Evolution of the Anchoring of Firms’ Inflation Expectations in Ukraine: Evidence from the TVP-VAR-SV Approach

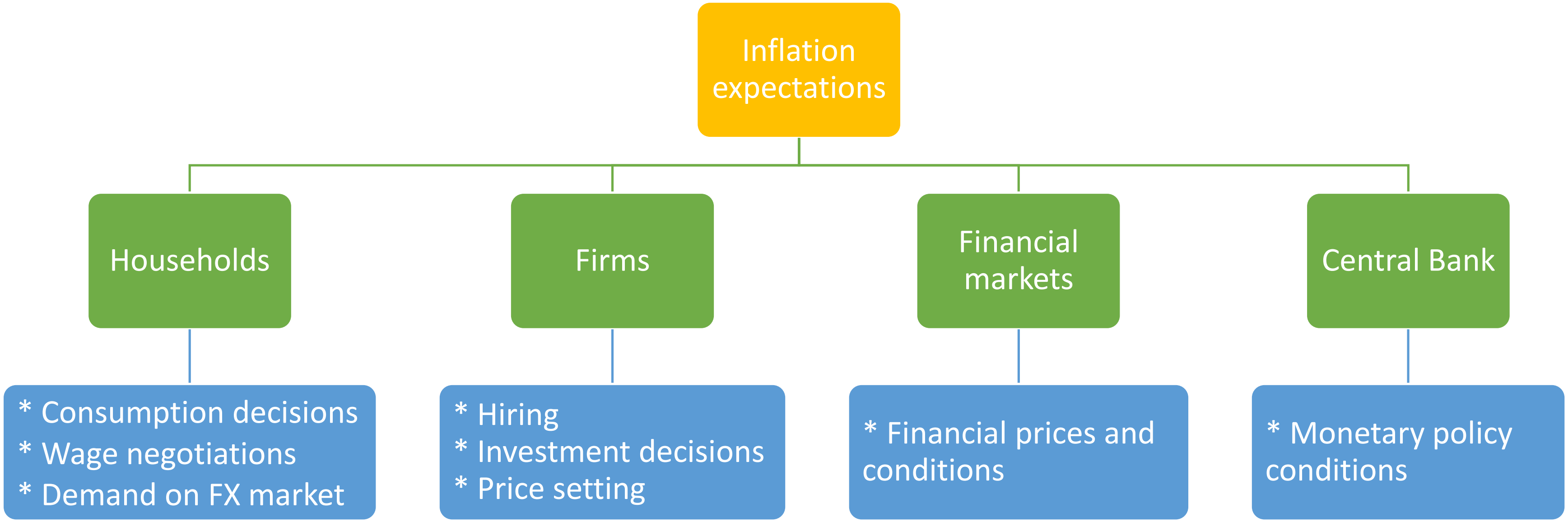
Speaker: Kramar V.R., Postgraduate Student,
Vasyl Stefanyk Precarpathian National University,
National Bank of Ukraine

Supervisor: Pilko A.D., Associate Professor, PhD in Economics,
Associate Professor of the Department of Economic Cybernetics
Vasyl Stefanyk Precarpathian National University

Seventh Conference for Students and Young Researchers
«Banking Sector and Monetary Policy: Future Prospects»
Kyiv, 2024

The role of inflation expectations in monetary policy transmission is captured in the expectations channel

Figure 1. Stylized overview of the transmission mechanism relating to inflation expectations



Source: based on ECB (2021).

- Expectations operate through the impact on price/wage setting as well as consumption, investment, borrowing, and saving via perceived RIR
- If agents expect higher inflation, they adjust their behavior, which can lead to increased persistence and sensitivity of inflation to shocks
- Firms' inflation expectations are relevant for hiring, pricing, and investment decisions, and households' expectations are appropriate for consumption (durable goods), saving, and financing decisions (Coibion et al., 2020; D'Acunto et al., 2022), and they influence wage negotiations and labor supply decisions (Glick et al., 2022)
- The effect of expectations is potentially dependent on the inflation environment, as well as cyclical and structural forces (Rudd, 2021; Coibion et al., 2020; BIS, 2022)

Anchoring inflation expectations helps the central bank stabilize the economy in nominal and real terms

- **The NBU has implemented monetary policy based on the IT regime since August 2015**
  → the effort to anchor inflation expectations at low and stable levels through an explicitly declared quantitative target
- **If inflation expectations are anchored to the central bank's target and are not sensitive to short-term developments**
  → monetary policy can be more expansionary in response to recessionary demand shocks and less restrictive to inflationary supply shocks (Bernanke, 2022)
- **Unanchored expectations**
  → central bank is forced to tighten policy preventively to convince economic agents that inflation will remain under control
- **The full-scale russian invasion caused high uncertainty in the economy and lower effectiveness of the IT regime, necessitating the NBU to suspend it and establish a fixed USD/UAH exchange rate**
  → the inflation expectations continue to be considered in monetary policy decisions
  → key parameter for monitoring prerequisites necessary to return to the IT regime
- **Well-anchored inflation expectations serve as automatic stabilizers and improve the effectiveness of the monetary policy transmission mechanism**
  → desirable in any monetary policy regime

Inflation expectations in Ukraine are under active study, but the evolution of their anchoring is less studied

- **Gorodnichenko & Coibon (2015)** found a significant correlation in time between inflation and exchange rate expectations, highlighting the latter's significance in signaling broader price movements
- **Zholud et al. (2019)** concluded that inflation expectations are formed not only under the influence of past inflation but also consider the prospective component, although firms' and households' expectations remained weakly anchored to the NBU's target
- **Grui et al. (2022)** observe improving but biased inflation expectations among economic agents, citing the influence of exchange rate shocks on firms' expectations
- **Yukhymenko (2022)** highlights the media's role in shaping inflation expectations, while **Yukhymenko & Sorochan (2023)** find monetary policy announcements impact expert expectations, reducing them
- **Savolchuk & Yukhymenko (2023)** confirm the crucial role of central bank credibility in shaping firms' inflation expectations, reducing sensitivity to past inflation deviations
- **Tsapin & Faryna (2024)** found that trust in banks and financial literacy are associated with lower household inflation expectations, and this relationship becomes stronger for respondents with unanchored inflation expectations

The objective is to investigate the evolution of the anchoring of firms' inflation expectations in Ukraine

Methodology: Utilize a time-varying parameter BVAR model with stochastic volatility to analyze inflation expectations from the survey of non-financial sector firm representatives conducted by the NBU since February 2006

Structure:

1. **Literature Review** on the concept of anchoring
2. **Theoretical Framework**: the Phillips curve and the formation of expectations according to Bomfim & Rudebusch (2000)
3. **Model Selection** is performed using marginal likelihoods to provide insights into the stability of the anchoring of inflation expectations over time
4. **Impulse Response Analysis** to examine the impact of inflationary shocks on inflation expectations and vice versa
5. **Anchoring Level and Degree** are calculated based on the model parameters
6. **Impulse Response Analysis with Fixed Volatilities**. Investigates whether the sensitivity of inflation expectations to short-term events is due to changes in shocks magnitude or changes in anchoring themselves
7. **Conclusions**

The literature provides desirable requirements for the approach to assessing the anchoring

Multi Characteristics of Anchoring → Assessing the level and degree of anchoring

- **Ball & Mazumder (2011)** consider shock anchoring – no response to shocks and level anchoring – stability at the central bank's target level
- **Kumar et al. (2015)** formalize five characteristics: closeness to the central bank's target, low dispersion among agents, confidence in forecasts, small forecast revisions, and minimal co-movement between short- and long-run expectations
- **ECB (2021)** summarizes two approaches: anchoring to a level (central bank's target) and the sensitivity of expectations to short-term developments; recent research explore higher moments of expectation distributions

Time Variation in Anchoring → Bayesian VAR model with time varying parameters and stochastic volatility

- **Mehrotra & Yetman (2018)** find a decline in anchors over time for most of the economies in the sample
- **Yetman (2020)** notes an increase in the share of economies having anchored expectations over time, with inflation targeting playing an important role
- **Kose et al. (2019)** show improvements in EMDEs' anchoring linked to inflation targeting, central bank transparency, trade integration, and low public debt
- **Bems et al. (2021)** document significant improvement in inflation expectations anchoring over recent decades. Influences: central bank independence, fiscal rules, policy transparency

Defined Time Horizons → The pre-full-scale invasion target horizon of NBU is **9-18 months** – covering next 12 months' expectations

- **Werning (2022) & Hajdini (2023)** suggest limited impact of long-term expectations on current inflation
- **Mehrotra & Yetman (2018)** point to a different time for inflation forecasts to converge to steady-state across economies, therefore the length of the horizon necessary to clarify
- **Domit et al. (2015)**: short-term expectations as risk indicators for unanchoring

Anchoring determines whether there will be a relation between the demand-supply gap and the level or the change in inflation

According to the Phillips curve:

$$\pi_t = \pi_t^e + \alpha \hat{y}_t + \beta s_t + \varepsilon_t, \qquad (1)$$

where π_t is the inflation rate;
π_t^e is inflation expectations;
$\hat{y}_t$ is the output gap;
s_t is a (vector of) relative price changes (most often oil prices or exchange rates)
ε_t is cost-push shock.

Assume that the expectation formation mechanism of the wage setters is drawn on the model proposed by Bomfim & Rudebusch (2000):

$$\pi_t^e = \lambda_t \pi_t^* + (1 - \lambda_t)\pi_{t-1}, \qquad (2)$$

$\lambda_t \in [0,1]$ quantifies the weight that wage setters give to the implicit anchor:

- $\lambda_t = 0$, private agents do not consider the anchor in the formation of expectations
- $\lambda_t \rightarrow 1$, expectations become more firmly anchored to the implicit target π_t^* and less influenced by temporary inflation shocks

Even if inflation expectations do not respond to past inflation, they cannot be considered anchored if they stand at a level that is undesirable for the central bank π^T

→ **Achieving the full anchoring requires $\boldsymbol{\pi_t^* = \pi^T}$ as well as $\boldsymbol{\lambda_t = 1}$ hold**

VAR framework allows to test simultaneously $\boldsymbol{\lambda = 1}$ as well as $\boldsymbol{\pi^* = \pi^T}$

The two anchoring concepts are simultaneously tested by adopting the method introduced by Demertzis et al. (2012):

$$\pi_t = a_{0t} + a_t(L)\pi_{t-1} + b_t(L)\pi^e_{t-1} + e_{1t} \tag{3}$$

$$\pi^e_t = c_{0t} + c_t(L)\pi_{t-1} + d_t(L)\pi^e_{t-1} + e_{2t} \tag{4}$$

The empirical measure of the degree λ_t and level π^*_t of the anchoring can be calculated using Eqs. (3) and (4) in the long-run equilibrium:

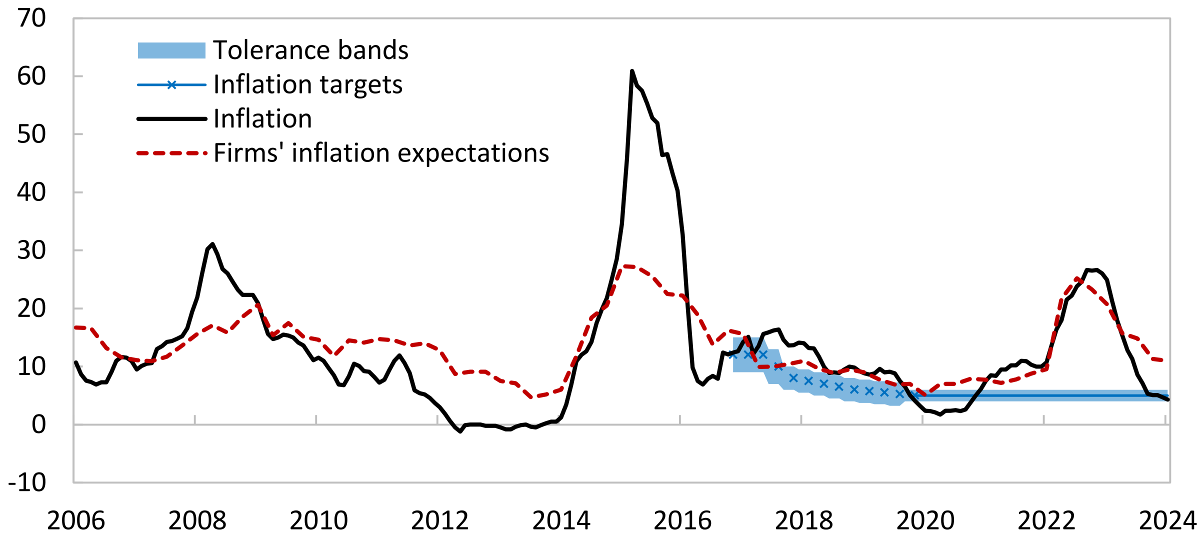
$$\lambda_t = 1 - \frac{c_t(L)}{1 - d_t(L)} \tag{5}$$

$$\pi^*_t = \frac{c_{t0}}{\big(1 - d_t(L)\big)\lambda_t} \tag{6}$$

The VAR framework allows testing the hypothesis that a shock in actual inflation does not affect inflation expectations. To satisfy the hypothesis, all elements of the impulse response function (IRF) should be zero.

Variables spiked during the GFC, after the initial russian invasion in 2014, and after the full-scale invasion

Figure 2. Actual inflation and firms' inflation expectations (in percent)



Source: NBU, author's calculations.

- Inflation is defined as the annual change in the CPI. Inflation expectations are the mean of responses from a quarterly survey of around 700 firms regarding their 1ya inflation expectations, which the NBU conducts
  - firms' expectations can be more relevant for price/wage-setting, employment, and investment
  - the survey of firms covers the longest period
- Since the IT regime, the NBU has set quantitative inflation targets and has begun publishing inflation forecasts that agents can use in the formation of expectations. Following the full-scale russian invasion, the NBU had to suspend the IT regime and commit to returning to the IT regime with the 5% ±1pp inflation target and the policy horizon of 9-18 months
- Quarterly data from 2006Q1 to 2024Q1 is used. Monthly data is aggregated into quarterly by taking the observation for the 2nd month of the quarter

The TVP-VAR-SV model is able to account for policy changes and time-varying shocks

Defining the $n \times 1$ vector of dependent variables as $\mathbf{y}_t$ to estimate BVAR model with stochastic volatility and time-varying parameters (Chan & Eisenstat, 2018; Berger et al, 2023):

$$\mathbf{B}_{0t}\mathbf{y}_t = \boldsymbol{\delta}_t + \mathbf{B}_{1t}\mathbf{y}_{t-1} + \cdots + \mathbf{B}_{pt}\mathbf{y}_{t-p} + \boldsymbol{\varepsilon}_t, \quad \boldsymbol{\varepsilon}_t \sim \mathcal{N}(0, \boldsymbol{\Sigma}_t), \qquad (7)$$

where $\mathbf{B}_{0t}$ is a $n \times n$ lower triangular matrix with ones on the diagonal;
$\boldsymbol{\delta}_t$ is a $n \times 1$ vector of intercepts;
$\mathbf{B}_{1t}, \cdots, \mathbf{B}_{pt}$ are $n \times n$ matrices with the parameters describing model dynamics;
$\boldsymbol{\varepsilon}_t$ is a $n \times 1$ vector of disturbances are assumed to be orthogonal, normally distributed and subject to stochastic volatility with $\boldsymbol{\Sigma}_t = \mathrm{diag}\big(\exp(\mathrm{h}_{1t}), \cdots, \exp(\mathrm{h}_{nt})\big)$.

The log volatilities $\mathbf{h}_t = (\mathrm{h}_{1t}, \cdots, \mathrm{h}_{nt})'$ evolve according to the random walk:

$$\mathbf{h}_t = \mathbf{h}_{t-1} + \boldsymbol{\zeta}_t, \quad \boldsymbol{\zeta}_t \sim \mathcal{N}(0, \boldsymbol{\Sigma}_h), \qquad (8)$$

The free parameters of $\boldsymbol{\delta}_t$ and $\mathbf{B}_{it}$ are gathered in the parameter vector $\boldsymbol{\theta}_t$, which follows a random walk as well:

$$\boldsymbol{\theta}_t = \boldsymbol{\theta}_{t-1} + \boldsymbol{\eta}_t, \quad \boldsymbol{\eta}_t \sim \mathcal{N}(0, \boldsymbol{\Sigma}_\theta), \qquad (9)$$

The error covariance matrices for the state equations: $\boldsymbol{\Sigma}_h = \mathrm{diag}\big(\sigma^2_{h1}, \cdots, \sigma^2_{hn}\big)$ and $\boldsymbol{\Sigma}_\theta = \mathrm{diag}\big(\sigma^2_{\theta 1}, \cdots, \sigma^2_{\theta k_\theta}\big)$. The diagonal elements of $\boldsymbol{\Sigma}_h$ and $\boldsymbol{\Sigma}_\theta$ are independently distributed.

The choice of prior distributions and parameters of the priors can have a substantial effect on model

Table 1. Prior distributions of parameters of model with two variables

Parameter	Description	Prior Family	Coefficients
θ_0	Initial states of the parameters	$\mathcal{N}(\mathbf{a}_\theta, \mathbf{V}_\theta)$	$\mathbf{a}_\theta = 0$ $\mathbf{V}_\theta = 5 \times \mathbf{I}_{k_\theta}$
$h_{i,0}$	Initial state of the log-volatilities	$\mathcal{N}(\gamma_i, \mathbf{V}_h)$	$\mathbf{V}_h = 0.25$ γ_i is set to match the prior mean of $\exp(\mathrm{h}_{i,0})$ with the residual variance of a constant-parameter univariate $\mathrm{AR}(p)$
$\sigma^2_{\theta i}$	Diagonal elements of $\mathbf{\Sigma}_\theta$	$\mathcal{IG}(\nu_{\theta i}, S_{\theta i})$	$\nu_{\theta i} = 5$ $S_\theta = 0.02$ for intercepts $S_\theta = 0.0001$ for coefficients
σ^2_{hj}	Diagonal elements of $\mathbf{\Sigma}_h$	$\mathcal{IG}(\nu_{hj}, S_{hj})$	$\nu_{hj} = 5$ $S_{hj} = 1.4$

Notes: $\mathcal{N}$ and $\mathcal{IG}$ denote normal and inverse Gamma distributions, respectively.
Source: author's calculations.

- This lag length $p = 2$ was chosen based on maximizing the marginal likelihood for the model without TVP and SV. The S_{hj} was selected using a grid search to maximize the marginal likelihood for the model without TVP. Then, $S_{\theta i}$ was selected through a grid search to maximize the marginal likelihood for the model with TVP and SV
- The MCMC sampler developed by Chan & Eisenstat (2018) is used for posterior inference. Throughout used 200,000 draws from the sampler with 50,000 draws as burn-in and retained every 10th draw for posterior inference to limit the impact of the sampler's autocorrelation
- Except for marginal likelihood calculations, draws with non-stationary regression parameters are removed

The framework allows to assess whether there is time variation in none, one or both equations of the model

Table 2. Log marginal likelihood estimates for various models with two variables

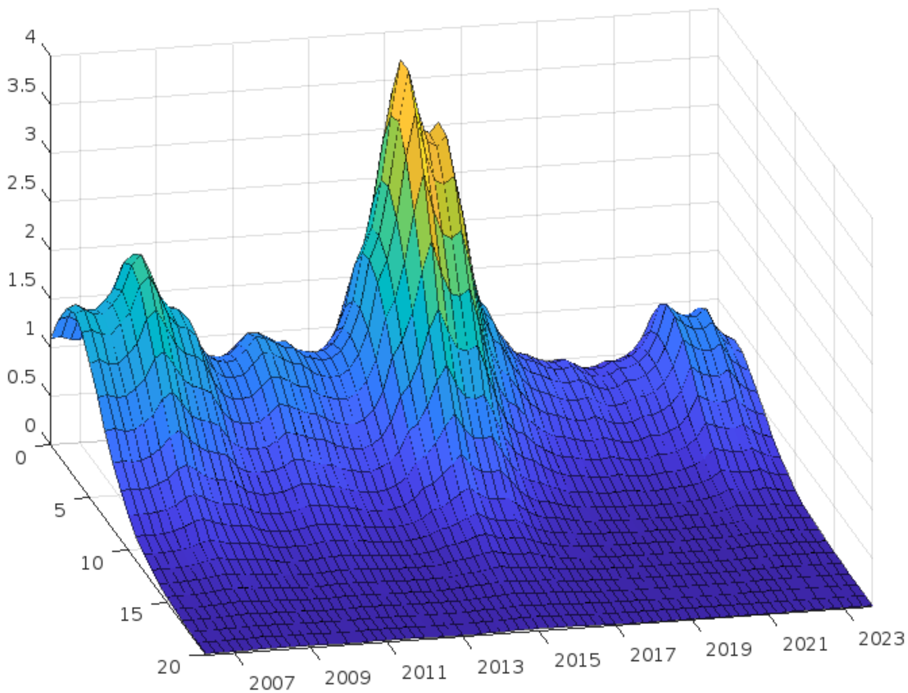
	Log marginal likelihoods
Both equations are constant	-387.8 (0.02)
Time variation in equation for inflation	-388.0 (0.04)
Time variation in equation for inflation expectations	**-387.2 (0.02)**
Both equations are time varying	-387.3 (0.11)

Note: Highest marginal likelihood given in bold. Standard errors in parentheses ().
Source: author’s calculations.

- The marginal likelihood is highest for the model with time variation in the parameters of the inflation expectations equation only
- The fact that the parameters of the inflation expectations equation appear to be time-varying indicates that the anchoring effect is not stable over time

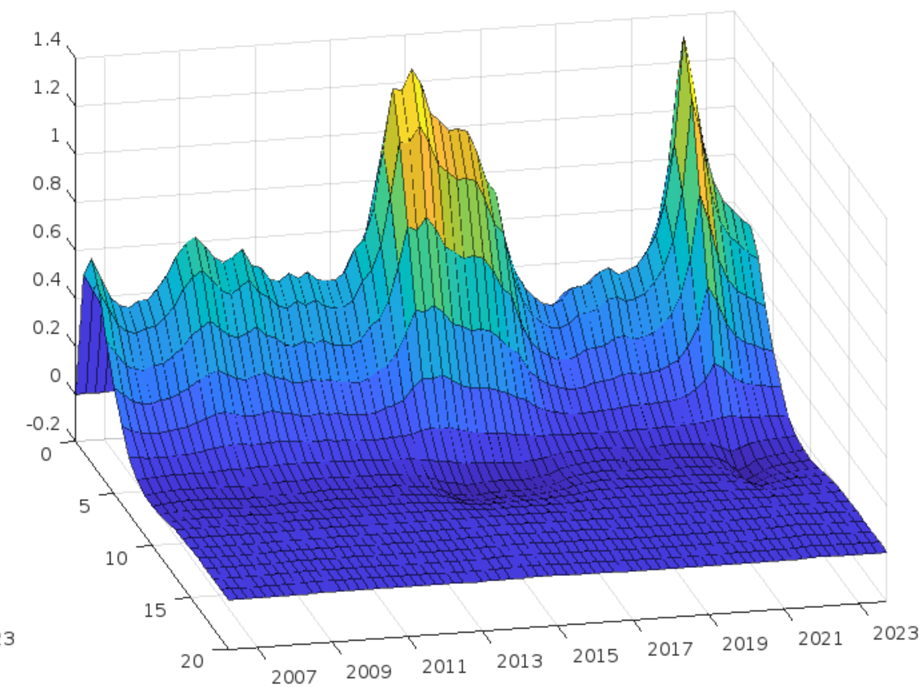
The inflation shocks had the largest effect on inflation expectations before IT regime implementation

Figure 3. Median impulse responses of expectations to one standard deviation of the inflation shocks (in pp)



Notes: Horizon in quarters and dates on horizontal axes.
Source: author's calculations.

Figure 4. Median impulse responses of inflation to one standard deviation of the expectations shocks (in pp)

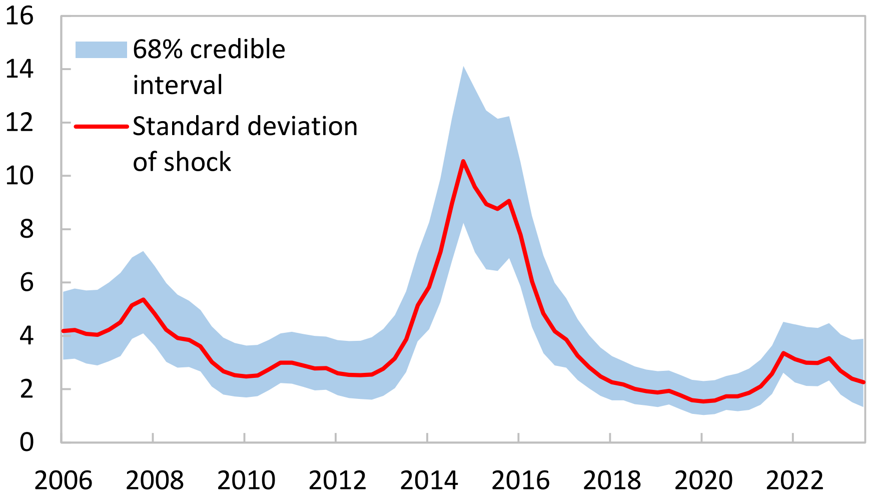


Notes: Horizon in quarters and dates on horizontal axes.
Source: author's calculations.

- The dynamics of the model have changed notably across the sample period
- The direction of the reaction is in line with the theory, showing that inflation shocks have a clear positive impact on inflation expectations and vise versa
- The impulse responses of inflation to expectations shock show the most notable peaks around 2015 and 2022

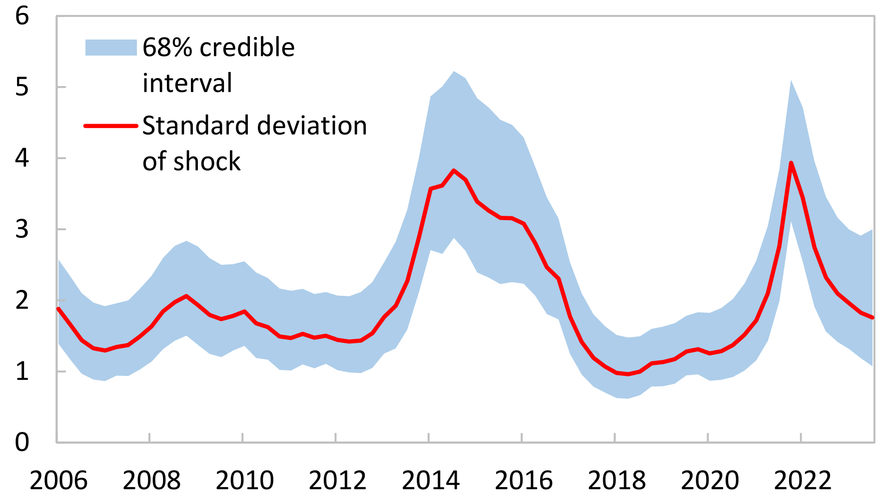
The size of the impulse is time-varying due to the model's stochastic volatility

Figure 5. Posterior median of the standard deviation of shocks to inflation



Source: author's calculations.

Figure 6. Posterior median of the standard deviation of shocks to inflation expectations

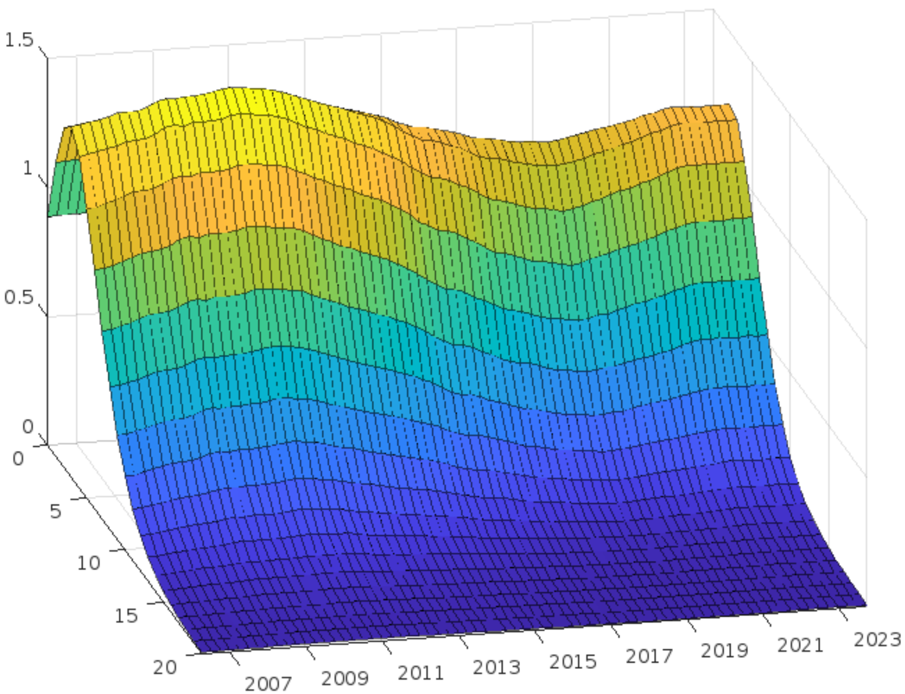


Source: author's calculations.

- The magnitude of shocks spiked during the rapid devaluation of the hryvnia in 2014-2015, but by 2018, they had decreased to lower levels
- Unlike the shock to inflation, the shock to inflation expectations also spiked during the full-scale russian invasion

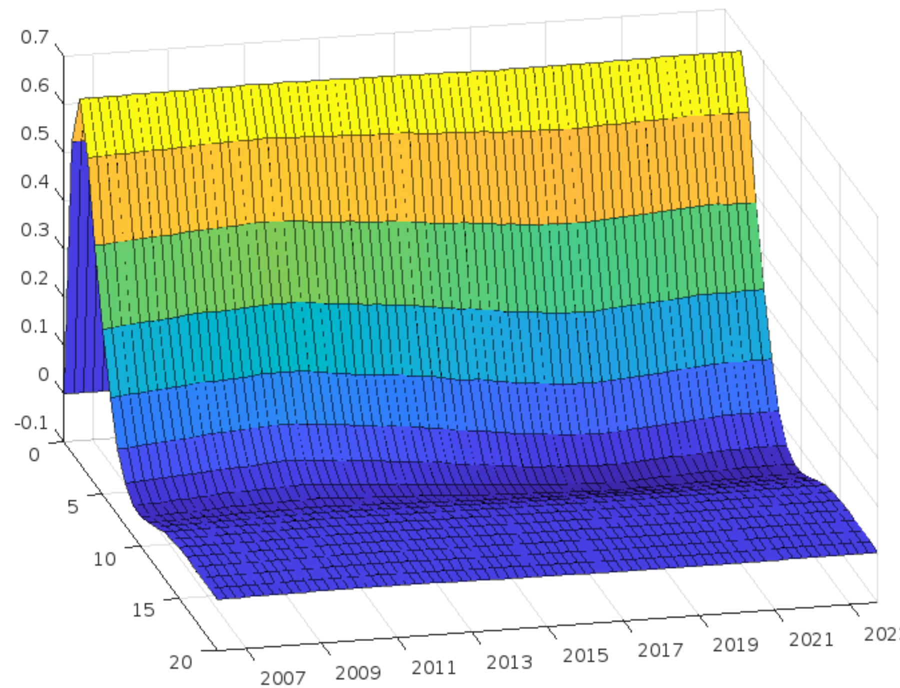
The time-varying nature of shocks' impact is predominantly driven by fluctuations in shocks magnitude

Figure 7. The sample average shock to inflation on inflation expectations (in pp)



Notes: Horizon in quarters and dates on horizontal axes.
Source: author's calculations.

Figure 8. The sample average shock to inflation expectations on inflation (in pp)

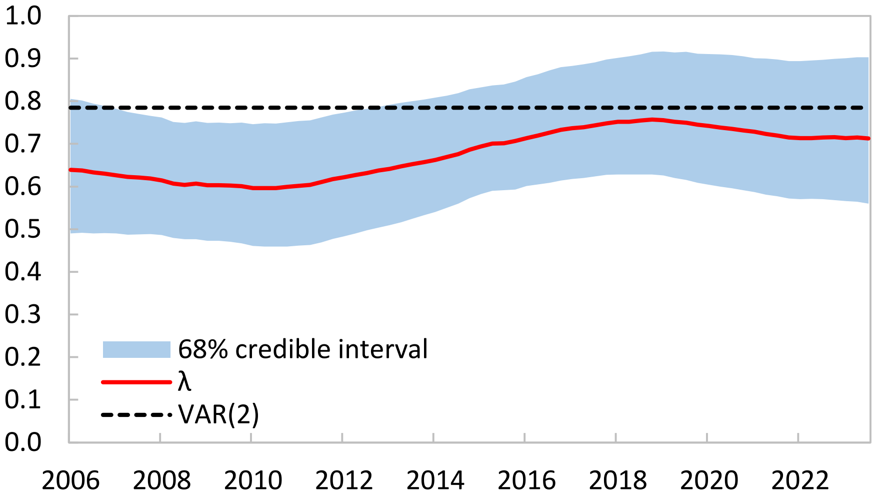


Notes: Horizon in quarters and dates on horizontal axes.
Source: author's calculations.

- The sensitivity of firms' expectations to inflation shocks during crisis periods can be attributed to an increase in shock magnitude, reflecting increased economic uncertainty and instability

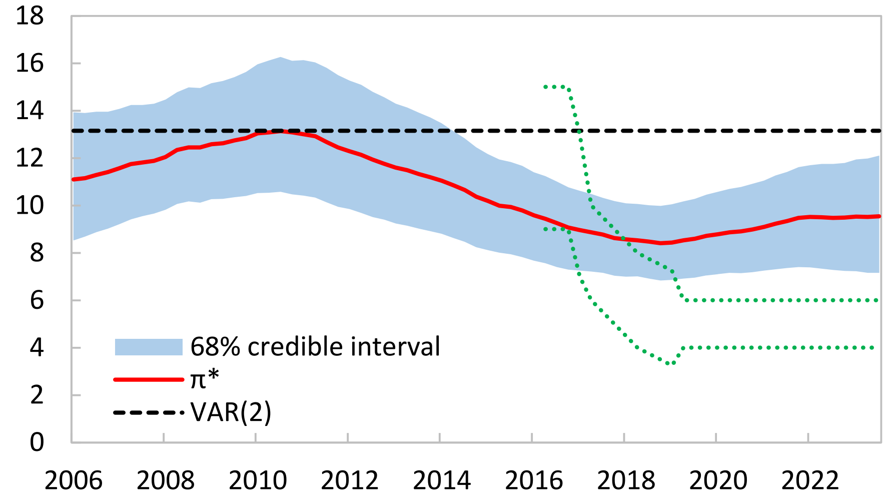
Firms now seem to pay less attention to past inflation and perceived lower inflation targets

Figure 9. Time-varying degree of anchoring (λ_t) versus the time-invariant VAR(2) model



Source: author estimates.

Figure 10. Time-varying level of anchoring (π_t^*) versus the time-invariant VAR(2) model



Source: author estimates.

- There was a decrease in the weights and an increase in the level of the implicit anchor from 2006 to 2011. This partly occurred against the background of the GFC 2007-2008
- The anchoring improvement seemed to have begun already in 2012, before the transition to the IT regime in August 2015. Further transition, coupled with the NBU's communicated focus on the inflation target, is associated with a noticeable improvement in anchoring in both level and degree
- The anchoring gradually increased until the middle of 2019. The perceived anchor's level and weight deteriorated marginally after the spread of the COVID-19 pandemic in March 2020 until the full-scale invasion. The full-scale russian invasion did not appear to significantly impact the anchoring
- The implicit anchor during a short time aligned with the target bands that had been in place since December 2016. The inflation target was lowered faster than the perceived target, which remained above the target bands until the end of the study period

The findings contribute to a broader discussion on the anchoring inflation expectations in Ukraine

This study examines the evolution of the degree and level of anchoring of firms' inflation expectations in Ukraine…

1. The degree and level of anchoring change during 2006-2024. The firms appear to have started placing more weight on the perceived anchor at the lower level as well
2. Despite the full-scale invasion, the model does not show signs of notable de-anchoring effects

…as well as the effect of inflation shocks on the expectations

1. The response of firms' expectations to shocks in actual inflation changed over time, being stronger during stagflation and weaker overall in the IT period
2. During these periods, the increased responsiveness of firms' expectations to inflation shocks can be attributed to the variability in the sizes of the shocks, which plays a crucial role in causing the time-varying effect of the responses, rather than changes in the anchoring effects
3. The NBU may need to implement more forceful measures due to higher response of inflation expectations to inflation shocks during the war
4. Ignoring the instability in the response of expectations to an unexpected increase in inflation may provide a misleading description of economic conditions