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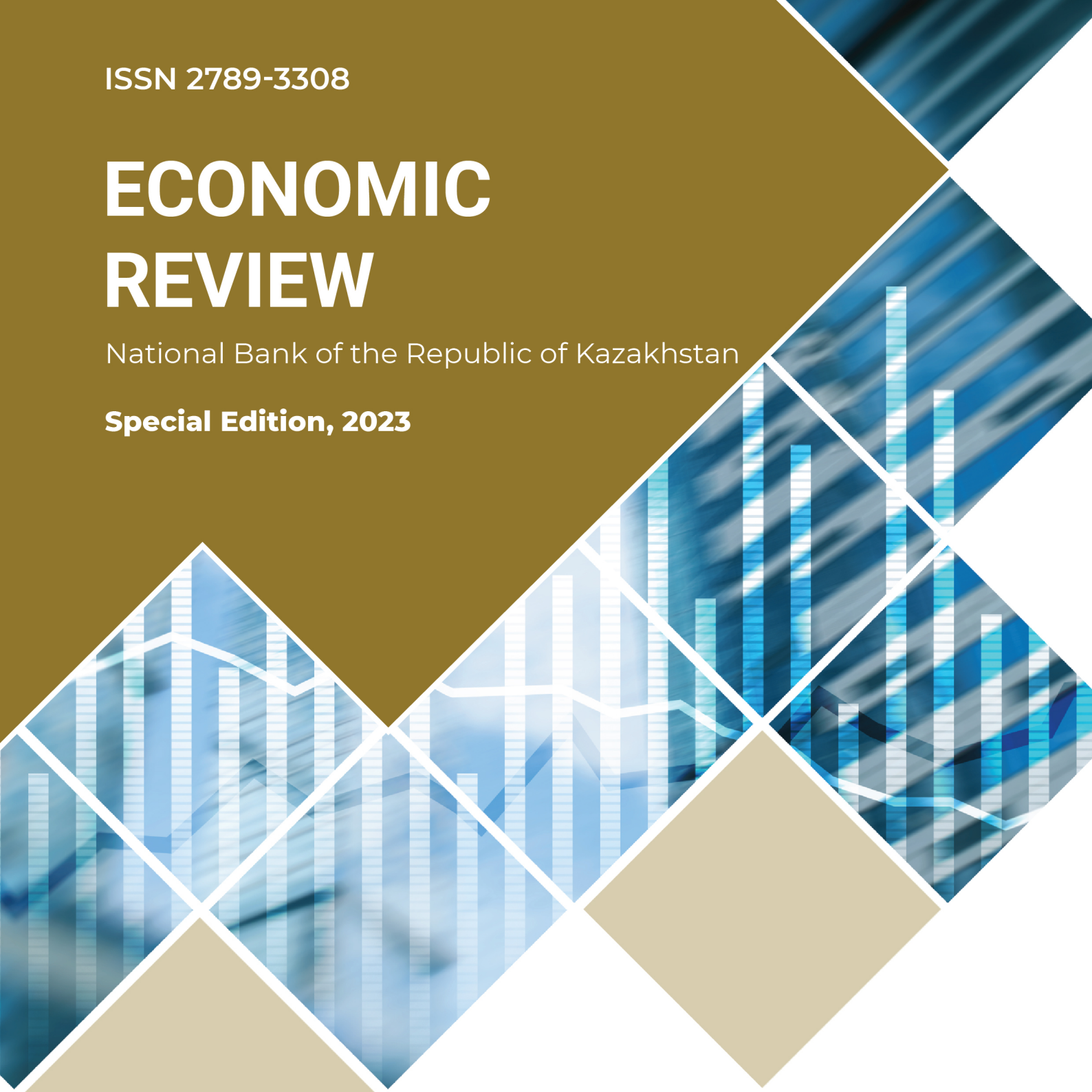
ECONOMIC REVIEW

National Bank of the Republic of Kazakhstan

Special Edition, 2023



NATIONAL BANK OF KAZAKHSTAN

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National Bank of the Republic of Kazakhstan

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The Special Edition is dedicated to the Third International Scientific and Practical Conference "Strategic Issues of the Monetary Policy: Challenges of the New Economic Reality"

The Edition incorporates the deliverables of studies conducted by the National Bank staff and the academic community and presented at the Third International Scientific and Practical Conference "Strategic Issues of the Monetary Policy: Challenges of the New Economic Reality" held on April 25, 2023 in the city of Almaty.

The Conference was attended by independent experts in the field of economics and finance, representatives of the academic community, research centers, financial and international organizations, and institutions of government.

The Conference Program was formulated based on the relevance of monetary policy issues and included three sessions.

The session "Long-Term Monetary Policy Strategy: Quantitative Formulation of the Target to Ensuring the Price Stability", addresses the aspects related to determining the optimal level of inflation target and the consistence of the targets with emerging challenges. The "Macroeconomic Coordination" session was devoted to macroeconomic coordination and interaction between government agencies. The main topic of the session "The Nature of Internal Inflation in the Republic of Kazakhstan and its Factors" – the factors of inflation in Kazakhstan – was aimed at looking into the main causes of inflation in order to develop the appropriate policy measures to reduce it.

The conference had been a follow-up of the transparent monetary policy pursued by the National Bank of Kazakhstan and the fundamental for a further work and dialogue with the community, experts, academic researchers and government authorities.

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SESSION I.

Long-Term Monetary Policy Strategy: Quantitative Formulation of the Target to Ensure the Price Stability

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Long-Term Monetary Policy Strategy: Quantitative Formulation of the Target to Ensure the Price Stability

Setting and Achieving Inflation Targets. Choosing Optimal Characteristics of the Inflation Target in Kazakhstan

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The paper presents a generalized experience of deliverables of the of research on determining the optimal target level of inflation, including estimates of the threshold level of inflation that has a negative impact on the economic growth; the historical dynamics of changes in inflation targets on a country-by-country basis since the introduction of inflation targeting is given, whereby the main advantages and disadvantages of various ways of formulating an inflation target (point target, target range, point target with tolerance band) are looked into; key arguments in favor of revising or maintaining the targets were discussed; the experience of setting and achieving the inflation target in Kazakhstan was reviewed; key risks and benefits associated with its revision were addressed.

Based on the analysis performed, key findings and recommendations were prepared that could be used in future in formulating and adjusting the monetary policy strategy.

Key Words: inflation targeting, monetary policy, inflation target, optimal inflation rate.
JEL-Classification: C55, E31, E12, E52, E58.

1. Preamble

With extensive use and development of inflation targeting, most central banks revised targets, indicators, horizons for achieving inflation, but their goal – ensuring the price stability – remained unshakable.

Achieving the price stability requires that a nominal anchor is established by the monetary policy, which means fixing a certain variable to stabilize the price level in the long run. In different periods, central banks used the gold standard, monetary aggregates, or fixed exchange rates as a nominal anchor.

The failure of monetary targeting in the mid-1980s and the subsequent collapse of the fixed exchange rate system in the early 1990s led to the emergence of floating exchange rate inflation targeting as the new preferred monetary policy paradigm.

The shift to inflation targeting was a pragmatic response from central banks to the views prevailing in the economic theory that a persistently higher inflation rate is not necessarily accompanied by the higher economic growth and employment, as well as to the increasing attention of the economic community to the thesis about the importance of inflation expectations and the need in their anchoring.

The growing number of developing countries that moved to inflation targeting points to the fact that this system has advantages versus the systems with monetary targeting or exchange rate targeting as nominal anchors.

The key specifics of an inflation-targeting regime are the recognition of price stability as the main goal of central bank policy, the public announcement of a numerical inflation target, the

formulation of monetary policy based on a broad set of macroeconomic data, and the application of high standards of transparency and accountability to the central bank policy.

At the same time, the choice of an optimal level of inflation for central banks is fundamental, since, based on the prospects for achieving the goal regarding the price growth, the monetary authorities make decisions on the policy rate and build their communication policy. In this respect, the next sections of this paper will include a study of key aspects of setting and achieving an inflation target in Kazakhstan, taking into account the results of research, international experience, the experience of the National Bank, as well as assessing the optimal characteristics of inflation for the Kazakh economy.

Section 2 contains an overview of academic studies aimed at determining an optimal level of inflation based on different economic assumptions.

Section 3 touches upon the revision of the target in countries in the context of recent crisis and describes the main parameters of inflation targets in countries that adhere to the inflation targeting regime (level, type, bounds of the corridor, number of revisions).

Section 4 shows the analysis of experience of the National Bank of the Republic of Kazakhstan (the "National Bank") in setting and achieving inflation targets and defines a number of references for choosing an optimal target.

Section 5 presents estimates of the optimal inflation target for the Republic of Kazakhstan according to various approaches within the basic assumption of maintaining stability, preserving the "status quo" in terms of trade structure with partner countries, demographic growth, labor market structure, the share of investments in the economy, and total factor productivity and economic growth in the long run.

The final part (Section 6), based on the analysis of all preceding sections, draws up a list of findings and recommendations for the National Bank that should be taken into account in setting the inflation target.

2. Academic Studies on the Optimal Inflation Rate

New Zealand was the first country to introduce inflation targeting (in 1990), setting an inflation target of 0-2%. Canada, Sweden, the UK and other advanced economies followed suit and also set an inflation target of around 2%. Thus, there is a consensus among the developed countries on inflation targets at the level of 2%. However, the fact that the 2% level has become the reference target is not stemming from studies conducted that would clearly establish that it is the most optimal target.

In other words, at the time inflation targeting began to find its way in the 1990s, there was no academic rationale for a 2% inflation target. This level was probably chosen because it seemed to be a reasonable level to achieve the goal – low enough for economic agents to make decisions under predictable conditions but at the same time not too high to have a negative impact on the country's macroeconomic indicators. More recent empirical studies indicate that the optimal level of inflation, above which inflation has a negative impact on the economic growth, is in the range of 1-4% for industrialized countries. For developing economies, studies vary and point to a higher optimal level of inflation – the range is 6-20%, depending on the country's income level (see table 1).

As inflation-targeting industrialized countries demonstrated success in curbing inflation, more countries, including emerging economies, have begun to implement this monetary policy regime. In developing countries, inflation targets have generally been set higher. High inflation goals in developing countries can be attributed to faster economic growth and higher exposure to emerging shocks. Target-setting approaches in developing countries also show no signs of rigorous research, and the targets chosen appear arbitrary.

Therefore, academic research did not serve as the basis in implementing inflation targeting by central banks, despite the fact that researchers made considerable efforts in an attempt to determine an optimal inflation target.

Basically, academic research is aimed at determining the optimal level of inflation target from a theoretical point of view. The authors of the studies do not attempt to give a numerical

value for the optimal inflation target; rather, an attempt is made to answer the question of what level of inflation is optimal – negative, zero or positive.

Diercks A.M. in his work summarized the main published (250) articles on optimal monetary policy since the mid-1990s. The results showed little support for the inflation target of 2% (Diercks A.M., 2017). In contrast, out of 100 studies that provide a numerical value for the optimal average inflation rate, 80 concluded that zero or negative values are best as optimal targets. The results of the remaining more recent 20 studies point to the need for positive inflation for sustainable economic development.

The various conclusions (zero, negative, positive inflation) are resulting from the assumptions underlying the studies. Studies based on flexible price assumptions, which imply zero welfare costs of price changes, lead to the conclusion that the inflation rate must be negative. The assumption of price fixity, which entails a potentially significant welfare cost through inflation or deflation, leads to the conclusion that a zero inflation target is optimal. More recent studies modify assumptions about price rigidity to allow economic agents to change prices after economic shocks, and add a near-zero rate problem to the model, which changes the result to that in which positive values are optimal instead of zero or negative rates.

Another approach of researchers to determine the optimal inflation target level is to empirically consider the relationship between economic growth and inflation and assess the level of price rise that is most favorable for the economic growth (Johnson, O.E., 1984). The literature on this approach is quite extensive and this paper addresses some of the most recent and detailed studies (see Table 1).

A research by A. López-Villavicencio et al, which includes 42 countries and covers the period of 1961-2007, demonstrates a non-linear relationship between inflation and economic growth and the thresholds beyond which inflation exerts negative effect on the growth are 2.7% and 17.5% for advanced and emerging economies, respectively (López-Villavicencio & Mignon, 2011).

Table 1

Assessment of Inflation Thresholds Exerting Negative Effect on the Economic Growth

Authors	Year	Number of Countries	Coverage	Results by Countries	
				Advanced	Emerging
Sarel	1995	87	1950-1990	8%	
Barro	1995	122	1960-1990	10%	
Khan and Senhadji	2001	140	1960-1998	1-3%	7-11%
Gylfason and Herbertsson	2001	170	1960-1992	10-20%	
Pypko	2009	CIS	2001-2008		8%
R.Burdekin	2004	72	1965-1992	3%	8%
P.Baranowski	2008	15 (EU)	1972-2005	3.5-4%	
R.Espinoza	2010	165	1960-2007		7-13%
López-Villavicencio and Mignon	2011	42	1961-2007	2.7%	17.5%
Vinayagathasan	2013	32 (Asia)	1980-2009	5.43%	
Kremer	2013	124	1950-2004	2%	17%
Eggoh, Kahn	2014	102	1960-2009	3.4%	10-12% (average income)
					20% (low income)
Kartayev, F.	2015	172	1980-2012	9%	
Perevyshina, Ye.	2016	82	1965-2014		6%

Source: “Inflation Target” analytical paper of the Monetary Policy Department, compiled by the authors

The analogous study by Kremer et al., covering 124 countries and the period of 1950-2004, demonstrated similar results (Kremer et al, 2013). In particular, the study showed that inflation in industrialized countries slows down the economic growth when it exceeds the critical value of 2.5%. For developing countries, the inflation threshold is around 17%.

In general, all such studies show that inflation has a significant negative impact on the economic growth in both developing and developed countries if it exceeds the threshold. However, none of the studies found a positive effect of inflation rising to the threshold level in emerging economies. Moreover, all studies show that the estimate for industrialized economies is relatively well in line with the 2% inflation target chosen by most countries. At the same time, the conducted studies do not exclude the possibility that the target indicator may be somewhat higher (M. Apel et al, 2017).

Differences in thresholds between groups of countries indicate higher inflation tolerance in developing countries, which is explained by various factors such as the Balassa-Samuelson effect, the use of indexation systems, exchange rate policies, and high levels of inflation faced by these economies.

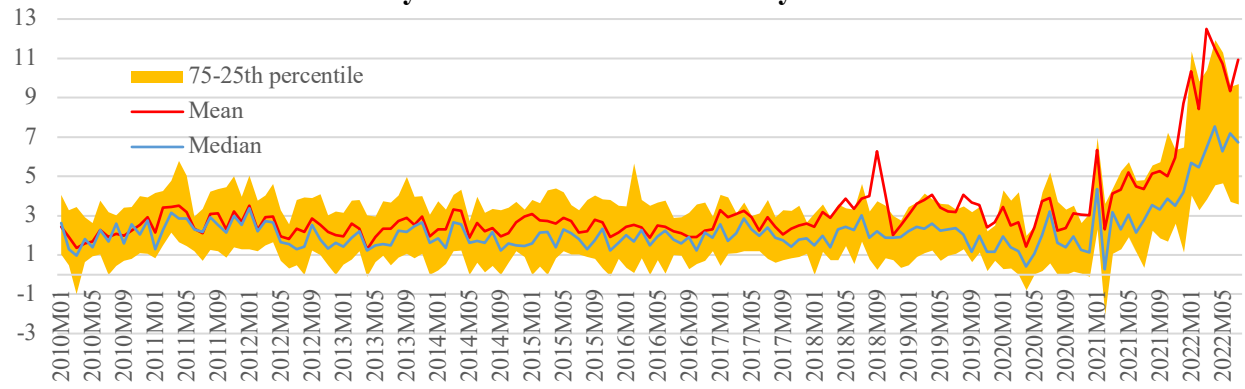
3. International Experience in Setting and Achieving Inflation Targets

Decisions of the authorities, as well as reactions of the markets to the recent pandemic and still continuing geopolitical crises in large measure had been the cause of the outburst of global inflation observed over the past year. Since the Covid-19 pandemic, governments around the world have launched a massive wave of fiscal stimuli that has led to an increase in public debt by about 15 percentage points of the world GDP from 2019 to 2021 (R. Banerjee at al, 2022). In Kazakhstan, the level of public debt during the reviewed period increased by 30% in absolute terms, and the debt-to-GDP ratio increased by 1.3 percentage points to 26.2%. The measures taken by the United States and European countries to strengthen their health systems, support households and businesses appeared to be especially significant in this context. In particular, during this period, the debt-to-GDP ratio in the United States went up by almost 25 percentage points, to more than 130%, and slightly less than 15 percentage points on average in eurozone countries, approximately to about 95% (I. Visco, 2022). Thus, the realized pent-up demand of economic agents, coupled with disruptions in logistics supply chains and ever-increasing protectionist measures in the form of tariff and non-tariff barriers at the national levels, against an extraordinary rise in energy and food prices associated with active hostilities in Eastern Europe, had been the main reasons for the global price surge.

According to the IMF World Economic Outlook for October 2022, in July 2022, the average annual core inflation among reviewed countries[1] was 10.91%, whereas in July 2021, the average value accounted for 4.34% only (see Figure 1).

Figure 1

Dynamics of Core Inflation by Countries



Source: IMF World Economic Outlook, October 2022

[1] The group of reviewed countries includes countries representing 89.4% of GDP of advanced economies and 75% of the GDP of emerging markets, totaling 81% of the world GDP.

In turn, among 45 countries that are practicing inflation targeting to one degree or another, the average annual inflation in July 2022 equaled 13.48% and in October 2022 – 14.3%[2] (in January 2022 – 7.76%). Such sharp and widespread bursts of inflation were accompanied by cycles of monetary tightening by the monetary authorities in advanced and emerging economies.

Thus, during eight months of 2022, advanced economies-members of the G20 raised the policy rate 25 times in total and by no means lowered it, whereas emerging economies within the G20 raised the rate 31 times and lowered it 7 times (see Figure 2).

Figure 2

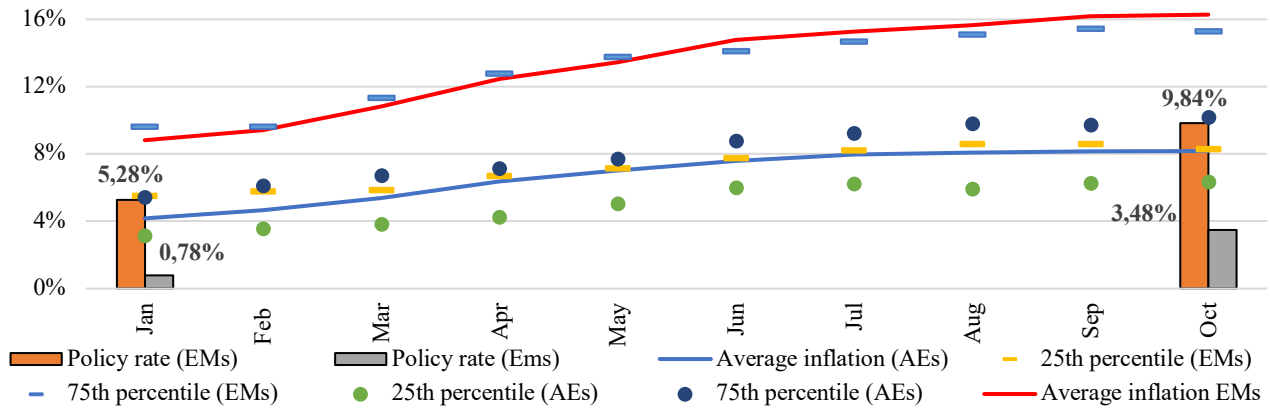
Change in the Monetary Policy Cycles among the G20 Member Countries

Source: IMF World Economic Outlook, October 2022

In 45 countries practicing inflation targeting, the policy rate increased by 410 basis points on average over 11 months of 2022, amounting to 9.84% in developing countries and 3.48% in developed countries on average (see Figure 3). Negative change over the period took place in Russia (-100 bp) and Turkiye (-500 bp). However, despite significant increases in policy rates by central banks, inflation remains well above the target (see Figures 4 and 5). For many central banks, this situation is exacerbated by the current slowdown in the global economic growth, which limits the potential for further tightening of monetary conditions. Thus, according to the IMF World Economic Outlook for October 2022, the forecasts for the growth rate of world GDP in 2022 have been revised downwards – from 3.6% to 3.2%, compared to the data of April 2022. In 2023, a further slowdown in GDP growth is expected – up to 2.7%.

Figure 3

Change in the Policy Rate in the IT-Countries for 2022



Source: compiled by the authors based on the data from the official central banks' sources, statistics bureaus and Trading economics

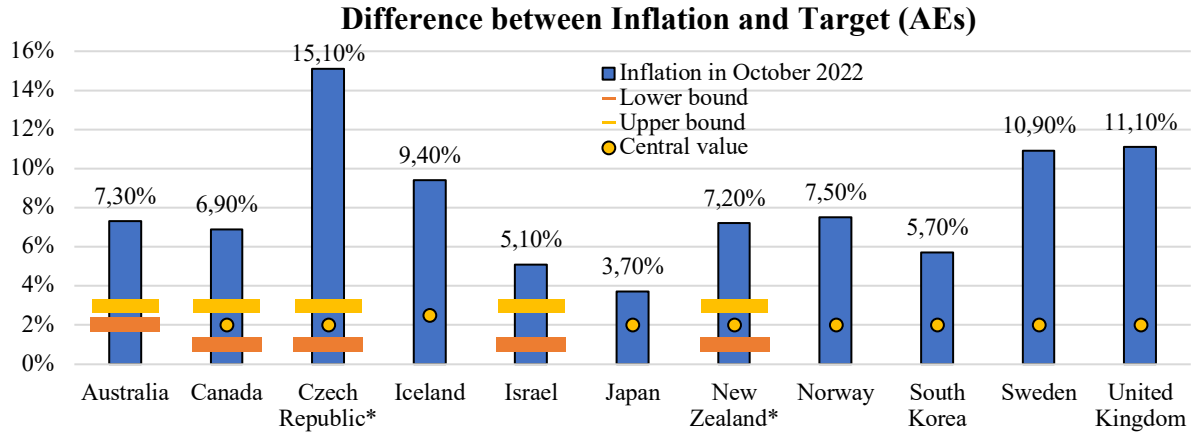
[2] The annual inflation for September 2022 was taken to calculate the average for Australia and New Zealand.

In these circumstances, given that inflation targets have been exceeded, some experts are bringing up a discussion in the information field of a number of advanced economies about the need to increase inflation targets.

The main argument in favor of the need to raise the inflation target is the thesis that inflation will be with us for a long time. The shocks of recent years associated with the pandemic, growing geopolitical and environmental risks, have exposed the problems of extreme vulnerability of existing logistics supply chains, which, coupled with the increased role of tariff and non-tariff barriers, has accelerated the processes of deglobalization. The decline in global specialization and the potential split of the global economy into competing blocks of security and trade are fraught with higher costs for economic agents.

Thus, limitation of access to cheap labor will provide more bargaining power for local professionals, while reduction of global competition in the economy will provide companies with greater pricing power, which will allow high labor costs to be passed on to consumers to offset the costs associated with reduced growth prospects for scale and more expensive supply chains.

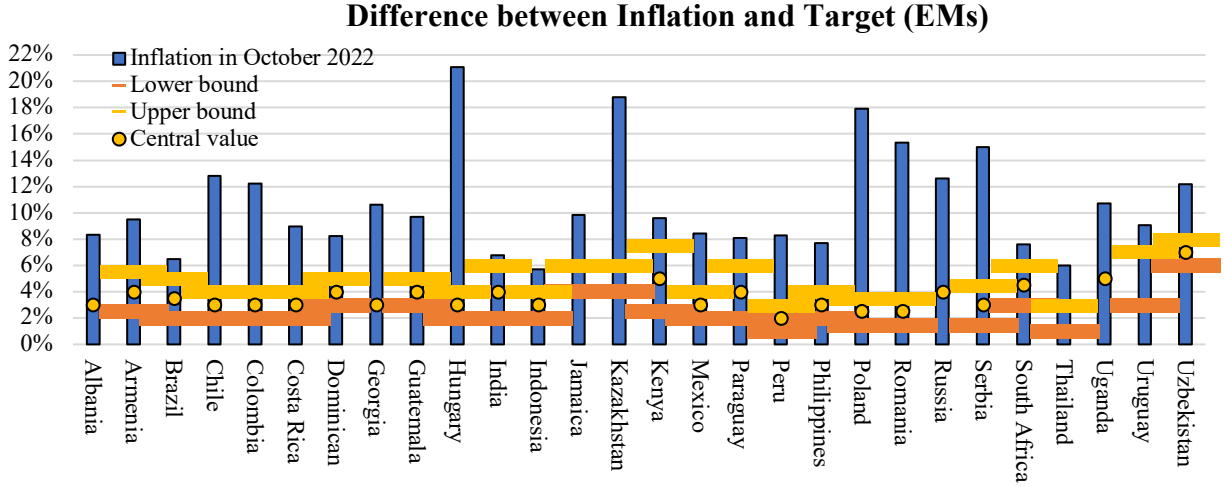
Figure 4



Source: compiled by the authors based on the data from the official central banks' sources, Trading economics

Thus, the systematic inability of a central bank to keep inflation within the set target, in the face of ever-increasing inflation and the existing limited potential for monetary tightening, could ultimately lead to the undermining of the central bank's credibility, unanchoring of inflation expectations and losing control over inflation.

Figure 5



Source: compiled by the authors based on the data from the official central banks' sources[3], Trading economics

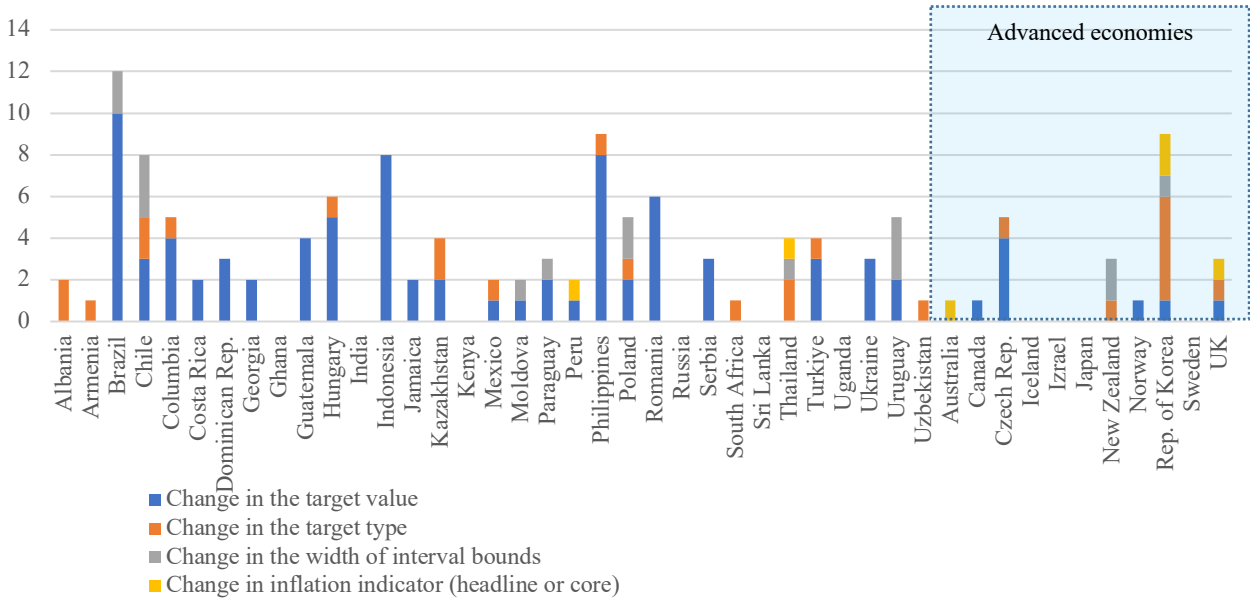
[3] Figure 5 does not include emerging markets with the annual inflation rate above 25%: Turkiye (85%), Sri Lanka (66%), Ghana (40.4%), Moldova (34.6%) and Ukraine (26.6%).

In turn, the following could be mentioned among the arguments in favor of maintaining the current targets. For decades, inflation in developed countries has been at low levels, often even falling below targets. In an effort to increase inflation with an aim to be within the target, many central banks have cut interest rates to near zero, facing the problem of the so-called "zero lower bound of nominal interest rates". Taking into account the IMF forecasts[4] for deceleration of inflation in the medium term, albeit to a lesser extent than expected, the upward change in targets may result in a recurring encounter with the problems of "zero lower bound of nominal interest rates" in future.

There have already been precedents for changing targets in a historical perspective (see Figure 6). In this connection, consideration of the main configurations inherent in targets, such as the type of target (point target, point target with tolerance band, or target range), target value, forecast horizon, will allow formulating the outlines of a potentially optimal target more accurately.

Figure 6

The Number of Target Revisions
(from the Time of Transition to IT up to the 1st Half of 2022)



Source: compiled by the authors based on the data from the official central banks' sources, Trading economics

What target type is optimal?

There are three main types of inflation targets in the practice of inflation-targeting central banks: point target, target range and point target with tolerance band.

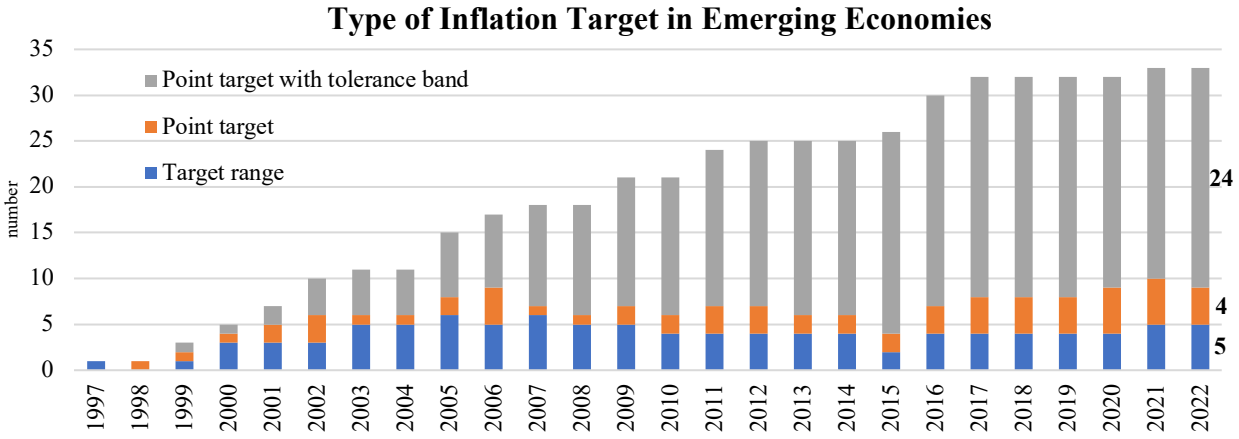
The advantage of point inflation targets, including point targets with tolerance bands, is their unambiguity, which allows the market to convey a clear signal about the the central bank's goal. The symmetry of such target also indicates the desire of the central bank to avoid both inflation and deflation to the same extent. The point target is also considered to be a better reflection of the medium-term nature of the target, since it is clear that inflation cannot reach the point target from month to month. Finally, a point target may be preferable when inflation volatility is wider than the width of the set range.

In turn, the advantage of a target range lies in the clarity of interpretation of results: inflation is either within the bounds of the target corridor or not.

[4] According to the IMF WEO data for October 2022, the inflation forecast: in 1Q 2023 – 6.2%, in 2Q 2023 – 4.6%, in 3Q – 3.7%, in 4Q – 3.1%. The previous forecast in July 2022: in 1Q 2023 – 4.9%, in 2Q 2023 – 3.4%, in 3Q – 2.7%, in 4Q – 2.3%.

The choice of the target range as a target may also indicate that the central bank does not establish clear control over its inflation goal but focuses on the ability to compensate for temporary price-level shocks.

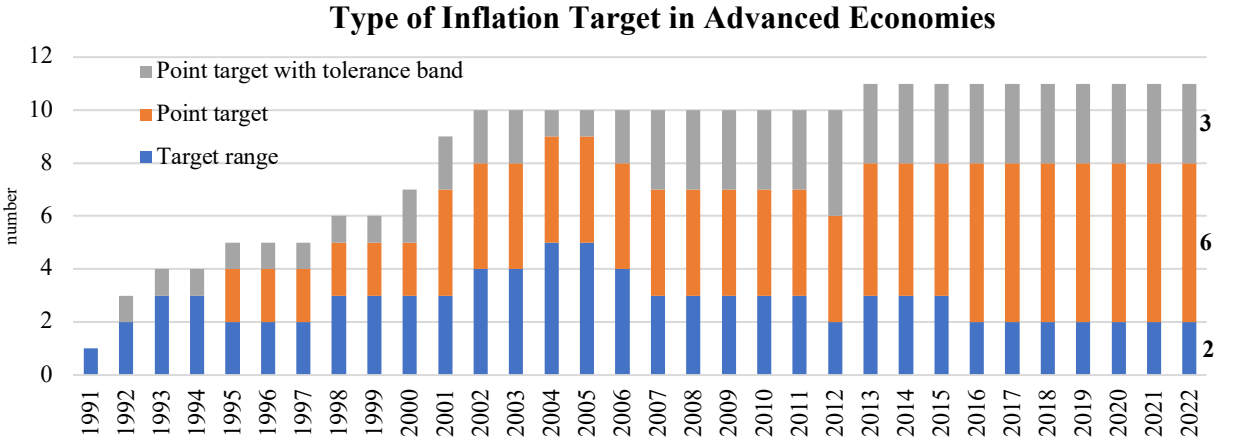
Figure 7



Source: compiled by the authors based on the data from the official central banks' sources

Emerging economies, as a rule, tend to prefer inflation targets with a tolerance band – 24 out of 33 CBs in emerging economies applying the IT regime prefer this type of target, while advanced economies rely more on point targets – 6 out of 11 CBs (Figures 7 and 8). This is driven by faster economic growth and greater exposure to emerging shocks among developing countries.

Figure 8



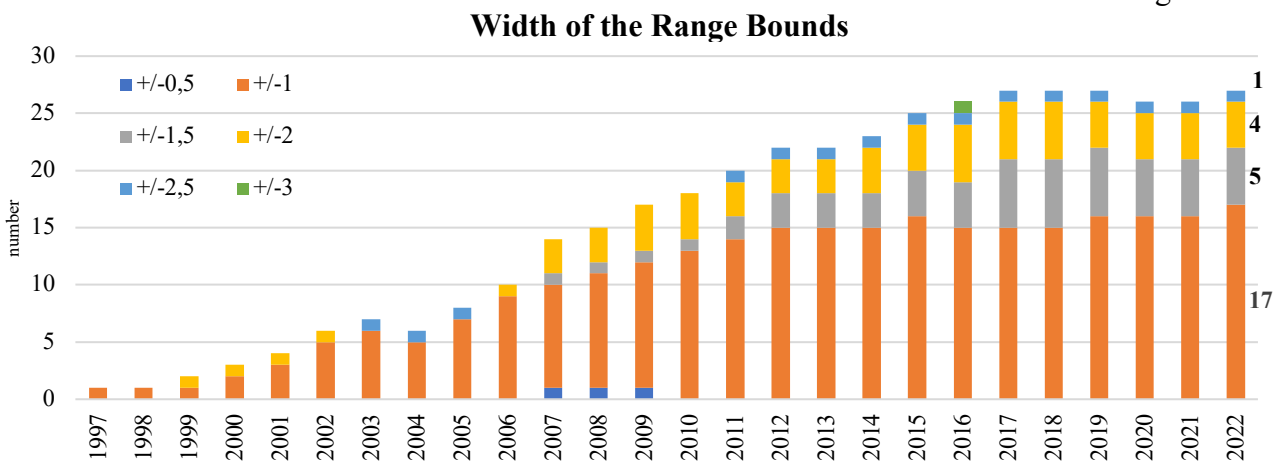
Source: compiled by the authors based on the data from the official central banks' sources

Target ranges among CBs using IT vary from +/-1 to +/-3 percentage points, the most common of which is +/-1 percentage point – 17 out of 26 countries that practice targeting with a tolerance band prefer this range (see Figure 9).

What target horizon is optimal?

The target horizon, as a rule, depends on whether inflation is within the range of price stability. Medium-term target setting locks in inflation expectations and explicitly allows for short-term deviations from the target when shocks hit the economy. The target horizon may also depend on the length of the monetary policy transmission mechanism. With a longer transmission mechanism, the central bank cannot influence inflation in the short-term perspective.

Figure 9



Source: compiled by the authors based on the data from the official central banks' sources

The choice in favor of a shorter target horizon is justified when using a disinflationary strategy. A shorter target horizon, coupled with the Government's coherent fiscal policy, provides greater accountability and flexibility to curb inflation when inflation expectations are not yet anchored.

What is the optimal target value?

The neo-Keynesian paradigm suggests that the optimal inflation rate should be zero. However, in practice, all inflation-targeting central banks have positive targets. This is primarily explained by the fact that measurable inflation tends to overestimate actual inflation by some amount, and a target above zero is intended to offset this effect. Another argument is that a positive inflation target reduces the likelihood of the zero lower bound on nominal rates that occurred in 2008-2009. In addition, the choice in favor of a positive inflation target may be driven by the greater commitment of central banks to accept inflation risks rather than deflation risks. Since the latter comes with the danger of debt deflation: in deflation, the nominal value of assets falls whereas the nominal value of debt remains unchanged.

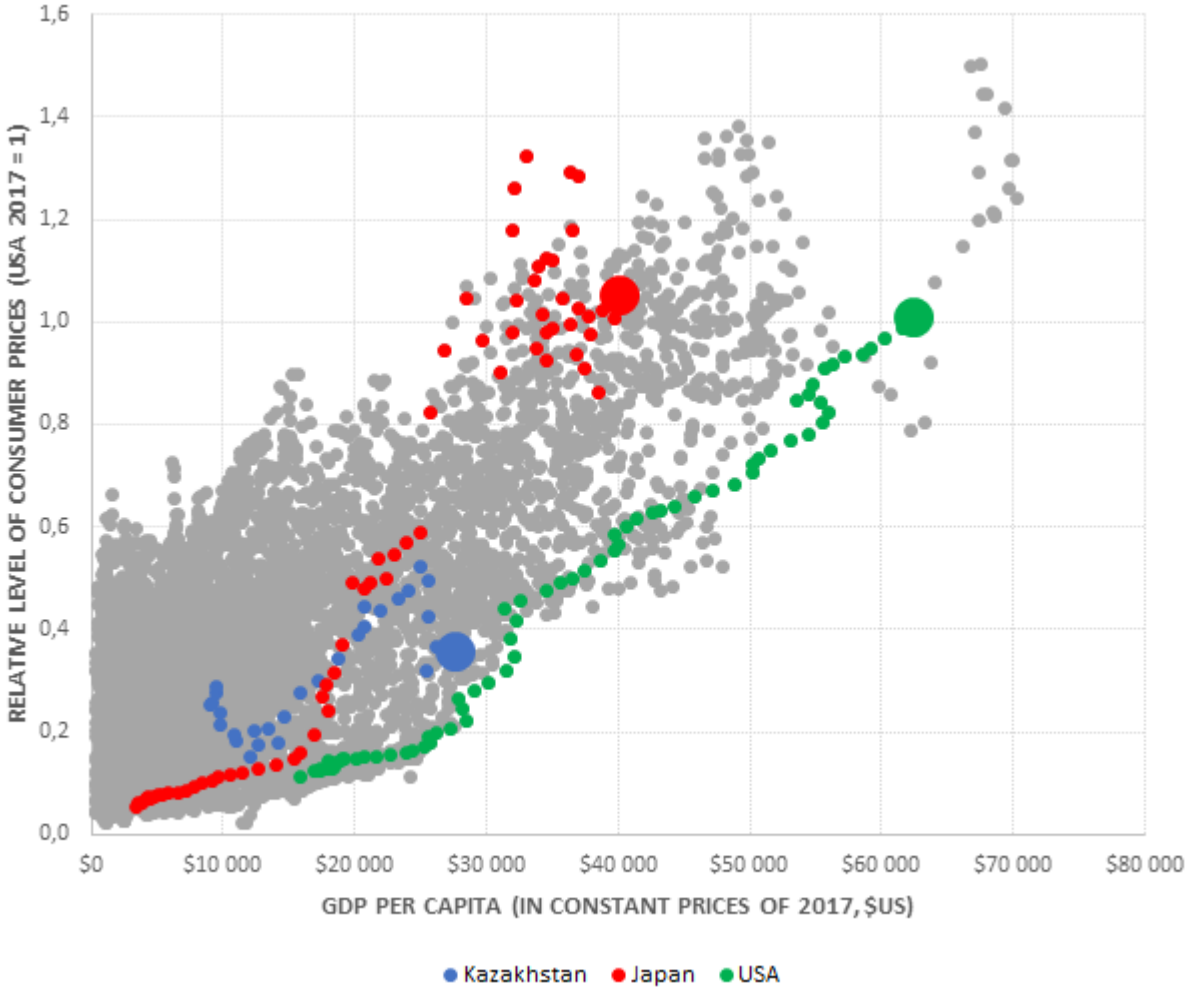
Under these conditions, when setting a target level of inflation, central banks should focus on the inflation rate that will be acceptable for the majority of economic agents. There is a consensus in the economic environment that inflation above the 3-4% threshold entails social security costs, while the potential benefits of bringing inflation below 2% are unlikely to outweigh the benefits of a positive inflation target.

This thesis is more relevant in relation to advanced economies, which is confirmed in practice. Thus, the target inflation levels in all developed countries that practice inflation targeting fit within the range of 1 to 3 percent (see Figure 4).

At the same time, inflation targets in developing countries vary over a wider range, up to 8% (see Figure 5). As mentioned in the previous section, this discrepancy in target levels between developed and developing countries is partly explained by the Balassa-Samuelson effect (Mads Kieler, 2003). The key implication of this effect is that countries with higher per capita income should experience a higher relative price level, which is well supported by empirical evidence (Figure 10).

Figure 10

Price Convergence According to the Balassa-Samuelson Effect (All Countries* from 1950 to 2019)

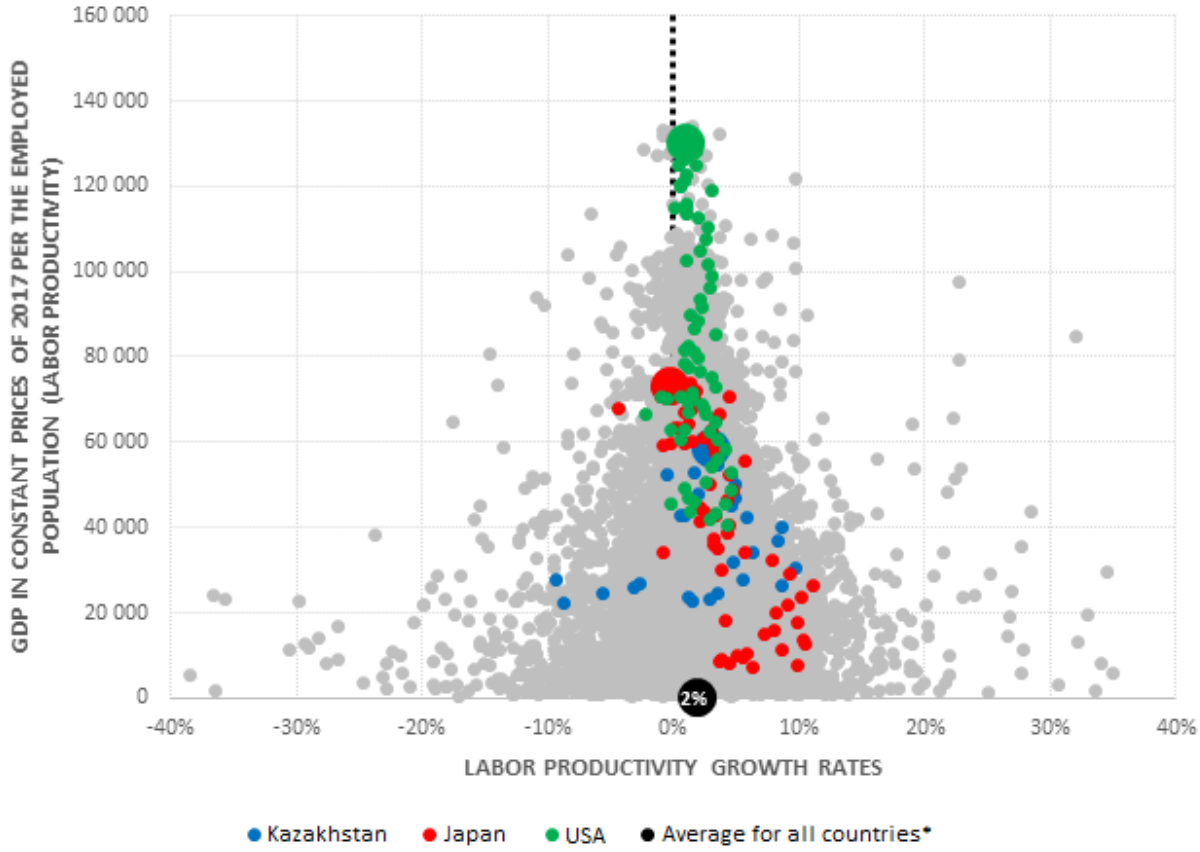


* excluding the following countries: Angola, Bahrain, Barbados, Bosnia and Herzegovina, Brunei, Macau SAR, Republic of the Congo, El Salvador, Gabon, Guinea-Bissau, Iran, Ireland, Kuwait, Luxembourg, Mozambique, Nigeria, Qatar, Saudi Arabia, Seychelles , Singapore, Switzerland, Syria, UAE, Venezuela, Yemen, British Overseas Territories.
Source: Penn World Table 10.01

It is assumed that the optimal level of inflation for developing countries will be higher than for developed countries. Developing countries can experience catch-up growth through higher productivity growth in the use of land, labor and capital. This effect leads to an increase in wages in tradable and non-tradable sectors of the economy and, ultimately, to a rise in prices. Thus, in an emerging economy with high productivity growth, there will be faster per capita GDP growth, resulting in higher price increases. In developed countries, productivity is already high and it is much more difficult to increase its growth rates; GDP per capita grows slower, whereby lower inflation is premised on (Figure 11).

Figure 11

Distribution of Labor Productivity Growth Rates



* excluding the following countries: Bahrain, Bosnia and Herzegovina, Brunei, Macau SAR, Equatorial Guinea, Gabon, Iran, Iraq, Ireland, Kuwait, Lebanon, Liberia, Qatar, Rwanda, Saudi Arabia, UAE, Venezuela, Zimbabwe, British Overseas Territories.
Source: Penn World Table 10.01

In addition to the level of productivity and economic growth (the Balassa-Samuelson effect), in setting inflation targets, developing countries should take into account the inflation targets of their main trading partners. Thus, the high value of the target in comparison with the trading partner countries provokes higher prices in the domestic market. Differences in inflation rates in partner countries affect the prices of imported goods, increasing the comparative advantage of imports. The increase in demand for imported goods, in turn, increases the demand for foreign exchange and ultimately leads to the pressure on the exchange rate towards its depreciation. Thus, for example, the target values at the end of 2022 in the Russian Federation and Kazakhstan are 4% and 4-6%, respectively. Therefore, in theory, the entry of Kazakhstan into the upper bound of the target, provided that the target is met by the Russian Federation, creates differences in the level of inflation, at which domestic goods, with the same labor productivity, can appreciate in price faster than Russian goods. This increases the demand for consumer imports from the Russian Federation and, consequently, the demand for Russian rubles, which may lead to systematic pressure on the tenge against the ruble. In the long run, in the context of structural imperfections of the economy and ill-conceived fiscal policy, this practice has a negative impact on the well-being of the population.

This effect can be significant, given the fact that the share of imports from the Russian Federation in the total imports of the Republic of Kazakhstan in 2022 was 34.7%. In addition, the ruble is the base currency in the EAEU space, whereby the mutual trade is carried out between the Republic of Kazakhstan and the Russian Federation, accounting for about 72.5% in the mutual trade of the EAEU countries. However, this effect is partially mitigated by the fact that about 53.2% of Kazakhstan's exports within the EAEU are also paid in rubles. However, it is worth mentioning that the difference in inflation is not necessarily reflected in the exchange rate

dynamics in all cases, so if higher inflation is accompanied by higher growth rates of labor productivity in the tradable sector, it is theoretically possible to observe capital inflow-driven appreciation of the nominal exchange rate, as a result of the Balassa-Samuelson effect.

Thus, based on the above, when assessing the optimal level of inflation, the central bank should take into account many factors, including economic growth, productivity, economic structure, and the level of targeting among trading partner countries. Based on international experience, the most preferable is a point target with a tolerance band of +/-1%. Developed countries prefer primarily point targets.

4. Setting and Achieving Inflation Targets in Kazakhstan

For Kazakhstan, as a small open economy, which implies the inability to have a significant impact on the processes in the global market and the presence of restrictions in the production of the entire list of necessary consumer goods, along with a number of internal factors, the situation in the external sector has a significant effect on price increases. This means that the control over inflationary processes in Kazakhstan is not an easy task and requires pursuing a consistent and effective monetary policy.

In 2015, after its transition to the inflation targeting regime, the National Bank's top priority objective had been to ensure the price stability, which is expressed through achievement of the established inflation targets. Despite certain progress in controling inflationary processes, the National Bank have changed the path of the set target twice over the past seven years.

Initially, amid a significant price growth (to 17.7% in July 2016), the inflation target was set at 6-8% in 2016-2017, followed by its reduction: to 5-7% in 2018, 4-6% in 2019, 4% from 2020 on.

In 2019, wthin the framework of the Agreement on Coordination of the Macroeconomic Policy Measures, the target corridor of 4-6% as established for that year was extended until the end of 2021 with its subsequent reduction to 3-5%.

In March 2021, in accordance with the adopted Monetary Policy Strategy until 2030, the inflation target corridor was determined as follows: 4-6% until the end of 2022, 4-5% in 2023-2024, and 3-4% from 2025 on.

First, it can be noted straight away that all targets in Kazakhstan represent a gradually decreasing target corridor. Although convenient in terms of a step-by-step achievement of the final inflation target, this approach has the disadvantage that the target is changed from time to time (or annually). This somewhat weakens the signal about the need to achieve the final target, since the National Bank in its information materials mainly communicates the intention to achieve the goal for the current year. Given the recurring revision of the target corridor, the shortcoming of this approach is more obvious: economic entities that rarely follow the activities of the National Bank may have erroneous judgments regarding the level and time of achieving the final inflation target. This, in turn, reduces the prospects for anchoring of inflation expectations near the target.

Setting the main target directly, without the presence of transitional targets, contributes to a greater monetary policy transparency. For example, since the transition to inflation targeting, the Central Bank of Russia has immediately set a medium-term target of 4% with a specific deadline for achieving it in 2017. In general, 20 out of 45 central banks pursuing monetary policy under the inflation targeting regime use this approach. It allows focusing the expectations of economic entities on a single goal without the need for additional communication of intermediate targets. Given that the National Bank's key objective in ensuring the price stability is to reduce and maintain inflation at the level of the final medium-term target, there is no need to resort to "auxiliary" targets at this stage[5].

Second, the existing inflation target corridor is narrowing starting from 2023. Given the exposure of the Kazakh economy to external shocks (which affects inflation volatility), a narrow corridor of only 1 pp may require more frequent reactions from the National Bank's monetary

[5] A number of central banks have made a successful transition to a single target through a consistently declining target corridor. Therefore, if a central bank does not revise its targets, there are no problems with this approach.

policy in the presence of even minor risks of inflation going beyond the corridor. In accordance with the international experience presented above, the range of targets set, as a rule, is ±1 pp. This enables the central bank to pursue a more consistent and predictable monetary policy without a sharp change in the vector of decisions made.

Third, during 7 years in the inflation targeting regime, the National Bank revised the target 2 times, which is generally acceptable from the point of view of international practice (especially among developing countries). At the same time, the revisions affected almost all parameters of the target (achievement horizon, type and level). All this required active information support to maintain the level of confidence from economic entities.

During the years of using the inflation targeting regime, the National Bank was able to stabilize inflation within the target range of 4-6%. In 2018, the annual inflation was at 5.3%, in 2019 – at around 5.4%. Ensuring a further steady deceleration of inflation closer to the final target of 4% became more difficult amid structural problems in the economy and possible risks of a negative effect from a higher base rate on the business activity. As a result, in 2019, a decision was made to extend the deadline for achieving the target. In 2020, the negative impact of the COVID-19 pandemic on the Kazakh economy again altered the deadlines for achieving the final target, requiring another revision. Thus, given the need for an on-and-off "postponing" of the final inflation target (even in the absence of significant external shocks), the question arises as to the advisability of setting a final target for price growth of 3-4% over the medium-term horizon[6]. In the long-term perspective, as inflation decelerates and stabilizes, we can come back to considering this level as the main target.

To search for references in order to determine the optimal target, one can briefly outline important theoretical assumptions regarding inflation, as well as analyze the dynamics of price growth in Kazakhstan (empirical estimates using various approaches are presented in the next section).

In economic theory, moderate inflation is a positive factor for the economy. It stimulates demand, promotes the expansion of production and investment. High inflation is always characterized as a negative phenomenon. As a rule, price increases close to 10% or more are undesirable and are considered as the lower threshold for galloping inflation.

In accordance with the table of the results of empirical research presented above (see Table 1), one can also judge the existence of a threshold, above which a negative influence on the economic growth is observed. As already mentioned, for developing economies, estimates lie in the range of 6-20%. At the same time, most of the results from the presented list of studies largely fluctuate within 7-13%. Therefore, it can be argued that inflation surges above a certain (most likely double-digit) level do not reflect the "normal" price growth rate that is inherent in the economy of a developing country and indicates the presence of crisis phenomena.

All of these is also true for the Kazakh economy[7], where the inflation dynamics[8] is characterized by on-and-off surges up to 15-20% (see Figure 12). As a rule, this results from prevailing influence of external negative factors on pricing. Periods of high and low inflation in Kazakhstan are cyclical, which is clearly seen when the data is smoothed[9]. Under such conditions, it is rather difficult for the National Bank, as well as for most central banks in developing countries with a small open economy, to maintain inflation within the established target corridor, since the

[6] When discussing the draft Monetary Policy Strategy until 2030 in relation to the chosen target, the IMF representatives put forward recommendations for the National Bank regarding the choice of a more cautious approach. It consists in focusing on testing the acceptability of the 4-6% inflation target, and then adjusting it as appropriate. According to the IMF, achieving the target corridor of 4-6% is sufficient to ensure the necessary level of confidence in the monetary policy pursued.

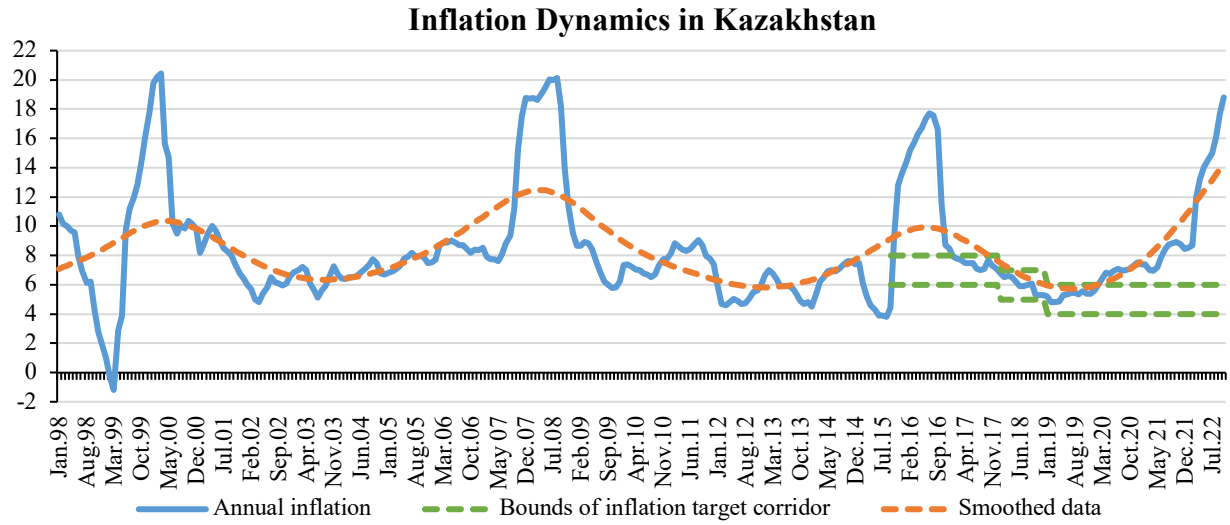
[7] According to the results of the study by Samat M., Mekenbayeva K. "Inflation and the Economic Growth: In Search of Equilibrium", the threshold level of inflation for Kazakhstan, above which there is a significant negative impact on the economic growth, is set at 9%. Exceeding this level of annual inflation by 1 pp will lead to a an economic downturn by 0.17 pp in annual terms.

[8] The monthly data on annual inflation has been used. The year of 1998 was chosen based on that starting from that period an extremely high inflation in Kazakhstan had decelerated to one-digit levels.

[9] The Hodrick-Prescott filter was used (solely for a more explicit visual picture).

influence of external factors on the price growth is mainly observed on the supply side. It must be understood that going beyond the upper bound of the corridor is permissible and will occur from time to time due to the inevitable emergence of new shocks and crisis phenomena of a local and global scale. This should not be a reason for constant revision of the set target. A change in the target should be justified only by fundamental factors, such as a change in the level of the neutral rate, costs of inflation, parameters of the transmission mechanism functioning (E.V. Sinelnikova-Murylyova, 2019).

Figure 12



Source: Bureau of National Statistics with ASPR RK, compiled by the authors

In the context of emerging shocks and crisis developments, the main task for the National Bank to focus on is achieving macroeconomic stability and taking measures to smoothly return inflation within the corridor with some regard to the economic activity. This is important in view of the fact that high inflation, as noted above, leads to the negative implications for the economy as a whole, and this factor will inevitably be taken into account when implementing a disinflationary monetary policy. At the same time, given a certain progress in terms of reducing both the general level and volatility of price growth since 2015, in the environment of macroeconomic stability (in the absence of external shocks), the National Bank is able to maintain inflation generally at a level close to the target, that is, without lengthy periods of inflation going beyond its limits.

In these periods, judging by the dynamics of inflation in Kazakhstan over the past 25 years, the rise in prices as a whole fluctuates around a certain average level, which does not change significantly. At the same time, taking into account the presence of price surges during crisis periods, the direct calculation of the arithmetic mean will be biased, i.e. overpriced. In this regard, it is better to use the median indicator, since it reflects the average level of the value of the distribution variable, which has an asymmetric shape and “heavy tails”, in a more accurate manner. The median inflation data from January 1998 to October 2022 was 7.4%. Accordingy, the value of the average historical inflation in Kazakhstan is close to this level. With reduction from a double-digit (undesirable for the economy) inflation, it can be denoted as a “first frontier”, whose achievement is necessary to ensure the price stability in Kazakhstan. This was done in 2016, when the National Bank established the first intermediate corridor at the level of 6-8%.

However, for now, despite the fact that the annual inflation rate has exceeded the highs of 2016, having successfully achieved a lower target of 4-6% (in 2018-2019), it is inappropriate to raise the target for the years to follow again closer to 7% (6-8%) and it may undermine the accumulated confidence of economic entities in the National Bank’s policy. The main negative consequences of such move were articulated by B. Bernanke – the former head of the US Fed (B. Bernanke, 2017) – and imply the declining effectiveness of communications, the increasing

conflict between the inflation goal and the mandate on ensuring the price stability, the risks of underestimating the costs of transition, heightened volatility of inflation expectations, and the risks of overheating of the economy in the context of a more eased monetary policy. Even if a target increase is fully substantiated based on fundamental factors that have been comprehensively studied over a long period, a target increase is not always justified. This, for example, is confirmed by the experience of the Bank of Canada, where, based on a five-year research work, the rationale for increasing the target from 2% to 3% was proved (Bank of Canada, 2016). However, in order to maintain the continuity of the monetary policy pursued over the years, it was decided to maintain the inflation target at 2%.

Thus, based on the above arguments and international experience, the inflation target is recommended to be kept at least at the values close to the current one (about 5%). If lower inflation rates (about 4%) are expected to be achieved in the medium term under the new target path, it is not advisable to revise the target due to the absence of significant fundamental differences from the existing corridor. Taking into account the experience gained by the National Bank, the setting of lower targets should be considered only in case of stable formation of inflation within the current corridor based on a comprehensive analysis of the changed economic situation (resulting from the consequences of the current crisis.

It is also necessary to keep in mind the following detail when setting a new target. Despite the fact that the modern economic theory and a number of empirical studies have identified inflation thresholds for developing countries that should not be exceeded in order to prevent a negative impact on the business activity, overall optimal levels of moderate price growth (for example, based on the Taylor rule or the IT rule), whose achievement is most preferable (maximizes the economic growth), has not been identified (the estimates for developed countries, as noted in the preceding sections, are quite accurate and reasonable). Most likely, this level cannot be the same for all developing countries and changes over time[10] (A. Klaus at al, 2020). This forces central banks to set a target being largely guided by their own judgements of its optimality and attainability. As a result, we observe a fairly wide range (from 2% to 8%) of targets in developing countries.

With regard to Kazakhstan's settings, from the above, we can conclude that it is important for the National Bank not so much to search for the "most optimal" target but to have a determined intention to achieve it, taking into account all factors and available experience. Setting an ambitious but hardly achievable goal will not increase the National Bank's credibility; on the contrary, it will have a negative effect on the level of confidence in the policy pursued and discredit the inflation targeting regime. That is why the choice of inflation target must be approached from all sides, based on the entire range of risks (global inflation due to deglobalization and stagflation against the backdrop of global warming, the risk of continued active fiscal expansion, and price liberalization reforms).

5. Choosing Optimal Characteristics for Inflation Goal in Kazakhstan

As part of this study, various calculations were performed to estimate the optimal inflation goal. An estimation of optimal inflation goal was carried out using 3 main methods that are based largely on the relative analysis rather than on the retrospective analysis:

1) the goal is consistent with the average weighted external target of main trading partners;
2) the goal is consistent with the forecast of external weighted average inflation;
3) the goal is consistent with the price convergence according to the Balassa-Samuelson effect.

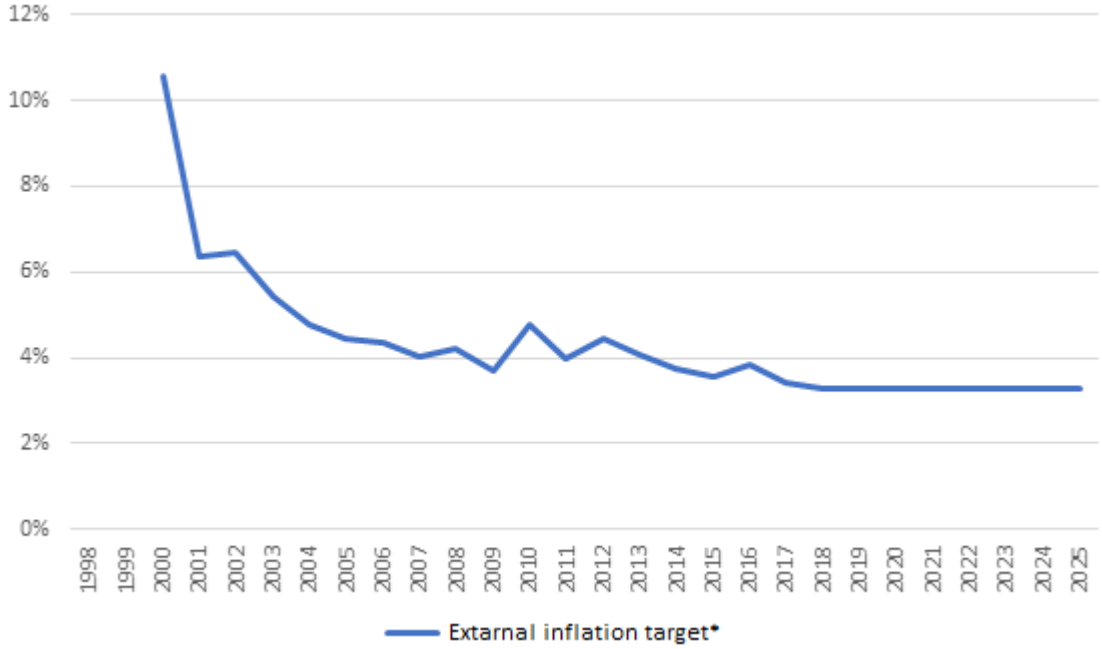
As a result of the first method, it is recommended not to change the current inflation goal of 3-4%, as it is consistent with the weighted average external inflation goal of 3.3% (Figure 13).

[10] For example, the study by A. Klaus, W. Henning entitled "Estimating the Optimal Inflation Target from Trends in Relative Prices" showed that the optimal inflation for the UK is gradually increasing over time (from 1.4% in 1996 to 2.6% in 2016). For emerging economies, the change in the dynamics of optimal inflation could be more significant

It should be noted that in this approach, a significant role is played by the high proportion of the Russian Federation and China, whose goals are just within the range of 3-4%.

Figure 13

Dynamics of Internal and External Inflation Goal

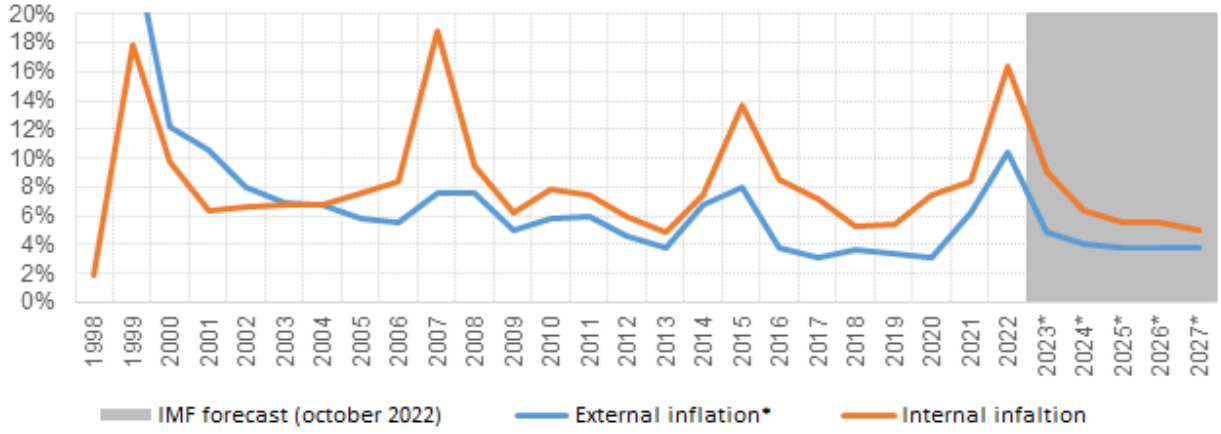


* trade-weighted values of inflation goals (excl. oil) of main trading partners
Source: IMF AREAER Database, central banks' official websites.

Since the established goals may often not be achieved, a second method was proposed with a focus on the predictive path of internal and external weighted average inflation. Starting from the beginning of the 2000s, internal inflation has consistently exceeded the weighted average external inflation, thus leading to the accumulation of REER imbalances and depreciation of the national currency (Figure 14). Based on the IMF October forecast (2022) until 2027, external inflation is projected at 4%, while inflation in Kazakhstan will reach 5% only by the end of the forecast period. Premised on this path, a much tighter monetary policy than expected is needed to achieve the medium-term inflation goal of 3-4%. Otherwise, it may be necessary to adjust the medium-term inflation goal to a more achievable indicator of 5%.

Figure 14

Dynamics of Internal and External Inflation



* IMF forecast, October 2022
** trade-weighted values of inflation goals (excl. oil) of main trading partners

At the same time, it should be emphasized that the inflation differential is not in all cases reflected in the exchange rate dynamics. Thus, if higher inflation is accompanied by higher productivity growth in the tradable sector, it is theoretically possible to observe the opposite – capital inflow-driven nominal exchange rate appreciation, as a result of the Balassa-Samuelson effect. That is, a more relative increase in the domestic labor productivity can lead to an offset of the inflation differential and a stable exchange rate.

The third method is an attempt try to estimate optimal inflation through price convergence according to the Balassa-Samuelson effect. Under this method, 2 variants of convergence were calculated: to the price level in the US and to the average world price level. In both cases, the UN median forecast until 2100 served as the basis for a long-term demographic trajectory, and the IMF forecast until 2027 of the path of macroeconomic indicators (GDP growth and inflation) served as a starting point. Further, at different sampling periods (the entire period and a more recent period since 2009), a logarithmic model was built according to the Cobb-Douglas function and an estimate of the long-term path of economic growth and labor productivity, respectively, was made from the assumption of a stable share of investments in GDP in the amount of 24.5 %. Using the obtained results of convergence of GDP per capita at PPP, price convergence trajectories were constructed and, based on the assumption of a stable purchasing power parity, the inflation path was calculated.

Table 2

Average Inflation Value and (in Brackets) the Number of Years for Convergence of Macro Indicators

Productivity Growth Rates		US			
		1.0%	1.5%	2.0%	2.5%
KAZAKHSTAN	2.0%	**3.7%** (72)	-		
	2.5%	**4.6%** (48)	**3.7%** (72)	-	
	3.0%	**5.2%** (40)	**4.6%** (48)	**3.7%** (72)	-
	3.5%	**5.9%** (34)	**5.2%** (40)	**4.6%** (48)	**3.7%** (72)
	4.0%	**6.5%** (30)	**5.9%** (34)	**5.2%** (40)	**4.6%** (48)

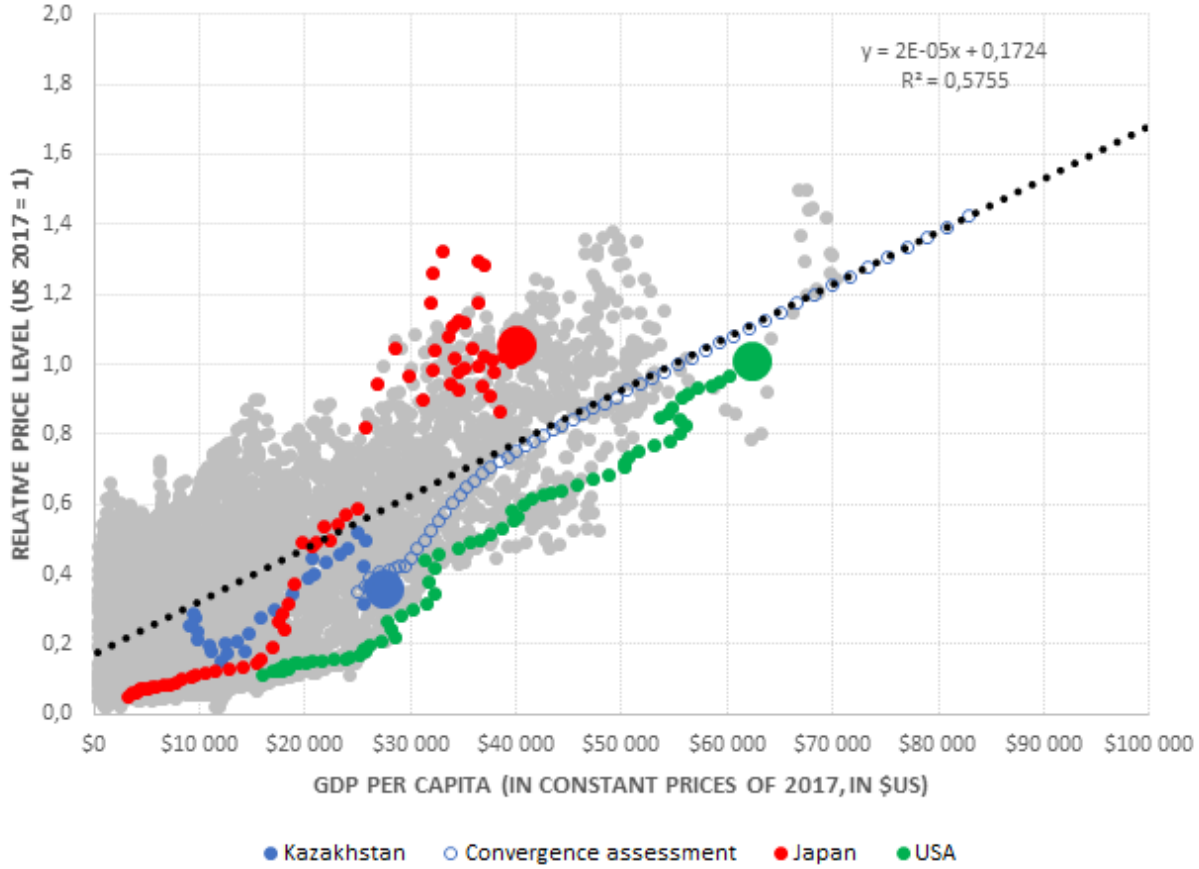
Thus, according to the first option, the convergence to the price level to the US was calculated. In the calculation across the entire sample period, the average of productivity growth rates was 3.4% for Kazakhstan and 1.3% for the US; on the sample starting from 2009, the averages decreased to 2.4% for Kazakhstan and 0.9% for the US.

Since such estimates have a high degree of uncertainty, a matrix of average inflation values was constructed at different rates of labor productivity growth in the United States and Kazakhstan, which led to the convergence of GDP per capita at PPP and the relative price level (Table 2).

Based on this table, given the current significant slowdown in productivity growth since 2009, convergence of prices to the US price level will take about 50 years, during which inflation could average 4.5%.

Figure 15

Estimated Trajectory of Kazakhstan's Convergence at GDP per Capita and the Relative Price Level to World Averages



Source: Penn World Table 10.01

Since the US may not always serve as a suitable "benchmark" for Kazakhstan, a second option was proposed, where the convergence to the world average price level was calculated. For this calculation option, we used the statistics cleared of outliers consisting of 8772 observations on 154 countries for the available period from 1950 to 2019, which revealed a significant relationship between GDP per capita and the price level; in addition, we constructed a simple estimate of this relationship in form of a trend linear regression:

$$y = 0{,}172437799 + 0{,}0000151 \cdot x \quad ,$$

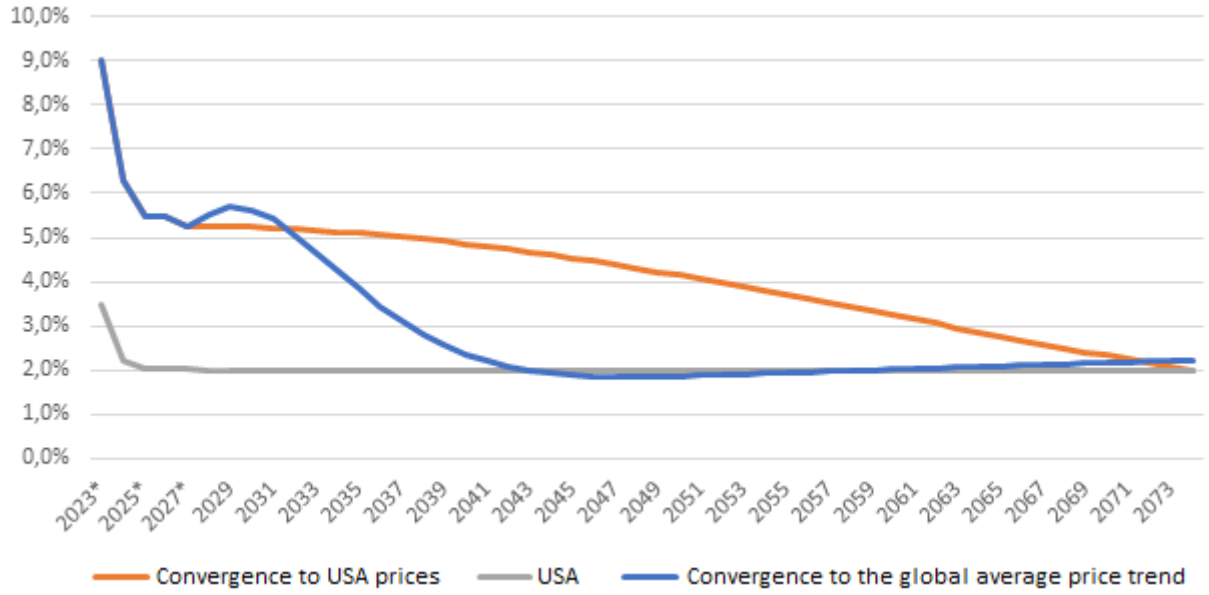
where y – is a relative level of prices to the US prices in 2017 and x – GDP per capita in constant prices of 2017 in the US dollars.

Further, based on the calculations obtained in the previous option on the convergence of GDP per capita, a new trajectory of convergence to the world average price level was estimated according to the above trend regression (Figure 15). In this case, over the same 50 years of convergence to the world average price level, inflation over the same period will be about 3% on average.

However, it should be understood that the estimates are given for a generally long period (during which the inflation dynamics slows down to 2%) that is beyond the horizons of the monetary policy strategic planning. Therefore, based on the trajectory of price convergence, it is possible to build inflation dynamics over the entire period of convergence, which will enable to estimate the optimal and achievable medium-term inflation goal (Figure 16).

Figure 16

Estimation of Inflation Dynamics Based on a Different Trajectory of Price Convergence According to the Balassa-Samuelson Effect



** IMF forecasts, October 2022*

Based on the estimated dynamics of the "status quo" scenario for both options, by the end of 2030, the optimal inflation goal is estimated at about 5%. The subsequent long-term dynamics depending on the trajectory of price convergence varies greatly.

The results of all three methods estimating the optimal inflation goal by 2030 are shown in the table below (Table 3).

Table 3

Aggregation of Results

	by 2030
The weighted average of external targets	3-4%
External inflation forecast (IMF)	4%
Internal inflation forecast (IMF)	5%
According to Balassa-Samuelson	5%

6. Key Findings and Recommendations

Based on the analysis of studies, a review of international experience of countries that have moved to inflation targeting, the experience of the National Bank, as well as estimates of the optimal target, a number of important assumptions and recommendations can be hihglighted that should be taken into account when setting an inflation target.

Studies have not shown a positive effect on the economic growth from bringing inflation closer to the threshold level in developing countries. This means that theoretically the central bank of a developing country can set any target that does not exceed "undesirable" threshold levels (7-13%)

Higher economic growth rates and the potential to increase factor productivity imply higher inflation in developing countries, which in turn leads to a difference in the optimal level of inflation in developing and developed countries. Thus, a slowdown in inflation is fundamentally inevitable as it approaches the level of prosperity of developed countries and vice versa.

In setting inflation targets, developing countries should take into account the inflation targets of major trading partner countries and the differential in external and domestic labor productivity.

The most common (and probably optimal for potential anchoring of inflation expectations) among developing countries is a point target with a tolerance band of +/-1%.

The use of a gradually decreasing target corridor is not mandatory and may weaken the National Bank's signal regarding the achievement of the final inflation target (especially in the event of the target revision). In this regard, from the point of view of improving communication and the capabilities of anchoring of inflation expectations, it is recommended to consider the possibility of establishing a single medium-term point target for the entire horizon.

The median value of annual inflation in Kazakhstan is close to 7%. However, given the National Bank's experience in achieving lower inflation and possible negative consequences, overestimating the target closer to the median level is inappropriate.

The target should be achievable based on the National Bank's experience and the specifics of conducting monetary policy in the context of the Kazakh economy (susceptibility to external shocks, non-monetary factors of inflation, limitations in the transmission mechanism, etc.). Other things being equal, the choice should be made in favor of a higher yet achievable goal. This will make it more likely to anchor the expectations of economic entities.

According to estimation results, the optimal inflation goal by 2030 is at about 5%. However, these estimates can only serve as an additional reference when setting inflation targets, as they do not take into account the full range of structural risks in ensuring the price stability.

Inflation target should not be revised frequently (the timing of a possible revision should be strictly specified in the monetary policy guideline), as this leads to a significant reduction in confidence in the policy pursued by the central bank. Inflation going beyond the target is acceptable in the current structure of the Kazakh economy and will periodically occur as a result of emerging temporary shocks, which need to be responded to not by revising the target but rather with the help of monetary policy instruments.

The paramount objective of a central bank is to ensure the stability of prices and inflation expectations. The search for the most optimal goal is secondary, as it depends on many factors, including the choice of estimation methodology. It is noteworthy that this study used estimation methods at the macroeconomic level only, without taking into account the structure of the economy at the microlevel. Further prospects for research in this area may include estimates of the impact of the CPI structure on the choice of inflation goal.

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Inflation Targeting, Monetary Policy and the Transition Back to Target in Kazakhstan

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Joep Konings – Professor, Nazarbayev University Graduate School of Business

The paper provides the results of analysis of inflation targeting, monetary policy and the transition back to inflation target in Kazakhstan. On the one hand, the NBK has an announced inflation target corridor, with a phased reduction, from 4-6% in 2021-2022, 4-5% in 2022-2023 and to 3-4% from 2025 onwards. On the other hand, actual inflation is well above target, at 20.7% in January 2023, albeit expected to fall sharply in the coming year.

The key findings of the study can be summarized as follows.

(i) Most central banks around the world have adopted a specific inflation target. While most developed economies tend to target inflation at between 2 and 3 percent, developing and emerging economies tend to have a higher inflation target.

(ii) More than half of emerging and developing economies (EMDEs) have inflation well above the inflation targets. Short-term inflation expectations have adjusted accordingly. In 40% of the EMDEs, the policy rate has been revised upwards recently.

(iii) There are various reasons why it may be optimal to have an inflation target above zero, including the zero lower bound on nominal interest rates; and biases in measured inflation. We focus on the most relevant ones for emerging economies: financial market frictions, inefficiency in public finances and taxation (resulting, for example, from a large informal economy), firm heterogeneity and imperfect competition.

(iv) Based on models that take into account competition in product markets, the size of the informal economy, and the state of financial development, the report concludes that the optimal inflation target for a country like Kazakhstan is likely to be significantly higher than for economies like the US, UK or euro area, which have inflation targets centered around 2%. While the models are stylized, an inflation target centered around 5% (consistent with the NBK's 2021-2022 target) is consistent with the findings.

(v) In order to analyze the transition from the current high inflation rate to the inflation target, this report employs the use of optimal policy analysis and concludes that a strict adherence to even achieving the 5% target (let alone the medium-term target of 3-4%) would entail significant output costs of the economy.

We highly appreciate the research input by Joris Hoste and Elzhas Kadyr. Our thanks to Yerken Turganbayev for his translation effort. We also express our gratitude to a team of NBK experts for their proposals and feedback.

Key Words: inflation targeting, monetary policy.
JEL-Classification: C55, E31, E12, E52, E58.

1. Preamble

Inflation targeting is a key component of monetary policy of most central banks across the world. In this way, central banks announce their goal of achieving a specific and stable annual rate of inflation. The European Central Bank sets an inflation target of 2% for the euro area. The US Federal Reserve, the Bank of England and the Bank of Canada also set a 2% target. In fact, most central banks in advanced countries have all converged to a 2% inflation target. In contrast, emerging and developing countries tend to set a higher inflation target. For instance, China has a target of around 3%, Russia of 4% and Turkiye – 5% (see Table A1).

Factors that inspire a particular inflation target are related to the underlying structure of the economy and the transmission mechanisms of shocks, which explains why emerging and developing countries may want to opt for a different inflation target. Ultimately, inflation targeting is an instrument to achieve a rule-based and credible monetary policy such that inflation remains under control. High inflation is often associated with low growth, balance of payments crises, reduced investment and savings. In emerging and developing economies, high inflation can

especially hurt the poor who allocate a relatively larger fraction of their budget to food expenditures (Comin et al. 2021) and food is often imported (see Colicev, Hoste and Konings 2022). Thus, striving for low and stable inflation has become a prime policy objective.

The US Fed policy is typically modelled as following a Taylor rule (Taylor, 1993):

$r_t = \phi_\pi(\pi_t - \pi_t^*) + \phi_y(y_t - y_t^*)$,

where r_t is the policy rate, π_t — the actual inflation rate, π_t^* — the target inflation rate, y_t — the actual GDP level, and y_t^* — the potential GDP level, such that the last term in this equation refers to the output gap. Depending on the weights ϕ_π and ϕ_y the policy rate will increase if inflation is above target, or when the economy overheats. Clarida et al. (1999) estimate that the Fed employed a Taylor Rule with $\phi_\pi = 2.15$ and $\phi_y = 0.93$ in the post-Volcker era.

In this Report, we study inflation and optimal inflation targeting with particular attention to the case of Kazakhstan. In section 2 we discuss determinants of inflation targets. We start by discussing inflation targets in developed and developing countries and discuss the key determinants of having an inflation target above zero percent. Then we discuss the relationship between inflation targets, inflation and expectations as well as arguments for and against adjusting inflation targets. In section 3 we turn to modelling inflation targets and a toolkit to simulate monetary policy experiments. In section 4 we adapt our models to Kazakhstan. Section 5 contains conclusions.

2. Determining Optimal Inflation Targets

2.1. Inflation Targets in Developed and Developing Countries

Most central banks around the world have adopted a specific inflation target. Table A1 in the Appendix shows that while most developed economies tend to target inflation at between 2 and 3 percent, developing and emerging economies tend to have a higher inflation target. The National Bank of Kazakhstan has set an inflation target of 4-6% for 2021-2022 and gradually wants to reduce it to 4-5% in 2023-2024 and to 3-4% in 2025[1].

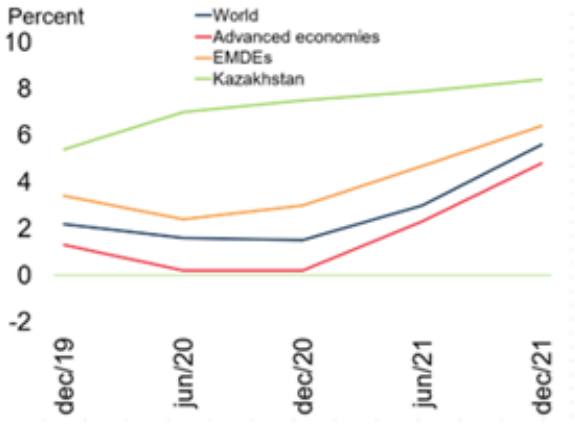
In 2021, global inflation has reached its highest level since 2008 (Figure 1, panel A), in most countries rising well above inflation targets, including Kazakhstan. More than half of the emerging and developing economies have inflation well above the inflation targets set by their country as illustrated in Figure 1, panel B. Short term inflation expectations have adjusted accordingly (Figure 1, panel C). This is not surprising. As inflation has increased and is persistently staying well above target, inflation expectations have also adjusted. In about 40% of emerging and developing economies (EMDEs), policy rates have been revised upwards between 2018 and 2021 (Figure 1, panel D).

[1] https://www.nationalbank.kz/en/links/dkp

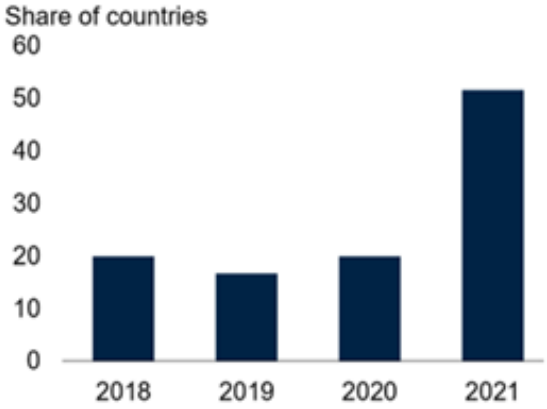
Figure 1

Recent Trends in Inflation, Targets and Expectations

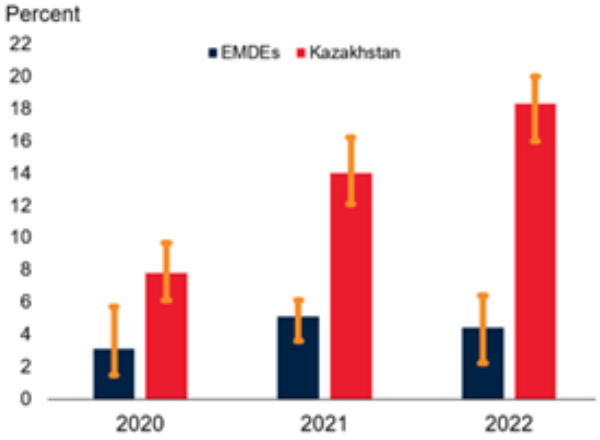
Panel A. CPI Inflation, Year on Year



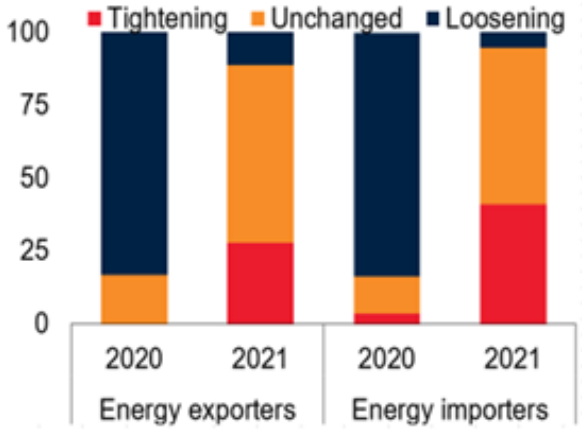
Panel B. Developing Countries with Inflation above Target



Panel C. Short-Term Inflation Expectations in EMDEs and in Kazakhstan



Panel D. Shifts in Monetary Policy in EMDEs



Source: Ha et al. (2022) and own computations

2.2. Optimal Inflation Targets: Theory and Evidence

Early models of the monetary transmission mechanism predict optimal inflation targets of at most zero percent per year. This became known as the Friedman rule (Friedman, 1969) which implies that the optimal monetary policy, defined as the one that maximizes consumer surplus, is given by a nominal interest rate of zero percent. Schmitt-Grohé and Uribe (2010) shows that both money demand, to overcome transaction costs, and sticky prices, the two main sources of monetary non-neutrality, give rise to an optimal nominal interest rate equal to zero. Because the nominal interest rate is the sum of the expected inflation rate and the real interest rate, which reflects the positive marginal product of productive investment, this implies a negative or zero optimal inflation target. For instance, if one expects that the return of a productive investment or the real interest rate was 2 percent, then a zero nominal interest rate implies an inflation rate of -2%.

The zero-lower bound (ZLB) on nominal interest rates, downward rigidity in nominal wages, and a quality bias in measured inflation, are often referred to as arguments for the desirability of inflation targets slightly above zero. In recent years, a number of authors have argued that financial market frictions, taxation issues and firm heterogeneity are other important factors to deviate from zero inflation targets. We discuss them in more detail next.

2.2.1. Financial Market Frictions

Targeting core inflation enables monetary policy to maximize welfare by replicating the flexible price equilibrium in closed or open economy models with complete markets. In Section 3.4, below, we calibrate the stylized financial frictions model of Brunnermeier and Sannikov (2016) to the economy of Kazakhstan. Anand et al. (2015) develop an open economy model with incomplete financial markets to show that headline inflation targeting (rather than core inflation) and thus including imported price-inflation, improves welfare outcomes. This is particularly relevant for EMDEs.

When financial markets are frictional, i.e. when financial intermediaries require risk premia to intermediate trades in different currencies, targeted foreign exchange (FX) interventions are needed as a complementary tool to be able to implement the optimal monetary policy (see Itskhoki and Mukhin, 2022). Frictions in financial markets limit the extent to which international risk sharing can occur and these need to be offset by FX interventions. To implement a particular inflation target it allows monetary policy to use the base rate for reducing inefficiencies in domestic goods and input markets. For instance, Bhatti (2014) shows that short-run deviations from the uncovered interest rate parity are important in Kazakhstan, which point to important risk sharing wedges in international financial markets.

2.2.2. Tazation, Public Finances and Informal Economy

The Friedman rule of a zero nominal interest rate has been a topic of much debate early on in the context of inefficient tax systems. That is, when ordinary taxes are costly to implement the Friedman rule breaks down as shown by Vegh (1989) and Aizenman (1983). Nicolini (1998) develops a simple model to study the public finance effects of tax evasion. He shows that if the economy is characterized by a large informal sector, where cash is used for transactions, the optimal inflation rate is higher than would in the absence of tax evasion. This is because higher inflation erodes real incomes and thus acts as an indirect way of taxing the underground economy. In section 3.3 we calibrate the model of Nicolini (1998) for Kazakhstan.

2.2.3. Firm Heterogeneity, Production and Structure of the Economy

Firm heterogeneity across matters not only for aggregate import exposure, but Adam and Weber (2019, 2022) also show how heterogeneity across firms and the entry of new firms (products) and the exit of incumbents can lead to a higher optimal inflation. They distinguish between two channels that might give rise to a deviation from a zero-inflation target. First, when entrants are more productive or have higher quality goods relative to incumbents, their relative prices should be lower than those of incumbents. Under nominal pricing frictions, it is costly for incumbents to change prices. Therefore, the optimal policy implies for new firms to set prices below the average price level of incumbents, thus creating negative inflation or deflation. Second, when the experience gains for incumbents are large, relative prices of incumbents should be lower relative to those of entrants. Hence, this channel implies for positive inflation by making new entrants charge relatively higher prices compared to the average price level for incumbents. Depending on the relative strength of each channel, the optimal inflation rate will be either positive or negative. Firm heterogeneity and the product life cycle are factors which have largely been ignored so far in discussions of optimal inflation targets. In section 3.2 we use the Adam-Weber model to estimate optimal inflation in Kazakhstan using data on the product life cycle in retailers.

Firm heterogeneity also matters for understanding the channels of how shocks affect inflation through differences in markups between firms, thus when taking into account market power. As shown by Amiti, Itskhoki and Konings (2019), large firms with market power tend to adjust markups in order to keep prices stable, while small firms with no market power tend to pass-through cost shocks into prices immediately. Thus, while this shows that inflation dynamics will depend to a certain extent on the degree of market power in an economy and thus the size distribution of firms, there has not been any work that links market power to the optimal inflation target. However, in a monopolistic economy with sub optimal investment, a positive inflation

target may trigger more investment. We discuss this in more detail in the context of Kazakhstan in section 3.1.

2.3. Adjusting Inflation Targets and Expectations

2.3.1. Anchoring Inflation Expectations

Besides setting an appropriate inflation target, central banks also need to ensure that inflation expectations are well-anchored around the inflation target. This is for two reasons. First, current inflation depends in part on what households and firms expect about future inflation. If households and firms expect inflation to rise above the inflation target, inflation today will already rise as agents anticipate the higher expected inflation and act accordingly. Second, during the period of persistently low inflation in the US and Europe, forward guidance was introduced as a complementary policy tool alongside the manipulation of the short-run policy rate. Forward guidance is complementary to manipulating the base rate as forward guidance tries to steer the long run expectations about inflation. In turn, changes in long run inflation expectations feed back into decisions today. For this reason, the efficacy of monetary policy depends critically on inflation expectations.

Long-term inflation expectations in EMDEs are not as well anchored as those in advanced economies, despite notable improvements over the past two decades. First, Ha et al. (2022) find that in emerging economies the sensitivity of inflation expectations to shocks is higher than in advanced countries. Based on an econometric analysis they find that for every one percentage point higher inflation surprise, expectations are revised up by roughly 0.2 percentage points six months later. As inflation tends to be more sensitive to both domestic and global inflationary shocks, predicting future inflation becomes harder. Combined with less transparency about the inflation target or its rule-based implementation, this increased uncertainty can lead to unanchored expectations. Second, Coibion et al. (2020) highlight that actively managing inflation expectations faces an important constraint as the surveys of inflation expectations that are currently accessible tend to be of low quality. Without good data on actual expectations, managing them becomes difficult.

These points also illustrate that there are several ways to ensure that inflation expectations are well-anchored. First, conducting extensive, nationally representative surveys of households', firms' and financial market participants' inflation expectations is a necessity. It has been demonstrated that the survey-based inflation expectations of households and professionals assists in estimates of future inflation (Ang et al. 2007). Macroeconomic researchers have also emphasized the significance of one particular group of agents, financial market participants' inflation expectations. For instance, Bernanke and Kuttner (2005) show that inflation expectations have an impact on asset prices, such as stock prices and interest rates. Second, Davis (2014) shows that the adoption of inflation targeting can decrease the sensitivity of 12-month inflation expectations to oil price shocks and shocks to observed inflation. De Pooter et al. (2014) use market-based measures of inflation expectations for Brazil, Chile, and Mexico to show that long-term inflation expectations became better anchored in these countries over the previous ten years, particularly in Chile and Mexico. They attribute this outcome to recent increases in the credibility of the central banks of these countries, despite the fact that they do not directly test for the role of inflation targeting. Therefore, the likelihood that inflation expectations are firmly anchored increases with how credible individuals and businesses view the central bank.

At the same time, this last point implies that changing the inflation target requires that these announcements are made in a transparent and credible way such that inflation expectations remain well-anchored. It is clear from Figure 1 that inflation expectations do adjust when inflation targets are missed and strong adjustment of expectations make it harder to bring inflation down without serious economic costs.

2.3.2. Adjusting the Inflation Target

The recent rise in inflation around the world has stirred a debate about optimal inflation targets and whether inflation targets should be adjusted upwards. Clearly, the key concern of

adjusting the inflation target is the impact on expectations and central bank credibility. However, only a decade ago, in the aftermath of the financial crisis, a different but related debate emerged. For years, inflation was zero or even negative resulting in interest rates close to or at the zero lower bound ZLB in most advanced economies. This resulted in the inability of central banks to effectively use traditional monetary policy instruments, such as the policy rate, to stimulate the economy in future downturns. Raising the inflation target to remedy this problem has been proposed by Blanchard et al. (2010) and Summers (2018) amongst others. A wide literature has also emerged on what the inflation target should be (e.g. Adam and Weber, 2019). L'Huillier and Schoenle (2019) argue that when raising the inflation target, it is important to consider that firm pricing behavior will also adjust. In particular, firms adjust prices more frequently in a high-inflation environment than when inflation is low. This, in turn, results in less effective monetary policy as the real economy becomes disconnected from nominal variables. For instance, Amiti, Itskhoki and Konings (2014, 2022) show a disconnect between exchange rate shocks and prices.

While the arguments to raise the inflation target may make sense in a zero-inflation environment as argued above, in recent years, developed economies have also moved from a low to a high inflation environment. Thus, the argument to adjust the inflation target upwards becomes less clear and the obvious risks related to expectations and credibility emerge. However, recent work by Alves and Violante (2022) shows that even with rising inflation, it may be optimal to adjust towards a higher optimal inflation target than the traditional 2 percent used by the ECB and the Fed. They argue that the distributional impact of moving towards a low inflation target is disproportionately falling on the low-income groups, who are more likely to lose their job when there is a tightening of monetary policy to bring down inflation to its low target level. This depends on the monetary policy framework adapted by central banks. For instance, the FED's new monetary policy framework includes a goal of maximum employment, which is a broad-based and inclusive goal. A hot economy brings benefits to low-income communities and policy is informed by shortfalls of employment from its maximum level. They suggest an adjustment of the optimal inflation target to 4%.

2.4. How Does Inflation Targeting Work in Central Banks?

In practice, the central bank makes a forecast of inflation and compares it with target inflation, which is the one the government believes is optimal for the economy. The difference determines then how monetary policy needs to be adjusted. Some countries use a symmetrical range around a mid-point while others have identified one target rate or an upper limit to inflation (see Table A1). Typically, elements of a rule based monetary policy and discretionary policy are applied. A precise inflation target is used in the medium term; while in the short-term responses to economic shocks are applied. Thus, rather than focusing on achieving the target at all times, the approach is about achieving the target in the medium term, usually considered as a two-to-three-year time horizon. This provides some options for the government to smooth output in the short run. The inflation target typically is a function of the structural features of the economy and the key factors behind these choices are the ones discussed in previous sections. They all relate to providing a stable price environment in the economy and more recently inclusive growth (in the US).

The first country to adopt inflation targeting was New Zealand, in December 1989. Armenia, the Czech Republic, Hungary, and Poland adopted inflation targeting while they were making the transition from centrally planned to market economies. Several emerging market economies adopted inflation targeting after the 1997 crisis, which forced a number of countries to abandon fixed exchange rate pegs (Jahan, 2010).

Inflation targeting seems to have been more resilient in turbulent environments. Recent studies have found that in emerging market economies, inflation targeting seems to have been more effective than alternative monetary policy frameworks in anchoring public inflation expectations. In some countries, notably in Latin America, the adoption of inflation targeting was accompanied by better fiscal policies. Often, it has also been accompanied by the enhancement of technical capacity in the central bank and improvement of macroeconomic data. Because inflation

targeting also depends to a large extent on the interest rate channel to transmit monetary policy, some emerging market economies also took steps to strengthen and develop the financial sector. Thus, the monetary policy outcomes after the adoption of inflation targeting may reflect improved broader economic, not just monetary policy-making.

3. Optimal Inflation Target in the Context of Elements of the Inflation Targeting

In this section, we focus on several key determinants rationalizing a positive optimal inflation target. In doing so, we provide evidence and new estimates of optimal inflation targets for Kazakhstan. This will allow us to analyze the consistency of the inflation target in the context of the current economic conditions, discuss how an inflation target is best set bearing in mind the ability of monetary policy's objective to maintain price stability and assess the role of anchoring long-term expectations.

We will focus in on the following key determinants of inflation and optimal inflation: (i) the role of market power, (ii) firm and product heterogeneity in the economy, (iii) taxation, public finances and the informal economy, and (iv) financial development (frictions).

3.1. The Role of Market Power

The effectiveness of monetary policy typically depends on the structure of the financial system and the expectations of consumers and businesses. However, the extent of corporate market power is typically overlooked while it can potentially matter substantially for inflation and inflation targets. Market power has risen in many developed and emerging economies in recent years, usually measured as markups, i.e. the ratio between the price of goods and services to its marginal cost of production. While inflation has been increasing, there is disagreement amongst economists that this has been driven by the rise in market power observed in recent years. As shown by Amiti, Itskhoki and Konings (2019), firms with high market power are able to adjust their markups when there is an unexpected cost shock and hence pass-through is limited, limiting the extent of cost-push inflation. As Robert Hall pointed out in a recent debate[2], "The proposition is an elementary confusion of levels and changes – market power causes high prices, not rising prices."

While market power or the rise of it may not be an important driver of inflation, the presence of monopoly power, however, may be a reason to have a positive inflation target set by monetary policy. The intuition is straightforward. Firms with market power typically constrain output below the level of the welfare maximizing optimum (when there is perfect competition). Monopoly power may also result in lower investment rates. Thus, central banks have an incentive to try to offset this by heating up the economy, hence having a positive optimal inflation, which would create an incentive for firms to invest more and expand output, rather than storing cash. While this argument makes sense intuitively, so far there has been no work, showing this more formally.

In Table 2 we provide evidence of markups in Kazakhstan relative to the rest of the world in 2016 and Figure 2 shows the evolution of markups for Kazakhstan. The average firm markup in Kazakhstan is 1.62, which is higher than the global average, but comparable to Europe. We can also note from Table 3 and Figure 2 that the markup has been increasing over time, which is consistent with the rise in global markups in the U.S. and elsewhere. While there is no clear evidence whether markups are driving inflation, in fact, it may actually result in a flatter Phillips curve as firms can absorb shocks more easily, the extend of market power may matter for the transmission mechanism of monetary policy as recently shown by the IMF (Duval et al., 2021). Consistent with the idea of incomplete pass-through and sticky prices, they find evidence that firms' market power weakens the response of their output to monetary policy shocks. The fact that some firms have market power, while typically smaller and young firms have less market power and face often also more financial constraints, suggests it is important to consider the heterogeneity

[2] https://cepr.org/voxeu/columns/inflation-market-power-and-price-controls-views-leading-economists

of firms in the economy to think about inflation targets. We take this as our starting point for estimating optimal inflation targets in the next sub-section 3.2.

Table 2

Countries: Average Markups

Average Markups	2016
Kazakhstan	**1.62**
Global Average	1.59
Europe	1.64
Denmark	2.84
Switzerland	2.72
Italy	2.46
United Kingdom	1.68
Norway	1.6
France	1.5
Sweden	1.31
Germany	1.35
Austria	1.33
North America	1.76
United States	1.78
Canada	1.53
Mexico	1.55

Source: Own calculations based on firm level data from the Statistics Agency of Kazakhstan and De Loecker and Eeckhout (2018) firm-level data.

Table 3

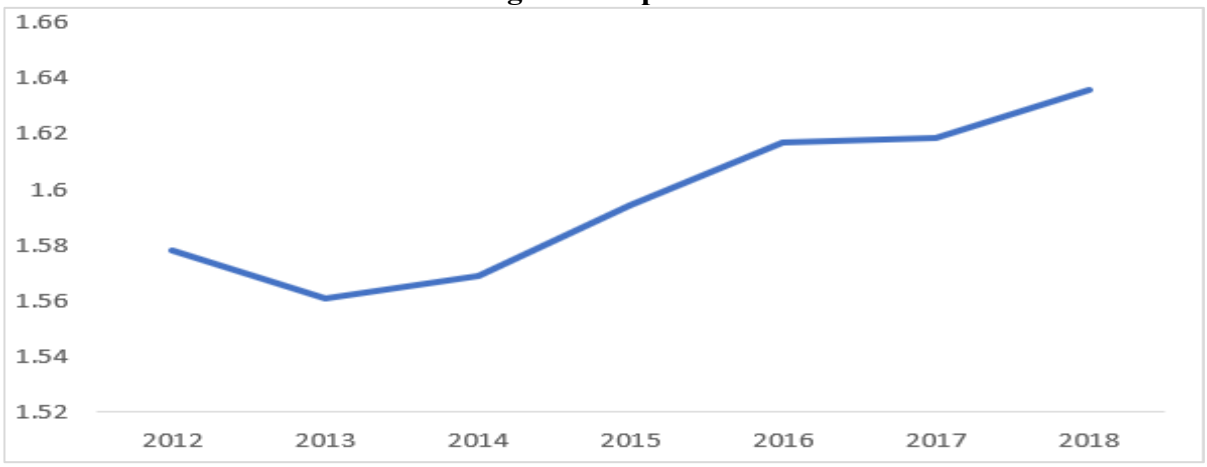
Evolution of Markups in Kazakhstan

Year	Average Markup	Aggregate Markup
2012	1.578251	2.347053
2013	1.560932	2.268597
2014	1.56898	2.262415
2015	1.594093	2.621403
2016	1.61694	2.620286
2017	1.618505	2.683433
2018	1.636033	2.878247

Source: Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan. The aggregate markup is computed by the sum of the weighted markup with weights in sales.

Figure 2

Average Markups in Kazakhstan



Source: Own estimates based on data from the Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan, firm level data (1-PF data employment more than 100)

3.2. Heterogeneity and Estimating Optimal Inflation Targets in Kazakhstan

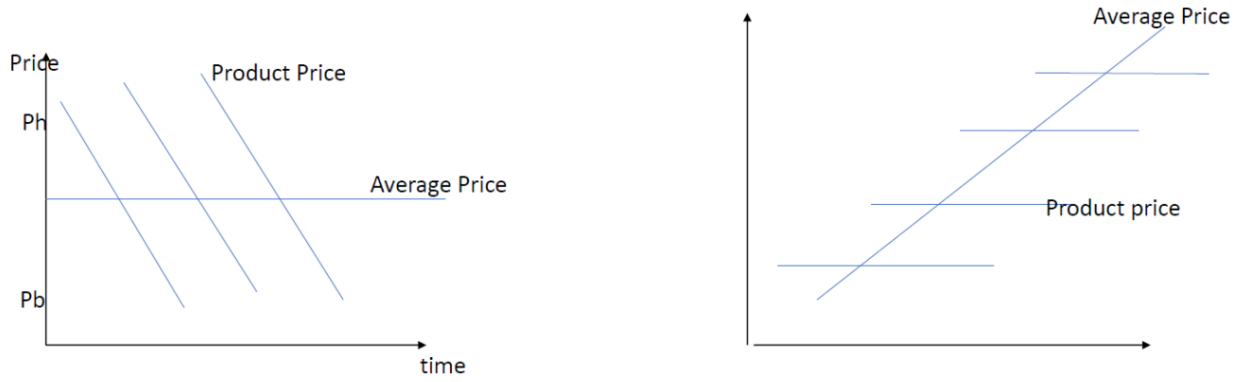
3.2.1. Adam-Weber Model (2022)

In this section, we estimate optimal inflation for Kazakhstan using the framework of Adam and Weber (2022). Their approach starts from the observation that for most expenditure items in the Consumer Price Index, the price of the individual products declines over the product life cycle, when measured relative to the average product price of the expenditure item. They show that it is closely related to the fact that there is substantial product turnover. Typically, new products are initially expensive and become relatively cheaper over time. There is also high heterogeneity in the average rate of the decline in relative prices over time, with some product items having a faster relative decline than others.

In earlier work for Kazakhstan, Colicev, Hoste and Konings (2022) have shown that pass-through of cost shocks into consumer prices takes time, consistent with sticky nominal prices. Adam and Weber (2022) show that when there are sticky nominal prices combined with substantially falling relative prices of incumbents, a positive inflation target is optimal. Importantly, they show that this optimal inflation can be estimated when relative product prices are available in combination with the age of the product. The intuition is given in Figure 3. The left panel shows the scenario when prices are fully flexible. There are three products entering at different times. Initially products set a high price, but over time, they lower their price. They set initially a high price because the costs to produce new products are initially higher, but over time costs drop and therefore prices drop. With constant entry and exit rates of products, the left panel in Figure 3 shows that in the cross-section we would have a constant average price in the economy, which suggests no inflation or a zero optimal inflation target. The right panel shows sticky prices, for each product entering, the price is fixed over time. Each new product that enters, will enter at a higher price which then stays the same until it exits. In the cross section, this implies an increasing average price and hence a declining relative price of old versus young products. An increasing average price implies a positive optimal inflation. It generates the same effect as in the left panel, i.e. relative prices declining as products are older, but in the left panel it is generated when prices are fully flexible, while in the latter when prices are sticky, which is the more realistic scenario.

Figure 3

Relative Price Trends and Inflation



Adam and Weber (2022) show that the optimal inflation rate can be computed using the following formula, which is correct up to the first-order:

$$\sum_{s=1}^{S} \emptyset_s \frac{\pi_s}{\pi} \ln(b_s) \quad (1)$$

$$ln\frac{P_{jst}}{P_{st}} = f_{js} + \ln(\boldsymbol{b_s}) \,.\, s_{jst} + u_{jst} \quad (2)$$

In equation (2) subscript *j* refers to the product, *s* refers to the product category and *t* to time. *P* stands for price, so $ln\frac{P_{jst}}{P_{st}}$ — the relative price of product *j* in category *s* (for instance, yoghurt in the category of dairy products). The age of the product is given by s_{jst}, and f_{js} — is a product fixed effect, which may capture quality differences. We use product scanner data to estimate (2). The estimated coefficient, $\widehat{\ln(\boldsymbol{b_s})}$, reflecting how relative prices respond to the age of the product is then used in (1) to construct the optimal inflation target. It measures the average growth rate of the relative product price over the product lifetime in a category. In (1) $\frac{\pi_s}{\pi}$ refers to the actual growth in prices of products in category s relative to the overall growth in prices. This thus captures the heterogeneity of different product categories in the speed at which they change relative prices. Finally, $\emptyset_s$— is a weighting factor capturing the share of sales of each category in total.

3.2.2. Data

We consider three different scanner data, with price on individual products, from two sources: data from the Metro retail chain and from AC Nielsen data. The AC Nielsen monthly dataset covers the period from January 2014 to December 2016 and from September 2019 to September 2022. The total number of product categories in the data from 2019 to 2022 is 61. Each product category contains data for the top 30 stock keeping units (SKUs) (based on the total sales value of the latest 12 months). There are three main divisions: Food, Drugs, and Cigarettes. The Metro data is a weekly dataset that covers the period from January 2014 to December 2017. The data contains 205 product categories. There are eight main divisions: Alcoholic Beverages and Tobacco, Clothing, Electronics, Food, Home, Housekeeping, Non-alcoholic beverages, and Other. Thus, the latter data set is more detailed[3]. Tables A2, A3 and A4 in the appendix show some summary statistics for the set of products and product categories for the Metro data.

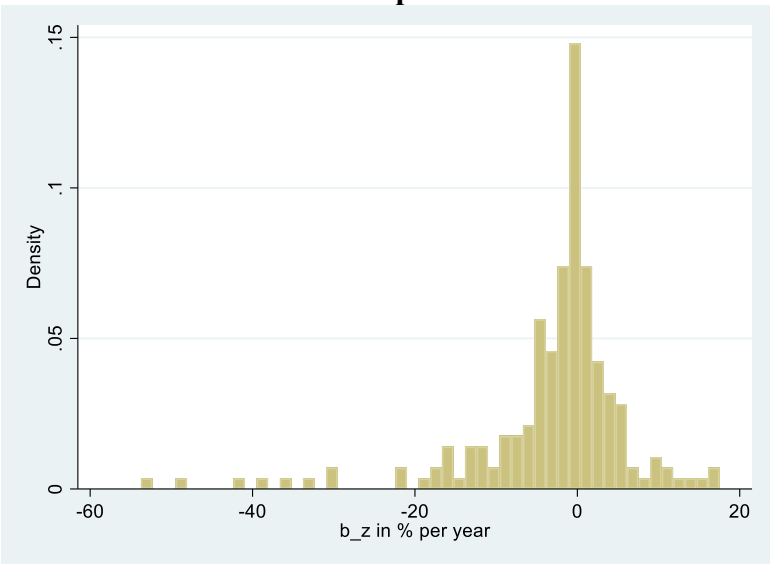
[3] See Colicev, Hoste and Konings (2022) for more details on the Metro data set.

3.2.3. Estimation Results

Figure 4 shows the distribution of product category-level estimated slope coefficients, weighting coefficients by their expenditure weight in the sample. We only show the graph for the Metro sample as the results are qualitatively similar for the two other AC Nielsen samples. To ease interpretation, figure 4 shows the estimated b_s coefficients in terms of annualized net growth rates in percent, $100(b_s^{12}- 1)$. We can note that there is quite a bit of heterogeneity with most of the distribution of the product-age coefficient negative or close to zero. Table 5a reports these estimated product category price trends together with the product category-level expenditure weights for the year 2017.[4] The observed rates of relative price trends range from 1.59 percent (for blue cheeses) to -5.28 percent per year (for tobacco products). Taken together, out of the product categories with a sufficient number of observations, 111 product categories have an estimated rate of relative price change over the product lifetime, which is negative.

Figure 4

Distribution of Estimated Slope Coefficients across Items



Source: Metro data (2014-2017). Own calculations

Table 5

Relative Price Changes over the Product Lifetime for Category

Category	Relative Price Trend (% per year)	Exp. Weights in 2017 (% per year)	Number of Items
Alcoholic Beverages & Tobacco	0.07	10.89	13
Clothing	-0.02	1.612	12
Electronics	-1.24	0.682	13
Food products	-0.05	53.84	88
Home appliances	-0.29	10.01	51
Housekeeping	-0.05	11.79	20
Non-alcoholic Beverages	0.08	9.469	7
Others	-0.02	1.683	2

Source: Metro data (2014-2017). Own calculations

Based on the results of estimating (2) and the empirical counterpart of (1) we can now compute the optimal inflation target (for details see Adam and Weber, 2022). Table 6 summarizes the results for the three samples, where we report separately the results for the year 2014 and the other years. Up to August 2015, the monetary policy regime in Kazakhstan was very different as it had a fixed exchange rate regime, which moved to a float in August 2015. This can be considered

[4] Some of items are removed, due to small number of observations.

as a structural break, which motivates separate reporting. There is some variation in the resulting estimates, ranging from 4.1% to 5.2%. Given the broader scope of the Metro scanner data, this may be a more accurate estimate compared to the results based on the AC Nielsen data. Taking the different time periods into account, it seems that it is fair to say that a consensus estimate would be around 5%. It is also clear that the estimated inflation target has increased between 2014 and later periods. The estimates for 2014 indicate an inflation target of between 1.4% and 1.8%, which is not surprising given the fixed exchange rate regime. The estimated inflation target increases afterwards, which is intuitively plausible.

Table 6

Optimal Inflation Targets in Kazakhstan based on Own Estimations

Data Set	**Optimal Inflation Target**
Metro Scanner Data	
2014	*1.5%*
2015-2017	**5.2%**
AC Nielsen Scanner Data	
2014	*1.8%*
2015-2016	**4.1%**
2020-2021	**5%**

3.3. Public Finance, Informal Economics and Optimal Inflation Target

While the previous section suggests an optimal inflation target of 5% for Kazakhstan, there are other reasons why the inflation target may be positive, which have not been considered in the set up in previous sub-section. One important friction is the inefficiency of the tax collection system or the size of the informal economy. We explore in this section the implications of an informal economy on the optimal inflation target.

The intuition is straightforward. In the underground economy transactions are more often carried out with cash. By definition, the government cannot effectively tax such transactions which results in reduced government income to finance government expenses. Inflation may then be an indirect way of taxing the underground economy (since inflation represents a tax on holding cash).

We use the model developed by Nicolini (1997) to estimate the optimal inflation rate for Kazakhstan. The model assumes a representative consumer who purchases goods from the formal and as well from the informal sector, with two types of goods. One type of good requires cash transactions, while for the other type of goods credit is used. The cash purchased goods in the informal sector avoid consumption taxes but are effectively subject to an inflation tax.

We calibrate the model by Nicolini (1997) for Kazakhstan and the U.S. using the following parameters. The size of the informal economy is taken from the Informal Economy Database, World Bank (Elgin et al. 2021) and is set at 32% of GDP in Kazakhstan and 7% for the US. Furthermore, government expenditures in Kazakhstan are set at 15% (IMF, World Economic Outlook) and 18% in the US. The ratio of the money stock (M1) to GDP is 9% in Kazakhstan and 16% in the US (IMF, World Economic Outlook). A key missing parameter, however, is the relative cash intensity, q, of the informal versus the formal economy. We assume this parameter is larger than 1, which means that more cash is used in the informal economy than the formal one, which is a reasonable assumption. We experiment with different values of q in our simulations.

Table 7

Optimal Nominal Interest Rate in Kazakhstan vs. US based on the Nicolini (1997) Model

	$q = 1$	$q = 2$	$q = 4$	$q = 8$
KZ	5.6%	8.0%	10.4%	12.4%
US	2.4%	3.8%	5.3%	6.9%
Difference	*3.2%*	*4.2%*	*5.1%*	*5.5%*

Table 7 shows the results of this exercise and shows the implied nominal interest rate in Kazakhstan vs the US. To back out the optimal inflation rate, we need to subtract the real natural interest rate. If we assume a real natural interest rate of 3% for Kazakhstan and 2% for the U.S., this implies that the optimal inflation rate in Kazakhstan is between 2.2 ppt and 4.5 ppt above the optimal inflation rate in the US. Based on an optimal inflation rate of 2% for this US, this would imply and optimal inflation rate between 4.2% and 6.5% for Kazakhstan.

Table A5 in the Appendix provides additional simulations in which the size of the informal sector is reduced, reflecting the notion that the size of the informal sector in Kazakhstan is slowly shrinking and is likely to continue shrinking in the decade ahead.

3.4. Financial Development and the Optimal Inflation Target

Another reason why central banks, especially in developing and emerging economies, may set a positive inflation target is related to the level of financial development. In particular, with less well-developed financial markets, households and businesses face greater non-insurable idiosyncratic risk. Since money serves as a riskless store of value, it can cause an overinvestment in money holdings and an underinvestment in risky physical capital. Increasing money growth, which would eventually imply an increase in inflation, decreases the incentive to hold money and increases the incentive to invest in riskier physical capital.

We use a simple monetary model of Brunnermeier and Sannikov (2016) to estimate the optimal inflation target for Kazakhstan, considering various assumptions of the stage of financial development and idiosyncratic risk in the economy. For the details of the model, we refer to Brunnermeier and Sannikov (2016). To estimate the model, we use an annual depreciation rate of capital of 10%, an annual time preference of households of 5%, the ratio of M1 to GDP for Kazakhstan is taken to be 9% as before. A key parameter in the model is to level of idiosyncratic income risk faced by household-entrepreneurs, which is denoted by σ.

Given the stylized nature of the model, the results are very sensitive to this parameter and therefore we show various results below in table 8**.** When we have low levels of idiosyncratic risk ($\sigma = 0.03$), optimal inflation is close to zero. Increasing the exposure to idiosyncratic risk slightly with one percentage point, increases the inflation target to almost 4%. If we double the level of idiosyncratic risk parameter from 0.03 to 0.06 we would get a very high optimal inflation target of 15.4%. While it is hard to argue that the financial development in Kazakhstan and hence the exposure to idiosyncratic risk is low, say comparable to the U.S., where the risk parameter would be around 0.036 (consistent with a 2% optimal inflation target), it is also unlikely it is at the other extreme of 0.06[5]. We therefore take an approach that it is somewhere in the middle. This would suggest an optimal inflation target of a little above 6% based on this stylized model.

Table 8

Estimated Inflation Target under Different Scenarios of Idiosyncratic Risk

	$\sigma = 0.03$	$\sigma = 0.036$	$\sigma = 0.04$	$\sigma = 0.05$	$\sigma = 0.06$
π^*	-0.2%	2%	3.9%	9.0%	15.4%

Note: Based on the model of Brunnermeier and Sannikov (2016).

In summary, this section has used data from Kazakhstan to estimate and calibrate several important models of optimal inflation targets in the academic literature. While the models are stylized in nature and each focus on one dimension in turn, they all suggest that the optimal inflation target for Kazakhstan is well in excess of the 2% value adopted in most developed economies. Nevertheless, as regulation tightens up on the informal sector and financial development allows more individuals to insure against idiosyncratic risk, the optimal inflation rate could begin to fall over the coming decade.

[5] In the model, the household faces idiosyncratic risk from holding physical capital—all households are essentially self-employed entrepreneurs. To get a sense of how to level of idiosyncratic risk for workers in the US, see for example Guvenen et al. (2021) and references therein

4. Modelling the Process Related to the Inflation Goal Formulation

4.1. Analyzing International Practices and the Existing Model Toolkit for Constructing Optimal Policy Scenarios

Over the last decade, the task of central banks has become more challenging. In most developed economies, the decline in the natural real interest rate and the severity of the recessionary and disinflationary forces associated with recent events such as the great recession and the 2019 Covid pandemic resulted in low nominal interest rates and hence the ZLB on nominal interest rates became much more likely to bind. As a result, central banks reacted to this new environment by expanding their policy tools to include several novel non-standard measures.

Forward guidance and large-scale asset purchases (QE) are prominent examples. However, this multiplicity of policy instruments complicates the setting of monetary policy because the central bank has to decide on the appropriate combination of these non-standard measures. Recently, it has become even more complicated as inflation has started to surge also in advanced countries.

The International practice has been to produce optimal policy projections with a commitment to follow a particular inflation target. Such optimal policy projections under commitment were first introduced by Svensson (2005) and applied to a policy setting by Svensson and Tetlow (2005) using the Fed's FRB/US model. Optimal policy projections are related to the targeting rule approach to optimal policy (e.g., Svensson and Woodford, 2004). Svensson (2010) describes optimal policy projections as the selection of projections for the target variables and policy instrument that "look best relative to the central bank's objectives".

A toolkit to compute optimal monetary policy in the presence of multiple policy instruments and constraints on the use of each of those instruments has been developed by de Groot et al. (2021). An important advantage of the toolkit is that it requires as input only the baseline projections for the target variables and the policy instruments, as well as impulse responses for those variables to policy instrument shocks. Target variables would typically be inflation and a measure of economic slack. This approach is different from other existing toolkits in that it does not require the specification of a model's structural equations to derive optimal policy. The second feature of the toolkit is that it can compute optimal policy projections under both the assumption that the central bank can fully commit to its future policy actions, and limited commitment and discretion (where the central bank cannot commit at all). A third important feature of the toolkit is that it can control the degree of forward-lookingness of economic agents when they are faced with optimal monetary policy. It is well documented that Dynamic Stochastic General Equilibrium (DSGE) models can generate puzzlingly strong effects of central bank's forward guidance about its future policy course. When optimal monetary policy prescribes policymakers to make promises about their future behavior, standard DSGE models can generate such a strong policy response that its plausibility has been questioned, i.e. the forward guidance puzzle. The toolkit can therefore mitigate the effects of the forward guidance puzzle.

4.2. Model Details, Scenarios and Results

In order to implement the de Groot et al. (2021) optimal policy projections toolkit, we begin by constructing impulse response functions to monetary policy shocks. To do this, we make use of Ireland (2007) which is a stylized new-Keynesian model, developed to study the effects of a changing the inflation target in the US. It essentially amounts to an IS curve

$$\lambda_t = E_t\lambda_{t+1} + \sigma(r_t - E_t\pi_{t+1}),$$

where λ_t is the habits-adjusted marginal utility of consumption; and a Phillips curve

$$(1+\alpha\beta)\pi_t = \alpha\pi_{t-1} + (1-\alpha)\pi_t^* + \beta E_t\pi_{t+1} - \beta(1-\alpha)E_t\pi_{t+1}^* + \kappa y_t,$$

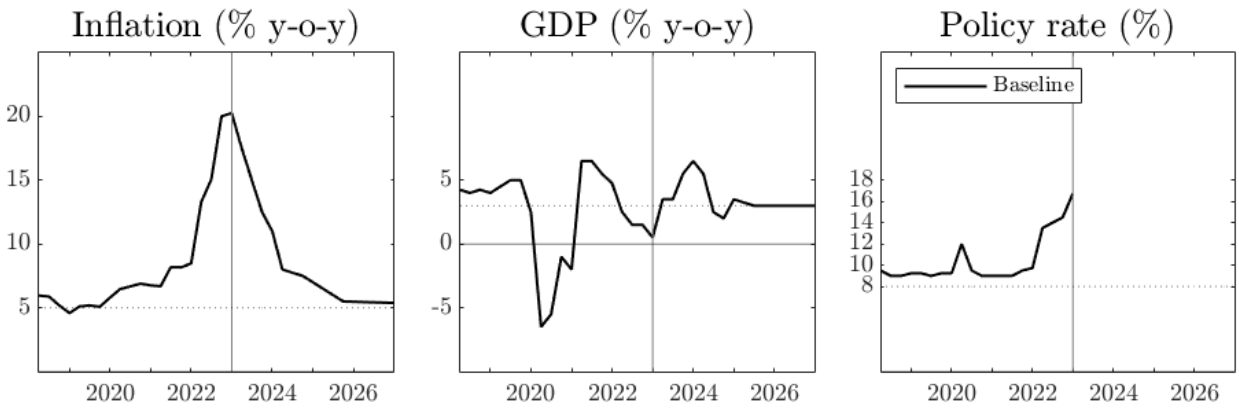
where α and 1-α denote the fraction of automatic price adjustment that follows past inflation vs. The announced inflation target, respectively. When not studying optimal policy, we specify monetary policy with an intertial Taylor-type rule:

$$r_t = \rho r_{t-1} + (1-\rho)\phi_\pi(\pi_t - \pi^*).$$

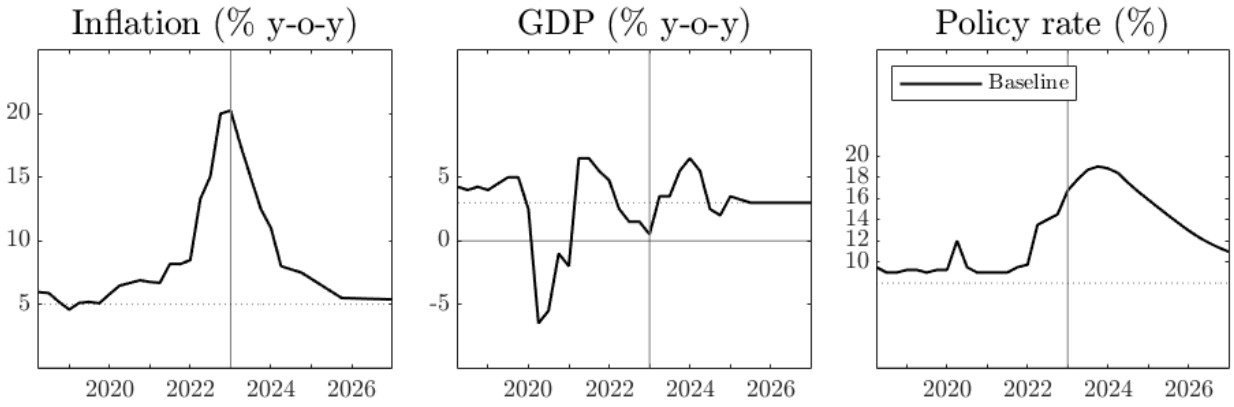
While the model may appear simple, it is important to recognize that all that is needed to set optimal policy is to know how policy shocks affect policy variables and t.arget variables (like

inflation). A structural understanding of the transmission mechanisms (whether via open economy channels, for example) is unnecessary. To ensure that the impulse responses reflect monetary policy in Kazakhstan, however, we calibrate the model. Importantly, the Phillips curve slope is a lot steeper in Kazakhstan that in the US. In particular, we use $\kappa = 0.43$.

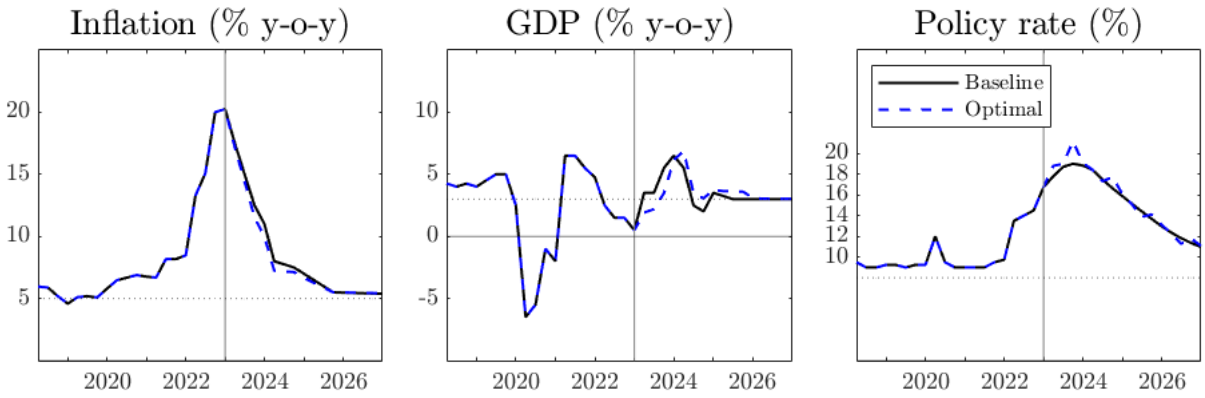
The optimal policy is constructed relative to a baseline projection. To demonstrate its use, we use the National Bank of Kazakhstan's (NBK) median projection from the December 2022 Monetary Policy Report (MPR). This is shown in the below panel. The baseline projection is one in which the inflation is well above target but is at its peak and is projected to fall rapidly towards target over the coming years.



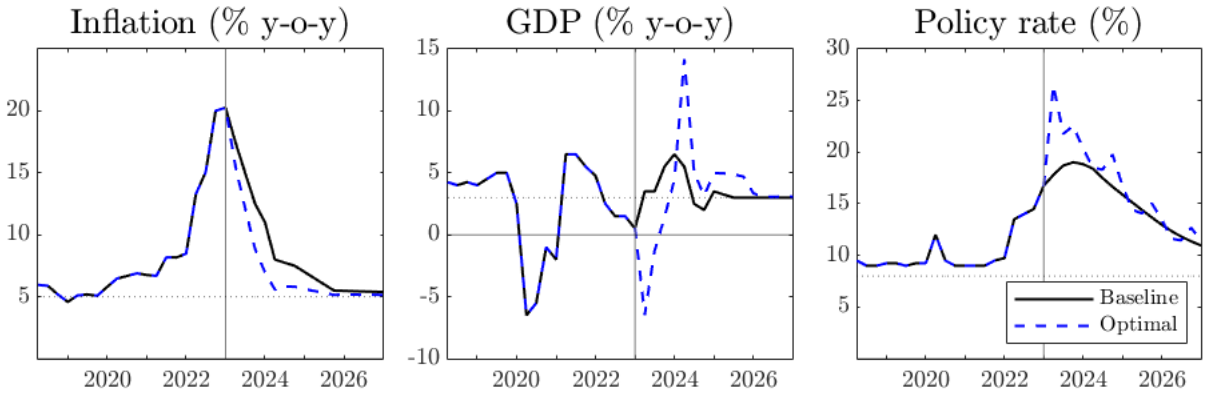
However, the NBK, like most central banks, does not publish the path of the policy rate that is consistent with its baseline projection for the economy. In order to back this out, we begin by estimating the simple inertial Taylor rule (from above) for Kazakhstan based on data from 2012-2022. We find $\phi_\pi = 1.296$ and $\rho = 0.859$. The baseline projection for the policy rate is added in the panel below. In this scenario, the base interest rate is projected to continue rising to approximately 19%. This is unlike the textual guidance from in the MPR which states that "The National Bank has approached the end of the base rate increase cycle".



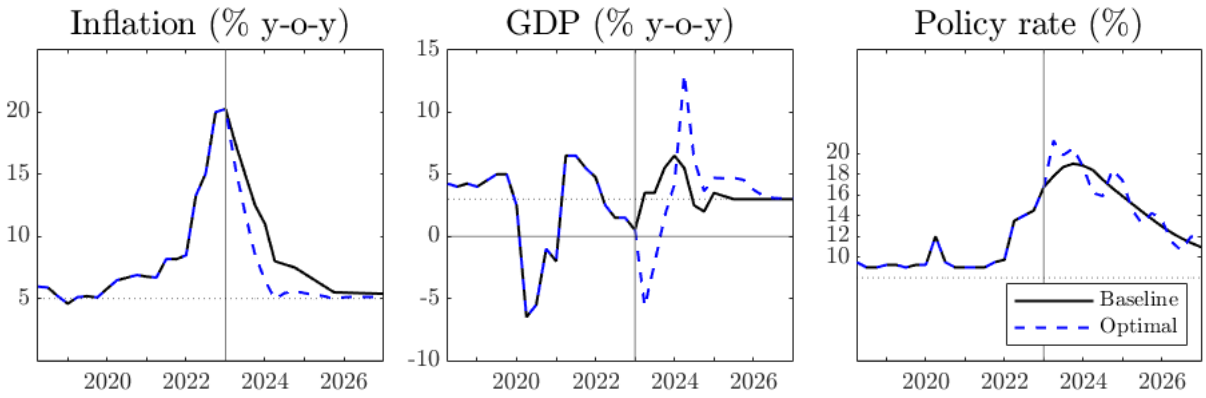
The next ingredient for solving optimal policy is to specify the goals (or preferences of the central bank). We assume that the goal is always to minimize quadratic losses around a set of weighed targets. However, before we impose a set of preferences on the NBK, it is instructive to first reverse engineer a loss function (based on inflation and the output gap) that gives an "optimal" path that is approximately equal to the baseline. The per-period component of the reverse engineered loss function is given by $(\pi_t - \pi_t^*)^2 + 2y_t^2$ and delivers the "optimal" projection given in the panel below. Notice that the weight on the output gap is necessarily very large in order to closer replicate the baseline projection (i.e. to justify the baseline projection as being near optimal).



Under a more standard loss function specification, where an inflation targeting central bank places equal weight on inflation and the output gap, given by $(\pi_t - \pi_t^*)^2 + \frac{1}{4}y_t^2$, the optimal path in fact deviates quite markedly from the baseline (see panel below). In particular, inflation is reduced more quickly (in a little over a year) but at the expense of a large near-term recession. To achieve this path, it requires a steep tightening of the policy rate to initially 25%.



The above simulation assumes that a minority (30%) of private sector agents (i.e., households and firms) are attentive to future promises and policy actions of the NBK. Since this is a conservative estimate (for the euro area, Christoffel et al. (2020), de Groot and Mazelis (2020), and de Groot et al. (2021) estimate a value close to 70%), the next panel below repeats the same exercise with the 70% attentiveness parameter. In this case, the need for further tightening to generate the desired faster return of inflation to target is much more modest, with the policy base rate only rising by another 2 percentage points. The overall improvement in welfare in this scenario is only modest, with the near-term slowdown being slightly less severe.



Next, and most importantly, we turn to analyzing how the use of a temporarily raised inflation target can alter the optimal policy prescriptions. In particular, we assume that the NBK announces a temporary (5 year) increase in the inflation target to 10%. This value is chosen from illustrative purposes only. The optimal policy toolkit is silent on the optimal inflation target—it only calculates the optimal path, given a set of policy preferences such as the optimal inflation target.

Below there are two panels, the first based on 30% attentive agents (consistent with survey results on expectations and anchoring of inflation and a 2021 IMF report that finds the interest rate channel in Kazakhstan to be relatively weak) and the second based on 70% attentive agents. In this scenario, of a temporarily raised inflation target, policy needs to tighten by less, reducing the impact on near-term economic activity.

The most striking differences (vis a vis the level of attention) relate to the future expected path of the policy rate. When attention is low (top panel), the policy rate is lower than under the baseline in the medium term. However, when attention is 70% the nominal policy rate actually remains high in the medium term. In the former, the policy rate needs to be lower to push inflation up to the 10% target (an old-Keynesian view of monetary transmission). In the latter, expectations do most of the work (a new-Keynesian view of monetary transmission). In this case, private sector agents' inflation expectations have adjusted to be consistent with the NBK's announced target. As a result, the nominal interest rate simply reflects the Fischer equation: $r_t = r_t^{real} + E_t\pi_{t+1}$: For a given real rate, if expected inflation is higher, then the nominal interest rate must also be higher.

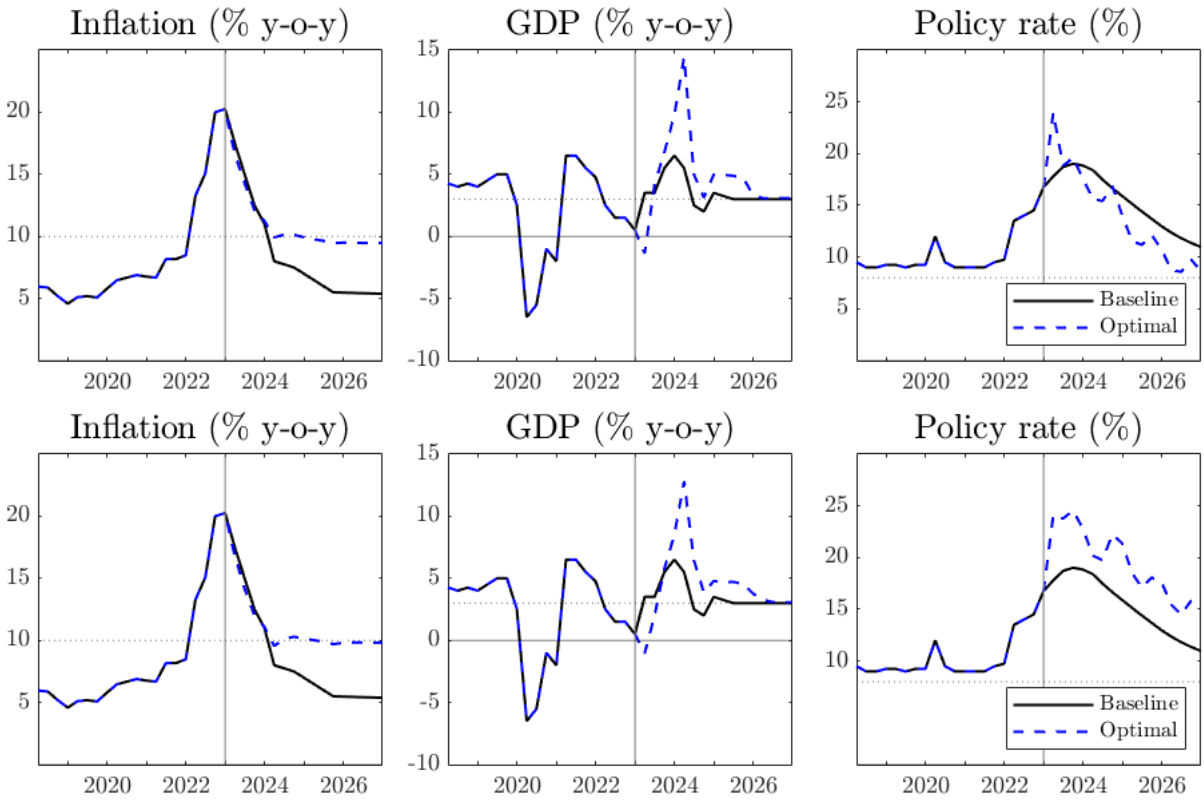


Figure 1A in the Appendix provides additional simulations in which the inflation target is instead set at 3.5% and 6.5%, respectively. In summary, while these simulations should not be taken with too greater quantitative predictive power, they provide a very useful methodology to be more transparent about the policy trade-offs that central banks face.

5. Conclusions and Discussion

This report provides an analysis of the monetary policy challenges facing the National Bank of Kazakhstan (NBK). On the one hand, the NBK has an announced inflation target corridor, with a phased reduction, from 4-6% in 2021-22, to 4-5% in 2022-23, to 3-4% from 2025 onwards.

On the other hand, actual inflation is well above target, at 20.7% in January 2023, albeit expected to fall sharply in the coming year. This raises two questions. First, is the announced inflation target corridor credible, and might sticking to it result in inflation expectations becoming unanchored? Second, is a 3-4% inflation target in the medium to long-term an optimal target for the NBK, given structural features of the economy?

On the latter, this report surveys the academic literature and combines the use of structural models and new empirical findings using Kazakhstan data to provide several qualitative insights. Based on models that account for competition in product markets, the size of the informal economy, and the state of financial development, the report concludes that the optimal inflation target for a country like Kazakhstan is likely to be significantly higher than for economies like the US, UK or euro area, which have inflation targets centered around 2%. While the models are stylized, an inflation target centered around 5% (consistent with the NBK's 2021-2022 target) appears in keeping with the findings.

On the former point, regarding the transition from the current high inflation rate, this report employs the use of optimal policy analysis and concludes that a strict adherence to even achieving the 5% target (let alone the medium-term target of 3-4%) would entail significant output costs of the economy.

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Appendix
Table 1

Inflation Target around the World[6]

DEVELOPING COUNTRIES	Central Bank	2022	Developed countries	Central Bank	2022
ALBANIA	Bank of Albania	3.0% +/-1%	AUSTRALIA	Reserve Bank of Australia	2.0% - 3.0%
ARGENTINA	Central Bank Rep. Argentina	0% mon. base	CANADA	Bank of Canada	2.0% +/-1.0%
ARMENIA	Central Bank of Armenia	4.0% +/-1.5%	CZECH REPUBLIC	Czech National Bank	2.00% +/-1.0%
AZERBAIJAN	C.B. of Rep. of Azerbaijan	4.0% +/-2.0%	EURO AREA	European Central Bank	2.0%
BANGLADESH	Bangladesh Bank	5.3%	HUNGARY	Central Bank of Hungary	3.0% +/-1.0%
BELARUS	N.B. of Rep. of Belarus	5.0%	ICELAND	Central Bank of Iceland	2.5%
BOTSWANA	Bank of Botswana	3.0% - 6.0%	ISRAEL	Bank of Israel	1.0% - 3.0%
BRAZIL	Central Bank of Brazil	3.75% +/-1.5%	JAPAN	Bank of Japan	2.0%
CHILE	Central Bank of Chile	3.0% +/-1.0%	NEW ZEALAND	Res. Bank of New Zealand	2.0% +/-1.0%
CHINA	People's Bank of China	around 3.0%	NORWAY	Norges Bank	2.0%
COLOMBIA	Central Bank of Colombia	3.0% +/-1.0%	POLAND	National Bank of Poland	2.5% +/-1.0%
DEM. REP. CONGO	Central Bank of Congo	7.0%	SOUTH KOREA	Bank of Korea	2.0%
COSTA RICA	Central Bank of Costa Rica	3.0% +/-1.0%	SWEDEN	The Riksbank	2.0%
DOMINICAN REP.	C.B. of Dominican Repl.	4.0% +/-1%	SWITZERLAND	Swiss National Bank	<2.00%
EGYPT	Central Bank of Egypt	7.0% +/-2%	UNITED KINGDOM	Bank of England	2.0%
ESWATINI	Central Bank of Eswatini	3.0% - 7.0%	USA	Federal Reserve	2.0%
GAMBIA	Central Bank of the Gambia	5.0%			
GEORGIA	National Bank of Georgia	3.0%			
GHANA	Bank of Ghana	8.0% +/-2.0%			
GUATEMALA	Bank of Guatemala	4.0% +/-1.0%			
HONDURAS	Central Bank of Honduras	4.0%+/-1.0%			
INDIA	Reserve Bank of India	4.0% +/-2.0%			
INDONESIA	Bank Indonesia	3.0% +/-1.0%			
JAMAICA	Bank of Jamaica	4.0%-6.0%			
KAZAKHSTAN	National Bank of Kazakhstan	4.0%-6.0%			
KENYA	Central Bank of Kenya	5.0% +/- 2.5%			
KYRGYZSTAN	N.B. of Kyrgyz Republic	5.0%-7.0%			
LIBERIA	Central Bank of Liberia	8.5%/+-2%			
MALAWI	Resserve Bank of Malawi	5.0%			

[6] http://www.centralbanknews.info/p/inflation-targets.html

MEXICO	Bank of Mexico	3.0% +/-1.0%
MOLDOVA	National Bank of Moldova	5.0% +/-1.5%
MONGOLIA	Bank of Mongolia	6.0% +/-2%
MOZAMBIQUE	Bank of Mozambique	5.6%
NEPAL	Nepal Rastra Bank	6.0%
NIGERIA	Central Bank of Nigeria	6.0% - 9.0%
PAKISTAN	State Bank of Pakistan	6.0%
PARAGUAY	Central Bank of Paraguay	4.0% +/-2.0%
PERU	Central Reserve Bank of Peru	2.0% +/-1%
PHILIPPINES	Bangko Sentral ng Pilipinas	3.0% +/- 1.0
ROMANIA	National Bank of Romania	2.5% +/-1.0%
RUSSIA	Bank of Russia	4.0%
RWANDA	National Bank of Rwanda	5.00% +/-3%
SAMOA	Central Bank of Samoa	3.0%
SERBIA	National Bank of Serbia	3.0% +/-1.5%
SOUTH AFRICA	South African Reserve Bank	3.0% - 6.0%
SRI LANKA	Central Bank of Sri Lanka	4.0% - 6.0%
TAJIKISTAN	N. B. of Tajikistan	6.0% +/-2.0%
TANZANIA	Bank of Tanzania	5.0%
THAILAND	Bank of Thailand	1.0% - 3.00%
TONGA	National Res. Bank of Tonga	5.0%
TURKIYE	C.B. of Rep. of Turkey	5.0% +/-2%
UGANDA	Bank of Uganda	5.0% +/-2.0%
UKRAINE	National Bank of Ukraine	5.0 +/- 1%
URUGUAY	Central Bank of Uruguay	3.0% - 7.0%
UZBEKISTAN	C. B. of Rep. Of Uzbekistan	5.0%
VIETNAM	State Bank of Vietnam	<4%
WEST AFRICAN STATES	Central Bank of West African States	2.0% +/-1%
ZAMBIA	Bank of Zambia	6.0% - 8.0%

Table 2

Analyzed Expenditure Items and Products (Metro Data)

	Number of Products per Item
Median	113
Mean	178.25
	Number of Price Quotes per Item
Median	2699
Mean	6121.40

Table 3

Analyzed Expenditure Items and Products (AC Nielsen data: 2019-2022)

	Number of Products per Item
Median	56
Mean	59
	Number of Price Quotes per Item
Median	6384
Mean	6186

Table 4

Analyzed Expenditure Items and Products (AC Nielsen data: 2013-2016)

	Number of Products per Item
Median	74.5
Mean	75
	Number of Price Quotes per Item
Median	4240
Mean	4637

Table 5

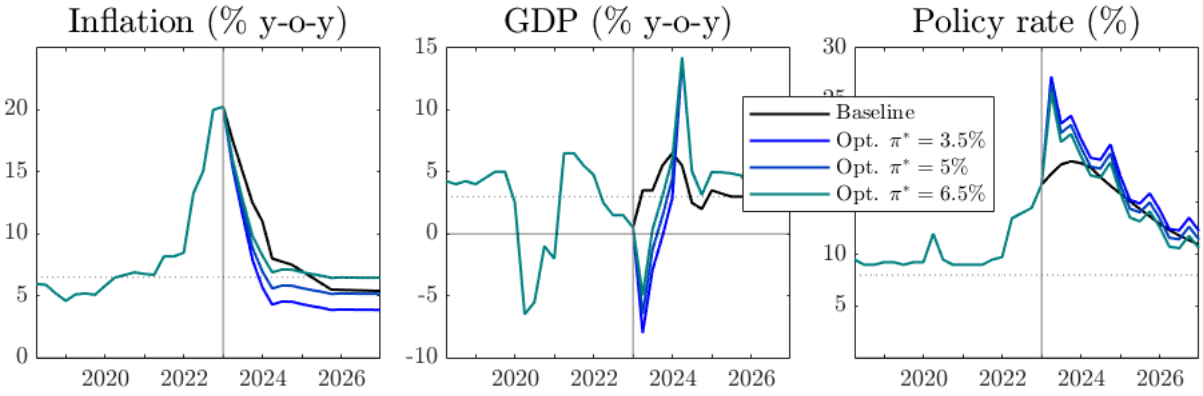
Optimal nominal interest rate in Kazakhstan based on the Nicolini (1997) model—changing the size of the informal sector

	$q = 1$	$q = 2$	$q = 4$	$q = 8$
KZ ($u = 0.32$)	5.6%	8.0%	10.4%	12.4%
KZ ($u = 0.20$)	4.0%	6.1%	8.5%	10.7%
KZ ($u = 0.10$)	2.3%	3.8%	5.6%	7.7%
KZ ($u = 0.07$)	1.7%	2.9%	4.4%	6.1%

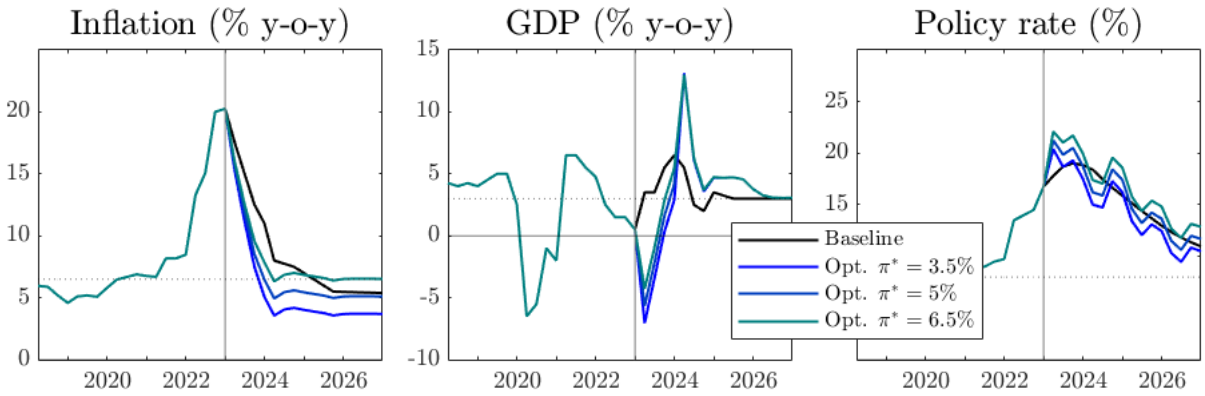
Note: See Section 3.3 and Table 7 for further details on the Nicolini (1997) model and the baseline calibration for Kazakhstan. In this table, unless otherwise stated, the calibration is the same as for Kazakhstan in Table 7. u is the size of the informal sector. The baseline value for Kazakhstan is 0.32 (32%). For reference, $u = 0.07$ is the size of the informal sector in the US.

Figure 1

Optimal policy: Alternative Inflation Targets



Note. Simulations based on 30% of private-sector attentive to the NBK policy.



Note. Simulations based on 70% of private-sector attentive to the NBK policy.

Central Bank Independence and Achieving the Inflation Target

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The concept of central bank independence is not strictly formulated. Instead, various indices have been proposed that reflect, to one degree or another, the independence of the central bank in elaborating and pursuing the monetary policy. The aim of the study is to determine the relationship between inflation and the independence of central banks in developed, former Soviet and developing countries. To achieve the goal of the study, the hypothesis of a negative statistical relationship between the inflation rate and the values of the CWN and GMT indices of central bank independence as well as their component sub-indices for developed, former Soviet and developing countries for 2001–2020, was tested. Econometric analysis based on averaged data did not reveal a stable negative relationship between them. Moreover, in some cases, on the contrary, their positive relationships were found. It has been established that for the former Soviet countries, an increase in the CWN and GMT indices or their sub-indices contributes to deceleration in the inflation rate, while in developed countries it does not reduce and even in some cases increases the inflation rate. This is explained by the fact that in the former Soviet countries the inflation rates in the reviewed time interval were significantly higher than in developed countries. The impact of central bank independence on inflation is also assessed by the ability to keep the inflation rate within a given corridor using a binary choice model.

Key Words: central bank independence, inflation, CWN and GMT indices, developed countries, former Soviet countries, developing countries.

JEL-Classification: E58, C23, C25.

1. Preamble

Central bank independence (CBI) is the ability of a central bank to control monetary instruments. Also, the CBI is a set of restrictions to the government's influence on managing the central bank's monetary policy. CBI can be limited or strengthened in three ways: personnel, financial and political independence. The first dimension, personnel, refers to how a bank governor is appointed and dismissed. As the influence of the government on the governor's tenure increases, the degree of the central bank independence decreases. The government can also influence the central bank staff by controlling membership on the central bank's board. Financial independence refers to the ability of the government to fund its spending. If the government has direct access to central bank credit, monetary policy is more likely to be subordinated to fiscal policy. The limitation on the government's ability to finance itself with monetary instruments reflects the higher degree of CBI. Finally, political independence reflects the authority of a central bank to formulate and implement the monetary policy.

The concept of central bank independence is not strictly formulated. There are various indices, which reflect, to one degree or another, the independence of a central bank in elaborating and pursuing the monetary policy. The most commonly used indices are GMT index (Grilli, Masciandro, Tabellini, 1991) and CWN index (Cukierman, Webb, Neyapti, 1992), named based on the capital letters of authors' last names.

CWN index is a method to measure the central bank independence developed on the basis of weighted average value of sixteen criteria responsible for certain criteria of independence and combined in four groups: personnel autonomy, monetary policy formulation, central bank priorities and goals, restrictions to the state budget financing.

The GMT index looks at the central bank independence in the context of its political and economic independence. Political independence refers primarily to the procedure for appointing

the senior management of a central bank, independent of the government, as well as its autonomous functioning. In turn, economic independence is determined by the existence of a possibility of the central bank lending to the government and the involvement of monetary authorities in the supervision of commercial banks.

The purpose of the study is to identify a relationship between inflation and central bank independence in developed, former Soviet and developing countries.

In order to achieve the goal of the study, the authors make a H_0 hypothesis about the existence of a negative statistical relationship between the inflation rate and measures of the CWN and GMT indices of the central bank independence as well as their component sub-indices.

2. Literature Review

2.1. Systematic Literature Review

Central bank independence (CBI) remains one of the most current and discussed issues and is the subject of many studies. Despite the fact that this topic has been studied over such a long period of time, there is still no precise definition of this concept. Most authors understand CBI as the economic and political independence of the bank in the implementing its monetary policy. The CBI is assessed using the GMT and CWN indices, which are central to most studies and include economic and political criteria. Various indices reflect to some extent the independence of the central bank in elaborating and implementing the monetary policy. The most widely used indices are the GMT index and the CWN index, named after the capital letters of the authors' last names.

Most of the studies on the CBI analyze and evaluate the impact of the degree of independence on achieving inflation targets. Doyle and Weale (1994) show that there is a fairly strong evidence that high central bank independence is associated with lower inflation. Of course, this does not mean that central banks should be free to pursue targets of their choice, but rather that they should use the monetary policy to achieve a target set by the parliament.

Mas (1995) notes that the mere creation of an independent central bank may not bring the claimed benefits in developing countries with underdeveloped financial markets, where the scope for a truly independent monetary policy is limited. The benefits of an independent central bank may be eroded by conflicts between fiscal and monetary policy and internal problems of the central bank's institutional structure, so that the problems of dynamic inconsistency associated with the monetary policy are not resolved but simply transformed. Less developed countries, wishing to move to a low-inflation path should focus on fiscal policy reforms that increase the resistance to inflation and on institutional arrangements that directly impose discipline on fiscal policy rather than indirectly through the monetary policy.

Piga (2000) shows that central bank independence arises from the need for politicians to maximize rent-seeking from private counterparties who engage in political transactions to obtain subsidies. The author also notes that Milton Friedman opposed an independent central bank. His argument was eminently libertarian, and he fought against the concentration of power and warned about the possibility of central bank corporatism.

Moiseev (2018) in his survey research provides many criteria for CBI. These criteria include: the ability of the central bank to independently apply monetary policy instruments, the characteristics of the rules, a limited influence of the government on the monetary policy, and independence of purpose and instruments. The author presents an overview of many studies showing that a high degree of CBI enables to keep inflation low. Moreover, additional benefits of CBI are cited, such as the ability of CBI to strengthen fiscal sustainability. It should be noted that CBI minimizes the impact of the political cycle on inflation. Thus, CBI is recognized as one of the key monetary policy principles. The strengthening of CBI is a global trend; however, during the global financial crisis of 2007-2009, the balance between fiscal and monetary authorities had changed.

Crowe and Meade (2007) note that measuring the central bank independence tends to focus on the set of legal characteristics that can be derived from the institution's charter. These legal characteristics refer to four aspects of the central bank independence from the government. First, independence is greater when the bank management is protected from political pressure by

sufficient tenure and independent appointment. Second, the central bank enjoys more freedom when the government cannot participate in or override its decisions. Third, the CBI is greater when the central bank's legal mandate clearly states the purpose of monetary policy. Finally, the financial independence of the central bank depends on restrictions on government lending. The authors also confirm the general conclusions of most economists that the CBI leads to low inflation. However, additional arguments are given that this phenomenon is not always observed in developing countries. The authors conclude that independent central banks with clear mandates, a good communication strategy, and experienced, technocratic management teams can calm the markets and reduce the economic costs of political crises or mistakes.

According to Reis (2013), while many experts advocate the CBI, looking at more specific issues leads to mixed conclusions. The author argues that sticking to a stable long-term nominal anchor can reduce the costs of price uncertainty, and this policy is completely different from maintaining a certain level of inflation. Research shows that a flexible price target can reduce the inflation variance and real activity. Moreover, the release of the central bank from the obligation to raise seigniorage to transfer funds to the fiscal authorities does not mean that the central bank can take on greater risks through uncontrolled lending policy.

Levenkov (2018) shows that the CBI can help countries to achieve lower inflation rates, mitigate the effect of political cycles on economic cycles, reinforce the financial system stability an to increase fiscal discipline without any costs in terms of the output volatility or slowing down of the economy. The author points to a positive relationship between the central bank independence and economic growth.

Trounin et al. (2010) note that the central banks of emerging markets are still deprived of the legal, economic and political independence that is typical for central banks of advanced economies. In turn, the position of central banks in the CIS countries varies from absolute dependence on the executive branch to relative autonomy in decision-making. According to the results of their study, the banks of Eastern Europe and the Baltic countries appeared to be the most independent. The least independent are the central banks of Belarus, Ukraine and Uzbekistan. At the same time, it can be assumed that the results obtained reflect only the formal independence of a central bank. In particular, if a high level of central bank independence in the Baltic States does not cause considerable doubts, the comparable level of central bank independence in Kyrgyzstan and Tajikistan does not look very convincing. As for the place of Russia and Kazakhstan, the Bank of Russia and the National Bank of Kazakhstan are characterized by an average level of independence among the reviewed countries. The authors explain that the trend of decreasing independence of the Central Bank of the Russian Federation creates obstacles for reducing inflation in Russia. Considering that the Russian economy is currently struggling to get out of the crisis, the low level of CBI can be used by the country's authorities to solve the existing problems. Despite the fact that such solutions can stabilize the situation in the economy in the short term, their effectiveness in terms of a long-term economic development may appear insignificant.

Berger et al. (2001), based on a survey research, showed that the negative relationship between the CBI and inflation is strong. Klomp and De Haan (2010) performed a meta-regression analysis using 59 studies that examined the relationship between inflation and the CBI. The authors show that the studies reviewed differ greatly in terms of the used CBI indicator, the sample of countries, the period covered, and the specification of the model. The authors concluded that the relationship between the CBI and inflation is strong. Thus, the generally accepted argument of most researchers is that the CBI is able to keep inflation low.

Baumann et al. (2021), based on their assessments, questioned the generally accepted fact that the CBI keeps inflation low. The authors concluded that, in general, there is only a weak, if any, causal relationship between independence and inflation. These results are obtained on the basis of a statistical approach, which has not yet been used in the analysis of macroeconomic processes. The authors propose their own method for assessing the impact of CBI on inflation. In particular, the researchers propose the long-term target maximum likelihood estimation. The evaluation procedure includes machine-learning algorithms and is designed to solve problems associated with complex macroeconomic panel data. In order to describe and eliminate relevant

confounding structures, the possible reasons that motivate a country's decision to accept a certain degree of central bank independence are taken into account; they range from the country's political institutions, political instability, history of inflation, and international pressure. Moreover, the authors use 17 measured variables, including money supply, energy prices, and economic openness, institutional variables such as central bank transparency and monetary policy strategies, and political variables. The study was conducted for 60 countries at various stages of development between 1998 and 2010. The authors come to an important conclusion that the CBI has no clear effect on inflation; moreover, one cannot rule out even an impact that nurtures an increase in inflation.

According to Haldane (2020), central bank independence contributed to two important outcomes, such as low and stable inflation at no cost in an environment of output volatility, and safe and sound banks. At the same time, central banks and the central bank independence encounter new challenges. Not least, this is due to the rapid growth of central bank balance sheets over the past decade. This contributed to a loss of understanding and perhaps some confidence in the role of monetary policy and the extent to which it is separated from government actions.

2.2. Bibliometrics of Literature

To do a bibliometric research of literarure, a selection of research articles from the Scopus database was used, based on the results of a search by a "central bank independence" key word. 762 publications posted before March 2022 were found in the database by this key word.

Articles are analyzed in terms of annual academic output, most important sources, most relevant institutions, a network of coincidences, and a thematic mapping and evolution to understand trends in the body of knowledge about the central bank independence. Bibliometric analysis was carried out using the R-package Biblioshiny tool.

Figure 1

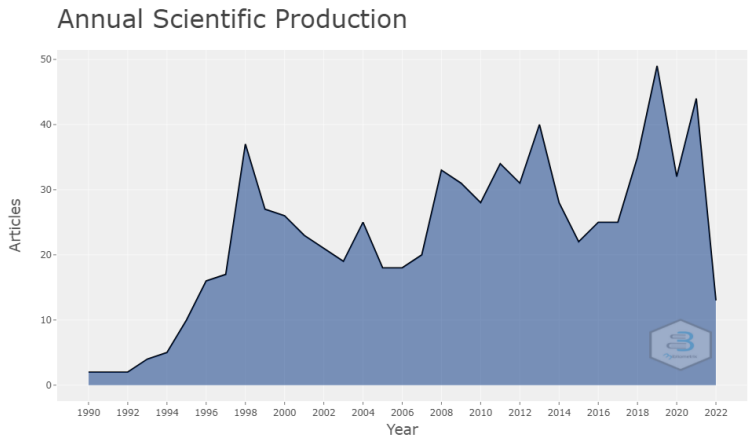


Figure 1 shows the annual volume of academic research on central bank independence. As can be seen in the figure, research on this topic began to be published in 1990, when 2 articles were published. Since 1993, there has been a noticeable increase in articles until 1998, when the number of studies reached 37. The highest publication activity is observed in 2019 – 49 articles were published during the year. In 2020, this indicator decreased, it can be assumed that the pandemic was the cause for reduction in the number of studies on the central bank independence. Since the scientific interests of many researchers have shifted towards research into the causes and consequences of the pandemic. In 2021-2022, an increase in publications is again noticeable; 13 papers have already been published in 3 months of this year.

From a three-fields plot, one can see the interrelationship between publication attributes. For example, Figure 2 shows what countries and journals are most involved in the study of central bank independence. Most of the articles came from the US, Germany and the UK. The relationship between the central bank independence and inflation is most studied in France, Australia, Switzerland and Turkiye. From this, we can conclude that mainly developed countries are involved

in the study of the subject. Figure 2 also shows the 3 journals where the largest number of articles on the central bank independence were published.

Figure 2

Three-Fields Plot (Country – Key Words – Source)

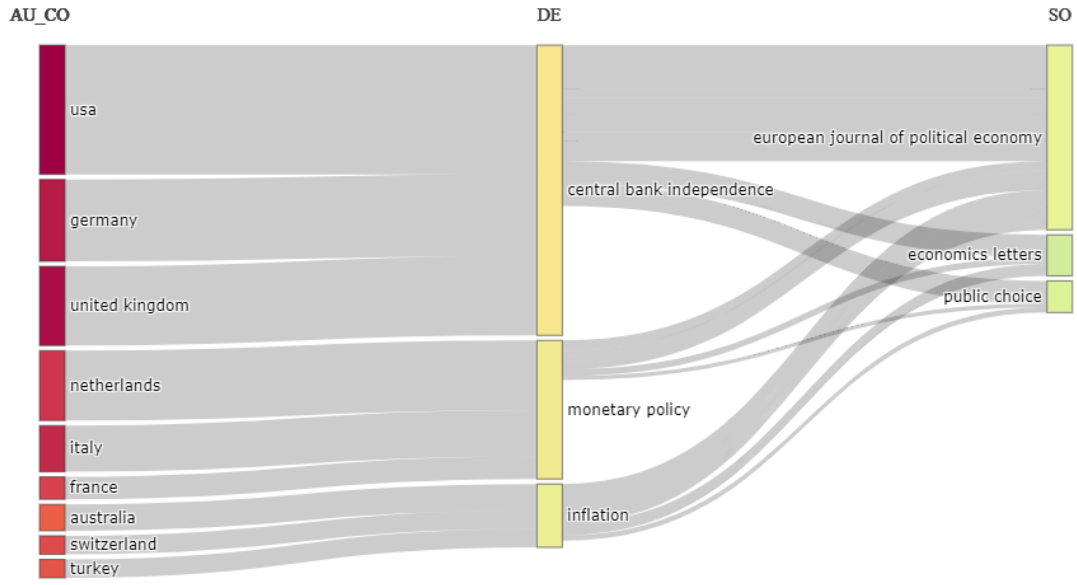
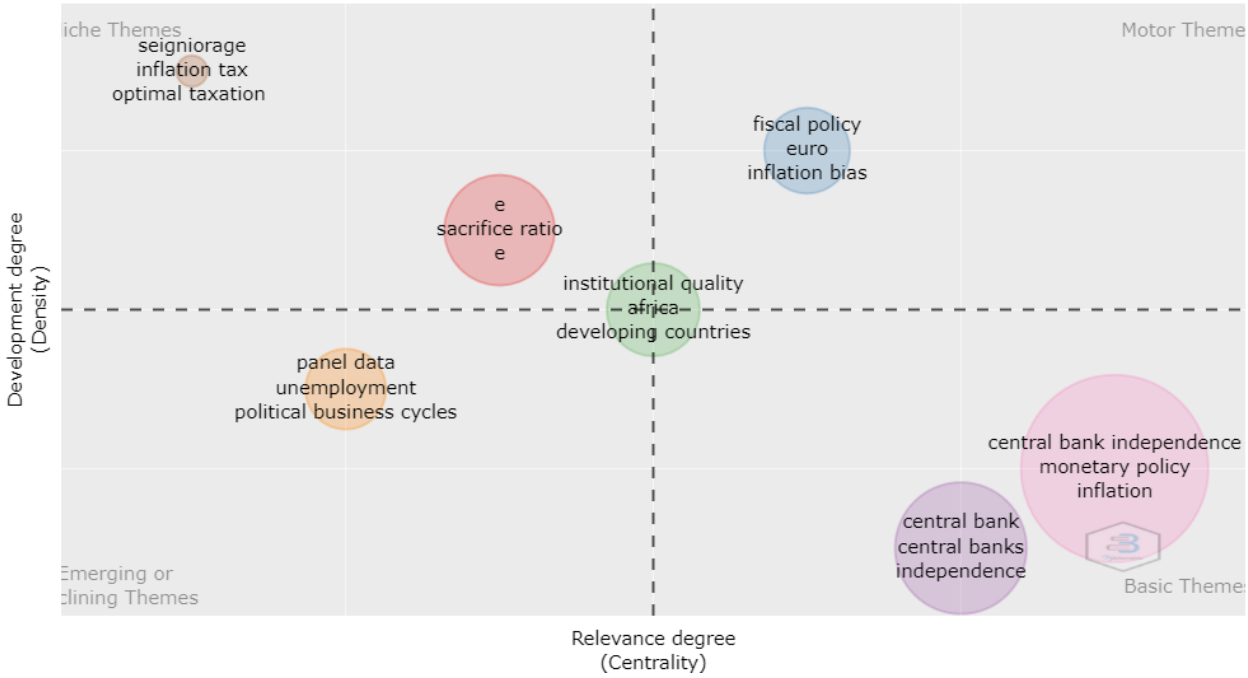


Figure 3 presents the current state in research on the central bank independence. To obtain a thematic map, the author's key words were used and a minimum clustering frequency of 5 points was set.

Figure 3

Thematic Map

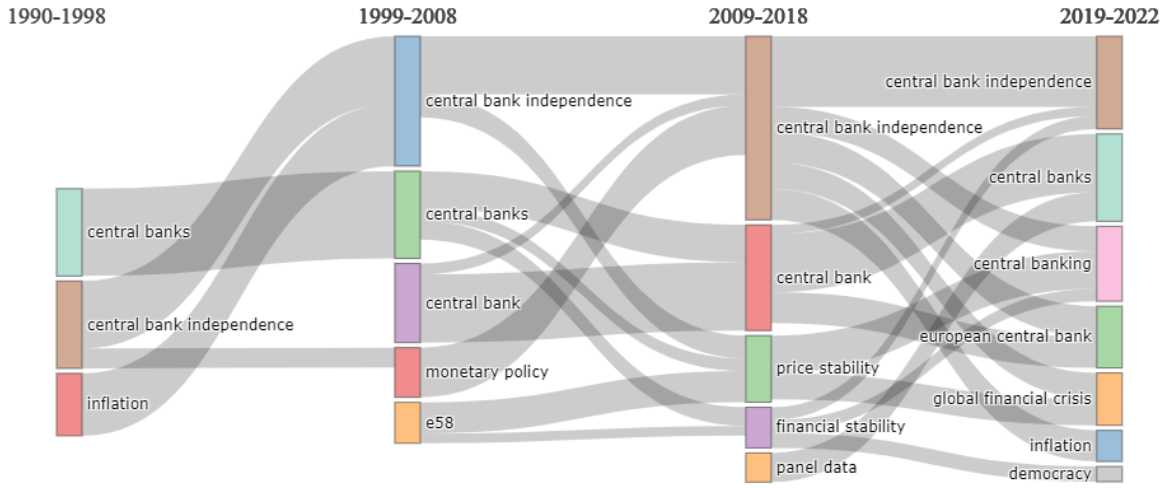


Among the central clusters, the largest is the "central bank independence", which includes such frequently occurring key words as "monetary policy" and "inflation". The "institutional quality" cluster along with such keywords as "Africa", "developing countries" is about to become a central topic. That is, in developing countries, more and more attention is paid to the study of this topic.

As for the motor themes, only the "fiscal policy" cluster belongs to this category. Niche themes include "taxation" and "cyber crimes".

Figure 4

Thematic Evolution over 1990-2022



In addition to the current state of research, the thematic map shows changes in the temporal development of the topic. For thematic evolution, a full sample of 762 articles was used. This dataset was split into quadruple slices. Time slices were selected according to the degree of publication activity. The first time slice (1990–1998) shows an increasing publication activity (Figure 1), while the second (1999–2008) and third (2009–2018) time slices indicate the volatility of publication activity. As for the fourth time interval (2019–2022), it is characterized by the largest increase in publication activity.

Thematic evolution shows the expansion of research areas. The independence of central banks was first divided into 2 topics – price stability and financial stability, then the panel data was added there and in the last 3 years, the relationship of central bank independence with themes such as the global financial crisis, inflation and democracy has been actively studied.

3. Methodology

To test the H_0 hypothesis, the CBI data on three groups of countries according to the UN for 2021 was collected (UN, 2021):

– 10 former Soviet countries except for Latvia, Lithuania, Estonia, Uzbekistan and Turkmenistan: Azerbaijan, Armenia, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan, Ukraine, Uzbekistan and Turkmenistan were excluded since there is no data about inflation by the CPI on these countries;

– 18 developed countries, for which at least three versiosn of the Central Bank Laws (Acts) are available: Canada, Australia, Belgium, Croatia, Cyprus, Estonia, Finland, Hungary, Latvia, Lithuania, the Netherland, Portugal, Romania, Slovakia, Iceland, Norway, Switzerland, and the UK;

– 32 developing countries, for which the Central Bank Laws (Acts) and inflation data are available: Zimbabwe, Cape Verde, Ghana, Nigeria, Brunei Darussalam, Cambodia, Indonesia, Malaysia, Mongolia, Philippines, Vietnam, Bangladesh, Bhutan, Bahrain, Iraq, Israel, Oman, Qatar, Yemen, Dominican Republic, Guatemala, Nicaragua, Panama, Ecuador, Tanzania, Lesotho, Mauritius, Botswana, South Africa, Sudan, Egypt, Libya.

The limitation of the study is that for many countries there are no Central Bank Laws (Acts) in the public domain. For former Soviet republics and developed countries, it was possible to find several versions of the Laws in order to trace the dynamics of change, and it was difficult to find even one version of the Law in case of developing countries.

The data to assess the central bank independence in these countries in accordance with the CWN and GMT indices was obtained from Central Bank Laws (Acts) of each country.

Inflation data for 2001-2020 for each country was gathered from the World Bank official website (World Bank 2022).

The following notations of variables were introduced for all central banks:

inf01, inf02, …, inf20 – inflation rate in the year 2001, 2002, ..., 2020, hence,

cwn – CWN index,

cwn1 – employee autonomy,

cwn11 – the tenure of the central bank executives,

cwn12 – agency that appoints the central bank governor,

cwn13 – early dismissal of the central bank governor,

cwn14 – a possibility for the central bank governor to fulfill other functions in the government,

cwn2 – monetary policy formulation,

cwn21 – agency engaged in the monetary policy formulation,

cwn22 – agency that has the last word in the conflict resolution,

cwn23 – participation of the central bank in the fiscal policy formulation,

cwn3 – priorities and primary objectives of the monetary policy,

cwn4 – constraints to the state budget deficit financing,

cwn41 – limitations to direct lending to the government,

cwn42 – purchases of government securities,

cwn43 – lending terms and conditions,

cwn44 – bank's potential borrowers,

cwn45 – limits to central bank lending,

cwn46 – maturity of loans,

cwn47 – interest rates on loans,

cwn48 – operations with government securities in the primary market,

gmt – GMT index,

gmt1 – GMT sub-index of political independence,

gmt11 – the central bank governor is appointed without government's interference,

gmt12 – the central bank governor is appointed for a term exceeding 5 years,

gmt13 – central bank management board is appointed without the government's involvement,

gmt14 – members of the central bank management board are appointed for a term exceeding 5 years,

gmt15 – there is no need in obligatory attendance of the government representatives on the central bank management board,

gmt16 – there is no need in approving the monetary policy guidelines by the government,

gmt17 – enshrining the price stability as the central bank's main objective in the law,

gmt18 – existence of legal support to the central bank in case of a conflict with the government,

gmt2 – GMT sub-index of economic independence,

gmt21 – there is no automatic procedure for lending to the government,

gmt22 – the central bank does not participate in the initial offering of government securities,

gmt23 – central bank independently sets interest rates on its operations,

gmt24 – bank supervision is not among the central bank functions.

CWN index: is calculated based on sub-indices under the formula:

$$cwn = 0.2cwn1+0.15cwn2+0.15cwn3 +cwn4$$

Alternatively, the calculation of GMT index is simpler than that of CWN index. It is equal to the sum of sub-indices of political and economic independence of a central bank:

$$gmt = gmt1 + gmt2$$

moreover, each of them equals to a simple sum of values of its sub-indices.

Many publications take it for granted that higher central bank independence helps reduce inflation (Berger et al., 2001; Klomp and De Haan, 2010; Levenkov, 2018). The methods of correlation analysis and multiple regression can be used to test this argument. The linear regression model has the following form:

$$inf = X\beta + \varepsilon, \quad (1)$$

where inf – inflation rate column across a sample of countries, X – matrix of explanatory variable values such as the values of CWN, GMT indices or their sub-indices and the constant, β – column of coefficients for model variables, ε – column of random regression members.

It was planned to build multiple linear regressions of the inflation rate for all years from 2001 to 2020 and for all indices and sub-indices. However, attempts to construct multiple regression equations did not lead to a satisfactory result. Therefore, further we stuck to the study of pairwise relationships between the inflation rate and all indicators of the central bank independence, based on their correlation coefficients. Since the data is correlated over the years and hardly change, the averaged data was used for 4 five-year intervals, for 2 ten-year and twenty-year intervals. They provide the same information about the relationship between the inflation rate and the central bank independence index or sub-index as paired linear regressions do.

The study used a pairwise linear regression model, for example, when there is only one explanatory variable, such as CWN or GMT. A statistically significant, negative value of the coefficient for this explanatory variable will confirm the hypothesis H_0, i.e. will correspond to the fact that there is a negative statistically significant linear relationship between the increase in the central bank independence index or its sub-index and the inflation rate. Pairwise linear regression corresponds to pairwise correlation coefficients between dependent and explanatory variables. In this case, it is necessary to take into account only those of them that are statistically significant at least at the 5% level.

The influence of central banks' independence on inflation can be assessed not only by their ability to influence the inflation rate but also by their ability to keep the inflation rate within a set corridor. The binary choice model in this case estimates the probability of inflation going beyond this corridor. The probit model is estimated based on the standard normal distribution. The probability that the dependent variable will take the value of 1 is determined by the probability distribution functions. Unlike linear regression models, a binary choice model requires more observations to obtain statistically significant relationships. Therefore, the evaluation of the Probit model was carried out on the basis of combined data for former Soviet, developed and developing countries. In total, we came up with a sample of 60 countries.

4. Results and Discussion

4.1. Former Soviet Countries

Calculations of correlation coefficients were carried out for 5-year intervals of 2001-2005, 2006-2010, 2011-2015 and 2016-2020, for 10-year intervals of 2001-2010 and 2011-2020, and, finally, for the full interval of 2001-2020 based on the averaged data for each interval. The results are shown in Table 1. Sub-indices with zero values are excluded from the table.

Table 1

Pairwise Correlation Coefficients for Indicators of Central Banks of Former Soviet Countries for 5-Year, 10-Year and 20-Year Intervals

	inf01-05	inf06-10	inf11-15	inf16-20	inf01-10	inf11-20	inf01-20
cwn							
cwn42	-0.70*		-0.73*		-0.64	-0.83*	-0.72*
cwn48	-0.70*		-0.69*		-0.64	-0.77*	-0.72*
gmt	-0.68*				-0.68*		-0.61
gmt15	-0.67*				-0.65	-0.55	-0.59
gmt2	-0.68*				-0.61		-0.65
gmt21	-0.70*				-0.64		-0.72*
gmt22	-0.70*		-0.69*		-0.64	-0.77*	-0.72*

All values shown in Table 1 are negative, i.e. in certain years, the gmt index and some of sub-indices are negatively correlated with the inflation rate:

cwn42 – purchase of government securities,

cwn48 – operations with government securities in the primary market,

gmt – GMT index,

gmt15 – there is no need in obligatory attendance of the government representatives in the central bank management board,

gmt2 – GMT sub-index of economic independence,

gmt21 – there is no automatic procedure for lending to the government,

gmt22 – the central bank does not participate in the initial offering of government securities.

The increase in these indicators in certain time intervals contributed to the decline in inflation. However, there is no universal negative relationship between the inflation rate and the cwn and gmt indices or their sub-indices for all intervals.

The coefficients for the gmt index, sub-indices gmt15 and gmt2, which are significant at the 5% level in the first 5-year interval from 2001 to 2005, turn out to be insignificant in the subsequent second, third and fourth 5-year intervals. They are also not significant at the 5% level over the last 10-year interval from 2011 to 2020 and at the full interval from 2001 to 2020. We believe that this is due to a relatively high inflation in the first 5-year interval compared to the intervals that follow.

4.2. Developed Countries

In addition, as for the former Soviet countries, correlation coefficients were calculated for 5-year intervals of 2001-2005, 2006-2010, 2011-2015 and 2016-2020, for 10-year intervals of 2001-2010 and 2011-2020, and finally, for the full interval of 2001-2020 based on the averaged data for each interval. The results are shown in table 2.

Table 2

Pairwise Correlation Coefficients for Indicators of Central Banks of Developed Countries for 5-Year, 10-Year and 20-Year Intervals

	inf01-05	inf06-10	inf11-15	inf16-20	inf01-10	inf11-20	inf01-20
cwn	0.58*				0.46		0.40
cwn2			0.60*	0.47*		0.56*	
cwn22			0.58*	0.49*		0.58*	
cwn4	0.44						
cwn47	0.62*						
gmt	0.42						
gmt1	0.44						
gmt13	0.42				0.43		0.42
gmt24			0.41				

In Table 2, all correlation coefficients for developed countries are positive, while in Table 1, for former Soviet countries, all coefficients are negative. In other words, the increase in the central independence, which is associated with an increase in the CWN or GMT indices and their sub-indices, in respect of developed countries, unlike the former Soviet countries, did not have a downward effect on inflation over time intervals of 5, 10 and 20 years.

4.3. Developing Countries

The initial sample contains 87 developing countries for which the latest revisions of central bank laws are found. However, it turned out to be problematic to find previous editions of these Central Bank Laws during the entire time interval of 2001-2020. Therefore, for further analysis, the data for 32 countries was used from the general sample of developing countries, where the latest version of the Central Bank Law was no later than 2010. For these central banks, the values of the CWN, GMT and their sub-indices are unchanged throughout the entire interval from 2011 to 2020. Table 3 shows the pairwise correlation coefficients for developing countries based on the averaged data at 5-year intervals for 2011-2015, 2016-2020, and at a 10-year interval for 2011-2020. Only those coefficients are shown, whose significance is not lower than 10%, and coefficients significant at the 5% level are marked with (*).

Table 3

Pairwise Correlation Coefficients for Indicators of Central Banks of Developing Countries for 5-Year, 10-Year and 20-Year Intervals

	inf11-15	inf16-20	inf11-20
cwn			
cwn21	-0.33	-0.54*	-0.57*
gmt			
gmt11	0.38*		
gmt13	0.43*		
gmt16		-0.44*	-0.45*

As can be seen in Table 3, in the context of developing countries, the coefficients of correlation of the *cwn* or *gmt* indices with inflation rates are not significant at the 5% level and even at the 10% level at all time intervals. Only some sub-indices have non-zero values. This means that for the rest of the sub-indices, the correlation coefficients are not significant even at the 10% level. These sub-indices did not significantly correlate with the inflation rate in any of the time intervals. This means that according to Table 3, we can also conclude that in the context of developing countries, there is no statistically significant general relationship between the CWN or GMT indices and their sub-indices and the inflation rate in all years from 2011 to 2020.

However, the cwn21 sub-index “agency engaged in the monetary policy formulation” had a significant negative relationship with the inflation rate at all reviewed time intervals. The gmt16 sub-index “there is no need in approving the monetary policy guidelines by the government” also had a negative 5% significant relationship with the inflation rate in the last 5-year interval and throughout the 10-year interval. At the same time, sub-indices gmt11 “the central bank governor is appointed without government’s interference” and gmt13 “central bank management board is appointed without the government’s involvement” in the first 5-year interval from 2011 to 2015 showed a significant 5% level but has a positive relationship with the inflation rate.

4.4. Binary Choice Models. Probit Model

We define the variable inftr5_m1 as equal to 1 if the inflation rate inf1120 is greater than 5 percent or less than minus 1 percent, and is equal to zero otherwise. The Probit model allows estimating the probability that central banks will keep the inflation rate within the range from minus 1 percent to 5 percent.

Table 4 provides the results of estimating the Probit model with the *cwn* explanatory variable. The P-values show that both the coefficient of this variable and the constant are not significant even at the 10% level. The same result can be obtained for the linear regression model.

Table 4

Probit Model. Dependent Variable inftr5_m1

Variable	Coefficient	P-value
const	0.69	0.35
cwn	-2.23	0.14

Probit model, whose estimates are provided in Table 5, differs from the previous model only in that the *cwn2* variable was chosen as an explanatory variable. For this model, the coefficient at the variable cwn2 is negative and significant at the 5% level. This means that an increase in cwn2 reduces the probability that the inflation rate will go beyond the [-1, 5] interval.

Table 5

Probit Model. Dependent Variable inftr5_m1

Variable	Coefficient	P-value
const	0.54	0.171
cwm2	-1.97**	0.012

The result of trying to narrow the range from minus 1 percent to 3 percent is shown in Table 6. The dependent variable inftr3_m1 has a value of 0 within this interval and a value of 1 outside of it. As can be seen, both the constant and the coefficient of the explanatory variable cwn2 appear to be statistically insignificant. It turns out that the new chosen interval for the inflation rate is too narrow to keep inflation within its bounds with an acceptable probability.

Table 6

Probit Model. Dependent Variable inftr3_m1

Variable	Coefficient	P-value
const	0.79	0.200
cwn2	-1.43	0.215

Table 7 shows the results of estimating the Probit model for the dependent variable inftr5_m1 and explanatory variable gmt21, for which the coefficient appeared to be negative and significant at the 1% level.

Table 7

Probit Model. Dependent Variable inftr5_m1

Variable	Coefficient	P-value
const	0.55	0.130
gmt21	-1.20***	0.004

4.5. Discussion

Let's pay attention to the signs of correlation coefficients in Tables 1-3. In case of former Soviet countries in Table 1, all correlation coefficients across time intervals are negative also including the coefficients that are significant at least at the 10% level.

There is a completely different picture for developed countries. In Table 2, all correlation coefficients calculated from the averaged data over time intervals are positive. It appears that the increase in the corresponding sub-indices created conditions for inflation to rise.

Whereas for developing countries in Table 3, the situation is intermediate between former Soviet and developed countries. It has both positive and negative coefficients.

Figures 5-7 show graphs of the average inflation rate in former Soviet, developed and developing countries, respectively, for 2001-2020. It can be seen that, on average, inflation in developed and former Soviet countries decreased, and its rate in former Soviet countries was several times higher than in developed countries. While in developing countries, the average inflation rate was slightly higher than in developed countries for almost the entire time interval. It has been growing only during the last 2 years.

Figure 5

Figure 6

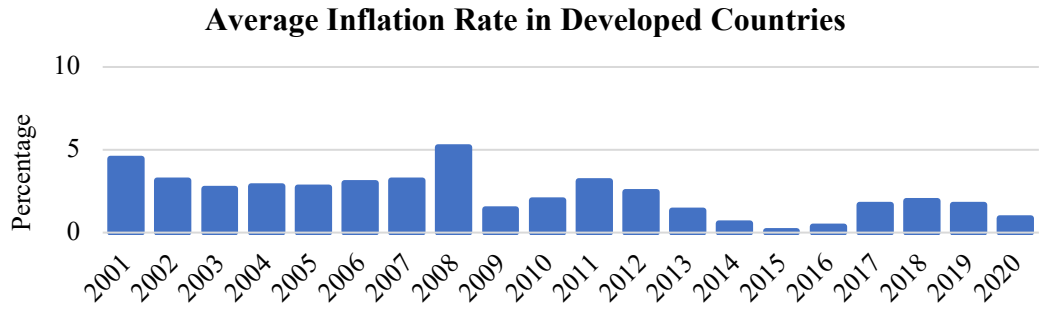
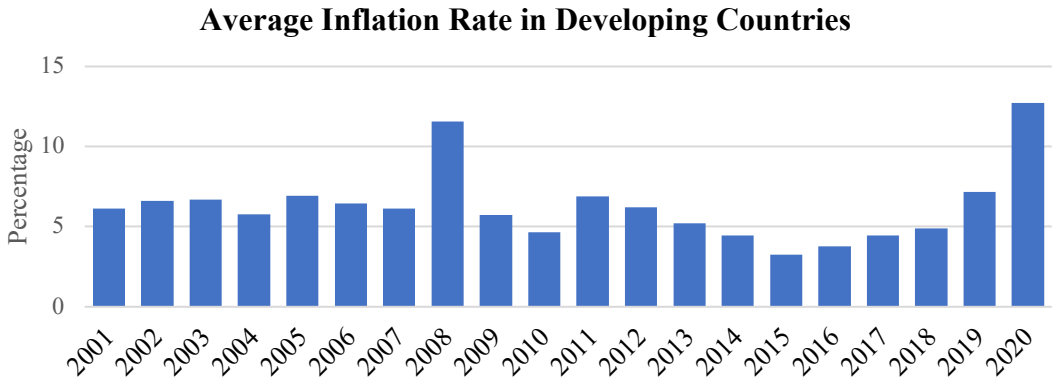


Figure 7



The above differences in the signs of the coefficients in table 1 for former Soviet countries and in table 2 for developed countries can be explained by the difference in average inflation rates in these countries and it can be assumed that the relationship between the central bank independence and inflation weakens as it decreases.

According to Kutlay (2021), Turkish President Recep Tayyip Erdogan has stated several times that he sees high inflation be stemming from high interest rates. This goes against the conventional wisdom that suggests otherwise. Through a series of interest rate cuts, the government aims to stimulate domestic investments and support export-oriented industries. In addition, the depreciation of the Turkish lira is expected to attract foreign investment and boost overall economic growth. However, the new economic policy aimed at lowering interest rates is likely to accelerate inflation. Lower interest rates – along with geopolitical risks – have led to a weakening of the lira. As Turkiye's economy depends on imports of goods in several sectors such

as energy and raw materials, the depreciation of its currency adds pressure to consumer prices. As a result, annual inflation reached 20%. In addition, rising consumer prices are likely to further worsen income distribution. Demiralp and Demiralp (2019) show that political pressure on the Central Bank of Turkiye has been increasing over the past decade, despite the Central Bank Law, which ensures the independence of instruments. The results of their study show that the government has increased its control over state-owned institutions. This trend not only entails economic costs, such as limited ability to deliver price stability and sustainable growth, but also limits the horizontal accountability of public institutions.

Bulgaria has higher CWN and GMT values than Norway, and inflation in Bulgaria was more volatile than in Norway, where it was close to the target. The Central Bank of Bulgaria, with high index values, managed to reduce inflation, which was significant until 2010, even to the level of deflation. In Norway, this was not required. This fully supports our conclusion that the relationship between the central bank independence and inflation weakens as inflation decelerates.

5. Conclusion

For 10 former Soviet countries, 18 developed countries and 32 developing countries, we tested the hypothesis of a negative relationship between the central bank independence and inflation based on the averaged data over 5-year, 10-year and 20-year time intervals. Although there is a number of authors who speak in favor of this hypothesis, other researchers question it. CWN and GMT indices are most widely recognized as criteria for the central bank independence.

The econometric analysis showed the absence of overall negative relationship between these indices as well as their sub-indices and inflation in certain years in developed, former Soviet and developing countries. Moreover, in some cases, in contrast, their positive correlation has been identified.

A complete picture of the relationship between these indices, their sub-indices and inflation rates is given by the constructed tables of pairwise correlation of the averaged data over 5-year, 10-year and 20-year time intervals. Although they showed the presence of a negative correlation in some cases, in general, it should be recognized that there is no statistically significant negative impact of the central bank independence measured by the CWN and GMT indices and their sub-indices, on inflation in developed, former Soviet and developing countries, which is true throughout the entire time interval.

Based on the binary choice model, one can conclude that high values of CBI indices and their sub-indices help keep inflation within a certain corridor.

In case of former Soviet countries, all significant coefficients in Table 1 for CWN and GMT indices or sub-indices are negative, i.e. their increase helps reduce the rate of inflation. As for developed countries, such coefficients in Table 2 are all positive. This can only be explained by the fact that in the former Soviet countries, inflation rates in the reviewed time interval were significantly higher than in developed countries.

This fully confirms the main conclusion of the study based on quantitative assessments: the relationship between the central bank independence and inflation weakens as inflation decreases. In foreign studies on developed countries, it was concluded that CBI does not have a clear impact on inflation; moreover, one cannot exclude even the impact that promotes the growth of inflation. We can explain their conclusion by the low rates of inflation in these countries. Moreover, the independence of central banks helps to keep inflation low.

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SESSION II.

Macroeconomic Coordination

Session II. Macroeconomic Coordination

Fiscal Rules in a DSGE Model for Kazakhstan

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We analyze and compare alternative fiscal rules for a small oil-exporting economy using a medium-scale DSGE model with public capital. We calibrate model parameters to the economy of Kazakhstan, which has a large volume of proven oil reserves. We analyze the performance of various fiscal rules in the presence of congestion of public capital and inefficiency of spending on public investment. We find that the government's new fiscal rules result in a countercyclical fiscal policy and lead to reduced macroeconomic volatility compared with the prevailing fiscal policy. In addition, the government's new rules outperform other fiscal rules if the government puts more weight on macroeconomic stability than household welfare. However, a set of rules with constrained net public assets and constrained government spending growth performs better than the government's new rules, if the government puts more weight on household welfare than macroeconomic stability. The constrained net public assets and government spending growth rules result in a procyclical fiscal policy whereas the government has committed to introducing a countercyclical fiscal policy, making them less relevant for policymakers, even though it results in welfare improvements for households.

Key Words: DSGE model, Fiscal rules, Oil price, Macroeconomic stability, Kazakhstan.
JEL-Classification: E62, H54, H62, H63.

The Impact of the Government Expenditures on the Current Account of the Balance of Payments of Kazakhstan through the Channel of Import of Goods

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The NBK continues the series of studies devoted to the analysis of the country's foreign economic activity. The purpose of this study is an empirical assessment of the extent to which public spending finances imports.

The study describes the structural problems of Kazakhstan's balance of payments, provides an overview of the expenditure side of the republican budget, and conducts an empirical assessment of the relationship between imports of goods and government spending to test the twin deficits hypothesis.

Key Words: current account, real current account, government spending, double deficit, non-oil current account, impulse responses.

JEL-Classification: E21, E63, F14, F32.

1. Preamble

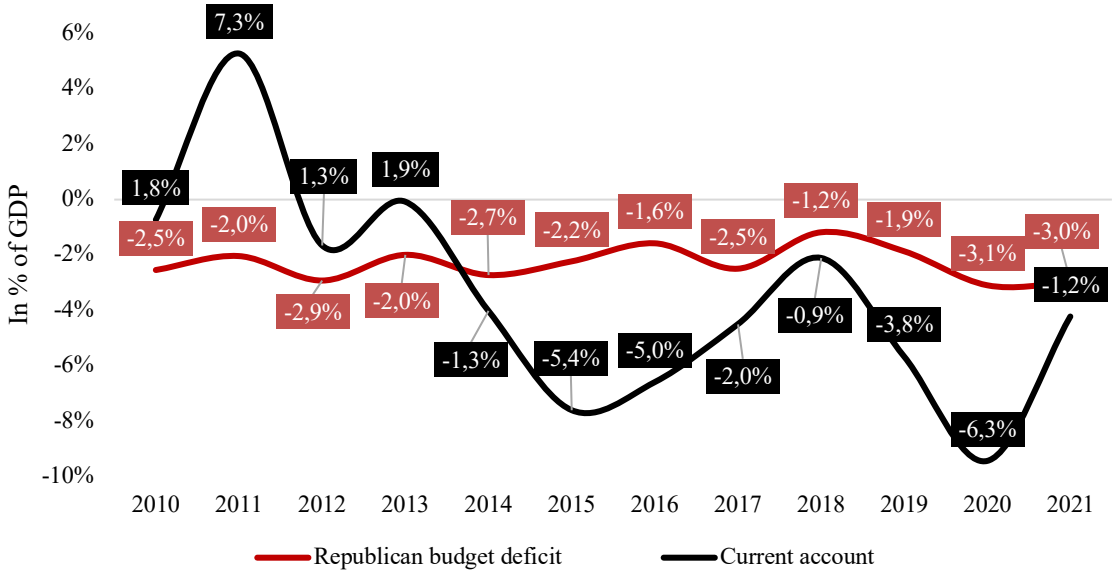
This research paper examines the presence of twin deficit phenomenon in Kazakhstan. The twin deficit was first seen in an analysis of the US economy in 1980-2000. In macroeconomics, the twin deficit hypothesis is the proposition that there is a strong causal link between a nation's government budget balance and its current account balance. That is, according to researchers who support this hypothesis, a higher budget deficit leads to a higher current account deficit.

Conventional analysis, albeit somewhat correct, fails to recognize an important distinction to be made between the ways in which the public sector deficits are created – by cutting taxes and increasing spending. It thus provides an inaccurate picture of the relationship between the fiscal policy and the balance of payments. To cut the trade deficit, reducing the government spending can be much more effective than increasing the tax burden.

The main reasons for the deficit of the current account of the balance of payments adjusted for a time lag in oil export statistics in Kazakhstan ("the current account") in 2014-2021 include relatively low prices for raw materials and a persistently high demand for foreign goods (Figure 1). The pressure on the current account from imports is constant because the local production is not sufficient to cover the domestic demand for various goods. As a result, the elasticity of demand for imports remains low. Thus, in the reviewed period, despite the deteriorating economic situation (depreciation of the national currency, economic slowdown, falling total factor productivity, and low prices for raw materials), imports of goods did not show a significant decline.

Figure 1

The National Budget Deficit and the Current Account[1] in Kazakhstan



Source: MF RK, NBK.

Note: There is a specificity of accounting in official trade statistics on the export of oil and gas condensate compiled by the SRC of the MF RK and the BNS of the ASPR RK. It is outlined as follows: the oil actually shipped in month t is reported in official statistics based on the date of submission of the final declaration, that is, with an approximate lag of up to 3 months. Within the scope of this study, the current account of the balance of payments is looked at with the adjustment of the lag in the statistics of oil exports. It represents an estimated current account that recognizes oil exports on a timely basis.

Sources for financing of imports include not only personal and borrowed funds of the population and businesses, but also the government spending whose growth has been quite significant recently. The purpose of this paper is an empirical assessment of the scale of financing of imports with the government spending.

2. Literature Review

At present, the global scientific community agrees that the fiscal policy pursued by the government has an impact on the nation's economic growth. That is, the government spending contributes to the economic growth in the long run. However, when it comes to the impact of fiscal impulses on the current account, the scientific community cannot come to unambiguous conclusions. Some researchers are trying to prove empirically that a higher budget deficit leads to a higher current account deficit (twin deficits hypothesis[2]), others prove otherwise and do not see any relationship between them.

Using the combined average group estimate of annual panel data from G7 countries, the European Central Bank researchers Katja Funke and Christiane Nickel (2006) examine the empirical relationship between the fiscal policy and international trade by analyzing the interrelation between the government spending and imports. The results of the authors' studies on developed countries show that a 1% growth in the government spending leads to a 0.4% increase in imports of goods and a nearly 0.5% increase in imports of services.

Researchers from the Netherlands (Beetsma, Giuliodori, Klaassen, 2007) elaborate this point in their study and expand it in various directions. They test this hypothesis for the European Union countries, and in the VAR models they use, break down the trade balance into components (exports, imports, ratio of GDP) as separate elements of the VAR. Thus, the authors are trying to

[1] Estimated current account where oil exports are reported on a timely basis. A more detailed description of the estimated current account is provided in the note to Figure 1.

[2] In macroeconomics, the twin deficits hypothesis is the proposition that there is a strong causal link between a nation's government budget balance and its current account balance.

determine the source of movement of the trade balance. According to the empirical analysis, a 1% growth in the government spending results in a 1.2% increase in the impact on GDP and a peak increase of up to 1.6%. According to their computations, the trade balance is deteriorating by 0.5% of GDP due to the growth in imports against reduction in the exports of goods.

In many economies in transition, the budget deficit and external deficit (current account deficit) arises simultaneously. Lasky (2009) argued that a direct and causal relationship appears only when private savings equal private investments (formula 4).

$$Y = C + S + T \quad (1)$$

$$Y = C + G + I + (X - M) \quad (2)$$

where Y – GDP, G – government spending, C – consumption, I – investments, S – savings, X – exports, M – imports, T – taxes.

$$S + T + M = G + I + X \quad (3)$$

$$I + (G - T) = S + (M - X) \quad (4)$$

A. Abel, B. Bernanke in their book noted the importance of relationship between the budget deficit and savings. The authors write that if an increase in the government deficit (G-T) is not accompanied by an equal increase in national savings (S), then this should result in the reduced domestic investments (I) or the increased current account deficit, or both. In addition, the authors pay attention to the sources of budget deficit. They agree that if the budget deficit is caused by an increase in government procurements, then it will affect the reduction in the current account balance. At the same time, the issue of the budget deficit arising due to tax cuts remains open.

According to the Ricardo equivalence theorem, the budget deficit resulting from tax cuts does not lead to a worsening of the current account, since households will send all the benefits from tax cuts to savings (the US experience in 2001). Tax cuts today are forcing the government to borrow more in order to cover its running costs. When the government begins to repay these debts, future taxes will have to increase along with interest. However, conflicting results were obtained in the mid-1980s in Canada and Italy. Despite the fact that the budget deficits in these countries are larger than in the United States, their current accounts remained in surplus zone.

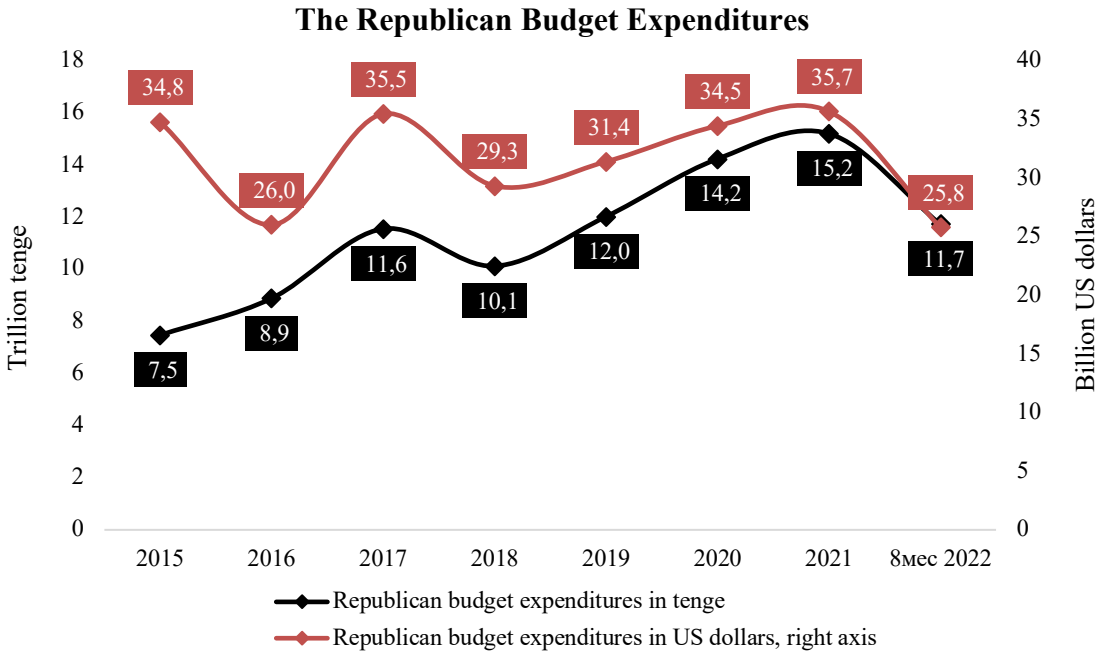
Hubert Gabrisch (2011) in his paper examines the long-term causal relationship between the budget and external deficits in three post-transition countries of Central and Eastern Europe (Poland, Czech Republic, Hungary). It is assumed that there is a long-term (intertemporal) equilibrium between private savings and investments. All results reject the twin deficit hypothesis. On the contrary, according to the author's observations, the trade balance is influenced by such specific transitional factors as high import intensity of exports and a net capital inflow.

3. An Overview of the Structure of the National Budget Expenditure Side

The volumes of imports are determined by many factors: the level of real income of the population and businesses (phases of economic activity), lending (consumer loans, leasing, and mortgages), fixed capital investments, the exchange rate, etc. However, the impact of government spending can be reflected through all of these factors due to the fact that the Kazakhstan economy is characterized by a high level of government participation.

The national budget of Kazakhstan makes up 83% of the state budget on average during the last seven years. Government financing of investment projects is accomplished from the national budget. The national budget expenditures in 2021 amounted to 35.7 billion US dollars exceeding the levels of 2015 despite the 92.1% depreciation of the tenge (Figure 2).

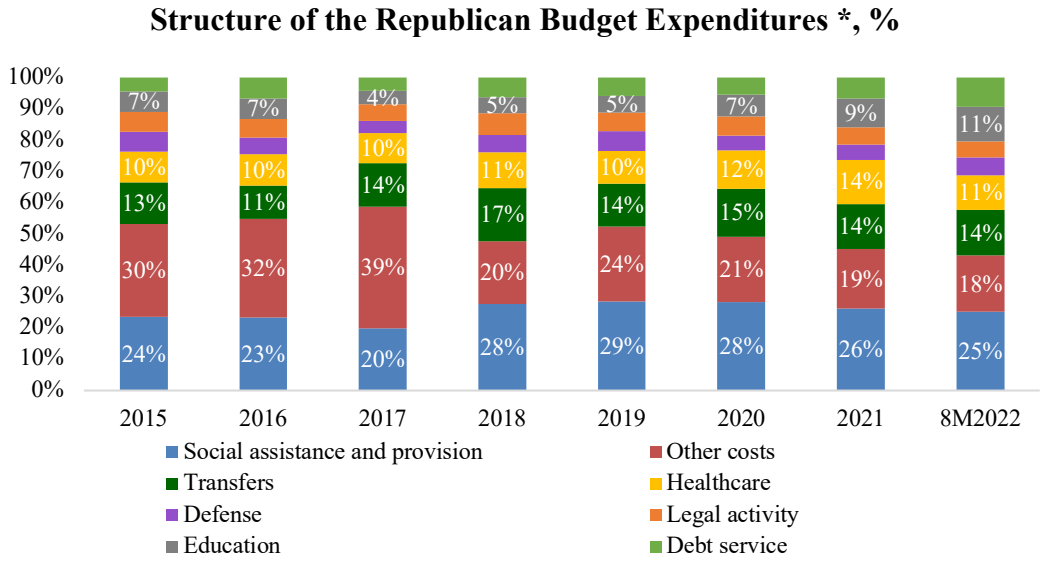
Figure 2



Source: MF RK.

The share of spending allocated to the social welfare and social security within the structure of the national budget (Figure 3) has been persistently high. It increased from 24% in 2015 to 29% in 2019. In 2021, a fourth part of the national budget was spent for this sphere. In 2017, the portion of resources allocated to education went down to 4%. Based on the results of 2021, more focus had been made by the government on this sphere, therefore the share of allocated resources reached 9%. In general, other items in the budget structure have not undergone significant changes over the reviewed period.

Figure 3

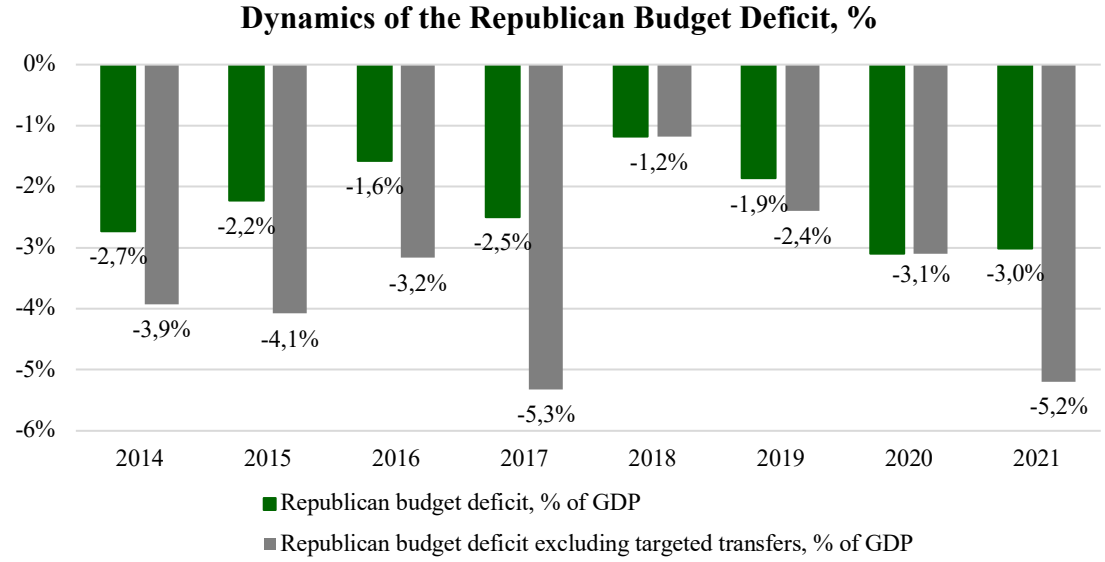


Source: MF RK.
Note: expenditures are shown excluding budget loans and financial asset acquisitions.

During the period from 2014 through 2021, the republican budget remained in the deficit zone. The highest level of deficit as percentage of GDP was observed in 2020 and equaled -3.1%. If it were not for the earmarked transfers from the National Fund, the republican budget deficit would have been higher. This is related to the fact that earmarked transfers are the least regulated channel of allocations from the National Fund and are characterized by the immediate decision-

making regarding their allocation. Excluding earmarked transfers, the national budget deficit would exceed 5% of GDP in 2017 and 2021 (Figure 4).

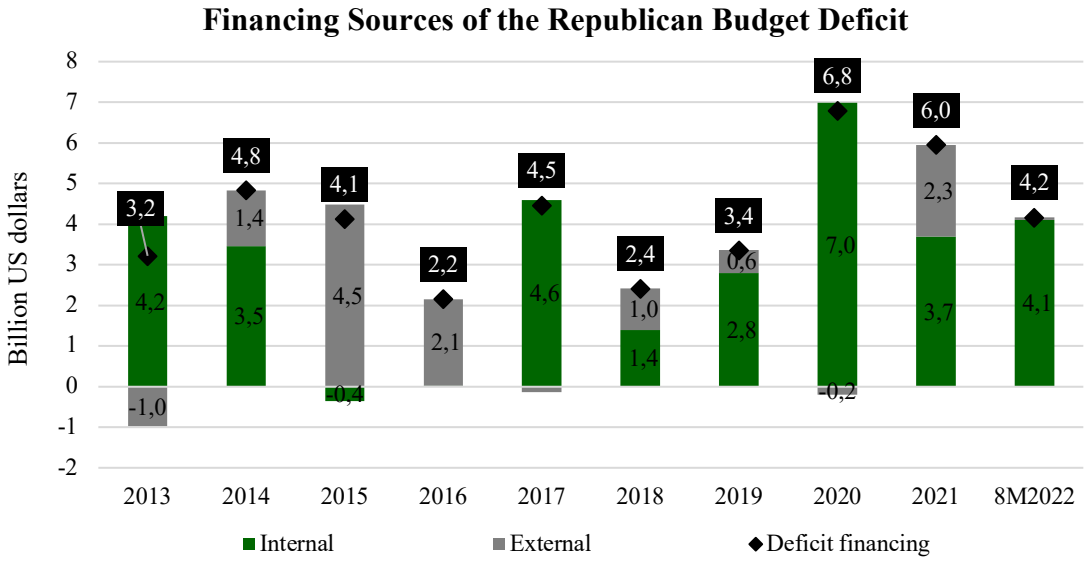
Figure 4



Source: MF RK.

The national budget deficit is financed from domestic and external sources by way of issuing bonds and capital raising. Since 2017, priority in financing of the national budget deficit has been given to domestic sources, whereas before 2017, the deficit was mainly financed by borrowing from abroad (Figure 5).

Figure 5



Source: MF RK.
Note: financing volumes are presented on a net basis (receipt less repayment).

In analyzing the republican budget spending, it becomes obvious that the budgetary system of Kazakhstan is more of a social nature. That is, the budget spending is not only focused on large investment projects in the country but also has a high share of welfare payments, in addition to the salaries of employees of state-owned organizations as well as employees of organizations funded from the state budget.

When viewed from the perspective of the demand for import of goods, this situation is an impulse for the demand for consumer goods created by the government spending. Thus, the continuous increase in government spending supports the demand for consumer goods in addition

to the demand for interim and investment goods. If we take into account the stability of public spending, regardless of the economic situation in the country, the abovementioned welfare payments from the budget restrain the cyclical change in imports.

4. An Overview of the Current Account of the Balance of Payments

The current account of the balance of payments has been traditionally characterized by a number of structural problems: a high percentage of raw materials in exports, the economy's dependence on imports, and concentration of attracted foreign direct investments in the mining industry.

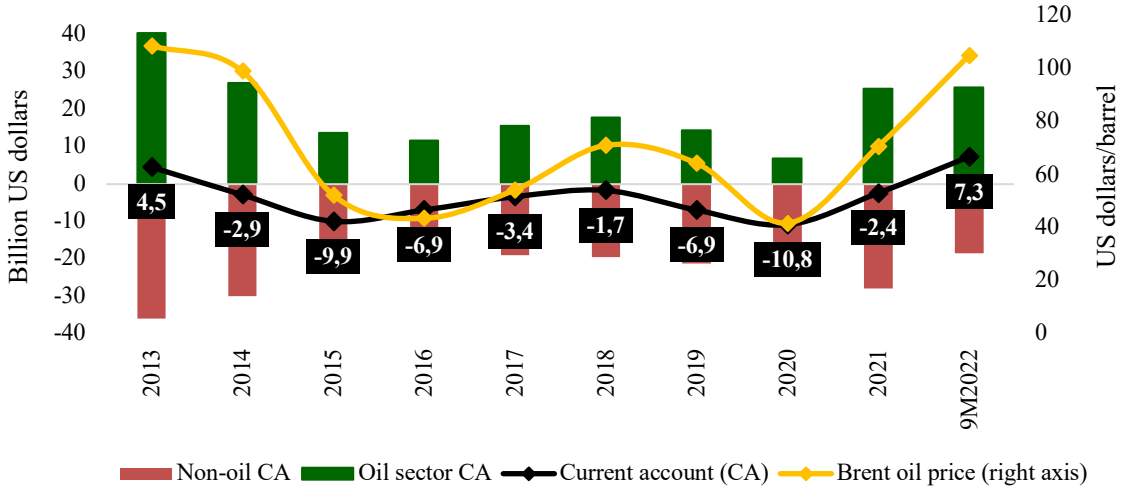
A large share of raw commodities in exports increase the balance of payment exposure to changes in world prices for raw materials. The current account path mainly repeats the dynamics of oil prices (Figure 6). Consequently, the following picture had been observed throughout the period in question: from 2014 to 2021, the current account had been in the deficit zone, in 2013, and at the end of 9 months of 2022 – in the surplus zone.

The non-oil current account had been in the negative zone throughout the reviewed period whereas the oil current account had stayed in the surplus zone.

The government spending on implementation of investment projects is mainly allocated to the non-oil sector of the economy. However, until now such spending had not contributed to the improvement of the current account and its migration to the surplus zone.

Figure 6

Decomposition of the Real Current Account



Source: MF RK, NBK.

The main reason for the deficit of the current account of the balance of payments in Kazakhstan in 2014-2021, in addition to relatively low prices for raw materials, was also a persistently high demand for foreign goods. Pressure on the current account from imports is constant due to the fact that the local production is not sufficient to cover the domestic demand for various goods. As a result, the elasticity of demand for imports remains low. Thus, in the reviewed period, despite deterioration of the economic situation (depreciation of the national currency, economic slowdown, the falling total factor productivity, low prices for raw materials), imports of goods did not show a significant reduction.

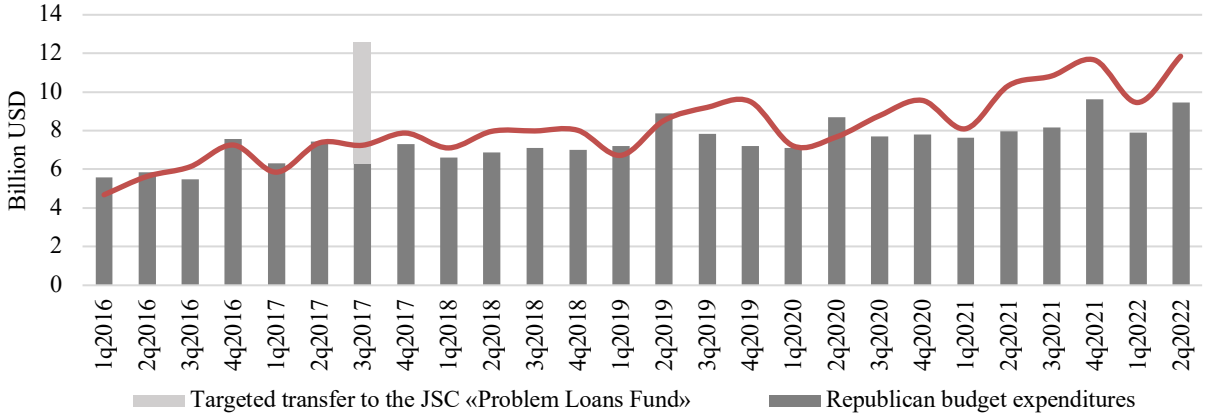
Yet another structural problem of Kazakhstan's balance of payments is a high concentration of attracted foreign investments in the mining industry. The ratio between the return payable to foreign investors and exports of goods remains high and over the recent 8 years (2014-2021) had averaged 37%. Therefore, when the trade balance improves owing to the rising world prices for raw materials, the current account does not improve proportionally.

5. Basic Empirical Model

In order to determine the scale to which the imports of goods are financed by the government spending, an empirical relationship was considered between the republican budget spending, excluding debt service costs, and imports of goods, cleared of procurements by oil companies (Figure 7). The need to clear imports is driven by the fact that investment projects in the oil sector are mainly financed by foreign investors, and not from the nation's budget.

Figure 7

Dynamics of Cleared Import of Goods and the Republican Budget Spending Excluding Debt Service Costs



Source: MF RK, NBK.

Note: the import of goods are cleared of procurements of oil companies under the CCEA "06100 – Crude oil and natural gas production".

Model Parameters. In order to determine the impact of government spending on the balance of payments via the import of goods channel, various econometric models (VAR, VECM, OLS, and ARDL) with the use of monthly data for 2016-8 months of 2022 were constructed and studied.

Among all constructed models, the vector autoregression model (VAR, Appendix 1) produced the best results on a number of statistical tests.

Table 1

Information about the Chosen VAR Model

Model Type	VAR
Factors included in the model	1) Import of goods (consumer, intermediate, investment) **without** oil projects. Imports were cleared of oil projects (87 companies in total, the share in imports – 7.3% in the period of 2016-8 months of 2022) given that almost all their procurements are financed not by the government spending but by foreign direct investments. 2) The republican budget spending excluding debt service costs.
Length of the time series used	January, 2015 – August, 2022
Time series frequency	Monthly data

Results of Empirical Assessment. The literature review presented the results of a study by the European Central Bank (Katja Funke and Christiane Nickel, 2006), whereby, in the G7 countries, a 1% increase in the government spending leads to an increase in imports of goods by about 0.4%.

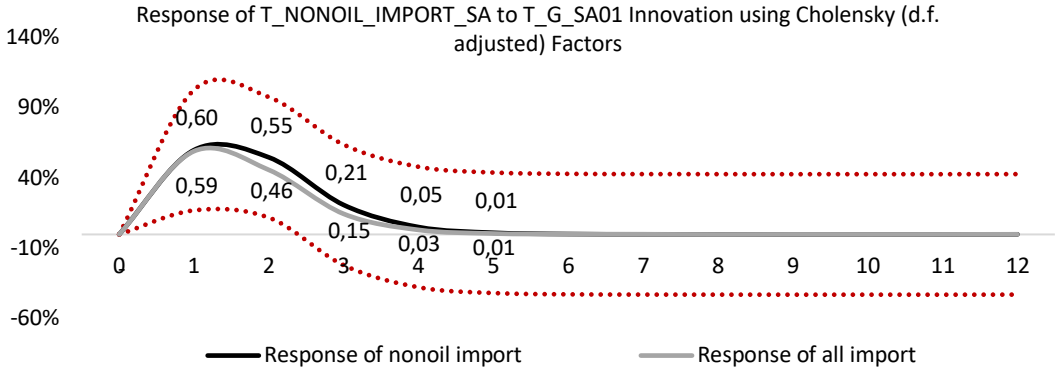
The results of this study show that the impact of government spending on import growth in Kazakhstan is more significant than in the G7 countries: a 1% growth in the budget spending in

the current month leads to a 0.6% increase in cleared imports next month, followed by a full impulse attenuation after 5 months (Figure 8)[3].

The impact of budget spending on total (uncleared of oil sector procurements) imports is not significantly different from the impact on net imports: a 1% growth in the budget spending in the current month leads to a 0.59% increase in total (uncleared) imports in the next month, followed by a full impulse attenuation after 5 months. Such insignificant difference in impulses can be explained by the fact that when imports are cleared of the oil sector procurements, purchases of oil companies through contracting enterprises were not taken into account. Imports of oil companies through contractors can be significant.

Figure 8

Impulse Response of Cleared Imports to the Government Spending Shocks



Source: the authors' computations.

Note. X axis shows months. The month t=0 is a period of shocks to the government spending. Y axis shows the response from imports to a surge in the government spending. Dotted lines denote a 95% confidence interval..

Impulse responses from cleared imports to the government spending shocks presented in Figure 8 demonstrate the following: other things being equal[4], the growth in budget spending by 1% on average in the current month will lead to a 1.42% increase in the average monthly cleared imports after 5 months. A growth in imports larger than the impulse itself (1.42%>1%) may be associated with a possible multiplier effect of the government spending.

The multiplier effect can be expressed as follows. A part of the republican budget spending is directed to implementation of investment projects, subsidizing agriculture, supporting SMEs, thereby stimulating the growth of imports of interim and investment goods in the period of utilization of resources allocated by the government. The resulting profit of economic entities is spent by such entities on real estate, cars and other tangible assets, which are either satisfied by imports or stimulate it (for example, the purchase of real estate stimulates the import of construction materials, household appliances and furniture).

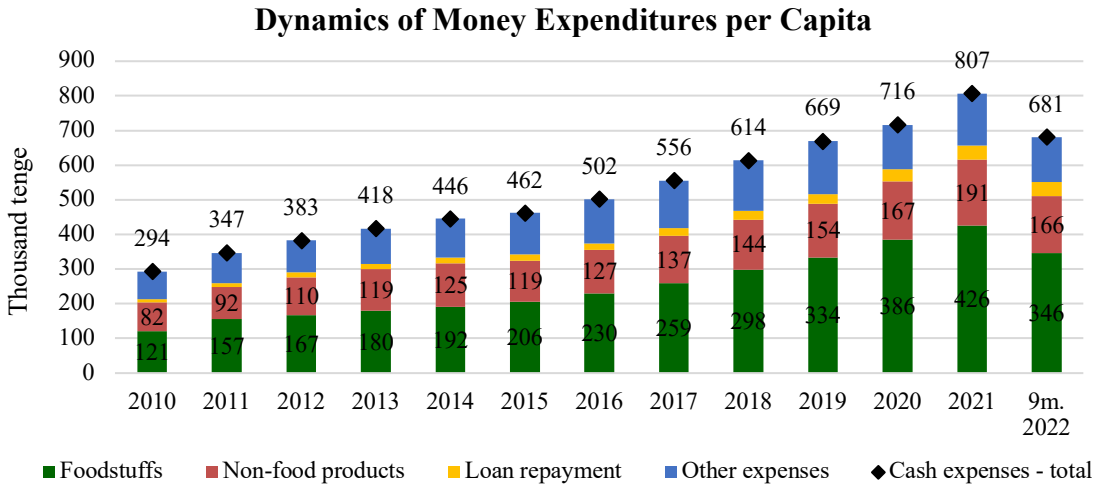
The budget spending includes not only expenditures related to implementation of investment projects, agricultural subsidies, SME support but also expenditures on wages to public sectors and social benefits. Such expenditures are distinguished by their stability and support the demand for consumer goods, including imported ones.

According to the BNS of the ASPR RK, based on the results of 2021, every resident of the country on average uses 76.5% of his/her expenditures for consumer goods (Figure 9).).

[3] According to the IMF, most studies conclude that a budget improvement of 1 percent of GDP improves the current account by 0.1-0.4 percent of GDP. Source: World Economic Outlook, IMF, September 2011.

[4] The volume of imports, in addition to the government spending, is also affected by a number of other factors – real income of the population and businesses (phases of the economic activity), lending (consumer loans, leasing, and mortgages), fixed capital investments, the exchange rate, and others. In making computations, we assume that the above factors remain unchanged.

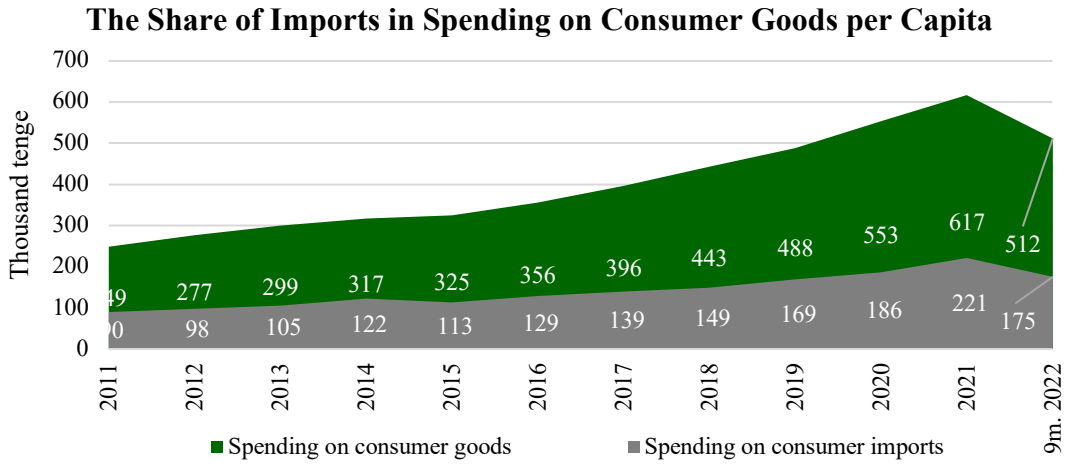
Figure 9



Source: ASPR BNS RK.

Based on the data from the BNS of the ASPR RK, an attempt was made to estimate the share of imports in spending on consumer goods. The analysis results show that for the year of 2021, every resident of Kazakhstan on average uses 36% of his/her expenditures for imported goods (Figure 10).

Figure 10



Source: ASPR BNS RK.

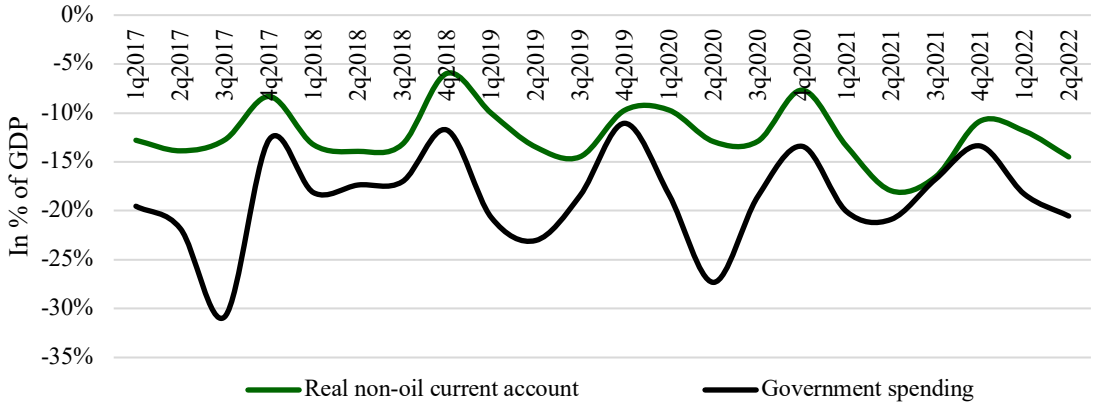
Given that the government spending is mainly directed to the sectors of economy not related to the oil and gas industry, a more precise reflection of the impact on the pursued fiscal policy is shown by the non-oil current account[5] (Figure 11).

A visual analysis indicates that the change in the non-oil current account deficit (Appendix 2) repeats the dynamics of the volumes of government spending. That is, an increase in budget expenditures leads to worsening of the current account.

[5] The oil sector is mainly developing owing to investments made by foreign direct investors.

Figure 11

The Non-Oil Current Account and the Republican Budget Spending Excluding Debt Service Costs



Source: MF RK, NBK.
Note: government spending is shown with a minus sign.

6. Conclusions

The empirical analysis showed the following results.

1. According to estimates, in Kazakhstan, a 1% growth in the budget spending excluding debt service costs in the current month leads to a 0.6% increase in imports less imports by oil companies in the next month, followed by a full impulse attenuation in 5 months.

In aggregate, the growth in the budget spending by 1% on average in the current month will lead to a 1.42% increase in cleared imports after 5 months in total. Other things being equal, a growth in imports larger than the impulse itself (1.42%>1%) may result from a multiplier effect of the government spending on overall expenditures in the economy.

2. The government spending stimulates the demand not only for production means and interim goods for implementation of investment projects, but also for consumer goods. This stems from the fact that welfare payments and salaries to the public sector employees account for a significant portion in the budget structure. Insufficient volumes of the local production to cover the domestic demand result in that a considerable part of public resources as well as private sector funds goes to finance the imports.

3. The government spending is characterized by stability, irrespective of the economic situation in the country. Such non-cyclical financial impulses on the part of the government explain the non-cyclical path of imports of goods.

4. An increase in the government spending fuels the worsening of the non-oil sector current account. Therefore, investment projects in the non-oil sector implemented with government resources until now haven't contributed to improvement in the current account.

5. The preformed empirical analysis demonstrates that the twin deficit hypothesis in Kazakhstan is confirmed: a worsening republican budget balance leads to the worsening of the current account via the import of goods channel.

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Appendix 1

To determine the impact of government spending on import of goods, a vector autoregression model (VAR model) was built using data for the period from 2015 to 8 months of 2022 on a monthly basis:

$$Import = a_1*Import(-1) + a_2*G(-1) + Dummy + \varepsilon_t$$

где:

Import – growth rates of imports of goods excluding imports of oil companies (month to the corresponding month of the previous year);

G – government spending growth rate excluding debt service costs (month on the corresponding month of the previous year);

Dummy – a dummy variable that takes into account the effects of events on the variable being explained.

At the same time, the variables under study (Import, G) are introduced into the model as endogenous variables, while the dummy variable is introduced as exogenous.

When constructing the VAR model, a short-term relationship between government spending and import of goods minus imports of oil companies was obtained, presented in the table.

	T_NONOIL_IMPORT_SA(-1)	T_G2_SA(-1)
Short-run relationship coefficient	0.670845	0.174274

The resulting model shows a **positive dependence of imports on government spending**. The corrected coefficient of determination was 0.71 and shows a high value, which means that the variables under study are informative for the analysis.

VAR model

Vector Autoregression Estimates
Date: 02/27/23 Time: 15:12
Sample: 2016M03 2022M08
Included observations: 78
Standard errors in ( ) & t-statistics in [ ]

	T_NONOIL_IMPORT_SA	T_G2_SA
T_NONOIL_IMPORT_SA(-1)	0.670845	0.353350
	(0.06479)	(0.13854)
	[10.3545]	[2.55050]
T_G2_SA(-1)	0.174274	0.290842
	(0.05046)	(0.10790)
	[3.45366]	[2.69537]
C	0.190745	0.358106
	(0.06972)	(0.14910)
	[2.73569]	[2.40181]
DUMMY_IMPORT	-0.251640	0.083548
	(0.06499)	(0.13898)

	[-3.87194]	[0.60117]
R-squared	0.723573	0.242093
Adj. R-squared	0.712366	0.211367
Sum sq. resids	0.594064	2.716480
S.E. equation	0.089599	0.191596
F-statistic	64.56718	7.879108
Log likelihood	79.54440	20.26030
Akaike AIC	-1.937036	-0.416931
Schwarz SC	-1.816179	-0.296074
Mean dependent	1.096304	1.047852
S.D. dependent	0.167063	0.215750

Determinant resid covariance (dof adj.)	0.000295
Determinant resid covariance	0.000265
Log likelihood	99.80534
Akaike information criterion	-2.353983
Schwarz criterion	-2.112269
Number of coefficients	8

The necessary tests were carried out to confirm the statistical significance of the model and the absence of false regression.

For this, a correlation table was constructed, which shows the presence of a positive statistical relationship between imports and government spending, which is also confirmed by the coefficients in the model.

Correlation

	T_G_SA	T_NONOIL_IMPORT_SA
T_G_SA	1	0.42479
T_NONOIL_IMPORT_SA	0.42479	1

The Granger causality test shows that changes in government spending cause changes in imports, and not vice versa.

VAR Granger Causality/Block Exogeneity Wald Tests
Date: 02/28/23 Time: 12:48
Sample: 2016M03 2022M08
Included observations: 78

Dependent variable: T_NONOIL_IMPORT_SA

Excluded	Chi-sq	df	Prob.
T_G2_SA	11.92778	1	0.0006
All	11.92778	1	0.0006

Dependent variable: T_G2_SA

Excluded	Chi-sq	df	Prob.

T_NONOIL_IMPORT_SA	6.505031	1	0.0108
All	6.505031	1	0.0108

Through the Lag Criteria Structure function, the optimal number of lags for the p=1 model is determined. This is confirmed by 5 out of 5 criteria, including the information criteria of Schwartz and Hanna-Queen.

VAR Lag Order Selection Criteria
Endogenous variables: T_NONOIL_IMPORT_SA
T_G2_SA
Exogenous variables: C
DUMMY_IMPORT
Date: 02/28/23 Time: 14:20
Sample: 2016M03 2022M08
Included observations: 73

Lag	LogL	LR	FPE	AIC	SC	HQ
0	66.16355	NA	0.000624	-1.703111	-1.577606	-1.653095
1	96.97340	58.24327 *	0.000300*	-2.437627*	-2.186618*	-2.337596*
2	100.9360	7.273737	0.000300	-2.436601	-2.060088	-2.286554
3	101.5497	1.092889	0.000330	-2.343826	-1.841808	-2.143763
4	101.9806	0.743783	0.000364	-2.246043	-1.618520	-1.995964
5	104.0097	3.391101	0.000385	-2.192046	-1.439018	-1.891951
6	105.9964	3.211404	0.000408	-2.136887	-1.258355	-1.786777
7	110.2177	6.592174	0.000408	-2.142951	-1.138914	-1.742825

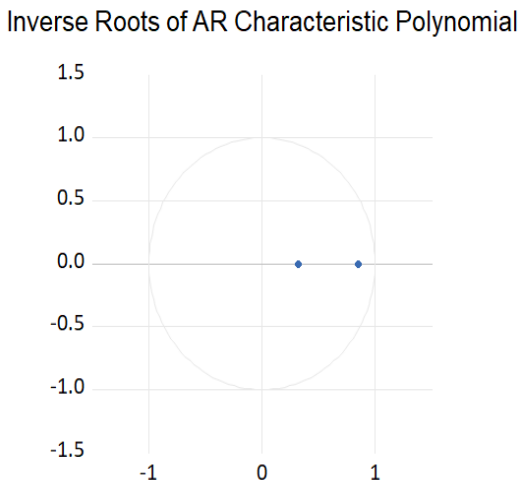
* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

The calculation model is stationary, because all reciprocal roots are less than unity in absolute value and are located inside the unit circle.

Roots of Characteristic Polynomial
Endogenous variables: T_NONOIL_IMPORT _SA T_G2_SA
Exogenous variables: C DUMMY_IMPORT
Lag specification: 1 1
Date: 02/28/23 Time: 14:27

Root	Modulus
0.793381	0.793381
0.168305	0.168305

No root lies outside the unit circle.
VAR satisfies the stability condition.



The Autocorrelation LM Test checks for residual serial correlation up to a specified order. Prob > 5% for all lags, which confirms the absence of serial correlation.

VAR Residual Serial Correlation LM Tests
Date: 02/28/23 Time: 14:34
Sample: 2016M03
2022M08
Included observations: 78

Null hypothesis: No serial correlation at lag h						
Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	4.867511	4	0.3012	1.229169	(4, 142.0)	0.3012

Null hypothesis: No serial correlation at lags 1 to h						
Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	4.867511	4	0.3012	1.229169	(4, 142.0)	0.3012

*Edgeworth expansion corrected likelihood ratio statistic.

The results of White's test for heteroscedasticity (variability of variances of deviations) show that the residuals of the model are homoscedastic (the probability is greater than 5% for both the general test and the residuals of individual variables), i.e. the variance of deviations is constant.

VAR Residual Heteroskedasticity Tests (Levels and Squares)
Date: 02/28/23 Time: 14:51
Sample: 2016M03 2022M08
Included observations: 78

Joint test:

Chi-sq	df	Prob.
8.159379	15	0.9172

Individual components:

Dependent	R-squared	F(5,72)	Prob.	Chi-sq(5)	Prob.
res1*res1	0.023799	0.351062	0.8800	1.856331	0.8686
res2*res2	0.008186	0.118848	0.9878	0.638492	0.9862
res2*res1	0.068594	1.060493	0.3895	5.350310	0.3746

Additionally, a normal distribution test was performed. As can be seen from the table, all variables have Prob > 5%, which allows us to speak about the normal distribution of the residuals of each variable individually and in general

.

VAR Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
Null Hypothesis: Residuals are multivariate normal
Date: 02/28/23 Time: 14:55
Sample: 2016M03 2022M08
Included observations: 78

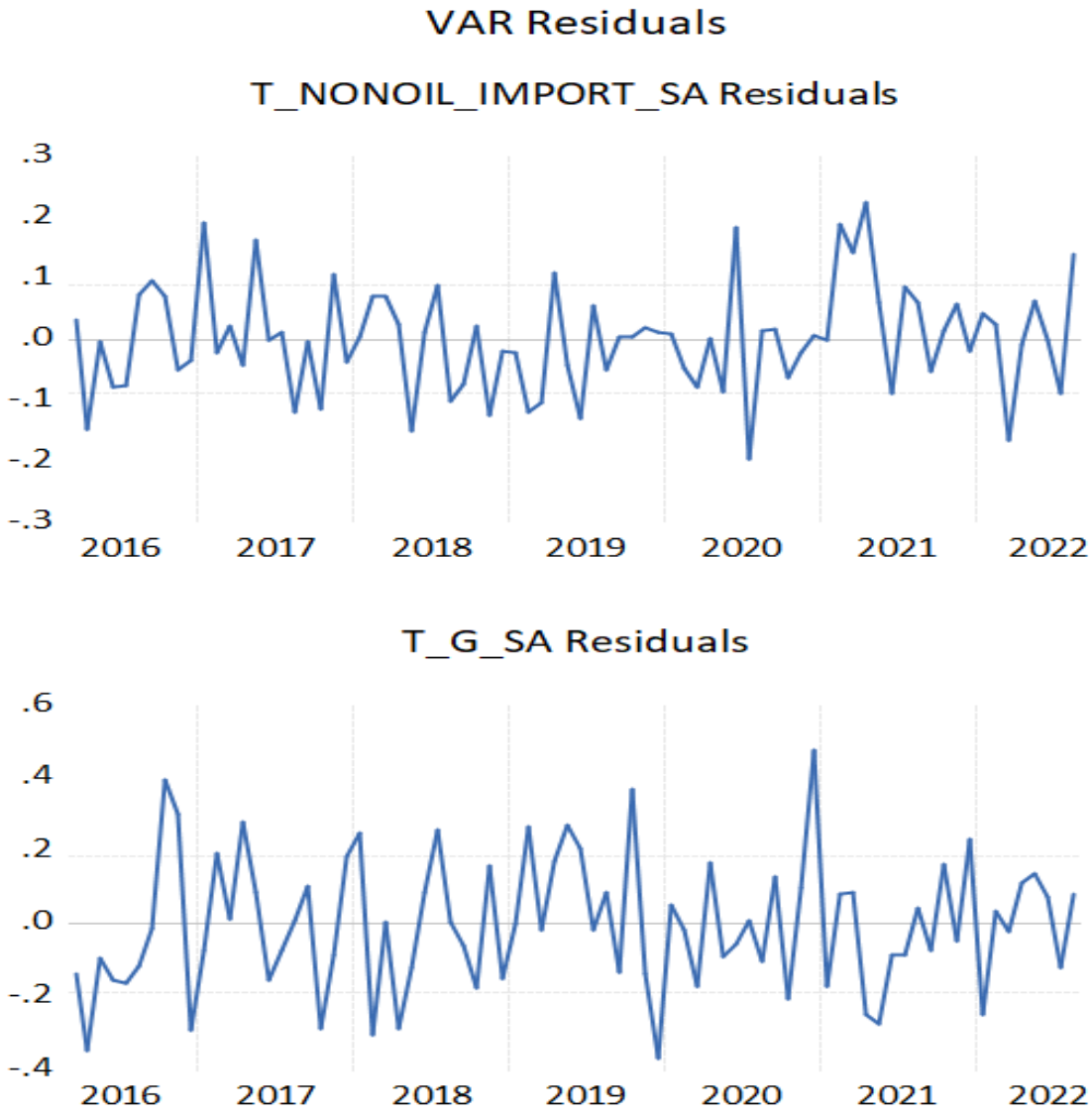
Component	Skewness	Chi-sq	df	Prob.*
1	0.285057	1.056349	1	0.3040
2	0.245075	0.780801	1	0.3769
Joint		1.837150	2	0.3991

Component	Kurtosis	Chi-sq	df	Prob.
1	3.062926	0.012869	1	0.9097
2	2.783130	0.152856	1	0.6958
Joint		0.165725	2	0.9205

Component	Jarque-Bera	df	Prob.
1	1.069218	2	0.5859
2	0.933657	2	0.6270
Joint	2.002875	4	0.7352

*Approximate p-values do not account for coefficient estimation

The residuals of the model are stable, indicating a good explanatory power of the model.



Appendix 2

The non-oil current account was estimated by excluding the following parameters from the general current account:

✓ Export of oil in the group of goods "2709 – oil and gas condensate";

✓ Import of oil-producing enterprises according to CCEA “06100 – Extraction of crude oil and natural gas”;

✓ Balance of services of enterprises according to CCEA "06100 - Extraction of crude oil and natural gas";

✓ Income balance of enterprises according to CCEA "06100".

Interrelation between Macroprudential and Monetary Policies: Goals, Instruments, Effects

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We use the Debt Service to Income Ratio (DSTI), which was previously introduced in Kazakhstan, as well as detailed information available from the local credit register, to study the impact of macroprudential instruments on borrowers' financial stability parameters. The results show that the introduction of DSTI limit of 50% results in a 1.2% reduction in outstanding debt, on average, compared to a number of loans provided in the first and second quarters of 2014. We also found that the imposition of DSTI limits reduced the probability of default on loans, on average, compared to loans originated just before the introduction of DSTI limits. Our results provide an overview of both the quantitative and qualitative effectiveness of DSTI in the growth dynamics of the consumer lending cycle. We also find that the impact of macroprudential policy instruments increases at a given inflation rate. Our deliverables show that macroprudential and monetary policy tools can complement each other depending on business cycle goals.

Key Words: consumer loan, household debt, DSTI, credit register, Kazakhstan.
JEL-Classification: E44, E10, G10.

1. Preamble

What are the transmission mechanisms that appear in household debt indicators, which can increase the probability of a financial crisis? Despite extensive and growing evidence of the relationship between household debt and the likelihood of financial crises, previous research on the precise transmission mechanisms driven by higher levels of debt or debt service parameters and loan quality is still sparse and inconclusive. Ultimately, establishing a strong relationship between these two factors is critical for proper elaboration of domestic macroprudential policies configuration, and in particular, those related to borrower protection-oriented instruments.

The real world experience of using macroprudential instruments to counter periods of consumer credit growth over the past two decades is diverse in both advanced and emerging market economies. This has given rise to a whole body of literature focused on examining the effectiveness of macroprudential policies in relation to various variables of economic, real and financial stability. It is important to note that much of the evidence for the usefulness of certain macroprudential instruments to date is based on aggregated data, either at the country level or at the bank level. There is still a limited number of studies that analyze micro-level datasets from local credit registers that potentially contain rich structural information about the operation of macroprudential constraints on the given loan portfolio.

Our empirical approach is based on a detailed diagnostics of the structure of individual loans at the credit level and a corresponding macroeconomic interpretation of aggregate household credit cycles. We classify each individual loan based on its ratio to the minimum wage, effectively converting the absolute amount of a given loan into a comparable and consistent ratio that can be internationally tested for other case studies. Therefore, using specific loan information from the local credit register database, we estimate the marginal impact of the marginal debt service-to-income ratio (DSTI) on household debt using the "Difference-in-Difference" model.

We use these microeconomic models based on the data from the Kazakh household lending market. The database contains information such as the type of loan (consumer or mortgage), loan amount at the time of origination, repayment period, currency and borrower's age. We include loans that come into effect one month before the DSTI introduction (April 1, 2014) and immediately after the introduction of the DSTI tool, and track them by key indicators for one year. A loan is considered as bad if it has payments 90+days pastdue.

We use Kazakhstan's early introduction of the debt service-to-income ratio, as well as available detailed information from the local credit register, to study the impact of macroprudential instruments on borrowers' financial stability parameters. The results show that imposition of a

50% DSTI limit results in a 1.2% reduction in outstanding debt, on average, compared to a range of loans originated in the first and second quarters of 2014. We also found that use of DSTI limits reduced the probability of default on loans, on average, compared to loans issued immediately before the imposition of DSTI limits. Our results provide an overview of both the quantitative and qualitative effectiveness of DSTI in the growth dynamics of the consumer lending cycle. We also find that the impact of macroprudential policy instruments increases at a given level of inflation. Our results show that macroprudential and monetary policy tools can complement each other depending on business cycle goals.

The paper specifically studies the relationship between the consumer lending cycle and macro- and microeconomic factors that determine the periods of boom-bust cycles of household credit waves. Hence, Section 2 shows the corresponding Literature Review. In Section 3, we provide a set of data obtained from Kazakhstan's Credit Register, and in Section 4 we present our empirical tests. Finally, Section 5 is the Conclusion.

2. Literature Review

One particular issue related to the evaluation of macroprudential measures is the different nature of its specific objectives and instruments. Therefore, as stated in the Gambacorta and Murcia (2020) report, there is no universal perspective for the use of macroprudential policy instruments. Their exact combination and choice for application, calibration mechanisms and the specific point in the credit cycle for their application depend on the monetary authorities' assessment of the degree of macro-financial vulnerability of the economy. In addition, it is essential to take into account the legal and institutional development of the local economy. Since the adoption of certain macroprudential measures, financial institutions begin to adapt to the new regulatory environment, which subsequently can virtually even distort the original intent of the measures introduced.

As we have already discussed in the introductory section, despite the resurgence of interest in the macroprudential approach to financial regulation, which aims to reduce the risks of the financial system as a whole, the impact of these instruments on financial stability and real variables is rather ambiguous and still remains unresolved. Galati and Moessner (2018) present a comprehensive literature review in which they provide a critical review of theoretical and empirical findings and demonstrate recent progress in the effectiveness of macroprudential policy instruments at both the macro and micro levels.

Based on the level of evidence used to empirically assess the effectiveness of macroprudential policies, the literature can be divided into three practical areas of aggregation (Gomez et al. 2020). First, there are studies that use information at the country level. At the same time others use the bank-level data, while a third group explores the implications of macroprudential policy instruments using bank-debtor relationship level data, which is mainly taken from credit register data.

In general, the first group of studies usually conducts event studies or regression of panel data at the country level. The findings can be summarized as follows: a) macroprudential policies can reduce the effects of a recession by reducing the impact on the real economy (Dell'Ariccia et al., 2012); b) its tightening is associated with a slowdown in bank lending growth and housing price bubbles (Bruno et al. 2017), (Cerutti et al. 2017) and (Akinci and Olmstead-Rumsey 2018); c) effects appear to be smaller in more financially advanced and open economies (Cerutti et al., 2017); and d) the macroprudential policy is more successful when it compliments the monetary policy by intensifying the monetary policy tightening rather than when it works in an opposite direction (Bruno et al., 2017). The seminal study in the first group of studies is the work of Alam et al. (2019) on evaluating the effectiveness of macroprudential instruments using the Integrated Macroprudential Policy (iMaPP) database. The authors note a significant impact of instruments of directed lending on the real volume of household lending, but a weaker impact on housing prices.

As for the second group, the studies use information at the bank level to study the impact of macroprudential policy instruments on certain indicators of the banking sector. This literature primarily concludes that DTI and LTV ratios appear to be comparatively more effective than

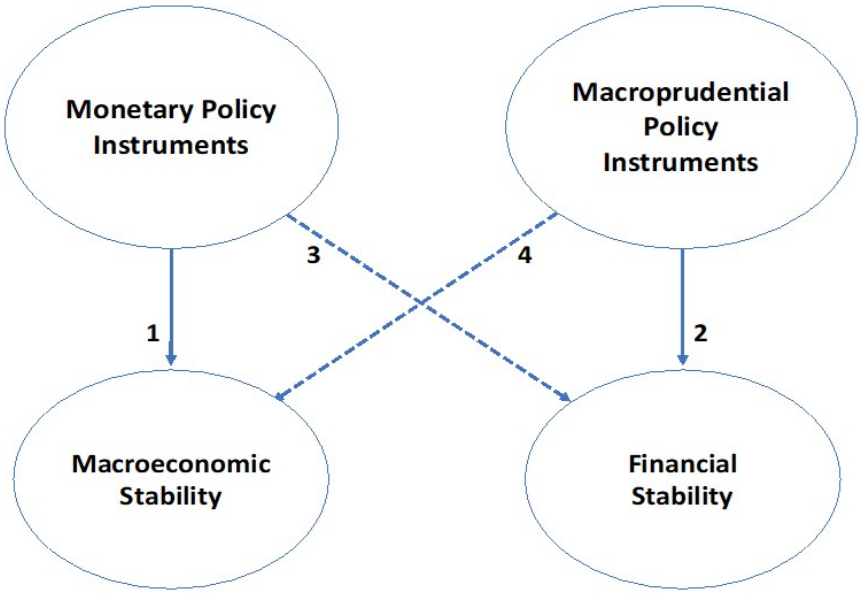
capital requirements as tools to curb the credit growth (Claessens et al., 2013), Lim et al., (2011). In a China case study, Wang and Sun (2013) concluded that reserve requirements and housing-related policies could be helpful in reducing procyclicality but not sufficient to mitigate systemic risks, suggesting that more focused policies could have more potential to contain macro-financial vulnerabilities. Altunbas et al. (2018) report that macroprudential instruments have a significant impact on banking risk, especially those designed to improve bank soundness. It is important to note that the implementation of macroprudential policies can lead to leakage effects in such a way that it encourages borrowers to seek loans from lenders outside the scope of regulation (Aiyar et al., 2014).

Within the third group, recent attempts to assess the impact of macroprudential policies include the analysis of credit register data, which allows conducting a detailed micro-level study of the impact from the introduction of individual macroprudential instruments. For example, Jiménez et al. (2017) document that acyclical measures were successful in mitigating the effects of the credit crunch (due to the build-up of capital buffers), but they were not effective in constraining the credit boom. Lopez et al. (2014) found that acyclical reserves helped reduce exacerbation of credit cycles, while Vargas et al. (2017) highlight that MaPPs reduced the bank's ex-post credit risk. Studies by Martins et al. (2013) on car loans and Dassatti Camors et al. (2019) show that reserve requirements for short-term loans on foreign deposit have reduced the supply of credit.

Another useful approach to reviewing the literature on the effects of macroprudential policy is to distinguish between a particular instrument and the goals it is intended to achieve (as shown in Figure 1). Thus, the first part of the literature analyzes the impact of macroprudential instruments on real economy variables (line 4). For example, Boar et al. (2017) analyze the impact of macroprudential instruments on the level and volatility of GDP growth over 5-year periods. Therefore, the authors report that the more often a country uses macroprudential measures, the better, the higher the country's per capita GDP growth rate, and the less volatile its economic growth. The second approach examines the macroeconomic impact of monetary and macroprudential policy instruments on the real business cycle (line 1 and line 4). In particular, Kim and Mehrotra (2018) use the data from four inflation-targeting countries in the Asia-Pacific region that were also considered heavy users of macroprudential instruments in the recent past. A key finding of their study is that the impact of monetary and macroprudential policy shocks on major key macro factors (real GDP, price levels, and credit levels) is similar. Transmission channels vary, and there is an interaction between monetary and macroprudential policies that is reduced over time in response to restrictive monetary policy.

Diagram 1

Interrelation between the Macroprudential and Monetary Policy



In summary, the literature on the effectiveness of macroprudential policy instruments is at a relatively early stage of development. Therefore, the experience of countries that have previously used these tools is of paramount interest. The results reported in the literature show different implications of using these tools for different sets of variables. In addition, there is evidence of other factors, such as the effects of monetary policy that typically accompany the implementation of macroprudential policies. We take advantage of the early implementation of the DSTI measure in Kazakhstan, as well as available detailed information from the local credit register, to study the impact of macroprudential instruments on borrowers' financial stability parameters.

3. DSTI Limit as a Macroprudential Instrument in Kazakhstan

First, we consider the provision of loans to households by type of expenditure (only in relation to the portfolio of the second-tier banking sector). Recent developments in the household sector show that, on average, consumer loans account for 60% of total household loans. The rest, approximately 40% of total retail lending, is spent on mortgage loans. This high share of consumer lending also raises concerns about the sustainability of household lending, with individuals having to rely on access to credit to balance their current and medium-term consumption.

This type of development of lending has broad economic implications. One of its consequences is the strengthening of the role of household lending in the financial system and, consequently, the accumulation of systemic risks, which are now shifting more towards the household sector rather than corporate industries. In addition, it can also offer a different mode of economic development. For example, recent studies highlight the importance of "excessive" credit growth for financial fragility and vulnerability. For example, Mian et al. (2017), using international long-term data, found evidence that an increase in the household debt-to-GDP ratio predicts lower GDP growth and higher unemployment over the medium term. In addition, Müller and Verner (2023) show that the sectoral distribution of credit – what credit is used for – plays an important role in understanding the links between the financial sector and the real economy. Lending to the tradable sector is associated with higher future productivity growth in the long run. The evidence presented by the authors confirms the longstanding view that lending to certain sectors, such as real estate loans, poses future macroeconomic and financial risks.

The maximum borrower's debt service ratio is currently limited to 50%, and this limit will be published in the future in the Resolution of the Board of the National Bank of Kazakhstan dated December 25, 2013 No. 292 "On Imposition of Limits on Certain Types of Banking and Other

Operations by Financial Organizations". The debt service-to-income ratio (DSTI) is calculated as the ratio of the amount of monthly payments on outstanding loans (excluding car loans, mortgages and education loans) of the borrower, including the amount of past due payments on all outstanding loans, and the average monthly payment on the borrower's new loan to the borrower's average monthly income for last six months.

The procedure for calculating and applying the DSTI for second-tier banks is provided for by the Resolution of the Board of the National Bank of Kazakhstan dated September 13, 2017 No. 170 "On the Establishment of Regulatory Values and Methods for Calculatiion of Prudential Ratios and Other Mandatory Ratios, and Limits, the Size of Bank Assets and the Calculation Rules and Limits of Currency Exposure". In Figure 4, we can see that the distribution of the outstanding loan amount has decreased significantly after the imposition of the DSTI limit.

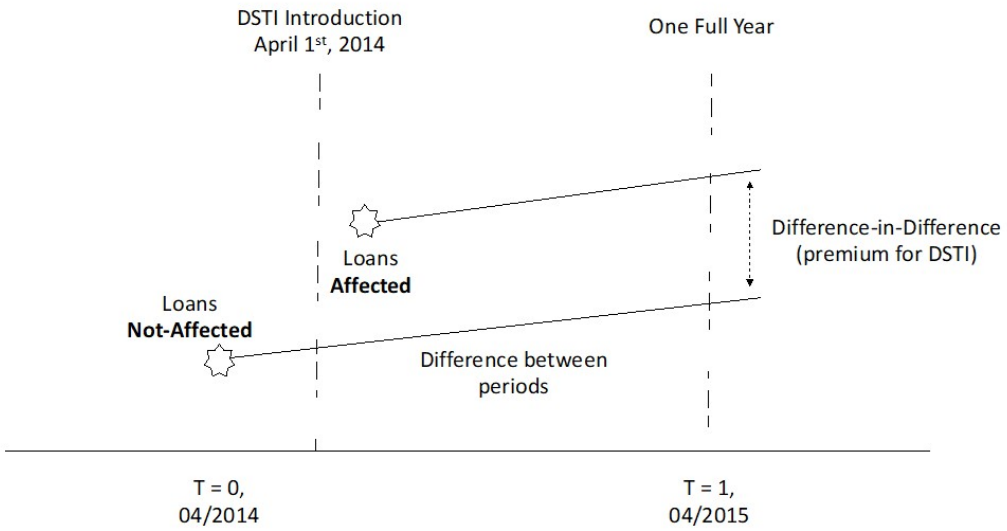
4. Empirical Methodology

We use Kazakhstan's credit register data for the period from 2014 to 2015. Credit register data is generally strictly confidential. This unique data set records all loans provided by second-tier banks to both households and non-financial companies since 2014. This data set at the loan level includes micro-level parameters such as the interest rate on the loan, the maturity at the time of issue, and the amount owed on it. The data we use is credit level data on a monthly basis. Other bank level data, such as balance sheets of banks, comes from National Bank Kazakhstan. Other macroeconomic data are obtained from the Bureau of National Statistics of Kazakhstan.

The approach we take in this paper allows us to evaluate the causal effect of a macroprudential policy instrument in terms of both the quantity and quality of consumer loan to households. In particular, we analyze the impact of marginal debt service-to-income ratios on borrowers' ability to effectively reduce the outstanding loan on their consumer debt over a full calendar year or two. Second, we correlate the loan size with average wages over a particular period to determine, which loans are most likely to be repaid and the type of loans that are most likely to default, effectively reducing the likelihood of a financial crisis occurring in future.

Diagram 2

The "Difference-in-Difference" Methodology



In particular, this should give us an idea of the threshold, which, if exceeded, significantly increases the probability of default. This approach can also be extended to other economies and eventually lead us to formulate an "early warning signal" of poor credit growth. As mentioned above, on April 1, 2014, Kazakhstan introduced a ceiling on the debt service-to-income ratio

(please see Figure 5). We use difference-in-difference (DiD) and panel logit regression to address two main questions: the quality of repayment and whether linking it to average wages helps predict the onset of a "bad" credit cycle.

In terms of the DiD approach, we collect a "certain basket" of loans issued to individuals before April 1, 2014, namely during March 2014, and track their difference in the outstanding loan amount throughout the year. Next, we take an identical basket of loans provided in April 2014 and similarly track their difference in outstanding loan amount for the entire year. In order to empirically assess the causal impact of a macroprudential policy instrument on the quality of household loans, we use the "difference-in-difference" empirical model:

$$\text{Loan} = \alpha 0 + \alpha 1\text{MPP} + \alpha 2\text{Bank} + \alpha 3\text{Macro} + \varepsilon,$$

where Loan – is the logarithm of the loan amount over a period of time, MPP is the difference in difference ratio, which shows the marginal contribution of the macroprudential instrument (DSTI limit) to the characteristics of loans. The Macro vector includes macroeconomic parameters such as the exchange rate, inflation, and GDP growth. Bank controls include several financial ratios such as bank size, return on assets, liquidity ratio and other relevant characteristics, and ε is an error term.

5. Deliverables

Next, we examine how the introduction of DSTI limit in Kazakhstan affects the dynamics of household consumer loan characteristics that are differentiated by the time of disbursement. Table 2 presents estimates of the short-term impact of the DSTI dummy variable on the absolute value of consumer loan.

Column 5 in Table 1 is a key regression specification with a fictitious value of the DSTI limit and other bank and macro-specific characteristics included. Therefore, columns 1-4 show different key regression specifications to track the individual effect of each variable. Overall, the negative sign of the DSTI limit means that the imposition of a 50% DSTI limit results in an average 1.2% reduction in outstanding loans across a range of loans originated around the first and second quarters of 2014. Our results provide a general idea of the DSTI quantitative effectiveness in the growth dynamics of the consumer lending cycle. To further test the robustness of our second equation, we repeat this exercise with a loan estimate adjusted for the average wage.

Table 1

DSTI Limit, Loan Amount and Inflation Rate

DSTI	-0.413***	-0.411***	-0.691***	-0.697***	-1.217***
	(0.004)	(0.004)	(0.003)	(0.003)	(0.031)
Interest rate		-0.001***	0.000	-0.000	-0.000
		(0.000)	(0.000)	(0.000)	(0.000)
Maturity			0.040***	0.038***	0.038***
			(0.000)	(0.000)	(0.000)
Bank size				-0.691***	-0.693***
				(0.007)	(0.007)
Exchange rate					0.147***
					(0.009)
Observations	289926	289926	289926	289926	289926
*R*2	0.059	0.059	0.419	0.437	0.437

We now analyze the impact of the debt service-to-income ratio on the probability of default on provided loans. A focus on default probabilities is necessary to examine the effectiveness of macroprudential instruments in terms of loan quality.

$$\text{Default} = \alpha 0 + \alpha 1\text{MPP} + \alpha 2\text{Bank} + \alpha 3\text{Macro} + \varepsilon,$$

where Default – is a 90+ days pastdue loan, MPP – a difference-in-difference coefficient, which shows a marginal contribution by the macroprudential instrument (DSTI limit) to loan characteristics. The Macro vector includes macroeconomic parameters such as the exchange rate, inflation, and GDP growth. Bank controls include several financial ratios such as bank size, return on assets, liquidity ratio and other relevant characteristics and ε is an error term.

Column 5 in Table 2 is the key regression specification, indicating the fictitious data limitation and default rate as well as other bank and macro-specific characteristics. Similar to Table 2, columns 1-4 contain various key regression specifications to track the individual effect of each variable. Overall, the negative sign of the DSTI limit means that the imposition of a 50% DSTI limit results in a 0.4% reduction in the probability of default on a number of loans originated around the first and second quarters of 2014. Our results provide a general idea of the qualitative effectiveness of DSTI application in the growth dynamics of the consumer lending cycle.

Table 2

DSTI Limit and Default Rate

DSTI	-0.488*** (0.021)	-0.488*** (0.022)	-0.435*** (0.022)	-0.405*** (0.022)	-0.394*** (0.022)
Loan amount		-0.629*** (0.018)	-0.603*** (0.018)	-0.482*** (0.021)	-0.325*** (0.021)
Interest rate			0.013*** (0.001)	0.013*** (0.001)	0.017*** (0.001)
Maturity				-0.013*** (0.002)	-0.014*** (0.001)
Bank size					3.423*** (0.082)
Constant	-1.991*** (0.013)	5.813*** (0.224)	5.118*** (0.230)	3.951*** (0.243)	-0.436* (0.260)
Observations	104332	104332	104332	104332	104332

In this subsection, we want to assess whether the effectiveness of macroprudential policy has been enhanced or reduced by monetary policy conditions. We test this interaction effect between our macroprudential instrumental variable and monetary policy measures (changes in the real exchange rate) as follows:

$$Loan_{it} = \alpha 0 + \alpha 1 MPP + \alpha 2 Bank + \alpha 3 Macro + \alpha 3 MPP * MP + \varepsilon,$$

The set of variables is identical to those shown in Equation 1, with the MPPtj ∗ MP interaction variable added, where MP means monetary policy variables, exchange rate or the base interest rate. Since Kazakhstan has moved to the inflation targeting system in August 2015, we use the exchange rate as an indirect variable for the monetary policy in our study.

Table 3

DSTI Limit, Loan Amount and Inflation Rate

DSTI	-0.004***	-0.004***	-0.007***	-0.007***	-0.012***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Interest rate		-0.001***	0.000	-0.000	-0.000
		(0.000)	(0.000)	(0.000)	(0.000)
Maturity			0.040***	0.038***	0.038***
			(0.000)	(0.000)	(0.000)
Bank size				-0.691***	-0.693***
				(0.007)	(0.007)
Exchange rate					0.147***
					(0.009)
c	12.239***	12.258***	11.448***	11.937***	-14.852***

	(0.002)	(0.003)	(0.004)	(0.006)	(1.552)
Observations	289926	289926	289926	289926	289926
*R*2	0.059	0.059	0.419	0.437	0.437

As a result, column 5 in Table 3 is the key regression specification with dummies of DSTI limit and inflation (as a monetary policy indicator), as well as other banking and macroeconomic characteristics. Similar to Table 2, columns 1-4 contain various key regression specifications to track the individual effect of each variable. Overall, a negative sign for the DSTI, given the inflation rate limitation, means that the imposition of DSTI limit is supported by the monetary policy stance. Our results show that macroprudential and monetary policy instruments can complement each other depending on business cycle goals.

6. Conclusion

We use the Debt Service-to-Income Ratio indicator (the "DSTI") introduced in Kazakhstan, as well as the available detailed information from the local credit register, to study the impact of macroprudential instruments on borrowers' financial stability parameters. The results show that the imposition of a 50% DSTI limit results in a 1.2% reduction in outstanding debt, on average, compared to the number of loans originated in the first and second quarters of 2014. We also found that the imposition of DSTI limits reduced the probability of default on loans, on average, compared to loans provided just before the introduction of DSTI limits. Our results provide an overview of both the quantitative and qualitative effectiveness of DSTI in the growth dynamics of the consumer lending cycle. We also found that the impact of macroprudential policy instruments increases at a given rate of inflation. Our results show that macroprudential and monetary policy instruments can complement each other depending on business cycle goals.

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SESSION III.

The Nature and Factors of Internal Inflation in the Republic of Kazakhstan

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The Nature and Factors of Internal Inflation in the Republic of Kazakhstan

Internal Factors of Inflationary Processes in the Republic of Kazakhstan

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This paper analyzes the internal and external factors of current inflationary processes in the Republic of Kazakhstan based on performance in 2021 and 2022. It was found that inflation factors are both on the aggregate demand side (due to the "pent-up demand" effect and the stimulation of consumer demand through government programs) and on the aggregate supply side (due to an increase in the average actual costs of Kazakhstani producers and disruptions in supplies because of the anti-Russian sanctions imposed by Western countries). The main non-monetary factors of inflation are identified: the rise in prices for Kazakhstani food exports (because of growing prices in global markets and instability of food production in the neighboring countries); changes in world oil prices (it is noted that inflationary pressure is observed both in the situation when oil prices are growing and when they are declining); and the level of competition in domestic markets. In these circumstances, measures aimed at expanding the aggregate domestic supply and diversifying the national economy, and increasing the stability of domestic supply of food products, are justified.

Key Words: inflation, inflationary processes, inflation factors, internal inflation factors, external inflation factors.

JEL-Classification: E31, E52.

1. Preamble

High inflation in the last two years has become a problem for monetary regulators in both developed and developing countries. Inflation above the central bank targets has many negative implications: from reducing the purchasing power of consumers to the risks of destabilizing the countriy's financial stability because of the rising interest rates. The problem of accelerated growth in the general price level in 2022 became especially important for Kazakhstan, and inflation in 2022 exceeded the 20% level and turned out to be higher than in the EAEU member countries: Armenia (8.3%), Belarus (12. 8), Kyrgyzstan (14.7%), Russia (11.9%) and other neighboring countries: China (1.8%), Uzbekistan (12.3%), Turkmenistan (17.5%), (IMF, 2023). Therefore, the understanding of reasons and consequences of inflation, strategies to control it is critical for all economic agents.

Nowadays, both foreign and domestic economists give attention to the topic of inflation. In the Russian literature, the focus is on assessments of the impact of various factors on inflation, for example, income inequality (Kartayev & Samsonova, 2022); the factors of heterogeinety of regional inflation are under study (Semitourkin, Shevelyov, & Kvaktoun, 2021). The number of research assesses trend inflation and its decomposition (Drobyshebskiy, Kazakova, Trounin, & Fokin, 2023). These problems are also looked into in Kazakhstani literature. A number of authors (Oshakbayev, Kysykov, & Schultz, 2017) in their studies analyze inflationary processes in Kazakhstan and suggest an econometric model to forecast inflation. The authors note that inflation in Kazakhstan has an inertial nature, i.e. it largely depends on past inflation, while foreign exchange rate, oil and gas prices serve as independent regressors. Pak E.A. also points to the rising oil prices, the USD/KZT exchange rate, imbalance in the labor market, economic inefficiency, etc.

among the inflation factors (Pak, "Two Myths about Reduction of the Base Rate in Kazakhstan", 2022), (Pak, "What is Hiding Behind the Shield of Inflation in Kazakhstan?", 2022). The researcher focuses on the impact of changes in the level of the base interest rate on inflation rates. A number of the National Bank studies are devoted to an in-depth review of fiscal price theory (Tuleuov, Zhuzbayev, & Beckzhan, 2021), of the assessment of contribution by external and internal factors to the dynamics of inflationary processes (Yerzhan & Seidakhmetov, 2022). Their empirical assessment is under the central bank focus (Bank of Russia, 2022), (Nagy & Tengely, 2018).

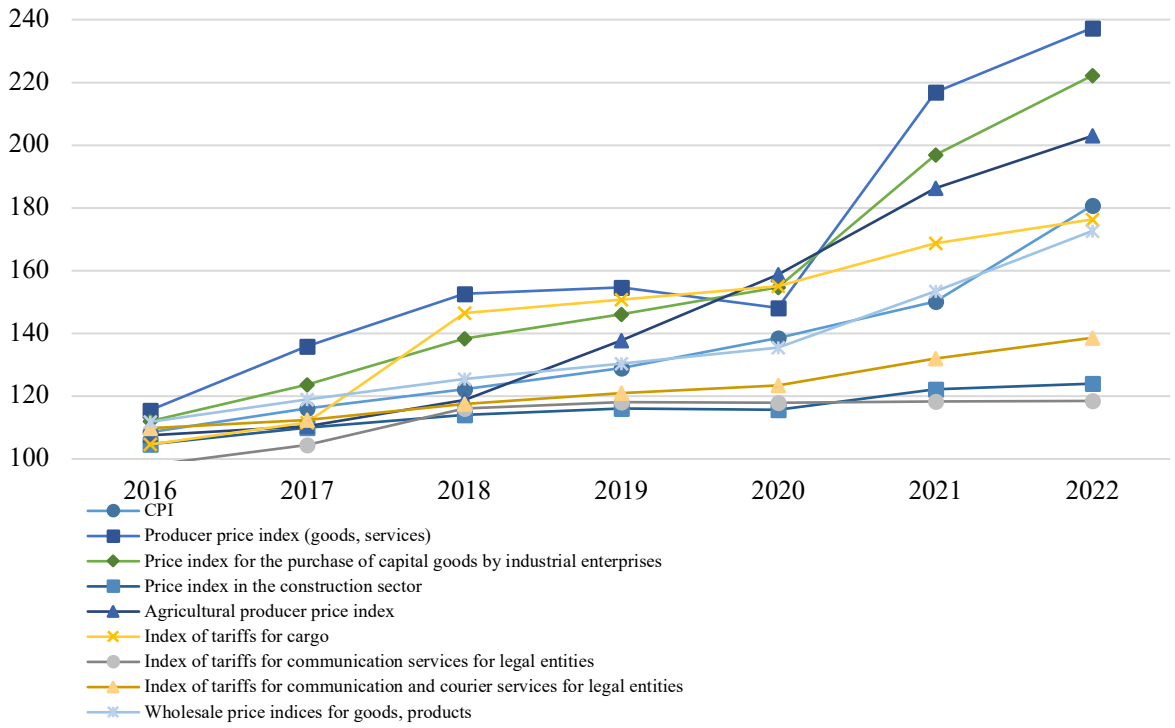
The analysis of articles on inflation in Kazakhstan enables to explicitly divide the factors influencing inflation in Kazakhstan into external and internal ones. However, while a lot of work is devoted to external inflation factors, there is insufficient attention paid to internal drivers. In this regard, the purpose of this study is to identify internal factors of inflation in Kazakhstan.

2. About the Dynamics of Inflationary Processes in Kazakhstan in 2021-2022

Based on performance in 2021 and 2022, some sectors of the Kazakh economy demonstrate high price growth rates. According to the data from the Bureau of National Statistics with the ASPR RK (the "ASPR BNS RK") shown in Figure 1 below, the largest price growth was observed among manufacturers of industrial goods (in 2021 – by 46.1% (YoY), in 2022 – by 9.4% (YoY)); for capital goods (in 2021 – by 27.1% (YoY), in 2022 – by 12.9% (YoY)); among agricultural producers (in 2021 – by 17.3% (YoY), in 2022 – by 9.0% (YoY)). The consumer price index (the "CPI") as at end-2021 and 2022 amounted to 108.4% and 120.3% versus the last year, respectively.

Figure 1

Prices Indices by Economic Sectors versus December 2015, as %



Source: compiled by the authors based on the data from the ASPR BNS RK

To assess the CPI level, the national statistical agency uses a fixed basket of goods and services, which includes 508 items (Table 1 below).

Table 1

Structure of the Goods and Services Consumer Basket

Category	Number of items (total of 508)	Weight (total of 100%)
Food products	160	40.7%
Non-food products	243	30.2%
Paid services	105	29.1%

Source: compiled by the authors based on the data from the ASPR BNS RK

According to the ASPR BNS RK, as at end-2022, prices of food products appreciated most in annual terms – by 25.28%, therefore, the contribution to annual inflation by this category was the largest – 10.3%; non-food products appreciated by 19.38% (YoY) in terms of price (contribution – 5.96%), and finally, the price of paid services increased by 14.07% (YoY) (contribution – 3.96%).

Appendices 1-3 present scatter diagrams of the benefits that are part of the consumer basket in Kazakhstan: the benefits are distributed into quadrants in accordance with the size of their share in the basket and with the growth rate of their prices in 2022.

A high concentration of goods (especially foods) in the quadrants that are above the 20% level of price growth is noteworthy. The upper right quadrant shows the goods with the highest share in the basket and the largest increase in the price level (granulated sugar, flour, sour cream, rice, cheese, butter, eggs, tea, fish, sweets, detergnt, shampoo, coal, house rent, primary appointment with a doctor, payment for higher education, services of sanatoriums).

In terms of regions, in 2022 the highest annual inflation rates were observed in Mangistau region (24%), in the city of Astana (23%), and in Akmola region (21.1%). Almaty region showed the lowest rate of inflation (17.7%).

Tariffs for cargo transportation have demonstrated the largest increase on a year-on-year basis in 2021 (see Table 2 below): air transport – на 42.5%, pipeline transport – 16.6%.

Table 2

Change in Tariffs for Cargo Transportation, by Types of Transport, as %

	Motor Transport	Air Transport	Pipeline Transport	Marine Transport
2020	-0.1%	2.4%	6.1%	6.9%
2021	0.4%	42.4%	16.6%	6.5%
2022	3.3%	2.6%	6.7%	6.7%

Source: compiled by the authors based on the data from the ASPR BNS RK

Thus, in 2021 – 2022, an acceleration in the rate of price growth was observed in all sectors of the economy, including agricultural producers and industrial enterprises. The increase in production costs in these industries, including logistics costs, had a negative impact on prices for the final products of Kazakhstani consumers, their purchasing power and well-being.

3. About Inflation Factors

Inflation is a complex economic phenomenon and, as truly described in the literature, not all of its driving forces are in the zone of central banks' influence.

In the economic theory, inflationary surges stem from a positive aggregate demand shock (positive fiscal or monetary stimulus) and/or a negative aggregate supply shock.

In the first case, a short-term shock may result in a temporary increase in economic activity, accompanied by a growth in aggregate output and employment. However, in the long run, the effect of such incentives will be completely absorbed by rising prices. At the same time, in the literature on developed countries, there is a tendency to weaken the relationship between inflation and economic activity (Goryunov, Drobyshevskiy, Mau, & Trounin, 2021), which could have a negative impact on the capacities of monetary policy. This trend is associated with globalization and the anchoring of inflation expectations. The authors note that globalization suppresses the effect of the pass-through of producer costs onto prices: "increasing competition between domestic

producers and foreign producers limits the ability of the former to raise prices in response to an increase in aggregate demand" (Goryunov, Drobyshevskiy, Mau, & Trounin, 2021).

In the second case, the totality of factors that lead to an increase in producer costs causes stagflationary processes in the economy (a concurrent rise in prices and decrease in output). Ways to restore the economic growth in this case involve different macroeconomic policy options aimed at expanding aggregate supply.

What had caused inflation surges in Kazakhstan? Are these causes on the aggregate demand side or/and aggregate supply?

An analysis of household spending on final consumption showed (see Table 3 below) that in 2021 consumer demand was recovering from the COVID-19 pandemic. Household spending on final consumption increased sharply in physical volume by 6.3% (YoY). This phenomenon, observed in many countries, was partly explained by the effect of "pent-up demand". According to the study (IMF, 2023), the recovery of demand from the pandemic shock driven by the fiscal stimuli, with a slower recovery in supply, was the initial "spark" to accelerate inflation.

Acceleration of inflation rates in 2022, while reducing the real income of consumers, was accompanied by deceleration of consumer demand. Thus, in 2022, following the results of 9 months, the growth of this indicator amounted to 99% only compared to the same period of the last year. Government spending during the same period showed a 97.6% increase (YoY), gross capital formation – 101.0% (YoY).

Exports and imports demonstrated a sharp growth in 2022. According to the the ASPR BNS RK, at the year-end imports to Kazakhstan from the CIS countries (Russia, Belarus) declined while imports from other ountries (China, the US) increased. In other words, already in 2022, the shock of demestic demand for imported goods was observed.

Additionally, factors of growth in the general price level were also outlining on the aggregate supply side. Supply disruptions amid the imposition of anti-Russian sanctions by Western countries since the start of Russia's military operation in Ukraine became the main reason for reduction in aggregate supply.

Given that Russia is Kazakhstan's main trading partner, anti-Russian sanctions have changed the structure of foreign trade and consumption and the domestic economy. The current account of Kazakhstan for the first time in the last 8 years has showed up a surplus. At the same time, in 2022, the increase in Kazakhstan's exports to Russia in value terms amounted to 25.1% (YoY), while imports from Russia decreased by 1.5%. Sanctions complicate the mutual trade of countries; therefore, there may be temporary interruptions in supplies.

Table 3

Quantum Index, as % of the Corresponding Period of the Last Year

	Year	1st Quarter	1st Half-Year	9 Months	Year
Household spending on final consumption	2020	101.0	91.7	95.3	96.3
	2021	103.7	105.9	105.0	106.3
	2022	99.2	98.0	99.0	-
General government spending on final consumption	2020	114.2	113.0	113.8	112.8
	2021	108.3	101.4	101.2	97.6
	2022	93.7	102.2	96.2	-
Gross formation	2020	95.0	92.9	101.9	99.0
	2021	103.4	105.1	100.0	101.5
	2022	101.2	100.9	101.0	-
Exports of goods and services	2020	101.4	98.1	86.2	88.7
	2021	83.5	91.8	98.4	102.3
	2022	124.6	116.9	118.0	-
Imports of goods and services	2020	95.8	89.2	89.7	91.0
	2021	93.2	95.6	94.9	99.7
	2022	111.8	109.3	111.2	-

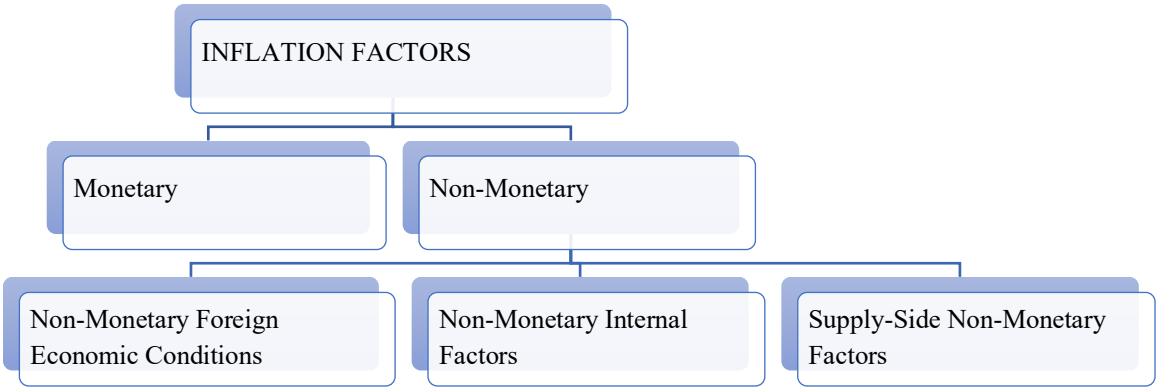
Source: compiled by the authors based on the data from the ASPR BNS RK

Alongside with that, an analysis of the average actual costs of Kazakhstani producers in the construction (costs per 1 sq.m.) and agricultural sectors (costs per 1 centner of the output) enabled to observe their growth by 1.05 and 1.41 times in 2021. In 2022, construction costs went up by 1.18. The rise in food prices in 2022 was caused by the growth in prices for agricultural stock, by transport and logistics failures, increase in prices of imported components and final goods.

Thus, we can say that the growth of inflation in Kazakhstan is associated not only with demand-pull factors, but also with supply factors – an increase in the cost of production in Kazakhstan (in agriculture, industry, construction). This is an evidence of the importance of interaction between fiscal and monetary policy measures to reduce the rate of price growth in the country.

Diagram 1

Inflation Factors Classification



Source: compiled by the authors based on the report (Bank of Russia, 2018)

Inflation factors (see Diagram 1) are also classified into monetary and non-monetary, which is quite debatable in the literature. The criterion, which is based on the ability of the central bank to influence monetary policy measures on a particular component (monetary factors: changes in the base rate, money market interest rates, inflation expectations, exchange rates, etc.) is mainly used (Bank of Russia, 2018), (Koudrin, Goryunov, & Trounin, 2017).

The Bank of Russia's Report notes that non-monetary conditions are exogenous for the economy, they cannot be eliminated but it is possible to increase the resilience of the national economy to their impact. Non-monetary internal factors include factors that have a long-term systemic impact on pricing (structural and institutional conditions). To change them, a comprehensive economic policy is required, the results of which will affect the pricing in the long term. Non-monetary factors on the supply side include factors that affect the volatility in the dynamics of prices for certain groups of consumer goods and services.

The National Bank of Kazakhstan's study (Yerzhan & Seidakhmetov, 2022) shows that the share of external factor in inflation is about 44% (from January 2011 through September 2021). It is clear that this estimate will vary from period to period; moreover, the task of decomposing inflation by influencing factors is extremely complex and requires the elaboration of a methodological approach, which explains the concentration of such studies in the central banks of countries.

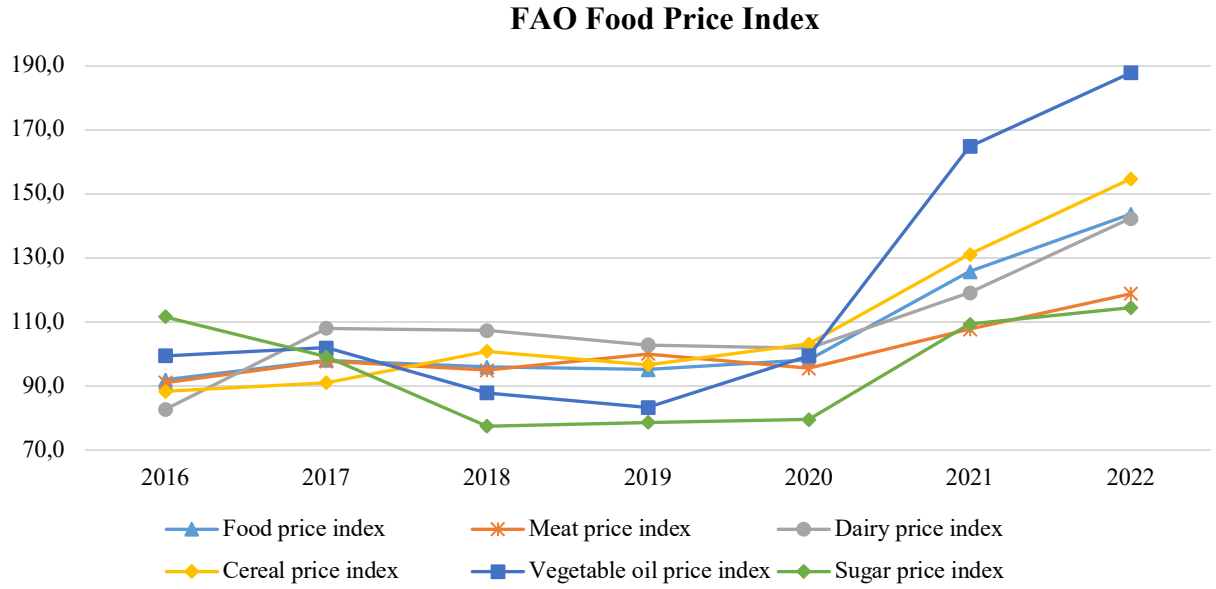
4. Key Non-Monetary Inflation Factors

4.1. Rise in Prices for Kazakhstan's Food Exports

In 2022, geopolitical shocks, unfavorable weather conditions in a number of countries-key exporters of agricultural products have led to a change in the world food markets: to a search for new suppliers and the growth of world food prices (Figure 2 below). These changes have not bypassed the Kazakh economy. According to the ASPR BNS RK, in 2022 exports from Kazakhstan among the following items increased in physical volume: sunflower oil – by 170%,

flour – by 32%, potatoes – by 23%, wheat – by 10%, barley – by 5%. The growth in demand from the external sector for Kazakhstani products spurred domestic prices. In Appendix 1, the specified categories of goods are in the zone above the 10% price growth.

Figure 2



Source: compiled by the authors based on the data from UN Food and Agriculture Organization

In 2022, the situations that arose in the sugar and rice markets in Kazakhstan were ullustrative. Both of these products in the figure in Appendix 1 are located in the upper right quadrant, which indicates a high share in the consumer basket and high rates of price growth. At the same time, self-sufficiency in sugar in Kazakhstan is 51%, and in rice – 128%. The rise in prices for rice in Kazakhstan amounted to 35% (YoY) in 2022 and was caused, first of all, by the increase in exports by Kazakhstani producers to Russia, where there is still a ban on the export of rice due to a low level of its production in 2022. Thus, the price increase for food in world markets stimulates the increase in exports of agricultural products from Kazakhstani producers and causes a rise in prices in the domestic market.

4.2. Change in World Oil Prices (Growth / Decline)

Decline in Oil Prices. The export value of oil and gas condensate accounts for 51.5% of the official exports of Kazakhstan. The decline in oil prices will contribute to deterioration in the trade balance and, as a result, depreciation of the national currency. A number of studies on inflation in resource-based economies point to the influence of currency exchange rate fluctuations on the growth of the general price level. This phenomenon, known as the "exchange rate pass-through effect", is observed in Kazakhstan, which is confirmed by the estimates of the National Bank of Kazakhstan. According to their latest report (National Bank of the Republic of Kazakhstan, 2022), the effect of a 1% change in the nominal effective exchange rate against the currencies of trading partner countries on food prices in the short term amounted to 1.06 pp, and the effect on the prices of non-food products – to 2.0 pp. While large-scale fluctuations in the exchange rate lead to a widespread price increase in the economy, the subsequent stabilization of the exchange rate (depreciation or return to its previous values) does not contribute to lower prices ("ratchet effect within the pass-through effect").

In 2022, the tenge/US dollar and the tenge/Russian ruble currency pair had demonstrated the highest volatility (see Table 4).

Table 4

Variance Coefficients of Daily USD/KZT and RUB/KZT Exchange Rates, %

	Variance Coefficients of Daily USD Exchange Rate, as %	Variance Coefficients of Daily RUB Exchange Rate, as %
2017	2.9%	2.6%
2018	5.9%	2.8%
2019	1.1%	2.6%
2020	4.7%	2.9%
2021	1.1%	2.1%
2022	**4.7%**	**16.8%**

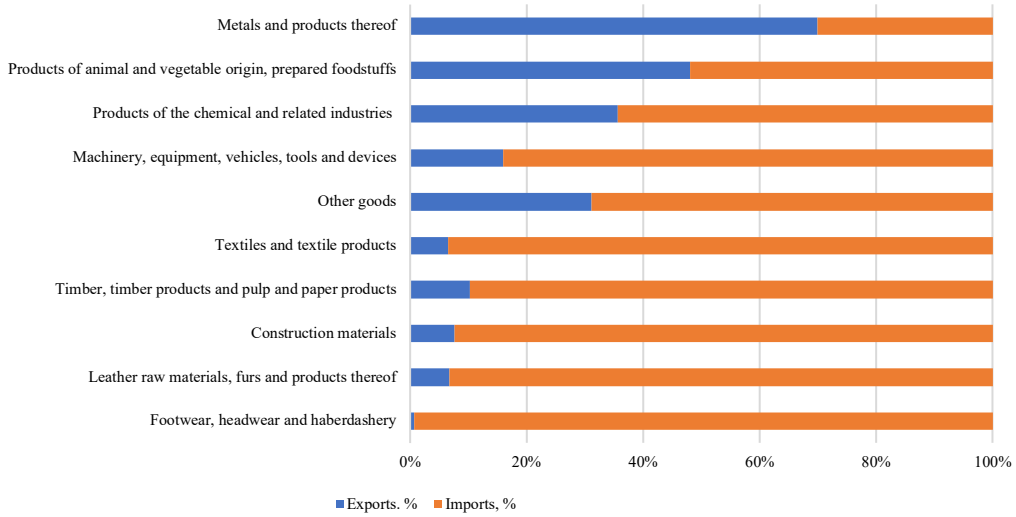
Source: computed and compiled by the authors based on the National Bank of Kazakhstan's data

The reason why domestic prices are sensitive to changes in exchange rates lies in the high share of imported goods in Kazakhstan's domestic market. If we exclude mineral products from the export and import basket of Kazakhstan, we'd find a significant 1.7 times excess of the value of imports (46.7 billion US dollars) over the value of exports (27.1 billion US dollars). At the same time, the predominance of imports is observed in almost all product groups (see Figure 3 below). In food markets, the share of domestic production is relatively higher than in the market of non-food products (products of the textile industry, household chemicals, furniture, etc.). According to the ASPR BNS RK, the main import partners of Kazakhstan are: Russia (34.7%), China (21.9%), Germany (4.5%), USA (3.8%), Turkey (3. 2%), Republic of Korea (3.1%).

Thus, prices for imported food and non-food products are sensitive to a sharp depreciation of the national currency against the ruble and the US dollar due to a high share of imported goods in the economy. The decline in oil prices is not the only reason for the exchange rate volatility; these may include global capital overflows, geopolitical shocks, etc.

Figure 3

Kazakhstani Exports and Imports of Major Commodity Groups

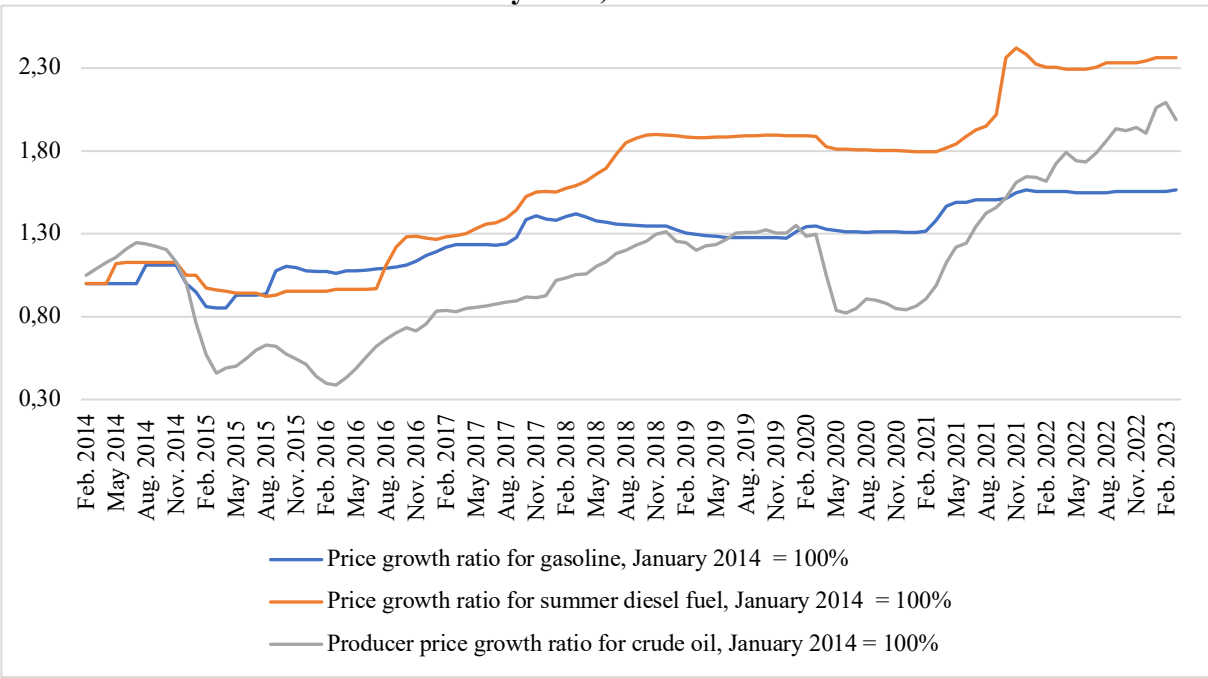


Source: compiled by the authors based on the data from the ASPR BNS RK

It should be noted that with the decline in oil prices, prices for produced petroleum products (diesel fuel, gasoline), which could compensate for the "exchange rate pass-through effect" by reducing transport costs, the costs of agricultural producers for fuel and lubricants (see Figure 4 below). On the graph, these areas are enclosed in an oval ("ratchet effect").

Figure 4

Price Growth Ratio for Gasoline, Summer Diesel Fuel and Crude Oil versus January 2014, %



Source: compiled by the authors based on the data from the ASPR BNS RK

Increase in Oil Prices. This factor also has an impact on inflationary processes. The rise in oil prices is accompanied by a growth in prices for petroleum derivatives (gasoline, jet fuel, diesel fuel). Fuel prices are important for production and logistics. Thus, fuel costs account for 12% in the structure of costs for the production of plant products. The rising fuel prices may provoke a growth in prices for agricultural products, an increase in the cost of logistics services, and passenger transportation.

In part, this problem is mitigated by current regulatory measures: the establishment of marginal retail prices (from July 2022), measures to support agricultural producers by subsidizing prices for fuel and lubricants. However, upward pressure remains: the higher the world oil prices, the more attractive its export is, rather than processing and selling it in the domestic market at lower prices. Moreover, the peculiarities of subsidizing mechanisms do not allow the full implementation of restraining measures. Additional pressure on rising fuel prices comes from higher prices in the neighboring countries (see Table 5 below).

Table 5

Prices for Gasoline and Diesel Fuel in Kazakhstan and Near-Bordering Countries as at May 1, 2023, in the US Dollars

	Price of gasoline, 1 liter, in the US dollars	Price of diesel fuel, 1 liter, in the US dollars
Kazakhstan	0.475	0.537
China	1.226	1.091
Kyrgyzstan	0.691	0.851
Russia	0.638	0.738
Turkmenistan	0.428	0.385
	0.932	0.963

Source: compiled by the authors based on the data from GlobalPetrolPrices.com

4.3. The Level of Competition in Domestic Markets

According to the study conducted by the Agency for Protection and Development of Competition ("Coursive" Newspaper, 2022), there is a negative correlation between the number of enterprises and the amounts of markup on products: the lower the level of market concentration, the smaller the markup.

Analysts classified the vegetable and beef markets as low-concentration markets (there are less than 9% of total sales per one leading entity). In these markets, there is a minimum margin – up to 7%. A moderately concentrated level is observed in the markets of eggs, milk, bread, cabbage and flour (10-20% of total sales per one leading entity). The Agency noted that at low or moderate levels of concentration, market participants rarely enter into price collusion among themselves. In such cases, the main reasons for the rise in prices are "natural" economic factors, such as higher prices for raw materials. Flour and bread have the lowest final markup (from producer to consumer): up to 18%. There are practically no intermediaries in these markets, and products are delivered directly to stores (76 enterprises in 15 regions of the country). In the egg market, the markup is 25%; this is explained by the presence of an intermediary between poultry farms and end consumers.

The highest markup (more than 25%) is observed in the markets of sunflower oil, chicken, sugar and buckwheat. These markets are highly concentrated (more than 20% of total sales per one entity), and analysts point to the risks of collusion. Sugar is produced at 4 enterprises, it is distributed by 14 organizations, and a churning surcharge is about 53%.

5. Monetary Inflation Factors

5.1. Money Supply Growth

In the literature, the analysis of relationship between the money supply and the price level traditionally begins with a quote by M. Friedman, according to which "inflation is always and everywhere a monetary phenomenon in the sense that it cannot occur without a more rapid increase in the quantity of money than in output" (Friedman, 2002). This relationship is most noticeable in the long run.

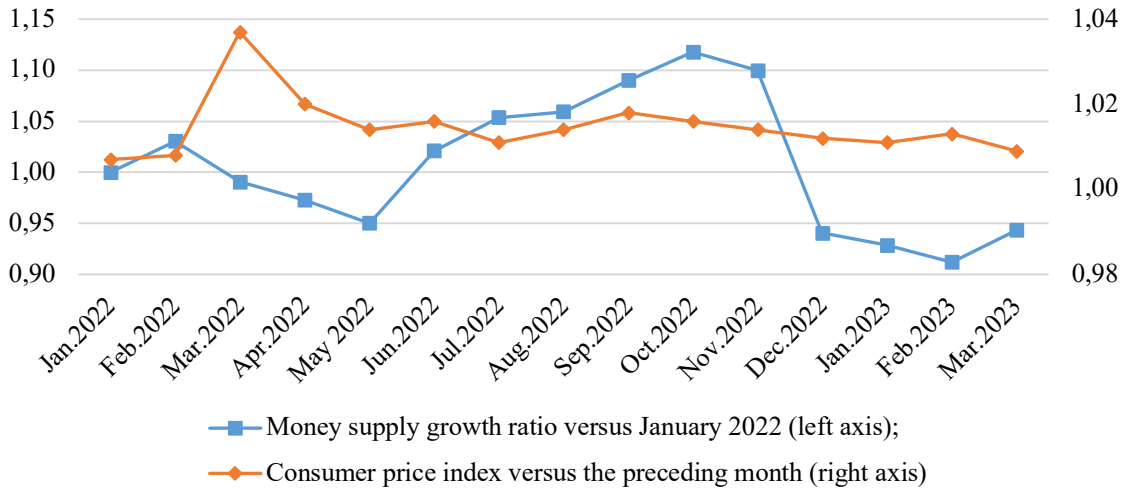
Thus, in Kazakhstan, over the past 13 years (from 2010 to 2022 inclusive), the money supply has grown from 7.49 trillion tenge to 33.83 trillion tenge (by 4.51 times), the quantum GDP in 2022 compared to 2010 was 1.51 (i.e. output of goods and services increased by one and a half times in real terms), and the GDP deflator was 2.99 versus 2010 (CPI for the same period – 2.63). That is, over a long period of time, the total growth in prices and the GDP output exactly corresponds to the growth in the money supply[1].

In the short term, such relationship is not observed, since the GDP deflator and the consumer price index are subject to non-monetary internal and external effects (see Figure 5 below). In 2022, the dynamics of money supply shows a downward trend in the first half of the year and an upward trend in the second half of the year (given a progressive increase in the base rate). These trends are in different direction with the dynamics of the consumer price index, which is an evidence of the impact of non-monetary factors on prices.

[1]The invariance of money velocity is determined from this ratio

Figure 5

Money Supply Growth Ratios versus January 2022 and the Consumer Price Index



Source: compiled by the authors based on the data from the National Bank RK and the ASPR BNS RK

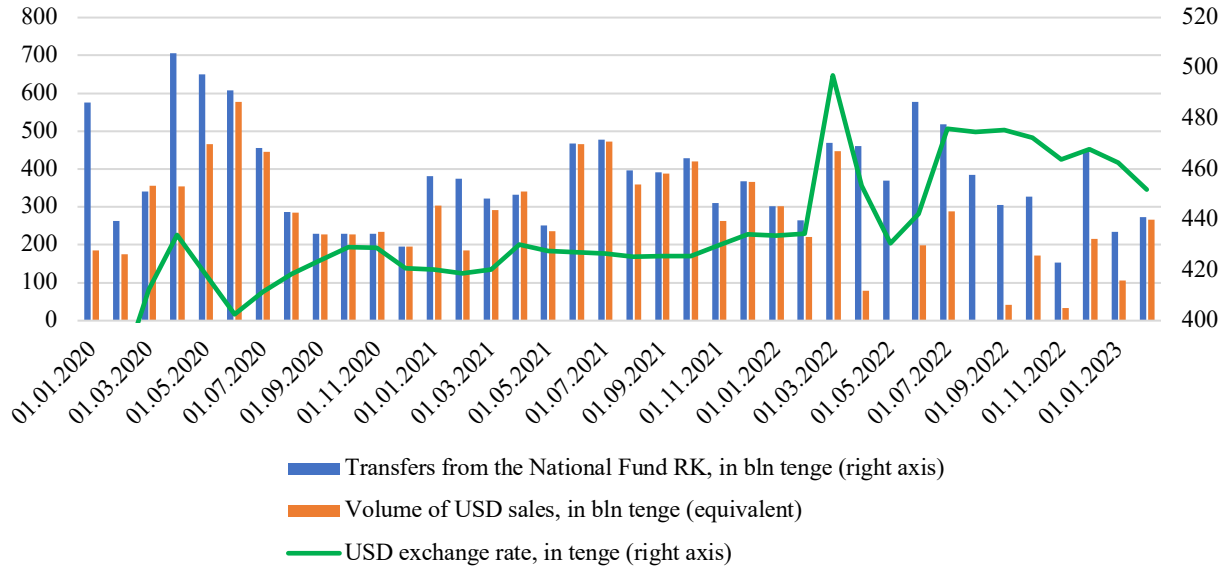
The National Bank intends to withdraw from all programs providing credits to the economy by 2025. The Bank financed the following programs: "Shanyrak" (390 billion tenge), "The Economy of Simple Things" (500 billion tenge), Concessional Lending to SMEs (800 billion tenge), the "Employment Roadmap" (500 billion tenge), and "Car Loans" (100 billion tenge). These programs are not homogeneous: they stimulate both aggregate demand and aggregate supply, which causes excessive stimulation of consumption.

5.2. Annual Transfers from the National Fund of the Republic of Kazakhstan

A specific feature of the national economic model of Kazakhstan is that the national budget is drawn up using resources of the National Fund of the Republic of Kazakhstan through guaranteed and earmarked transfers. Over the past three years, the annual volume of transfers amounted to at least 4 trillion tenge. On a monthly basis, the National Bank converts the dollar liquidity into tenge in order to transfer it to the national budget (see Figure 6 below).

Figure 6

Dynamics of Monthly Tranfers from the National Fund of the Republic of Kazakhstan



Source: compiled by the authors based on the data of the National Bank of Kazakhstan

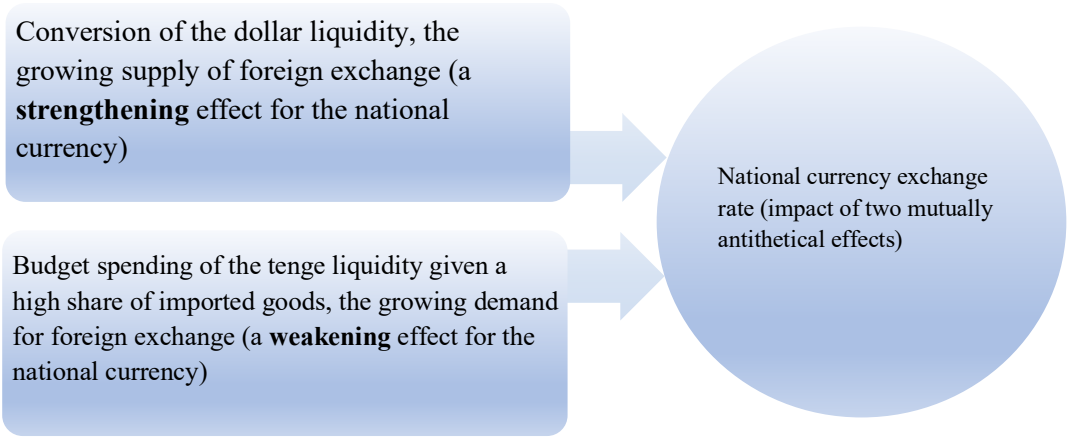
Such operations influence inflationary processes through a change in the exchange rate of the national currency. However, it is difficult to determine the unambiguous effect of such influence, since we can observe two processes that are opposite in their effect (see Diagram 2 below).

First, the conversion of dollar liquidity contributes to the strengthening of the national currency, which, in turn, restrains the rise in prices for imported goods. At the same time, the allocation of transfers to the budget is the future source of changes in the reserve money (as a consequence of the money supply), which is compensated by liquidity withdrawal toolkit for second-tier banks.

Second, the spending of budgetary resources on final and interim consumption in the economy in the context of a high share of imported goods creates the opposite effect (the demand for foreign exchange to pay for imports). According to the most recent study by the National Bank (Turabay, Uskenbayev, Muratov, Almagambetova, & Ospanov, 2023), "a 1% increase in spending excluding debt service costs this month leads to a 0.6% increase in imports minus imports of oil companies next month, followed by a complete fading of momentum after 5 months".

Diagram 2

Channels of Influence by Transfers of the National Fund of the RK on the Exchange Rate of the National Currency



Source: compiled by the authors

Therefore, the final effect from the impact on the national currency exchange rate and hence on the price level will depend on the balance of these forces.

6. Findings and Recommendations

1. The growth of prices in Kazakhstan in 2021-2022 is related not only to the positive aggregate demand shock but also to the negative aggregate supply shock. The decreasing domestic consumer demand due to disinflationary monetary measures may not be sufficient to slow the price growth and absorb external shocks, both now and in the future. Given the underutilization of capacities, the aggregate domestic supply needs to be increased, however, not by reducing the base rate. The problem is the existence of effective mechanisms that would promote the growth of the domestic production sector, rather than the consumer sector. Otherwise, the opposite effect can be achieved.

2. In non-food markets with a high share of foreign goods, the price volatility results from depreciation of the national currency (in case of exchange rate appreciation, there is no reverse effect). Under these conditions, the key measures are aimed at diversifying the national economy (developing the production in the non-resource sector of the economy, increasing domestic consumption of Kazakhstani goods) and its exports.

3. In foodmarkets with a relatively high share of domestic production, the price volatility is stemming from instability of the domestic supply (due to the growing volume of exports to those

countries where prices are higher; because of adverse weather conditions; due to a drop in the efficiency of agricultural production, etc.). Measures are needed on the part of the Government to increase sustainability of the domestic supply of food products (improving soundness of agricultural producers, creating reserves of agricultural products, etc.). Agriculture provides the population with food, which must be economically and physically affordabble to the people. In doing so, the profitability of agricultural production should satisfy the producer and stimulate investments in the sector. These two mutually antithetical objectives (economic availability of food products and a stable level of profitability of production) complicate the implementation of an effective government policy in the agricultural sector. In this regard, it is advisable to single out a subdivision within the general government whose activities would be aimed at developing agricultural risk management as a whole.

4. The study by the Agency for Protection and Development of Competition of the Republic of Kazakhstan has been analyzed: the lower the level of market concentration, the smaller the markup for food products. Measures are required to support the small and medium-sized business in order to reduce the excessive market concentration (especially on staple foods), develop the stock exchange trading.

5. Dramatic changes in oil prices (both declining and rising prices) can increase upward pressure on prices in the economy. In the first case, due to the impact on the inflow of foreign exchange proceeds, the depreciation of the national currency and the rise in prices of imported goods of final and interim consumption. In the second case – because of the rise in prices for petroleum products and, as a result, the growth of producer costs. Additional pressure is exerted by higher prices for petroleum products in the neighboring countries (Russia, Uzbekistan, Kyrgyzstan, and China).

6. In the long run, price dynamics are determined by the dynamics of money supply (in the time interval from 2010 to 2022). This points to the excess of the growth rate of money supply over the growth rate of the physical volume of goods and services produced. It could be caused by the participation of the National Bank of Kazakhstan in the government program financing, which had a stimulating effect not only on aggregate supply but also on aggregate demand.

7. The analysis of the channels of influence by annual transfers from the National Fund of the Republic of Kazakhstan on inflationary processes in the economy (mainly through changes in the exchange rate) showed the presence of counteracting forces. The final effect of the impact on the exchange rate of the national currency and, as a result, on the price level, will depend on the ratio of these forces.

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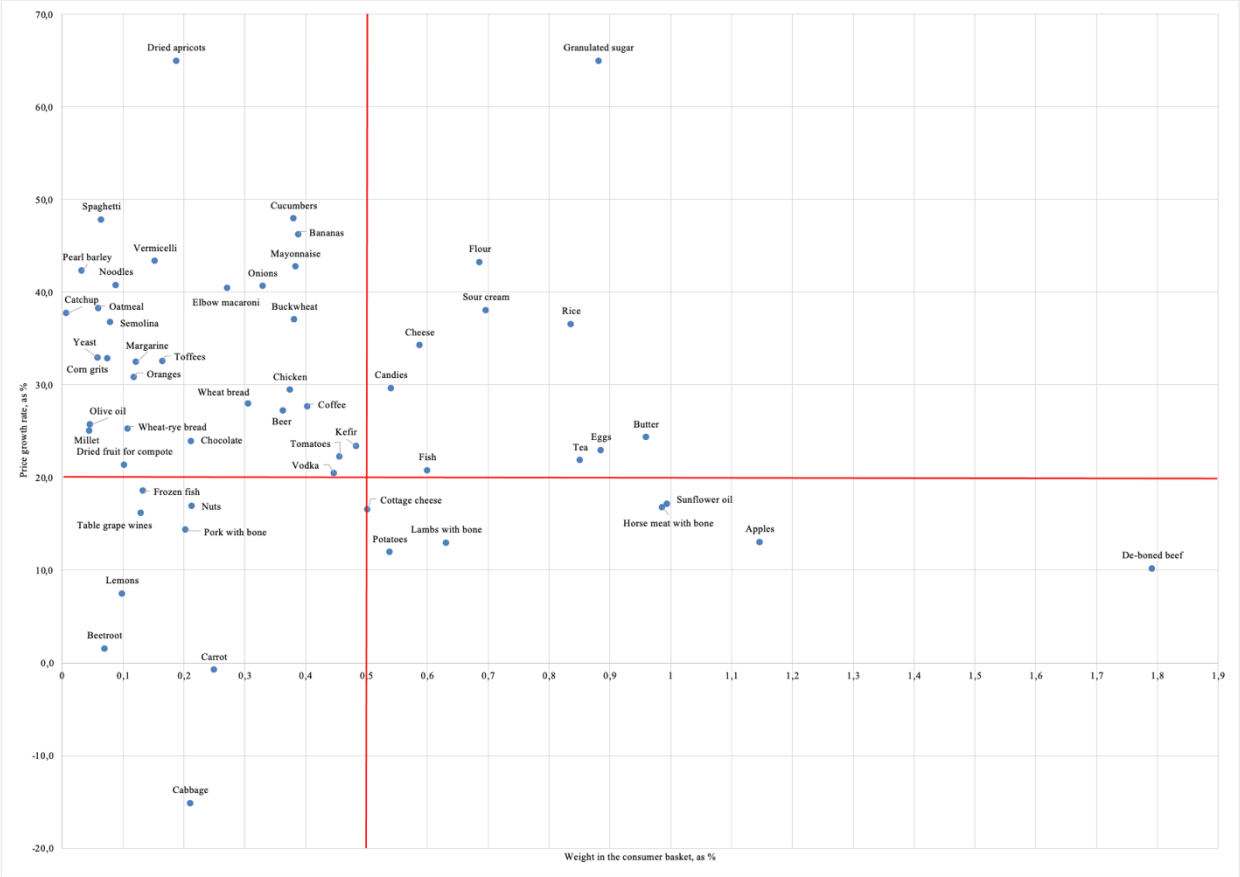
Appendix 1

Scatter Diagram of Food Products in 2022[2]

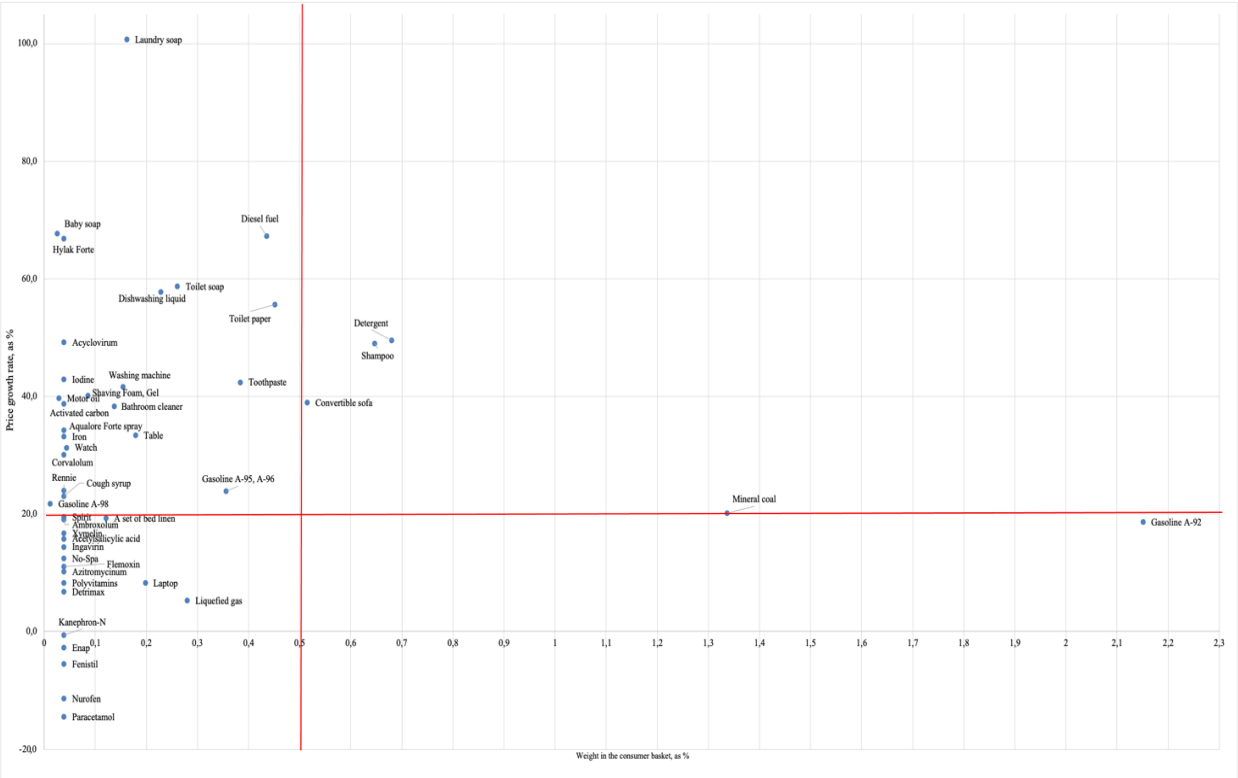


Source: compiled by the authors based on the data from the ASPR BNS RK

[2]In the process of analysis, 60 items out of 160 were reviewed (the weight of reviewed goods is 23.1% out of 40.7%).

Appendix 2

Scatter Diagram of Non-Food Products in 2022[3]

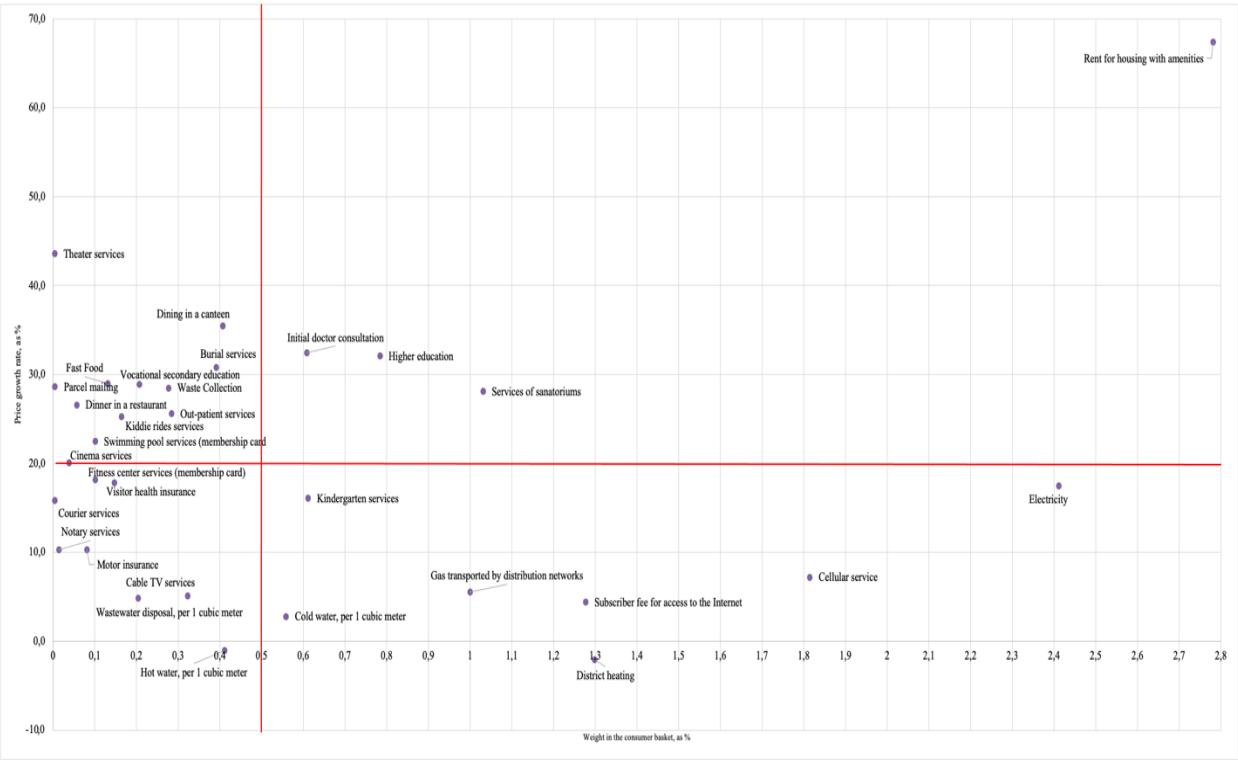


Source: compiled by the authors based on the data from the ASPR BNS RK

[3]In the process of analysis, 63 items out of 243 were reviewed (the weight of reviewed goods is 11% out of 30.2%).

Appendix 3

Scatter Diagram of Paid Services in 2022[4]



Source: compiled by the authors based on the data from the ASPR BNS RK

[4]In the process of analysis, 31 items out of 105 were reviewed (the weight of reviewed goods is 17% out 29.1%).

A Study of Inflation Persistence in Kazakhstan: What Has Changed?

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The paper analyzes the persistence properties of the monthly inflation and its components in Kazakhstan using a fractionally integrated approach. The results suggest the presence of long memory behaviour in the inflation series. The general inflation, food inflation, and non-food inflation experienced a break in late 2015 when the National Bank of Kazakhstan announced a shift in the monetary policy regime. Non-food inflation is fractionally cointegrated with the nominal depreciation rate. The estimates of the Bayesian DSGE model reveal shifts in the sources of inflation persistence. The evidence for the effect of the policy change on inflation persistence and its sources is mixed. Finally, the estimation of the persistence parameter is sensitive to the choice of data frequency.

Key Words: Inflation, persistence, fractional integration, DSGE, monetary policy, Bayesian estimation.

JEL-Classification: C11; C22; E31; E52.

Assessing the Anchoring of Inflation Expectations in Kazakhstan

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In this study, we assessed the degree of anchoring of inflation expectations of the population and professional analysts in Kazakhstan since the introduction of the inflation targeting regime. The anchoring was assessed using non-structural methods. Additionally, the rationality of inflation expectations as an indicator of confidence in the central bank was evaluated.

Overall, the results of the study showed that household inflation expectations are unanchored, and the degree of anchoring has decreased in recent years, reflecting sensitivity to short-term fluctuations in macroeconomic indicators. Inflation expectations of professional analysts are also not anchored; however, the degree of anchoring of their expectations is higher than that of the population.

Key Words: inflation expectations, anchoring, inflation.
JEL-Classification: E31, E19, D84.

1. Preamble

Anchored expectations represent a key aspect of an effective monetary policy. The objective of the central bank of a country is to maintain inflation expectations of businesses and the population at a stable level close to a long-term inflation goal.

The importance of the anchoring of inflation expectations within inflation targeting lies in the fact that they are one of the factors in shaping future price dynamics. If inflation expectations are anchored, then the deviations of inflation from its target will be less pronounced, and the comeback of inflation to its target will be faster. In this case, the central bank does not have to react to short-term supply shocks and other events thus allowing it to be more flexible.

The monetary policy goal is to avoid either low or high inflation expectations. If businesses anticipate high inflation, they may raise the existing product prices to offset higher production costs in the future. Otherwise, consumers who expect prices to fall may reduce their spending, increasing disinflationary pressure on prices as a result of reduced demand.

Anchored inflation expectations should not change frequently and should be stable over time. The degree of anchoring of inflation expectations can be measured by the degree of sensitivity to new information. If firms and households do not adjust their expectations in response to economic news, this may be the result of anchored inflation expectations and an effective monetary policy (Kose, 2022). In general, the most common approach is that inflation expectations are anchored if they are close to the central bank's long-term goal, their volatility is reduced, and unforeseen shocks have a less sustainable impact in the long run.

The degree of anchoring also depends on institutional factors. Such key factors as the central bank's independence, transparency of its policy, monetary instruments, and a sustainable fiscal policy are the basis for confidence in the monetary policy pursued (Bems et all., 2021)[1]. Moreover, a systematic failure to achieve inflation goals leads to the unanchoring of inflation expectations (Beckmann et all., 2022, Mishkin, 2000).

According to a survey of central banks conducted by the Bank for International Settlements (BIS, 2016), the most important determinants for the formation of inflation expectations are the indicators of past inflation and the level of its volatility. In addition, such nominal indicators were mentioned as the nominal effective exchange rate, base interest rate, growth rate of nominal wages,

[1] For example, (Bems et all., 2021) found higher degree of anchoring in the countries with fiscal rules, higher levels of monetary policy transparency and the central bank's independence.

and the real ones – the unemployment rate, the level of production as well as the central bank's independence and the existence of inflation targeting regime.

Anchored expectations help reduce the inertia of inflation, limit the degree of the pass-through effect from depreciation of the national currency onto domestic prices. This allows the monetary policy to focus more on smoothing out fluctuations in output and increasing resilience to adverse external shocks (IMF, 2018).

In general, inflation expectations can provide valuable information, even though inflation forecasts are subject to essential errors. A part of the forecast errors is related to the unpredictability of future shocks, and inflation expectations often react to shocks with a significant lag. Even when there are material forecast errors, inflation expectations can still contain useful information, such as the direction of future inflation or how anchored inflation expectations are.

This study examines expectations of various economic agents: the population (monthly FusionLab survey commissioned by the National Bank of Kazakhstan) and professional analysts (Consensus Economics) with the use of non-structural methods in the assessment.

In general, the results of various approaches demonstrate a low degree of anchoring of inflation expectations. Inflation expectations of the population are unanchored and irrational, while the degree of anchoring has decreased in recent years. Weak anchoring reflects sensitivity to short-term fluctuations in macroeconomic indicators, fluctuations in monthly inflation in particular. In addition, the sample shows the increased sensitivity of inflation expectations to exchange rate shocks over time. Inflation expectations of professional analysts at Consensus are also weakly anchored, although in some periods they were close to inflation targets and, in general, their degree of anchoring is higher than that of the population.

2. Literature Review

Approaches to the Definition of Anchoring. There is no single definition in the literature for the "anchoring" of inflation expectations and no consensus regarding which indicator inflation expectations should be linked to.

The most common approach is that inflation expectations are considered anchored if they meet the central bank's inflation targets over an extended period of time. It is believed that longer-term expectations/forecasts (from 5 to 10 years) reflect the behavior of economic agents in setting wages and prices in a better way (Bernanke, 2007). In addition, long-term expectations (from 3 years and above) do not reflect the impact of temporary shocks and the reaction of monetary policy (Bems et al., 2021).

A central bank can have a direct or indirect influence on three parameters that allow determining the degree of anchoring of inflation expectations over time: level, volatility and stability.

For example, a central bank can influence the level by declaring a quantitative inflation target. This, in turn, indirectly lowers volatility of expectations by reducing the uncertainty about the central bank's objectives. Additionally, volatility and stability of expectations could be reduced if the central bank adjusts the nominal interest rate more drastically to stabilize inflation near the target. If investors expect the central bank to act decisively on shocks, they may assume that the effects of these shocks will attenuate soon and set prices accordingly. As a result, inflation expectations will be less responsive to external shocks (Doh T., 2018).

Based on that, there are mainly three parameters of anchoring (linking) of inflation expectations in the literature (Łyziak and Paloviita, 2017):

1) Sensitivity of inflation expectations to current inflation (to macroeconomic shocks);
2) Response of longer-term expectations to short-term expectations;
3) Impact of the inflation target and the central bank's forecast on inflation expectations.

If inflation expectations are anchored, perceptions of future inflation should be close to the target as pursued by the monetary authorities (Demertzis, Marcellino, and Viegi, 2012; Kumar and others, 2015).

Inflation expectations can change in response to news and are an important source of long-term nominal interest rate fluctuations (Bauer, 2015). He used an indicator of absolute deviations in inflation forecasts from the target; an indicator of variability in inflation forecasts over time, and the variance of inflation forecasts by individual forecasters (Capistrán and Ramos-Francia, 2010; Dovern et al., 2012; Ehrmann, 2015; Kumar et al., 2015).

Another criterion for anchoring is the rationality of expectations of economic agents. In this case, people's expectations reflect all available economic information and the confidence in the central bank's actions. Businesses and households view the shock to wages and prices as temporary, resulting in that the wage growth and inflation quickly come back to the target and expectations remain anchored.

Thus, several approaches to the definition of anchoring have shaped in the literature; in most cases, the researchers use a combination of various definitions and methods.

Methods for Assessing the Anchoring. In order to assess the anchoring of inflation expectations, economists use both structural and non-structural models in their studies. Having a structural model provides a better interpretation of what anchored expectations are than approaches based on the rolling regression of either news or changes from short-term expectations to long-term expectations, (Gurkaynak, Levin, and Swanson (2010), Beechey (2011).

In most works, econometric methods used to assess the anchoring are based on the approach of Łyziak and Paloviita (2017), Ehrmann (2015), where the analysis of the dependence of expectations on actual inflation and the pass-through effect from short-term to long-term expectations is performed. The method of Bomfim, Rudebusch (2000) reflects the relationship between deviations from long-term expectations and the target.

Anchored inflation expectations need to be stable not only at the existing level but also in future forecasts. Hence, some authors look at the distribution of probability of future values in order to observe a change in the degree of anchoring.

The study performed by the Bank of Russia also derives a whole range of parameters based on the international experience. However, the concept of anchoring is used in a more strict way.

For example, Berms (2021) constructed indices for 45 countries that combine all three characteristics of anchoring (proximity of expectations to the inflation goal during a long period of time, stability of average values of expectations, and low variance of expectations).

The IMF study (2018) examined the degree of anchoring of inflation expectations in developing and developed countries. Using the experience gained by other researchers, the authors ranked countries according to the degree of anchoring based on four criteria: variance of inflation expectations, sensitivity to shocks from macro indicators, standard deviation of inflation expectations, and the level of spread between forecasts. Each method can have advantages and disadvantages but these four measures paint a consistent picture for each country.

The authors have come to the conclusion that the degree of anchoring has improved over the past two decades, but there is still heterogeneity in anchoring expectations and instability of long-term expectations in certain countries.

In the same study, the authors conclude that the contribution by a change in long-term inflation expectations to inflation is much larger than in the countries with less anchored expectations (by 0.4 pp per annum on average).

The anchoring of inflation expectations can be also assessed using multidimensional models. In such case, the sensitivity of expectations to shocks from some macroeconomic indicators is tested. If expectations are anchored, they feebly respond to a shock from macro variables, and vice versa.

Thus, Beechey et al. (2011) studied the impact of the lack of a clear inflation target in the communication strategy on long-term inflation expectations in the US compared to the Euro area. In particular, the authors found that inflation expectations are more anchored if market participants have a consensus on the central bank's long-term inflation target. Conversely, when inflation expectations are not anchored firmly because the private sector is unsure of the central bank's inflation target, long-term inflation expectations of agents are subject to change, as macroeconomic news arrive. Empirical analysis shows that long-term inflation expectations are

anchored more firmly in the Euro area than in the US due to the presence of a specific inflation target. Similar results, but for a wider list of countries, were obtained by Demertzis M. et al, 2009. In their work, the authors also tested the extent to which inflation expectations are linked to a specific goal (implicit target) and determined the goal itself for countries without an explicit target.

The publication by Davis J.S. (2014) examined the response of inflation expectations to shocks to inflation expectations, inflation and oil price shocks before and after the introduction of the inflation targeting regime. The authors showed that in a number of countries that adopted inflation targeting in the 2000s, there were significant changes in the response of inflation expectations to shocks to macro variables after the introduction of the targeting regime. No similar change in the behavior of inflation expectations in the control group of countries without an inflation targeting regime was observed. Thus, the study showed that the adoption of inflation targeting regime helped anchor expectations in a number of developed and developing countries.

Another example of the use of multivariate models to assess the degree of anchoring of inflation expectations is given in Dräger L., Lamla M. (2013). In particular, the authors analyze the relationship between short-term and long-term inflation expectations over time. The main finding of this article is that since 1978, inflation expectations have become more robust in the US: the impulse in short-term inflation expectations produces less of response in long-term expectations over time. Thus, the authors of the paper come to the conclusion that the degree of anchoring of inflation expectations among the US population has increased.

Table 1

Various Parameters for Assessing the Anchoring of Expectations

Parameter	Models	Sources
The impact of inflation target and the central bank's forecast on inflation expectations	Vector autoregressions, volatility indicator	Gurkaynak, Levin, and Swanson (2010); Beechey et al. (2011); Grischenko (2022)
Response of longer-term expectations to short-term expectations	Linear regressions	Łyziak and Paloviita (2017); Ehrmann (2015); Dräger L., Lamla M. (2013); Davis J.S. (2014)
Sensitivity of inflation expectations to the current inflation (to macroeconomic shock)	Vector autoregressions; regression with a sliding window;	Beechey et al. (2011); Davis J.S. (2014); Grischenko (2022)

3. Data

The following different sources of inflation expectations are used in the international practice. These can be surveys (of the population, enterprises, financial analysts), a survey of organizations and experts who specialize in developing macro-parameter forecasts as well as obtaining market estimates based on financial instruments. In addition, in recent years, it is common to obtain estimates using the tools for developing news-based indices or comments using big data tools.

Criterion	Types
Source	• Surveys Market-based financial instruments • Big Data
Type of economic agents	• Households • Enterprises • Financial organizations • Specialized agencies (Consensus, Bloomberg, etc.) and professional analysts

Surveys represent a traditional and most common practice among central banks. According to a study by the Bank for International Settlements, emerging- market central banks increased the number of surveys on inflation expectations between 2009 and 2015, especially inflation-targeting central banks.

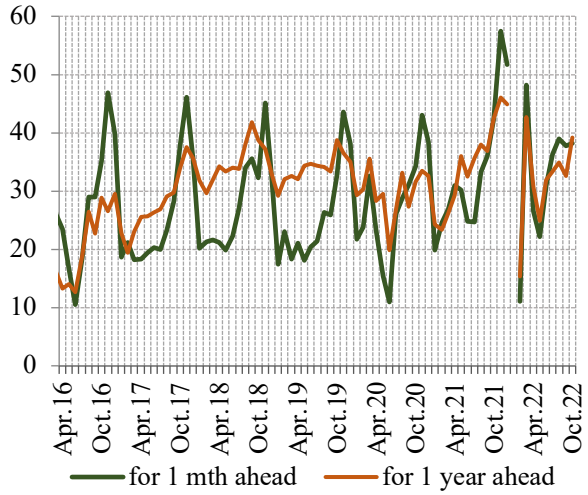
Survey methods have advantages in the form of coverage of the main groups of economic agents, while market-based methods have a greater frequency and more horizons for measuring expectations. At the same time, inflation expectations obtained on the basis of inflation-linked financial instruments reflect new information available to market participants in a timely manner.

On average, the expectations themselves and the level of their volatility among households and firms are much higher than the expectations of professional forecasters in both developed and developing economies. For households, past inflation is a strong predictor of expectations; they are more adaptive (back-looking) than professional analysts. At the same time, inflation expectations of professional analysts tend to be closer to the central bank's forecasts (Colibion and Gorodnichenko, 2015). In addition, the volatility of expectations among professional forecasters is below market expectations (Kose, 2022). Households do not know official statistics and often believe in higher inflation rates. In addition, unlike professional analysts, there is more inconsistency in responses of the population. At the same time, the population can generally catch trends in inflationary processes.

This study used the results of public polls (household surveys) in Kazakhstan conducted at the National Bank's request by FusionLab and professional forecasters (Consensus Economics) for Kazakhstan.

Figure 1

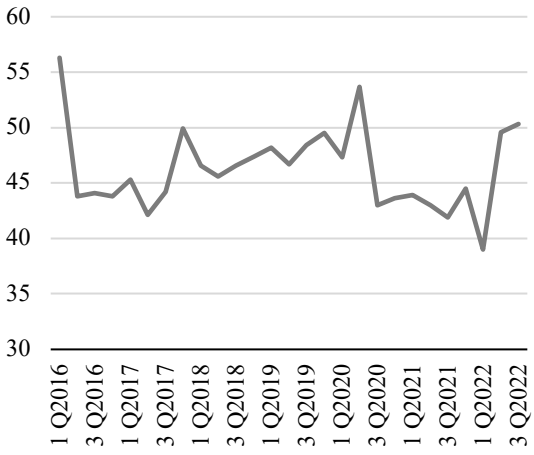
Expectations of the Population (Balance of Responses)



Source: FusionLab, NBK's computations

Figure 2

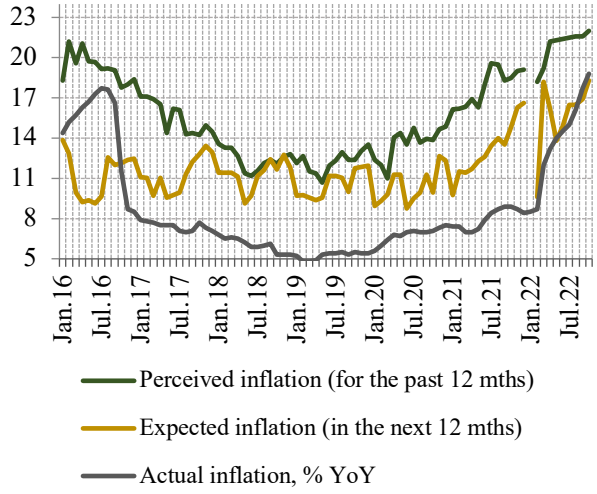
Enterprise Expectations for a Year Ahead, Balance of Responses



Source: FusionLab, NBK's computations

Figure 3

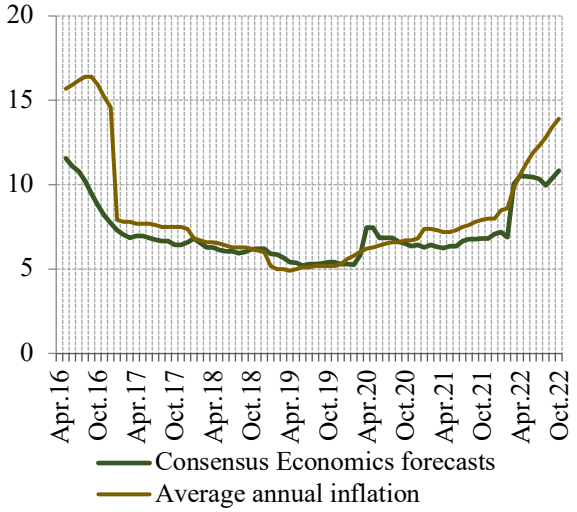
Expectations of the Population (Median Estimates) for 1 Year Ahead



Source: FusionLab, ASPR BNS, NBK's computations

Figure 4

Expectations of Professional Analysts (Consensus Economics)*



Source: Consensus Economics, ASPR BNS

*Note: Expectations of Consensus Economics have been transformed into moving annual averages

Population surveys on the assessment of inflation expectations commissioned by the National Bank have been conducted since 2016. The surveys involve 1,500 respondents living in cities of national significance and regional centers of Kazakhstan. The survey covers the adult population (18 years and older) with the distribution of the sample by gender, age, employment, nationality according to the official statistics of the Republic of Kazakhstan. The population survey includes qualitative and quantitative questions about the rise in prices in past and future periods, an assessment of financial situation, savings and credit behavior, and expectations regarding the prospects for the development of the country's economy. In addition, the National Bank's survey on the price growth is conducted as part of the surveys of real sector enterprises. In aggregate, due to the short series of quarterly data, this source was not considered.

The analysis uses both balances of responses to short-term (one month ahead) and medium-term expectations (one year ahead), as well as median estimates of the observed and expected inflation one year ahead. The balance of responses is the difference between proportions of respondents who expect an increase and decline in the indicator. Computation example:1*W (a faster price growth) +0,5*W (the same as now price growth)-0,5*W (price invariance) - 1* W (decline in prices), where W – is the percent of respondents who have chosen the respective answer. The score may vary from -100 (all responses: "will decline") to +100 (all responses: "will be growing faster than now").

The timeframe of data for inflation expectations of the population is from January 2016 through October 2022, and for the Consensus analysts – from May 2016 through October 2022.

To get the one-year forecasts of the Consensus analysts, we transformed the average annual consensus forecasts for two consecutive years and compared them with the average annual inflation. Since the experts give forecasts of average annual inflation every month until the end of the year and average annual inflation for the next year, and in each subsequent month, they know the actual data for the prior months.

In addition, the monthly data on the headline inflation and individual macroeconomic indicators for the period from 2016 through 2022 published on the Taldau information and analytical platform of the ASPR BNS were used[2].

[2] The Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan

4. Results

Based on the literature review, we have chosen some methods for the anchoring of expectations and have analyzed the results.

1. Sensitivity of Long-Term Expectations to Current Inflation. Assessment of regressive relationship between inflation expectations and current inflation (Ehrman, 2017):

$$E_t(\pi_{t+f}) = \alpha_t + \beta_t \pi_{t-1} + \varepsilon_t \quad (1)$$

where $E_t(\pi_{t+f})$ – inflation expectations at time *t* (the median or balance of responses) made for *f* periods ahead, π_{t-1} – actual inflation with the lag of 1 period, ε_t – error.

If the expectations are anchored, then the null hypothesis about the insignificance of coefficient βt in the regression cannot be rejected. The rolling regression with a window of 30 periods was evaluated to analyze the changing relationships between variables over time. Rolling regression enables to obtain estimates of regression parameters on a sample interval of constant width sequentially shifted in time. Regression allows building the paths of coefficient estimates along with their confidence bands and test the hypothesis that the coefficients of the regression equation are constant over time. Using a larger sample size or window will result in fewer parameter estimates but more observations. The Newey-West (HAC) standard errors are applied, consistent with heteroscedasticity and autocorrelation.

Because of the January events, the sample was divided into 2 parts: a variant with a sample until 2022 and a full sample with the data replaced by averages (Table 1). Monthly inflation was used as the actual inflation, since significance of annual inflation was considerably smaller. This indicates that the population's expectations are based on the events of the current or preceding month; in general, the picture of the whole year is not included, implicitly confirming the presence of seasonality in the time series of median estimates.

Table 2

Dependence of Inflation Expectations of the Population on Actual Inflation

	Sample **2016/01-2021/12**		Full Sample	
	β	**Adjusted R**	**β**	**Adjusted R**
Median inflation expectations one year ahead	2.657483 [0.0004]	0.165049	2.596222 [0.0000]	0.336547

Figure 5 shows rolling coefficient estimates at actual inflation. An analysis of the dynamics of sensitivity of inflation expectations one year ahead to the actual inflation indicates that there are unanchored expectations in both samples, since the coefficient rises over time and becomes higher than one. However, at the beginning of the expectation period, the degree of unanchoring was lower than at present.

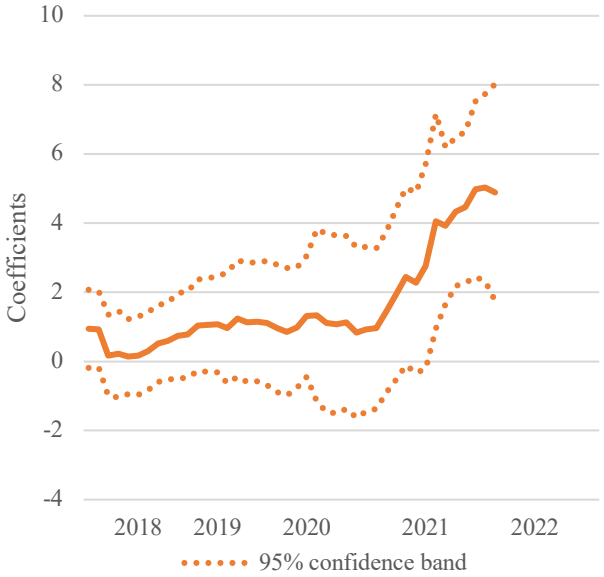
As for the forecasts made by the Consensus analysts, the actual average annual inflation is also significant for their expectations (β =0.45, Ad.R2 = 0.780413), while average annual inflation has more significance for them than the monthly inflation.

As in the case of expectations of the population, the degree of anchoring has become smaller in the last three years.

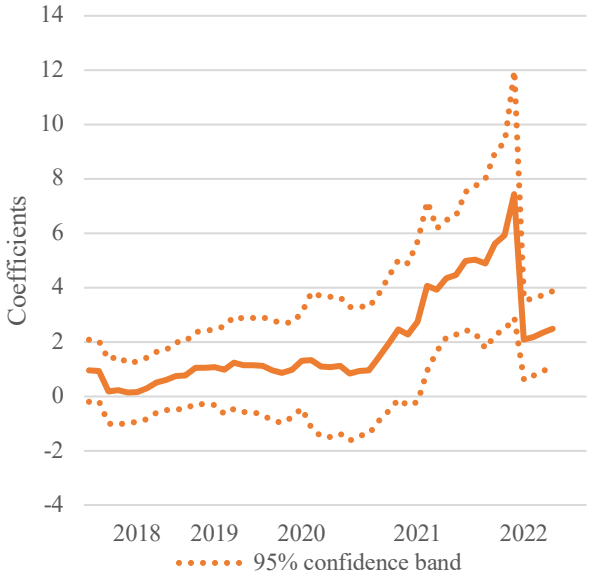
Figure 5

Sensitivity of Medium-Term Expectations (1 Year) of the Population to Current Inflation

Sample 2016/01-2021/12



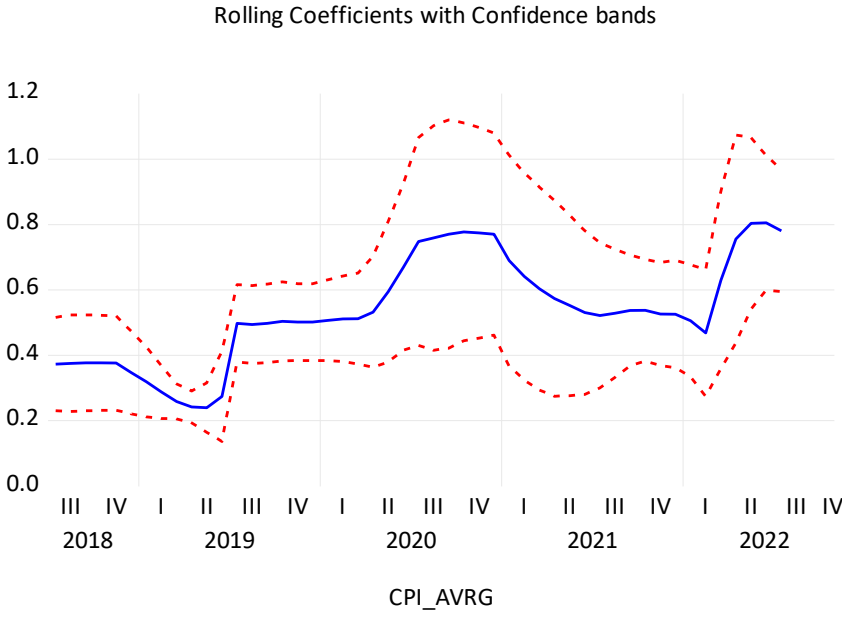
Full Sample with Data Replacement



Note: Rolling regression. Newey-West standard errors. Sliding window = 30 observations. First sample =01/2016 through 05/2018

Figure 6

Sensitivity of Medium-Term Expectations (1 Year) by Consensus To the Current Inflation (cAverage Annual)



2. Sensitivity of Long-Term Expectations to Short-Term Expectations. The sensitivity of long-term expectations to short-term expectations was assessed via regression relationship (Łyziak, Paloviita, 2016). Just as in the study by Grischenko et al. (2022), due to the absence of long-term expectations, sensitivity of short-term expectations of the population (one year ahead) to short-term expectations (one month ahead) was assessed, in the form of a balance of responses:

$$E_t(\pi_{t+f}) = \alpha_t + \beta_t E_t(\pi_{t+m}) + \varepsilon_t \quad (2)$$

where $E_t(\pi_{t+f})$ – long-term (medium-term) inflation expectations in the period *t*, $E_t(\pi_{t+m})$ – short-term inflation expectations in the period *t*.

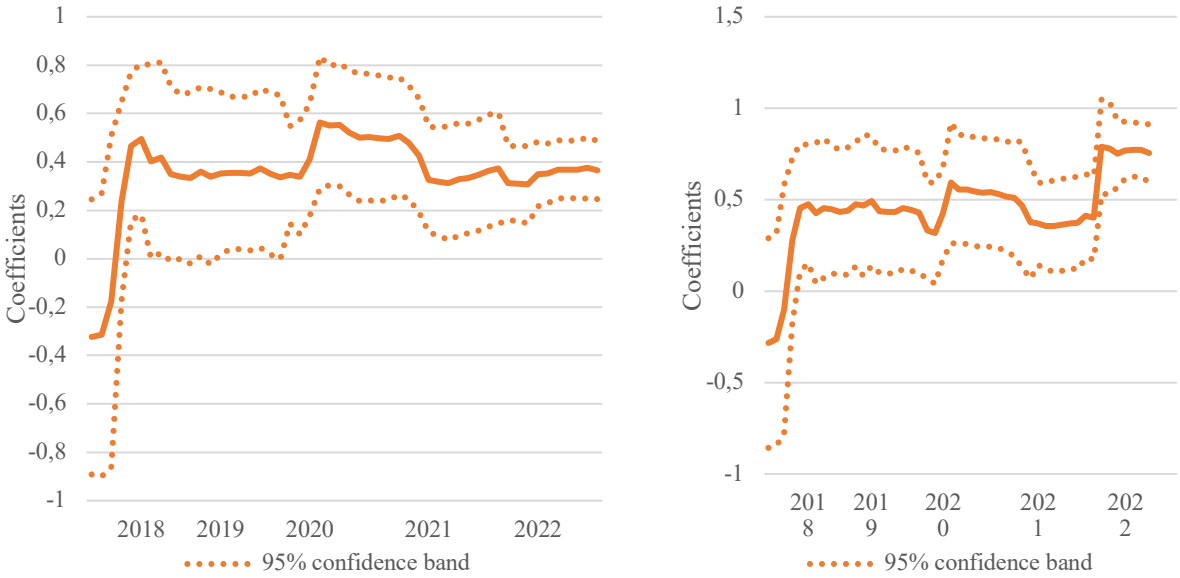
In doing so, given that in January 2022 the data was missed because of the January events, in January-February the averages of the preceding three months were used. In contrast to the initial equation (2), an autoregression component was added into the equation.

The rolling regression was evaluated using a 30-period window. Figure 7 shows the coefficient with the variable of short-term expectations (expectations one month ahead) and its 95% confidence band.

Figure 7

Sensitivity of Medium-Term Expectations to Short-Term Expectations

With replacement of the January-February Data *W/o Replacements*



Note: Rolling regression. Newey-West standard errors. Sliding window = 30 observations. First sample =01/2016 through 05/2018

In the period under review, medium-term expectations (one year ahead) depend on short-term expectations (one month ahead). The general dependence of medium-term expectations of the population on short-term expectations is observed almost all the time, while in the initial samples the coefficient was significant only at a 10% significance level. The value of the coefficient increased during the coronavirus pandemic, that is, both medium-term and short-term expectations reacted to the events taking place in the economy in the same way. At the same time, the results indicate that it is impossible to consider the medium-term expectations of the population as anchored.

3. Sensitivity of Expectations to Macroeconomic Shocks. To obtain estimates of the anchoring of inflation expectations in Kazakhstan, a second-order vector autoregression (VAR) model was used, followed by estimates of the impulse response function of inflation expectations for the year ahead to shocks of macro variables. Structural identification of the VAR model was performed using a recursive short-term identification according to Cholesky. The choice of an optimal lag was made based on the Akaike criterion.

The model in its general form is presented as follows:

$$y_t = \sum_{j=1}^{p} A_j \cdot y_{t-j} + B_t x_t + C d_t + \varepsilon_t, \qquad (3)$$

where y_t – k-dimensional vector of endogenous variables, x_t – vector of exogenous variables, d_t – vector of dummy variables, A_j, …, A_p, B_t, C – matrices of coefficients to be estimated, ε_t – residual vector.

To evaluate the model, we used the data from the beginning of the surveys on inflation expectations, that is, from January 2016 to September 2022. In doing so, to assess the change in the degree of anchoring, the regression was evaluated on a sliding window of 30 observations (Grischenko, 2022).

The following endogenous variables were used in the model:

- Median estimate of the expected inflation one year ahead (EXP_MED);
- Nominal effective exchange rate index (NEER);
- Consumer price index (CPI), deseasonalized;
- A proxy of the output gap (OGPROXY) – a percentage deviation of a short-term economic indicator (SEI) from the Hodrick-Prescott filter trend ($\lambda = 14400$).

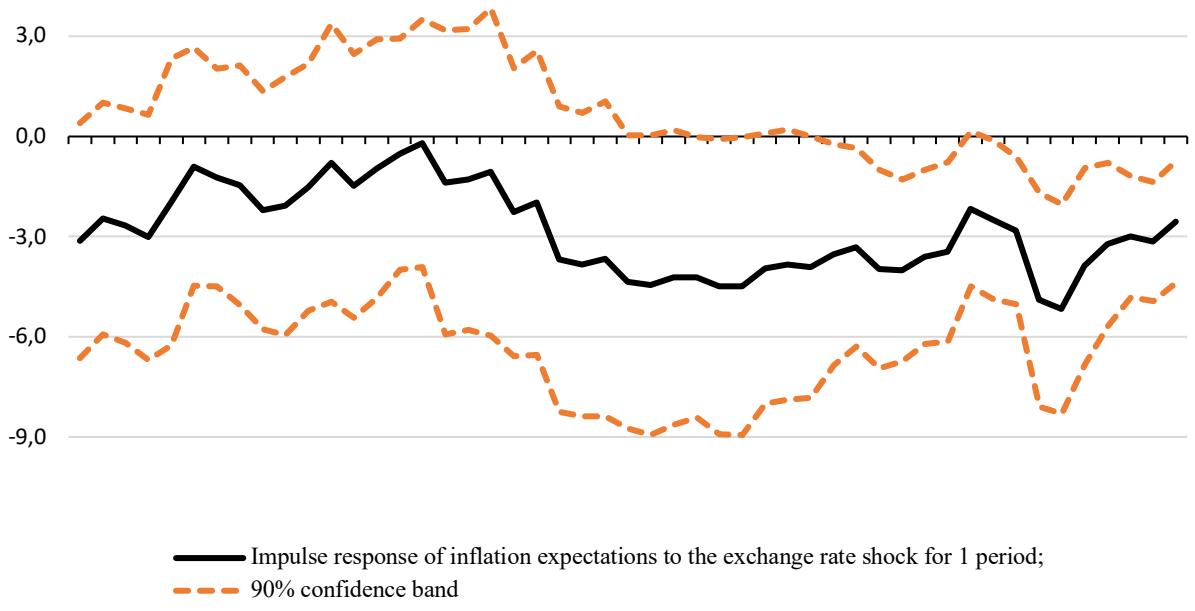
Exogenous variables:

1. Dynamics of Brent oil prices (OIL). The inclusion of this indicator is stemming from a high share of fuel resources in Kazakhstani exports and significant dependence of the dynamics of the tenge exchange rate and the output gap on conditions in the oil market.

2. Inflation in Rusia (CPI_RU). Due to a high share of consumer imports from Russia, inflation in Russia exerts significant effect on the pricing within the country.

Figure 8

Reaction of Iflation Expectations to the Exchange Rate Shock



Thus, it is assumed that in the case of anchoring, the impulse responses of inflation expectations to shocks of other macrovariables are not significant. However, as a result, the responses of inflation expectations to the nominal effective exchange rate shocks turned out to be significant in some periods (Figure 4). At the same time, the sensitivity of inflation expectations increases over time. Such reaction of expectations to the exchange rate shocks speaks in favor of reducing the degree of anchoring of household expectations.

4. Proximity of Inflation Expectations to the Inflation Goal. Proximity to the goal was evaluated similarly to the study by Grischenko et al. (2022), IMF (2018), based on the 12-month rolling volatility of expectations (mean root square deviation).

Figure 9

Proximity of People's (Households') Expectations to the Goal

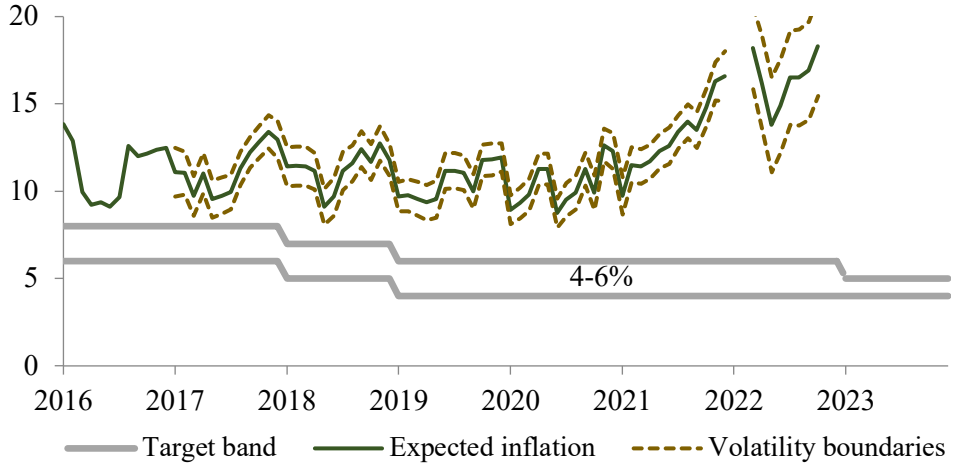
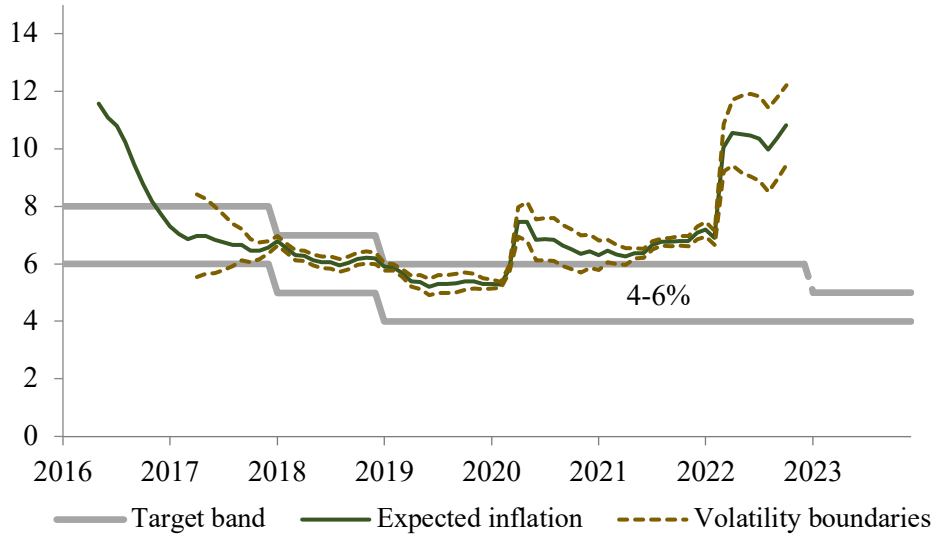


Figure 10

Proximity of Expectations by Consensus Professional Analysts to the Goal



Note: the results should be compared based on that annual averages of expected inflation and the annualized inflation target are compared

Inflation expectations of Consensus analysts were anchored in the period 2017-2019, when annual inflation in Kazakhstan was generally in the target range. Household inflation expectations have remained unanchored since 2016.

The inflation goal in Kazakhstan is formulated on an annual basis. A gradual lowering of inflation targets was announced in 2016 – from 6-8% in 2016-2017 to 3-4% by 2020; further, in 2019 – a gradual lowering from 4-6% to 3-4% by 2025. Economic agents find it difficult to adapt to new numbers, and they may often fail to keep the recurrent shifts of the target bands in their minds. In terms of the anchoring of inflation expectations, it is not desirable to frequently revise the quantitative goals and forms of the target.

At the same time, inflation-targeting countries are beginning to set a permanent medium-term target to be achieved all the time, not at the end of the year. In Kazakhstan, in the context of the transition period, the achievement of the target continues to be measured by inflation at the end of the year, while the emphasis may change in various communications.

5. Assessing Rationality of Inflation Expectations. In this part, we performed a group of tests for rationality of expectations. We added the annual inflation and annual movement of the exchange rate of the tenge against the US dollar.

If the null hypothesis is rejected, then the expectations of economic agents are biased, which does not correspond to the hypothesis of their rationality. The results of the test for unbiasedness of the error of inflation expectations are presented in Table 3.

The test results indicate that the hypothesis of rationality of inflation expectations from professional forecasters (Consensus) and the population is rejected.

Table 3

Tests for Rationality of Expectations

	Criterion	Equation	H0	**Results** Population	**Results** Consensus
1	Unbiasedness	$\pi_t - \pi^e_{t-12} = \alpha + \varepsilon_t$	$\alpha_t = 0$	α_t= -3.772097 H0 rejected	α_t=0.547424 H0 rejected
2	The use of all information	$\pi_t - \pi^e_{t-12} = = \alpha + \gamma\pi^e_{t-12} + \sum \beta_i X_{it-12} + \varepsilon_t$	$\beta_i = 0$, γ=0	ß(usd/kzt)= 0.027808 ß Cpi = -0.154527 γ= -1.130024 H0 rejected	ß(usd/kzt)= 0.026982 ß Cpi = -0.648304 γ= --2.146913 H0 rejected

5. Conclusion

It is paramount for the monetary policy to analyze the dynamics of inflation expectations and the factors affecting them. Expectations represent an important indicator of confidence in a central bank.

In this study, the authors conducted an initial assessment of the anchoring based on Kazakhstani data. However, it is worth mentioning that the analysis of the degree of anchoring of inflation expectations in Kazakhstan must take into account some specific features and limitations of the data (short data series, not all sources of formation of expectations are covered).

Moreover, the absence of estimates for long-term inflation expectations is stemming from the fact that the inflation targeting regime was introduced relatively recently and is at a transitional stage.

Further accumulation and study of the data, including from various sources and categories of economic agents, will provide a basis for setting up communication tools. In addition, this will enable to monitor how the attitude of economic agents to new information and the central bank policy changes over time, to understand the differences between expectations of various agents. It is possible to study the process using alternative structural approaches. The presence of a structural model provides a better interpretation of the anchoring of expectations, however, it certainly also has its limitations.

The process of the anchoring of expectations is slow and time consuming. A longer actual staying of inflation near the target, a better communication policy, openness and transparency of the National Bank of Kazakhstan will help increase the degree of anchoring of inflation expectations. In addition, in the context of inflation targeting, it is also important to pursue a sustainable fiscal policy and, in general, ensure the coherence of macroeconomic policies. What is important is not an in-and-out effect but a complex effect of all possible factors that have influence on the anchoring of inflation expectations.

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Various Core Inflation Estimates for Kazakhstan

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Central banks pursuing the inflation targeting policy need to monitor current trends in the development of price processes and highlight key changes that are of a permanent nature. In this regard, in addition to the CPI, central banks closely monitor other price changes, among other things often building separate core inflation indices that characterize stable trends and are related to other macroeconomic indicators. In this paper, we make estimates of core inflation using several methods from different classes, evaluate and compare them with each other, and study the relationship between core inflation and other macroeconomic variables.

Key Words: inflation, core (trend) inflation, factor models, state space models.
JEL-Classification: C19, C32, E31, E37

1. Preamble

Central banks adhering to the principles of inflation targeting, in the course of monetary policy implementation need a full understanding of the dynamics of inflation as a process of sustainable price growth. Usually, the consumer price index (CPI) acts as the main benchmark and target, but this value is often subject to various temporary shocks of individual goods and services and may not reflect the current price trend as well as possible future trends. Core inflation (or trend inflation) should have such properties – a theoretical concept that macroeconomists try to evaluate using various methods. At the moment, in order to analyze the current situation, the National Bank of the Republic of Kazakhstan uses several methods, which are presented in the study (Orlov, Yerzhan, 2019).

In addition to the National Bank, currently only the Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan ("the ASPR BNS RK") deals with the estimation of core inflation on a permanent basis. However, the ASPR BNS RK uses only few methods of elimination[1], without seasonal adjustment, which may be insufficient for a comprehensive view on inflationary processes (The Methods for Computing the Base Consumer Price Index, 2016).

In this regard, the purpose of this study was to expand the range of methods used in the National Bank, as well as to compare them according to various criteria. Thus, the methodology for estimating core inflation with the help of methods from various classes such as methods of elimination, truncation, weight alterations, filtering, and applying state space models, is presented. At the same time, many estimates were considered in each class in order to broadly cover the approaches to estimating core inflation that are currently available in the literature. This fact was based on that often one or another method of estimating core inflation does not have all the properties that economic theory imposes on it.

The work consists of several parts. The first section provides a review of the literature describing the application of various methods for estimating core inflation, the second section describes the data used and the estimation methodology, and the third section based on the obtained time series examines their statistical properties as well as their relationship with the traditional CPI and other macroeconomic indicators. Finally, the fourth section presents findings and recommendations for future research.

[1] Since 2021, the ASPR BNS RK has ceased to publish estimates of core inflation by truncation methods, leaving only methods of elimination of a fixed set of goods and services (as of the end of January 2023))

2. Literature Review

By virtue of the fact that the CPI as a measure of inflation that is most understandable to the general public and the most popular can be influenced by various temporary noises and changes in relative prices, economists have thought about determining such price change that would have the properties of stability, generality (that is, would reflect the general price change) and could serve as a benchmark for future inflation. Understanding the dynamics of such value is necessary, first of all, for central banks whose mandate is the price stability, since the impact of monetary policy on changes in prices for goods and services is of a general and long-term nature (1-2 years) and does not extend to their relative change. In this regard, almost all central banks of the world, for example, in Canada, the USA, Norway, Japan, Korea, and the Czech Republic, and emerging markets, monitor and in some cases publish individual series of core inflation.

At present, there is no generally accepted definition of core inflation, but Eckstein (1981) interpreted core inflation as "the rate that would occur on the economy's long-term growth path provided that the path was free of shocks and the state of demand were neutral." According to this paper, the CPI without food and energy-related goods was the first such measure. As defined in (Bryan and Cecchetti, 1994), core inflation is "the long-term or persistent component of a measurable price index that is related in some way to the growth in money supply". In the work of (Quah and Vahey, 1995), core inflation is "as that component of measurable inflation that has no medium or long-term effect on real output." Since the monetary policy is assumed to be output-neutral in the long run, core inflation will be the portion of inflation that can be influenced by the monetary policy.

Later, the works of (Roger, 1998) and (Wynne, 1999) presented a number of required features of core inflation such as:

- unskewness (that is, the same average) relative to the CPI;
- stability over time, when new data becomes available. The problem refers mainly to filtration methods and methods based on model estimates;
- ability to predict future inflation;
- the understanding by the central bank top management and the public at large when the central bank uses such indicators in its communication policy (internal and external);
- relationship with macroeconomic variables.

As the experience with core inflation estimates shows, no single indicator can fully satisfy these criteria, and therefore the use of a variety of different estimates is recommended (Mankikar and Paisley, 2004). When these methods show generally the same results, we can talk about the good quality of core inflation estimate (Silver, 2007; Laflèche T. et al, 2006). At the same time, if these estimates differ, this can provide additional insight into inflationary processes.

The paper of (Silver, 2007) presents a classification of existing methods for estimating core inflation. Thus, the methods are divided into methods of elimination, truncation, weight alteration, filtering (trend extraction) and the use of various modeling techniques. To one degree or another, central banks use all of the above methods.

Methods of Elimination. These methods are viewed as the simplest and understandable to the general public and may serve as an operating benchmark for inflation (Laflèche et al, 2006). In their simplest form, they represent an exclusion of the most volatile and manageable components of inflation from the computation; in the United States, in particular, these are food and energy products (Eckstein, 1981). There is also an exception for transportation services, utilities, mortgage payment services and the impact of indirect taxes, for example, CPIX for Canada with an exception of 8 components in operation (Laflèche et al, 2006).

The main disadvantage of these classes of methods is the exclusion of components that may contain future price trends, and, conversely, the possible ignoring of the exclusion of components containing noise. In this regard, in addition to this traditional method, central banks pay attention to other methods of elimination. For example, in (Pedersen, 2005) and (Deryugina et al., 2015), the most volatile components for a certain moving period acted as excluded components. This approach enables to only partially eliminate the listed shortcomings and achieve the desired results.

Truncation Methods. Another common method of computing core inflation is to truncate at each month the ordered distribution of price changes in the CPI components. The truncation refers to extremes of the price change, which mainly reflect relative price change and, in theory, should not be related to core inflation. Subsequently, the remaining components are combined into a new measure proportionally with the new weights, summing up to 1. An extreme case would be the median of the distribution, where a 50% truncation applies at both ends.

This method was first proposed in (Bryan and Ceccehetti, 1994), where a 15% trimmed mean and median were calculated for the US data. The results showed that the median had the best ability to predict future inflation and had a high correlation with lagging money supply. Later, due to its simplicity and generally acceptable properties, this method became firmly established in the core inflation estimation toolkit of almost all central banks and individual researchers.

With regard to recent work, Alsabban et al. (2022) examined the properties of the 25% trimmed mean in the case of Saudi Arabia in the context of phasing out oil dependence by 2030. It was confirmed that this measure of core inflation has a close relationship with the inflation trend, has the capability to predict future inflation and is thus free of supply shocks in the context of economic restructuring.

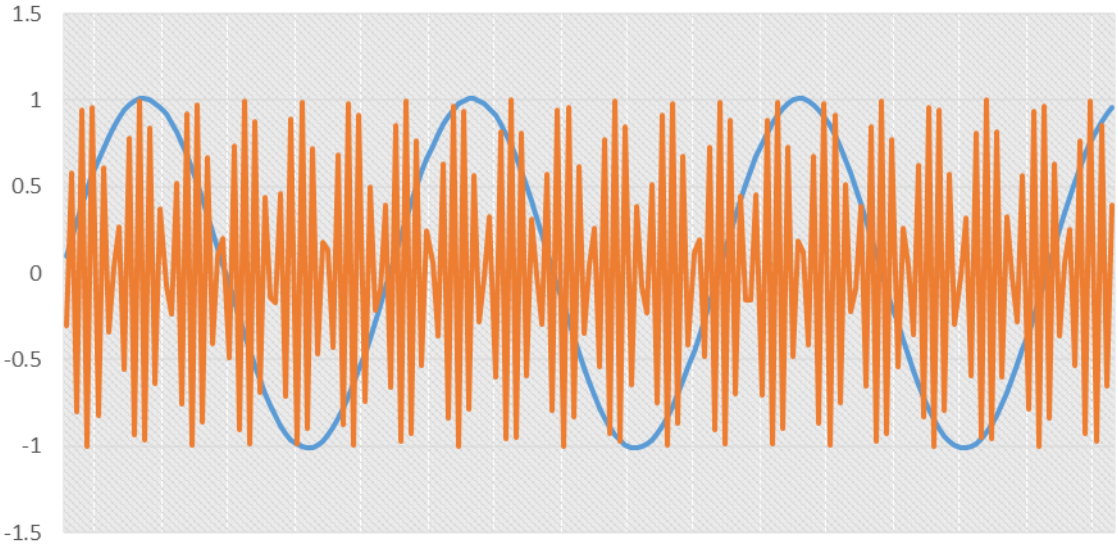
It is worth mentioning that the main problem when using this method is to determine the size of truncation and its symmetry, since a certain level of truncation may not lead to the desired properties of unbiasedness, closeness with the inflation trend and predictive power (Rich et al., 2022). So, in the works (Tsyplakov A. et al., 2004), (Meyer, Venkatu, 2014), (Deryugina et al., 2015), asymmetric filters and their properties were considered. In addition, in (Rather et al., 2016) a method to obtain truncation sizes, minimizing the skewness of the remaining distribution was provided.

Methods of Weight Alterations. This class of methods appeared and developed as a result of attempts to overcome the shortcomings of elimination methods, when certain components are not removed, but they are given less weight. (Laflèche et al, 2006) estimated core inflation by weighing each component as the product of its CPI weight and a reciprocal of the component's volatility. This value turned out to be unskewed, less volatile than the CPI, and contained information about future inflation. In (Çeliku, 2009) and (Deryugina et al., 2015), this approach was also considered as one of the methods for estimating core inflation used in central banks.

In addition to volatility, the concept of persistence is often used as a weight criterion. The persistence of the time series characterizes the duration of a certain trend and characterizes the degree of absence of noise, thereby proving the need for core inflation to have such a property. At the same time, the concept of persistence does not coincide with volatility (Figure 1). Therefore, excluding or giving less weight to volatile but stable components can lead to misleading conclusions about the dynamics of core inflation. Thus, (Silva et al., 2015), using the example of oil prices behavior from 1999 to 2012, showed that changes in relative prices can be quite long-term and have secondary effects in the form of an increase in prices for other goods and services, which demonstrates the need to take into account oil prices in the dynamics of core inflation, regardless of its volatility.

Figure 1

Two Time Series with Equal Variance (Volatility) but Different Persistence



Source: authors' computations

Persistence of the CPI components may be computed by using different methods but the most common would be the sum of autoregressive coefficients of the following type of equation

$$\pi_t^i = \alpha_j + \sum_{k=1}^{q_i} \rho_{t-k}^i \pi_{t-k}^i + \varepsilon_t^i, \quad (1)$$

where π_t^i – i–th CPI component versus the preceding month, q_i – the value of maximum lag, which is either initially set or estimated using the Schwartz information criterion. Moreover, if the persistence of the component turned out to be negative, then its new weight will be equal to 0.

This method of estimating core inflation was used for the UK in (Cutler, 2001), for EU countries – (Bilke, Stracca, 2007), for Albania - (Çeliku, 2009), for Brazil - (Silva et al., 2015), for the USA - (Gamber, 2016) and generally showed its viability in comparison with other methods. In addition, (Silva et al., 2015) and (Gamber, 2016) looked at weights that take into account both the persistence and initial weights of the components. Moreover, in (Silva et al., 2015), core inflation that takes into account both volatility and persistence, and the initial weights of the components was constructed.

Finally, in (Bilke and Stracca, 2007), correlations of components with the general CPI index were used as new weights.

Thus, as a result of applying the methods of weight alterations, we obtain a new ordered distribution of price changes. We can apply, as in (Gamber, 2016), truncation methods to such distribution, for example, the computation of the median.

Filtering Methods. According to the fundamental work (Eckstein, 1981), "core inflation is the trend rate of increase of the price of aggregate supply". At the same time, in the economic literature, various smoothing and filtering methods are often used to find a trend in time series, which enable to clear the series of excessive noise. Having such advantages initially, these things can be subject to significant revision due to the addition of new points and are usually used less frequently than other methods (Silver, 2007). The use of such methods can be found in recent works for the USA (exponential smoothing – Rich, 2007) and Russia (spectral filter – Deryugina et al., 2015). At the same time, in the study of (Bashar, 2011) for Bangladesh, the decision was made to abandon the use of filtering methods (moving average, exponential smoothing, HP filter, BP filter) since the resulting time series did not meet the required criteria.

However, the smoothed nature of the dynamics of such series enables to use them as a retrospective estimate of core inflation, and the amount of deviation from them as a criterion for evaluating the properties of one or another estimate of core inflation (Shiratsuka et al, 2015).

Moreover, the method of data filtering by means of wavelets has proven its worth in a number of works on the estimation of core inflation.

The essence of the method lies in the fact that any time series can be decomposed into components in terms of time and frequency and, in this regard, they can take into account the properties of the time series both in time and in different fluctuation frequencies (that is, to distinguish from short-term noise to a long-term trend). This approach allows solving the problems of the Fourier transform, when the frequency decomposition is applied to the entire time interval and can be distorted because of the presence of various local shocks.

Among recent works, the positive experience of applying this principle in New Zealand (Baqaee, 2010), the USA (Dowd et. al, 2011), South Africa (Du Plessis et. al, 2015), and Pakistan (Hanif, 2020) can be pointed out. These studies make a point that such approach is at least as good as traditional estimates of core inflation and surpasses them in terms of some criteria.

An illustrative review of using wavelets in the estimation of core inflation is presented in the study by (Baqaee, 2010).

Methods of Models Applications. The use of the model toolkit in constructing core inflation estimates is intended to take into account elements of the economic theory. Thus, the first such approach is to build a SVAR model. In (Quah and Vahey, 1995), the view of core inflation as neutral with respect to output in the long run was implemented through factoring appropriate constraints on shocks into the model. Despite a solid theoretical foundation, this approach contains a number of such complexities as sample dependence, model specification, and the problem of obtaining up-to-date estimates. Among recent works that used the approach of a structural vector model, it is worth mentioning the work (Martel, 2008) of the Bank of Canada, where the model included the price of oil and labor (Deryugina et al., 2015), and where structural constraints were imposed on the shocks of the factor model.

Another approach for estimating core inflation is to use state space models estimated by applying the Kalman filter. The advantage of these models is their economic interpretation, and the disadvantage is the limited number of variables used without imposing additional prerequisites. Thus, the work (Dementiev, Bessonov, 2012) provides a specification that can be used to estimate core inflation

$$\pi_t^* = \pi_{t-1}^* + u_t \quad (2)$$
$$\pi_t^i = \pi_{t-1}^* + \varepsilon_t^i,$$

where π_t^* – a general component, π_t^i – a change in prices of *i*-th component, u_t – general noise of all components, ε_t^i – specific noise. A similar specification is presented in the components, and the second reflected the relative change in prices. In addition to price variables, other macroeconomic variables were also used in (Amstad et al., 2014) to estimate the general component.

In addition, (Reis et al., 2010) proposed to isolate a general component from the price changes of the components, called “net inflation”, which equally (the coefficient is 1) affects all components and does not correlate with changes in relative prices in any period of time. This approach was looked at in (Brzoza-Brzezina et al., 2009) for Poland, (Humala et al., 2012) for Peru, (Deryugina et al, 2015) for Russia.

Finally, the general component tool can also be used to validate stylized facts about the economy. Thus, in (Guðlaugsdóttir et al., 2018) it was shown that the dynamics of core inflation in Iceland estimated using the factor model is determined by imported inflation, which is not surprising for the island country.

3. The Data and Methodology Used

3.1. Data Description

To apply various methods of core inflationestimation, time series of the monthly price growth rate of 66 CPI subgroups (Appendix 1) were used, which were previously seasonally adjusted according to the methodology presented in (Orlov, Yerzhan, 2019). Deseasonalization is

necessary to obtain a smoother series so that the time series does not have excessive volatility due to the seasonal factor alone and there is comparability between components with and without explicit seasonality. The deseasonalization procedure is used by many central banks, for example, in the Russian Federation (Deryugina et al, 2015), Turkiye (Tekatli, 2010), the ECB (Bilke, Stracca, 2007), Korea (Kim et al., 2009), Saudi Arabia (Alsabban, 2022), Canada (Khan et al, 2015).

In turn, the above-mentioned groups of goods and services are used in forecasting inflation at the National Bank of Kazakhstan (Tuleuov O., 2017). Thus, this breakdown aligns the procedures for deseasonalization, core inflation estimation and forecasting, thereby improving the analysis of inflationary processes. At the same time, in order to further implement regular and efficient procedures for core inflation estimation, updated price data on goods and services and their groups are downloaded from the Taldau information and analytical system ("the Taldau"). Due to the lack of price data in the Taldau for all groups of goods and services until January 2011, it was decided to use the data from January 2011 until present. All algorithms for estimating core inflation presented in this paper as well as procedures for their comparison with each other and their pseudo-real estimates, were implemented in the Eviews 12 statistical package.

3.2. Methodology for Constructing Various Core Inflation Estimates

Methods of Elimination. Several methods of elimination were used in this work. First of all, this is a deseasonalized CPI without 7 components, similar to the indicator computed by the ASPR BNS RK without deseasonalization2. The second method was to exclude the 8 most volatile components over the past 2 years, similar to the approach used by the Bank of Canada (Laflèche et al, 2006) and the Bank of Russia (Deryugina et al, 2015). Additionally, similar indicators were computed for the 13 and 25% most volatile components over the past 2 years, which is generally consistent with the ASPR BNS RK method of elimination in terms of the number of excluded groups (7 ASPR BNS RK components turn into 13 components, taking into account the breakdown into 66 groups) and the share of excluded groups (about 30% by weight and about 20%=13/66 by quantity). Historical results of the elimination are presented in Appendix 2 and Appendix 3.

Finally, a hybrid method was used to exclude components, which showed the least cooperativeness with the general component when applying the state space model, similar to the work of (Dementiev, Bessonov, 2012). The results of assessing the natural logarithms of the standard deviation of each component from the general component are presented in Appendix 4. As can be seen from the results, the groups of fruits and vegetables, fuel and lubricants, food products with a predominance of imports, education services and utility services were excluded.

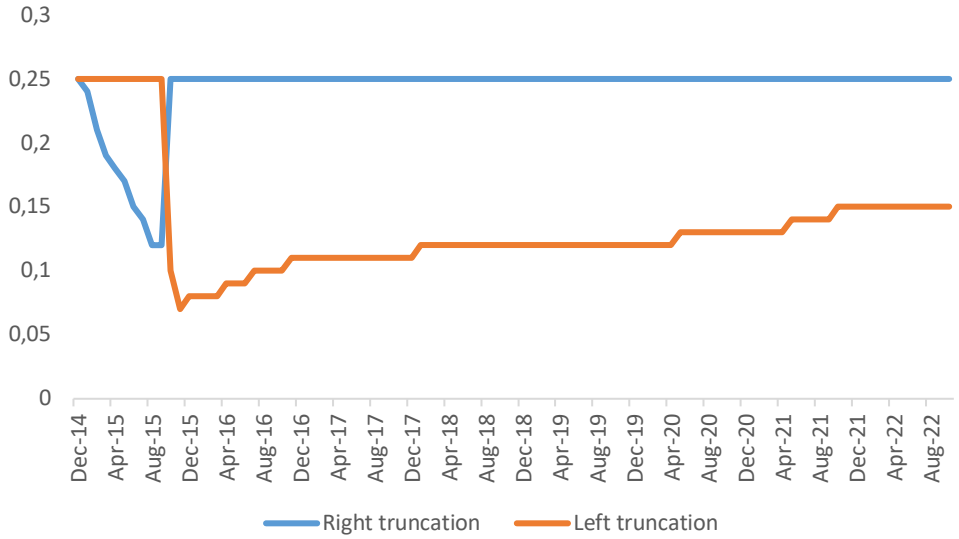
Sample Truncation Methods. In this class of methods, a truncation of 10% at both ends of the ordered distribution of monthly price changes, a weighted median as well as a method for determining the optimal truncation were looked at. The latter method chooses a truncation level at both ends in the range from 1% to 25% in 1% steps (625 options in total) in search of such option that would minimize the mean squared error between the modified core inflation computed for this truncation and the centered moving average of the deseasonalized CPI similarly to (Deryugina et al, 2015). The selected truncation options apply to the entire sample. Below are the results of optimal truncation in pseudo-real time (Figure 2), and Appendix 5 and Appendix 6 contain the historical results of applying these methods.

Finally, an optimal truncation method was used in the range from 1 to 25% at both ends (here, each month a different truncation scheme is selected) in order to minimize the bias of the remaining price distribution, similar to the work of (Rather et al., 2016). Historical estimation results are shown in Appendix 7.

[2] Fruits and vegetables, gasoline, coal, diesel fuel and utilities, railway transport and communication are excluded from the CPI

Figure 2

Optimal Levels of Left Truncation and Right Truncation of the Ordered Monthly Price Change Distribution in Pseudo-Real Time Computations



Source: authors' computations

Methods of Weight Alterations. Methods used in this section are similar to the works presented in the respective part of the Literature Review. Core inflation estimates were looked into, where new component weights had been defined as:

– the product of the reciprocal of component volatility for the last 2 years and the initial weight in the CPI;

– the reciprocal of component volatility for the last 2 years;

– the product of component persistence (one lag was taken for the computation) in the landmark window and the initial weight in the CPI;

– the product of component persistence (one lag was taken for the computation) in the landmark window, the reciprocal of component volatility for the last 2 years;

– the product of component persistence (one lag was taken for the computation) in the landmark window, the reciprocal of component volatility for the last 2 years and the initial weight in the CPI;

– the product of component correlation (henceforth with the lag of 6 months) with the CPI in the landmark window and the initial weight in the CPI;

– the reciprocal of RMSE component and the CPI trend expressed by a 24-month moving average;

– the product of the reciprocal of RMSE component and the CPI trend expressed by a 24-month moving average, and the initial weight in the CPI.

Since the new weight assignment results in a different price distribution, various truncation methods can be applied to it. Thus, for all distributions obtained above, the median was computed. In addition, the median was computed also for those price distributions where new component weights were based on persistence only[3].

Correlation of components with the CPI and their persistence are shown in Appendices 8 and 9, and the results of new weight assignments to the CPI components for October 2022 – in Appendix 10.

Filtering Methods. Exponential Smoothing. Unlike the moving average method, where all observations are weighted equally, with exponential smoothing, the "older" the observation, the exponentially less weight is assigned to it. The one-parameter exponential smoothing method

[3] Due to the fact that in some periods this series was strongly isolated from the CPI dynamics and other estimates of core inflation, it was decided to take it into account only with reference to the initial weights

is suitable for series that randomly move around a constant mean without a trend or seasonal patterns:

$$\hat{y}_t = \alpha \sum_{l=0}^{t-1} (1-\alpha)^l \, y_{t-l}, \quad (3)$$

where $0 < \alpha \leq 1$ – smoothing coefficient. This study used coefficient α, which is estimated recursively with the help of Single Smoothing procedure in Eviews12; in doing so, the smoothing per se was performed for each of 66 groups of goods and services, and then the series obtained were combined in one series based on their weight in the CPI (an indirect method).

Filtering Methods. Hodrick-Prescott Filter. The Hodrick-Prescott Filter (HP) — is a smoothing method, which is widely used by macroeconomists to obtain a smoothed-curve estimate of the component of a long-term trend in a time series. This method was used for the first time in the work of Hodrick-Prescott (1997) to analyze the post-war cycles of business activity in the US.

The HP filter is a two-sided linear filter that computes a smoothed series *s* of variable *y* by minimizing the variance *y* around *s*, taking into account parameter λ that limits the second-order difference s. In its general form, the HP may be presented as:

$$\sum_{l=1}^{T} (y_t - s_t)^2 + \lambda \sum_{t=2}^{T-1} ((s_{t+1} - s_t) - (s_t - s_{t-1}))^2 \quad (4)$$

Parameter λ controls smoothness of a time series. As λ approaches infinity, *s* approaches a linear trend. The value λ=1 was used in this study. As in the case of exponential smoothing, filtering was applied to each of the 66 groups of goods and services, and then from the resulting series, taking into account their weights in the CPI, an estimate of core inflation was obtained (indirect method).

Filtering Methods. Bandpass Filter (BP-Filter). Bandpass (frequency) filters are used to isolate the cyclic component of the time series by specifying the range of its duration. Therefore, in order to use bandpass filters, it is necessary to determine the periodicity of cycles. In the case of core inflation, the current trend of the inflationary background should be taken as the cycle. The cycle range is predetermined by the parametersP_L and P_U, presented as the quantity of leads and lags. In this study, the asymmetric full-sample band pass filter described by Christiano-Fitzgerald (2003) is implemented. Cycle ranges vary from min(P_L, P_U) = (3,6) to max(P_L, P_U) = (18.96). As before, filtering is applied to each of the 66 groups of goods and services, and then the resulting series are combined based on their weights in the CPI (indirect method).

Filtering Methods. Wavelets. The computation by this method was carried out in the context of various approaches. First, the chosen filtering procedure was applied only to the CPI series (direct method) or to all 66 components and then combined into one series based on the weights in the CPI (indirect method), and second, the transform method or the threshold method was used. For both methods, the maximum frequency was taken equal to 6, since the number of monthly observations was 142 ($2^{6+2} > 142$), and the type of transformation took into account the maximum overlap: for transforms – MOMRA (maximum overlap multiresolution analysis), and for thresholds – MODWT (maximum overlap discrete wavelet transform), so that to use series of any length without additional assumptions and not necessarily the length equal to the power of 2.

In our case, the transform method is a decomposition of a time series at different frequencies, with its help one can select a trend, a cycle and discard the noise:

$$\pi_t = S_t^6 + \sum_{j=1}^{6} D_t^j, S_t^0 = \pi_t, S_t^j = S_t^{j+1} + D_t^{j+1}, \quad (5)$$

where S_t^6 – is a trend component, D_t^j – a component with the period of motion within the range $[2^j, 2^{j+1}]$, S_t^j – a de-noised time series j with growth (from $S_t^0 = \pi_t$ to trend S_t^6). S_t^2, and S_t^3 were also looked at as a core inflation estimate. Moreover, the search was performed for all types of wavelets available in Eviews12 (Haar, Daubechies, least asymmetric) based on the criteria of minimum deviation from the inflation trend expressed through a 12, 24- monthly moving average and HP14400-filter, minimum variance and minimum mean absolute deviation. The resulting

value met all criteria; therefore, 4 core inflation estimates were obtained by using the transform method (direct or indirect method, S_t^2 *or* S_t^3).

In turn, the threshold method is the elimination of some wavelet coefficients. As in the case of the transform method, the search was performed according to the same criteria in the context of wavelet types, as well as all kinds of ways to compute the threshold values. Besides, cases were additionally considered when the wavelet length was limited to 12 and limited to 20 (for Daubechies, Least asymmetric). As a result of the search, the criteria for minimum deviation from the CPI trend, minimum variance and minimum deviation from the CPI itself gave three different estimates of core inflation, whereby 12 estimates of core inflation were obtained using the threshold method (direct or indirect method, a limitation for a wavelet length of 12 or 20, which of the 3 selection criteria was chosen)

Methods of Models Application. State Space Models. This study assessed a state space model (unobservable components) similarly to the work by (Dementiev, Bessonov, 2012) with the following specification

$$\pi_t^* = \pi_{t-1}^* + u_t, var(u_t) = \exp\,(c(11)) \qquad (6)$$
$$\pi_t^i = \pi_t^* + \varepsilon_t^i, var\left(\varepsilon_t^i\right) = \exp\left(c(i)\right), i = 1, \dots, 10$$

where π_t^* – general component, π_t^i – a monthly change in prices of *i*-th component, u_t – composite noise of all components, ε_t^i – specific noise, $c(i)$ – parameters of variances estimated by using the Kalman filter. The estimation was made on 10 aggregated groups of goods and services, while this model was also used in estimating core inflation using the method of elimination described above. The results of this model are presented in Appendix 4.

Another model we estimated was similar to the first one, except that instead of 10 components (indirect method) we took the entire CPI versus the preceding month (direct method).

Methods of Models Application. Dynamic Factor Model. A factor model is a statistical technique that converts the variances in a set of variables into the sum of one or more unobservable factors that reflect interrelated trends in the dynamics of these variables (Stock and Watson, 1989; Forni et al. 2000). An obvious area of application of the factor model in macroeconomics is measuring core inflation. Thus, it can be assumed that the dynamics of individual components of the consumer price index in Kazakhstan are determined by both general factors of the economy and unrelated own shocks. Thus, it is supposed that with the help of factor decomposition it is possible to single out a general component of individual subgroups that constitute the CPI, which reflects the monetary nature of inflation. The factor model can be expressed in the general form as:

$$\pi_{i,t} = \Lambda_i F_t + \varepsilon_{i,t} \qquad (7)$$
$$\tilde{\pi}_t = \Lambda_i F_t$$

Each CPI sub-group ($\pi_{i,t}$) is related to the general factor (F_t), via factor loadings (Λ_i), and ($\varepsilon_{i,t}$) is a vector of idiosyncratic factors reflecting unrelated intrinsic shocks that are not correlated with F_t. Therefore, following the definition, core inflation in equation (7) is presented as $\tilde{\pi}_t$ (Khan et al., 2013). Besides, in order to reflect the dynamics of general component, it is assumed that the general factor follows some autoregressive process $AR(L)$. In this paper, L was taken equal to 1, and the general component was extracted from 66 time series of Kazakhstan's CPI. The number of factors that were taken to estimate the general component was 1, since the proportion of the explained variance of the factors following the first one was quite small. The results of such an analysis are given in Appendix 11.

Appendix 12 shows the values of correlation between the general factor and 66 CPI sub-indices, which were used to derive this factor as well as values of R^2 – the proportion of variation in group prices explained by the general factor. As can be seen, the general component is most "related" to imported goods (furniture, household goods, fish and seafood, clothing and footwear,

etc.) and is less related to those goods whose pricing is regulated by the non-market methods (regulated utility services, fuel and lubricants, communication)

Hybrid Model. This method combines the truncation method and the use of adjustments obtained with the help of modeling techniques. For example, Rich et al. (2022) studied the relationship between the inflation gap (that is, the difference between core inflation and the CPI) and the skewness of price distribution, and found a significant negative linear relationship. At the same time, if we proceed from the criterion of the minimum deviation of core inflation from the trend, then a long, either positive or negative, gap means that core inflation strongly deviates from the inflation trend, which is well approximated by a moving average. This means that the median of price distribution, which is close in value to the symmetrical truncated averages of core inflation, systematically deviates from the mean of the price distribution (and that is the CPI!). Then, if the price distribution is constantly skewed in a certain direction (that is, the bias is different from 0), then the median and mean will deviate significantly, which will also apply to the constant deviation of core inflation from the CPI. In this regard, the authors of the study propose to make an adjustment for the magnitude of skewness in estimates of core inflation computed by the truncation of the mean.

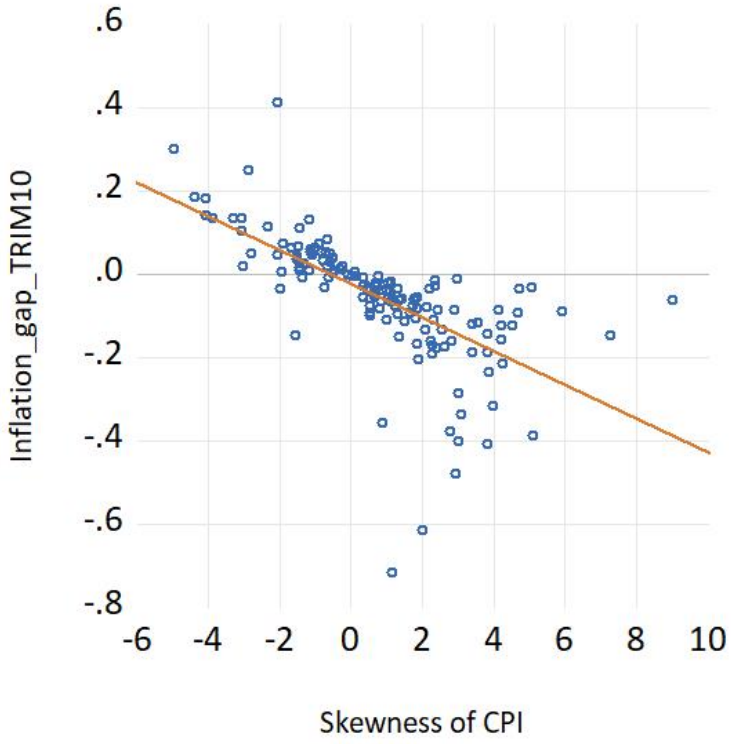
In turn, such dependence also is present in the case of Kazakhstan. For example, the figure below shows the relationship between the inflation gap computed using the 10% trimmed mean and the magnitude of skewness of price distribution (Figure 3).

This dependence was estimated using a standard linear model with one variable. The obtained coefficients are used to adjust the core inflation estimate by the method of trimmed mean (Rich et al., 2022).

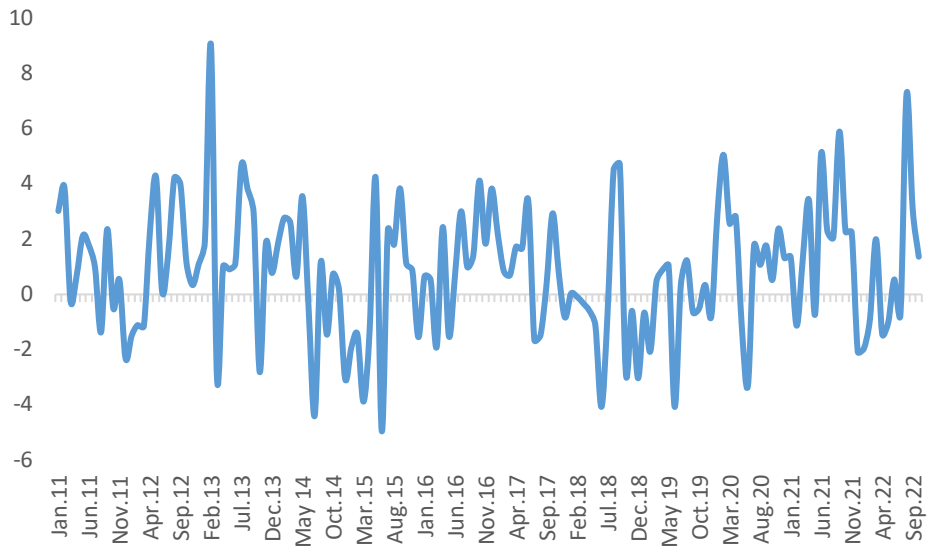
Figure 3

Linear Relationship between the Inflation Gap Computed Using the 10% Trimmed Mean and the Magnitude of Skewness of Price Distribution (a) and Skewness of Price Distribution (b

(a)



(b)



4. Discussion of Results

In total, 63 core inflation estimates in different classes have been computed. Detailed explanation of abbreviations henceforth used in the text and appendices is presented in Appendix 13.

Assessment Based on the Core Inflation Indicators. To select optimal core inflation indicators, we applied a set of necessary selection criteria based on the work of (Marques et al., 2003). Thus, according to the conclusions made by the authors, the optimal indicator of core inflation should satisfy the following conditions:

I. The difference between a core inflation indicator and the headline inflation presented as $\pi_t - \pi_t^*$, must be a stationary variable with a zero mean.

II. There is an error correction model that is defined as follows $z_{t-1} = (\pi_{t-1} - \pi_{t-1}^*)$ for $\Delta\pi_t$, which can be defined as:

$$\Delta\pi_t = \sum_{j=1}^{m} \alpha_j \Delta\pi_{t-j} + \sum_{j=1}^{m} \beta_j \Delta\pi_{t-j}^* - \gamma(\pi_{t-1} - \pi_{t-1}^*) + \varepsilon_t \quad (8)$$

III. π_t^* is exogenous for parameters in equation of condition II.

Condition I implies that inflation and core inflation cannot show a systematically divergent trend, otherwise the latter is likely to give false signals about the trend inflation. According to Kalra et al. (2018), in order to fulfill condition I, passing the $\pi_t - \pi_t^*$ of ADF stationarity test will be an insufficient condition. Even if $u_t = (\pi_t - \beta\pi_t^*)$ is stationary but $\beta \neq 1$, the headline inflation and underlying indicators tend to diverge. One of the ways to check this property is to perform the Wald test with $\beta = 1$ and $\alpha = 0$ in the following equation:

$$(\pi_t - \pi_t^*) = \alpha + (1 - \beta)\pi_t^* + \varepsilon_t \quad (9)$$

According to condition II, the trend inflation indicator should behave as a leading indicator of inflation. That is, Condition II implies that core inflation indicators provide some information about a future headline inflation. However, here Marques et al. depart from other literature on computing core inflation and argue that this condition does not mean that the optimal indicator of core inflation should have good predictive qualities. Therefore, coefficient γ in equation (8) must significantly differ from zero. It is worth mentioning here that the analysis of unobserved components following from the methodology of its construction, meets the first two conditions automatically (Bashar, 2011).

Finally, according to condition III it is important to get convinced that the second condition is not met conversely, that is, so that π_t would not be an attractor for π_t^*, and also so that π_t^* would not be sensitive to observed shocks π_t in the recent past:

$$\Delta\pi_t^* = \sum_{j=1}^{m} \delta_j \Delta\pi_{t-j}^* + \sum_{j=1}^{m} \theta_j \Delta\pi_{t-j}^* - \lambda(\pi_{t-1} - \pi_{t-1}^*) + \varepsilon_t \quad (10)$$

Thus, criterion III of the selection would be the condition that the coefficient λ in the equation (10) must slightly differ from zero or must be negative.

Resulting from the use of the above described procedures on the sample from 2016 through 2022[4] we examined 63 core inflation estimates (series in monthly terms) and selected those 15 (Table 1) that met all the criteria (complete table in Appendix 14).

At the same time, it should be noted that the extension and inclusion of the full period up to 2011 into the sample would lead to a significant deterioration in meeting these criteria. This confirms that significant price shocks (as it happened in Kazakhstan in 2015 due to a dramatic exchange rate depreciation) can significantly undermine core inflation estimates and their usefulness for a central bank (Pincheira-Brown, 2019).

Economic Meaningfulness. The analysis of economic meaningfulness of computed core inflation indicators was performed in the form of a comparative analysis on several parameters. Thus, we apply several criteria for evaluating information content indicators. Criteria are mainly used to understand how much information each core indicator provides in relation to some macro variables.

Correlation with Macrovariables. The analysis of economic meaningfulness of computed core inflation indicators was performed in the form of a comparative analysis on several parameters. Thus, we apply several criteria for evaluating information content indicators. Criteria are mainly used to understand how much information each core indicator provides in relation to some macro variables[5]:

- Broad money growth *M3*
- Retail sales gap *Retail_gap*
- Exchange rate of the tenge against the US dollar *ER*
- Nominal income of the population *Nominal_income*
- Average nominal wage *Nominal_wage*
- TONIA Index *IR*

Table 1

Selection of Core Inflation Estimates based on the Criteria of Optimality [6]

		1	2	3	4	5	6	7	8	9	10	11
1	Excl_8_sa	0.00	0.96	0.24	0.70	0.16	0.42	0.44	-0.83	0.03	0.19	0.39
2	Excl_13_sa	0.00	0.74	0.52	0.77	0.16	0.12	0.45	-0.84	0.03	0.19	0.41
3	Excl_25%_sa	0.00	0.98	0.40	0.70	0.11	0.08	0.48	-0.89	0.03	0.20	0.40
4	Persistance_one_mediana	0.00	0.41	0.68	0.45	0.05	0.03	0.22	-1.10	0.00	0.20	0.44
5	Persistance_volatility_mediana	0.00	0.16	0.25	0.38	0.06	0.01	0.26	-0.98	0.00	0.21	0.35
6	Wavelet_min_std_transform_direct	0.00	0.76	0.44	0.58	0.37	0.28	0.25	-0.30	0.47	0.14	0.37
7	Wavelet_min_std_transform_inderect	0.00	0.08	0.08	0.74	0.26	0.61	0.43	-0.72	0.02	0.20	0.37
8	Wavelet_min_std_transform_S3_direct	0.00	0.73	0.43	0.74	0.32	0.23	0.14	-0.62	0.12	0.12	0.33
9	Wavelet_transform_min_std_S3_indirect	0.00	0.18	0.10	0.75	0.22	0.54	0.51	-0.75	0.02	0.18	0.33
10	Wavelet_dev_thresh_direct	0.00	0.98	0.29	0.14	0.16	0.25	0.32	0.08	0.81	0.14	0.45
11	Wavelet_dev_tresh_short_direct	0.00	0.98	0.29	0.14	0.16	0.25	0.32	0.08	0.81	0.14	0.45
12	HP_smoothing	0.00	0.90	0.60	0.09	0.11	0.33	0.31	0.32	0.16	0.15	0.40
13	BP_12_24	0.00	0.99	0.77	0.42	0.09	0.02	0.06	-1.01	0.04	0.20	0.45
14	DFM_2stage	0.00	0.46	0.59	0.62	0.08	0.31	0.29	-1.01	0.01	0.23	0.45
15	Unobserved_components	0.00	0.70	0.24	0.09	0.23	0.37	0.33	0.30	0.52	0.14	0.39

Source: authors' computations based on the data from the ASPR BNS RK

Notes:

1 - P-value ADF-test for difference between core inflation and the CPI in 2016-2022.

[4] The sample shows the period after the transition to inflation targeting within the free floating exchange rate regime

[5] Lags of macro variables are presented in the form of (n)

6 Significance estimates were obtained by estimating the Newey-West covariance matrix, which takes into account the autocorrelation and heteroscedasticity of residuals

2 - P-value of a constant in the regression of difference between core inflation and the CPI over the constant in 2016-2022.
3 - P-value of the Wald test for cointegration between core inflation and the CPI in 2016-2022.
4 - P-value of the Wald test for predictive capability of core inflation in 6 months in 2016-2022.
5 - P-value of the Wald test for predictive capability of core inflation in 12 months in 2016-2022.
6 - P-value of the Wald test for predictive capability of core inflation in 18 months in 2016-2022.
7 - P-value of the Wald test for predictive capability of core inflation in 24 months in 2016-2022.
8 – Coefficient responsible for weak exogeneity of core inflation
9 - P-value of the preceding coefficient
10 - RMSE between core inflation and a 24-month moving average CPI in 2016-2022.
11 – A standard deviation of core inflation estimates in 2016-2022.

Based on the results, on average there is the strongest relationship of core inflation with the exchange rate of the tenge against the US dollar (*ER*) as well as with the growth in money supply (M3).

A study by (Deryugina et al, 2015) suggests alternative methods of assessing the economic meaningfulness. Thus, in order to test the relationship with fundamental indicators, the authors proposed to use a simple model[7]:

$$w_t = \mu + \lambda\pi_{t-1} + \sum_{j=1}^{L} \Theta_j X_{t-j} + \sum_{j=1}^{L} \Omega_j w_{t-j} + e_t, \quad (11)$$

where w_t – is a quarterly rate of growth in nominal income of the population; π_t – an indicator of annual growth rates of core inflation; X – output gap.

Estimates were made based on the quarterly data for 2016-2022 with L=1. The meaningfulness of the inflation indicator for the income dynamics is characterized by the significance of coefficient λ, provided it is positive. The estimation results for all 63 core inflation indicators are shown in Appendix 16.

Stability of Estimates in Real Time. The last and rather important criterion for evaluating core inflation indicators is the stability of its estimates over time. This problem is relevant for filtering methods and in applying the models. As shown in Appendix 17, the mean absolute difference for most indicators quickly reaches small values, which indicates the presence of stability in core inflation estimates by these methods for Kazakhstan.

Therefore, based on consideration of all 63 core inflation estimates, one can conclude that generally various core inflation estimates have sense and possess all necessary properties.

At the same time, given that Kazakhstan's economy is exposed to external shocks, due to its weak diversification, it is difficult to predict the behavior of inflation in Kazakhstan, which is also confirmed by the weak predictive capability of most of core inflation estimates in this paper. This is related to the fact that the coefficient of determination in the forecast equation for different periods does not look large enough to predict future inflation dynamics with confidence.

This problem is generally more typical for countries with emerging markets than for developed countries, when the economies of the former are more exposed to various shocks and contain a larger share of food products in their consumer baskets. This conclusion was reached, for example, in the study by (Pincheira-Brown, 2019), which considers the countries of Latin America. In the work of (Wiesiołek et al., 2009) for the countries of Eastern Europe (Czech Republic, Poland, Hungary), the weak predictive capability of some core inflation estimates was also observed, especially of the traditional estimates that are the easiest to explain to the general public.

In this regard, the shaping of inflation expectations and, consequently, the finding of an inflation target at low values in Kazakhstan is difficult, since the dynamics of sustainable price growth components assessed using a wide range of methods may not always unambiguously "predict" future inflation.

[7] For detailed information and the reasons to use such models, see the study by Deryugina et al. (2015)

It is also impossible to univocally assert that one indicator will be an estimate of core inflation and a benchmark for monetary policy. World experience shows that all central banks analyze several indicators of core inflation to form an outlook on future policies. For this reason, we also recommend taking into account various methods as an assessment of the stable dynamics of price changes in the economy.

Thus, from 63 estimated time series of core inflation, we arranged into separate groups the methods of weight alterations without a median, weight alterations with a median, wavelets, BP filters, 3 estimates from the hybrid method of adjustment for skewness. In each of these groups, we find the median and then add the resulting series to the remaining core inflation series. The final estimate will also be the median of the reviewed series, and the maximum and minimum values will be the range of core inflation values. A similar trend is also used in the Bank of Russia (Deryugina et al, 2015).

Appendices 18-23 provide core inflation estimates as well as its estimates in pseudo-real time in monthly and annual terms.

5. Findings

In this paper, we provide an estimation of core inflation for Kazakhstan using several methods from different classes, evaluate and compare them with each other, and study the relationship of core inflation with other macroeconomic variables.

As a result, 63 estimates of core inflation were constructed using the methods of elimination, truncation, weight alterations, filtering, and the use of modeling techniques. The consistency of such estimates in the context of criteria accepted in the literature, the relationship with other variables (money supply, exchange rate, interest rate, nominal wage) was shown, and stability over time was proved. Nonetheless, the predictive capability of estimates deteriorated when considering the full data sample, including 2015 that was the peak year for monthly inflation; this is in line with other developing countries in the presence of price shocks. This result indicates that it is difficult to shape inflation expectations in Kazakhstan at low levels.

Finally, it was recommended to compute core inflation by combining individual indicators into one group, finding the median in this group, followed by inclusion into the final set of indicators to find the range of core inflation estimates.

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Appendix 1

List of 66 CPI Components (with Weights in 2022) Used to Compute the Deseasonalized CPI

#	Name of the Group of Goods or Services	Weight
1	Bread and bakery and cereals	6.75%
2	Meat	10.71%
3	Fish and seafood	1.49%
4	Dairy products, cheese and eggs	5.05%
5	Oils and fats	2.29%
6	Fruits	3.21%
7	Vegetables	2.94%
8	Sugar, jam, honey, chocolate and confectionery	2.75%
9	Food products not included in other categories	1.33%
10	Coffee, tea and cacao	1.44%
11	Mineral water, soft drinks, fruit and vegetable juices	0.80%
12	Alcohol beverages	1.18%
13	Tobacco products	0.77%
14	Materials for manufacturing of clothing	0.02%
15	Upper garments	6.27%
16	Other items of clothing and accessories	0.29%
17	Boots, shoes and other footwear	3.18%
18	Materials for maintenance and repair of residential premises	1.58%
19	Solid fuel	1.72%
20	Furniture, household goods, carpets and other floor coverings, their repair	1.69%
21	Textile products used in household	0.60%
22	Household appliances	1.02%
23	Glass ware, cutlery and housewaress	0.36%
24	Tools and implements used at home and in horticulture	0.16%
25	Goods and services used in housekeeping	1.47%
26	Medications, therapeutic equipment and instrumentation	1.66%
27	Purchase of motor vehicles	0.99%
28	Spare parts and accessories for personal motor vehicles	0.42%
29	Fuel and lubricants for personal motor vehicles	2.98%
30	Audio-visual equipment, photographic equipment and information processing equipment	0.69%
31	Other large-size durable goods for recreation and cultural activities	0.02%
32	Other goods and equipment for recreation, sports and gardening and home pets	0.33%
33	Newspapers, books and stationery	0.20%
34	Electric appliances of personal use	0.06%
35	Other articles, devices and personal goods	3.22%
36	Personal care items not included into other categories	0.56%
37	Clothing cleaning, repair and rental	0.22%
38	Footwear repair and rental	0.08%
39	Actual housing rental payment	2.78%
40	Services for maintenance and repair of residential premises	0.93%
41	Water supply	0.56%
42	Garbage disposal	0.28%
43	Sewage	0.20%
44	Other services related to upkeep of residential premises and not included into other categories	1.15%

45	Electricity	2.41%
46	Gas	1.28%
47	Thermal power	1.71%
48	Outpatient services	2.87%
49	In-patient services	1.32%
50	Maintenance and repair of personal motor vehicles	0.32%
51	Other services related to personal motor vehicles*	0.00%
52	Transport services	2.93%
53	Communication	4.28%
54	Services in the field of recreation, entertainment and culture	0.71%
55	Arranging all-inclusive leisure	0.08%
56	Pre-school and elementary education	0.83%
57	Secondary education	0.09%
58	Post-secondary education	0.21%
59	Higher education	0.78%
60	Education not subdivided into stages	0.02%
61	Public catering services	0.73%
62	Hotel service	0.01%
63	Services of hairdressers and personal service establishments	2.19%
64	Insurance	0.23%
65	Financial services not included into other categories	0.21%
66	Other services not included into other categories	0.42%

Source: ASPR BNS RK
* – starting from 2021, this category is excluded from the consumer basket

Appendix 2

CPI Components Most Frequently Excluded from Computation of Core Inflation by the Authors Using the Method of Elimination of 13 Most Volatile Components in a Moving Two-Year Window (as % of 119 Observations)

#	Name of the Group of Goods or Services	Frequency, %
1	Vegetables	100
2	Fuel and lubricants for personal motor vehicles	81
3	Garbage disposal	80
4	Sewage	71
5	Fruits	65
6	Water supply	55
7	Sugar, jam, honey, chocolate and confectionery	55
8	Electricity	49
9	Arranging all-inclusive leisure	49
10	Thermal energy	48
11	Purchase of motor vehicles	38
12	Tobacco products	35
13	Solid fuel	31
14	Gas	30
15	Other large-size durable goods for recreation and cultural activities	29
16	Communication	29
17	Higher education	29
18	Electric appliances of personal use	28
19	Insurance	26
20	Other services not included into other categories	23
21	Transport services	22

22	Upper garments	21
23	Other items of clothing and accessories	21
24	Materials for manufacturing of clothing	20
25	Boots, shoes and other footwear	20
26	Furniture, household goods, carpets and other floor coverings, their repair	20
27	Textile products used in household	20
28	Household appliances	20
29	Glass ware, cutlery and housewaress	20
30	Services for maintenance and repair of residential premises	20
31	Other services related to personal motor vehicles	18
32	Materials for maintenance and repair of residential premises	17
33	Post-secondary education	16
34	Oils and fats	15
35	Audio-visual equipment, photographic equipment and information processing equipment	14
36	Pre-school and elementary education	14
37	Footwear repair and rental	13
38	Coffee, tea and cacao	9
39	Other services related to upkeep of residential premises and not included into other categories	9
40	Personal care items not included into other categories	7
41	Education not subdivided into stages	4
42	Dairy products, cheese and eggs	3
43	Newspapers, books and stationery	3
44	Financial services not included into other categories	3
45	Actual housing rental payment	2
46	Medications, therapeutic equipment and instrumentation	1
47	Bread and bakery and cereals	0
48	Meat	0
49	Fish and seafood	0
50	Food products not included into other categories	0
51	Mineral water, soft drinks, fruit and vegetable juices	0
52	Alcohol beverages	0
53	Tools and implements used at home and in horticulture	0
54	Goods and services used in housekeeping	0
55	Spare parts and mountings for personal motor vehicles	0
56	Other goods and equipment for recreation, sports and gardening and home pets	0
57	Other articles, devices and personal goods	0
58	Clothing cleaning, repair and rental	0
59	Outpatient services	0
60	In-patient services	0
61	Maintenance and repair of personal motor vehicles	0
62	Services in the field of recreation, entertainment and culture	0
63	Secondary education	0
64	Public catering services	0
65	Hotel service	0
66	Services of hairdressers and personal service establishments	0

Source: the authors' computations based on the data from the ASPR BNS RK

Appendix 3

Frequency of Appearance of Each of the 66 CPI Components in the Course of Core Inflation Computation by the Authors Using the Method of Elimination of 25% Most Volatile Components in a Moving Two-Year Window (as % of 119 Observations)

#	Name of the Group of Goods or Services	Frequency, %
1	Vegetables	0
2	Fuel and lubricants for personal motor vehicles	9
3	Garbage disposal	20
4	Sewage	20
5	Fruits	26
6	Arranging all-inclusive leisure	33
7	Electricity	42
8	Sugar, jam, honey, chocolate and confectionery	42
9	Water supply	45
10	Thermal energy	45
11	Tobacco products	51
12	Higher education	52
13	Gas	59
14	Purchase of motor vehicles	60
15	Other large-size durable goods for recreation and cultural activities	60
16	Other services not included into other categories	61
17	Household appliances	69
18	Transport services	69
19	Solid fuel	69
20	Communication	71
21	Electric appliances of personal use	72
22	Footwear repair and rental	74
23	Insurance	74
24	Oils and fats	76
25	Furniture, household goods, carpets and other floor coverings, their repair	76
26	Upper garments	79
27	Materials for manufacturing of clothing	80
28	Other items of clothing and accessories	80
29	Boots, shoes and other footwear	80
30	Textile products used in household	80
31	Glass ware, cutlery and housewares	80
32	Services for maintenance and repair of residential premises	80
33	Other services related to personal motor vehicles	82
34	Pre-school and elementary education	82
35	Post-secondary education	82
36	Materials for maintenance and repair of residential premises	83
37	Other services related to upkeeping of residential premises and not included into other categories	83
38	Audio-visual equipment, photographic equipment and information processing equipment	85
39	Actual housing rental payment	85
40	Personal care items not included into other categories	91
41	Coffee, tea and cacao	91
42	Education not subdivided into stages	92
43	Dairy products, cheese and eggs	95

44	Other articles, devices and personal goods	95
45	Maintenance and repair of personal motor vehicles	97
46	Newspapers, books and stationery	97
47	Financial services not included into other categories	97
48	Medications, therapeutic equipment and instrumentation	98
49	Goods and services used in housekeeping	99
50	Bread and bakery and cereals	99
51	Services in the field of recreation, entertainment and culture	100
52	Meat	100
53	Fish and seafood	100
54	Food products not included into other categories	100
55	Mineral water, soft drinks, fruit and vegetable juices	100
56	Alcohol beverages	100
57	Tools and implements used at home and in horticulture	100
58	Spare parts and mountings for personal motor vehicles	100
59	Other goods and equipment for recreation, sports and gardening and home pets	100
60	Clothing cleaning, repair and rental	100
61	Outpatient services	100
62	In-patient services	100
63	Secondary education	100
64	Public catering services	100
65	Hotel service	100
66	Services of hairdressers and personal service establishments	100

Source: the authors' computations based on the data from the ASPR BNS RK

Appendix 4

Groups of Goods and Services and the Degree of their Cooperativeness with Core Inflation Estimated by Using the State Space Model

Name of the Group of Goods or Services	Coefficient	Value	Weight
Fruits; Vegetables	C(1)	1.18E-05	6.1%
Solid fuel; Fuel and lubricants for personal motor vehicles	C(6)	1.03E-05	4.7%
Food products not included into other categories; Fish and seafood; Mineral water, soft beverages, fruits and vegetable juices; Coffee, tea and cacao; Alcohol beverages; Sugar, jam, honey, chocolate, confectionery; Tobacco products	C(2)	-5.34E-06	9.8%
Pre-school and elementary education; Secondary education; Post-secondary education; Higher education; Education not subdivided into stages	C(8)	-5.63E-06	1.9%
Water supply; Garbage disposal; Wastewater disposal; Other services related to residential premises and not included into other categories; Electricity; Gas; Thermal energy; Communication; Transport services	C(7)	-6.44E-06	14.8%
Materials for manufacturing of clothing; Upper garments; Other items of clothing and accessories; Boots, shoes and other footwear; Textile products used in household	C(4)	-9.83E-06	10.4%
Household appliances; Goods and services for housekeeping; Medications, therapeutic equipment and instrumentation; Audio-visual equipment,	C(5)	-1.47E-05	14.4%

photographic equipment and information processing equipment; Electric appliances of personal use; Other articles, devices and personal goods; Personal care items not included into other categories; Other large-size durable goods for recreation and cultural activities; Other goods and equipment for recreation, sports and gardening and home pets; Books and stationery; Materials for maintenance and repair of residential premises; Furniture, household goods, carpets and other floor coverings, their repair; Glass ware, cutlery and housewares; Instruments and devices used at home and in horticulture; Purchase of motor vehicles; Spare parts and mountings for personal motor vehicles			
Actual housing rental payment; Services for maintenance and repair of residential premises; Services in the field of recreation, entertainment and culture; Public catering services; Hotel service; Financial services not included into other categories; Arranging all-inclusive leisure; Insurance; Other services not included into other categories	C(9)	-1.56E-05	6.1%
Meat; Dairy products, cheese and eggs; Bread and bakery and cereals; Oils and fats	C(3)	-3.71E-05	24.8%
Cleaning and repair of clothing; Footwear repair and rental; Outpatient services; Maintenance and repair of personal motor vehicles; Other services related to personal motor vehicles; Services of hairdressers and personal service establishments; In-patient services	C(10)	-5.37E-04	7.0%

Source: the authors' computations based on the data from the ASPR BNS RK

Appendix 5

Frequency of Appearance of Each of the 66 CPI Components in the Course of Core Inflation Computation by the Authors Using the Method of Truncation of 10% from Both Ends of the Ordered Price Change Distribution (as % of 142 Observations)

#	Name of the Group of Goods or Services	Frequency, %
1	Vegetables	20
2	Fuel and lubricants for personal motor vehicles	50
3	Garbage disposal	54
4	Sewage	56
5	Fruits	57
6	Sugar, jam, honey, chocolate and confectionery	60
7	Tobacco products	62
8	Water supply	63
9	Thermal energy	64
10	Gas	67
11	Arranging all-inclusive leisure	68
12	Other services related to personal motor vehicles	68
13	Oils and fats	68
14	Transport services	69
15	Pre-school and elementary education	74
16	Communication	74

17	Financial services not included into other categories	74
18	Electricity	76
19	Purchase of motor vehicles	76
20	Actual housing rental payment	79
21	Other services related to upkeep of residential premises and not included into other categories	79
22	Footwear repair and rental	79
23	Coffee, tea and cacao	80
24	Electric appliances of personal use	82
25	Dairy products, cheese and eggs	82
26	Maintenance and repair of personal motor vehicles	82
27	Audio-visual equipment, photographic equipment and information processing equipment	83
28	Other services not included into other categories	84
29	Other large-size durable goods for recreation and cultural activities	85
30	Solid fuel	85
31	Education not subdivided into stages	85
32	Services for maintenance and repair of residential premises	85
33	In-patient services	86
34	Household appliances	86
35	Secondary education	86
36	Insurance	86
37	Medications, therapeutic equipment and instrumentation	86
38	Bread and bakery and cereals	87
39	Meat	87
40	Hotel service	87
41	Outpatient services	88
42	Higher education	88
43	Clothing cleaning, repair and rental	89
44	Services in the field of recreation, entertainment and culture	91
45	Mineral water, soft drinks, fruit and vegetable juices	91
46	Textile products used in household	91
47	Post-secondary education	91
48	Other items of clothing and accessories	91
49	Materials for manufacturing of clothing	92
50	Spare parts and mountings for personal motor vehicles	92
51	Food products not included into other categories	93
52	Services of hairdressers and personal service establishments	93
53	Goods and services used in housekeeping	93
54	Fish and seafood	93
55	Alcohol beverages	93
56	Glass ware, cutlery and housewares	93
57	Furniture, household goods, carpets and other floor coverings, their repair	93
58	Public catering services	93
59	Boots, shoes and other footwear	93
60	Materials for maintenance and repair of residential premises	94
61	Newspapers, books and stationery	94
62	Other articles, devices and personal goods	94
63	Tools and implements used at home and in horticulture	94
64	Other goods and equipment for recreation, sports and gardening and home pets	94

65	Personal care items not included into other categories	96
66	Upper garments	97

Source: the authors' computations based on the data from the ASPR BNS RK

Appendix 6

Frequency of Appearance of Each of the 66 CPI Components in the Course of Core Inflation Computation by the Authors Using the Method of Variable Truncation up to 25% at Both Ends of the Ordered Price Change Distribution (as % of 142 Observations)

#	Name of the Group of Goods or Services	Frequency, %
1	Vegetables	13
2	Tobacco products	29
3	Garbage disposal	31
4	Fuel and lubricants for personal motor vehicles	31
5	Fruits	38
6	Sugar, jam, honey, chocolate and confectionery	40
7	Sewage	41
8	Gas	44
9	Oils and fats	45
10	Water supply	45
11	Thermal energy	47
12	Communication	51
13	Arranging all-inclusive leisure	52
14	Financial services not included into other categories	53
15	Pre-school and elementary education	53
16	Dairy products, cheese and eggs	53
17	Footwear repair and rental	54
18	Transport services	55
19	Other services related to personal motor vehicles	56
20	Purchase of motor vehicles	58
21	Bread and bakery and cereals	58
22	Electricity	59
23	Electric appliances of personal use	60
24	Coffee, tea and cacao	60
25	Outpatient services	61
26	Meat	61
27	Medications, therapeutic equipment and instrumentation	61
28	Solid fuel	62
29	Actual housing rental payment	62
30	Maintenance and repair of personal motor vehicles	63
31	Hotel service	64
32	Other services related to upkeep of residential premises and not included into other categories	65
33	Other services not included into other categories	67
34	Other large-size durable goods for recreation and cultural activities	68
35	Mineral water, soft drinks, fruit and vegetable juices	68
36	Household appliances	68
37	Fish and seafood	68
38	In-patient services	69
39	Public catering services	69
40	Textile products used in household	69

41	Services of hairdressers and personal service establishments	69
42	Services for maintenance and repair of residential premises	71
43	Food products not included into other categories	71
44	Insurance	72
45	Audio-visual equipment, photographic equipment and information processing equipment	72
46	Education not subdivided into stages	72
47	Clothing cleaning, repair and rental	73
48	Materials for manufacturing of clothing	74
49	Spare parts and mountings for personal motor vehicles	75
50	Materials for maintenance and repair of residential premises	75
51	Higher education	76
52	Other items of clothing and accessories	76
53	Services in the field of recreation, entertainment and culture	77
54	Secondary education	77
55	Other articles, devices and personal goods	77
56	Newspapers, books and stationery	77
57	Boots, shoes and other footwear	77
58	Alcohol beverages	78
59	Post-secondary education	78
60	Glass ware, cutlery and housewares	79
61	Furniture, household goods, carpets and other floor coverings, their repair	79
62	Tools and implements used at home and in horticulture	79
63	Personal care items not included into other categories	81
64	Goods and services used in housekeeping	81
65	Other goods and equipment for recreation, sports and gardening and home pets	83
66	Upper garments	86

Source: the authors' computations based on the data from the ASPR BNS RK

Appendix 7

Frequency of Appearance of Each of the 66 CPI Components in the Course of Core Inflation Computation by the Authors Using the Method of Variable Truncation up to 25% at Both Ends of the Ordered Price Change Distribution with an Aim to Minimize the Skewness of Residual Distribution (as % of 142 Observations)

#	Name of the Group of Goods or Services	Frequency, %
1	Vegetables	18
2	Fuel and lubricants for personal motor vehicles	47
3	Tobacco products	48
4	Garbage disposal	49
5	Fruits	51
6	Sewage	55
7	Gas	59
8	Sugar, jam, honey, chocolate and confectionery	59
9	Water supply	60
10	Oils and fats	60
11	Thermal energy	62
12	Pre-school and elementary education	62
13	Transport services	65
14	Communication	65

15	Other services related to personal motor vehicles	65
16	Arranging all-inclusive leisure	67
17	Electricity	68
18	Financial services not included into other categories	68
19	Actual housing rental payment	68
20	Maintenance and repair of personal motor vehicles	71
21	Other services related to upkeep of residential premises and not included into other categories	73
22	Dairy products, cheese and eggs	74
23	Footwear repair and rental	74
24	Purchase of motor vehicles	75
25	Solid fuel	75
26	Meat	76
27	Bread and bakery and cereals	76
28	In-patient services	77
29	Hotel service	77
30	Coffee, tea and cacao	77
31	Outpatient services	78
32	Medications, therapeutic equipment and instrumentation	78
33	Household appliances	79
34	Electric appliances of personal use	79
35	Education not subdivided into stages	79
36	Other services not included into other categories	80
37	Audio-visual equipment, photographic equipment and information processing equipment	80
38	Insurance	82
39	Public catering services	83
40	Services of hairdressers and personal service establishments	83
41	Other large-size durable goods for recreation and cultural activities	84
42	Services for maintenance and repair of residential premises	84
43	Services in the field of recreation, entertainment and culture	84
44	Textile products used in household	84
45	Fish and seafood	84
46	Spare parts and mountings for personal motor vehicles	85
47	Clothing cleaning, repair and rental	85
48	Higher education	85
49	Materials for maintenance and repair of residential premises	85
50	Furniture, household goods, carpets and other floor coverings, their repair	85
51	Materials for manufacturing of clothing	86
52	Post-secondary education	86
53	Alcohol beverages	86
54	Mineral water, soft drinks, fruit and vegetable juices	86
55	Boots, shoes and other footwear	87
56	Secondary education	87
57	Other items of clothing and accessories	87
58	Food products not included into other categories	88
59	Other articles, devices and personal goods	88
60	Tools and implements used at home and in horticulture	89
61	Newspapers, books and stationery	89
62	Other goods and equipment for recreation, sports and gardening and home pets	89

63	Goods and services used in housekeeping	90
64	Glass ware, cutlery and housewares	90
65	Personal care items not included into other categories	93
66	Upper garments	95

Source: the authors' computations based on the data from the ASPR BNS RK

Appendix 8

Correlation of Each of the 66 CPI Components (a Deseasonalized Price Change versus the Preceding Month) with the Specified Lag with the Corresponding Current CPI, January 2011-October 2022

#	Name of the Group of Goods or Services	6 months	9 months	12 months
1	Actual housing rental payment	20.36%	10.04%	14.67%
2	Maintenance and repair of personal motor vehicles	18.92%	5.49%	-7.53%
3	Alcohol beverages	18.56%	6.86%	-7.65%
4	Higher education	18.08%	7.66%	6.39%
5	Services for maintenance and repair of residential premises	16.87%	6.61%	-1.93%
6	Sugar, jam, honey, chocolate and confectionery	16.12%	3.10%	-4.31%
7	Food products not included into other categories	13.25%	-1.43%	-1.18%
8	Personal care items not included into other categories	12.78%	0.93%	-5.97%
9	Household appliances	12.18%	7.58%	-8.72%
10	Mineral water, soft drinks, fruit and vegetable juices	12.09%	2.73%	-3.67%
11	Other articles, devices and personal goods	11.56%	-0.63%	-10.22%
12	Education not subdivided into stages	11.34%	0.01%	-6.19%
13	Post-secondary education	11.28%	1.22%	8.37%
14	Electric appliances of personal use	11.15%	2.19%	-4.93%
15	Goods and services used in housekeeping	11.12%	-1.45%	-5.97%
16	Fish and seafood	10.02%	0.15%	-7.86%
17	Tools and implements used at home and in horticulture	9.58%	1.78%	-5.00%
18	Furniture, household goods, carpets and other floor coverings, their repair	9.56%	5.29%	-3.40%
19	Footwear repair and rental	9.49%	-4.06%	1.03%
20	Vegetables	9.36%	16.40%	2.51%
21	Public catering services	9.35%	-2.64%	-0.67%
22	In-patient services	8.95%	3.37%	6.27%
23	Bread and bakery and cereals	8.67%	2.66%	5.63%
24	Outpatient services	6.93%	-11.31%	-9.77%
25	Tobacco products	5.89%	12.05%	2.10%
26	Fruits	5.72%	-0.07%	-5.55%
27	Fuel and lubricants for personal motor vehicles	5.70%	-23.09%	-1.72%
28	Arranging all-inclusive leisure	5.47%	3.52%	-5.41%
29	Services in the field of recreation, entertainment and culture	5.00%	-5.18%	-9.51%
30	Clothing cleaning, repair and rental	4.82%	4.68%	-5.70%
31	Other services not included into other categories	4.65%	-0.75%	-1.74%
32	Insurance	4.26%	8.86%	5.68%
33	Materials for maintenance and repair of residential premises	4.07%	0.67%	-6.41%
34	Medications, therapeutic equipment and instrumentation	4.05%	2.84%	-1.34%
35	Textile products used in household	3.92%	1.67%	-7.55%

36	Glass ware, cutlery and housewares	3.88%	1.92%	-5.29%
37	Solid fuel	3.76%	1.76%	-5.52%
38	Purchase of motor vehicles	3.49%	-7.78%	-4.46%
39	Coffee, tea and cacao	3.43%	1.34%	-0.38%
40	Dairy products, cheese and eggs	3.35%	-15.57%	-21.37%
41	Other large-size durable goods for recreation and cultural activities	3.27%	4.21%	-3.51%
42	Services of hairdressers and personal service establishments	3.11%	-10.13%	-4.99%
43	Spare parts and mountings for personal motor vehicles	2.90%	1.46%	-7.67%
44	Other items of clothing and accessories	2.23%	5.44%	-3.85%
45	Other goods and equipment for recreation, sports and gardening and home pets	2.01%	1.67%	-3.66%
46	Oils and fats	2.01%	7.12%	0.25%
47	Newspapers, books and stationery	1.73%	-3.61%	-8.01%
48	Boots, shoes and other footwear	1.45%	2.05%	-5.85%
49	Upper garments	0.90%	1.65%	-2.93%
50	Materials for manufacturing of clothing	0.85%	4.43%	-4.21%
51	Communication	0.74%	5.77%	-6.31%
52	Financial services not included into other categories	0.13%	-10.44%	11.50%
53	Hotel service	-0.25%	-6.83%	-5.33%
54	Other services related to upkeeping of residential premises and not included into other categories	-0.90%	11.78%	1.37%
55	Audio-visual equipment, photographic equipment and information processing equipment	-1.61%	9.00%	-16.13%
56	Secondary education	-3.49%	0.79%	-14.16%
57	Pre-school and elementary education	-5.70%	-11.09%	5.85%
58	Water supply	-6.27%	-11.88%	-2.99%
59	Electricity	-6.30%	19.02%	-1.38%
60	Sewage	-7.24%	-7.42%	6.63%
61	Thermal energy	-8.26%	-9.89%	-9.36%
62	Garbage disposal	-9.07%	-5.98%	-4.12%
63	Meat	-9.10%	-13.05%	-6.09%
64	Transport services	-28.11%	7.01%	-14.49%
65	Gas	-28.67%	-3.63%	-0.18%
66	Other services related to personal motor vehicles	omission	omission	omission

Source: the authors' computations based on the data from the ASPR BNS RK

Appendix 9

Stability of Each of the 66 CPI Components (a Deseasonalized Price Change versus the Preceding Month), January 2011-October 2022

#	Name of the Group of Goods or Services	Value
1	Bread and bakery and cereals	79.80%
2	Food products not included into other categories	77.89%
3	Goods and services used in housekeeping	74.11%
4	Other articles, devices and personal goods	72.54%
5	Coffee, tea and cacao	70.60%
6	Medications, therapeutic equipment and instrumentation	64.37%
7	Mineral water, soft drinks, fruit and vegetable juices	64.24%
8	Spare parts and mountings for personal motor vehicles	61.46%
9	Fish and seafood	61.35%

10	Meat	60.26%
11	Other goods and equipment for recreation, sports and gardening and home pets	59.68%
12	Alcohol beverages	59.48%
13	Actual housing rental payment	57.13%
14	Dairy products, cheese and eggs	53.99%
15	Materials for maintenance and repair of residential premises	52.22%
16	Purchase of motor vehicles	51.53%
17	Oils and fats	50.89%
18	Sugar, jam, honey, chocolate and confectionery	50.73%
19	Tools and implements used at home and in horticulture	46.48%
20	Fruits	44.20%
21	Glass ware, cutlery and housewares	41.67%
22	Upper garments	41.60%
23	Electric appliances of personal use	41.37%
24	Other services related to upkeep of residential premises and not included into other categories	40.59%
25	Materials for manufacturing of clothing	38.95%
26	Other items of clothing and accessories	37.99%
27	Furniture, household goods, carpets and other floor coverings, their repair	37.79%
28	Public catering services	37.39%
29	Boots, shoes and other footwear	35.57%
30	Footwear repair and rental	34.53%
31	Other services not included into other categories	34.27%
32	Services of hairdressers and personal service establishments	34.14%
33	Fuel and lubricants for personal motor vehicles	33.85%
34	Textile products used in household	32.88%
35	Water supply	32.18%
36	Personal care items not included into other categories	28.46%
37	Outpatient services	28.16%
38	Gas	27.77%
39	Other large-size durable goods for recreation and cultural activities	27.12%
40	Sewage	26.87%
41	Vegetables	26.25%
42	Financial services not included into other categories	25.94%
43	Solid fuel	24.30%
44	Thermal energy	21.58%
45	In-patient services	20.34%
46	Tobacco products	19.15%
47	Clothing cleaning, repair and rental	18.66%
48	Electricity	18.21%
49	Services for maintenance and repair of residential premises	18.09%
50	Maintenance and repair of personal motor vehicles	15.90%
51	Services in the field of recreation, entertainment and culture	15.82%
52	Newspapers, books and stationery	13.57%
53	Post-secondary education	11.27%
54	Audio-visual equipment, photographic equipment and information processing equipment	8.66%
55	Transport services	8.06%
56	Garbage disposal	6.84%
57	Hotel service	3.87%

58	Pre-school and elementary education	2.73%
59	Household appliances	1.15%
60	Education not subdivided into stages	0.96%
61	Higher education	-2.17%
62	Secondary education	-3.67%
63	Communication	-8.29%
64	Arranging all-inclusive leisure	-12.58%
65	Insurance	-20.65%
66	Other services related to personal motor vehicles	omission

Source: the authors' computations based on the data from the ASPR BNS RK

Appendix 10

New Weights of Groups of Goods and Services Resulting from the Use of Weight Alteration Methods in October 2022

#	Name of Group of Goods and Services	0	1	2	3	4	5	6	7	8
1	Bread and bakery and cereals	6.75%	5.24%	1.22%	1.11%	4.70%	12.52%	2.94%	10.23%	10.74%
2	Meat	10.71%	14.74%	2.17%	2.15%	14.46%	15.01%	3.93%	21.75%	0.00%
3	Fish and seafood	1.49%	1.60%	1.68%	1.56%	1.46%	2.13%	3.11%	2.40%	2.75%
4	Dairy products, cheese and eggs	5.05%	3.55%	1.11%	1.08%	3.42%	6.34%	1.80%	4.69%	3.10%
5	Oils and fats	2.29%	1.50%	1.03%	0.80%	1.15%	2.71%	1.58%	1.87%	0.84%
6	Fruits	3.21%	1.37%	0.67%	0.67%	1.34%	3.29%	0.90%	1.48%	3.37%
7	Vegetables	2.94%	0.58%	0.31%	0.31%	0.58%	1.79%	0.25%	0.38%	5.05%
8	Sugar, jam, honey, chocolate and confectionery	2.75%	0.91%	0.52%	0.48%	0.83%	3.24%	0.80%	1.13%	8.13%
9	Food products not included into other categories	1.33%	1.09%	1.29%	1.16%	0.97%	2.41%	3.03%	2.08%	3.24%
10	Coffee, tea and cacao	1.44%	1.33%	1.46%	1.47%	1.33%	2.36%	3.10%	2.30%	0.91%
11	Mineral water, soft drinks, fruit and vegetable juices	0.80%	0.69%	1.35%	1.26%	0.63%	1.20%	2.61%	1.08%	1.78%
12	Alcohol beverages	1.18%	1.47%	1.96%	2.04%	1.51%	1.63%	3.50%	2.14%	4.02%
13	Tobacco products	0.77%	0.80%	1.64%	1.40%	0.67%	0.34%	0.95%	0.37%	0.83%
14	Materials for manufacturing of clothing	0.02%	0.02%	1.60%	1.67%	0.02%	0.02%	1.88%	0.02%	0.00%
15	Upper garments	6.27%	9.98%	2.51%	3.23%	12.69%	6.06%	3.14%	10.16%	1.03%
16	Other items of clothing and accessories	0.29%	0.29%	1.59%	1.81%	0.33%	0.26%	1.82%	0.27%	0.12%
17	Boots, shoes and other footwear	3.18%	4.46%	2.21%	2.66%	5.31%	2.63%	2.36%	3.89%	0.85%
18	Materials for maintenance and repair of residential premises	1.58%	1.41%	1.40%	1.39%	1.38%	1.92%	2.20%	1.80%	1.18%
19	Solid fuel	1.72%	2.48%	2.27%	2.37%	2.55%	0.97%	1.66%	1.47%	1.19%
20	Furniture, household goods, carpets and other floor coverings, their repair	1.69%	1.02%	0.95%	0.98%	1.04%	1.48%	1.08%	0.94%	2.96%

21	Textile products used in household	0.60%	1.10%	2.87%	3.66%	1.38%	0.46%	2.84%	0.88%	0.43%
22	Household appliances	1.02%	0.30%	0.47%	0.47%	0.30%	0.03%	0.02%	0.01%	2.29%
23	Glass ware, cutlery and housewares	0.36%	0.49%	2.17%	2.28%	0.51%	0.35%	2.73%	0.50%	0.25%
24	Tools and implements used at home and in horticulture	0.16%	0.18%	1.74%	1.89%	0.19%	0.18%	2.44%	0.21%	0.29%
25	Goods and services used in housekeeping	1.47%	0.86%	0.92%	0.88%	0.81%	2.53%	2.06%	1.56%	3.00%
26	Medications, therapeutic equipment and instrumentation	1.66%	2.67%	2.52%	3.23%	3.37%	2.49%	4.89%	4.20%	1.24%
27	Purchase of motor vehicles	0.99%	0.80%	1.28%	1.21%	0.75%	1.18%	1.99%	1.01%	0.63%
28	Spare parts and mountings for personal motor vehicles	0.42%	0.40%	1.50%	1.57%	0.41%	0.59%	2.77%	0.60%	0.22%
29	Fuel and lubricants for personal motor vehicles	2.98%	1.79%	0.94%	0.93%	1.73%	2.35%	0.96%	1.48%	3.12%
30	Audio-visual equipment, photographic equipment and information processing equipment	0.69%	0.29%	0.66%	0.68%	0.29%	0.14%	0.17%	0.06%	0.00%
31	Other large-size durable goods for recreation and cultural activities	0.02%	0.03%	2.71%	3.19%	0.03%	0.01%	2.21%	0.02%	0.01%
32	Other goods and equipment for recreation, sports and gardening and home pets	0.33%	0.47%	2.26%	2.79%	0.57%	0.46%	4.07%	0.69%	0.12%
33	Newspapers, books and stationery	0.20%	0.03%	0.27%	0.27%	0.03%	0.06%	0.11%	0.01%	0.06%
34	Electric appliances of personal use	0.06%	0.03%	0.83%	0.84%	0.03%	0.05%	1.04%	0.03%	0.11%
35	Other articles, devices and personal goods	3.22%	2.05%	1.00%	0.97%	1.96%	5.42%	2.19%	3.64%	6.83%
36	Personal care items not included into other categories	0.56%	0.20%	0.56%	0.56%	0.20%	0.37%	0.48%	0.14%	1.31%
37	Clothing cleaning, repair and rental	0.22%	0.24%	1.71%	1.78%	0.25%	0.10%	0.96%	0.11%	0.20%
38	Footwear repair and rental	0.08%	0.04%	0.87%	0.86%	0.04%	0.06%	0.91%	0.04%	0.14%
39	Actual housing rental payment	2.78%	0.93%	0.53%	0.48%	0.84%	3.70%	0.91%	1.31%	10.40%
40	Services for maintenance and repair of residential premises	0.93%	0.91%	1.55%	1.54%	0.89%	0.39%	0.84%	0.40%	2.87%

41	Water supply	0.56%	0.70%	1.97%	1.49%	0.52%	0.42%	1.91%	0.55%	0.00%
42	Garbage disposal	0.28%	0.15%	0.85%	0.72%	0.12%	0.04%	0.18%	0.03%	0.00%
43	Sewage	0.20%	0.25%	1.92%	1.62%	0.21%	0.13%	1.56%	0.16%	0.00%
44	Other services related to upkeep of residential premises and not included into other categories	1.15%	0.87%	1.20%	1.34%	0.97%	1.08%	1.46%	0.87%	0.00%
45	Electricity	2.41%	1.64%	1.07%	1.14%	1.72%	1.02%	0.59%	0.73%	0.00%
46	Gas	1.28%	0.71%	0.87%	0.86%	0.69%	0.83%	0.73%	0.48%	0.00%
47	Thermal energy	1.71%	1.86%	1.71%	1.31%	1.41%	0.86%	1.11%	0.98%	0.00%
48	Outpatient services	2.87%	3.32%	1.83%	1.96%	3.53%	1.88%	1.55%	2.29%	3.65%
49	In-patient services	1.32%	2.15%	2.57%	2.44%	2.02%	0.62%	1.57%	1.07%	2.17%
50	Maintenance and repair of personal motor vehicles	0.32%	0.67%	3.29%	2.62%	0.53%	0.12%	1.58%	0.26%	1.12%
51	Other services related to personal motor vehicles	0.00%	0.00%	0.05%	0.02%	0.00%	0.00%	0.16%	0.00%	0.00%
52	Transport services	2.93%	4.63%	2.48%	2.26%	4.15%	0.55%	0.60%	0.91%	0.00%
53	Communication	4.28%	7.29%	2.68%	2.10%	5.64%	0.00%	0.00%	0.00%	0.58%
54	Services in the field of recreation, entertainment and culture	0.71%	0.96%	2.14%	2.45%	1.09%	0.26%	1.02%	0.37%	0.65%
55	Arranging all-inclusive leisure	0.08%	0.05%	0.94%	0.98%	0.05%	0.00%	0.00%	0.00%	0.08%
56	Pre-school and elementary education	0.83%	0.98%	1.87%	2.14%	1.11%	0.05%	0.15%	0.07%	0.00%
57	Secondary education	0.09%	0.16%	2.78%	2.75%	0.16%	0.00%	0.00%	0.00%	0.00%
58	Post-secondary education	0.21%	0.11%	0.86%	0.90%	0.12%	0.05%	0.29%	0.03%	0.43%
59	Higher education	0.78%	0.37%	0.75%	0.76%	0.37%	0.00%	0.00%	0.00%	2.60%
60	Education not subdivided into stages	0.02%	0.02%	1.34%	1.42%	0.02%	0.00%	0.04%	0.00%	0.05%
61	Public catering services	0.73%	0.63%	1.35%	1.36%	0.62%	0.63%	1.52%	0.57%	1.25%
62	Hotel service	0.01%	0.01%	1.26%	1.38%	0.01%	0.00%	0.15%	0.00%	0.00%
63	Services of hairdressers and personal service establishments	2.19%	3.21%	2.31%	2.43%	3.33%	1.74%	2.37%	2.68%	1.25%
64	Insurance	0.23%	0.07%	0.48%	0.49%	0.07%	0.00%	0.00%	0.00%	0.18%
65	Financial services not included into other categories	0.21%	0.56%	4.11%	2.31%	0.31%	0.13%	3.21%	0.35%	0.00%
66	Other services not included into other categories	0.42%	0.26%	0.99%	1.06%	0.28%	0.33%	1.03%	0.22%	0.36%
	Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

#	Short Name	Explanation to the Corresponding Column No. in the Table
0	CPI	CPI weighting
1	Volatility double	Weighting based on volatility for the last 2 years and initial weights

2	Volatility_one	Weighting based on volatility for the last 2 years
3	Rmse_trend_one	Weighting based on deviation from the CPI trend
4	Rmse_trend_double	Weighting based on deviation from the CPI trend and initial weights
5	Persistence_double	Weighting based on persistence and initial weights
6	Persistence_volatility	Weighting based on persistence and volatility for the last 2 years
7	Persistence_volatility_triple	Weighting based on persistence, volatility for the last 2 years and initial weights
8	Correlation_double	Weighting based on the CPI correlation with the change in price of the corresponding component 6 months ago and initial weights

Source: the authors' computations based on the data from the ASPR BNS RK

Appendix 11

Eigen Values in Ascending Order and Contribution of Each Factor to the Percent of Explanation of Variance of 66 Groups of Goods and Services

No. of the Factor (Own Vector)	Eigen value	Eigen Value to the Next Value	Percent of Explanation of Variance of All Components
1	24.3	5.4	37.1%
2	4.5	1.2	6.8%
3	3.7	1.4	5.6%
4	2.6	1.1	4.0%
5	2.4	1.3	3.6%
6	1.8	1.1	2.7%
7	1.7	1.1	2.6%
8	1.5	1.0	2.3%
9	1.5	1.1	2.2%
10	1.3	1.0	2.0%
11	1.3	1.1	2.0%
12	1.2	1.1	1.9%
13	1.1	1.1	1.7%
14	1.0	1.0	1.6%
15	1.0	1.0	1.6%
16	1.0	1.0	1.5%
17	1.0	1.1	1.5%
18	0.9	1.0	1.4%
19	0.9	1.2	1.3%
20	0.7	1.0	1.1%
21	0.7	1.1	1.1%
22	0.7	1.0	1.0%
23	0.6	1.1	1.0%
24	0.6	1.0	0.9%
25	0.6	1.2	0.9%
26	0.5	1.0	0.8%
27	0.5	1.1	0.8%
28	0.5	1.0	0.7%
29	0.4	1.1	0.7%
30	0.4	1.1	0.6%
31	0.4	1.0	0.6%

32	0.4	1.1	0.6%
33	0.3	1.1	0.5%
34	0.3	1.1	0.5%
35	0.3	1.1	0.4%
36	0.3	1.1	0.4%
…	…	…	…
65	0.0	1.2	0.0%
66	0.0		0.0%
Sum	**65.5**		**100%**

Appendix 12

Correlation of Core Inflation Estimated Using the Dynamic Factor Model with the Groups of Goods and Services and the Percent of Their Variance Explained by the Model Individually

#	Name of the Group of Goods or Services	Correlation with Core Inflation	Percent of Explanation of Variance
1	Tools and implements used at home and in horticulture	0.95	0.91
2	Glass ware, cutlery and housewares	0.93	0.86
3	Furniture, household goods, carpets and other floor coverings, their repair	0.93	0.86
4	Fish and seafood	0.92	0.85
5	Electric appliances of personal use	0.91	0.82
6	Spare parts and mountings for personal motor vehicles	0.91	0.82
7	Other goods and equipment for recreation, sports and gardening and home pets	0.90	0.82
8	Materials for manufacturing of clothing	0.89	0.80
9	Upper garments	0.89	0.79
10	Boots, shoes and other footwear	0.89	0.79
11	Textile products used in household	0.88	0.78
12	Other items of clothing and accessories	0.88	0.77
13	Other articles, devices and personal goods	0.86	0.74
14	Other large-size durable goods for recreation and cultural activities	0.85	0.73
15	Food products not included into other categories	0.85	0.72
16	Goods and services used in housekeeping	0.84	0.70
17	Medications, therapeutic equipment and instrumentation	0.84	0.70
18	Personal care items not included into other categories	0.84	0.70
19	Oils and fats	0.82	0.67
20	Mineral water, soft drinks, fruit and vegetable juices	0.80	0.65
21	Public catering services	0.74	0.55
22	Materials for maintenance and repair of residential premises	0.74	0.54
23	Bread and bakery and cereals	0.72	0.52
24	Fruits	0.70	0.48
25	Alcohol beverages	0.69	0.48
26	Purchase of motor vehicles	0.68	0.46
27	Clothing cleaning, repair and rental	0.66	0.44
28	Household appliances	0.66	0.44
29	Services in the field of recreation, entertainment and culture	0.62	0.38

30	Sugar, jam, honey, chocolate and confectionery	0.60	0.36
31	Dairy products, cheese and eggs	0.59	0.35
32	Maintenance and repair of personal motor vehicles	0.59	0.34
33	Services for maintenance and repair of residential premises	0.56	0.32
34	Coffee, tea and cacao	0.56	0.31
35	Education not subdivided into stages	0.55	0.30
36	Footwear repair and rental	0.54	0.30
37	Outpatient services	0.53	0.28
38	Audio-visual equipment, photographic equipment and information processing equipment	0.50	0.25
39	Services of hairdressers and personal service establishments	0.49	0.24
40	In-patient services	0.38	0.14
41	Hotel service	0.34	0.12
42	Secondary education	0.31	0.09
43	Other services not included into other categories	0.30	0.09
44	Vegetables	0.29	0.08
45	Meat	0.28	0.08
46	Newspapers, books and stationery	0.28	0.08
47	Solid fuel	0.27	0.07
48	Actual housing rental payment	0.25	0.06
49	Arranging all-inclusive leisure	0.20	0.04
50	Other services related to upkeep of residential premises and not included into other categories	0.19	0.03
51	Pre-school and elementary education	0.17	0.03
52	Financial services not included into other categories	0.16	0.03
53	Tobacco products	0.14	0.02
54	Post-secondary education	0.10	0.01
55	Higher education	0.08	0.01
56	Transport services	0.07	0.00
57	Insurance	0.04	0.00
58	Thermal energy	0.03	0.00
59	Communication	0.03	0.00
60	Electricity	0.02	0.00
61	Garbage disposal	0.01	0.00
62	Water supply	-0.01	0.00
63	Gas	-0.02	0.00
64	Fuel and lubricants for personal motor vehicles	-0.05	0.00
65	Sewage	-0.06	0.00
66	Other services related to personal motor vehicles	-0.23	0.05

Source: the authors' computations based on the data from the ASPR BNS RK

Appendix 13

Explanations to Symbols of Core Inflation Estimates

#	**Notation**	**Description**
1	BCPI_sa	Seasonally adjusted CPI excl. fruits and vegetables, gasoline, coal, diesel fuel and utility services, railway transport and communication
2	Excl_8_sa	Seasonally adjusted CPI excl. 8 most volatile components for the last 2 years
3	Excl_13_sa	Seasonally adjusted CPI excl. 13 most volatile components for the last 2 years

4	Excl_25%_sa	Seasonally adjusted CPI excl. 25% most volatile components for the last 2 years
5	Trim_10_sa	Seasonally adjusted CPI with the 10% truncation at both ends of an ordered monthly price change distribution
6	Trim_2525_sa	Seasonally adjusted CPI with truncation for the entire time series from 1% to 25% at both ends of an ordered monthly price change distribution based on the minimum mean square error between the computed modified core inflation for a given truncation and the centered moving average of the deseasonalized CPI for 24 months
7	w_mediana_SA	Median of an ordered distribution of the seasonally adjusted monthly price change
8	Overweight_sa	Seasonally adjusted CPI with new component weights determined by the product of the reciprocal of component volatility for the last 2 years and the initial weight in the CPI
9	Volatility_one	Seasonally adjusted CPI with new component weights determined by the reciprocal of component volatility for the last 2 years
10	Rmse_trend_one	Seasonally adjusted CPI with new component weights determined by the reciprocal of RMSE of the component and the CPI trend expressed by 24-month moving average
11	Rmse_trend_double	Seasonally adjusted CPI with new component weights determined by the product of the reciprocal of RMSE of the component and the CPI trend expressed by 24-month moving average and the initial weight in the CPI
12	Persistence_double	Seasonally adjusted CPI with new component weights determined by the product of the component persistence (one lag was taken for the computation) in the landmark window and the initial weight in the CPI
13	Persistence_volatility	Seasonally adjusted CPI with new component weights determined by the product of the component persistence (one lag was taken for the computation) in the landmark window, the reciprocal of component volatility for the last 2 years
14	Persistence_volatility_triple	Seasonally adjusted CPI with new component weights determined by the product of the component persistence (one lag was taken for the computation) in the landmark window, the reciprocal of component volatility for the last 2 years and the initial weight in the CPI
15	Correlation_double	Seasonally adjusted CPI with new component weights determined by the product of the component correlation (with the lag of 6 months) with the CPI in the landmark window, and the initial weight in the CPI
16	Volatility_double_mediana	Median of an ordered distribution of seasonally adjusted monthly price change with new weights as for indicator #8
17	Volatility_one_mediana	Median of an ordered distribution of seasonally adjusted monthly price change with new weights as for indicator #9
18	Rmse_trend_one_mediana	Median of an ordered distribution of seasonally adjusted monthly price change with new weights as for indicator #10
19	Rmse_trend_double_mediana	Median of an ordered distribution of seasonally adjusted monthly price change with new weights as for indicator #11
20	Persistence_double_mediana	Median of an ordered distribution of seasonally adjusted monthly price change with new weights as for indicator #12

21	Persistence_volatility_mediana	Median of an ordered distribution of seasonally adjusted monthly price change with new weights as for indicator #13
22	Persistence_volatility_triple_median a	Median of an ordered distribution of seasonally adjusted monthly price change with new weights as for indicator #14
23	Correlation_double_mediana	Median of an ordered distribution of seasonally adjusted monthly price change with new weights as for indicator #15
24	Persistence_one_median a	Median of an ordered distribution of seasonally adjusted monthly price change with new weights determined by the product of component persistency (one lag was taken for the computation) in the landmark window
25	Wavelet_min_std_transform_direct	Wavelet method (direct method, transforms, without one component) with parameters providing a minimal variance
26	Wavelet_min_std_transform_indere ct	Wavelet method (indirect method, transforms, without one component) with parameters providing a minimal variance
27	Wavelet_min_std_transform_S3_direct	Wavelet method (direct method, transforms, without two components) with parameters providing a minimal variance
28	Wavelet_transform_min_std_S3_indirect	Wavelet method (indirect method, transforms, without two components) with parameters providing a minimal variance
29	Wavelet_dev_thresh_direct	Wavelet method (direct thresholding method) with parameters providing a minimum deviation from the CPI
30	Wavelet_rmse12_thresh_direct	Wavelet method (direct thresholding method) with parameters providing a minimal mean square error between the indicator and the CPI trend (12-month moving average)
31	Wavelet_std_thresh_direct	Wavelet method (direct thresholding method) with parameters providing a minimal variance
32	Wavelet_dev_tresh_short_direct	Wavelet method (direct thresholding method, wavelet length is limited by 12) with parameters providing a minimum deviation from the CPI
33	Wavelet_rmse12_tresh_short_direct	Wavelet method (direct thresholding method, wavelet length is limited by 12) with parameters providing a minimal mean square error between the indicator and the CPI trend (12- month moving average)
34	Wavelet_std_tresh_short_direct	Wavelet method (direct thresholding method, wavelet length is limited by 12) with parameters providing a minimal variance
35	Wavelet_dev_thresh_inderect	Wavelet method (indirect thresholding method) with parameters providing a minimum deviation from the CPI

36	Wavelet_rmse12_thresh_inderect	Wavelet method (indirect thresholding method) with parameters providing a minimal mean square error between the indicator and the CPI trend (12-month moving average)
37	Wavelet_std_thresh_inderect	Wavelet method (indirect thresholding method) with parameters providing a minimal variance
38	Wavelet_std_thresh_short_inderect	Wavelet method (indirect thresholding method, wavelet length is limited by 12) with parameters providing a minimal variance
39	Wavelet_rmse_12_thresh_short_inderect	Wavelet method (direct thresholding method, wavelet length is limited by 12) with parameters providing a minimal mean square error between the indicator and the CPI trend (12- month moving average)
40	Wavelet_dev_thresh_short_inderect	Wavelet method (indirect thresholding method, wavelet length is limited by 12) with parameters providing a minimum deviation from the CPI
41	Exp_smoothing	Exponential smoothing (indirect method)
42	HP_smoothing	Hodrick-Prescott filter (indirect method)
43	Trim_skew	Seasonally adjusted CPI with truncation from 1% to 25% at both ends of an ordered monthly price change distribution based on the minimal skewness of the residual price distribution
44	ADJ_INF_TRIM_SA	Method of adjusting the estimate (5) for the skewness of an ordered seasonally adjusted monthly price change distribution
45	ADJ_INF_TRIM2525_SA	Method of adjusting the estimate (6) for the skewness of an ordered seasonally adjusted monthly price change distribution
46	ADJ_INF_MEDIAN_SA	Method of adjusting the estimate (7) for the skewness of an ordered seasonally adjusted monthly price change distribution
47	BP_3_6	Bandpass filter or BP filter with the range of (3,6)
48	BP_3_12	Bandpass filter or BP filter with the range of (3,12)
49	BP_3_18	Bandpass filter or BP filter with the range of (3,18)
50	BP_3_24	Bandpass filter or BP filter with the range of (3,24)
51	BP_6_12	Bandpass filter or BP filter with the range of (6,12)
52	BP_6_18	Bandpass filter or BP filter with the range of (6,18)
53	BP_6_24	Bandpass filter or BP filter with the range of (6,24)
54	BP_12_18	Bandpass filter or BP filter with the range of (12,18)
55	BP_12_24	Bandpass filter or BP filter with the range of (12,24)
56	BP_18_36	Bandpass filter or BP filter with the range of (18,36)
57	BP_18_48	Bandpass filter or BP filter with the range of (18,48)
58	BP_18_60	Bandpass filter or BP filter with the range of (18,60)
59	BP_18_96	Bandpass filter or BP filter with the range of (18,96)
60	DFM_2stage	Estimate obtained using a dynamic factor model
61	UC_noise	Estimate obtained using a state space model by an indirect method
62	Unobserv_components_noise_excl	Seasonally adjusted CPI excl. components showing the largest noise relative to a general component estimated using a state space model by an indirect method in (61)

63	Unobserved _components	Estimate obtained using a state space model by a direct method

Source: the authors' computations based on the data from the ASPR BNS RK

Appendix 14

Estimating Core Inflation Indicators based on the Optimality Criteria

	P-value of the ADF test for the difference between core inflation& CPI in 2016-2022	P-value of the constant in regression of the difference between core inflation & CPI by a constant in 2016-2022.	P-value of the Wald test for the cointegration between core inflation& CPI in 2016-2022.	P-value of the Wald test for predictive capability of core inflation after 6 mths in 2016-2022.	P-value value of the Wald test for predictive capability of core inflation after 12 mths in 2016-2022.	P-value value of the Wald test for predictive capability of core inflation after 18 mths in 2016-2022.	P-value value of the Wald test for predictive capability of core inflation after 24 mths in 2016-2022.	Coefficient responsible for weak exogeneity of core inflation	P-value of the preceding coefficient	RMSE between core inflation and 24-mth moving average CPI in 2016-2022.	Standard deviation of core inflation estimates in 2016-2022
BCPI_sa	0.00	0.04	0.01	0.87	0.21	0.11	0.43	-0.98	0.02	0.18	0.50
Excl_8_sa	0.00	0.96	0.24	0.70	0.16	0.42	0.44	-0.83	0.03	0.19	0.39
Excl_13_sa	0.00	0.74	0.52	0.77	0.16	0.12	0.45	-0.84	0.03	0.19	0.41
Excl_25%_sa	0.00	0.98	0.40	0.70	0.11	0.08	0.48	-0.89	0.03	0.20	0.40
Trim_10_sa	0.00	0.01	0.00	0.20	0.15	0.23	0.13	-0.57	0.19	0.19	0.41
Trim_2525_sa	0.00	0.00	0.00	0.04	0.02	0.05	0.03	-0.44	0.16	0.24	0.37
w_mediana_SA	0.00	0.00	0.01	0.30	0.08	0.18	0.18	-0.65	0.01	0.22	0.41
Overweight_sa	0.00	0.05	0.00	0.30	0.22	0.30	0.20	-0.62	0.13	0.19	0.35
Volatility_one	0.00	0.00	0.00	0.21	0.10	0.15	0.20	-0.62	0.03	0.20	0.31
Rmse_trend_one	0.00	0.01	0.00	0.28	0.12	0.18	0.24	-0.71	0.03	0.20	0.33
Rmse_trend_double	0.00	0.20	0.00	0.42	0.24	0.40	0.35	-0.78	0.09	0.19	0.36
Persistance_double	0.00	0.00	0.00	0.00	0.27	0.08	0.61	-1.36	0.08	0.21	0.59
Persistance_volatility	0.00	0.92	0.54	0.66	0.05	0.03	0.23	-1.28	0.01	0.18	0.39
Persistance_volatility_triple	0.00	0.01	0.02	0.68	0.12	0.07	0.59	-1.17	0.02	0.20	0.45
Correlation_double	0.00	0.30	0.00	0.00	0.00	0.00	0.00	-1.46	0.00	0.38	0.61
Volatility_double_mediana	0.00	0.00	0.00	0.10	0.06	0.12	0.15	-0.66	0.01	0.24	0.31
Volatility_one_mediana	0.00	0.00	0.00	0.06	0.03	0.05	0.10	-0.54	0.01	0.25	0.27
Rmse_trend_one_mediana	0.00	0.00	0.00	0.08	0.04	0.06	0.11	-0.58	0.01	0.25	0.29
Rmse_trend_double_mediana	0.00	0.01	0.01	0.11	0.06	0.12	0.19	-0.71	0.01	0.24	0.32
Correlation_double_mediana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-1.50	0.02	0.32	0.84
Persistance_one_mediana	0.00	0.41	0.68	0.45	0.05	0.03	0.22	-1.10	0.00	0.20	0.44
Persistance_double_mediana	0.00	0.09	0.03	0.02	0.11	0.05	0.49	-0.85	0.01	0.22	0.49
Persistance_volatility_mediana	0.00	0.16	0.25	0.38	0.06	0.01	0.26	-0.98	0.00	0.21	0.35
Persistance_volatility_triple_mediana	0.00	0.92	0.98	0.23	0.03	0.03	0.38	-0.89	0.00	0.24	0.41
Wavelet_min_std_transform_direct	0.00	0.76	0.44	0.58	0.37	0.28	0.25	-0.30	0.47	0.14	0.37
Wavelet_min_std_transform_inderect	0.00	0.08	0.08	0.74	0.26	0.61	0.43	-0.72	0.02	0.20	0.37
Wavelet_min_std_transform_S3_direct	0.00	0.73	0.43	0.74	0.32	0.23	0.14	-0.62	0.12	0.12	0.33
Wavelet_transform_min_std_S3_indirect	0.00	0.18	0.10	0.75	0.22	0.54	0.51	-0.75	0.02	0.18	0.33
Wavelet_dev_thresh_direct	0.00	0.98	0.29	0.14	0.16	0.25	0.32	0.08	0.81	0.14	0.45
Wavelet_rmse12_thresh_direct	0.00	0.61	0.00	0.70	0.54	0.26	0.46	0.00	1.00	0.14	0.21
Wavelet_std_thresh_direct	0.00	0.58	0.62	0.00	0.18	0.76	0.66	-0.12	0.18	0.20	0.09
Wavelet_dev_tresh_short_direct	0.00	0.98	0.29	0.14	0.16	0.25	0.32	0.08	0.81	0.14	0.45
Wavelet_rmse12_tresh_short_direct	0.00	0.58	0.00	0.53	0.51	0.19	0.45	0.02	0.89	0.14	0.23
Wavelet_std_tresh_short_direct	0.00	0.55	0.44	0.00	0.16	0.75	0.65	-0.11	0.18	0.21	0.11
Wavelet_dev_thresh_inderect	0.00	0.50	0.18	0.00	0.00	0.15	0.14	-0.54	0.00	0.25	0.23
Wavelet_rmse12_thresh_inderect	0.00	0.67	0.00	0.99	0.64	0.31	0.24	-0.19	0.27	0.18	0.23

Wavelet_std_thresh_inderect	0.00	0.96	0.99	0.00	0.02	0.73	0.50	-0.23	0.08	0.25	0.14
Wavelet_std_thresh_short_inderect	0.00	0.96	0.99	0.00	0.01	0.76	0.45	-0.26	0.07	0.25	0.15
Wavelet_rmse_12_thresh_short_inderect	0.00	0.63	0.00	0.99	0.51	0.35	0.09	-0.29	0.19	0.19	0.25
Wavelet_dev_thresh_short_inderect	0.00	0.79	0.00	0.25	0.17	0.47	0.11	-0.38	0.07	0.22	0.24
Exp_smoothing	0.00	0.78	0.52	0.00	0.07	0.02	0.10	-1.05	0.00	0.15	0.33
HP_smoothing	0.00	0.90	0.60	0.09	0.11	0.33	0.31	0.32	0.16	0.15	0.40
Trim_skew	0.00	0.00	0.00	0.23	0.08	0.12	0.18	-0.72	0.03	0.22	0.39
ADJ_INF_MEDIAN_SA	0.00	0.13	0.02	0.89	0.50	0.45	0.50	-0.28	0.31	0.17	0.43
ADJ_INF_TRIM2525_SA	0.00	0.19	0.00	0.25	0.55	0.22	0.51	0.22	0.55	0.16	0.39
ADJ_INF_TRIM_SA	0.00	0.34	0.01	0.14	0.28	0.05	0.29	0.33	0.52	0.16	0.42
BP_3_6	0.00	0.66	0.71	0.47	0.00	0.00	0.00	-0.59	0.01	0.23	0.45
BP_3_12	0.00	0.79	0.53	0.15	0.00	0.03	0.00	-0.80	0.01	0.28	0.44
BP_3_18	0.00	0.81	0.49	0.06	0.00	0.00	0.01	-1.18	0.00	0.26	0.42
BP_3_24	0.00	0.84	0.80	0.11	0.01	0.00	0.00	-1.12	0.00	0.19	0.38
BP_6_12	0.00	0.66	0.61	0.11	0.00	0.02	0.00	-0.95	0.00	0.29	0.49
BP_6_18	0.00	0.71	0.61	0.17	0.00	0.00	0.00	-1.32	0.00	0.28	0.47
BP_6_24	0.00	0.73	0.86	0.41	0.00	0.00	0.00	-1.29	0.00	0.21	0.43
BP_12_18	0.00	0.94	0.61	0.19	0.04	0.05	0.11	-1.12	0.04	0.22	0.47
BP_12_24	0.00	0.99	0.77	0.42	0.09	0.02	0.06	-1.01	0.04	0.20	0.45
BP_18_36	0.00	0.63	0.55	0.01	0.01	0.11	0.04	-1.04	0.01	0.25	0.45
BP_18_48	0.00	0.50	0.30	0.00	0.01	0.04	0.05	-1.01	0.00	0.28	0.44
BP_18_60	0.00	0.46	0.29	0.00	0.00	0.04	0.06	-1.05	0.00	0.28	0.44
BP_18_96	0.07	0.42	0.54	0.00	0.00	0.03	0.09	-0.95	0.00	0.31	0.38
DFM_2stage	0.00	0.46	0.59	0.62	0.08	0.31	0.29	-1.01	0.01	0.23	0.45
UC_noise	0.00	0.22	0.46	0.50	0.01	0.03	0.02	-0.45	0.56	0.22	0.45
Unobserv_components_noise_excl	0.00	0.02	0.00	0.29	0.17	0.30	0.56	-0.75	0.04	0.21	0.52
Unobserved_components	0.00	0.70	0.24	0.09	0.23	0.37	0.33	0.30	0.52	0.14	0.39

Source: the authors' computations based on the data from the ASPR BNS RK

Appendix 15

Correlation of Core Inflation Indicators with Macroeconomic Variables

	M3(-1)	Retail_gap (-12)	ER (-1)	IR(-18)	Nominal Income (3)	Nominal Income (-3)	Nominal wage(-3)
BCPI_sa	0.38	0.17	0.52	-0.14	0.14	0.21	0.20
Excl_8_sa	0.40	0.16	0.57	-0.16	0.14	0.31	0.25
Excl_13_sa	0.37	0.16	0.50	-0.17	0.11	0.33	0.30
Excl_25%_sa	0.36	0.16	0.50	-0.15	0.11	0.32	0.31
Trim_10_sa	0.39	0.14	0.53	-0.13	0.13	0.19	0.19
Trim_2525_sa	0.36	0.11	0.49	-0.12	0.11	0.18	0.21
w_mediana_SA	0.33	0.10	0.50	-0.12	0.11	0.17	0.23
Overweight_sa	0.39	0.15	0.51	-0.15	0.12	0.31	0.27
Volatility_one	0.42	0.17	0.52	-0.12	0.14	0.27	0.20
Rmse_trend_one	0.38	0.15	0.51	-0.11	0.11	0.22	0.19
Rmse_trend_double	0.35	0.11	0.51	-0.13	0.06	0.25	0.25
Persistence_double	0.43	0.15	0.59	-0.12	0.16	0.22	0.15
Persistence_volatility	0.44	0.17	0.60	-0.12	0.16	0.23	0.17
Persistence_volatility_triple	0.38	0.14	0.58	-0.14	0.14	0.25	0.22
Correlation_double	0.44	0.10	0.56	-0.04	0.19	0.16	0.04
Volatility_double_mediana	0.26	0.09	0.40	-0.15	0.07	0.28	0.33
Volatility_one_mediana	0.36	0.13	0.48	-0.11	0.16	0.26	0.23
Rmse_trend_one_mediana	0.30	0.11	0.44	-0.10	0.11	0.19	0.22
Rmse_trend_double_mediana	0.19	0.04	0.38	-0.11	-0.02	0.21	0.31
Correlation_double_mediana	0.44	0.17	0.60	-0.06	0.20	0.17	0.10
Persistence_one_mediana	0.41	0.16	0.59	-0.09	0.18	0.19	0.14
Persistence_double_mediana	0.38	0.16	0.61	-0.12	0.20	0.17	0.11
Persistence_volatility_mediana	0.41	0.16	0.55	-0.10	0.15	0.23	0.18
Persistence_volatility_triple_mediana	0.29	0.11	0.49	-0.09	0.11	0.23	0.24
Wavelet_min_std_transform_direct	0.54	0.15	0.47	-0.14	0.05	0.21	0.17
Wavelet_min_std_transform_inderect	0.56	0.23	0.46	-0.18	0.04	0.19	0.19
Wavelet_min_std_transform_S3_direct	0.48	0.16	0.34	-0.16	0.10	0.16	0.13
Wavelet_transform_min_std_S3_indirect	0.51	0.26	0.34	-0.21	0.08	0.14	0.15
Wavelet_dev_thresh_direct	0.42	0.14	0.53	-0.10	0.13	0.17	0.15
Wavelet_rmse12_thresh_direct	0.39	0.11	0.49	-0.15	0.19	0.15	0.10
Wavelet_std_thresh_direct	0.13	0.05	0.32	-0.15	0.18	0.06	0.05
Wavelet_dev_tresh_short_direct	0.42	0.14	0.53	-0.10	0.13	0.17	0.15
Wavelet_rmse12_tresh_short_direct	0.40	0.11	0.51	-0.14	0.17	0.16	0.12
Wavelet_std_tresh_short_direct	0.20	0.06	0.41	-0.10	0.19	0.09	0.06
Wavelet_dev_thresh_inderect	0.21	0.18	0.28	-0.28	0.15	0.09	0.08
Wavelet_rmse12_thresh_inderect	0.40	0.20	0.45	-0.19	0.14	0.13	0.15
Wavelet_std_thresh_inderect	0.16	0.22	0.24	-0.19	0.12	0.03	0.11
Wavelet_std_thresh_short_inderect	0.20	0.22	0.30	-0.17	0.13	0.06	0.12
Wavelet_rmse_12_thresh_short_inderect	0.41	0.21	0.47	-0.17	0.14	0.14	0.16
Wavelet_dev_thresh_short_inderect	0.37	0.21	0.46	-0.15	0.14	0.12	0.15
Exp_smoothing	0.28	0.18	0.22	-0.14	0.00	0.18	0.25
HP_smoothing	0.53	0.14	0.53	-0.12	0.06	0.21	0.18
Trim_skew	0.36	0.14	0.50	-0.12	0.13	0.14	0.17
ADJ_INF_MEDIAN_SA	0.36	0.09	0.49	-0.10	0.09	0.16	0.19
ADJ_INF_TRIM2525_SA	0.39	0.10	0.48	-0.10	0.08	0.16	0.18
ADJ_INF_TRIM_SA	0.41	0.13	0.53	-0.11	0.11	0.17	0.17
BP_3_6	0.48	0.14	0.45	-0.07	0.07	0.24	0.16
BP_3_12	0.48	0.11	0.33	-0.21	0.06	0.15	0.10
BP_3_18	0.39	0.21	0.29	-0.08	0.12	0.13	0.10
BP_3_24	0.30	0.19	0.18	-0.14	0.10	0.14	0.04
BP_6_12	0.42	0.10	0.43	-0.23	0.12	0.08	0.09
BP_6_18	0.33	0.18	0.40	-0.11	0.17	0.05	0.08
BP_6_24	0.25	0.15	0.32	-0.17	0.16	0.06	0.03
BP_12_18	0.36	0.20	0.50	0.02	0.16	0.16	0.14
BP_12_24	0.28	0.18	0.44	-0.02	0.16	0.17	0.10
BP_18_36	0.31	0.02	0.44	-0.11	0.09	0.18	0.10
BP_18_48	0.30	-0.02	0.42	-0.06	0.11	0.17	0.07
BP_18_60	0.29	-0.03	0.42	-0.05	0.10	0.16	0.07
BP_18_96	0.23	-0.03	0.41	-0.07	0.08	0.14	0.08
DFM_2stage	0.41	0.22	0.56	-0.14	0.14	0.17	0.18
UC_noise	0.48	0.09	0.52	-0.07	0.13	0.15	0.10
Unobserv_components_noise_excl	0.38	0.17	0.53	-0.16	0.15	0.20	0.19
Unobserved_components	0.52	0.15	0.52	-0.13	0.09	0.20	0.17

Source: the authors' computations based on the data from the ASPR BNS RK

Appendix 16

Assessment of the Effect of Core Inflation Estimates on Nominal Wage

	Coefficient	P-value of the coefficient	R^2
BCPI_sa	0.88	0.00	0.69
Excl_8_sa	0.73	0.01	0.59
Excl_13_sa	0.74	0.01	0.61
Excl_25%_sa	0.76	0.01	0.61
Trim_10_sa	0.89	0.00	0.69
Trim_2525_sa	0.90	0.00	0.69
w_mediana_SA	0.90	0.00	0.69
Overweight_sa	0.76	0.01	0.59
Volatility_one	0.77	0.01	0.58
Rmse_trend_one	1.07	0.01	0.45
Rmse_trend_double	1.09	0.01	0.47
Persistence_double	0.73	0.03	0.53
Persistence_volatility	0.75	0.02	0.54
Persistence_volatility_triple	0.76	0.02	0.54
Correlation_double	0.75	0.03	0.52
Volatility_double_mediana	0.84	0.00	0.61
Volatility_one_mediana	0.79	0.00	0.58
Rmse_trend_one_mediana	1.10	0.01	0.45
Rmse_trend_double_mediana	1.22	0.00	0.50
Correlation_double_mediana	0.75	0.03	0.52
Persistence_one_mediana	0.74	0.03	0.53
Persistence_double_mediana	0.75	0.03	0.52
Persistence_volatility_mediana	0.77	0.02	0.54
Persistence_volatility_triple_mediana	0.83	0.01	0.55
Wavelet_min_std_transform_direct	0.90	0.00	0.69
Wavelet_min_std_transform_inderect	0.89	0.00	0.69
Wavelet_min_std_transform_S3_direct	0.90	0.00	0.69
Wavelet_transform_min_std_S3_indirect	0.88	0.00	0.69
Wavelet_dev_thresh_direct	0.88	0.00	0.69
Wavelet_rmse12_thresh_direct	0.88	0.00	0.69
Wavelet_std_thresh_direct	0.81	0.07	0.69
Wavelet_dev_tresh_short_direct	0.88	0.00	0.69
Wavelet_rmse12_tresh_short_direct	0.89	0.00	0.69
Wavelet_std_tresh_short_direct	0.82	0.03	0.69
Wavelet_dev_thresh_inderect	0.87	0.00	0.69
Wavelet_rmse12_thresh_inderect	0.83	0.00	0.69
Wavelet_std_thresh_inderect	0.57	0.18	0.69
Wavelet_std_thresh_short_inderect	0.60	0.15	0.69
Wavelet_rmse_12_thresh_short_inderect	0.84	0.00	0.69
Wavelet_dev_thresh_short_inderect	0.82	0.00	0.69
Exp_smoothing	1.10	0.00	0.71
HP_smoothing	0.89	0.00	0.69
Trim_skew	0.89	0.00	0.69
ADJ_INF_MEDIAN_SA	0.92	0.00	0.69
ADJ_INF_TRIM2525_SA	0.92	0.00	0.69
ADJ_INF_TRIM_SA	0.90	0.00	0.69
BP_3_6	0.89	0.00	0.69
BP_3_12	0.91	0.00	0.69
BP_3_18	0.89	0.00	0.69
BP_3_24	0.88	0.00	0.69
BP_6_12	0.90	0.00	0.69
BP_6_18	0.88	0.00	0.69
BP_6_24	0.87	0.00	0.69
BP_12_18	0.87	0.00	0.69
BP_12_24	0.85	0.00	0.69
BP_18_36	0.89	0.00	0.69
BP_18_48	0.87	0.00	0.69

BP_18_60	0.87	0.00	0.69
BP_18_96	0.88	0.00	0.69
DFM_2stage	0.85	0.00	0.69
UC_noise	0.88	0.00	0.69
Unobserv_components_noise_excl	0.87	0.00	0.69
Unobserved_components	0.89	0.00	0.69

Source: the authors' computations based on the data from the ASPR BNS RK

Appendix 17

Mean Absolute Revision of Core Inflation Estimates (versus the Preceding Month) for 12 Months Ago with the Appearance of One New Observation, as pp

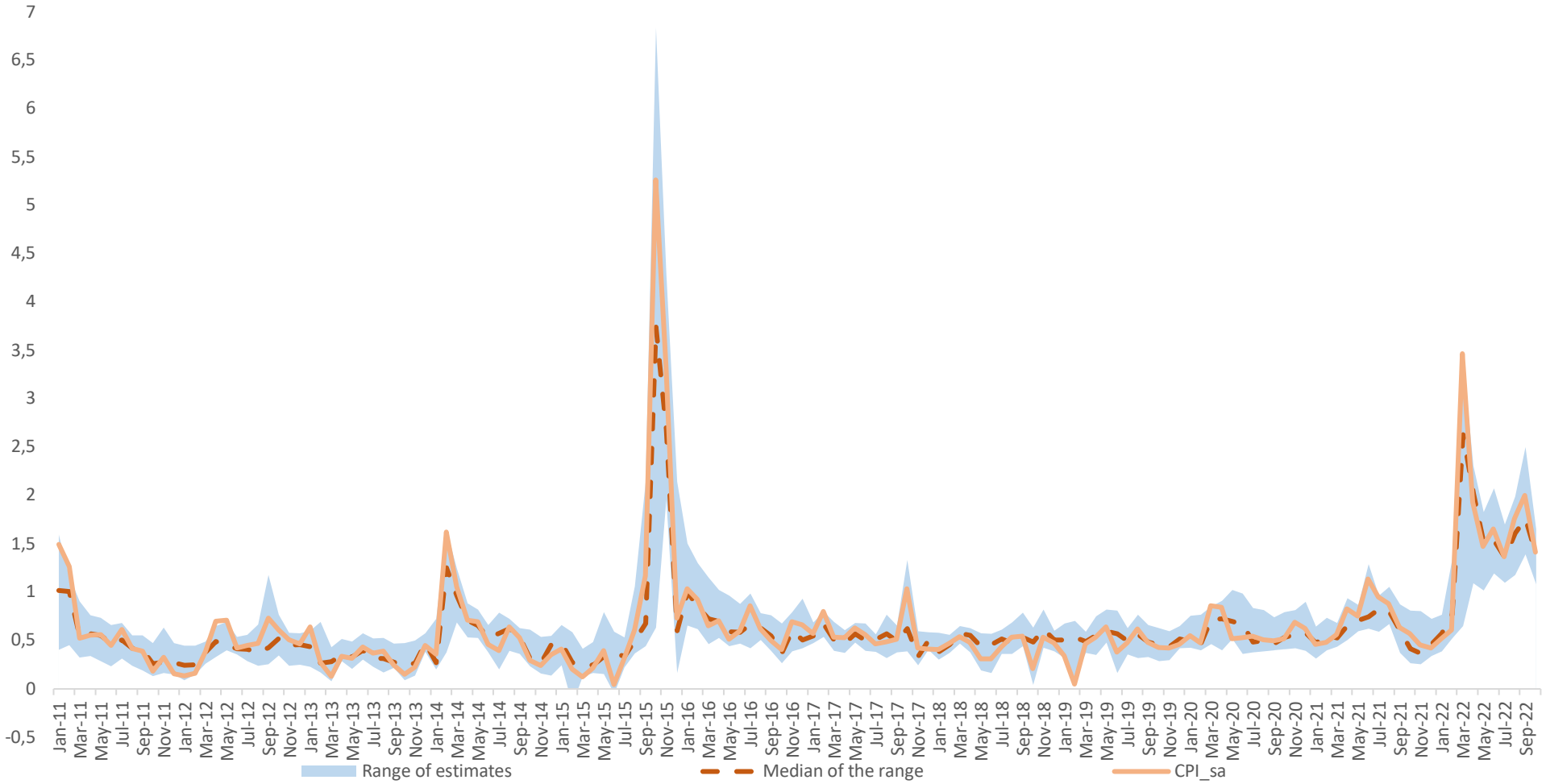
№	Trim_25 25_sa	Exp_smo othing	HP_smoo thing	ADJ_INF_ MEDIAN_ SA	ADJ_INF_ TRIM2525 _SA	ADJ_INF_ TRIM_SA	DFM_2st age	Unobserv ed_comp onents	UC_noise	BP_3_6	BP_3_12	BP_3_18	BP_3_24	BP_6_12	BP_6_18	BP_6_24	BP_12_18	BP_12_24	BP_18_36
1	0.01	0.03	0.11	0.002	0.002	0.001	0.01	0.07	0.01	0.00	0.04	0.05	0.06	0.04	0.05	0.06	0.02	0.03	0.02
2	0.00	0.01	0.02	0.002	0.002	0.001	0.00	0.03	0.01	0.09	0.09	0.08	0.07	0.00	0.01	0.02	0.01	0.02	0.02
3	0.00	0.01	0.01	0.002	0.002	0.001	0.00	0.02	0.00	0.00	0.04	0.03	0.03	0.04	0.03	0.03	0.00	0.01	0.01
4	0.00	0.01	0.01	0.002	0.002	0.001	0.00	0.01	0.00	0.05	0.00	0.00	0.00	0.05	0.05	0.05	0.00	0.00	0.01
5	0.00	0.01	0.01	0.002	0.002	0.001	0.00	0.01	0.00	0.00	0.03	0.04	0.04	0.03	0.04	0.04	0.01	0.01	0.00
6	0.00	0.01	0.00	0.002	0.002	0.001	0.00	0.01	0.00	0.00	0.00	0.02	0.02	0.00	0.02	0.02	0.02	0.02	0.00
7	0.00	0.01	0.00	0.002	0.001	0.001	0.00	0.01	0.00	0.00	0.02	0.00	0.00	0.02	0.00	0.00	0.02	0.02	0.01
8	0.00	0.01	0.00	0.002	0.002	0.001	0.00	0.00	0.00	0.02	0.00	0.02	0.02	0.02	0.01	0.00	0.02	0.02	0.01
9	0.00	0.01	0.00	0.002	0.002	0.001	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.00	0.01	0.01	0.02	0.01
10	0.00	0.01	0.00	0.002	0.002	0.001	0.00	0.00	0.00	0.02	0.02	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.01
11	0.00	0.01	0.00	0.002	0.002	0.001	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.01	0.02
12	0.00	0.01	0.00	0.002	0.002	0.001	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.01	0.00	0.02

№	BP_18_4	BP_18_60	BP_18_96	Wavelet_ min_std_ transfor m_direct	Wavelet_ min_std_ transfor m_inder ect	Wavelet_ min_std_ transfor m_S3_dir ect	Wavelet_ transfor m_min_s td_S3_in direct	Wavelet_ dev_thre sh_direct	Wavelet_ rmse12_t hresh_dir ect	Wavelet_ std_thres h_direct	Wavelet_ dev_tres h_short_ direct	Wavelet_ rmse12_t resh_sho rt_direct	Wavelet_ std_tresh _short_di rect	Wavelet_ dev_thre sh_inder ect	Wavelet_ rmse12_t hresh_in derect	Wavelet_ std_thres h_indere ct	Wavelet_ std_thres h_short_i nderect	Wavelet_ rmse_12_ thresh_s hort_ind erect	Wavelet_ dev_thre sh_short _inderect
1	0.02	0.02	0.03	0.11	0.12	0.04	0.04	0.04	0.05	0.01	0.04	0.07	0.01	0.17	0.04	0.04	0.08	0.04	0.05
2	0.02	0.02	0.03	0.10	0.11	0.04	0.04	0.02	0.03	0.01	0.02	0.03	0.01	0.29	0.03	0.01	0.03	0.03	0.01
3	0.02	0.02	0.02	0.06	0.06	0.03	0.04	0.03	0.02	0.01	0.03	0.02	0.01	0.08	0.02	0.01	0.02	0.01	0.01
4	0.01	0.01	0.02	0.00	0.00	0.03	0.03	0.01	0.02	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.02	0.01
5	0.01	0.01	0.01	0.00	0.00	0.03	0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01
6	0.00	0.00	0.01	0.00	0.00	0.02	0.03	0.01	0.01	0.01	0.01	0.01	0.00	0.02	0.01	0.01	0.01	0.01	0.00
7	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.00	0.01	0.01	0.00	0.01	0.01	0.00	0.01	0.01	0.00
8	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.00	0.01	0.01	0.00
9	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.03	0.01	0.01	0.01	0.01	0.01
10	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.03	0.01	0.01	0.01	0.01	0.00
11	0.02	0.02	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.01	0.01	0.00	0.10	0.01	0.00	0.01	0.00	0.00
12	0.02	0.02	0.02	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.01	0.01	0.00	0.02	0.00	0.00	0.00	0.00	0.00

Source: the authors' computations based on the data from the ASPR BNS RK

Appendix 18

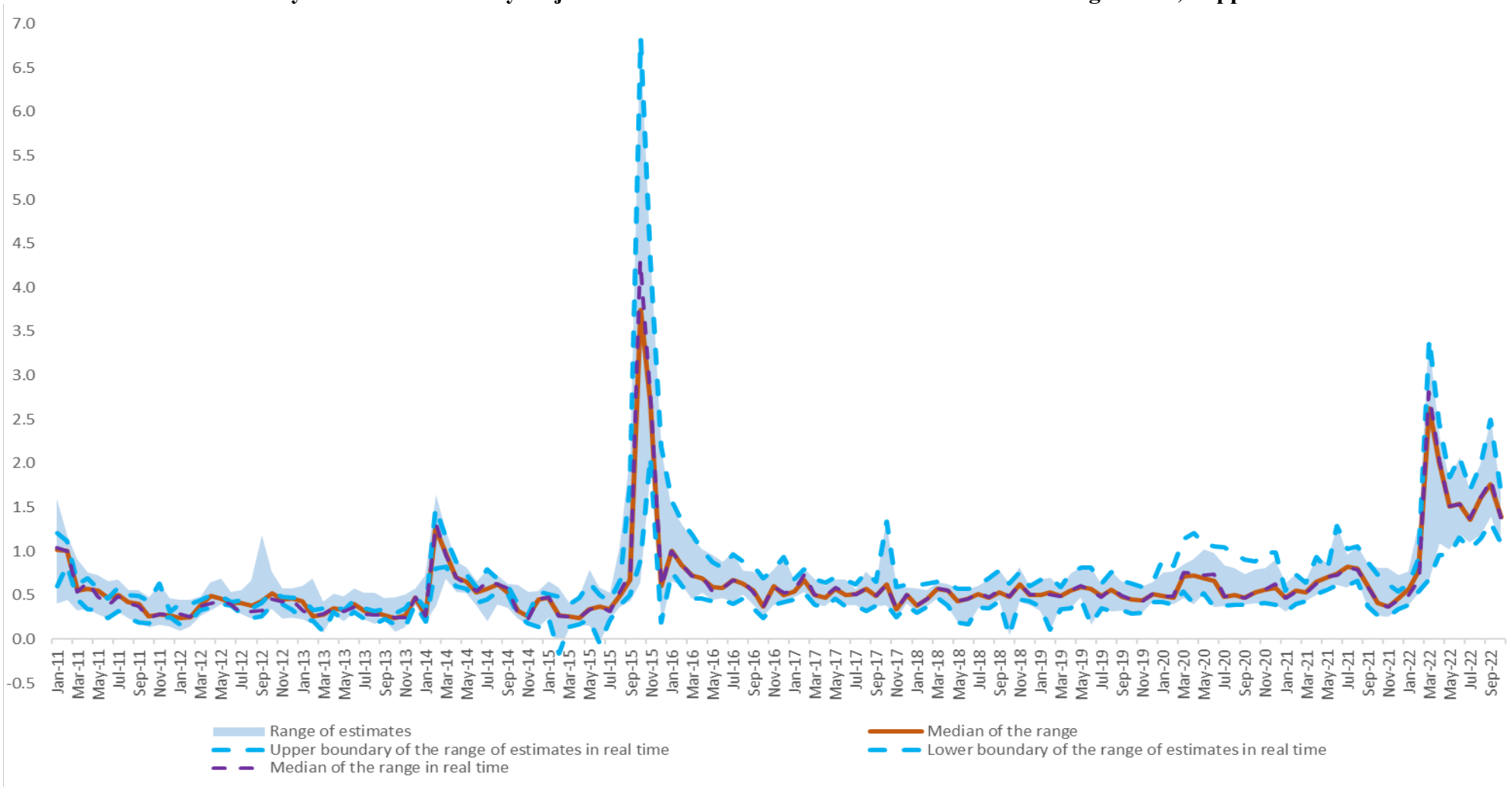
Dynamics of the Seasonally Adjusted CPIs and Core Inflation Estimates versus the Preceding Month, as pp



Source: the authors' computations based on the data from the ASPR BNS RK

Appendix 19

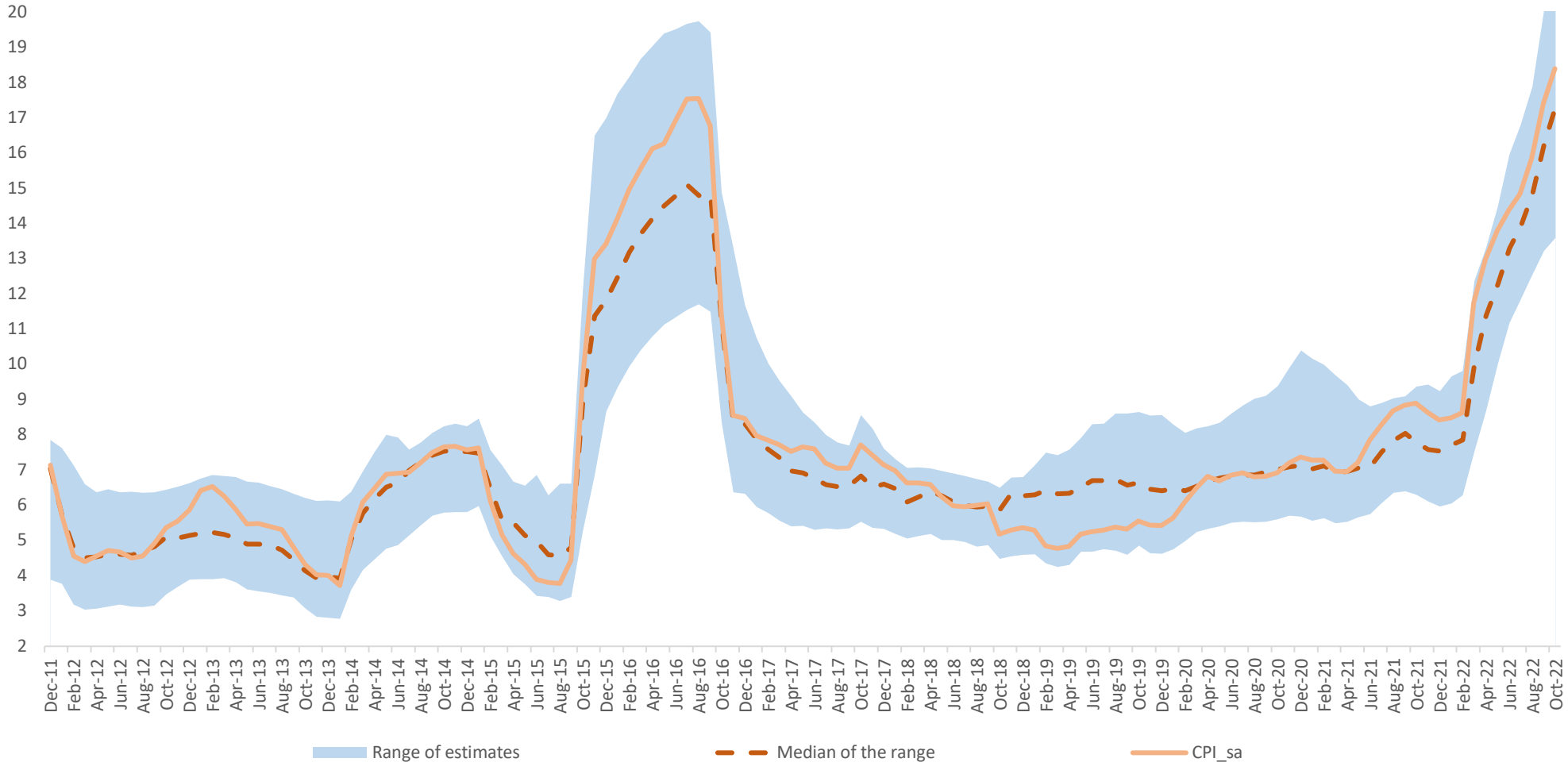
Dynamics of Seasonally Adjusted Core Inflation Estimates versus the Preceding Month, as pp



Source: the authors' computations based on the data from the ASPR BNS RK

Appendix 20

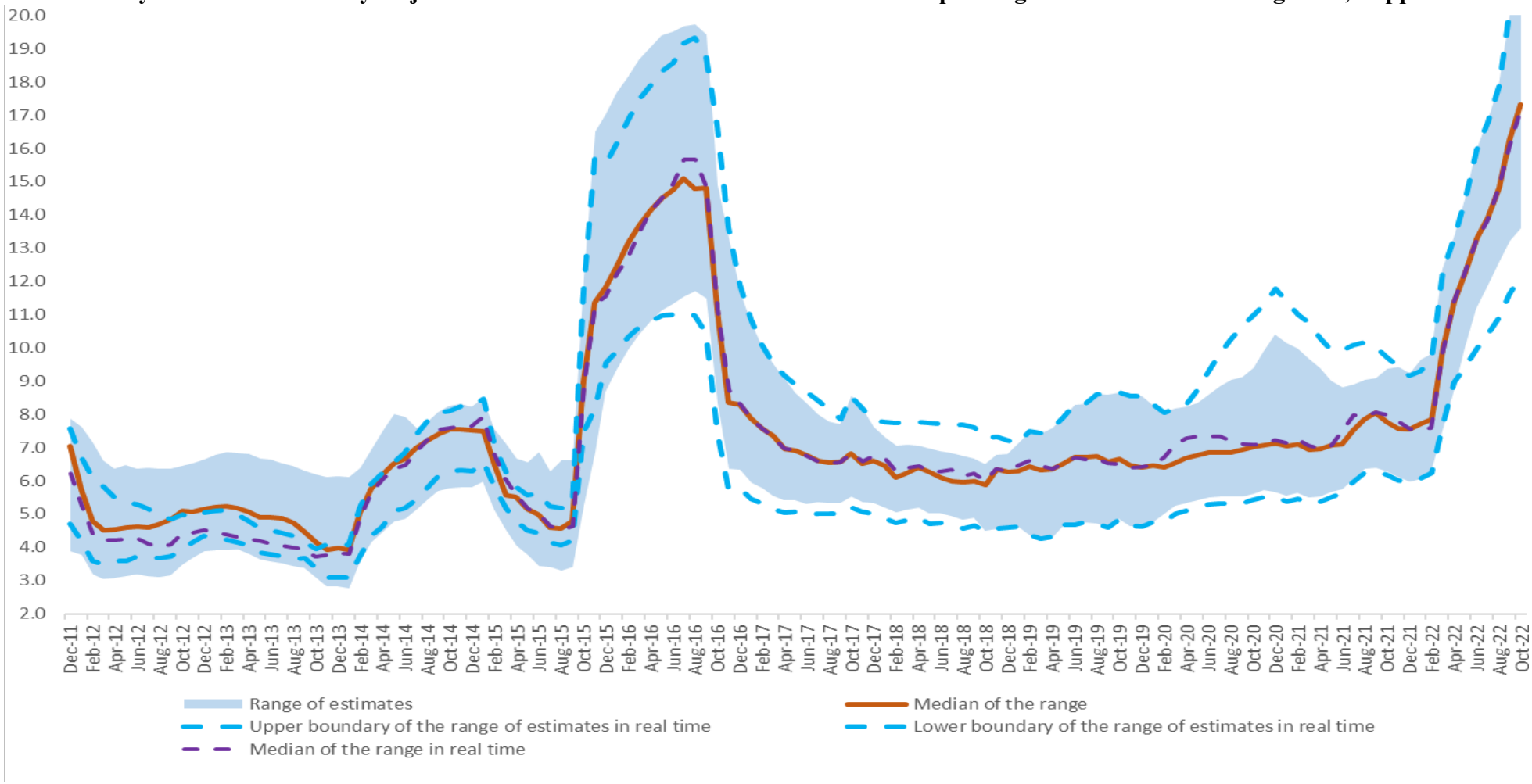
Dynamics of Seasonally Adjusted CPIs and Core Inflation Estimates versus the Corresponding Month of the Preceding Year, as pp



Source: the authors' computations based on the data from the ASPR BNS RK

Appendix 21

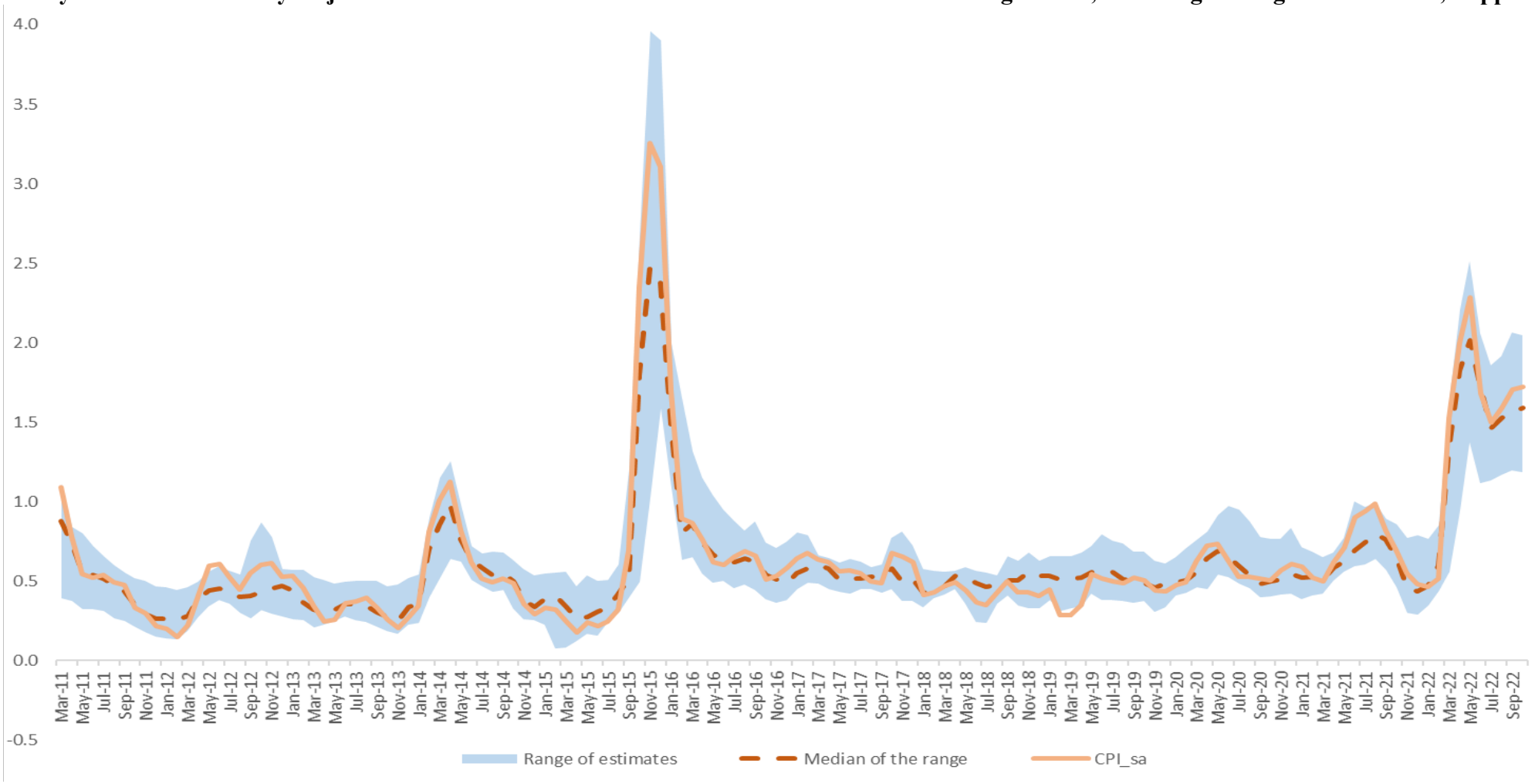
Dynamics of Seasonally Adjusted Core Inflation Estimates versus the Corresponding Month of the Preceding Year, as pp



Source: the authors' computations based on the data from the ASPR BNS RK

Appendix 22

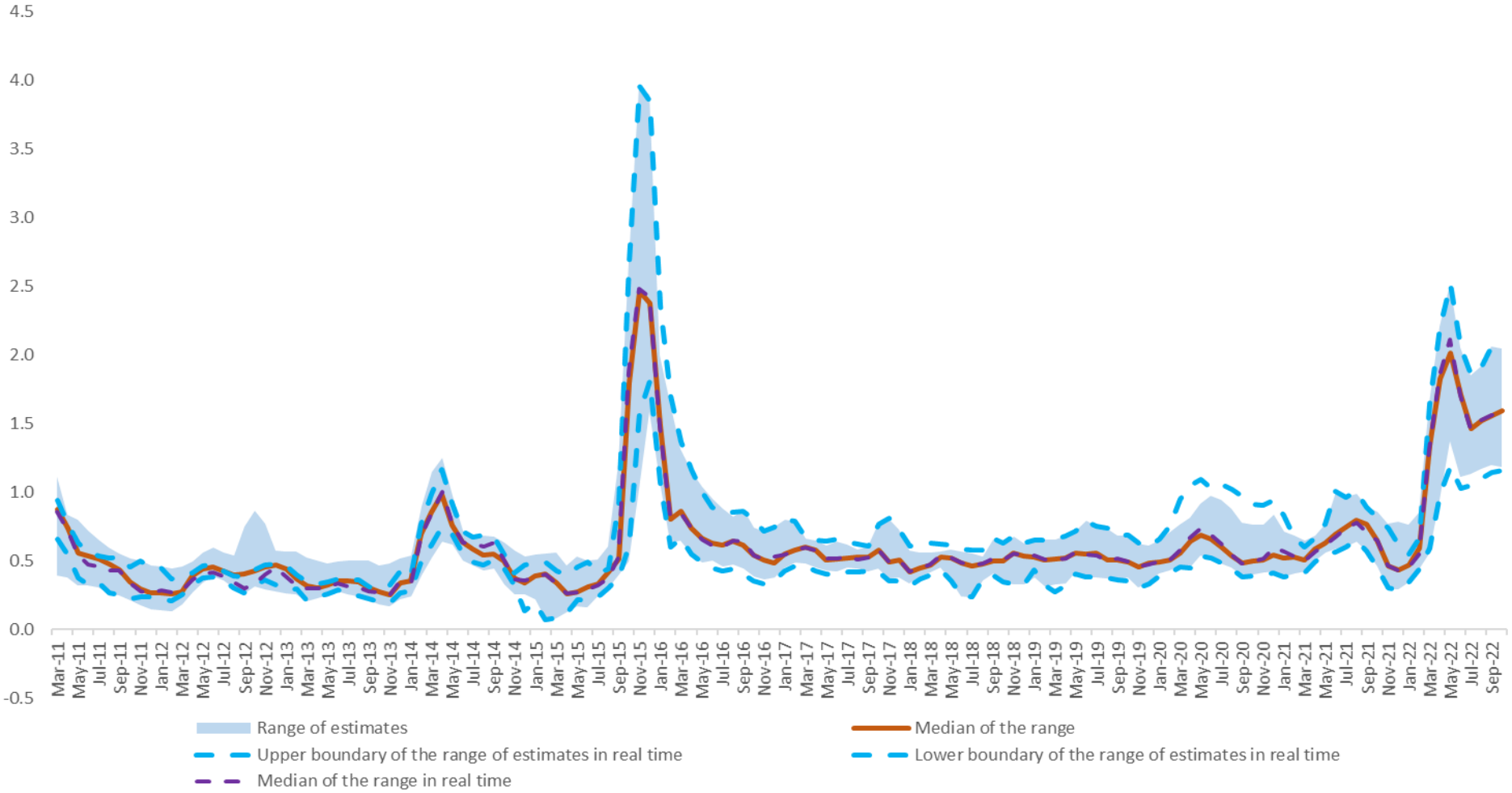
Dynamics of Seasonally Adjusted CPIs and of Core Inflation Estimates versus the Preceding Month, a Moving Average for 3 Months, as pp



Source: the authors' computations based on the data from the ASPR BNS RK

Appendix 23

Dynamics of Seasonally Adjusted Core Inflation Estimates versus the Preceding Month, Moving Average for 3 Months, as pp



Source: the authors' computations based on the data from the ASPR BNS RK