INFLATION ATTENTION THRESHOLD IN UKRAINE: EVIDENCE OF A TEMPORARY SPIKE IN PUBLIC ATTENTION TO DOUBLE-DIGIT INFLATION

by

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Head of the KSE Defense Committee, Professor

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Date _____

Kyiv School of Economics

Abstract

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This study examines the dependence of the level of public attention to inflation on the actual inflation rate in Ukraine. Specifically, it estimates the threshold level of inflation above which public attention to it begins to grow more rapidly. The analysis is based on monthly inflation data and the Google Trends index for the period from January 2017 to January 2022. A threshold generalized linear model is used to model and estimate the attention threshold. For the selected period, the inflation attention threshold in Ukraine is estimated at 9.9%; after this point, attention to inflation rises sharply but then gradually begins to decline. As a robustness check, the model was also estimated using parliamentary mentions of inflation, which produced similar results. Awareness of this critical value will allow the National Bank of Ukraine to respond more promptly to crisis situations and will also help it, as well as other domestic and international experts and organizations, to more clearly quantify what constitutes a high level of inflation for the Ukrainian population.

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LIST OF ABBREVIATIONS

NBU. National Bank of Ukraine.

OECD. Organisation for Economic Co-operation and Development.

SSSU. State Statistics Service of Ukraine

Chapter 1

INTRODUCTION

Inflation is undoubtedly one of the most important macroeconomic indicators. It directly affects investment, savings, and thus the decisions of economic agents. Today, information is distributed so easily and quickly that knowing the current inflation rate seems almost costless. However, the volume of information people encounter on a daily basis is so large that they must prioritise what to follow. Therefore, in practice, even such important indicators as inflation remain out of the public eye until their impact no longer allows them to be ignored. And to some extent, this limited attention works in favour of the central bank, as minor inflation shocks may go unnoticed, reducing the risk of unanchored expectations.

At the time of the study, inflation in Ukraine, after declining from 26.6% y-o-y in December 2022 to 3.2% y-o-y in April 2024, began to accelerate again. In this context, it is important to understand that high inflation rates encourage households and businesses to change their behavior, prompting them to pay more attention to inflation (Korenok et al., 2023). This internalization of inflation can lead to an accelerated inflationary regime, which in turn increases the likelihood of hyperinflation (Evans and Ramey, 1995). In addition, close attention to high inflation rates can also further provoke greater persistence of such rates (Pfäuti, 2023) and changes in inflation expectations, which in turn have an impact on the actual inflation rate. Thus, excessive attention to inflation is usually a negative phenomenon for the country's economy, which further complicates the NBU's task of bringing inflation back to its target level.

Also, no instrument at the disposal of the central bank can be used without certain costs, since any decision involves a trade-off between inflation control and other economic goals (Goodhart, 2003). Therefore, there is always a need to

find an optimal balance between the negative effects of inflation and the costs of measures to curb it. And here the question always arises of tolerating certain levels of inflation that are not yet "critical" and do not warrant extraordinary measures. However, there is no clear numerical definition of "critical" inflation levels for Ukraine in terms of public attention.

Consequently, when conducting its monetary policy, the central bank needs to understand and consider the level of inflation above which the population begins to pay attention to it. The intuition behind the threshold is that in periods of low inflation, it has little or no impact on the activities of economic agents, and therefore they have little incentive to spend their resources on monitoring it (Korenok et al., 2023). But after passing a certain threshold, the costs of inflation increase to the extent that the population pays more and more attention to it to plan their activities.

The threshold of attention to inflation can serve as a good benchmark for the criticality of certain levels of inflation. As shown by Pfäuti (2023), after passing such a threshold, the cost of bringing inflation back to the target usually increases due to greater persistence. Accordingly, an early understanding of this level allows the central bank to respond more appropriately to accelerating inflation by keeping it above the threshold to avoid the increased future costs of bringing it back to the inflation target.

The issue of the inflation attention threshold has gained some traction over the past few years and has been addressed for a large number of developed countries. However, available studies usually focus on advanced economies: Korenok et al. (2023) on OECD countries, Pfäuti (2023) on the United States, and Buelens (2024) on the Euro area. There are no similar studies for Ukraine, and, accordingly, there is no clear understanding of the "critical" inflation rate.

Therefore, the focus of this study will be to find such a threshold inflation rate for Ukraine.

To do so, this paper uses the methodology for estimating the inflation threshold from Korenok et al. (2023), in which they empirically estimate the relationship between attention and inflation for 37 countries. The results obtained using this methodology indicate that the threshold level of attention to inflation in Ukraine is 9.9% (with confidence intervals of 8.9-10.9% at the 5% significance level).

The main problems of studying attention to inflation in Ukraine using only Google Trends index as a proxy for attention are, firstly, the low percentage of Internet coverage before 2015 and, secondly, the high number of external and internal non-economic shocks after 2014. During periods of these shocks (armed aggression by the russian federation), it is very likely that the mechanism of the population's attention to inflation will change. At the very least, people switch their attention to other things that are more relevant to them. In other words, during the active phase of the russian-Ukrainian war, the attention of the population and economic agents is likely to be more focused on the task of survival and/or obtaining the necessary information (news) and less (than would be expected in peacetime) on the current level of inflation. These dynamics can be seen in Figure 1, which shows the dynamics of the Google Trends index for the query "news" in the two most common languages in Ukraine.

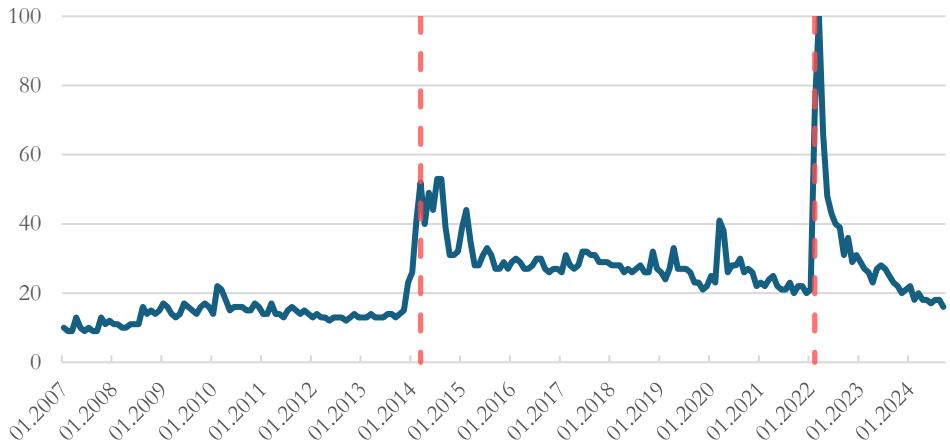

Figure 1. Google Trends index for the query "новини + новости" in Ukraine

Here you can see how such external factors dramatically change people's interests and how the situation "stabilizes" over time. As an example of the significant impact of this "attention shock," Appendix 1 shows the same graph, but for the United States. It shows only one pronounced sharp jump in the population's attention to the news - during the outbreak of the COVID epidemic. The graph for Ukraine also shows this spike in April 2020, but it does not compare to the spike at the beginning of the russian armed aggression. To be more specific, the level of attention to news in Ukraine increased by as much as 5 times in the first 2 months of the full-scale invasion, February-March 2022. Therefore, there are strong reasons to believe that the mechanisms of attention to inflation during these periods also underwent significant changes and did not reflect the behavior of economic agents in normal times.

Considering the above issues, it was decided to exclude from the regression in the Google Trends index methodology the periods before 2014 due to low Internet penetration, as well as 2014-2016 and 2022-2024 (except for January 2022 as the last before the invasion) due to the active phases of the war. We also

additionally estimated the inflation attention threshold levels using mentions of inflation in Ukrainian parliament as an alternative proxy for attention that is available starting from May 2002 until November 2023.

Structure. Chapter 2 reviews the existing literature. Chapter 3 describes methodologies used for estimating the inflation threshold in Ukraine. Chapter 4 discusses the data used in this study, and possible problems with it. Chapter 5 and Chapter 6 describe, compare and summarize the results of the analysis of the inflation threshold estimates by the main models.

Chapter 2

LITERATURE REVIEW

The topic of the inflation attention threshold is fairly new and has gained a lot of attention after the COVID crisis, when inflation rates in developed countries rose sharply after being stable for a long period. But even before this crisis, there were studies that pointed to low attention to inflation in countries where it is low. For example, in Cavallo et al. (2017), the authors show that individuals in low-inflation environments have significantly weaker perceptions of inflation rates even when this information is available to them and easily accessible. Maćkowiak et al. (2023) in their study explore this issue even further by reviewing the existing literature on rational inattention and develop a neoclassical model that captures this behavior of economic agents based on this evidence.

Apart from attention to inflation, there is also a body of literature that estimates other thresholds of inflation levels, primarily ones that focus on levels of inflation after which it starts to hinder economic growth. The big part of it is based on Khan and Senhadji (2001) and Kremer et al. (2012) who provided foundational analyses on inflation thresholds. For example, Vinayagathasan (2013) found that for Asian countries inflation hurts growth when it exceeds 5.43% but has no effect below this level. For African countries Ndoricimpa (2017) finds 9% threshold for the low-income sub-sample of and 6.5% threshold for middle-income. Hwang and Wu (2011) estimate a similar 2.5% threshold for China. Muhammad and Khan (2020) in their work have empirically shown that in both developing and developed countries, after inflation passes a certain threshold (12.3% for developing and 5.4% for developed countries), a significant negative relationship between inflation and economic growth appears. The only known study on inflation thresholds in Ukraine is the article by Mishchenko et al. (2018),

which estimates a threshold inflation rate of 4.51%, beyond which inflation begins to hinder economic growth.

Studies that specifically address the inflation attention threshold appear only along with the periods of high inflation in 2021-2022. This period allowed agents to be brought out of the state of rational inattention and allowed researchers to assess what level of inflation finally makes people start paying attention to it. One of the first to empirically estimate values for these inflation attention thresholds in different countries were Korenok et al. (2023). They used a single-threshold fixed-effect panel model with the Google trends index as a proxy for attention to inflation in a sample of OECD countries and confirmed that most countries have an inflation threshold above which the population begins to pay more attention to it.

Later, Buelens (2024) used a similar methodology to estimate thresholds for the Euro area. But in his study, Buelens also goes further and shows considerable heterogeneity in the patterns of attention to inflation across euro area countries. Pfauti (2023) follows a different path in his study and estimates the presence and magnitude of the threshold using a model that builds on Maćkowiak et al. (2023). To incorporate the level of attention to inflation, he uses the method of Bracha and Tang (2024), in which they show that it is possible to use inflation expectations to measure consumers' inattention. This approach not only allows him to estimate the threshold using a different method, but also allows him to develop a theoretical framework that estimates the difference between the effects of shocks on inflation persistence in two attention regimes – low and high.

To estimate the inflation attention threshold for Ukraine this study applies the methodology from Korenok et al. (2023) which was further augmented by an alternative measure of attention based on mentions of inflation in the Ukrainian parliament. The choice of this methodology was mainly motivated by the lack of

other alternatives that can be applied to Ukrainian case in literature at the time of the study.

In the case of United States, the results of Korenok et al. (2023) indicate the presence of a threshold inflation rate of 3.55%, after which the relationship between the inflation rate and attention becomes statistically significant and increases substantially[1].

Table 1. Classification of results by country thresholds adapted 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 Belgium (2.02) – 2.28 Chile (3.34) – 3.93 Denmark (1.51) – 1.98 France (1.34) – 2.45 Germany (1.58) – 2.55 Iceland (4.61) – 3.42 Indonesia (5.60) – 4.83 Latvia (3.83) – 4.62 Lithuania (3.17) – 2.94 Luxembourg (1.92) – 2.92 Norway (2.09) – 1.24 Saudi Arabia (2.84) – 4.87 Sweden (1.25) – 3.10 **U.S. (2.29) – 3.55**	Canada (1.88) – 3.06 Czechia (2.47) – 2.47 Finland (1.42) – 2.85 Italy (1.51) – 2.38 Korea (2.19) – 3.02 Mexico (4.25) – 5.43 Netherlands (1.75) – 2.08 Poland (2.43) – 3.70 Portugal (1.45) – 2.83 Slovakia (2.60) – 4.03 Spain (1.87) – 3.60 U.K. (2.18) – 2.20	Brazil (5.75) – 7.14 Columbia (4.26) – 4.84 Estonia (3.32) – 4.65 Greece (1.49) – 2.64 Hungary (3.75) – 6.00 Ireland (1.24) – 1.37 Japan (0.27) – 1.5 Slovenia (1.91) – 3.85 Switzerland (0.36) – 1.44 Turkey (11.00) – 9.48
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 is indicated by a dash

[1] See Figure 1 in Korenok et al., 2023

Also, as a result of the study that is interesting for the Ukrainian case, the authors divided the countries studied into 3 groups: countries whose results coincide with the United States, intermediate countries, and countries whose results do not coincide with the United States (Table 1). In the first group, the relationship between inflation and attention to inflation before the threshold is not statistically significant. In the second group of countries, the relationship between inflation and attention to inflation before the threshold is still smaller than the relationship after the threshold, but it is statistically significant. The third group includes countries in which the relationship between inflation and attention to inflation before the threshold is greater than the relationship after the threshold.

Another important finding in Korenok et al. (2023), which allows us to put forward a preliminary hypothesis about the level of the inflation threshold in Ukraine, is the strong positive relationship between inflation thresholds and the average inflation rate in the respective country[2]. Given this relationship and Ukraine's average inflation rate of 13% (even higher than Turkey's, which has historically experienced very high inflation rates) for the period from January 2007 to September 2024, we can expect a threshold value higher than all the countries in their study, at around 10-11%.

To test the reliability of the study's results, Korenok et al. (2023) use another proxy for attention to inflation - the frequency of tweets containing the word "inflation." However, this method of measuring attention to inflation has its limitations due to the different prevalence of X.com (ex-Twitter) in different countries. Therefore, it was applied only to 15 out of 37 countries in which more than 5% of the population had an X.com (ex-Twitter) account as of 2012.

[2] For better understanding see Figure 8 in Korenok et al., 2023

The authors conclude that using Twitter data as an alternative proxy for measuring attention for countries where it is possible yields results that are consistent with those obtained from Google data. First, the threshold level of attention to inflation is present in all alternative models, and second, its levels differ only marginally from the values obtained using Google data. Korenok et al. (2023) note that, generally speaking, using Twitter data as an alternative proxy for attention yields results that are fairly consistent with those obtained using Google data.

Given the limitation of using mentions on Twitter for Ukraine due to a small share of users among the population, this study uses parliamentary mentions as an alternative proxy for attention. This additional dimension allows us to further test the robustness of the results obtained from Google Trends and shed light on potential differences in attention to inflation between the general public and policymakers. To the best of the author's knowledge, this is the first study to apply mentions of inflations in parliament as a proxy for inflation attention.

Chapter 3

METHODOLOGY

The main hypothesis is that the relationship between inflation and attention in Ukraine, as in other countries from the literature, exhibits a threshold effect. That is, attention increases sharply once inflation crosses a certain level. To identify such a threshold, a non-linear model is required – one that allows for a structural change in the relationship between inflation and attention after that point.

The study by Korenok et al. (2023) uses the following single-threshold fixed-effect panel model:

$$y_{it} = \alpha + x_{it}(x_{it} < \gamma)\beta_1 + x_{it}(x_{it} \geq \gamma)\beta_2 + u_i + e_{it}, \quad (1)$$

However, this study is based on data from a single country, so we consider the following threshold generalized linear model from the R statistical package chngpt (Fong et al., 2017), which does not have a fixed effect (u_i):

$$y_t = \alpha_1 + \alpha_2 I(x_t > \gamma) + \beta_1 x_t + \beta_2 (x_t - \gamma)_+ + e_t, \quad (2)$$

where

- y_t is a measure of attention to inflation (Google Trends index, mentions in parliament) in Ukraine in period t;
- x_t is a measure of inflation (CPI) in Ukraine in period t;
- γ – 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 to $x_t - \gamma$ if $x_t > \gamma$, 0 otherwise.

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

$$y_t = \alpha_1 + \beta_1 x_t + e_t, \quad (3)$$

And for inflation values after the threshold level:

$$y_t = (\alpha_1 + \alpha_2) + \beta_1 x_t + \beta_2 (x_t - \gamma) + e_t, \quad (4)$$

That is, $(\alpha_1 + \alpha_2 - \beta_2\gamma)$ 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.

The analysis employs a generalized linear model to capture a structural break in the relationship between inflation and attention. Both attention measures – the Google Trends index and the share of parliamentary mentions – are treated as continuous variables on a 0-to-100 scale, and the model is estimated with a Gaussian family. This specification retains straightforward coefficient interpretation while the chngpt R package framework provides the flexibility needed to estimate the single-threshold effect central to the study.

To ensure the reliability of the results, robust confidence intervals and p-values for the estimated coefficients and threshold were computed using a nonparametric bootstrap procedure with 1000 replications, following Singh and Xie (2008). This approach helps correct for potential bias in standard errors due to the relatively small sample size.

In addition, to test whether the estimated inflation attention threshold is specific to public behavior or more broadly observable, we conduct a robustness check using an alternative proxy for attention – the share of parliamentary speeches mentioning the word "inflation." This allows us to assess whether similar non-linear dynamics are present when measuring attention among policymakers rather than the general public. Further robustness checks include models using lagged values of CPI (by one to three months) to account for delayed responses in public attention, as well as a specification based on Google Trends data restricted to the "news" category, which may better reflect information-driven searches rather than general interest.

Chapter 4

DATA

4.1 Google Trends index

Figure 2 shows all available monthly data on the relative volumes of "inflation" and "inflationary" searches in Ukraine from January 2004 to September 2024, obtained using Google Trends[3][4]. In the study by Korenok et al. (2023), the authors used queries in the most common languages in the countries, which together cover more than 75% of the total population. For Ukraine, these two languages are Ukrainian and russian.

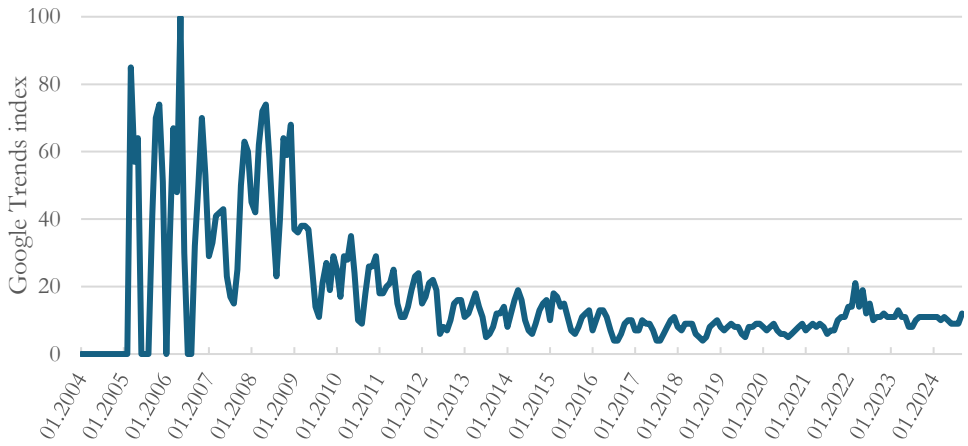

Figure 2. Google Trends index for the query "інфляція + инфляция" in Ukraine

[3] Google Trends, query «інфляція + инфляция» (word "inflation" in both Ukrainian and russian) in Ukraine for the period 01.2007 - 09.2024 / URL: https://trends.google.com/trends/explore?date=2007-01-01%202024-09-30&geo=UA&q=інфляція%20%2B%20инфляция&hl=en-US

[4] It is worth noting that, according to the Google Trends website, on January 01, 2011, Google improved the geographic distribution, and on January 01, 2016 and January 01, 2022, there were improvements in data collection.

One can observe the high volatility of the index of search queries "інфляція" and "инфляция" for Ukraine in earlier periods. Besides the global financial and economic crisis, one of the possible reasons for the high index values and strong volatility in 2007-2009 and earlier may be the significantly low level of Internet access in Ukraine during this period[5] (Figure 3).

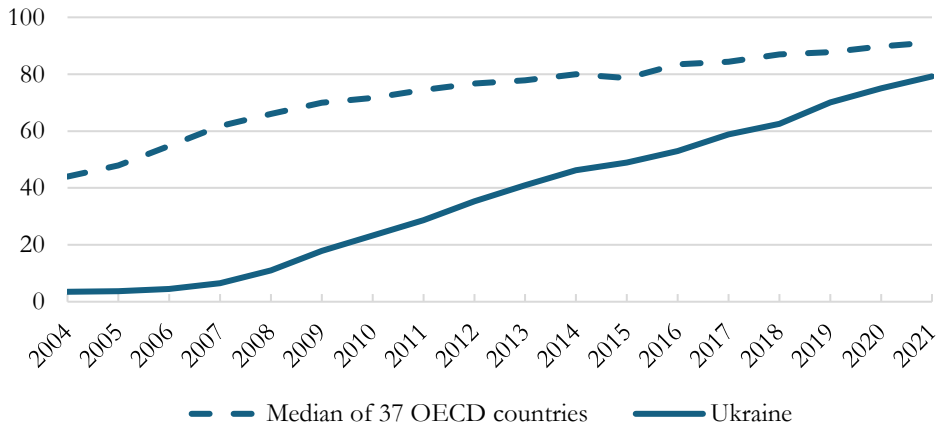

Figure 3. Percentage of people in Ukraine who use the Internet, %
Source: World Bank

It is important to interpret the Google Trends index values correctly. According to Google Trends: Understanding the data[6]: "A downward trend means that the relative popularity of a search query is decreasing - not necessarily that the total number of searches for that query is decreasing, but its popularity compared to other queries is decreasing." In other words, a smaller absolute number of

[5] World Bank. Individuals using the Internet (% of population) / URL: https://data.worldbank.org/indicator/IT.NET.USER.ZS?end=2022&start=2004

[6] Google Trends: Understanding the data / URL: https://newsinitiative.withgoogle.com/resources/trainings/google-trends-understanding-the-data/

Internet users should not affect the level of the index, as it is normalized by the total number of search queries.

However, there is a potential problem of sampling bias. In 2007, according to the World Bank, only 6.55% of the population used the Internet. It is very likely that at that time the users were wealthier people who could afford it. It is also likely that their interests differ from those of the general population, which may explain the higher share of inflation searches in 2007-2009.

Additionally, it should be borne in mind that in the early years of the Internet's development, due to technical limitations (speed, availability of the Internet), the popularity of entertainment content on the Internet could have been lower, which in turn contributed to a larger share of inflation queries compared to the total number.

To illustrate the lower popularity of entertainment content, the graph below shows that the relative popularity of "video" and "video" queries in 2004 is about 5 times lower compared to 2011[7] (Figure 4).

It is also important to note the pronounced seasonality of the inflation Google Trends index. The values mostly reach local peaks in November-December and March-May, and local lows in January-February and July-August. The reasons for this seasonality may vary. For example, in November-December, most economic agents prepare annual reports and make plans for the coming years, and before the New Year holidays, household spending and economic activity increase, which can draw more attention to inflation.

[7] Google Trends, query "видео + відео" (word "video" in both Ukrainian and russian) in Ukraine for the period 01.2007 - 12.2012 / URL: https://trends.google.com/trends/explore?date=2007-01-01%202013-01-01&geo=UA&q=видео%20%2B%20відео&hl=en

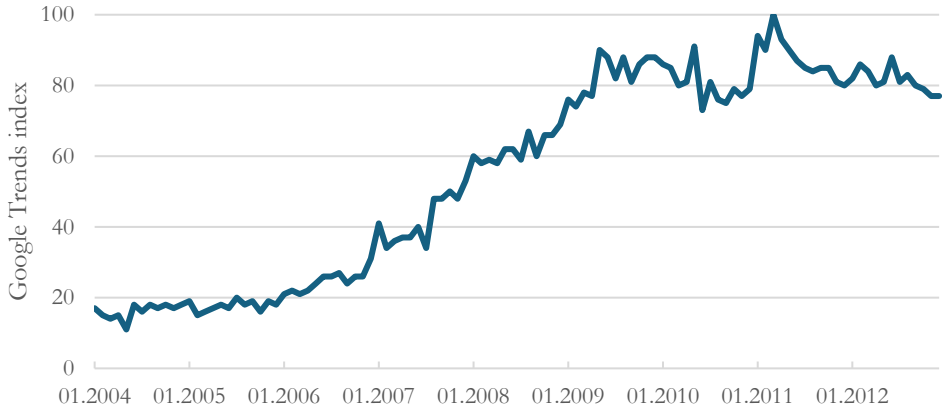

Figure 4. Google Trends index for the query "відео + видео" in Ukraine

In March and May, taxpayers may become more interested in inflation. Schoolchildren/students may also make a significant contribution to these seasonal peaks, as spring is a period of active writing of term papers, diploma papers, and tests. For example, a similar trend can be seen in the query "робота" (Appendix 2), where queries such as "контрольна/самостійна/курсова" can make up a significant percentage of the total number of queries and create peaks during the end of semesters (November-December and April-May). Such a seasonality rationale would also explain well the summer downturns in inflation Google Trends index.

Another problematic period in the data available for Ukraine is the period of the russian federation's armed aggression against Ukraine, both indirect (2014-2016) and direct (2022-2025). Such severe external shocks of a primarily non-economic nature can strongly influence the behavior of the population and the nature of its attention.

An example of a certain anomaly in the years of russia's armed aggression is the period of 2014-2015. In Figure 5, each of the points is labeled according to the month of the corresponding year. The figure shows that up until April 2015,

inflation was growing every month, reaching values above 50%, while the level of attention to it had a downward trend.

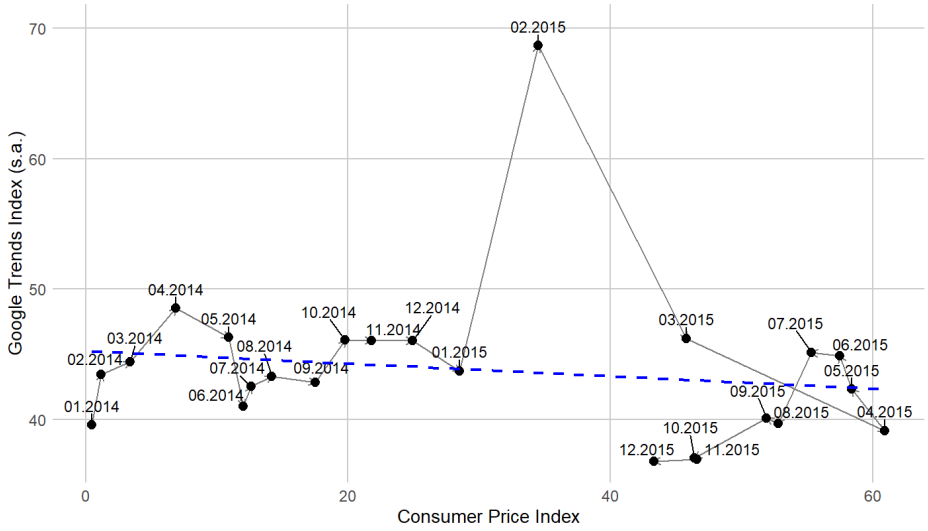

Figure 5. Scatter plot of the s.a. inflation Google Trends index vs. CPI in Ukraine in 2014-2015 with a linear trend.

This behavior was likely caused by people shifting their attention online and in life to other more important things in times of serious external shocks, as well as by general habituation to high inflation rates.

Given their problematic nature, periods of armed aggression by the russian Federation were excluded from the observations used for the main model. Namely, the periods from January 2014 to December 2016 and from February 2022 to September 2024 were excluded. Data from January 2011 to December 2013 were not used for the main model due to the low level of Internet penetration compared to the period from January 2017 to January 2022, which may create additional distortions in the results.

It is worth noting that between January 2017 and January 2022, russia's armed aggression in eastern Ukraine did not stop, but the lower level of public attention to it, lower inflation rates and the overall "normalization" of the situation in the eyes of ordinary citizens make this period more stable for research. Taking into account the above comments, only the values of the index from 2017 to January 2022 were used. Observations after adjusting the Google Trends index data using the X-11 method (Sax and Eddelbuettel, 2018) are shown in Figure 6.

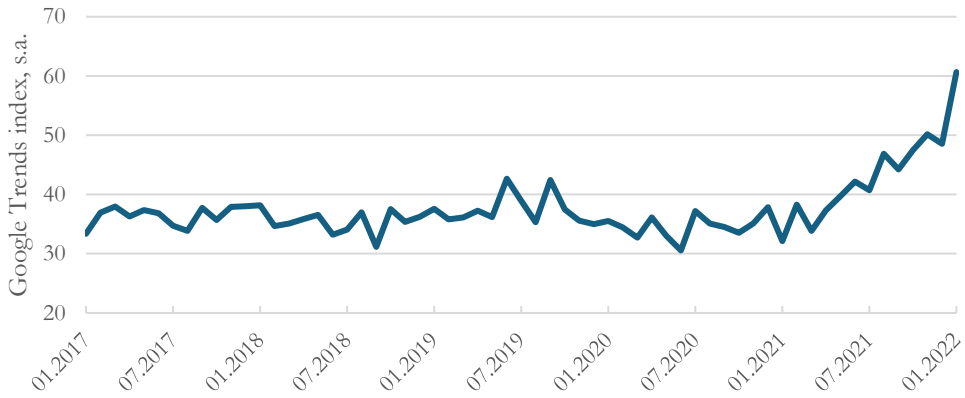

Figure 6. Google Trends index for the query "інфляція + инфляция" in Ukraine, seasonally adjusted

Monthly inflation data (Consumer Price Index to the corresponding month of the previous year, %) from January 2017 to January 2022 were obtained from the website of the State Statistics Service of Ukraine[8] (Figure 7).

[8] State Statistics Service of Ukraine / URL: https://www.ukrstat.gov.ua/

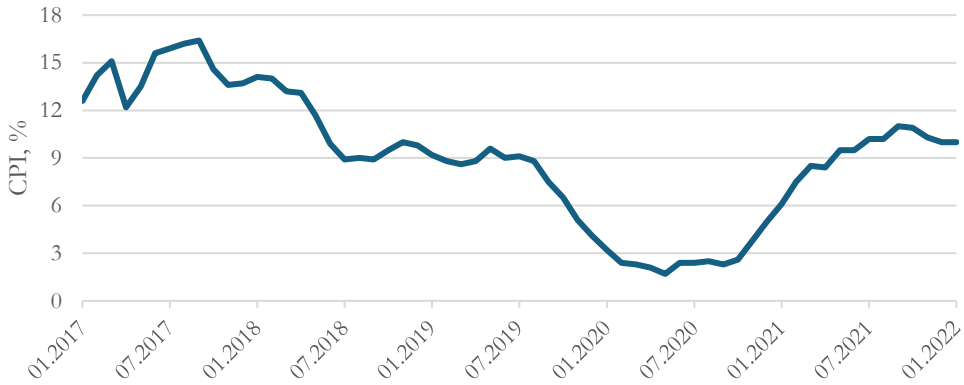

Figure 7. CPI in Ukraine (to the corresponding month of the previous year, %)

The final data period scatterplot with Ukrainian monthly CPI on the x-axis and s.a. Google Trends index of "inflation" word in both Ukrainian and russian on the y-axis is shown on Figure 8. As can be seen, attention to inflation increases sharply around the 10% mark, which already points to a possible threshold.

Figure 8. Scatter plot of the dependence of the seasonally adjusted inflation Google Trends index on the CPI in Ukraine in the period from 01.2017 to 01.2022.

4.2 Mentions in the Ukrainian Parliament

As an additional measure of attention to inflation we used mentions of the word "inflation" in Ukrainian parliament discussions and speeches. The data about corpora of parliamentary debates was obtained from ParlaMint project. We used linguistically annotated multilingual comparable corpora in English to remove possible problems with mentions in different languages (Ukrainian and russian). Data for Ukraine here is available starting from 14 May 2002 session ending with 10 November 2023 session.

To calculate a proxy for attention to inflation in the parliament for each session we calculated the percentage of speeches mentioning the word "inflation" at least once. To ignore speaker's word passing and other short exclamations we filtered out speeches that are less than 50 words long. Resulting monthly values speeches, speeches frequencies along with the corresponding monthly year-on-year CPI are shown on Figure 9.

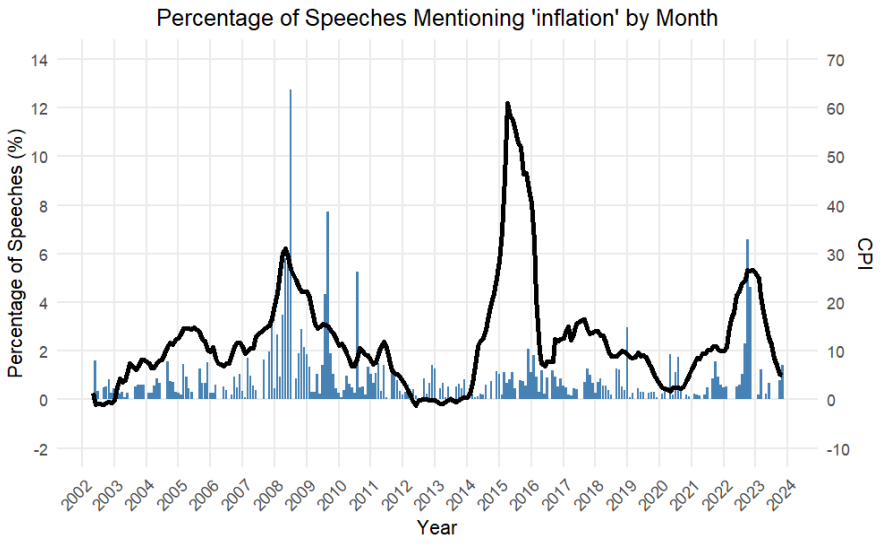

Figure 9. Share of parliamentary speeches mentioning "inflation" and corresponding CPI in Ukraine (monthly data)

This data further supports the hypothesis of significant attention shifts during the 2014-2016 period, when, despite a sharp acceleration in inflation, there was no noticeable spike in the share of parliamentary speeches mentioning inflation. A similar picture can be seen in the first months after the full-scale invasion, where the share of speeches containing the word "inflation" dropped to zero regardless of the inflation dynamics.

Chapter 5

ESTIMATION RESULTS

5.1 Results using Google Trends index

In this section, we present the results of estimating the threshold generalized linear model (1) on the aforementioned 01.2017 – 01.2022 sample with an additional robustness check of the obtained results depending on the selected sample. The results of the main model are shown in Figure 10 and Table 2:

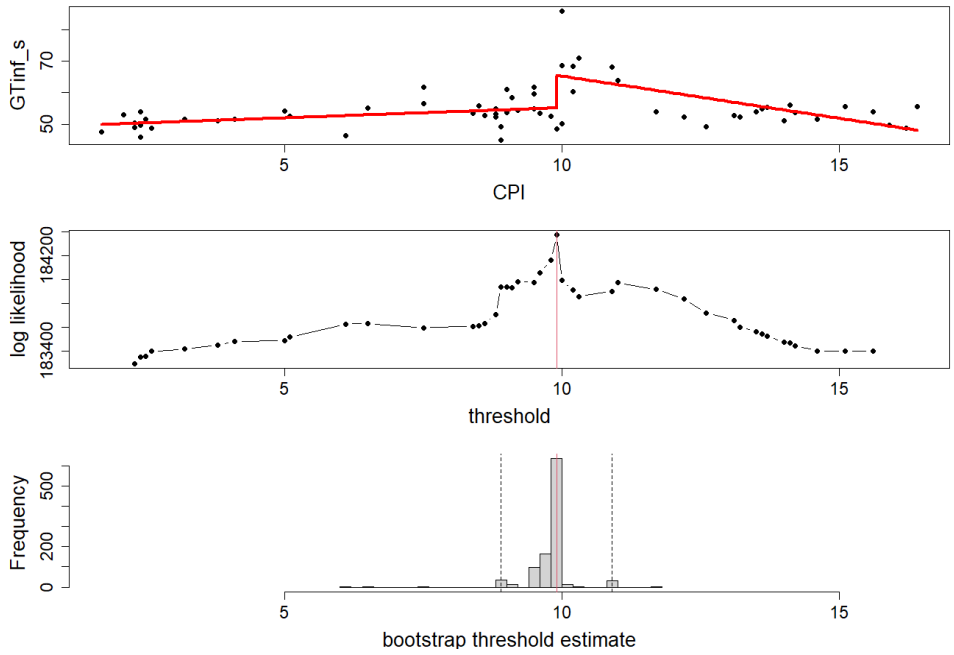

Figure 10. Model results based on data for the period 01.2017 - 01.2022.[9]

[9] Hereinafter in the similar: the first graph is a visualization of the model (the ordinate axis is the seasonally adjusted Google Trends index, the abscissa axis is CPI, %); the second graph is the log-likelihood of different thresholds; the third graph is a histogram of the distribution of thresholds when applying the bootstrap method

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)
9.9	0.510	8.9	10.9

In equation (2):

$$y_t = 48.756 + 10.409 * I(x_t > 9.9) + 0.643x_t - 3.330 * (x_t - 9.9)_+ + e_t.$$

Standard errors, and thus confidence intervals and p-values, in this and all subsequent models were calculated using the bootstrap method (Singh and Xie, 2008) with a number of replications of 1000.

Thus, the threshold for inflation attention estimated on the basis of the data without seasonal adjustment of the Google Trends index is 9.9% with a confidence interval of 8.9% to 10.9% at the 5% significance level. Before this threshold, the coefficient on inflation (β_1) is positive, equal to 0.643, and statistically significant. After passing the 9.9% Google Trends threshold, the index increases by 10.409, and α_2 is statistically significant at the 10% level. It turns out 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.

It is worth noting that in this model, after such a sharp increase in attention after passing 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 inflation rate reaches 10% or more, there is a sharp jump in attention to it, after which attention begins to decline. This dynamic of attention puts Ukraine in the group of countries whose results do not coincide with those of the United States. Similar results are observed for countries such as Brazil, Colombia, Estonia, Greece and Japan[10].

To check the robustness of the model results, we also estimated models for all possible periods ending in January 2022, starting from January 2014. A graph of the corresponding thresholds for each model is shown in Figure 11. To improve the accuracy of the results, the corresponding period of the Google Trends index was used to evaluate each model separately. For more details, see Appendix 3.

It can be seen that the 9.9% threshold is quite stable, with the models only beginning to deviate significantly from it when the 2014-2015 sample is included. It is also worth noting that all estimated models with a sample ending in January

[10] For details see Appendix A.1 in Korenok et al., 2023

2022 indicate that Ukraine belongs to the group of countries whose outcome does not coincide with the United States, which is quite expected.

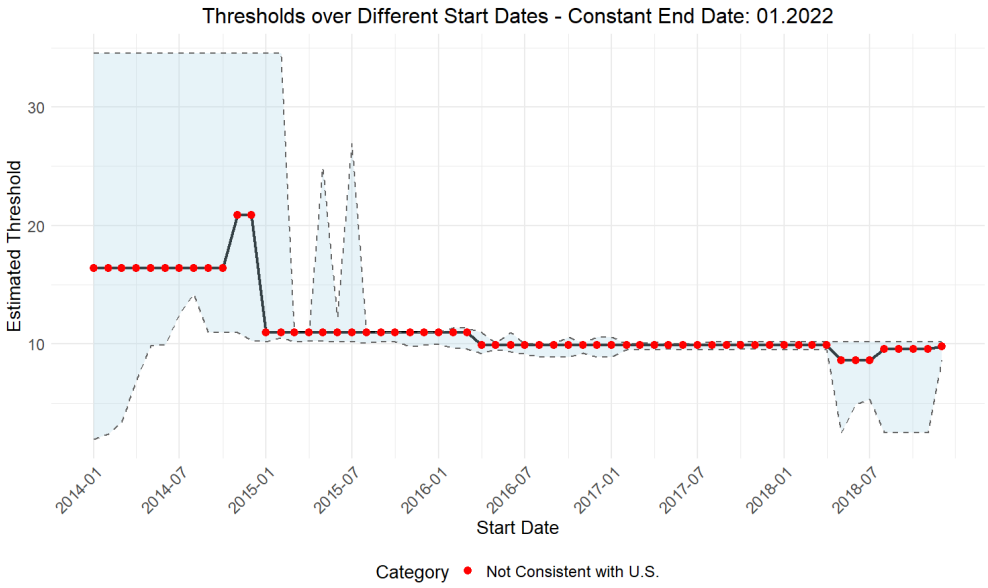

Figure 11. Thresholds for each model with the period ending in January 2022. Note: Confidence intervals were built using the bootstrap method with the number of replications of 100, significance level 0.05.

The models for all possible periods starting in January 2017 were estimated in a similar way. A graph of the corresponding thresholds for each model is shown in Figure 12. It shows that in the models ending in the months 01.2020 - 04.2022, the thresholds are also either equal to 9.9% or fluctuate around it, always including it in the confidence interval. And starting from 05.2022, i.e., when full-scale invasion observations are included in the sample, the threshold values increase sharply and begin to have high confidence intervals, which further confirms the need to exclude these observations from the sample for greater model adequacy.

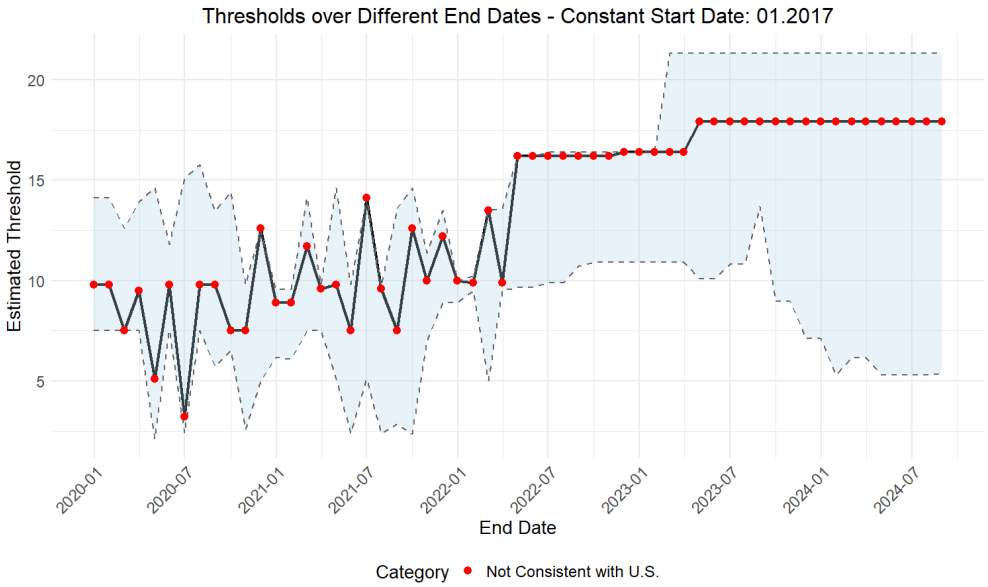

Figure 12. Thresholds for each of the models with the period starting in January 2017.
Note: Confidence intervals were constructed using the bootstrap method with the number of replications of 100, significance level 0.05.

Given that in Figure 11, the models starting in 2016 have identical or very similar thresholds to the main model, Figure 12, where the models start in January 2016 instead of January 2017, is shown in Appendix 4. Also, the higher volatility in Figure 12 compared to Figure 11 indicates that it is more important to include less recent months of observations in the model than more recent ones.

To further check the robustness of the 9.9% threshold, the model was also estimated on all possible continuous samples for the period from January 2016 to January 2022 with at least 60 observations (5 years). The distribution of the estimated thresholds for this set of models is shown in Figure 13. The median of this distribution is 10, which does not conflict with the previously presented results.

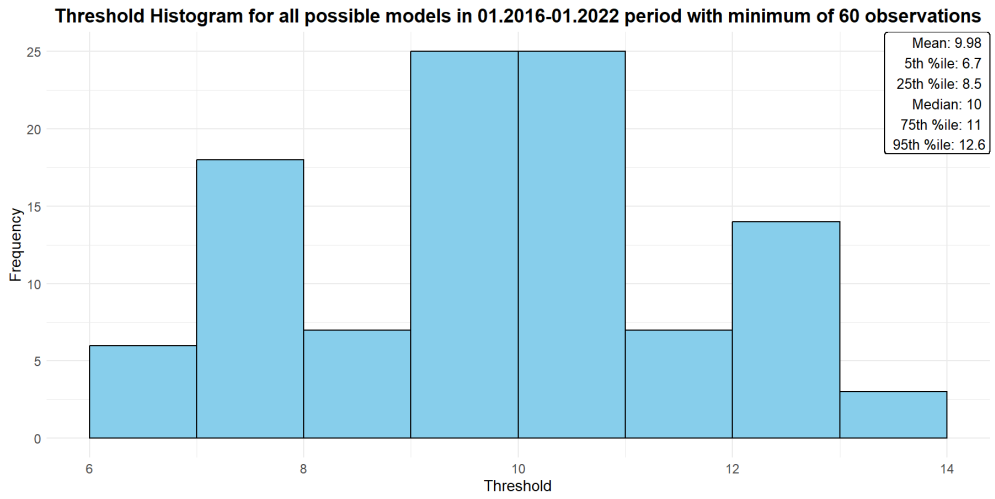

Figure 13. Distribution of thresholds across all possible continuous samples for the period from 01.2016 to 01.2022 with at least 60 observations, n = 105.

We also considered models in which the inflation rate is taken with a lag of 1 to 3 months. Their results do not differ much from the main model: the thresholds are 9.9%, 10.2%, and 10%, respectively, and the direction of all coefficients remains unchanged. They are presented in detail in Appendix 5.

As an additional robustness check, we also estimated a variant of the model using search volumes for the same queries ("інфляція" and "инфляция") limited to the "News" category instead of the general search. The results presented in Appendix 6 are similar to all before with a 9.1% threshold.

Since the Google Trends index is a relative indicator, an equation with a logarithmic dependent variable was also estimated for a better interpretation of the β2 coefficient (Figure 14, Table 3):

Table 3. Model results based on data from 01.2017 to 01.2022 with a logarithmic dependent variable.

Coefficients:	Estimate
α_1	3.9188
β_1	0.0073
α_2	0.1331
β_2	-0.0409

Threshold (γ):	Estimate
	9.9

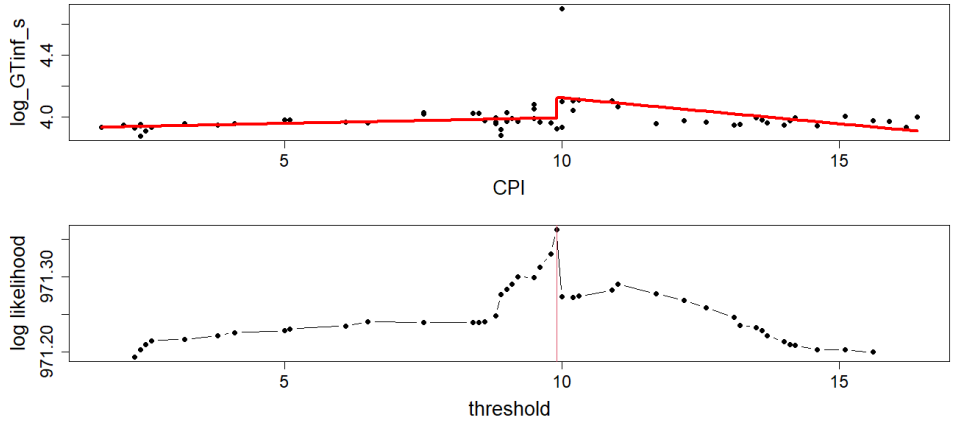

Figure 14. Model results on data from 01.2017 - 01.2022 with a logarithmic dependent variable.

In the modified equation (2):

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

Before the inflation rate threshold of 9.9% is passed, the coefficient on the inflation rate is 0.0073, meaning that on average, a 1% increase in the inflation rate after the threshold increases the expected value of the Google Trends index, and thus the attention to it, by 0.73%. At the moment of passing the threshold, the expected value of the Google Trends index increases sharply by ($e^{0.1331}$-1)*100%, i.e. by about 14.24%. And after passing the threshold, the coefficient for the inflation rate is -0.0336, meaning that on average, a 1% increase in the inflation rate after the threshold reduces the expected value of the Google Trends index by 3.36%.

5.2 Results using mentions in the Ukrainian Parliament

Since another proxy for attention to inflation – mentions on Twitter – is not representable enough in the Ukrainian context, this study explores a different measure of attention that is new to the literature: mentions of inflation in parliamentary speeches. This proxy reflects the attention of policymakers rather than the general public and allows analysis over a much longer period – from May 2002 to November 2023.

As shown on Figure 15, using mentions in parliament as an alternative measure of attention to inflation did not significantly change the point estimates of thresholds for the January 2017 – January 2022 period. Specifically, the threshold based on the percentage of individual parliamentary speeches mentioning "inflation" was estimated at approximately 8.8% (p-value 0.182). Importantly, at least in terms of point estimates, the direction of regression coefficients from these parliamentary-based models remained consistent with those derived from the Google Trends data, further supporting the robustness of the earlier results.

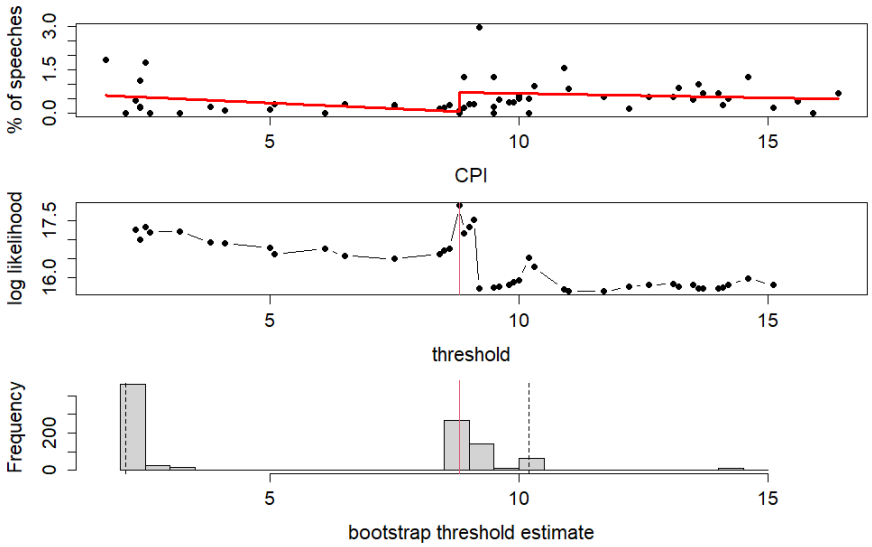

Figure 15. Estimation results using parliamentary mentions of inflation, sample period: 01.2017 – 01.2022

These findings suggest that, similarly to the general public, policymakers' attention to inflation also increases notably when inflation approaches double-digit values and gradually fades beyond that point. At the same time, unlike public attention – which tends to remain low and stable during periods of low inflation – policymakers show heightened attention even when inflation is close to zero.

Such behavior, unlike the general public's attention which, as evidenced by Google Trends, remains stable at low inflation rates, can likely be explained by two alternative reasons. The first possible explanation is that policymakers may be more aware of potential macroeconomic risks associated with very low inflation or deflation. The second explanation is more political. Policymakers can highlight and frame low inflation rates as a positive achievement or a good environment for other reforms.

To further assess the robustness of our results in stable macroeconomic environments like the period from January 2017 to January 2022, we applied the same estimation procedure to an earlier sample beginning in May 2002 – the earliest available period for parliamentary mentions data. When the end date is set at September 2007 – the last quarter before the onset of the global financial crisis – the estimated threshold is estimated at 9.8%, with a p-value of 0.030, indicating reasonable statistical significance.

Importantly, as shown in Figure 16, the form of the relationship between inflation and attention is very similar to that observed in the period from January 2017 to January 2022, with a visible spike in attention appearing around the 10% threshold and leveling off afterward. However, the threshold estimates begin to change significantly when the end of the sample extends beyond 2007, gradually taking into account the onset of the global financial crisis and the accompanying surge in inflation.

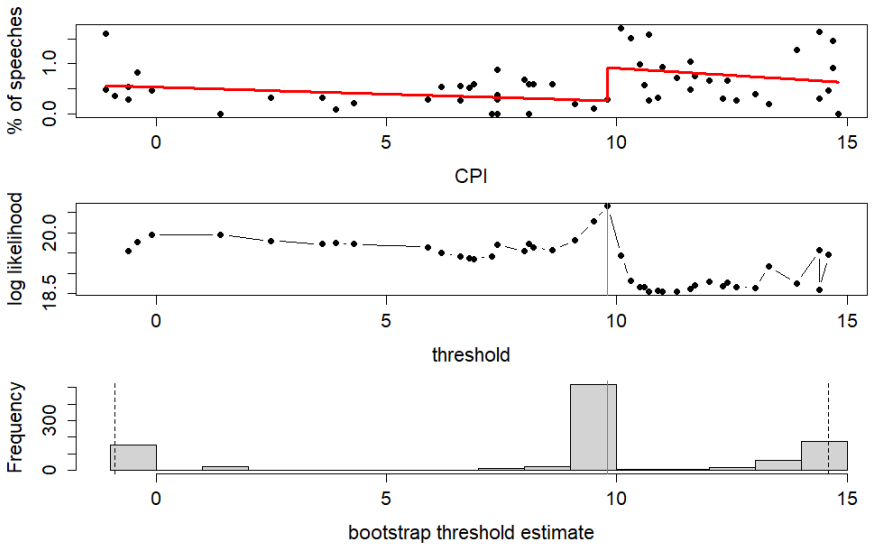

Figure 16. Estimation results using parliamentary mentions of inflation, sample period: 05.2002 – 09.2007.

To sum up, when the analysis is limited to a more stable macroeconomic period, both Google Trends and parliamentary mentions point to similar threshold estimates and attention patterns. However, once we include years with strong external shocks, like 2008–2009 or the war, the results become much less stable. This shows that such shocks can significantly change how different groups focus their attention on inflation, shifting it away from typical patterns. Taken together, both attention measures point to a consistent threshold around 9–10% during stable periods, reinforcing the robustness of the core finding.

Chapter 6

CONCLUSIONS AND POLICY RECOMMENDATIONS

Given the results of the estimated models, we can conclude that the real threshold for the level of inflation in Ukraine, after which the population and economic agents begin to pay special attention to it, is 9.9% with confidence intervals from 8.9% to 10.9% at the 5% significance level. At inflation rates below this level, each 1% acceleration in inflation increases the level of attention to inflation by 0.7% on average. When inflation reaches double-digit levels, attention to it increases by an additional 14.2%. And at inflation rates above the 9.9% threshold, each 1% increase in inflation reduces attention to inflation by 3.4% on average.

A similar threshold of 8.8% was found when using the share of parliamentary speeches mentioning "inflation" as a proxy for attention, which reflects the behavior of policymakers and confirms the robustness of the main result.

If we use the categorization from Korenok et al. (2023), Ukraine falls into the third group of countries in terms of attention to inflation, with results that do not coincide with the United States. As the relationship between the level of public attention to inflation and the level of inflation is positive and statistically significant up to the above threshold, and after that attention increases sharply, but the relationship becomes negative. This dynamic is similar to the dynamics of attention to inflation in Brazil, Colombia, and Greece, which was shown in Korenok et al. (2023).

The results of this study are important for the NBU's understanding of the levels of consumer inflation above which households and economic agents begin to pay special attention to it. In the case of Ukraine, it is especially important to take into account the estimated threshold, because, as the results of this study show, after

passing this threshold, the population's attention to inflation does not just start to grow faster, but makes a sharp jump.

Such sharp changes can have a significant impact on the stability of inflation expectations, and without taking this rapid growth into account in advance in its forecasts, the NBU may find it difficult to adapt its monetary policy in a timely and appropriate manner. The increased attention of the population and economic agents to inflation may provoke an acceleration regime and make it more difficult to control it (Korenok et al., 2023). Relevant to the situation of the war in Ukraine, the pro-inflationary effects of supply shocks, which are usually relatively short-lived, can increase and become persistent when the inflation attention threshold is exceeded (Pfäuti, 2023).

High inflation rates also weaken public confidence in the central bank and the country's politics (van der Cruijsen et al., 2023). Deteriorating expectations about the short-term nature of the price surge are increasing the population's propensity to consume and wage demands. 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 also close to the 12.3% threshold estimated by Muhammad and Khan (2020) for developing countries, after which there is a significant negative relationship between inflation and economic growth. This makes crossing the inflation attention threshold even more critical, as the NBU's mandate includes not only the primary goal of price stability, but also the goal of promoting sustainable economic development. Thus, double-digit inflation rates may prevent the NBU from fulfilling both of these mandates simultaneously for a longer period of time.

In conclusion, the rapid surge in attention to inflation in Ukraine after it reached double-digit levels may lead to a greater persistence of such high levels, which in

turn undermines confidence in the NBU, hinders economic growth, and increases the time it takes for inflation to return to its target. Therefore, the NBU's understanding of the specific value of the inflation attention threshold is important for making more effective and timely monetary policy decisions in the face of accelerating inflation.

This study also points to several directions for future research. Due to the previously mentioned problem of the objectively limited sample of stable years for Ukraine, one of the main options for continuing the study would be to repeat the exercise done here when more observations are available. This problem can also be solved by using another way of measuring attention to inflation, which is not so much affected by the availability of the Internet and external war-related shocks. Such potential indicators could include inflation expectations (as shown in Pfäuti, 2023), the frequency of inflation references in the news (as an alternative to Twitter, which is not widespread in Ukraine), regular surveys of citizens on their awareness of the current inflation rate, etc. The use of parliamentary mentions, which are less sensitive to internet access or civilian information-seeking behavior during war, shows promise as a more stable alternative proxy and supports the general conclusion even when based on different types of attention.

Another area for improvement is that the current literature using the Google trends index does not take into account the state of falling or rising inflation at a particular point in time when assessing the threshold. Especially in the case of countries like Ukraine, it would be worth testing the hypothesis that attention to the same inflation levels will be on average higher during acceleration than during its subsequent decline and its approach to the threshold from the upper side.

Given the history of several sharp devaluations during crises and the large dependence on imported products, the Ukrainian population still tends to pay a big part of its attention to currency devaluation rather than inflation. However,

none of the articles on attention to inflation mentions the problem of devaluation of the national currency and 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 is an area for further research.

These research directions – from expanding the sample and refining proxies to capturing attention asymmetries and exchange rate effects – can contribute to a more detailed understanding of how attention thresholds function in practice. Considering the importance of this concept highlighted in the literature, a clearer understanding of attention dynamics can further strengthen the NBU's policy toolkit for managing inflation expectations.

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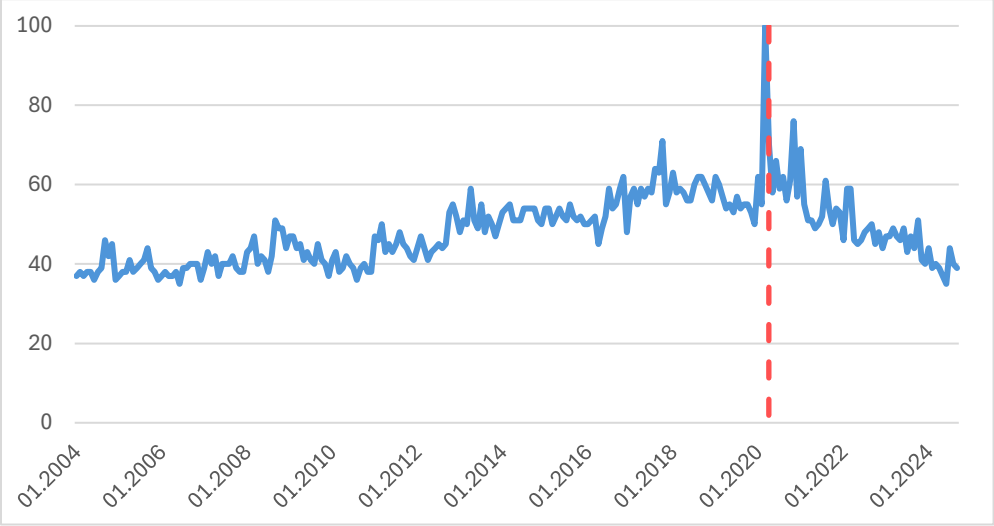
APPENDIX 1

Google Trends index for the query "news" in the USA



APPENDIX 2

Comparison of queries “робота” and “робота -домашня -контрольна -курсова -дипломна -самостійна”[11]

“-” symbol before the query removes it from the counted searches.

[11] Google Trends, queries “робота” and “робота -домашня -контрольна -курсова -дипломна -самостійна” in Ukraine / URL: 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

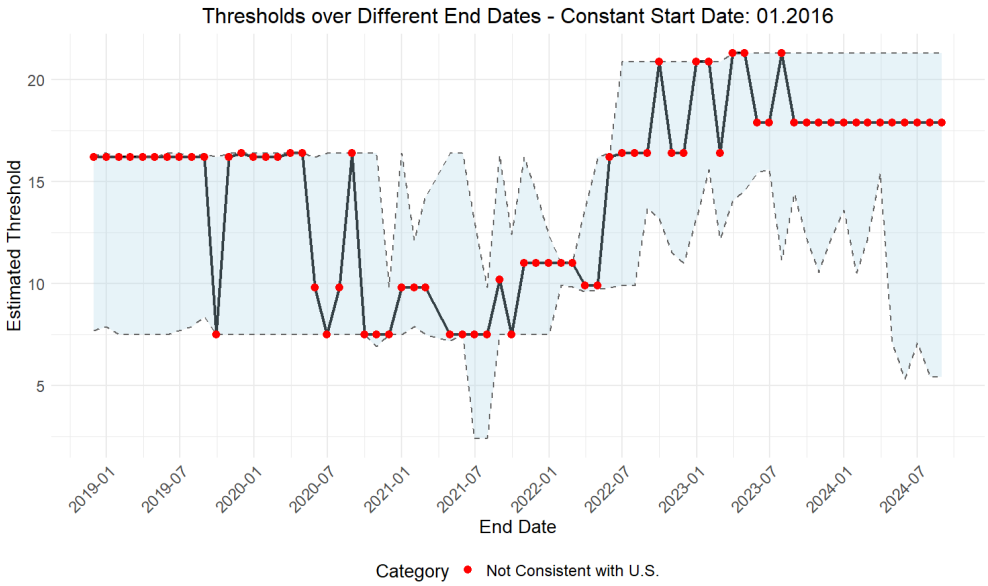
APPENDIX 3

The automated retrieval of data on the Google Trends index was performed using the gtrendsR[12] package. And, for example, for the model 01.2015 - 01.2022, the index values were taken for this particular period. If the period was less than 5 years, the number of months required for a 5-year period was added to its beginning. This was done because for shorter periods, Google Trends started displaying the index with a weekly rather than monthly frequency. Seasoning was also performed for each period of the Google Trends index separately.

[12] gtrendsR package documentation / URL: https://cran.r-project.org/web/packages/gtrendsR/gtrendsR.pdf

APPENDIX 4

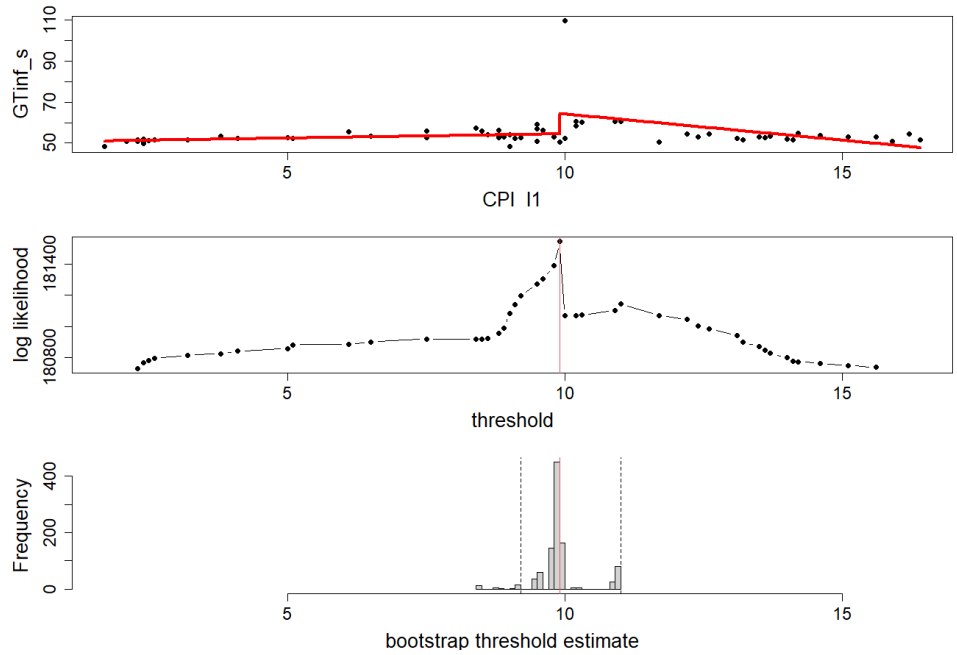
Thresholds for each of the models, the period of which begins in January 2016. Confidence intervals were constructed using the bootstrap method with the number of replications of 100, significance level 0.05.



The thresholds are more volatile than in the main model, but still have 9.9% in their confidence intervals.

APPENDIX 5

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

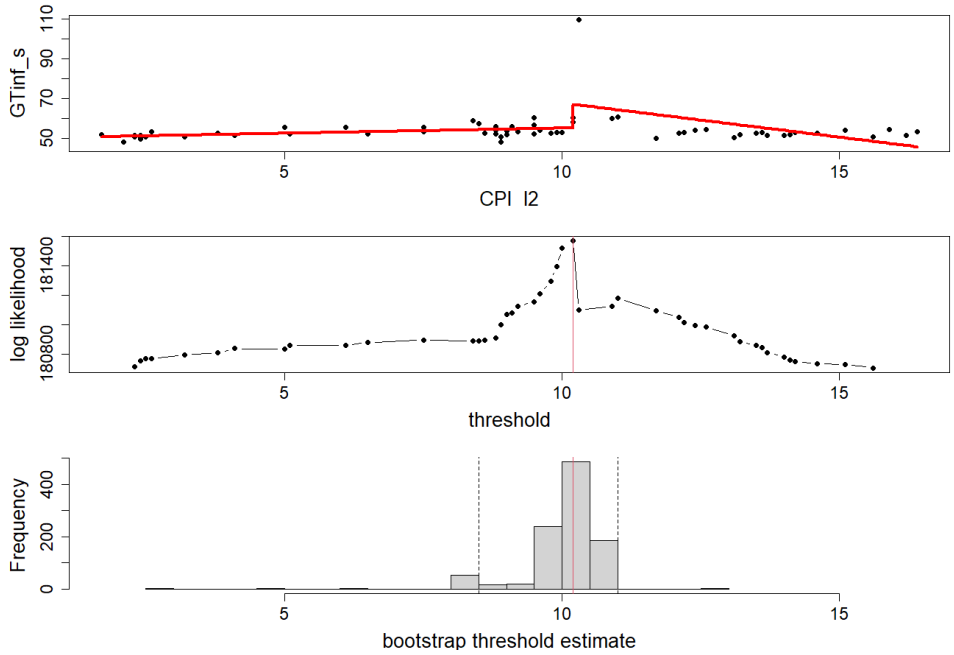
Threshold (γ):

Estimate	Std. Error	(lower	upper)
9.9	0.459	9.2	11.0

In equation (2):

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

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

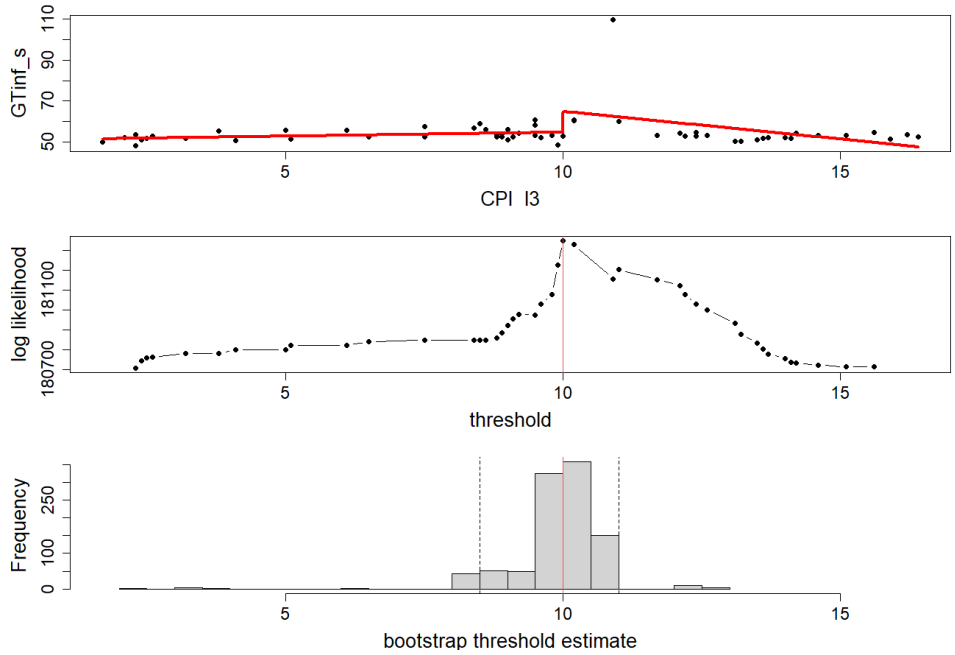
Threshold (γ):

Estimate	Std. Error	(lower	upper)
10.2	0.638	8.5	11.0

In equation (2):

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

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):

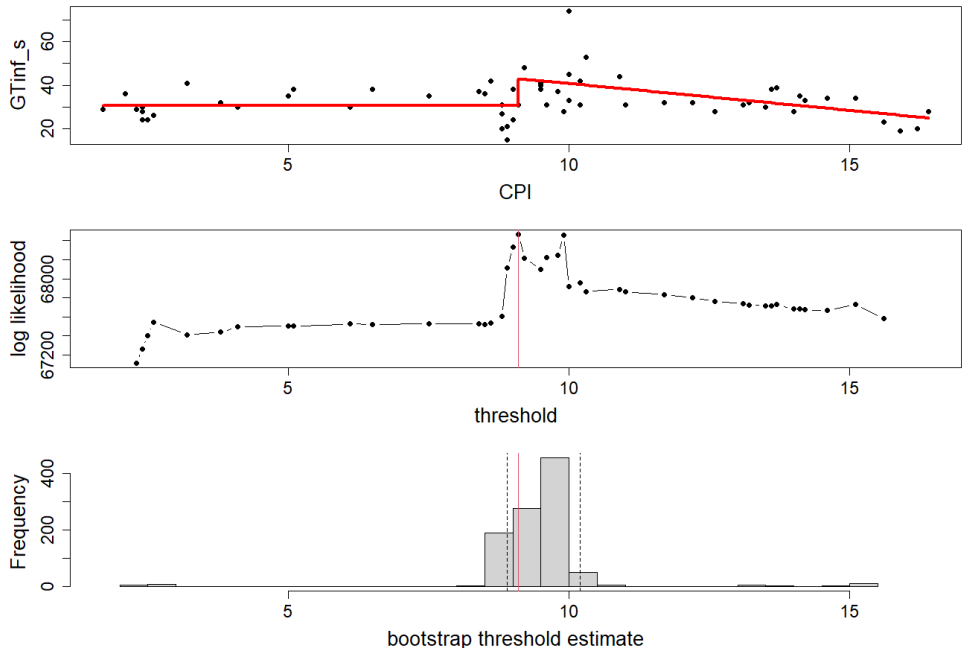
Estimate	Std. Error	(lower	upper)
10.0	0.638	8.5	11.0

In equation (2):

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

APPENDIX 6

Results of estimating a model using Google Trends data for "inflation" queries in the "News" category



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)
9.1	0.331	8.9	10.2

In equation (2):

$$y_t = 30.779 + 12.273 * I(x_t > 9.1) - 0.010x_t - 2.466 * (x_t - 9.1)_+ + e_t.$$