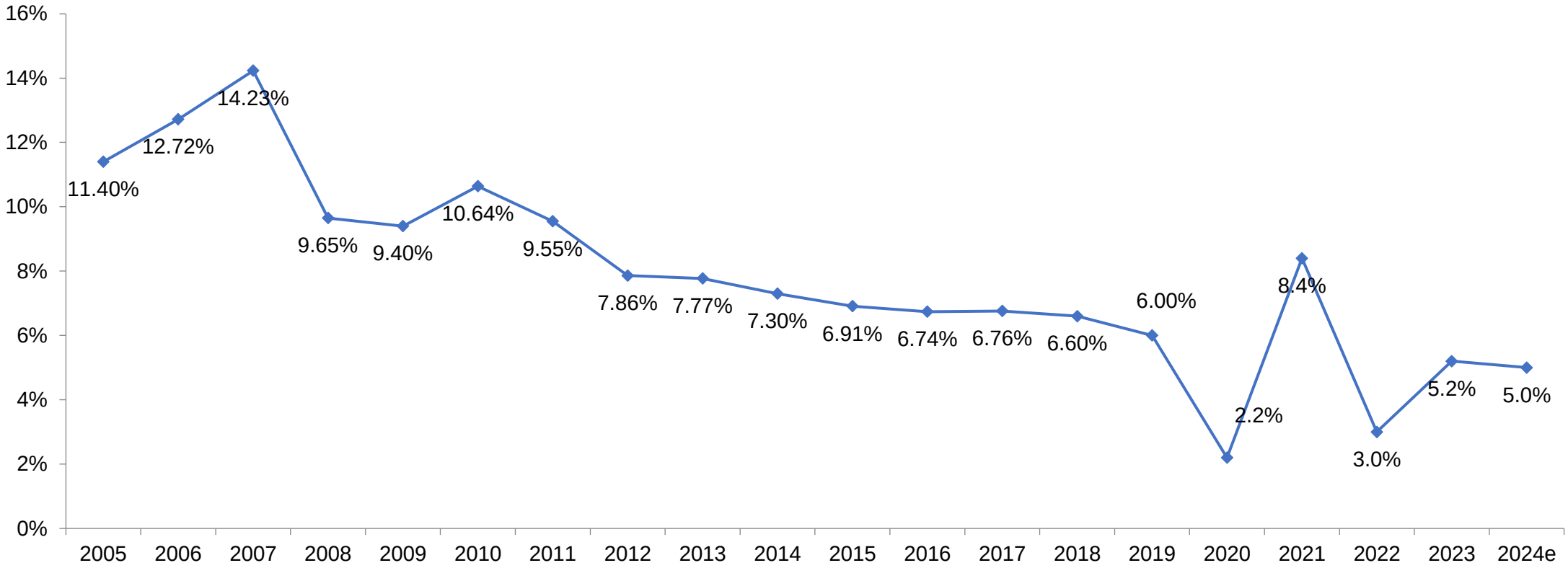
# China's GDP-at-Risk: Real-Time Monitoring, Risk Tracing, and Monetary Policy Effects

For presentation at the Monetary and Fiscal policies in Emerging Markets Amid Heightened Uncertainty conference

# **Stylized Facts:** GDP growth rate **slows down** + **fluctuates**; hence facing the risk of GDP decline

*China's real GDP growth rate over the past two decades*



# **Perspective:** Considering GDP growth rate as a random variable from a long long-term view

- Disadvantage:
  - Time horizon?
  - random variable?

- Advantages:
  - GDP $\backsim$ a distribution
  - Risk management point of view

# Literature Review: The measurement of macroeconomic downturn risks

- Adrian et al. (2019), Prasad et al. (2019), and Aikman et al. (2021) proposed the Growth-at-Risk (GaR) framework, a.k.a. GDP-at-Risk, based on the total distribution of economic growth.
- They adopt the lower quantile level of the economic growth to measure macroeconomic downside risk and predict future growth.
  - Entire distribution vs. point forecast;
  - Backward looking vs. forward looking;
  - Functionary channel vs. end to end.
- We are among the first to compute Chinese GaR using a set of multiple predictors.

# Literature Review: The formation mechanism of macroeconomic downside risks

- From external shocks to endogenous factors, fluctuations in the financial system are now the focus of what lead to macroeconomic downturns; thus, many scholars have explored the formation mechanism of macroeconomic downside risks from the performance of financial and financing-related markets.
- Extant studies investigated various financial sub-markets (banks, equity, bonds, exchange rates), utilizing credit spread, credit leverage, and excess bond premiums to be suitable indicators for predicting macroeconomic downside risks (Gilchrist and Zakrajšek, 2012; Giglio et al., 2016; Caporin et al., 2022).

# Literature Review: The macro-regulatory framework for macroeconomic downturn risks

- While previous studies on regulatory policies focus on managing the lower-order moment fluctuations of economic and financial variables, more recent literature begins to highlight the role of monetary policy in managing economic growth tail risks (Duprey and Ueberfeldt, 2020; Galan, 2020; Suarez, 2022).
- The motivation is that the current monetary regulation measures can not effectively deal with the impact of extreme risk events. This is because the changing tendency of lower quantiles in China's GDP distribution differ significantly from those of means and variances.

# Motivation: The limitations of extant studies

1. Most previous studies fit the probability distribution of future economic growth based on a single set of information regarding financial conditions. **We consider more comprehensive predictors.**
2. Most scholars discuss the left-tail risk of economic growth distribution responding to extreme event shocks, focusing more on the static risk evaluation. **We conduct real-time monitoring of the long-term dynamic changes in macroeconomic downside risks.**
3. Existing studies emphasize the theoretical analysis of the transmission channels from monetary policy to macroeconomic downside risks. **We examine the regulatory effects and the channels using times series model fitted to real data.**

# Motivation: Why choosing China as the laboratory

1. China is in an economic phase of relatively high downward pressure, and the issue of monitoring and regulating economic downside risks is extremely important;
2. The study of downside risks in China can provide an important practical basis and empirical support for policymaking in other emerging economies;
3. Actively exploring the sources of risks that lead to increased downside risks can, on the one hand, search for relevant experiences from an international comparative perspective and, on the other hand, tap into staring targets for macroeconomic policy governance at this stage.

# **Methodology:** The Choice of information set as the **inputs**

| Information source | Input indicator |
|---|---|
| Credit market | Credit growth rate as proxied by the annual growth rate of credit-to-GDP |
| Real estate market | Real estate price growth rate as proxied by the annual growth rate of new housing price index of 70 large and medium-sized cities in China |
| Money market | Interest rate change as proxied by the current minus previous 7-day interbank lending rate |
| Financial market | Financial conditions as proxied by a synthesized index of China‘s domestic financial conditions using principal component analysis of 16 representative indicators from four major financial markets, as well as stock price fluctuation as proxied by the conditional volatility of shanghai A-share index |
| Price level | Inflation as proxied by the annual growth rate of CPI |

# **Methodology**: The **output** is predicted GDP growth distribution

- The first step obtains the regression results of important quantiles via quantile regression, and the second step maps the regression results to a skewed *t*-distribution and fits an entire predictive GDP growth distribution.

$$G_{t+h,q|X_t} = X_t \beta_q + \varepsilon_{t,q}$$

- By minimizing the squared distance between the conditional quantile function and the inverse function of the cumulative skewed *t*-distribution, the above four parameters of the skewed *t*-distribution can be estimated as follows:

$$(\hat{\mu}_{t+h}, \hat{\omega}_{t+h}, \hat{\eta}_{t+h}, \hat{\upsilon}_{t+h}) = \underset{\mu,\omega,\eta,\upsilon}{\arg\min} \sum_{q} [\hat{Q}_{G_{t+h|X_t}}(q \mid X_t) - F^{-1}(q; \mu, \omega, \eta, \upsilon)]^2$$

# Methodology: The SV-TVP-VAR model

- To identify the time-varying regulatory effects of different monetary policy tools on China's GDP-at-Risk, we construct an SV-TVP-VAR model for systematic analysis to provide a useful theoretical approach and empirical evidence for emerging market economies to strengthen the effectiveness of monetary policies.

$$AY_t = F_1 Y_{t-1} + F_2 Y_{t-2} + \cdots + F_s Y_{t-s} + \mu_t \,, \quad t = s+1, s+2, \cdots, n$$

$$Y_t = X_t \beta_t + A_t^{-1} \Sigma_t \varepsilon_t \,, \quad t = s+1, s+2, \cdots, n$$

$$\begin{aligned} \beta_{t+1} &= \beta_t + \mu_{\beta t}, \\ a_{t+1} &= a_t + \mu_{at}, \\ h_{t+1} &= h_t + \mu_{ht}, \end{aligned} \quad \begin{pmatrix} \varepsilon_t \\ \mu_{\beta t} \\ \mu_{at} \\ \mu_{ht} \end{pmatrix} \sim N\left\{ 0, \begin{bmatrix} I & O & O & O \\ O & \Sigma_\beta & O & O \\ O & O & \Sigma_a & O \\ O & O & O & \Sigma_h \end{bmatrix} \right\} \quad t = s+1, s+2, \cdots, n$$

# Empirical Results: The time-varying characteristics of China's GDP growth distribution

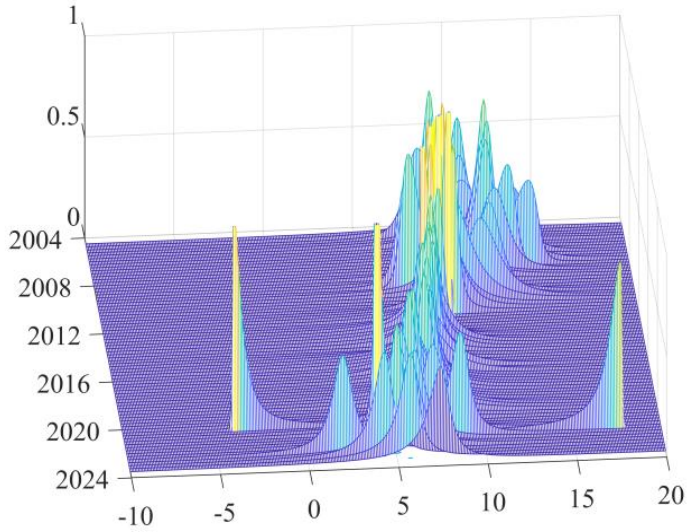



Figure 1 One-quarter-ahead distribution of China's GDP growth

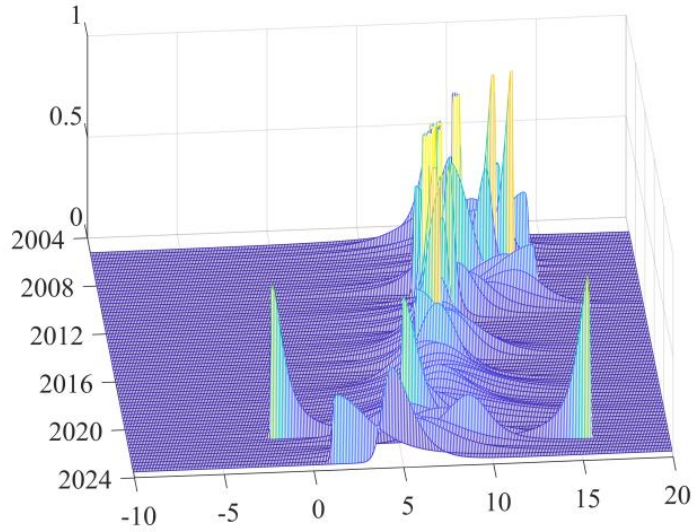



Figure 2 Four-quarter-ahead distribution of China's GDP growth

# Empirical Results: The time-varying characteristics of China's GDP growth distribution

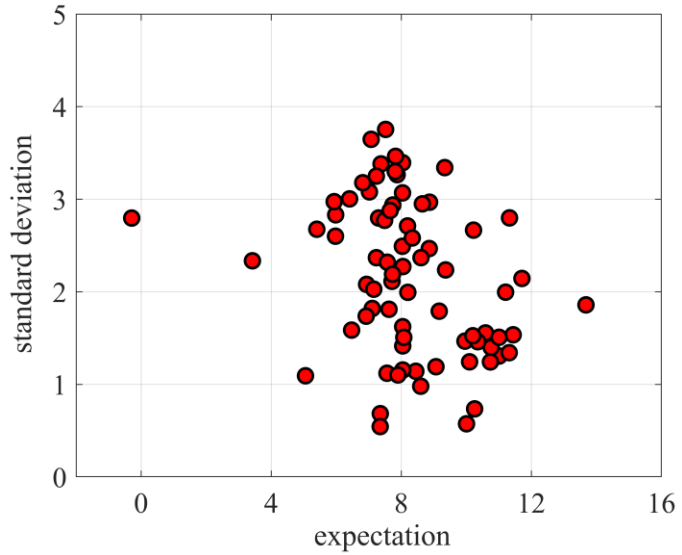



Figure 3 Scatter plot of expectation and standard deviation of China's GDP growth distribution

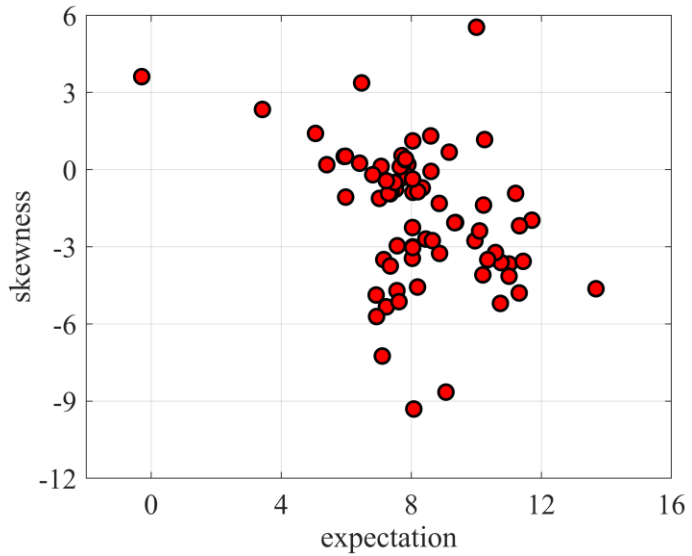



Figure 4 Scatter plot of expectation and skewness of China's GDP growth distribution

# Empirical Results: The dynamic evolutionary path of China's GDP-at-Risk

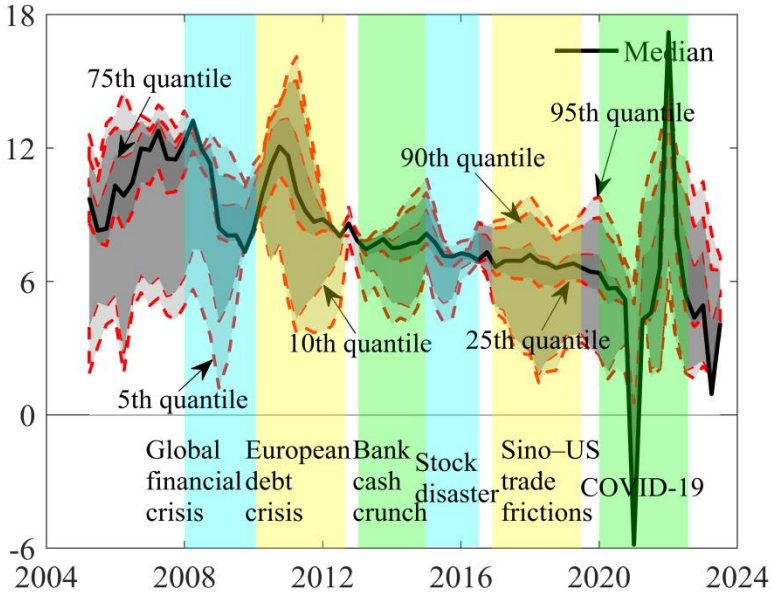



Figure 5 Dynamic evolutionary path of predicted GDP growth in different quantiles

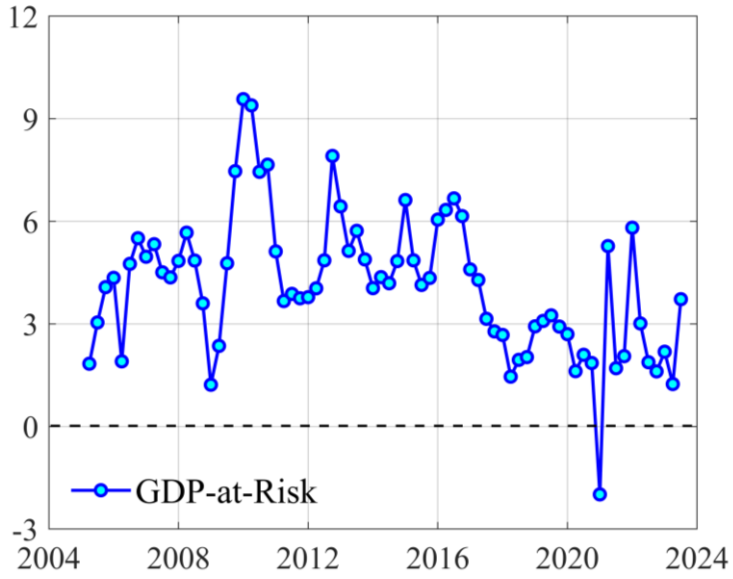



Figure 6 Dynamic evolutionary path of China's GDP-at-Risk

# **Empirical Results:** Determining the relationship between China's GDP-at-Risk & its risk sources

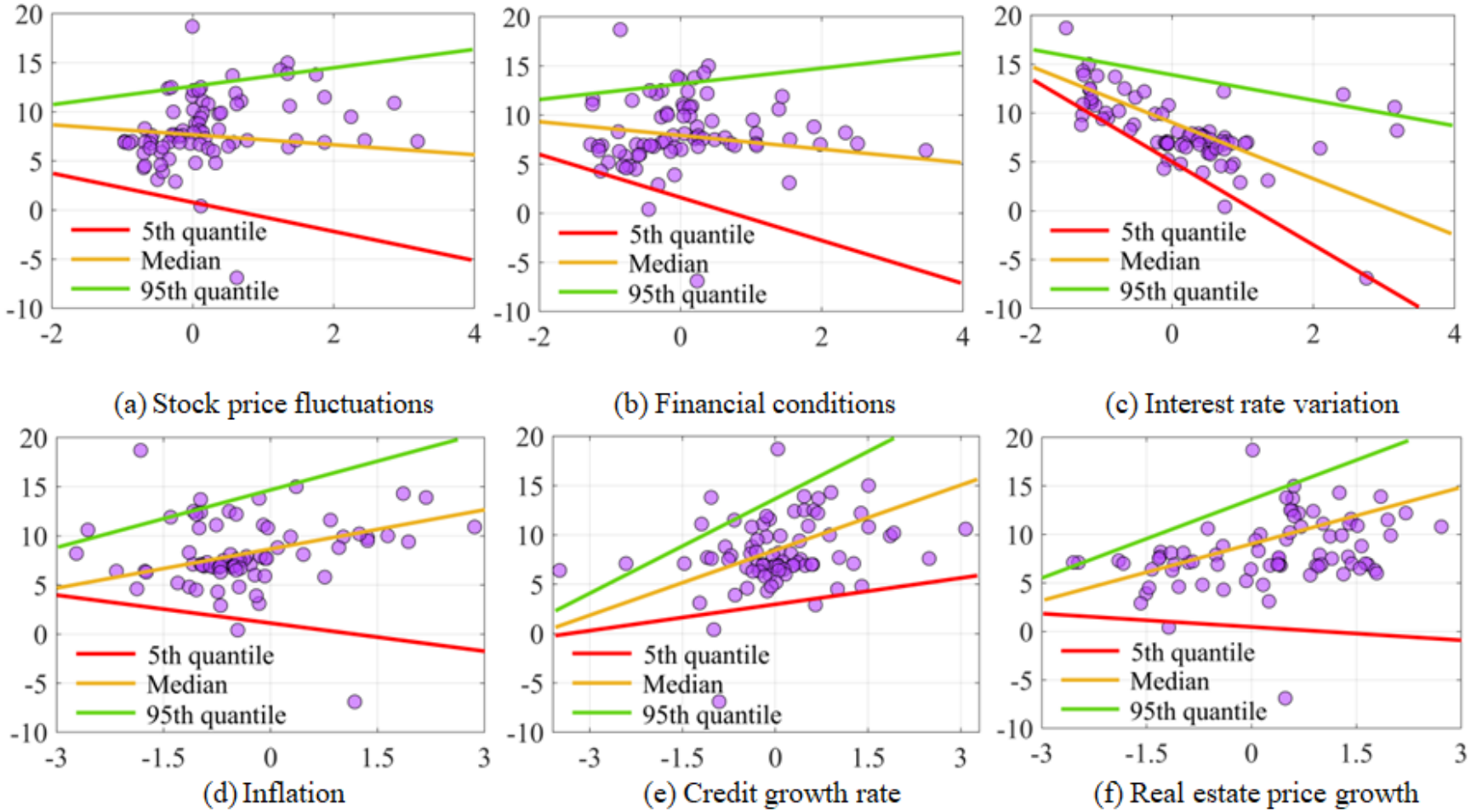



Figure 7 Scatter plot of the predicted GDP growth and predictive information index

# **Empirical Results:** Tracing the **risk sources** of China's GDP-at-Risk

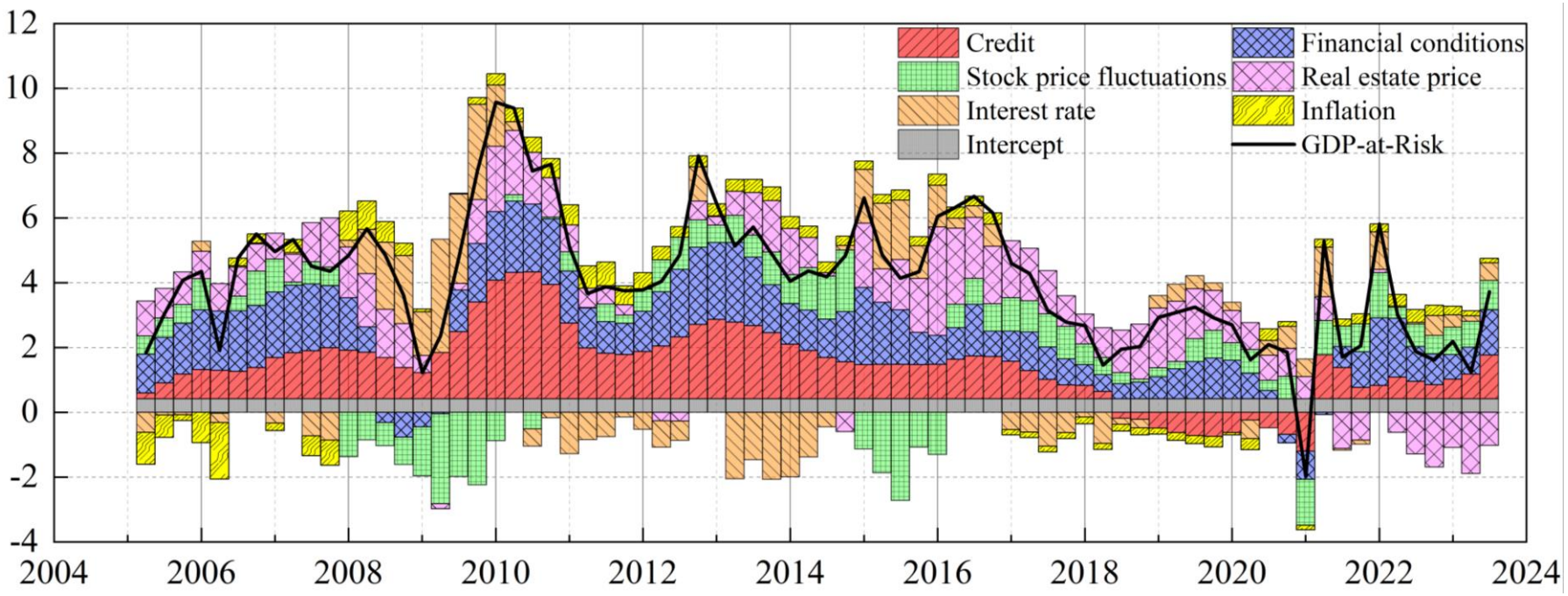



Figure 8 Traceability results of China's time-varying GDP-at-Risk

# **Empirical Results:** The **driving mechanism** of monetary policy on China's GDP-at-Risk

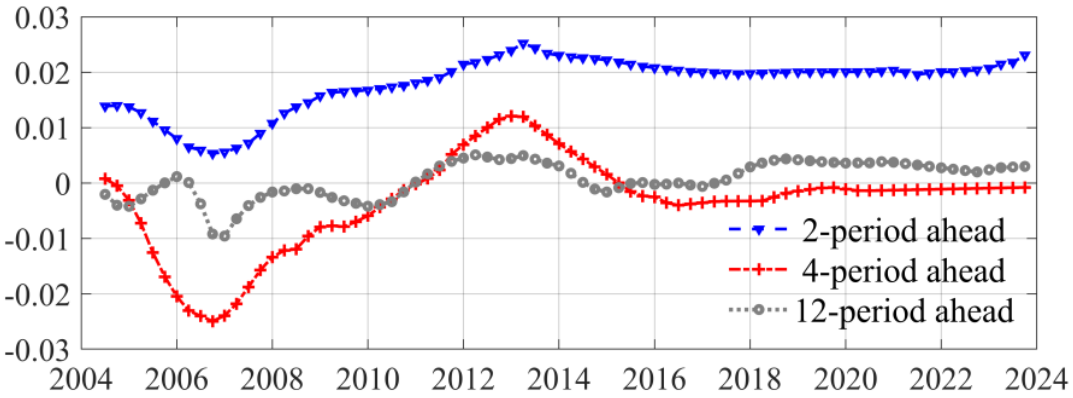



Figure 9 Equal-interval impulse response function of GDP-at-Risk to quantity-based monetary policy shocks

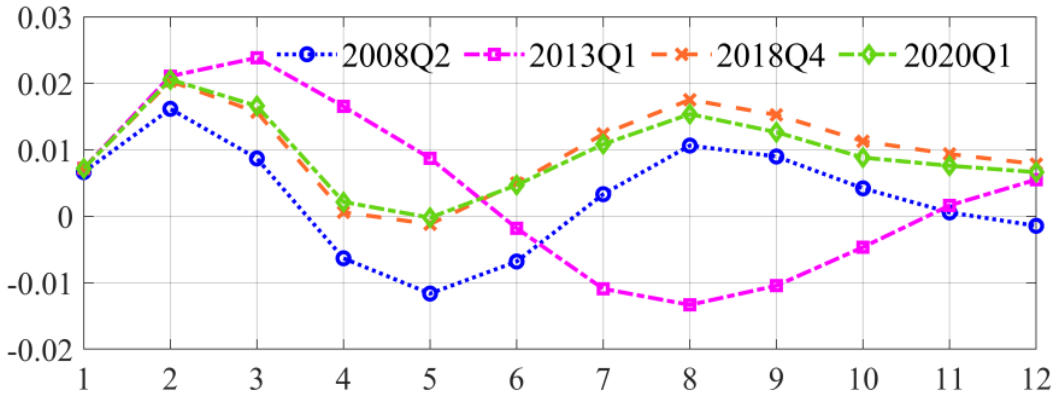



Figure 10 Time-point impulse response function of GDP-at-Risk to quantity-based monetary policy shocks

# **Empirical Results:** The **dynamic effects** of price-based monetary policy on China's GDP-at-Risk

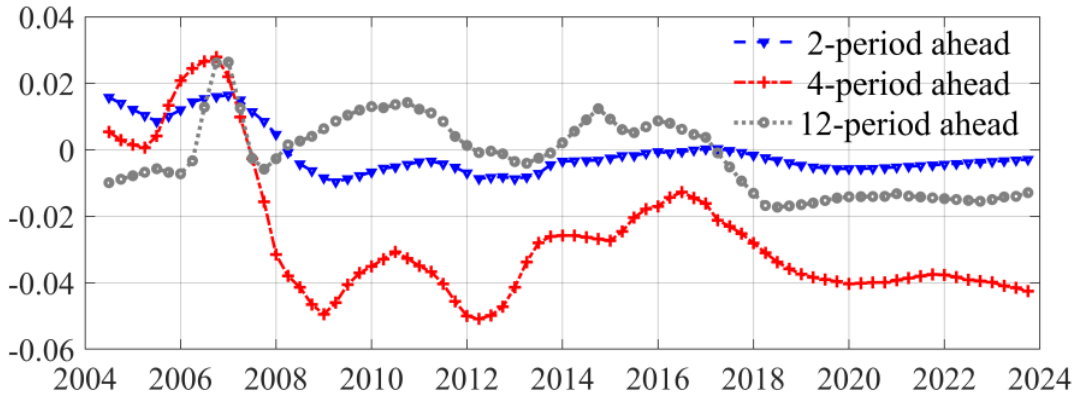



Figure 11 Equal-interval impulse response function of GDP-at-Risk to price-based monetary policy shock

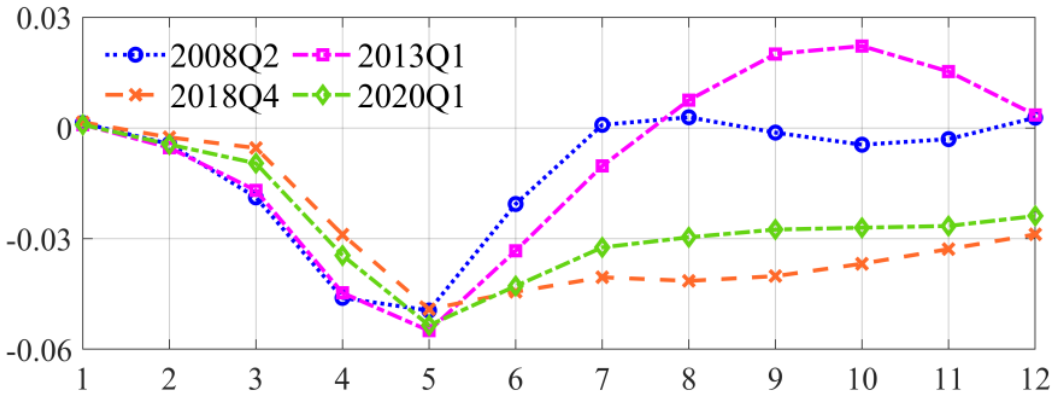



Figure 12 Time-point impulse response function of GDP-at-Risk to price-based monetary policy shock

# Conclusions

- The dynamic evolutionary path of China's GDP-at-Risk exhibits significant **event-driven** characteristics.
- The probability distribution of China's GDP growth is **asymmetric**, i.e., the relation between GDP decline risk and increase prob. is reversed.
- After the pandemic, the risk-driven **effect of housing price** growth gradually increased, **shifting** from the early positive value (good for the economy) to the current larger negative value (adverse effect).
- **Quantity-based** monetary policy can effectively manage macroeconomic downside risks in the **short term**; whereas **price-based** monetary policy can curb excessive economic prosperity and reduce medium- to **long-term** downside risks.

# Policy Implications

- Monitor the real-time dynamics of GDP-at-Risk indicators, establishing early intervention approaches to mitigate macroeconomic risks.
- China's real estate prices at this stage can provide more valuable early warning information about future growth risks, laying the foundation for the development of precise risk warning and prevention systems.
- In the early stage of the formation of macroeconomic downside risks, quantity-based monetary policy should be used to prevent short-term economic recession. During boom periods, policymakers should use combined quantity- and price-based monetary policy tools to intertemporally control potential future economic and financial risks and then strengthen risk supervision and expectation management.