prices increase, decreasing the purchasing power and household real incomes (Edwards, 2023).
- Input cost pressures: The companies that experience an increase in the cost of imports can cut down production, dismiss workers, or increase the prices intensifying the recession by lowering output and employment.

The level of this pass-through will be based on the competitiveness of price determination in the domestic market and the proportion of cost increment that firms absorb or pass on (Chen & Davis, 2024).

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Impact on Trade Balances and Export Competitiveness: Although depreciation of exchange rates can lower the prices of exports to foreign buyers, increasing the volume of exports, which is not necessarily the case in recessions:

- Weak external demand: In case world demand is low (e.g., in a world-wide recession), the competitive export prices might fail to translate into increased export revenues (Forbes & Warnock, 2023).
- The cost of imports exceeds export earnings: In economies relying on imported inputs, the importation cost can be much higher than export earnings leading to a declining balance of trade. This is a mixed effect especially to small open economies whose export performance is closely related to global demand conditions. The competitiveness of exports can be enhanced only when the goods are elastic in their demand and there is a supply capacity (Gupta et al., 2023).

2.15 Inflation Expectations Transmission Effects and Monetary Policy Trade-Offs

ERPT has an impact on the inflation expectations that impact monetary policy decisions. During a recession, sharp currency depreciation may cause inflationary pressures that are difficult to respond to by the central bank. Central banks might be caught in a dilemma of either promoting growth or fighting inflation. Assuming that ERPT increases inflation, policymakers might be reluctant to engage in aggressive monetary easing, which is generally required to spur demand during recessions (Romer and Lucas, 2024). The future economic conditions affect demand and supply choices based on the inflation expectations of the future. Consumption and investment are postponed when households and businesses believe that the recession will continue or intensify, limiting demand. At the same time, companies can delay employment, investments, or increasing the capacity, limiting supply increase. Even after the first trigger has gone (Friedman and Savage, 1948), these expectation effects may still be felt. In terms of the negative feedback loop, reduction in supply, including the shutting down of factories, limits the supply of goods. This shortage may spur prices (supply-side inflation) and this decreases real purchasing power and further lowers demand. An increase in the cost of inputs may then compel companies to reduce production or dismiss employees and this undermines aggregate demand even more. This is the feedback loop that was evident in the pandemic as the bottlenecks in the supply chains were causing price to rise at the same time consumer demand was declining across most sectors (Galí, 2008).

Credibility and Inflation Expectations: The impact of high or persistent ERPT may lead to the unanchoring of inflation expectations which makes it more difficult to control inflation without tightening the monetary conditions, which further dampens economic activity. The central banks of emerging economies, especially those in the developing world, have to juggle between stabilizing their currency and facilitating recovery, which may have little policy room (Demirguc-Kunt and Singer, 2024).

Table 2: Transmission Pathways (2023-2026)

Channel	The Pathway	The Outcome
Credit Channel	Banks tighten lending standards →Investment falls.	Liquidity Crisis
Trade Channel	Supply chain break →Production halt.	Supply Shock
Exchange Rate	Capital flight →Currency crash →Debt burden.	Stagflation
Confidence	Fear/Uncertainty →Precautionary savings.	Demand Collapse

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3. METHODOLOGIES

3.1 Simulation Frameworks

To adequately capture the multi-dimensional nature of modern macroeconomic shocks, this study moves beyond historical diagnostic modeling. A multi-tiered advanced simulation methodology was employed to analyze behavioral panic, structural diversification, probabilistic risk, and financial sector resilience. By combining bottom-up and top-down econometric frameworks, this methodology enables a robust evaluation of counterfactual recovery strategies.

Agent-Based Modeling (ABM) for Behavioral Contagion: Traditional macroeconomic models often assume rational equilibrium, which fails to capture the sudden market panic observed during the 2008 financial crisis or the 2020 pandemic. To model digital asset contagion and bank runs, we utilized the ABM. The ABM framework constructs the economy from the bottom up. It simulates thousands of heterogeneous interacting agents (households, MSMEs, and commercial banks), each programmed with bounded rationality and heuristic decision-making rules. The model introduces an exogenous shock (e.g., a sudden rumor of systemic insolvency) and tracks how localized panic transmits through the network. It measures the threshold at which individual precautionary savings behavior mathematically cascades into a systemic liquidity freeze. Agent state transitions (from solvent to defaulting or holding to withdrawing) are governed by network topology and localized probability functions, isolating the exact speed of confidence-channel contagion.

Computable General Equilibrium (CGE) for Sectorial Dynamics: To evaluate the structural diversification recovery framework, a Computable General Equilibrium (CGE) model was deployed. Unlike dynamic time-series models, CGE provides high-fidelity granularity across specific economic sectors (e.g., agriculture, oil extraction, manufacturing, and services). The CGE framework relies on a multi-sector structural matrix that maps the entire supply chain of the economy. Production in each sector is modeled using a Constant Elasticity of Substitution (CES) function to represent how firms substitute capital and labor during a shock:

$$Q_j = A_j \left[\alpha L_j^{\frac{\sigma-1}{\sigma}} + (1-\alpha) K_j^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}} \tag{1}$$

Where Qj is the output of sector j, σ is the elasticity of substitution, and L and K represent labor and capital). This simulates the exact reallocation of resources. By mathematically shocking the oil sector (dropping global demand), the CGE model calculates the precise volume of capital and labor that must migrate to non-oil sectors (like agriculture and MSMEs) to restore equilibrium, quantifying the true cost of structural transition.

Monte Carlo Stochastic Simulations for Risk Probability: Because future poly-crises are defined by extreme uncertainty, deterministic historical analysis is insufficient. Monte Carlo simulations were utilized to transition the research from static outcomes to dynamic probability forecasting. The simulation relies on randomized, repeated sampling of exogenous variables (such as global oil prices and global interest rates) drawn from historical probability distributions. The structural shock vector St is modeled dynamically:

$$S_t = \Phi S_{t-1} + \varepsilon_t, \varepsilon_t \approx N(0, \Omega) \tag{2}$$

Where ε_t represents the randomized shock matrix with covariance Ω, allowing for simultaneous, compounded crises). By running 10,000 distinct iterations of interacting variables (e.g., fluctuating

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oil prices colliding with supply chain bottlenecks), the methodology generates a probability density function. This provides policymakers with empirical risk metrics, such as identifying an 85% mathematical probability of a recession if foreign reserves fall below a specific threshold while inflation simultaneously exceeds 15%.

3.2 Macro-Financial Stress Testing for Credit Channel Resilience

To specifically isolate the Credit Channel and evaluate the banking sector's capacity to absorb versus amplify shocks, this study implements a top-down macro-financial stress Test. This framework forcibly applies extreme, hypothetical macroeconomic contraction scenarios directly to the aggregated balance sheets of the commercial banking sector. The primary transmission mechanism evaluated is the deterioration of asset quality, modeled via the Non-Performing Loan (NPL) ratio sensitivity:

$$NPL_t = \gamma_0 + \gamma_1 \Delta REER_t + \gamma_2 \Delta Y_t + \gamma_3 R_t + u_t \qquad (3)$$

Where NPLt responds dynamically to shocks in the real effective exchange rate ΔREERt, real output ΔYt, and policy rates Rt). The stress test simulates a severe currency devaluation scenario (mirroring 2016) to determine how many commercial banks would breach their capital adequacy ratios. This empirically proves whether the financial architecture requires preemptive recapitalization to avoid a secondary financial crisis triggered by an initial commodity shock.

3.3 Predictive Risk Assessment Modeling for Recession Forecasting

To provide a forward-looking view of economic risks and enable early intervention strategies, this study integrates a suite of predictive risk assessment models. While operational models track physical disruptions, these predictive econometric frameworks analyze historical patterns and current leading indicators specifically global commodity prices, interest rate spreads, and political stability indices to calculate the mathematical probability of an impending economic downturn.

Dynamic Probit Regression for Leading Indicator Probability: The Dynamic Probit model is employed as the primary early warning system. Unlike standard linear regressions that forecast continuous GDP growth, the Probit model treats a recession as a binary outcome, making it ideal for direct risk classification and probability scoring. The model calculates the probability that the economy will enter a recessionary state ($Y_t = 1$) at a future horizon (k periods ahead), conditioned on a set of observed leading indicators (Ω_{t-k}). The probability is mapped using the cumulative distribution function of the standard normal distribution (Φ):

$$P(Y_t = 1 | \Omega_{t-k}) = \Phi(\delta_0 + \delta_1 CP_{t-k} + \delta_2 IR_{t-k} + \delta_3 PS_{t-k} + e_t) \qquad (4)$$

Where CP represents global commodity price volatility, IR represents the interest rate spread or yield curve inversion, and PS is a quantified political stability index). By feeding current macroeconomic data into this equation, the model generates a strict percentage-based risk score (e.g., a 72% probability of recession within the next 12 months). This allows policymakers to establish definitive thresholds (e.g., risk > 50%) that automatically trigger preventive fiscal measures.

Markov-Switching Vector Autoregression (MS-VAR) for Regime Transitions: Because economies do not transition from expansion to recession linearly, this study utilizes a Markov-Switching Vector Autoregression (MS-VAR) model. This framework is specifically designed to detect sudden regime shifts in the business cycle based on historical patterns of volatility. The MS-VAR model assumes the economy operates in distinct, unobserved states (St), and typically

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defined as State 1 (Expansion) and State 2 (Recession). The behavior of the economic variables (Yt) changes depending on which state the economy is currently in:

$$Y_t = \mu(S_t) + \sum_{i=1}^{p} A_i(S_t) Y_{t-i} + e_t \quad (5)$$

Where $\mu(S_t)$ is the state-dependent intercept, Ai(St) represents the state-dependent autoregressive coefficients, and St evolves according to a hidden Markov chain with specific transition probabilities). This model tracks the historical behavior of commodity dependencies and interest rate shocks to estimate the transition matrix the exact probability that an economy currently in expansion will flip into a recession next quarter. It mathematically identifies the hidden "threshold points" where normal volatility mutates into a systemic crisis.

Ensemble Machine Learning (Random Forest) for Non-Linear Risk Interactions: Traditional econometric models often struggle to capture complex, non-linear interactions between variables (e.g., an oil price crash might only trigger a recession if political stability is simultaneously deteriorating). To capture these compounding risks, a Random Forest classification algorithm is integrated into the methodology. The model constructs a multitude of decision trees during the training phase on historical economic data. It evaluates risk by splitting data nodes based on the minimization of Gini impurity:

$$Gini = 1 - \sum_{i=1}^{C} (p_i)^2 \quad (6)$$

Where pi is the probability of an economic state i occurring within a specific node based on the intersection of variables). The algorithm continuously ingests high-frequency data (daily commodity futures, central bank rate announcements, and real-time geopolitical risk scores). It identifies highly complex historical patterns such as how specific combinations of supply chain delays and interest rate hikes preceded previous downturns.

Integrating Outcomes for Preventive Intervention: The convergence of these three predictive models provides a comprehensive early warning architecture. The **Probit Model** provides clear, interpretable risk percentages for immediate policy briefings; the **MS-VAR Model** identifies structural regime shifts before they are visible in lagging GDP data; and the **Random Forest** algorithm maps the non-linear compounding effects of geopolitical and commodity shocks. Ultimately, this methodology equips decision-makers with the empirical foresight required to deploy preemptive capital buffers, adjust monetary policy, and secure supply chains well before a forecasted recession materializes.

3.4 Construction and Estimation of the Cross-Country Financial Stress Index (FSI)

To systematically measure the intensity of financial instability and map its transmission across different economic structures during recessions, this study constructs a composite Financial Stress Index (FSI). The FSI translates unobservable systemic risk into a single, quantifiable metric. By applying this index across a strategically categorized panel of countries, the research evaluates how identical exogenous shocks (such as the 2008 Global Financial Crisis or the 2020 COVID-19 pandemic) propagate differently depending on a nation's structural macroeconomic vulnerabilities.

For the reason that the raw variables possess different units of measurement (e.g., percentages, index points, basis points), they must be standardized before aggregation. Each financial variable x for country i at time t is standardized into a z-score. This process transforms the data to have a

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mean of zero and a standard deviation of one, allowing for direct comparison across disparate economies:

$$z_{ijt} = \frac{x_{ijt} - \mu_{ij}}{\sigma_{ij}} \quad (7)$$

Where xijt is the raw value of variable j for country i at time t, μ_{ij} is the sample mean of variable j for country i, and σ_{ij} is the sample standard deviation). To construct the final FSI without assigning arbitrary subjective weights to the variables, the study employs Principal Component Analysis. PCA mathematically identifies the unobserved common factor (financial stress) driving the variance across all standardized variables. The overall index is calculated as a weighted sum of the standardized variables, where the weights (wj) are derived from the first principal component:

$$FSI_{it} = \sum_{j=1}^{k} w_j z_{ijt} \quad (8)$$

The total financial stress level of country i in period t is denoted by FSIit, and k is defined to be the total number of financial variables in the analysis. The FSI produces a normal metric once constructed with 0, meaning the historical stress levels as the base, and any positive figure represents an abnormal increase of the standard deviations to the usual levels of financial distress. The FSI Construction and Contagion Analysis structured cross-country Panel is Table 3. To establish a strong Financial Stress Index (FSI), it is important that the panel used be highly diversified and cross-country in nature to guarantee that world financial systems and responses to macroeconomic shocks are fully covered. In case the countries that are characterized by the same economic structure were chosen the data obtained would most likely be redundant hence hiding the processes in which the financial contagion spread. Thus, the countries in the expanded panel are well selected according to their unique macroeconomic archetypes and export reliance and their integration into the world financial system. This heterogeneity makes the FSI model more meaningful to explain, as the statistical comparison of very specific global records is possible, which shows how the same global shock like the 2008 GFC, or the 2020 COVID-19 pandemic, affects different financial systems in different ways. An example would be when recessions in states, such as Argentina and Greece are associated with sovereign default risks as compared to corporate debt crises in other countries, such as South Korea. Brazil and Turkey, on the other hand, have monetary pressures that are mostly attributable to drastic currency devaluation. Both of these manifestations of financial stress can offer a good insight into the specific weakness of various economic models. The FSI can quantify and contrast the level of financial instability in response to global shocks and thus assess the behaviour of financial systems under stress by examining these different cases and provides a more sensitive insight into behaviour. The countries chosen are a broad economic mix of the world economies such as the developed financial capitals, emerging commodity exporters and the global manufacturing and industries and the economies immersed in debts. Global financial shocks are normally initiated by advanced financial centers and monetary union like USA, UK, EU and Japan, and recessions in these markets tend to spread liquidity crises in the world by tightening credit and taking capital back home. Conversely, new commodity exporters such as Brazil, Russia, South Africa, Nigeria, Chile, and Australia also featured to capture the financial insult on the entire globe commodity price collapses. In the case of these countries, the major avenue on contagion is via extreme exchange rate volatility and imported inflation, which results in serious financial instability. The global manufacturing and export centers, China, South Korea, Mexico and

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Indonesia are also an important point of study regarding the financial misery associated with supply chain shocks and declining industrial demand on the world stage. These economies are also at a particular risk regarding the shocks in the corporate credit market because their economic activity is following global trade and production significantly. Finally, debt-distressed economies, such as Argentina, Turkey and Egypt, are chosen because they may experience extreme regime changes during recessions to cause systemic sovereign defaults, hyperinflation, and severe balance of payments crisis. The FSI itself comprises four main high-frequency financial variables, which will be replicated in all the countries of the selected panel, but with different weights of stresses depending on the economic category of the country. The volatility of the exchange rate is an important element, as it assesses the month-to-month percentage change and variance of currency in a country against the US dollar. This aspect is quite pertinent to the exporters of commodities and the economies with debt problems where the phenomenon of capital flight and stress of balance of payments are more intense. Another significant variable is the volatility of stock markets, which is determined as the conditional variance of the index of equity benchmark (e.g. S&P 500, BOVESPA) as it removes the effects of abrupt changes in investor confidence and the equity value of companies. The FSI also includes credit spreads both sovereign and corporate to reflect the risk premium that investors require. To emergent markets, this is the yield spread between domestic sovereign bonds and US Treasuries, whereas to advanced economies; this includes interbank lending spreads, e.g. the TED spread, which measures the illiquidity of the banking sector. The interest volatility was included to capture abrupt and violent changes of central bank policy rates or the short-term interbank rates. In a recession of the whole world, the FSI exhibits very different performances in different categories of countries, due to the different vulnerability to financial performance and transmission of each group. Spiking credit spreads and stock market volatility are the two major causes of financial stress in mature financial centres. These are important indicators in evaluating the efficacy of central bank interventions, e.g. RBA quantitative easing, in solving the problem of liquidity and thawing of interbank lending markets. The utility of the FSI in this regard, is to evaluate the effectiveness of such policy actions to alleviate the financial instability and regain market confidence. In countries that trade in commodities, the determinant of the financial stress is extreme exchange rate volatility. The volatility is largely instigated by the crash of commodity prices around the world and this can affect the domestic currency by direct and drastic effect. The lag time between localized currency contagion and a crash in a commodity price can then be measured using the FSI of these countries. This assists in learning how currency devaluation works and the wider economic implications, including inflation and balance of payment crises. This is manifested in manufacturing centres (that include East Asia and Latin America) who are stressed by the spreads of corporate credit and equity market crashes. Since these economies are highly dependent on the supply chains and industrial production across the globe, global demand upheavals tend to cause a major problem with the debt-servicing of corporations. The FSI of these nations play a critical role in determining the susceptibility of the industrial sector in the event of a global disruption in supply chains, providing a clue regarding the sustainability of manufacturing companies that experienced financial troubles. There are debt-distressed economies, where sovereign spreads and interest rate shocks are leading sources of financial stress, that are prone to a different set of challenges. The FSI in these countries assists in assessing the tipping point where the normal stress of recessions starts to develop into a sovereign default. The FSI makes it straightforward to understand how paired with the increasing spreads of sovereign, the volatility of interest rates may indicate that the fiscal stability of the country may be under attack, and that this could trigger a drawdown in the entire system. The

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changes are normally used to protect the currency of a nation or to provide emergency liquidity into the financial system. The combined elements of the FSI allow a complete view of financial stress, allowing cross-country comparisons and giving valuable insights into the way different financial systems react to global recessions. Through these stress variables, the FSI assists in determination of the contribution of the financial instability to the propagation and recovery of recessions and finally leaves us with an insight on relations between financial stability and long run economic growth. It enables policymakers to monitor whether the stress in the financial sector of Advanced Economies, begins in the banking sector, and spills into the foreign exchange market of Emerging Economies, thus providing essential, data-driven information on the order of preferred recovery responses.

Table 3: Cross-Country Panel for FSI Construction and Contagion Analysis

Country / Region	Economic Archetype	Primary Historical Recessions for FSI Calibration	Key Financial Stress Factors (Vulnerability Metrics)	Expected Contagion Pathway
European Union	Integrated Advanced Bloc / Monetary Union	Eurozone Debt Crisis (2008-2012), COVID-19 (2020)	Sovereign debt crises, austerity measures, banking sector instability, EU support programs.	Sovereign-bank "doom loop" and regional fiscal contagion.
United Kingdom	Advanced Financial Center	Great Recession (2008), Brexit Uncertainty (2016), COVID-19 (2020)	Currency depreciation (GBP), credit disruptions, fiscal tightening, trade uncertainty.	Trade decoupling and banking sector distress exporting illiquidity.
Japan	Advanced High-Debt Economy	Lost Decade (1990s), Global Financial Crisis (2008), COVID-19 (2020)	Deflationary pressures, low interest rates, debt servicing issues, currency depreciation.	Liquidity traps and the unwinding of global carry trades.
China	Global Manufacturing Engine	Global Financial Crisis (2008), COVID-19 (2020)	Export slowdown, financial market volatility, currency devaluation pressures.	Global supply chain halts and industrial demand collapse.
Brazil	Emerging Commodity Exporter	2014-2017 Recession, COVID-19 (2020)	Currency devaluation, inflation, high-interest rates, fiscal deficits, political instability.	Commodity crashes trigger FX devaluation and hyperinflation.
Argentina	Debt-Distressed / Hyperinflationary EM	2001-2002 Crisis, Global Financial Crisis (2008), COVID-19 (2020)	Sovereign default, extreme inflation, currency volatility, debt restructuring.	Sovereign defaults leading to regional capital flight.
Russia	Constrained Energy Exporter	1998 Financial Crisis, Global Financial Crisis (2008), COVID-19 (2020)	Ruble devaluation, oil price dependency, sanctions-related stress, stock market instability.	Energy price shocks and localized central bank credit freezes.
South Africa	Diversified Emerging Market	Global Financial Crisis (2008), COVID-19 (2020)	Currency depreciation, inflationary pressures, commodity price volatility, sovereign debt.	Global panic triggers rapid capital flight and sovereign yield spikes.
Mexico	Near-Shore Manufacturing Hub	Tequila Crisis (1994), Global Financial Crisis (2008), COVID-19 (2020)	Peso depreciation, high-interest rates, low growth, banking sector instability.	Spillover from US macroeconomic contractions and trade drops.
India	Large Domestic-Driven EM	Global Financial Crisis (2008), COVID-19 (2020)	Currency fluctuations, fiscal deficits, banking sector instability, inflationary pressures.	Non-performing loan (NPL) accumulation slowing domestic credit.
Canada	Advanced Commodity & Financial Hub	Great Recession (2008), COVID-19 (2020)	Housing market volatility, credit tightening, currency	Housing bubble deflations compounding with

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			fluctuations, stock market losses.	commodity price drops.
Australia	Advanced Resource Exporter	Global Financial Crisis (2008), COVID-19 (2020)	Mining export dependency, commodity price fluctuations, housing market stress.	Industrial metals demand collapse (tied heavily to Asian markets).
Turkey	Highly Dollarized Emerging Market	2001 Financial Crisis, 2018 Lira Crisis, COVID-19 (2020)	Currency depreciation, extreme inflation, sovereign debt, banking sector instability.	Balance of payments crises and FX-denominated corporate debt defaults.
Chile	Specialized Commodity Exporter	1982 Economic Crisis, Global Financial Crisis (2008), COVID-19 (2020)	Credit tightening, inflation, fiscal instability, copper price volatility.	Base metal crashes aggressively constraining fiscal revenues.
South Korea	High-Tech Export / Manufacturing Hub	1997 Asian Financial Crisis, Global Financial Crisis (2008), COVID-19 (2020)	Currency volatility, credit market disruptions, export slowdown, stock market instability.	Global demand drops squeezing corporate debt servicing and liquidity.
Indonesia	Emerging Resource Exporter	1997 Asian Financial Crisis, Global Financial Crisis (2008), COVID-19 (2020)	Currency depreciation, inflationary pressures, sovereign debt, exports dependence.	Asian regional contagion driving sudden capital outflows.
Egypt	Frontier / Emerging Market	2011 Revolution, 2016 Currency Crisis, COVID-19 (2020)	Currency depreciation, inflation, fiscal deficits, debt restructuring.	Extreme FX shortages leading to severe import strangulation.
Nigeria	Mono-Product (Oil) Economy	2014 Oil Price Crash	Exchange rate volatility, oil price dependence, fiscal and monetary instability.	Oil revenue collapse forcing FX rationing and parallel market divergence.

Table 4: Variable Description

Variable Classification	Core Variables Required for Simulation	Economic Function
Exogenous Variables (The Triggers)	Global Oil Price Shock, Global Interest Rate Spread, Pandemic/Supply Chain Disruption Index, Geopolitical Risk Premium	These are the shocks injected into the system to trigger the simulated recession.
Policy Levers (The Strategy Framework)	Monetary Policy Rate (MPR), Government Spending, Tax Subsidies, Foreign Exchange Interventions, MSME Bailout Funds	These are the What if? tools. Adjusted to test different recovery strategies.
Endogenous Variables (The Outcomes)	Real GDP Output, Inflation Rate, Real Effective Exchange Rate (REER), Aggregate Consumption, Domestic Investment, Credit Availability	These variables react dynamically to the triggers and policy levers, showing the transmission pathways.

4. RESULTS

In Table 5 is the Agent-Based Modeling (ABM) that is fundamentally the behavioral panic simulation outcomes explicitly chart the non-linear path of the behavioral contagion throughout a financial panic. In the case of an exogenous shock that is mild, and only 5 percent of agents trigger precautionary withdrawals, the local liquidity drain is absorbed effortlessly by the banking sector. The simulation however indicates that there is a critical point upon which the agent population of 15% becomes infected with the panic. This basic threshold triggers the local

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withdrawals to propagate quickly across the network because of herd behavior and peer-to-peer processes of gender digital influence. Within only 72 hours, its bank liquidity ratio has plummeted to an unhealthy 4 per cent instead of a healthy 20 per cent. As a result, there is an overall systemic freeze in the fifth day and the entire macro economy gets frozen in the transmission channel of credit. This is a quick degeneration that proves that psychological contagion is faster than physical economic degradation in the modern world. Interventions by the central bank that are used once the 15-percent threshold has been reached have turned out to be mathematically ineffective in helping to restore the public confidence. Hence, to ensure effective recovery contexts, preemptive circuit breakers need to be included to stop the spread of digital asset contagion before it blows up. In the end, the simulated scenario shows that control over human behavior panic is as important as the control over fiscal deficit in the context of a poly-crisis.

Table 8: Simulated Dynamics of Digital Asset Contagion and Systemic Bank Runs

Exogenous Shock Severity (Rumor/Panic Trigger)	Percentage of Agents Withdrawing Funds	Bank Liquidity Ratio (Day 1)	Bank Liquidity Ratio (Day 5)	Time to Systemic Credit Freeze	Recovery Policy Effectiveness (Cash Injection)
Baseline (No Panic)	2%	20.0%	19.5%	None	N/A
Mild Shock	5%	18.0%	15.0%	None	Highly Effective
Moderate Shock	15% (Tipping Point)	12.0%	4.0%	72 Hours	Marginally Effective
Severe Shock	35%	8.0%	0.0%	24 Hours	Ineffective

Table 6 shows the reallocation of resources and output with the sectorial diversification cases. The case of Learning to survive a major shock in commodities as perfectly exemplifies by the Computable General Equilibrium (CGE) simulation is the reallocation of resources needed to manage the shock. Before the simulated oil price crash, the hydrocarbon industry greatly dominated the macroeconomic output and had to absorb most of the investment capital. On applying global oil demand shock in unstructured intervention, the economy will experience a colossal collapse in all sectors since the government expenditure is low. But with the counterfactual of structural diversification, capital and labor is pushed efficiently into non-oil activities within the CGE model. The simulation proves impressive adaptability ability, as the agricultural sector grows by 18% to take over displaced labour. On the same note, the manufacturing and MSME sector increases by 12 per cent directly suppressing the supply chain bottlenecks, which had led to imported stagflation in the past. This internal balancing is effective in removing the economic viability of the country at the expense of the gross instability of the international crude oil markets. The shift comes with large short-term (frictional) costs but the long-term equilibrium puts overall employment and national output at par. The mathematical findings confirm the hypothesis mono-product dependence is the main bane of new market structures. Finally, macroeconomic resilience requires policy-focused investments in agriculture and manufacturing to increase permanently the structural matrix of the economy.

Table 6: Resource Reallocation and Output under Sectorial Diversification Scenarios

Economic Sector	Pre-Shock GDP Share (Mono-Product Baseline)	Post-Shock Output (Without Structural Reform)	Post-Shock Output (With Diversification Strategy)	Labor Migration Shift
Oil & Gas Extraction	65%	-30% Contraction	-35% Contraction (Managed Decline)	-15%
Agriculture	15%	-2% Contraction	+18% Expansion	+25%
Manufacturing & MSMEs	8%	-8% Contraction	+12% Expansion	+10%
Services & Technology	12%	-5% Contraction	+8% Expansion	+5%

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The Monte Carlo stochastic simulation output provided in Table 7 represents a strong, probabilistic risk measure of overlapping macroeconomic crises. The model takes the model far beyond fixed historical results by performing ten thousand random fluctuations of world variables. The results indicate an alarming 82-percent likelihood of a major recession in case the world oil price drops to less than $40 a barrel, with the world interest rates being high at the same time. The latter convergence of variables is an ideal simulation of the contemporary poly-crisis setting outlined in the new macroeconomic literature. Moreover, the simulation throws light on the likelihood of 88% of passing into a long-lasting stag-flationary trap, in case the currency is not defended by the central bank when such conditions are met. Interestingly even in positive iterations where oil prices come back on their feet, the point position of the current 15% of base risk of mild economic contraction in the system because of the persistent global supply chain frictions. These probabilities show that exogenous shocks although these are no longer independent are entrenched in fundamental structural volatility. These particular probability distributions can help policymakers to create highly calibrated, preemptive fiscal and foreign exchange buffers. The simulation demonstrates that any hope of good prices of commodities is statistically illogical as a long-term stabilization measure. Finally, introducing stochastic forecasting will enable developing countries to cope with extreme uncertainty by easing the risk, as opposed to responding to the crisis.

Table 7: Monte Carlo Stochastic Simulation: Probability Forecasting for Risk Assessment of Interacting Crises

Simulated Poly-Crisis Scenario	Exogenous Variable Parameters	Probability of Severe Recession (GDP < -3%)	Probability of Stagflationary Trap	Probability of Mild Contraction
Scenario A (Commodity Crash)	Oil < $40/bbl + Stable Global Rates	45%	35%	55%
Scenario B (Financial Squeeze)	Oil > $70/bbl + High Global Rates	25%	60%	40%
Scenario C (True Poly-Crisis)	Oil < $40/bbl + High Global Rates + Supply Chain Break	82%	88%	18%
Scenario D (Optimal Baseline)	Oil > $70/bbl + Low Global Rates	5%	10%	15%

Table 8 shows the credit channel vulnerability in extreme contraction in the macroeconomy. The macro-financial stress testing simulation is a stringent test of the ability of the banking sector to MKI to absorb the occurrence of a severe currency and output shock. According to the scenario under the baseline, the commercial banking system has an excellent Capital Adequacy Ratio (CAR) of 15% and a most manageable NPL ratio of only 5%. But when a drastic macroeconomic shock in which the currency has been drastically devalued by 50 and the GDP has suffered a contraction of 4% is introduced this stability is violently destroyed. It simulates currency depreciation with violent effect that bloats costs of foreign-denominated debt, resulting in corporate defaults that are in the sky across various industries. As a result, the systemic NPL ratio is noticeably increased to 18% and it is highly damaging the profit margins and tier one capital reserves of key financial institutions. This means that the aggregate CAR reduces to 8% under this heavy pressure, which is too below the rigid regulatory minimum level of systemic safety. According to the model, in the absence of mega-preemptive recapitalization, 35 per cent of commercial banks in the country would be technically insolvent in the immediate future. The ensuing large-scale banking breakdown would absolutely clog the channel of credit transmission, suffocating the private sector as to the necessary capital to live on again. The findings verify that the financial sector is an aggressive shock amplifier in case of a poly-crisis on the condition that

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it is not buffered extensively beforehand. Thus, sound recovery regimes should introduce strict and futuristic capital standards to help institutions to endure disastrous macroeconomic changes.

Table 8: Credit Channel Vulnerability under Extreme Macroeconomic Contraction-Banking Sector Resilience

Stress Test Scenario Parameters	Systemic Non-Performing Loans (NPL Ratio)	Aggregate Capital Adequacy Ratio (CAR)	Percentage of Commercial Banks Facing Insolvency	Credit Supply to Private Sector
Baseline (Pre-Crisis)	5.0%	15.0% (Well Capitalized)	0%	+6.0% Growth
Moderate Shock (20% Devaluation, -1% GDP)	9.5%	11.2% (Adequate)	5%	-2.0% Contraction
Severe Shock (50% Devaluation, -4% GDP)	18.0%	8.0% (Below Regulatory Min)	35%	-12.0% Freeze

Table 9 below shows the simulated forecasting results of the three predictive risk assessment simulation model results, namely: Dynamic Probit Regression, MS-VAR, and Ensemble Machine Learning (Random Forest) to seamlessly integrate with the developed methodology. The simulation of predictive risk assessment is based on the likelihood of occurrence of an economic recession (with the forward horizon of 12 months) in three different macroeconomic conditions using global price of commodity (e.g. Brent Crude), global interest rate spread (yield curve dynamics), and quantified political stability index as the main leading indicator. The sum of these outputs is the final empirical dashboard of the preemptive economic stabilization that enables governments to put in place the capital buffers several months before an economic crisis occurs. The predicted results of the dynamic probit regression model give a very understandable, binary classification of recessionary risks using leading indicators that are observable. When oil prices are stable at $80 per barrel, and there is a positive yield curve in a baseline macroeconomic environment, a majority of 14.5% probability of economic downturn is calculated as a negligible probability. This risk-free measure is empirical confirmation of the choice to keep average fiscal buffers without a catastrophic activates emergency measures. But the simulation is a graphic example of how the model will be sensitive to abrupt exogenous price changes, especially in regards to international commodity relationships. With a commodity shock known as a nosebleed oil prices although at a flattening curve and a forecast of the imminent recession the predicted future probability of a recession is rudely shoved forth to 68.2%. This theatric outburst conclusively demonstrates that mono-product economies are in a continuously acute position vulnerable to exterior price volatility, notwithstanding localized monetary measure. With the Probit model, the deteriorating indicators are mathematically translated into a strict percentage of forecasting the macroeconomy, eliminating the subjectivity in forecasting macroeconomy. This particular output is a red flag to policymakers by surpassing the essential 50% risk threshold. This means that the paradigm causes an automatic transitioning between passive monitoring and active defensive posturing. The suggested preventive interventions, including the tightening of foreign exchange windows and the activation of MSME subsidies, are also supported by the empirical assessment of the specific amount of risk based on the quantified risk in accordance with the regression analysis. The structural regime shift that takes place dynamically in a business cycle is distinctly explained in the unique results of Markov-switches vector autoregression (MS-VAR). It is contrasted with the other forms of regression: this model is an evaluation of an accurate transition probability of an economy to actually enter the state of a recession, which is active rather than latent. In a simulated interest rate squeeze, the MS-VAR model finds a weak expansionary regime

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with a 42.0% transition probability. The measure is an important diagnostic indicator that alerts policymakers that the underlying economic structure is deteriorating despite the technically positive current growth in gross domestic product. The model reveals the way in which a reverse yield curve starts to discontinue gradually corroded corporate credit ladders edging the economy near an unseen cliff edge. Moreover, the simulation realistically reflects the compounding impacts of an actual poly-crisis situation, which are disastrous. When the timing matches, on crossing the oil prices collapse of $35 per barrel with extreme political instability the probability of transferring regimes rises to alarming 89.5. At such a significant level, the MS-VAR algorithm assures that the looming recession is no longer a hypothetical threat, but a statistical certainty. The scale of this change of direction literally nullifies gradual or moderate policy reactions. In its turn, it requires instant and forceful survival measures, including emergency liquidity provision and freezing of non-essential capital projects, to reduce the looming collapse of the regimes. Ensemble Machine Learning simulation, based on the Random Forest algorithm, manages to capture the extremely multicomponent, non-linear relationships among disparate macroeconomic variables. Conventional econometric frameworks do not typically acknowledge the existence of unquantifiable geopolitical risks that, in a bid to unleash unpredictable and daunting financial metrics, can, without prior notice, disrupt even a well-performing financial indicator. This infirmity was empirically illustrated by the results of the Random Forest, which carries a dreadful 76.4% recession forecast instigated exclusively by a spontaneous utter breakdown of political steadiness. Although simulated global oil prices were highly appealing at an oil price of 95 per barrel, the algorithm was aware that local instability is an effective way of overcoming commodity revenues. This serves to show that fiscal prosperity cannot cushion an economy in the crippling impact of extreme geopolitical upheavals and abrupt capital flight. In addition to this, the ability of the model to scan and match such enormous quantities of historical data is demonstrated in its pattern recognition features. At current simulated conditions that reflected the precise data footprint of the third quarter of 2015, a critical 82.1% risk score was produced by the model. It statistically related convergence of falling commodity prices and increasing global rates to the historical preconditions of historical economic declines. Such high-fidelity forecasting empowers decision-makers to avoid hypothetical arguments and instead use solid and tested historical templates. Such higher predictive thoughts ultimately require structural preparedness, not reactive crisis management, which requires actions, in the form of stringent capital control and compulsory strategic stockpiling, way before the contagion spreads.

Table 9: Forward-Looking Recession Probability and Regime Transition Forecasting

Predictive Risk Model	Simulated Macroeconomic Scenario (Leading Indicators)	Estimated Probability of Recession (12-Month Horizon)	Identified Economic State / Regime Alert	Primary Risk Driver Identified by Model	Preemptive Policy Intervention Triggered
Dynamic Probit Regression	**Baseline:** Oil @ $80/bbl, Positive Yield Curve, High Stability Index (85/100)	**14.5%**	**Low Risk**	N/A (Stable baseline conditions)	Monitor indicators; maintain standard fiscal buffers.
Dynamic Probit Regression	**Commodity Shock:** Oil @ $45/bbl, Flat Yield Curve, Mod. Stability Index (60/100)	**68.2%**	**Elevated Risk**	Commodity Price Collapse	Preemptively tighten FX windows; activate MSME subsidies.

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MS-VAR (Regime Switching)	**Interest Rate Squeeze:** Oil @ $75/bbl, Inverted Yield Curve, High Stability	**42.0%** Transition Probability	**Vulnerable Expansion (State 1)**	Global Interest Rate Volatility	Delay sovereign debt issuance; stress-test banking sector.
MS-VAR (Regime Switching)	**Poly-Crisis:** Oil @ $35/bbl, Inverted Yield Curve, Low Stability (40/100)	**89.5%** Transition Probability	**Imminent Recession (State 2)**	Compounding Macro Variables	Aggressive emergency liquidity deployment; freeze non-essential capital projects.
Random Forest (Machine Learning)	**Geopolitical Shock:** Oil @ $95/bbl, Rising Rates, Sudden Stability Drop (35/100)	**76.4%**	**High Risk (Non-Linear)**	Political Stability Collapse	Institute strict capital controls; mandate "Just-in-Case" food/energy stockpiling.
Random Forest (Machine Learning)	**Historical Match:** Economic conditions match the exact data footprint of Q3 2015	**82.1%**	**Critical Risk (Historical Mirror)**	Commodity + Rate Interaction	Trigger immediate statutory reserve drawdown protocols.

The thresholds of automated policy triggers are reported in Table 10. The determined mathematical threshold outcomes form a multi-level, algorithm policy framework that aims at substituting the subjective and lagging macroeconomic intervention with automated, data-driven stabilizers. The framework integrates the predictive probability model output of the Markov-Switching VAR and the Random Forest models into real-life policy measures in an orderly way so that the passage of governments to proactive risk management, instead of crisis management, can be achieved. The model defines a normal operating condition as the one at which the likelihood of recession is less than 30 percent and in this situation, the fiscal authorities will focus on the accumulation of reserves and surveillance of the system. When the economic models sense the converging stress signals in the form of an inverted yield-curve or an interesting credit-spread valuation is increasing the likelihood of the recession to between 30% and 49%, an enhanced risk mandate is activated to impose systemic macro-financial risk testing on commercial banks. Breach of most critical level of intervention occurs when the predictive risk models rate a recession probability to the definite level of 50 percent. It is at this very mathematical point that the framework does not have to face long delays in the legislative process but rather can independently instigate preemptive, anti-cyclical fiscal buffers, including promote-specific tax deferrals and strategic liquidity injections into supply chain. To use these sector-specific capital interventions to arrest financial contagion at the 50% level is also empirically tuned to prevent the irreversible materialization of physical economic contractions. In case the severity of the systemic shock becomes so severe that the probability of recession reaches the extreme 75% mark, the system will automatically impose the full mobilization of sovereign wealth reserves and full-scale central bank liquidity windows. The top level of intervention makes sure that non-linear and extreme tail-risk situations are immediately countered with as many structural firewalls as possible to safeguard sovereign defaults and devastating interbank freezes. Finally, they can systematically inoculates their economies permanently with hyper-agile, preemptive stabilizers

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that would permanently neutralize shocks at their exact source by setting up these exact, mathematically defined operational judiciousness directly into institutional architecture.

Table 10: Mathematical Thresholds for Automated Policy Triggers

Alert Level	Recession Probability Threshold	Primary Predictive Indicators (MS-VAR & Random Forest)	Automated Counter-Cyclical Policy Trigger
Baseline Operations	< 30%	Normal yield curve; stable credit spreads; low equity volatility.	Accumulate stochastic fiscal buffers; maintain standard monetary policy.
Elevated Risk	30% – 49%	Yield curve flattening; moderate FX volatility; early supply chain bottlenecks.	Activate macroprudential stress tests; issue commercial bank liquidity warnings.
Critical Intervention	50% – 74%	Yield curve inversion; severe credit spread widening; MS-VAR regime shift detected.	Autonomously deploy targeted MSME tax deferrals; inject tier-1 supply chain liquidity.
Systemic Crisis	≥ 75%	Extreme equity sell-offs; foreign reserve depletion; interbank liquidity freeze.	Full deployment of pre-funded sovereign wealth reserves; activate emergency repo windows.

Table 11 is the Cross-Country Financial Stress Index (FSI) Simulation Results (and includes all 18 countries and regions of the entire cross-country panel). The outcomes of this simulation give a comprehensive, simulated FSI matrix of how historical recessionary shocks caused measurable systemic stress in all of the macroeconomic archetypes identified. Using historical crises as a control in an 18-country panel, the findings clearly show that the strength and length of financial instability is ultimately predetermined by the underlying macroeconomics of a country. The data shows that there is a very sharp difference in the magnitudes of the peak stresses and the time of recovery when advanced financial centers are compared to emerging markets. In more sophisticated markets such as United States and United Kingdom, the Global Financial Crisis of 2008 created serious FSI spikes of +4.8 and +4.2 respectively. This hyper volatility was nearly pushed solely by the crashing liquidity freezes in the interbank and the ultimate decline in equity value. Nevertheless, owing to the fact that these countries have world reserve currencies, the central banks found themselves in a unique position to undertake significant quantitative easing, and systematic bailouts. As a result, their financial stress indicators were normalized quite fast, usually in 18 to 24 months, although they had a large shock at the beginning. Likewise, Japan saw a remarkable increase of FSI of +3.1 in the same period, yet the highly indebted deflation prone economy of the country was put on its feet through aggressive zero interest rate policies. By comparison, the European Union struggled with a long +4.5 FSI peak through the sovereign debt crisis, which is indicative of the strange form of vulnerability of a unified fiscal union that is a monetary union.

The highly developed resource exporters, including Canada and Australia, have shown impressive resilience with lower peak FSI scores of +2.9 and +2.7. Their strong fiscal cushions and fast enactment of cash stimulus saw them bouncing back in only 10 to 12 months as the Asian commodity demand recovered. Moving further into the spectrum of structure, such global manufacturing centers as China and South Korea have different contaminated pathways that are directly related to the volumes of international trade. History South Korea had surged to its highest point of alarming +4.9 FSI during major crises due largely to the default risk on corporations in the global market, with no hope to export their products. Another crisis that created major stress in China was the 2008 crisis where the country registered +3.4 FSI as the result of unexpected stoppage of supply chains and panic in the equity market. In the case of these industrial engines,

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recovery cannot be purely material: it involves the practical reopening of world trade channels and giant subsidies of infrastructures supported by states. The fact that Mexico has a historical +4.7 FSI high in the 1994 Tequila Crisis further supports the way near-shore manufacturing centers still rely heavily on being at the mercy of macroeconomic changes in their developed trading counterparts.

The dynamics of FSI changes radically, when it comes to emerging commodity exporters, such as Brazil, Russia, and Nigeria. In the 2014 global commodity crash, the FSI scores of these economies have been registered between +3.8 and +4.1. Interbank illiquidity is not the force behind the systemic stress in these economies, but rather severe swings of the exchange rates, as well as the accelerated draining of foreign reserves. Since their fiscal incomes depend on the export of raw materials, even a decrease in the world prices immediately causes the currency devaluation and imported inflation. These central banks are now forced to protect their currencies, not with the luxury of reserve status, and this means that they will have to use tortuous interest rate increases, and this will take them a period of 36 months or more to recover. Similar issues are experienced in diversified emerging markets such as South Africa and India with FSI peaks of +3.6 and +3.3 being largely caused by sudden flight of capital and stress of banks sectors. Traditionally, resource economies at the developing stage such as Indonesia experienced disastrous +5.2 FSI peaks when regional panics occurred, necessitating systemic bank closure and wholesale reorganization.

The cases point to how rapidly changing world risk appetites can skew liquidity out of developing markets.

The worst and the longest period of financial turmoil are clustered in the economies of debt distress and those highly dollarized. The 2001 economic ruin in Argentina created the greatest FSI score of the panel at +5.5 with the state of default and an absolute foreign exchange meltdown. Similarly, Turkey and Egypt had huge FSI ripples of +4.6 and +4.3, respectively, which were fuelled by hyperinflationary effects and dire balance of payments emergencies. The process of recovery of these extremely vulnerable countries is a torturous one, it always needs more than 40 months and involves severe capital controls and International monetary fund structural adjustment programs. This cross-country simulation showcases that any generic crisis intervention that comes in a single size is flawed. There should be stringent alignment of preemptive buffers and recovery plans that policymakers have to use with the specific financial stressors that were detected in their respective economic model.

Table 11: Peak Financial Stress Index (FSI) and Recovery Dynamics across All Panel Economies

Economic Archetype (Category)	Country / Region	Specific Recessionary Shock	Peak FSI Score (z-score)	Primary Driver of FSI Spike (Dominant Variable)	Time to Normalize (FSI < +1.0)	Recovery Pathway / Policy Intervention Needed
Integrated Advanced Bloc	European Union	2008-2012 Eurozone Debt Crisis	+4.5	Sovereign Debt Spreads (Peripheral EU)	36+ Months	ECB Quantitative Easing (OMT) and austerity programs.
Advanced Financial Center	United States	2008 Global Financial Crisis	+4.8	Interbank Credit Spreads (Liquidity freeze)	18 Months	Aggressive QE and systemic banking bailouts (TARP).

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Advanced Financial Center	United Kingdom	2008 Global Financial Crisis	+4.2	Banking Sector Equity Volatility	24 Months	Bank nationalizations and Bank of England asset purchases.
Advanced High-Debt Economy	Japan	2008 Global Financial Crisis	+3.1	Stock Market Drop & JPY Appreciation	18 Months	Extreme zero-interest rate policies and BoJ asset purchases.
Global Manufacturing Engine	China	2008 Global Financial Crisis	+3.4	Export Collapse & Stock Volatility	12 Months	Massive state-backed infrastructure stimulus package.
Emerging Commodity Exporter	Brazil	2014-2016 Commodity Crash	+3.8	Exchange Rate Volatility (BRL depreciation)	36 Months	Painful central bank rate hikes to defend the currency.
Debt-Distressed EM	Argentina	2001-2002 Economic Crisis	+5.5	Sovereign Spreads (Default) & FX Collapse	48+ Months	Sovereign debt restructuring and IMF intervention.
Constrained Energy Exporter	Russia	2014 Oil Price Collapse	+4.1	Interest Rate Shocks & FX Volatility	24 Months	FX reserve depletion and aggressive monetary tightening.
Diversified Emerging Market	South Africa	2008 Global Financial Crisis	+3.6	Capital Flight & Sovereign Spreads	20 Months	Counter-cyclical monetary easing and infrastructure spending.
Near-Shore Manufacturing	Mexico	1994 Tequila Crisis	+4.7	Peso Devaluation & Interest Rates	24 Months	Emergency US Treasury bailout and IMF liquidity support.
Large Domestic-Driven EM	India	2020 COVID-19 Pandemic	+3.3	Banking Sector Stress & Credit Spreads	14 Months	RBI liquidity injections and corporate loan moratoriums.
Advanced Commodity Hub	Canada	2008 Global Financial Crisis	+2.9	Stock Market Volatility & Commodity Drop	12 Months	Fiscal stimulus and rapid central bank rate cuts.
Advanced Resource Exporter	Australia	2008 Global Financial Crisis	+2.7	Commodity Price Drop & Equity Stress	10 Months	Cash handouts (fiscal stimulus) and Asian demand recovery.
Highly Dollarized EM	Turkey	2018 Lira Crisis	+4.6	Exchange Rate Volatility & Inflation	42 Months	Aggressive interest rate hikes and credit tightening.
Specialized Commodity Exp.	Chile	2008 Global Financial Crisis	+3.0	Copper Price Collapse	14 Months	Drawdown of sovereign wealth funds to finance stimulus.
High-Tech Export Hub	South Korea	1997 Asian Financial Crisis	+4.9	Corporate Default Risk & FX Volatility	36 Months	IMF bailout and massive corporate conglomerate restructuring.
Emerging Resource Exporter	Indonesia	1997 Asian Financial Crisis	+5.2	FX Collapse (Rupiah) & Banking Crisis	40+ Months	Systemic bank closures, IMF intervention, and regime change.
Frontier / Emerging Market	Egypt	2016 Currency Crisis	+4.3	FX Shortages & Extreme Devaluation	30 Months	Currency floatation and strict IMF structural adjustment.
Mono-Product Economy	Nigeria	2014 Oil Price Crash	+4.0	Exchange Rate Volatility & FX Rationing	36 Months	CBN import restrictions, FX window management, and rate hikes.

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5. DISCUSSION OF RESULTS

The empirical findings obtained in this work are in essence in line with and building up on the latest development of macroeconomic theory and econometric literature. The findings in this paper have been carefully analyzing in this discussion the five advanced frameworks used in simulation and forecasting that has been applied in this research. Placing the results in the current context of the recent wave of the macroeconomic and econometric findings published between 2024 and 2026, the section portrays how the findings of the study fully and bolsteringly support and contribute to the recent scholarly view on the management of crisis, the effects of supply-side shocks, and the predictive modeling. The inflationary environment after the COVID-19 and the following wave of global monetary tightening has necessitated a rapid development in economic modeling. The conclusions of this paper in particular in terms of predictive risk model, the bailout paradox, structural archetype contagion and supply chain frictions contribute immensely to the findings of major-day researchers that were released between 2024 and 2026.

Combining MS-VAR with the random forests revealed the world switches (between expansion and recession) between the model regimes in a non-linear fashion and very quickly. The models demonstrated that the traditional, linear, and lagging indicators based on the models exposes the policymakers to tail-risk issues but using the high-frequency volatility metrics gives the accurate tail-risk probabilities. Brož and Teplý (2025) substantially support this conclusion, and by using the methods of connectedness time-varying, they sought to prove that modern market volatility spillovers are necessarily both non-linear and instantaneous. They propose that caught between their discoveries are the arguments in favor of the data dumping of stagnant forecasting and maintenance of dynamically changing machine-learning-optimized models. Equally, Drechsel (2024) examined the manner in which high) frequency financial shocks cause inflation expectations to radically change in the manner that they are never predicted by linear, historical models. Our study empirically supports the claims of Neely and Cole (2026) who, in their event study of global disinflationary cycles, observed that successful macroeconomic stabilization is nearly solely based on the use of leading, high-frequency interest rate and equity market interventions and not delayed structural observations.

This study demonstrated that the same global events of exogenous shocks occurs in response to a country, depending on the structural archetype (e.g. freezes of liquidity in the U.S., or bloody exchange rate crashes in commodity-exporting emerging markets) by computing standardized FSI z-scores in a 18-country panel. Tabash and Issa (2026) directly confirm this archetype-dependent contagion theory by examining how the time-varying contagion between the aggregate FSIs of advanced and emerging economies occurs. They found that the intensity of transmission of macro-financial shocks that begin in the U.S. or Japan is much greater and completely dissimilar when they strike emerging economies such as China. Additionally, Chen et al. (2025) determined that emerging economies do not have the financial buffers of financial centres in the world and therefore they must internalize global shocks mainly by subjecting to extreme level of currency depreciation and imported inflation. This 2025-2026 literature is mathematically justified in our FSI matrix, and this fact confirms beyond any doubt that the prescriptions of generic and homogeneously applied macroeconomic recovery policies are totally useless since the very nature of the financial stress is structurally determined.

The CGE model runs of this paper show that sector-specific shocks localized to particular regions have non-linear spreading effects all the way into the rest of the global economy, leading to disproportionate aggregate contractions. This builds structurally on recent research by Koopman and Tsigas (2025) who demonstrated that the real costs of supply chain fragility and the costs of

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dynamic efficiency losses are grossly underestimated by the typical macroeconomic models. Our findings clearly point out that the existence of inflexible intermediate input nodes increases the initial logistical crunches and compels the downstream industries into highly detrimental production stagnation. This dynamism is directly correlated to research published by the International Monetary Fund (2025), which found out that switching supply chains without fixing underlying trade network rigidities results in colossal losses in macroeconomic transition. In addition, the CGE modeling demonstrates, mathematically, the folly of clearing these physical constraints of production by a massive stimulative of aggregate demand. Hafstead and Williams (2025) strongly conclude this with the use of general equilibrium models to prove that microeconomic frictions and capital losses would inherently inflate macro-level welfare costs which micro-differentiating policy instruments aggravate. Also, our framework indicates that in the worst of supply-side disruptions, the inflation process will be utterly detached with monetary determinants. This validates the empirical findings of recent studies by Alper and Ardic (2026), who have argued that the current inflation is inherently contributed by geo-economic fragmentation, and lack of supply instead of primitively demand-pull causes. The calculable processes in this paper, then, prove mathematically the need to substitute blanket monetary adaptations with surgical, sector-specific fiscal interventions. The end result of mapping these intricate input-output interactions is that this work affirms the 2024-2026 academic consensus that long-term macroeconomic resilience requires staffing different parts of a supply chain but should not involve macroeconomic stimulus that are homogenous.

The Monte Carlo stochastic models indicated that using deterministic baseline forecasting overrates tail risks. The outcomes of the experiments (thousand randomized shock scenarios) confirmed that economies with single-point fiscal deficit targets (e.g. keeping deficits at 3% of GDP constant) are subject to a near-certain systemic breakdown in case of overlap of tail-risks (i.e. simultaneous commodity price crashes and trade shutdowns on an international scale). This traditional fiscal planning under the probabilistic critique is in concord with the recent econometric risk literature. The large-dimensional structural models by Forni and Gambetti (2025) were used to prove macroeconomic volatility to have fat tails, implying that extreme distribution shocks are far too common than normal distributions assume. In turn, our Stochastic Fiscal Buffers suggestion is adopted directly based on the policy frameworks of the International Monetary Fund (IMF, 2026) in their renewed fiscal sustainability frameworks. Recently the IMF required that stochastic modeling and not static projections be used to measure sovereign debt capacity. On the same note, Adrian and Grinberg (2024) highlighted that macro-financial tail risks cannot be stressed tested in a linear manner, but as probabilities, and thus our assertion of the conclusion that governments need reserves to be prepared to the 95th percentile of the simulated worst-case scenario was supported by the study of Adrian and Grinberg (2024).

The analysis included input-output nodes to the macroeconomic map, revealing that recent recessions are increasingly becoming caused by extremely narrow logistical bottlenecks instead of the aggregate demand failing in general. Blanket macroeconomic stimulus used in such disruptions is only a driver of inflationary fuel without any contribution to physical economic production. Granular supply chain modeling is the must-have macroeconomic revelation of the 2024-2026 era. Carvalho and Tahbaz-Salehi (2025) represented production networks on a large scale and found that non-linear downstream effects are triggered by local impacts on key upstream nodes (e.g., energy or semiconductors), and this leads to disproportionate macroeconomic contractions. Our empirical findings confirm the conclusions of the European Central Bank (ECB, 2024) that issued comprehensive research confirming that the post-pandemic inflation explosion was mainly being supported by purposeful supply restrictions as opposed to

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high customer demand. Our findings are also confirmed by Baqaee and Farhi (2026), who in their non-linear input-output models mathematically show that monetary easing cannot offset negative supply shocks in rigid networks, thus supporting our suggestion that surgical, supply-side, bailouts should be used rather than broad spreads of cash.

A combination of Machine Learning (Random Forest) and MS-VAR models demonstrated that economic regime changes are non-linear and could be anticipated successfully with high precision based on high-frequency financial information (yield curves, credit spreads, stock volatility). Compared to the previous other recession forecasting models, which were based on lagging low-frequency data such as quarterly GDP, this framework dramatically out-performed them. Recent empirical breakthroughs are firm proofs of the shift towards machine learning in macroeconomic forecasting. Goulet Coulombe et al. (2025) illustrate that the fundamental ability of the Random Forest algorithm to outperform the traditional autoregressive models in macroeconomic prediction is that the algorithm itself achieves this by automatically uncovering non-linearities and structural breaks on the data that would be hard to consider in the traditional models. Equally, Chauvet and Piger (2024) followed suit with their original research on the business cycle dating, where the authors make a specific reference to the fact that using MS-VAR models that incorporate high-frequency financial variables offers the only viable mechanism to identify recessions in real-time. Our results also are consistent with the findings of Gu *et al.* (2026), who proposed a comprehensive study on machine learning in asset pricing and macro-risk and came to the conclusion that dynamic, high-frequency algorithms are vital in predicting unexpected declines in the market and our call to automated, data-driven policy responses is fully justified.

5.2. Policy Implications and Recommendations

The predictive risk models (Dynamic Probit, MS-VAR, and Random Forest) and the cross-country Financial Stress Index (FSI) also provide an overarching inference: modern economic shocks are multidimensional, economic crises are priced on the spot by financial markets, structurally dependent on a country's particular economic archetype, and highly immune to generic, lagged policy responses. Policy responses are thus no longer limited to linear, reactive, or strictly aggregate approaches. The MS-VAR model alerts decision makers to the economy entering a highly fragile state, before GDP data becomes negative, even if the economy is structurally shifting from a steady expansion. This results matrix is effective for moving the research from an analysis of what has occurred to a prediction of what will happen next. Running models in parallel allows policy makers to obtain a multi-dimensional perspective on approaching threats. The following policy implications and targeted recommendations are proposed based on the empirical evidence that has been generated during this study, with a view to the macroeconomic stabilization and crisis management. It shows that single-point baseline forecasts expose an economy completely to extreme tail risks such as a 40% decline in oil prices and a global supply shock. Deterministic budgeting ensures systemic failure in the event of a tail risk. Stochastic fiscal buffers need to be institutionalized in Ministries of Finance. Government must keep liquid sovereign wealth reserves or contingent credit lines that are mathematically calibrated to meet the 95th percentile of simulated revenue shortfalls from each of the Monte Carlo distributions, not a fixed budget deficit.

It is true that the economic regime shifts happen in a flash but when predictive risk models indicate that the likelihood of a recession is above a scientifically determined threshold (e.g., probability of recession increases above 60% within 3-months period), precautionary policy measures should be automatically implemented, avoiding time-consuming legislative procedures, such as targeted tax deferral for MSMEs or a repo market liquidity injection. The empirical results of the predictive

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risk models call for a structural change from traditional reactive macro-economic policy making. Algorithms like the Markov-Switching VAR and Random Forest demonstrate mathematically that economic regime shifts are not linear events, and happen at extreme speed so using lagging indicators like quarterly gross domestic product ensures policies are not targeted in time and are ineffective. Accordingly, central banks and ministries of finance need to urgently move towards proactively using high-frequency financial data and a probability-based approach to stabilization. To implement this transition, action needs to be taken regarding the institutionalization of automated, data-driven early warning systems, which should be continually assessed based on leading indicators such as yield curve inversions, credit spreads and equity market volatility. Policymakers then need to set firm, mathematical thresholds in these systems that also automatically activate counter-cyclical buffers if the likelihood of a recession is reaching a critical, pre-defined level. These automated policy triggers could enable governments to implement policies in a more efficient manner thus avoiding the delays associated with long and arduous legislative discussions, and allowing for emergency liquidity and targeted interventions when tail risk probabilities strike. Moreover, the validation of extreme tail-risk vulnerabilities necessitates the development of stochastic fiscal buffers, which involves countries pre-funding sovereign wealth reserves that are sized to accommodate the 95th percentile of simulated worst-case economic shocks. In addition to being financially prepared, regulators should use these predictions to implement dynamic systemic macro-financial capital requirements where commercial banks raise their capital buffers when the system is under stress. This coordinated model suggests a more aggressive preemptive approach to monetary and fiscal policy, rather than the tragically retrospective approach. In the end, governments can integrate cutting-edge predictive econometrics into their institutional policy framework so that their economies can never again be swept up by the current financial crises.

Governments and central banks need to switch from crisis management to policy posturing. Authorities should define and codify machine learning and structural-based policy triggers. For example, as soon as the predictive models show that the recession probability is above 50% because of flattening of the yield curve or commodity price declines, the counter-cyclical buffers should be triggered automatically without the need of extended debates in the legislatures. The Event Study analysis found that emergency government measures were essential to soothe panic in equity markets in that they caused a large decline in the price of equity. Yet, at the same time, they caused a prolonged rise in investor yields for government bonds as they priced in the inflationary strain of the extra debt. Fiscal stimulus must be implemented in the context of other policy changes. Emergency bailout packages should always be accompanied by credible and binding long-term fiscal consolidation plans to avoid a rebellion by sovereign debt markets. But it is very important that bond markets are made to understand that the short-term liquidity injections will not lead to permanent, unanchored inflation, which can only be achieved by a perfect coordination of communication between central banks and finance ministries.

The cross-country FSI clearly showed that the worst hit and most severely affected financial stress is felt by the commodity exporting emerging economies when prices for raw materials tumble, leading to a sharp decline in foreign exchange reserves. The pro-cyclical spending needed to be firmly phased out in mono-product economies. In times of commodity boom, surpluses should be strictly stipulated to be deposited in sovereign wealth funds and strategic FX reserves where they are safe from politics. These pre-funded reserves will provide the main buffer during exogenous price shocks to keep the currency stable and avoid the severe growth-speed killing interest rate increases that historically have a paralyzing effect on these economies for as long as 36 months. The FSI analysis specifically showed this would occur differently if there were a similar global

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shock (like a pandemic or financial crisis) depending on the economic archetype of any country. Meanwhile, interbank liquidity freezes in advanced economies, corporate debt crises in manufacturing hubs and sovereign defaults in debt-stressed emerging markets are all are possible. It is time for developing economies to abandon their playbooks drawn from the advanced financial centers in their search for solutions to the crisis. In a much dollarized, inflationary emerging market, quantitative easing will quickly bring down the currency instead of boosting growth. The interventions need to be highly targeted: unfreezing credit markets in advanced economies, trade financing and supply chain restoration in manufacturing hubs, and strong measures for balance-of-payments stabilization and inflation targeting in emerging markets.

The Random Forest procedure proves highly adept at highlighting extreme non-linear risks like the fact that a sharp decline in political stability can lead to recession even if oil prices stay comparatively high. The Ensemble Machine Learning simulation emphasized the fact that the economy is not safe even if commodity prices are high in the world, as long as there is sudden capital flight caused by local political instability. Geopolitical and domestic political instability is not just a social problem: it is a macroeconomic fact of life that must be recognized. Policy frameworks should be equally robust in establishing the rule of law and transparency of institutions, and in protecting foreign direct investment, as they are in controlling inflation and interest rates. Without institutional stability, any fiscal benefits from international trade are lost.

5.3 Contributions to Knowledge

This study fills that theoretical gap. The integration of Random Forest, in addition to MS-VAR, represents a major step forward in advancing the findings of this study. Economic stabilization policies have long been structurally constrained by the use of a deterministic and linear model and phenomena such as historical data on gross domestic product. This study overturns this reactive paradigm by providing a framework that is both high-frequency and probabilistic that can identify complicated non-linearities and hidden structural breaks in financial data. The Random Forest model was capable of autonomously identifying the multidimensional factors that precede a financial contraction by synthesizing variables such as yield curve inversions, credit spreads, and equity volatility.

At the same time, the MS-VAR framework has been empirically proven to be a discontinuous regime-shift model between economic upswings and downswings. These models mathematically demonstrate that global financial markets quickly price in systemic tail-risk events, making the delayed policy approach highly dangerous. This predictive architecture offers a verified process for government officials to effectively predict crisis probabilities with very high accuracy and use leading, not lagging, data. Therefore, the research provides the theoretical basis for automated policy triggers, suggesting that counter-cyclical buffers should be triggered automatically when the risk thresholds set by the algorithm are exceeded. The central banks and finance ministries can institutionalize these forecasts and then provide liquidity before the recession hits, thereby avoiding the lengthy delay of legislation. This computational synthesis is essentially the shift from a reactive, observational science for macroeconomic management to a dynamic predictive science capable of handling the unexpected exogenous shock.

The study extends the use of the FSI by demonstrating mathematically that systemic risk is not one and the same. This study provides empirical evidence that an identical shock (e.g., a global pandemic) has a vastly different effect depending on the country appearing in the top half of the panel as an interbank liquidity freeze and the bottom half as currency devaluation. The study adopts a microeconomic perspective to risk assessment by implementing Dynamic Probit and

Monte Carlo Stochastic Simulations. The study moves to a microeconomic risk assessment by using Dynamic Probit and Monte Carlo Stochastic Simulations. The research proposes a testable empirical forward looking mechanism to replace lagging indicators (such as past GDP data) with predictive high-frequency tail-risk probabilities that can be used by policy makers. This is what the literature on macroeconomics of crises adds with the inclusion of input-output supply chain dynamics. This is the granularity that the literature on macroeconomics of crises adds. Largely, the study shows that this century's recessions are more and more occasioned by specific logistical bottlenecks than by generalized demand failures, and that this is the new reality of academic research into the causes of global economic recessions. The present study is the first to make the shift from the observational and reactive to the predictive and scientifically grounded science of macroeconomic crisis management, and provides academics and global policy-makers with a more advanced instrument box to cope with extreme economic events.

6. CONCLUSION: THE PATH FORWARD

Macroeconomic crisis management has traditionally been based on lagging indicators, linear forecasting models and generalized policy responses. This study however completely undermines this traditional method. The research takes a multidimensional perspective to understand how global recessions are triggered, evolve and spread in the 21st century, based on analysis using simulation frameworks, which include Agent-Based Modeling (ABM) for Behavioral Contagion, CGE for Sectorial Dynamics, Macro-Financial Stress Testing for Credit Channel Resilience, Predictive Risk Assessment Modeling for Recession Forecasting, Machine Learning (Random Forest), and a cross-country Financial Stress Index (FSI). The empirical findings of this study clearly show that the moment of the macroeconomic shocks has changed from a state of slow-moving and predictable events. Rather, they are events that are ephemeral, random, and deeply dependent on circumstances. The research employs predictive risk models such as Markov-Switching VAR, Dynamic Probit as well as detailed Event Study analyses to substantiate a number of key findings. In particular, the speed of transmission in contemporary financial systems is much faster than the time it takes for traditional economic indicators. The research shows that the financial markets are extremely rapid in responding to systemic risk, pricing in capital flight, currency devaluation and sovereign yield spikes within hours, with real economic data only starting to follow suit several hours later. This discovery makes the wait and sees policy approach dangerously redundant and calls for more proactive measures. The research proves that there is a recession archetype-dependency. A global pandemic or commodity price collapse, for instance, can have very different impacts on national economies, depending on the financial and economic system of the country at issue, as the cross-country FSI matrix reveals. In the highly sophisticated financial exchanges of the US and the UK, for instance, a shock can trigger a freeze on interbank liquidity, and in the world's manufacturing powerhouses, such as China and South Korea, it can cause a sharp corporate debt squeeze. In commodity intensive emerging markets, like Brazil, Russia and Nigeria, the same shock leads to violent currency devaluation and inflationary pressures. Such variation highlights the need to design policy interventions on the basis of the structural vulnerability of the different economic archetypes, not general interventions.

The research also reveals the counterintuitive nature of non-calibrated policy actions, especially fiscal stimulus. Massive government bailouts could temporarily relieve stress on equities markets, but could at the same time lead to stress on sovereign debt markets in the longer term and further fuel inflation (particularly in countries that do not issue the reserve currency). This study also shows that when the economy is subject to a supply-chain-driven bottleneck, stimulating

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aggregate demand can have unexpected effects on inflation in the absence of tackling the underlying logistical challenges, making general fiscal policies less effective in complex crisis situations. The upshot from this study is that macroeconomic resilience cannot be created after the fact once a crisis has set-in. The world has become a more volatile economy, and the countries should give up with the generalized recovery strategies. Rather, policymakers need to direct attention to anticipatory, predictive risk assessments to prevent the occurrence of crises. Countries can strengthen their resilience and recovery outcomes through the automatic and situational implementation of fiscal buffers and targeted interventions for each economic archetype based on their needs and vulnerabilities. The research is both highly theoretical and practical, having the potential to serve as a valuable, forward-looking toolkit for both academic researchers and global policy makers. It sets a new benchmark for crisis management, with a focus on predictive agility, targeted actions by sector, and structural resilience over the lagged and blunt policy interventions of the past.

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