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INFLATION AND ATTENTION THRESHOLDS IN UKRAINE

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Abstract This article investigates the relationship between inflation levels and public attention to inflation in Ukraine. Specifically, it estimates a threshold value of inflation above which the population's attention to inflation intensifies. The analysis utilizes monthly inflation data and the Google Trends index for the period spanning January 2017 to January 2022. A threshold generalized linear model is employed to model and estimate the attention threshold. For the selected period, the estimated attention threshold for inflation in Ukraine is 9.9%. Beyond this point, public attention to inflation initially increases sharply before gradually declining. Awareness of this critical value can enable the National Bank of Ukraine to respond more swiftly to emerging crisis situations. Furthermore, this quantification can assist the National Bank, along with other domestic and international experts and organizations, in more precisely defining and communicating the concept of high inflation to the Ukrainian populace.

JEL Codes E31, E52, E58

Keywords inflation, attention to inflation, Google Trends, monetary policy, Ukraine

1. INTRODUCTION

Inflation in Ukraine, following a decline from 26.6% year-over-year (yoy) in December 2022 to 3.2% yoy in April 2024, again began to accelerate rapidly. In this context, it is crucial to recognize that elevated inflation rates induce shifts in the economic behavior of households and businesses, compelling them to devote increased attention to inflation (Korenok et al., 2023). Such an internalization of inflation potentially precipitate an accelerated inflation regime, thereby heightening the risk of hyperinflation (Evans and Ramey, 1995). Moreover, heightened attention to high inflation rates can further entrench their stability (Pfäuti, O., 2023) and influence inflation expectations, which, in turn, affect the actual inflation rate (Adrian, 2023). Consequently, excessive public attention to inflation typically carries negative implications for a country's economy, further complicating the central bank's task of returning inflation to its target level.

Furthermore, no instrument at the disposal of a central bank can be applied without incurring certain costs, as any decision involves a trade-off between inflation control and other economic objectives (Goodhart, 2003). Therefore, it is paramount to identify the optimal balance between the adverse effects of inflation and the costs associated with its containment. This necessitates determining inflation levels that, while not yet critical, do not warrant the deployment of extraordinary measures. However, for Ukraine, a precise numerical definition of these critical inflation levels, particularly concerning public attention, remains unestablished. Consequently, in formulating its monetary policy, the central bank must comprehend and account for the inflation level beyond which the population begins to direct their attention towards it. The rationale underpinning such a threshold is that during periods of low inflation, it exerts minimal or no discernible impact on the activities of economic agents, thus providing little incentive for them to expend resources on monitoring it (Korenok et al., 2023). Yet, once a certain threshold is surpassed, the costs associated with inflation escalate to an extent that prompts the population to increasingly monitor it for the purpose of planning their economic activities.

A robust benchmark for discerning the criticality of specific inflation levels can be the inflation attention threshold. As demonstrated by Pfäuti (2023), crossing this threshold typically leads to increased costs associated with bringing inflation back to its target due to greater persistence. Accordingly, prior knowledge of this level empowers the central bank to respond more appropriately to accelerating inflation, preventing it from exceeding these threshold values and thereby mitigating future costs of achieving the inflation target. The issue of the inflation attention threshold has garnered considerable interest in recent years and has already been examined for numerous developed countries. However, existing studies typically concentrate on advanced economies: Korenok et al. (2023) focus on OECD countries, Pfäuti (2023) – on the United States, and Buelens (2023) on Eurozone countries. There are as yet no corresponding studies for Ukraine, leading to a lack of a clear understanding regarding critical inflation levels within the country. In terms of inflation attention, Ukraine also presents a unique case study. Price growth here has exhibited high volatility due to repeated external shocks, and various developments, such as political reforms and the full-scale war, vie for people's attention.

This paper addresses this significant gap in the literature by providing the first empirical measure of Ukraine's inflation attention threshold. Utilizing monthly Google Trends data for "inflation" and official Consumer Price Index (CPI) figures, I employ the threshold regression framework established by Korenok et al., 2023. To mitigate the influence of extraordinary shocks, the analysis focuses on the period of January 2017 to January 2022, a timeframe characterized by relative macroeconomic stability in Ukraine.

The estimates place Ukraine's attention breakpoint at 9.9% CPI, with a 95% confidence interval ranging from 8.9% to 10.9%. Below this threshold, search intensity related to inflation increases only gradually as inflation rises. However, once prices enter double-digit territory, attention increases sharply. Interestingly, further increases in the inflation rate beyond this point do not result in sustained higher attention. After this initial "double-digit" shock, public attention to inflation appears to diminish, even as the inflation rate continues to grow, likely due to a rapid shift in focus to other pressing topics.

This study contributes to the existing literature in three key ways:

- First empirical measure for Ukraine: It offers the first empirical measurement of Ukraine's inflation attention threshold. This provides the National Bank of Ukraine (NBU) with a concrete early-warning indicator, which can inform its policy calendar and communication strategy.
- Spike-and-fade pattern: The paper documents a unique "spike-and-fade" pattern of attention, which contrasts with the monotonic responses often observed in advanced economies. This finding adds crucial evidence that attention dynamics are not universal but vary significantly with a country's inflation history and institutional context.
- Importance of stable subsamples: By isolating a stable subsample for analysis, the study demonstrates that including crisis periods can significantly inflate the estimated threshold, thereby overstating the level at which public attention normally becomes engaged.

Structure

The remainder of this paper is organized as follows. Section 2 provides a comprehensive review of the relevant literature concerning inflation thresholds and attention dynamics. Section 3 describes the data used in the study, elaborates on the sample restrictions applied, and summarizes key observed patterns. Section 4 details the empirical methodology and estimation strategy employed. Section 5 presents the main empirical results. Section 6 discusses robustness checks and alternative model specifications. Finally, Section 7 concludes the study and highlights its policy implications. Supplementary figures and tables are provided in the Appendices.

2. LITERATURE REVIEW

The topic of the inflation attention threshold is relatively new area of research that has garnered significant interest following the COVID-19 crisis, particularly as inflation rates in developed countries experienced sharp increases after prolonged periods of stability. Nevertheless, even prior to this crisis, studies had highlighted low levels of attention to inflation in economies characterized by low inflation. For instance, Cavallo et al. (2017) demonstrated that individuals in low-inflation environments exhibit significantly weaker perceptions of inflation rates, even when this information is readily available and easily accessible. Maćkowiak et al. (2023) further explored this phenomenon by reviewing the existing literature on rational inattention and developing a neoclassical

model that captures this behavioral aspect of economic agents.

In addition to research explicitly focused on attention thresholds, a broader body of literature examines inflation thresholds from the perspective of economic growth. A substantial portion of this literature on economic growth thresholds builds on the foundational analyses provided by Khan and Senhadji (2001) and Kremer et al. (2012). For example, Vinayagathasan (2013) finds that for Asian countries, inflation adversely affects growth when it exceeds 5.43% but has no discernible effect below this level. For African countries, Ndoricimpa (2017) identifies a 9% threshold for low-income sub-samples and a 6.5% threshold for middle-income sub-samples. Hwang and Wu (2011) estimate a 2.5% threshold estimate for China. Azam and Khan (2020) empirically demonstrated that in both developing and developed countries, a significant negative relationship between inflation and economic growth emerges once inflation surpasses a certain threshold (12.3% for developing and 5.4% for developed countries). The only known study on inflation thresholds in Ukraine is by Mishchenko et al. (2018), which estimated a threshold inflation rate of 4.51%, beyond which inflation begins to impede economic growth.

Studies specifically addressing the inflation attention threshold have emerged predominantly during periods of high inflation in 2021-2022. This period fascilitated the disruption of agents' states of rational inattention, enabling researchers to assess the inflation level that ultimately prompts public attention. Korenok et al. (2023) are among the first to have empirically estimated values for these inflation attention thresholds across different countries. They employed a single-threshold fixed-effect panel model, using the Google Trends index as a proxy for attention to inflation in a sample of OECD countries. Their findings confirmed that most countries exhibit an inflation threshold above which the population begins to pay increased attention to inflation. For instance, the results of Korenok et al. (2023) for the United States indicate the presence of a threshold inflation rate of 3.55%, after which the relationship between the inflation rate and attention to it becomes statistically significant and substantially larger.[1]

Later, Buelens (2023) employed a similar methodology to estimate thresholds for the Euro area. His study further demonstrates considerable heterogeneity in patterns of attention to inflation across Euro area countries. Pfäuti (2023) pursued a distinct approach, estimating the presence and magnitude of the threshold using a model building on the work of Maćkowiak et al. (2023). To incorporate the level of attention to inflation, he adopted the method proposed by Bracha and Tang (2025), who demonstrate the feasibility of using inflation expectations to measure consumer inattention. This approach not only allowed Pfäuti to estimate the threshold using an alternative method but also enabled the development of a theoretical framework to quantify the differential impact of shocks on inflation persistence across low- and high-attention regimes.

Korenok et al. (2023) further categorize the countries in their study into three groups based on their findings (Table 1). The first group comprises countries whose results align with those of the United States, where the relationship between inflation and attention to inflation is not statistically significant before the threshold is crossed. The second group consists of intermediate countries, where the relationship between inflation and attention to inflation before the threshold is statistically significant but remains weaker than the relationship observed after the threshold. Finally, the third group includes countries where the relationship between inflation and attention to inflation is greater before the threshold than after it.

Table 1. Classification of Results by Country Thresholds, from Korenok et al. (2023)

Consistent with U.S. (n = 15)	Intermediate (n = 12)	Not Consistent with U.S. (n = 10)
Austria (1.99) – 2.00	Canada (1.88) – 3.06	Brazil (5.75) – 7.14
Belgium (2.02) – 2.28	Czechia (2.47) – 2.47	Columbia (4.26) – 4.84
Chile (3.34) – 3.93	Finland (1.42) – 2.85	Estonia (3.32) – 4.65
Denmark (1.51) – 1.98	Italy (1.51) – 2.38	Greece (1.49) – 2.64
France (1.34) – 2.45	Korea (2.19) – 3.02	Hungary (3.75) – 6.00
Germany (1.58) – 2.55	Mexico (4.25) – 5.43	Ireland (1.24) – 1.37
Iceland (4.61) – 3.42	Netherlands (1.75) – 2.08	Japan (0.27) – 1.5
Indonesia (5.60) – 4.83	Poland (2.43) – 3.70	Slovenia (1.91) – 3.85
Latvia (3.83) – 4.62	Portugal (1.45) – 2.83	Switzerland (0.36) – 1.44
Lithuania (3.17) – 2.94	Slovakia (2.60) – 4.03	Turkey (11.00) – 9.48
Luxembourg (1.92) – 2.92	Spain (1.87) – 3.60	
Norway (2.09) – 1.24	U.K. (2.18) – 2.20	
Saudi Arabia (2.84) – 4.87		
Sweden (1.25) – 3.10		
U.S. (2.29) – 3.55		
*Avg. Inflation = **2.63***	*Avg. Inflation = **2.23***	*Avg. Inflation = **3.33***

Note: The average inflation rate for the period under study is indicated in parentheses, and the estimated inflation attention threshold follows the dash.

Another significant finding by Korenok et al. (2023), which allows for a preliminary hypothesis regarding

[1] For a more detailed understanding, refer to Figure 1 in Korenok et al. (2023).

Ukraine's inflation threshold level, is the robust positive correlation observed between inflation thresholds and a country's average inflation rate. Given this relationship and Ukraine's average inflation rate of 13% for the period from January 2007 to September 2024 (a figure even higher than Turkey's, a country historically characterized by very high inflation), we can anticipate a threshold value in Ukraine that exceeds those found in all countries in their study, estimated to be around 10-11%.

To assess the reliability of their findings, Korenok et al. (2023) employ an alternative proxy for attention to inflation: the frequency of tweets containing the word "inflation." However, this measurement method has limitations due to the varying prevalence of X.com (formerly Twitter) across countries. Consequently, it was applied to only 15 out of 37 countries where more than 5% of the population had an X.com account as of 2012. The authors conclude that for countries where it is feasible, using Twitter data as an alternative attention proxy yields results consistent with those derived from Google data. Specifically, a threshold level of attention to inflation is present in all alternative models, and its values differ only marginally from those obtained using Google data. Korenok et al. (2023) generally observe that using Twitter data as an alternative proxy for attention produces results largely consistent with those obtained from Google data.

3. METHODOLOGY

The central hypothesis of this study is that the relationship between inflation and attention in Ukraine, consistent with findings from other countries in the literature, demonstrates a threshold effect. Specifically, it is hypothesized that public attention to inflation increases sharply once inflation surpasses a certain critical level. To identify such a threshold, a non-linear model is required – one that can accommodate a structural change in the relationship between inflation and attention beyond that particular point.

The study by Korenok et al. (2023) uses a single-threshold panel fixed effect model.[2] However, our study is based on data from a single country, so we consider the following threshold generalized linear model[3] with no fixed effect (u_i):

$$y_t = \alpha_1 + \alpha_2 I(x_t > \gamma) + \beta_1 x_t + \beta_2 (x_t - \gamma)_+ + e_t. \quad (1)$$

where:

y_t is the measure of attention to inflation (Google Trends index) in Ukraine in period t;

x_t is the measure of inflation (CPI) in Ukraine in period t;

γ is the threshold inflation level to be estimated;

$I(x_t > \gamma)$ – indicator function equal to 1 if $x_t > \gamma$, 0 otherwise;

$(x_t - \gamma)_+$ – equals $x_t - \gamma$ if $x_t > \gamma$, 0 otherwise.

Thus, for inflation values up to the threshold, the equation looks like this:

$$y_t = \alpha_1 + \beta_1 x_t + e_t, \quad (2)$$

And for inflation values beyond the threshold level:

$$y_t = (\alpha_1 + \alpha_2) + \beta_1 x_t + \beta_2 (x_t - \gamma) + e_t, \quad (3)$$

That is, $(\alpha_1 + \alpha_2 - \beta_2 y)$ becomes the new intercept of the function, and $(\beta_1 + \beta_2)$ reflects the new coefficient of change in the level of attention for inflation values above the threshold.

4. DATA DESCRIPTION

Figure 1 presents the available monthly data on the relative search volumes for “інфляція” (“inflation” in Ukrainian) and “инфляция” (in russian) in Ukraine from January 2004 to September 2024, obtained using Google Trends.[4] Following the methodology of Korenok et al. (2023), who utilize queries in the most widely spoken languages covering over 75% of the total population for each country. Ukrainian and russian were selected for Ukraine.

The index of search queries for “inflation” in Ukraine exhibits high volatility in earlier periods. One possible explanation for the elevated index values and pronounced volatility observed in 2007-2009 and prior years, beyond the global financial and economic crisis, could be the comparatively low level of Internet penetration in Ukraine during that time (Figure 2).

[2] $y_{it} = \alpha + x_{it}(x_{it} < \gamma)\beta_1 + x_{it}(x_{it} \geq \gamma)\beta_2 + u_i + e_{it}$,
[3] From the R package chngpt (Fong et al., 2017).
[4] Google Trends, запит “інфляція + инфляция” в Україні для періоду 01.2007 р. - 03.2024 р. https://trends.google.com/trends/explore?date=2007-01-01%202024-03-31&geo=UA&q=інфляція%20%2B%20инфляция&hl=en-US

It is crucial to interpret Google Trends index values correctly. As stated by Google Trends: Understanding the data[5]: “A line trending downward means that a search term’s relative popularity is decreasing – not necessarily that the total number of searches for that term is decreasing, but that its popularity compared to other searches is shrinking.” This implies that a smaller absolute number of Internet users should not inherently impact the index level, as it is normalized by the total number of search queries.

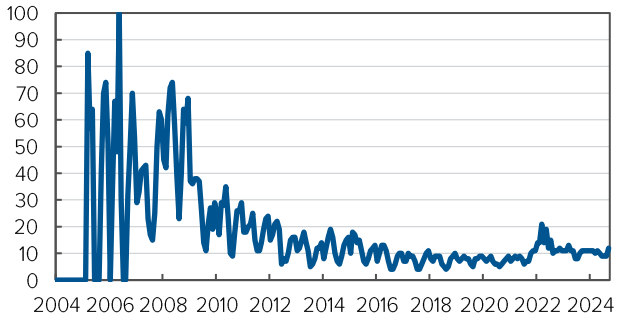

Figure 1. Google Trends Index for the Query "інфляція + инфляция" (“inflation”) in Ukraine[6]

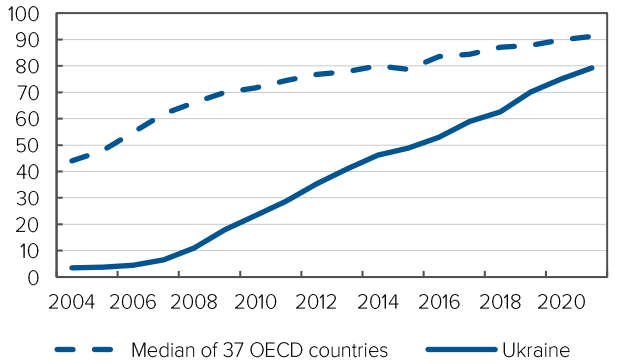

Figure 2. Individuals using the Internet (% of population)[7]

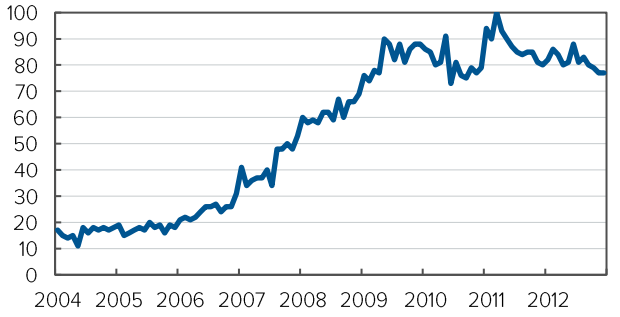

Figure 3. Google Trends Index for the Query "відео + видео" (“video”) in Ukraine

However, a potential issue of sampling bias exists. In 2007, according to the World Bank, only 6.55% of the Ukrainian population used the internet. It is highly probable that internet users at that time comprised a wealthier demographic who could afford internet access. Consequently, the interests of this segment of the population may have differed from those of the general populace, potentially accounting for the elevated share of inflation-related searches observed during 2007-2009. Furthermore, in the nascent stages of internet development, technical limitations (e.g., speed, accessibility) might have led to lower popularity of entertainment content online. This, in turn, could have contributed to a higher proportion of inflation queries relative to the total number of searches. To illustrate the comparatively lower popularity of entertainment content, Figure 3 demonstrates that the relative popularity of "відео" (video in Ukrainian) and "видео" (video in russian) queries in 2004 was approximately five times lower than in 2011.

Another problematic period in the available data for Ukraine is that of the russian federation’s armed aggression against Ukraine, encompassing both the indirect phase (2014-2016), and the direct, full-scale invasion (2022-2025). During periods of significant shocks, it is highly probable that the mechanism governing public attention to inflation undergoes notable change. At the very least, attention is likely to shift towards more immediately relevant concerns. In essence, during the active phases of the russian-Ukrainian war, the attention of the populace and economic agents is likely to be predominantly focused on survival and/or acquiring essential information (news) rather than (to the extent expected in peacetime) on the current inflation level. This dynamic is illustrated in Figure 4, which shows the dynamics of the Google Trends index for the query “news” in Ukraine’s two most common languages.

Here, one can observe how such external factors dramatically alter public interests, and how the situation stabilizes over time. As an illustration of the significant impact of this attention shock, Figure 15 in the Appendix A displays a similar graph for the United States. It shows only one pronounced sharp increase in public attention to the news – at the onset of the COVID-19 pandemic. The graph for Ukraine also exhibits this spike in April 2020, but it is dwarfed by the events at the beginning

[5] Google Trends: Understanding the data. https://newsinitiative.withgoogle.com/resources/trainings/google-trends-understanding-the-data/
[6] Note that, according to the Google Trends website, on 1 January 2011, Google improved the geographic distribution, and on 1 January 2016 and 1 January 2022, it improved data collection.
[7] Source: World Bank, https://data.worldbank.org/indicator/IT.NET.USER.ZS?end=2022&start=2004

of the russian armed aggression. More specifically, the level of attention to news in Ukraine increased fivefold during the first two months of the full-scale invasion, February-March 2022. Consequently, there are substantial grounds to assume that the mechanisms of inflation attention during these periods also underwent significant changes, and did not accurately reflect the behavior of economic agents in normal times.

An example of such a pattern is evident during the years of russia's armed aggression, specifically the 2014-2015 period. In Figure 5, each data point is labeled according to the month of the corresponding year. The figure shows that up until April 2015, inflation consistently increased month-over-month, ultimately exceeding 50%, while the level of attention simultaneously exhibited a downward trend.

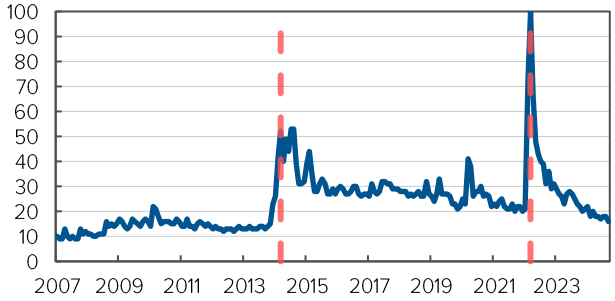

Figure 4. Google Trends Index for the Query "новини + новости" ("news") in Ukraine

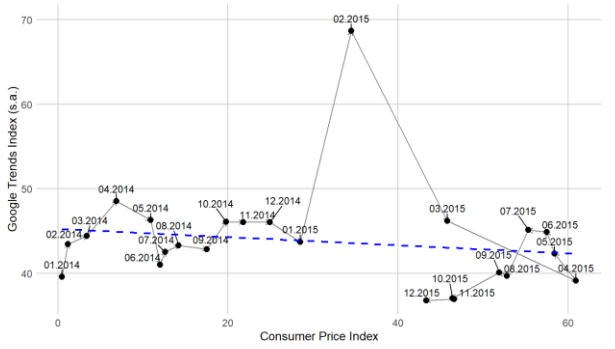

Figure 5. Scatter Plot of the Inflation Attention Index Against the Inflation Rate in Ukraine in 2014-2015 (with linear trend)

As previously discussed, this behavior is likely attributable to the population redirecting their attention, both online and in daily life, toward more pressing concerns during periods of severe external shocks, as well as a general habituation to high inflation rates. Given the potential for estimation bias, periods of armed aggression by the russian federation were excluded from the observations used for the main model. Specifically, the periods from January 2014 to December 2016 and from February 2022 to September 2024 were omitted. Data from January 2011 to December 2013 were also exclude from the main model due to lower Internet penetration compared to the January 2017 to January 2022 period, which could introduce additional distortions into the results. It is important to acknowledge that russia's armed aggression in eastern Ukraine persisted throughout the period from January 2017 to January 2022, the comparatively lower level of public attention to it, reduced inflation rates, and the general normalization of the situation render this period more stable for the purposes of this research.

Moreover, the inflation attention index exhibits pronounced seasonality. Its values predominantly reach local peaks during November-December and March-May, and local troughs in January-February and July-August. The underlying reasons for this seasonality are likely varied. For instance, in November-December, most economic agents are engaged in preparing annual reports and formulating plans for the upcoming years. Additionally, increased household spending and economic activity prior to the New Year holidays may contribute to heightened attention to inflation.

In March and May, taxpayers may exhibit increased interest in inflation. Furthermore, schoolchildren and students could contribute significantly to these seasonal peaks, as spring is a period of intensive academic work, including term papers, diploma theses, and examinations. For instance, a similar trend is observable in query "work" (Figure 16 in the Appendix A), where searches such as "homework", "control work" or "coursework" can constitute a substantial percentage of total queries, leading to peaks at the end of academic semesters (November-December and April-May). This seasonal rationale also effectively explains the downturns in attention to inflation observed during the summer months .

Consequently, after considering the aforementioned factors, only the index values from January 2017 to January 2022 were utilized to estimate the inflation attention threshold in Ukraine. Monthly inflation data (Consumer Price Index, year-over-year percentage change) for the period of January 2017 to January 2022 were obtained from the State Statistics Service of Ukraine website.[8] The adjusted Google Trends index

[8] https://www.ukrstat.gov.ua/

data, after applying the X-11 method (Sax and Eddelbuettel, 2018), are presented in Figure 6.

Figure 7 presents the resulting scatter plot, with each point representing a single month from January 2017 to January 2022. The horizontal axis indicates the annual CPI inflation rate, while the vertical axis shows the seasonally adjusted Google Trends index for “інфляція + инфляция” (“inflation”).

Observe that when the inflation is below approximately 10%, the data points are tightly clustered, suggesting that pubic attention to inflation remains relatively constant as inflation increases from low to moderate levels. However, at an inflation rate of around 10%, attention dramatically increases. Subsequently, as inflation continues to rise further, attention values begin to decline, eventually approaching the levels observed prior to the sharp increase.

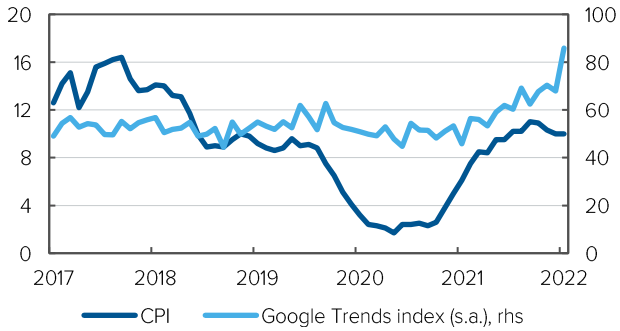

Figure 6. Google Trends Index for the Query "інфляція + инфляция" (“inflation”), Seasonally Adjusted, and CPI (to the corresponding month of the previous year, %) in Ukraine

Figure 7. Scatter Plot of the Seasonally Adjusted Inflation Attention Index and Inflation Rate in Ukraine in the Period 01.2017 – 01.2022

Overall, even after excluding crisis periods, the relationship between attention to inflation and the CPI in Ukraine is demonstrably non-linear. Attention increases only marginally as inflation transitions from low to high single-digit figures, then experiences a significant surge once prices enter double digits, before subsequently stabilizing. This non-monotonic pattern suggests a non-trivial threshold in public awareness, a hypothesis formally tested in the next section.

5. RESULTS DISCUSSION

This section presents the results from estimating the threshold generalized linear model (1) on the specified January 2017 – January 2022 sample. Additionally, it includes robustness checks of the obtained results, examining their sensitivity to sample selection. The results of the main model are illustrated in Figure 8 and detailed in Table 2.

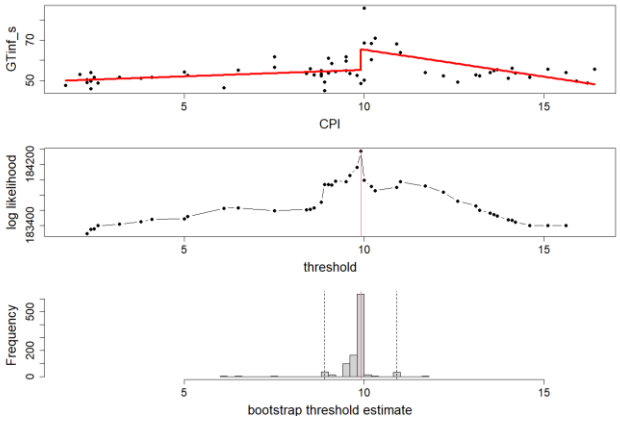

Figure 8. Model Results Based on Data from 01.2017 to 01.2022[9]

Table 2. Model Results Based on Data from 01.2017 to 01.2022

Coefficients	Estimate	Std. Error	(lower	upper)	p.value
α_1	48.756	1.153	46.394	50.915	0.000
β_1	0.643	0.254	0.168	1.166	0.012
α_2	10.409	6.201	-6.869	17.438	0.093
β_2	-3.330	1.004	-4.939	-1.004	0.001

Threshold (γ):	Estimate	Std. Error	(lower	upper)
	9.900	0.510	8.900	10.900

In equation (2):

$$y_t = 48.756 + 10.409 * I(x_t > 9.9) + 0.643x_t - 3.330 * (x_t - 9.9)_+ + e_t, \quad (4)$$

[9] hereinafter in similar: a) first graph – visualization of the model (y-axis – seasonally adjusted Google Trends index, x-axis – CPI, %);
b) second graph – log-likelihood of different thresholds;
c) third graph – histogram of the distribution of thresholds when applying the bootstrap method.

Standard errors, confidence intervals, and p-values for this and all subsequent models were computed using the bootstrap method (Singh and Xie, 2008) with 1,000 replications.

The estimate inflation attention threshold, based on data with the seasonally adjusted Google Trends index, is 9.9%, with a 95% confidence interval of 8.9% to 10.9% at a 5% significance level. Below this threshold, the coefficient on inflation (β_1) є is positive, equal to 0.643, and statistically significant. After passing the 9.9% Google Trends threshold, the index increases by 10.409, and α2 is statistically significant at the 10% level. This means that at the moment of crossing the "psychological threshold" when the inflation rate becomes two-digit, the Google Trends index increases from 48.756+9.9*0.643 = 55.122 to 65.531, i.e. by 18.9%. According to the likelihood-ratio test, the 9.9% threshold is statistically significant (p-value = 0.000) compared to a conventional linear model without a threshold.

Notably, in this model, after such a sharp increase in attention after the threshold, the relationship between inflation and attention becomes negative ($\beta_1 + \beta_2$ is -2.687). This may be due to the gradual acclimatization of the population to high inflation rates after a sharp shock of passing the threshold. This is especially true if we take into account that the average inflation rate in Ukraine for the period 01.2017 - 01.2022 was 9.1%, and for the wider period 01.2012 - 01.2022 the average value was 12.1%.

That is, according to the results of this model, up to the inflation rate threshold of 9.9%, the population still pays attention to it – with a 1% increase in inflation, the expected value of the Google Trends index increases by 0.643. Then, when the CPI reaches 10% or more, there is a sharp jump in attention to inflation, after which attention begins to decline. This dynamic of attention puts Ukraine in a group of countries whose results do not coincide with the United States. Similar results in Korenok et al. (2023) are observed for countries such as Brazil, Colombia, Estonia, Greece, and Japan (Figures 17a-17e in the Appendix A).

To assess the robustness of the model results, we also estimated models for all possible periods ending in January 2022, commencing from January 2014.

Figure 9 illustrates the corresponding thresholds for each model. To enhance the accuracy of the results, the respective Google Trends index period was utilized for the evaluation of each model separately.[10] It is evident that the 9.9% threshold value remains quite stable; significant deviations from this value only emerge when the sample incorporates the 2014-2015 period. It is also noteworthy that all estimated models whose sample concludes in January 2022 consistently classify Ukraine within the group of countries whose results do not align with those of the United States, which is an expected outcome.

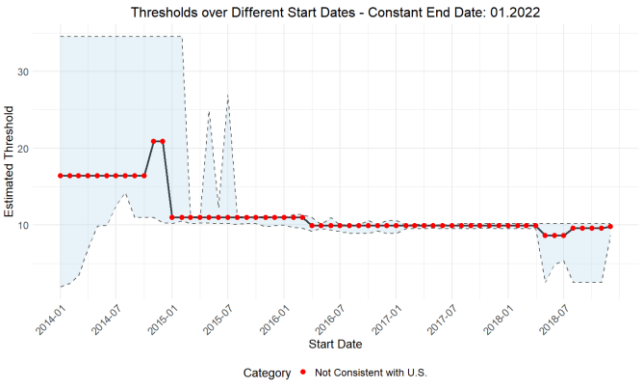

Figure 9. The Estimated Thresholds for Each of the Models Ending in January 2022

Note: confidence intervals were constructed using the bootstrap method with 100 replications, at a 0.05 significance level.

Similarly, models were estimated for all possible periods starting in January 2017. A graph illustrating the corresponding thresholds for each model is presented in Figure 10. The figure shows that for models ending between January 2020 and April 2022, the estimated thresholds are either precisely 9.9% or fluctuate around this value, consistently including it within their confidence intervals. However, beginning in May 2022, when observations from the full-scale invasion are incorporated into the sample, the threshold values increase sharply and are accompanied by wide confidence intervals. This result further confirms the need to exclude these observations to ensure greater model adequacy.

Given that Figure 9, which includes models starting in 2016, shows thresholds that are identical or very similar to those of the main model, a supplementary figure (Figure 11) is included in Figure 18 (Appendix 18), which

[10] The automated retrieval of data on the Google Trends index was performed using the gtrendsR package (Massicotte & Eddelbuettel, n.d.). For the model covering the period from January 2015 to January 2022, the index values were taken for this specific period. If a period was shorter than five years, the necessary number of months was added to the beginning of the period to reach a five-year duration. This was done because for shorter periods, Google Trends provides data with a weekly rather than a monthly frequency. Seasoning was also performed separately for each period of the Google Trends index.

presents the results for models starting in January 2016 instead of January 2017. Furthermore, the higher volatility evident in Figure 11 compared to Figure 10 suggests that including a longer history of observations in the model is more important than including more recent data, particularly during periods of significant instability.

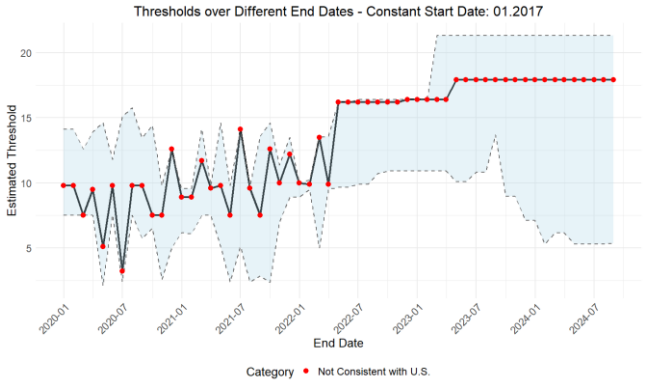

Figure 10. Thresholds for Each of the Models, starting in January 2017

Note: confidence intervals were constructed using the bootstrap method with 100 replications, at a 0.05 significance level.

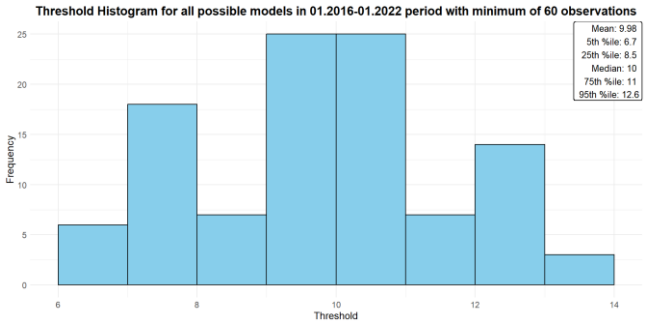

Figure 11. Distribution of Thresholds on All Possible Continuous Samples for the Period from 01.2016 to 01.2022 with at Least 60 Observations, n = 105

To further verify the reliability of the 9.9% threshold, the model was also estimated on all possible continuous samples from January 2016 to January 2022, provided each sample contained at least 60 observations (5 years). The distribution of the estimated thresholds for this set of models is shown in Figure 11. The median of this distribution is 10, a result that is consistent with the findings previously presented.

Models where the inflation rate is lagged by one to three months were also considered. Their results do not differ significantly from the main model, with thresholds of 9.9%, 10.2%, and 10%, respectively. The direction of all coefficients remains unchanged. Detailed results are available in Appendix B. Additionally, as an alternative approach, we considered variations of the model where the attention proxy was limited to searches for the queries “інфляція” and “инфляция” (“inflation”), and specifically within the "News" category of Google Trends. The results of these queries, dating back to 2004, are presented in Figure 12.

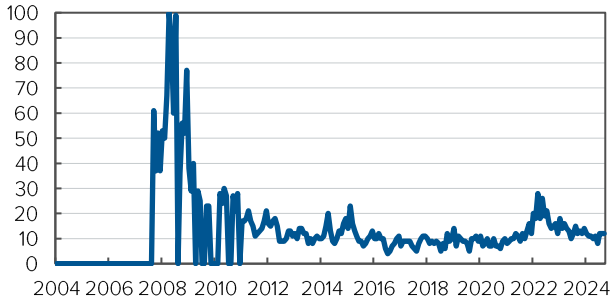

Figure 12. Google Trends Index for the Query "інфляція + инфляция" (“inflation”) in Ukraine in the “News” Category

The results of estimating the main model for the period January 2017 to January 2022 with the alternative dependent variable (the Google Trends index in the "News" category) are presented in Figure 13 and Table 3. This model differs from the previous one in that there is no discernible relationship between the inflation rate and the level of attention to inflation before the threshold. In this specification, such indifference to minor price changes is offset by an even larger jump in attention when the threshold is crossed. The Google Trends index is predicted to increase from 30.779 − 9.1 × 0.010 = 30.688 to 42.961, a surge of 40%. After the threshold, the direction of the relationship remains consistent with the basic model.

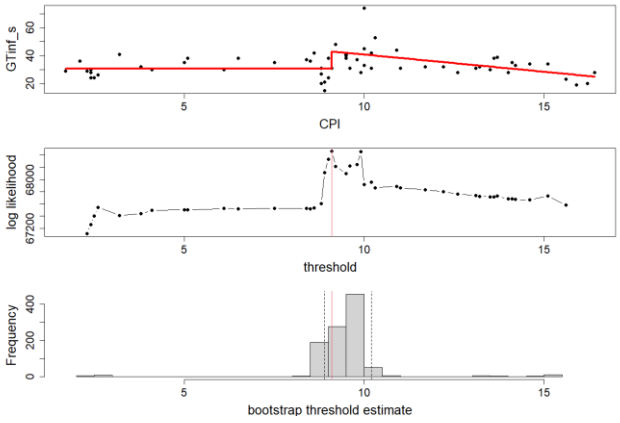

Figure 13. Alternative Model (“News” Category) Results Based on Data from 01.2017 to 01.2022

Table 3. Alternative Model ("News" Category) Results Based on Data from 01.2017 to 01.2022

Coefficients	Estimate	Std. Error	(lower	upper)	p.value
α_1	30.779	2.458	25.753	35.389	0.000
β_1	-0.010	0.552	-0.963	1.202	0.986
α_2	12.273	6.576	-4.562	21.215	0.062
β_2	-2.466	1.374	-5.982	-0.596	0.073

Threshold (γ):	Estimate	Std. Error	(lower	upper)
	9.100	0.331	8.900	10.200

In equation (2):

$$y_t = 30.779 + 12.273 * I(x_t > 9.1) - 0.010x_t - 2.466 * (x_t - 9.1)_+ + e_t, \quad (5)$$

In this model, the threshold is lower at 9.1%, but the value of 9.9% is the next highest in log-likelihood. Additionally, Figure 19 (Appendix A) includes a graph showing that "neighboring" models – those whose samples begin in months between October 2016 and August 2017 – yield a threshold of 9.9%, consistent with the main model. Graphs similar to Figure 9 and Figure 10, but for queries in the "News" category, are provided in Appendices 7 and 8. These also demonstrate that, when the years of military aggression by the russian federation are excluded, the threshold values consistently fluctuate around 10%.

An equation with a logarithmic dependent variable was also estimated to better interpret the β_2 coefficient, as the Google Trends index is a relative indicator. The results of this model are shown in Figure 14 and Table 4.

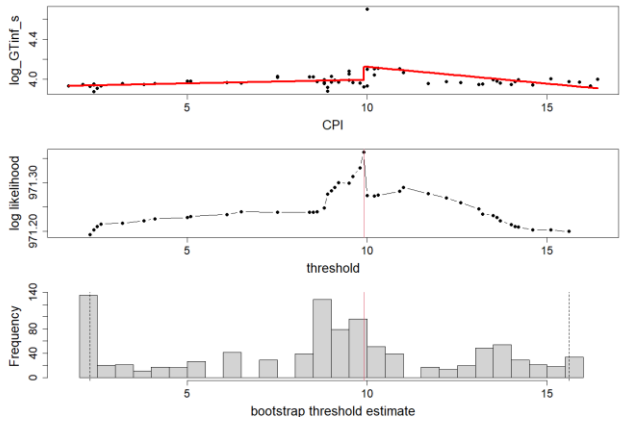

Figure 14. Model Results for the Period 01.2017 – 01.2022 with a Logarithmic Dependent Variable

Table 4. Model results for the period 01.2017 - 01.2022 with a logarithmic dependent variable

Coefficients	Estimate
α_1	3.919
β_1	0.007
α_2	0.133
β_2	-0.041

Threshold (γ):	Estimate
	9.900

In the modified equation (2):

$$\ln(y_t) = 3.9188 + 0.1331 * I(x_t > 9.9) + 0.0073x_t - 0.0409 * (x_t - 9.9)_+ + e_t, \quad (6)$$

Prior to the inflation threshold of 9.9%, the coefficient on the inflation rate is 0.0073. This means that, on average, a 1% increase in the inflation rate before the threshold is passed increases the expected value of the Google Trends index, and thus attention to it, by 0.73%. Upon crossing the threshold, the expected value of the Google Trends index rises sharply by approximately $(e^{0.1331} - 1) \times 100\%$, i.e. by about 14.24%. After the threshold is surpassed, the coefficient for the inflation rate becomes -0.0336, indicating that on average, a 1% increase in the inflation rate reduces the expected value of the Google Trends index by 3.36%

This study did not test the reliability of the Google Trends index as a proxy for attention using an alternative variable, such as mentions on Twitter. This is because of Twitter's low prevalence in Ukraine. In this regard, the study relies on the findings of Korenok et al. (2023), which indicate that the Google Trends index is a reliable measure.

Finally, it is worth noting that the well-known effect of round number bias provides additional support for the 9.9% threshold's consistency with the actual mechanisms of attention to inflation. As highlighted by Fraser-Mackenzie et al. (2015), research across various fields has demonstrated that individuals tend to fixate on round numbers as cognitive landmarks, a phenomenon known as left-digit bias. Accordingly, it is highly probable that if a mental threshold exists for economic agents, after which they pay more attention to inflation, it would be situated somewhere between 9.9% and 10%, at the point where the number becomes round and two-digit. It is unlikely that any economic journalist could resist writing a headline as attention-grabbing as "Inflation in Ukraine has surpassed 10%" or "Inflation in Ukraine has reached two-digits."

5. CONCLUSIONS

The results of the estimated models suggest that the real inflation attention threshold in Ukraine, beyond which the population and economic agents begin to pay specific attention to it, is 9.9%, with a 95% confidence interval ranging from 8.9% to 10.9%. At inflation rates below this threshold, a 1% acceleration in inflation increases the level of attention by an average of 0.7%. When inflation reaches double-digit levels, attention increases sharply by an additional 14.2%. However, for inflation rates above the 9.9% threshold, each 1% increase in inflation is associated with a 3.4% average reduction in the level of attention.

Using the categorization from Korenok et al. (2023), Ukraine is placed in the third group of countries, exhibiting a pattern of attention to inflation that does not align with that of the United States. This is because the relationship between public attention and inflation is positive and statistically significant up to the threshold, but after this point, attention increases sharply and the relationship subsequently becomes negative. This pattern is similar to the one observed by Korenok et al. (2023) for Brazil, Colombia, and Greece.

The study did not account for observations during the active phases of russia's armed aggression because of the difficulty in modeling the sharp shift in public attention away from inflation and toward war-related topics (e.g., news). Due to this change in focus, high inflation rates had less of an impact on driving additional attention. Additionally, it should be noted that for over half of the period since the Google Trends index was created in 2004 (up to 2015), Ukraine's internet penetration was below 50%. In contrast, the median internet penetration for the OECD countries studied in Korenok et al. (2023) exceeded this value as early as 2006. This low internet prevalence makes the Google Trends index a biased measure for use in models covering the period from 2004 to 2015.

In addition to the instability of more than half of the observations, another significant portion of the data, specifically from 2014-2016 and 2022-2024, is also unsuitable for this study due to the military aggression of the russian federation. Consequently, the relatively stable period for analysis comprises only about five years, and this study used the interval from January 2017 to January 2022. While such a small number of observations somewhat limits the statistical power of this study and may reduce the reliability of the findings, the analysis still provides valuable insights into the threshold of public attention to inflation in Ukraine. The results can also serve as a foundation for future research, particularly as an expanded sample of stable months becomes available.

The results of this study are important for the National Bank of Ukraine’s understanding of the levels of consumer inflation above which households and economic agents begin to pay specific attention. In the case of Ukraine, it is especially crucial to account for the estimated threshold, because, as the results of this study show, after this threshold is surpassed, public attention to inflation does not merely grow faster but experiences a sharp spike.

Such sharp changes can significantly impact the stability of inflation expectations. If the National Bank of Ukraine does not account for this rapid growth in its forecasts, it may be challenging to adapt monetary policy in a timely and appropriate manner. Increased attention from households and businesses can trigger an acceleration regime, making inflation more difficult to control (Korenok et al., 2023). This is especially relevant in Ukraine’s current wartime context, as the pro-inflationary effects of supply shocks – which are typically short-lived – can become amplified and persistent once the inflation attention threshold is surpassed (Pfäuti, 2023).

Higher inflation rates can also weaken public confidence in the central bank and the country's economic policies (van der Cruijsen et al., 2023). When people's expectations about the short-term nature of a price surge worsen, they become more likely to consume and demand higher wages (NBU, 2024). Taken together, these factors stimulate further inflation acceleration and make the price surge more powerful and long-lasting (Pfäuti, 2023).

Ukraine's inflation attention threshold of 9.9% is close to the 12.3% threshold estimated by Azam and Khan (2020) for developing countries, after which a significant negative relationship between inflation and economic growth emerges. This makes crossing the inflation attention threshold even more critical, as the National Bank of Ukraine’s mandate includes not only the primary goal of price stability but also the objective of promoting sustainable economic development. Consequently, double-digit inflation rates could prevent the central bank from fulfilling both of these mandates simultaneously for an extended period.

To summarize, the rapid surge in attention to inflation in Ukraine after it reaches double-digit levels may contribute to the greater persistence of these high

levels. This, in turn, undermines confidence in the National Bank of Ukraine, hinders economic growth, and prolongs the time required for inflation to return to its target. Consequently, the central bank's understanding of this specific inflation attention threshold is crucial for making more effective and timely monetary policy decisions in the face of accelerating inflation.

Due to the aforementioned challenge of an objectively limited sample of stable years for Ukraine, one of the primary avenues for continuing this research is to replicate the analysis once more stable observations become available. This problem could also be addressed by using alternative measures of attention to inflation that are not as heavily influenced by internet availability and external war-related shocks. Such potential indicators could include inflation expectations (as demonstrated by Pfäuti, 2023), the frequency of inflation references in news media (as an alternative to Twitter, which is not widely used in Ukraine), or regular surveys of citizens regarding their awareness of the current inflation rate.

Another area for improvement is that the current literature utilizing the Google Trends index does not account for whether inflation is rising or falling at a particular point in time when assessing the threshold. Especially in the case of countries like Ukraine, it would be valuable to test the hypothesis that attention to the same inflation levels will be, on average, higher during periods of acceleration than during periods of subsequent decline as inflation approaches the threshold from above.

Given the history of several sharp devaluations during crises and a high dependence on imported products, the Ukrainian population tends to direct a significant portion of its attention toward currency devaluation rather than inflation. However, the existing literature on inflation attention does not address the issue of national currency devaluation or the nature of economic agents' attention to this process. A more detailed study of attention to currency depreciation in Ukraine and other countries, and its interaction with attention to inflation, represents a promising area for further research.

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APPENDICIES

APPENDIX A. FIGURES

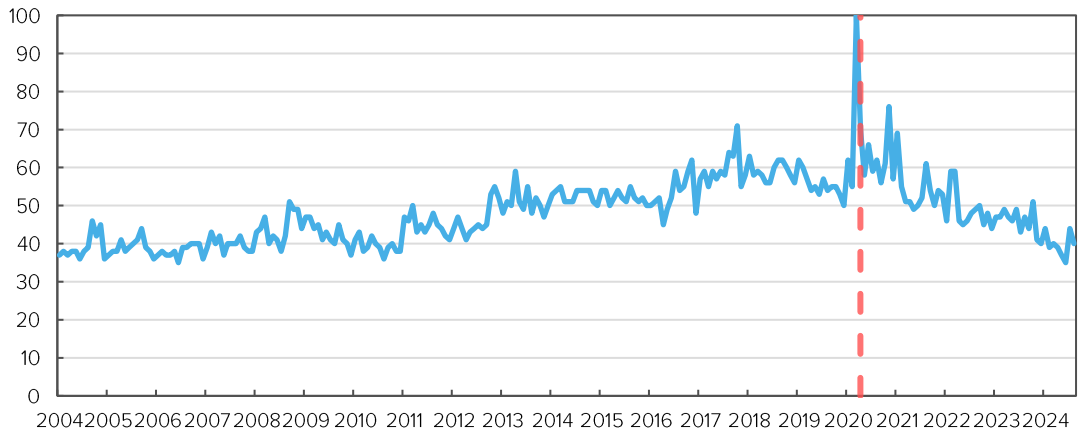


Figure 15. Google Trends Index for the Query “news” in the United States

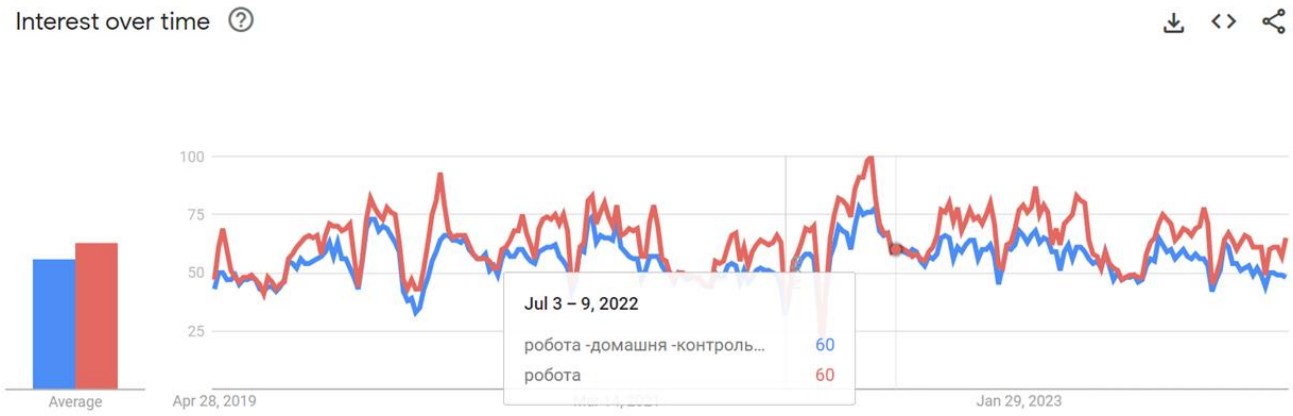
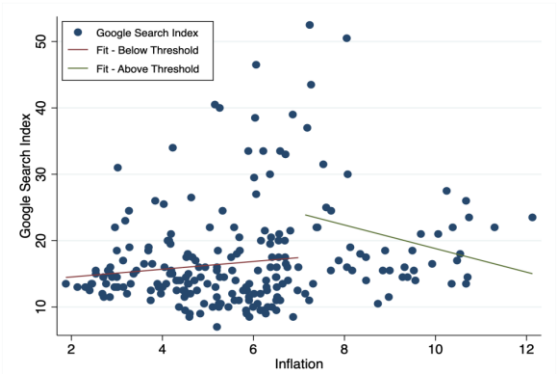


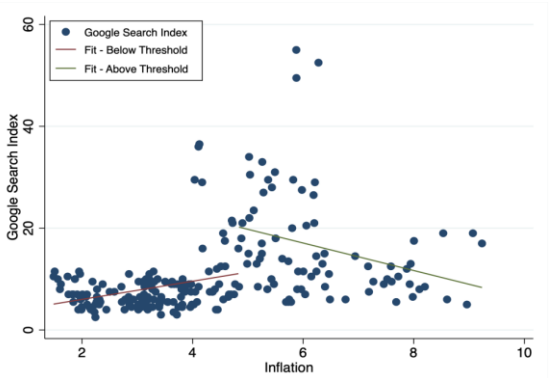
Figure 16. Comparison of Queries “робота” and “робота -домашня -контрольна -курсова -дипломна -самостійна”[11]

Note: This figure demonstrates how students can influence certain search queries, introducing seasonality. The “inflation” query exhibits similar patterns, suggesting that the seasonality of attention to inflation may be significantly affected by students conducting research for their academic work.

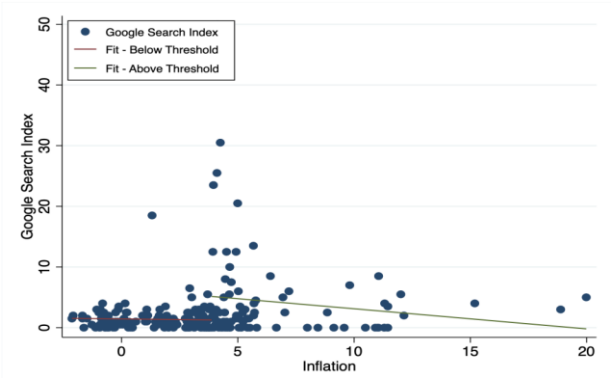
[11] Google Trends, queries “робота” and “робота -домашня -контрольна -курсова -дипломна -самостійна” в Україні / https://trends.google.com/trends/explore?date=today%205-y&geo=UA&q=робота%20-домашня%20-контрольна%20-курсова%20-дипломна%20-самостійна,робота&hl=en-US
“робота” means “work” or “job” in Ukrainian. The first query captures all searches for "робота," while the second excludes terms related to schoolwork (“домашня” – homework, “контрольна” – test, “курсова” – term paper, “дипломна” – thesis, “самостійна” – independent assignment), thereby focusing more on job-related search interest.



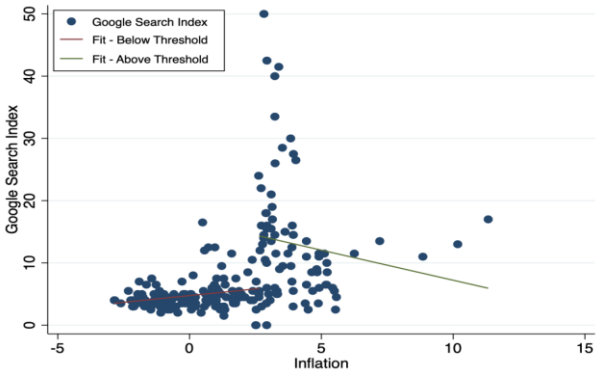
a) Threshold Model for Brazil, γ=7.14



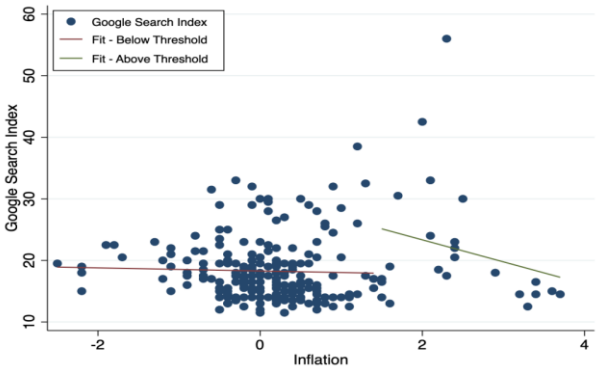
b) Threshold Model for Columbia, γ=4.84



c) Threshold Model for Estonia, γ=4.65



d) Threshold Model for Greece, γ=2.64



e) Threshold model for Japan, γ=1.5

Figure 17. Threshold Model for Different Countries (from Korenok et al., 2023)

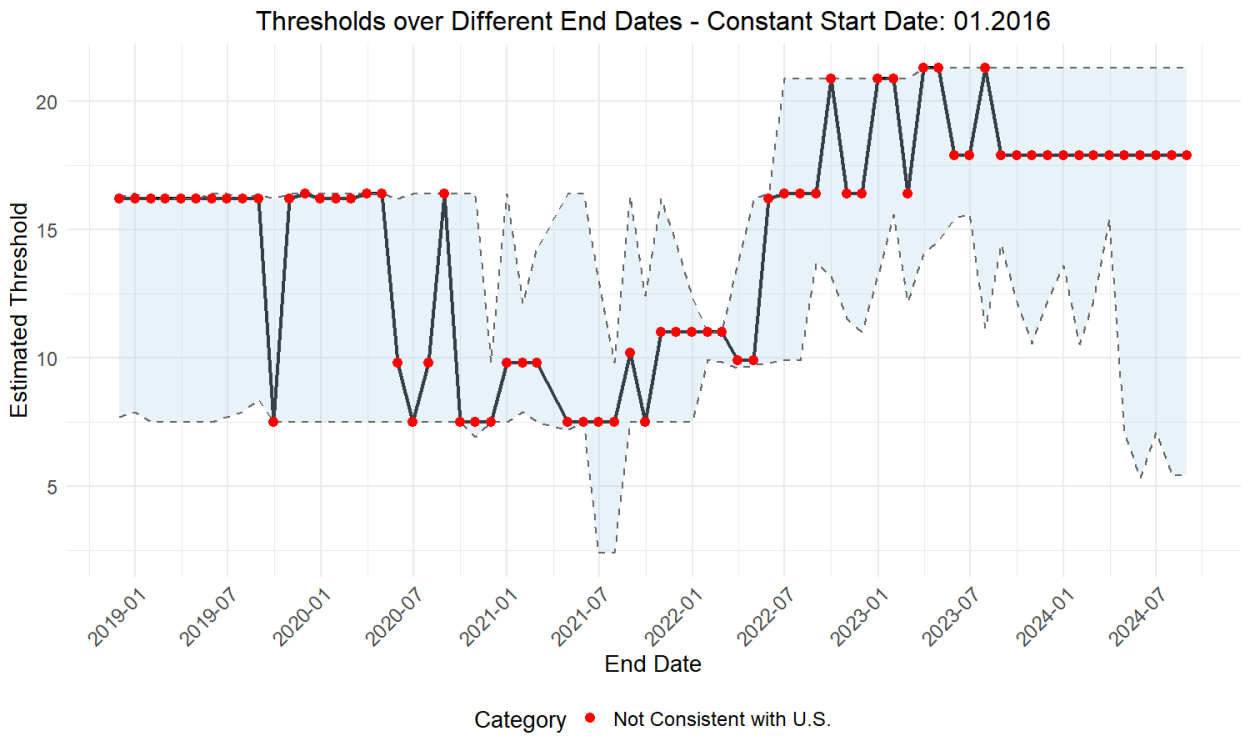


Figure 18. Thresholds for Each of the Models Starting in January 2016

Note: Confidence intervals were constructed using the bootstrap method with 100 replications, at a 0.05 significance level. The thresholds exhibit greater volatility compared to the main model, but they consistently include 9.9% within their confidence intervals.

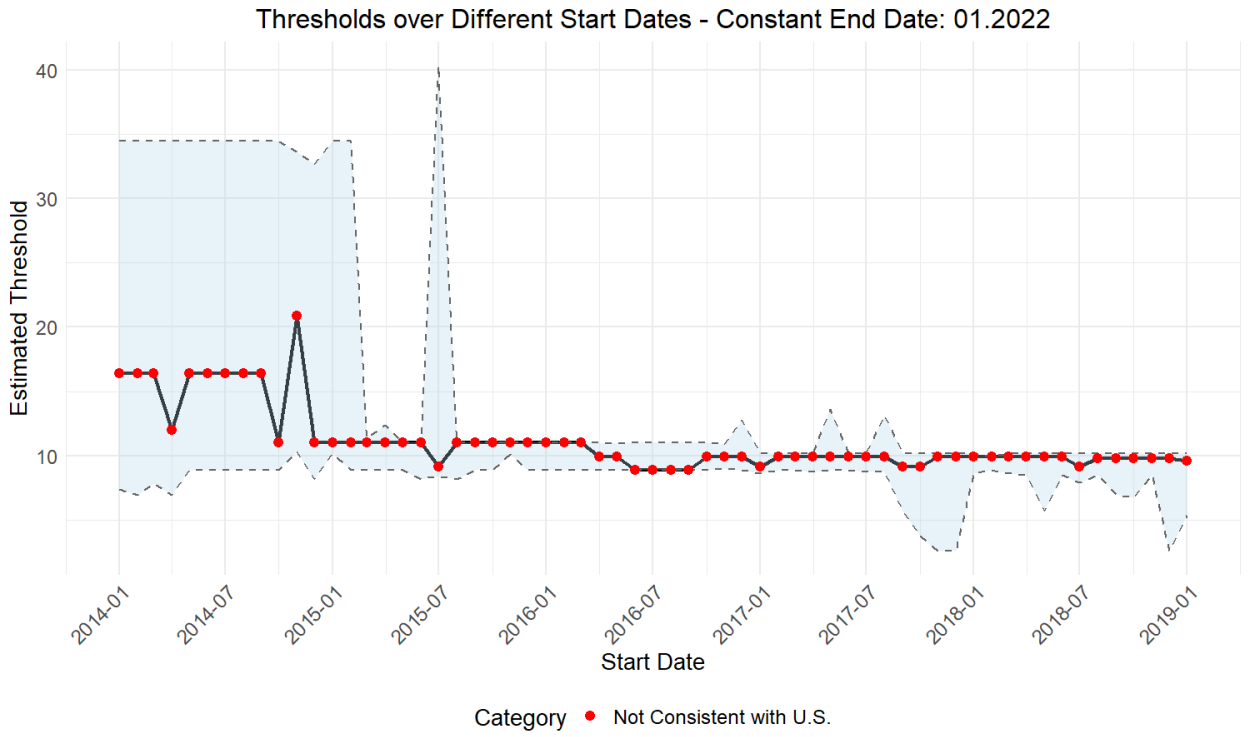
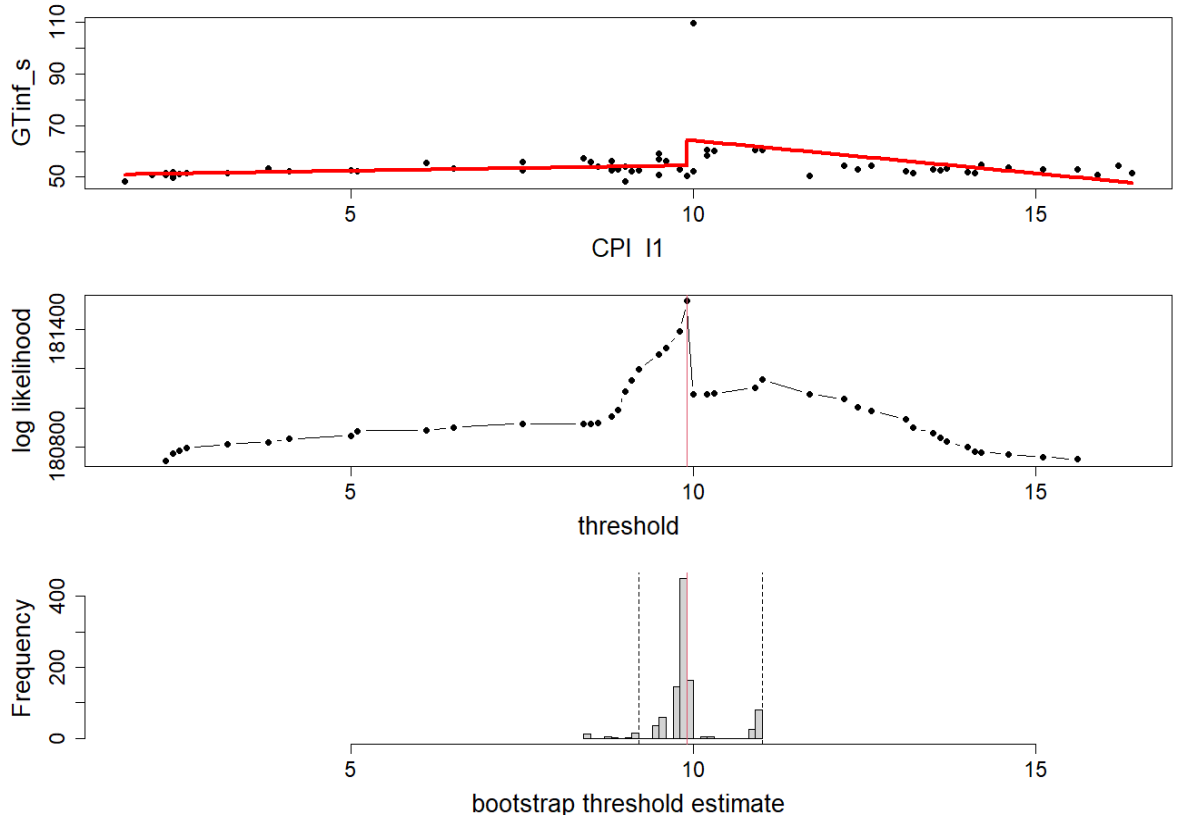


Figure 19. Thresholds for Each of the Alternative models (Google Trends index with the “News” category), ending in January 2022

Note: Confidence intervals were constructed using the bootstrap method with 100 replications, at a 0.05 significance level.

APPENDIX B. MODELS WHERE THE INFLATION RATE IS LAGGED BY ONE TO THREE MONTHS

A) Results of estimating a model in which the inflation rate is taken with a lag of 1 month



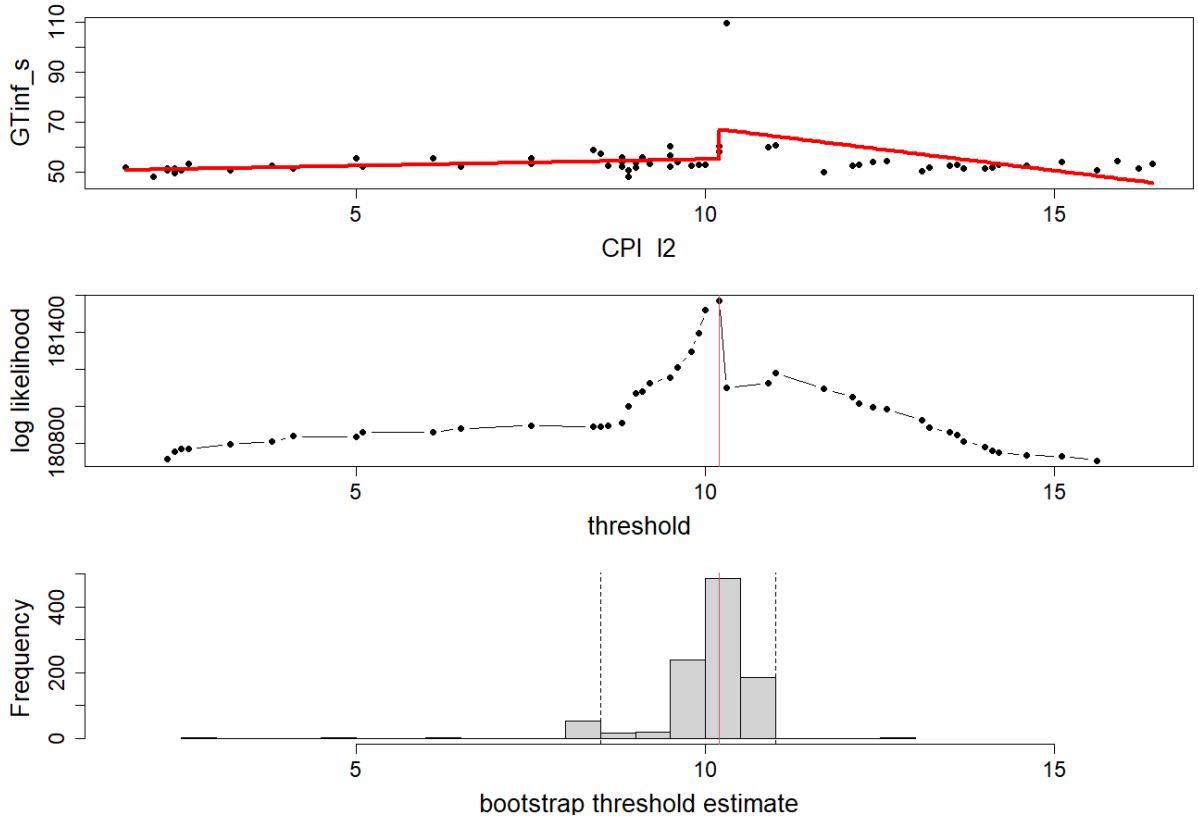
Coefficients	Estimate	Std. Error	(lower	upper)	p.value
α_1	50.267	0.744	48.531	51.447	0.000
β_1	0.419	0.168	0.187	0.843	0.012
α_2	9.968	7.335	-4.968	23.786	0.174
β_2	-2.974	1.506	-6.197	-0.292	0.048

Threshold (γ):	Estimate	Std. Error	(lower	upper)
	9.900	0.459	9.200	11.000

In equation (2):

$$y_t = 50.267 + 9.968 * I(x_{t-1} > 9.9) + 0.419x_t - 2.974 * (x_{t-1} - 9.9)_+ + e_t.$$

B) Results of estimating a model in which the inflation rate is taken with a lag of 2 months



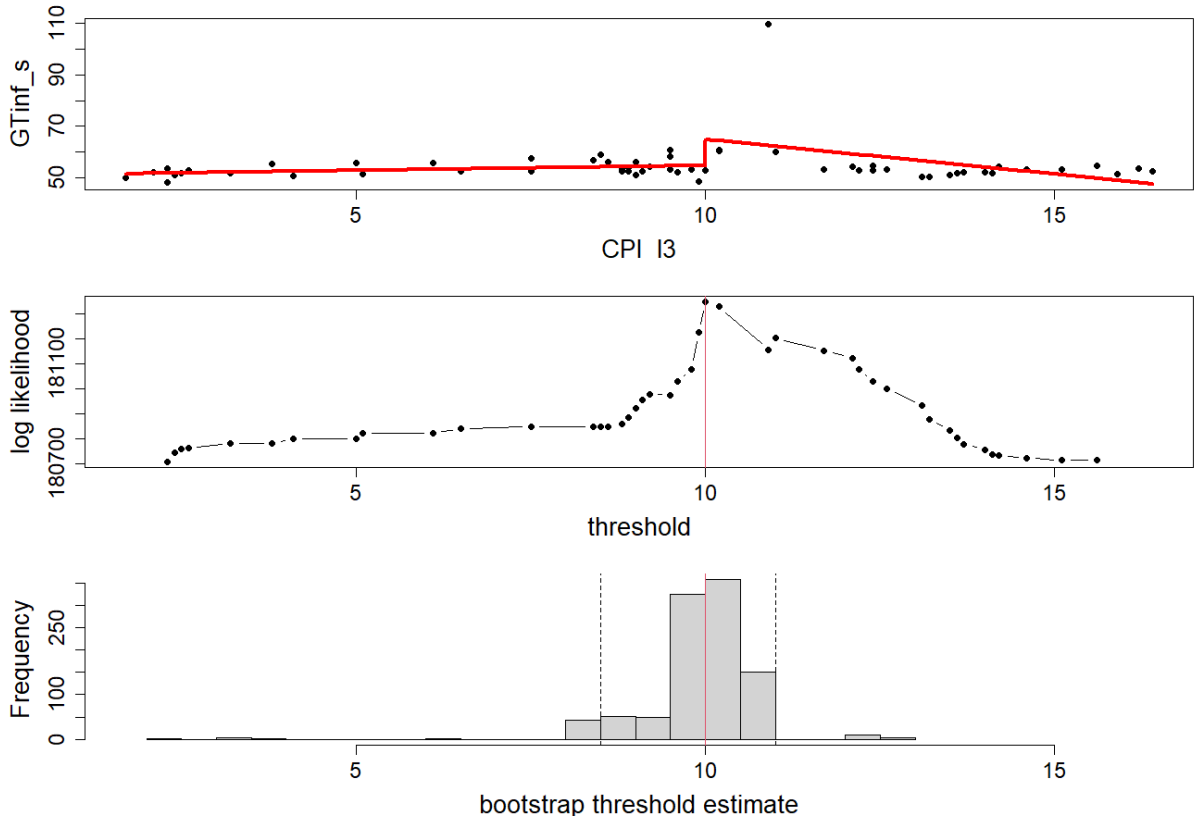
Coefficients	Estimate	Std. Error	(lower	upper)	p.value
α_1	50.051	0.921	47.964	51.574	0.000
β_1	0.519	0.234	0.213	1.129	0.026
α_2	11.850	9.286	-5.664	30.738	0.202
β_2	-3.957	2.184	-8.768	-0.206	0.070

Threshold (γ):	Estimate	Std. Error	(lower	upper)
	10.200	0.638	8.500	11.000

In equation (2):

$$y_t = 50.051 + 11.850 * I(x_{t-2} > 10.2) + 0.519x_t - 3.957 * (x_{t-2} - 10.2)_+ + e_t.$$

C) Results of estimating a model in which the inflation rate is taken with a lag of 3 months



Coefficients	Estimate	Std. Error	(lower	upper)	p.value
α_1	50.855	1.363	46.739	52.081	0.000
β_1	0.385	0.291	0.181	1.320	0.186
α_2	10.208	10.254	-8.399	31.796	0.319
β_2	-3.090	2.222	-8.994	-0.285	0.164

Threshold (γ):

Estimate	Std. Error	(lower	upper)
10.000	0.638	8.500	11.000

In equation (2):

$$y_t = 50.855 + 10.208 * I(x_{t-3} > 10.0) + 0.385x_t - 3.090 * (x_{t-3} - 10.0)_+ + e_t.$$