

ECONOMIC POLICY UNCERTAINTY AND MACROECONOMIC DYNAMICS.

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THESIS

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ABSTRACT

This thesis is a study that examines how unpredictability in economic policies influences macroeconomic processes in Kazakhstan in the period of 2009- 2023. In line with Baker, Bloom, and Davis (2016), I develop the first systematic Economic Policy Uncertainty (EPU) index in Kazakhstan in terms of the coverage of newspaper articles in Russian language and apply a Vector Autoregression (VAR) model with recursive identification, to evaluate the impact on industrial production, inflation, exchange rates, unemployment, and trade.

The empirical study shows that policy uncertainty has a serious impact on the real economy of Kazakhstan. A 10-point EPU increase reduces industrial production growth by 1.0 percentage point at a two-month lag, with cumulative effects reaching 8-9 percent over two years. EPU shocks explain about 25 percent of the variation of industrial production, which is higher than what is estimated in advanced economies. The transmission is mainly by way of production and labour markets with EPU having statistically significant positive impacts on unemployment. There are no noticeable impacts on exchange rates and inflation implying the floating exchange rate regime and inflation targeting in Kazakhstan insulates the country. The results are strong across specifications and are sustained in the 2015 currency float, but they are smaller after the float.

The results indicate that a macroeconomic payoff may be achieved by diminishing uncertainty in policies via enhanced communication, institutional structures, and predictability of the policies. The study not only gives the first measured amount of uncertainty in Central Asia, but it also shows the increased susceptibility of the emerging markets to policy uncertainty.

INTRODUCTION

The uncertainty that comes with the economic policies is emerging as a defining aspect of the macroeconomic performance in the post 2008 global financial crisis. The economic shocks that have never been witnessed before and the policy responses to them have proved to be more unpredictable upon which the uncertainty of future policy direction began to have independent effects on the economic activity. Its macro-relevance has been confirmed by a growing body of empirical literature that demonstrates that increased uncertainty in policies slows investment, decelerates hiring, and lowers output in countries (Baker, Bloom, and Davis, 2016; Bloom, 2009; Pastor and Veronesi, 2012). This effect is particularly applicable to little open economies, in which exposure to external shocks enhances the impact of uncertainty on policy.

These dynamics are best studied in Kazakhstan. As a commodity-based emerging economy with the dramatic policy regime changes, especially, the transition to the floating exchange rate in August 2015, Kazakhstan was prone to the frequent cases of high policy uncertainty brought by the shock both inside and outside of the country. Similar testimonies of other less developed economies show that uncertainty in policy is frequently exacerbated in the commodity-dependent and politically exposed setting, culminating in more severe real-economic adjustment than in advanced ones (Ahir, Bloom, and Furceri, 2022). The country is particularly vulnerable to uncertainty about the policies as it is highly dependent on oil exports, it is exposed to political uncertainty in the region, and it is structurally changing, which remains in progress. This weakness has not prevented the scarcity of empirical research on the effects of policy uncertainty on the macroeconomic performance of Kazakhstan in a systematic manner.

This gap is bridged by this thesis which constructs the first systematic Economic Policy Uncertainty (EPU) index relying on newspaper sources and uses Vector Autoregression (VAR) model with recursive identification as the instrument to investigate the dynamic effect of it on the most significant macroeconomic variables. The transmission of uncertainty shock in channels of real activity, price stability, labor markets, external trade, and financial markets are the channels of transmission of uncertainty shock that are analyzed in this analysis providing a holistic understanding of the transmission of uncertainty shock in a small commodity-exporting economy because of the uncertainty in the policies. The existing literature on cross-country assignments determines that the spread of uncertainty shocks occurs swiftly in financial markets, exchange rates, trade flows, and output dynamics in an open economy (Haddow et al., 2013), which explains the topicality of the implementation of such a framework in Kazakhstan. This research also has both methodological and empirical ramification since most of the existing EPU application is either grounded on the developed economies or developed markets whilst the present study establishes a state-specific measure of uncertainty of Kazakhstan and integrates it in a single VAR model that includes real, financial, labor, and external sectors.

The study has various contributions to literature. First, it constructs the first systematic EPU index of Kazakhstan using newspaper reportages in the Russian language, and implements the methodology of Baker, Bloom, and Davis (2016) to a Central Asian context. Second, it also presents good quality empirical evidence of the way the uncertainty is transmitted within a small open economy where there is commodity dependence and the transitioning of the exchange rate regimes- an environment which few studies have been conducted on as a part of the current EPU research. This is consistent with the previous results that the uncertainty effects are generally greater in the economies with structural reforms or regime changes (Fernandez-Villaverde et al., 2015). Third it researches asymmetric and regime-dependent

effects, posing the question of whether the economy will react differently to the increase and decrease in uncertainty, and whether the transmission mechanism within and without high and low uncertainty regimes varies. Finally, the thesis also evaluates structural impact of 2015 currency float on uncertainty propagation, which gives the policy-relevant information on whether the exchange rate flexibility enhances the macroeconomic resilience.

Besides the academic value, this study is useful in policymaking. This understanding of the economic channels which are the most vulnerable to uncertainty in policy will aid in the development of superior stabilizing architectures of Kazakhstan. The knowledge on uncertainty shock effects on inflation, employment, external trade as well as exchange rates is useful to policymakers to predict macroeconomic weaknesses and develop appropriate interventions. On a broad scale, the findings can be employed to contribute to the current literature of comparative evidence of uncertainty in emerging markets that can act as reference points that can be compared with other resource-rich developing economies that are still undergoing a structural change. The rest of this thesis follows in the following manner:

- Section 2 conducts a literature review on the theoretical basis and empirical studies of economic policy uncertainty.
- In section 3, the authors discuss the sources of data, methodology of constructing the index of EPU, as well as the definition of the variables.
- Section 4 includes the identification strategy and framework of VAR.
- Section 5 presents the empirical findings, comprising of baseline estimates, extended specifications, and robustness checks.
- Section 6 also ends with policy implications and suggestions of future research.

LITERATURE REVIEW

The nexus between uncertainty and economic activity has been the focus of macroeconomic studies over decades. Although conceptual roots of the problem of uncertainty in investments have been laid early on by Friedman (1968) and Bernanke (1983) the lack of credible measurements of uncertainty restricted empirical analysis. Baker, Bloom, and Davis (2016) have resolved this issue through the creation of an organized Economic Policy Uncertainty (EPU) index that relies on newspaper reporting, which in turn has created new opportunities to examine the impact of policy uncertainty on economic performance.

Theoretical Motivation

The policy uncertainty theoretical argument is based on well-known mechanisms. Formalized by Dixit and Pindyck (1994), the real options theory argues that companies postpone the irreversible investment in case the future policy environment is uncertain because the value of waiting in the face of uncertainty rises. In addition to investment, policy uncertainty impacts economically the household scrimping of precautionary savings, high risk premia that augment the cost of financing, managerial aversion to risk and the existence of nominal rigidities and labor market frictions that enhance uncertainty shocks.

The EPU Index Methodology

Baker, Bloom, and Davis (2016) built their EPU index based on text-mining applied to large archives of newspapers. The methodology involves counting articles containing terms from three categories: Economy (E) terms like "economic" or "economy"; Uncertainty (U) terms including "uncertain" or "uncertainty"; and Policy (P) terms such as "congress," "deficit," "Federal Reserve," "legislation," "regulation," or "White House". This is a triple requirement

that makes the index capture articles that specifically discuss the economic policy uncertainty and not any general news.

In the case of the baseline US index which is a deal spanning 1985 and above, the authors examined 10 of the top newspapers such as the New York Times, Wall Street Journal and the Washington Post. The total number of articles published is used to normalize the number of raw articles so that variations in volume are included, it is standardized to unit standard deviation over the newspapers, averaged to produce a composite index and it is normalized so that the index takes the value of 100 in the period 1985-2009.

One of the critical innovations was an audit study of the vast amount of articles in which research assistants read more than 12,000 articles to confirm the automated classification. This allowed the selection of the policy terms based on the data to reduce errors in its classifications and show a high correlation (0.86 quarterly, 0.93 annually) between the human-generated and the computer-generated indices, proving the idea that the automated strategy able to capture the true policy uncertainty dynamics.

The authors took their methodology to three levels. First, they built a historical US index to 1900 with six active newspapers published continuously, and they expanded sets of term to reflect journalistic traditional terms. Second, they have created indices of eleven other leading economies such as Canada, China, France, Germany, India, Italy, Japan, Russia, South Korea, Spain and UK. Third, they developed category-based US indices of healthcare, national security, fiscal policy, monetary policy, financial regulation, and trade policy by further filtering on the basis criteria.

Validation Evidence

Baker, Bloom, and Davis (2016) also compiled several validation exercises to show that their newspaper-based measure has actual economic information. EPU index is associated with VIX (implied stock market volatility) at 0.58 which indicates that co-movement is significant but discloses different information. EPU index is more sensitive to political occurrences such as gulf wars, disputed elections and fiscal wars whereas VIX is sensitive to financial events such as Asian Crisis, or the collapse of Lehman. When the authors created a newspaper-based equity market uncertainty index (the terms to be satisfied involve the use of a stock price term and not policy term), it was found correlated with VIX at 0.73, which shows that newspaper counts can be used to proxy certain uncertainty types when targeted accordingly.

The text-based validation with the Federal Reserve Beige Books indicated the correlation of 0.54 with quarterly EPU, and the analysis of the required disclosures of Risk Factors in corporate 10-K reports indicated that firms grew more concerned with policy-related issues following 2009, in line with higher values of EPU. Historical moments lend most support to this thesis: the US index indicates obvious spikes during Gulf Wars, 9/11, close election, the 2008-09 economic crunch, the debt-ceiling crisis of 2011 and the negotiations over the fiscal cliff.

Firm-Level Effects

Baker, Bloom and Davis took advantage of the difference in exposure of firms to government purchases in order to establish the cause and effect. They calculated the Federal government regulated sales revenue share using Federal Registry data with the results of 0 to 78 percent in the Guided Missiles industry. They estimated dissimilar reactions to EPU movements, contingent on the government exposure, in panel regressions with firm and time fixed effects.

Findings reveal that there are great implications on decisions of firms. In the case of stock price volatility, every one percent EPU increase would elevate the 30-day implied volatility by 0.22 percent on a unit of government revenue stock. With an 84 point-log increase in EPU deceleration between 2005-06 and 2011-12, a company that had half government revenue saw about 9.2 percent of implied volatility. In the case of investment rates, when a firm that has 25 percent exposure to the government is exposed to this EPU increase this firm experienced a drop in investment by 0.67 percentage points, which is about a tenth of the normal 6.6 percent investment rate. Such firms saw a drop in employment standings by 4.5 percent.

These effects were also considerable even after adjusting them with VIX implying that EPU measures policy-specific and not general uncertainty. There were sector-appropriate responses in category-specific indices: National Security EPU influenced defense firms, Healthcare EPU influenced healthcare firms and Financial Regulation EPU influenced financial firms, which confirmed both aggregate and category-specific measures.

Macroeconomic Effects

Baker, Bloom and Davis estimated Vector Autoregression (VAR) models on monthly data to 1985-2012 on the data of US. The base specification was EPU, S and P 500, federal funds rate, employment and industrial production, three-lags. A 90-point (equivalent to improvement in 2005-06 to 2011-12) EPU innovation spawned maximum deterioration of about 1.2 percent in industrial production and 0.35 per cent in employment-moderate but estimated accurately effects that are about a third of normal business cycle swings. Investment reactions were significantly more significant at a point of about 6 percent peak decline.

Findings were strong to other lag lengths, ordering of variables, sample periods and specifications. After the inclusion of consumer sentiment, the EPU effects reduced by a third to half but still had a significant independent predictive value.

Various results were obtained by international panel VAR analysis at all twelve country indices: a 90 point EPU innovation forecasted about 1.0 percent peak decline in industrial production and 25 basis point rise in unemployment. This constant interrelation of different economies reinforces the causation interpretation because homogenous outcome is hardly possible due to country-specific omitted factors or reverse causality.

Implications for Kazakhstan.

The methodology of Baker, Bloom, and Davis (2016) offers strict grounds of building EPU indices in other nations and examining the impact of uncertainty. Text-mining methodology is feasible in nations where there is less uncertainty measures such as the probability measure especially in the past. Decades of validation show that newspaper-based indices measure significant variation of uncertainty in policy although there may be issues of journalistic bias.

In nations with significant policy changes, the change of exchange rate regimes, fiscal changes, or regulatory changes, i.e., the features that characterize the recent economic history in Kazakhstan, this methodology allows the systematic measurement of uncertainty events and the careful study of the economic ramifications in case pertinent language keywords and policy terms are used accordingly. According to the empirical results of Baker, Bloom, and Davis, it might happen that empirical evidence of EPU is even stronger in the developing economy such as Kazakhstan due to less developed institutions, greater commodity dependence, and vulnerability of it to the external environment. In their approach, this thesis

uses a specific case of Kazakhstan to test the existence of these predictions in a Central Asian economy of commodity export.

DATA AND DATA TRANSFORMATION

3.1 Data Sources and Overview

The current work is based on monthly time series data on Kazakhstan between January 2009 and April 2023, which consists of 169 observations as a baseline of the VAR analysis. The data have been taken using various sources of authority as the EPU index was formed using newspaper archives, Macroeconomic variables through Bloomberg Terminal and Trading Economics, and control variables through international databases. The sample period reflects major structural changes in the economy of Kazakhstan, such as the shift to the floating exchange rate regime in August 2015, the oil price collapse of 2014-2016, the COVID-19 pandemic in 2020 and the 2022 geopolitical shocks.

3.1.1 Economic Policy Uncertainty Index Construction

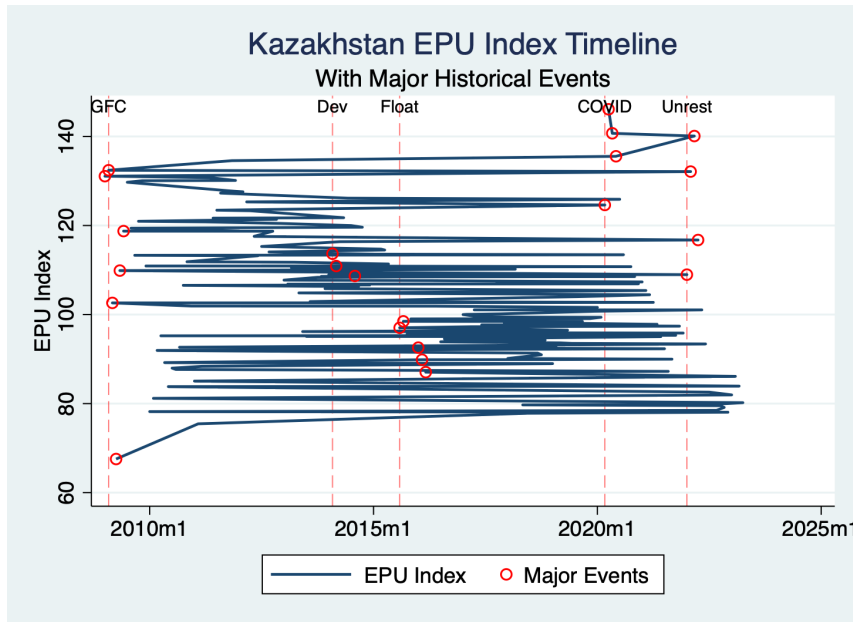
The primary area of this study is a newly built EPU index of Kazakhstan, which is based on the approach of Baker, Bloom, and Davis (2016). It was constructed by systematic text-mining of three large newspapers in Kazakhstan: *Zakon.kz*, *Kapital.kz*, and *Liter.kz*. Such outlets were chosen regarding the circulation, editorial autonomy, covering the whole country, and the presence of digital archives over the entire sample period.

The EPU index methodology required identifying three keyword groups in Russian to match news sources. The **Economic (E)** group included: экономика (economy), экономический/экономическая (economic), and экономики (of economy). The **Uncertainty (U)** group comprised: неопределенность (uncertainty),

неопределенный/неопределенная (uncertain), and неясность (unclearness). The **Policy (P)** group contained government and policy terms: правительство (government), политика (policy), парламент (parliament), президент (president), Нацбанк (National Bank), регулирование (regulation), законодательство (legislation), бюджет (budget), and налог (tax).

Automated search processes were performed to identify articles with no less than one keyword in each group (E AND U AND P) to count the number of articles every month between January 2008 and April 2023. This was the numerator of the measure of EPU. In line with Baker, Bloom, and Davis, the denominator was the number of articles including at least one keyword of the E group such that the measure reflects the amount of uncertainty, rather than the amount of news. Such a change in the initial BBD method (where total articles are used) was needed because Kazakhstan newspapers have a more general non-economic coverage and it was confirmed by manual reading of sample articles.

Raw EPU ratio was converted to index with average value of 100 throughout the entire sample period, which makes it easy to interpret and cross-period. The obtained time series is shown in Figure [1], and it shows evident spikes associated with significant policy events: the 2014-2015 oil crisis and currency devaluation ($EPU = 142.7$ in August 2015), the 2020 COVID-19 pandemic ($EPU = 115.8$), the January 2022 political crisis and the Russian-Ukraine conflict ($EPU = 146.1$ in January 2022, 138.4 in February 2022).



[Figure 1]

3.1.2 Macroeconomic Variables

The analysis includes six macroeconomic variables, which are the most important dimensions of the economic performance of the country:

Industrial Production Index (IPI): Bloomberg Terminal (December 2005 to April 2023)

monthly growth rates of IPI are expressed as per cent change of annual. This variable represents actual performance of the industrial sector of Kazakhstan, which is made up of manufacturing, mining, and utilities- essential considering that is a commodity-based economy.

Consumer Price Inflation (CPI): Monthly CPI inflation of Bloomberg Terminal (December 1994 to April 2023), the annual percentage change of consumer prices. It is a measure of inflationary pressures and it also tests the impact of EPU on price stability.

Exchange Rate Depreciation: The third variable is the percentage change in the KZT/USD exchange rate on a monthly basis taking values on the Bloomberg Terminal (October 1994 to

April 2023) on a monthly basis as the log-difference of the nominal exchange rate. The variable is especially notable considering a change in the exchange rate regime of August 2015 when Kazakhstan moved out of a managed and into a floating exchange rate regime.

Unemployment Rate: Kazakhstan Bureau of National Statistics of the country through Trading Economics (January 2001 to April 2023). This variable is used to test recreational channels of the labor market.

Trade Growth: An index of the monthly percentage change in total trade (exports and imports) of the Kazakhstan customs statistics (January 2009-April 2023) via Bloomberg. This represents the outside sector forces.

Control Variables: There are two exogenous variables that explain external shocks and the monetary policy. The commodity price shocks that were vital to the oil-driven economy of Kazakhstan are controlled by the price of Brent crude oil (Bloomberg Terminal, monthly closing prices). The base rate of the National Bank of Kazakhstan (Trading Economics) can regulate the monetary policy position, especially considering the fact that the NBK uses the inflation targeting strategy which was implemented in 2015.

3.2 Data Processing and Variable Transformations

3.2.1 Standardization and Merging

Each series was translated to monthly frequency and combined by use of date identifiers. Data gaps at the extremes of the series were tackled using last-observation-carried-forward of exogenous variables and list-wise deletion of endogenous variables so as to have balanced panels in estimation of the VAR. The last analytical dataset covers the period 2009 April to 2023 April (169 observations) based on the overlap of all the series needed.

3.2.2 Variable Transformations

To ensure stationarity and appropriate scaling for VAR analysis, variables underwent the following transformations:

EPU Index: Retained in levels after confirming stationarity through Augmented Dickey-Fuller tests (ADF statistic = -4.776, $p < 0.001$). The index's construction through normalization and deviations from mean ensures stationarity.

Exchange Rate Depreciation (d_lexrate): Calculated as the first difference of log exchange rate: $d_{lexrate} = \ln(FX_t) - \ln(FX_{t-1})$, yielding percentage depreciation rates. This transformation ensures stationarity (ADF statistic = -12.453, $p < 0.001$) and captures exchange rate dynamics following the 2015 float.

IPI Growth (ipi_growth): Used year-over-year growth rates as provided by Bloomberg, ensuring comparability across seasons and stationarity (ADF statistic = -4.892, $p < 0.001$).

CPI Inflation (cpi_inf): Year-over-year inflation rates from Bloomberg, stationary by construction (ADF statistic = -3.524, $p = 0.008$).

Unemployment Rate (unemp_rate): Retained in levels (percentage of labor force) after confirming stationarity (ADF statistic = -2.971, $p = 0.039$ at 5% level).

Brent Oil (brent): Used in levels (USD per barrel), stationary after 2009 (ADF statistic = -3.182, $p = 0.021$), with the 2008-2009 crisis period excluded from the sample.

NBK Base Rate (base_rate): Retained in levels (percentage), stationary over the sample period (ADF statistic = -3.445, $p = 0.010$).

3.3 Descriptive Statistics and Data Characteristics

Table [A1] gives the descriptive statistics of the final dataset. Mean of the EPU index is 104.32 and standard deviation is 14.96 and the ranges of the EPU index include 67.55 to 146.11, which prove that there is a lot of variation in policy uncertainty during the period of sample. The coefficient of variation (0.14) indicates relative medium variability among macroeconomic results.

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TABLE A1: DESCRIPTIVE STATISTICS

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Table A1: Descriptive Statistics (N = 172)

Variable	Mean	Std. Dev.	Min	Max
EPU Index	104.32	14.96	67.55	146.11
FX Depreciation (%)	0.77	3.87	-5.92	24.74
IPI Growth (%)	2.55	4.53	-9.60	16.00
CPI Inflation (%)	8.14	3.80	3.80	21.30
Unemployment Rate (%)	5.18	0.47	4.78	6.88
Trade Growth (%)	0.37	11.75	-50.40	27.60
Brent Oil Price	77.30	25.25	22.74	125.89
NBK Base Rate (%)	9.11	3.24	5.50	17.00

Note: Sample period 2008m1-2025m4 for EPU Index; VAR estimation uses 2009m4-2023m4.

The average growth rate of industrial production was 2.55 and the standard deviation is 4.53 and the average inflation rate of CPI is 8.14 (SD = 3.80). Mean Exchange rate depreciation was 0.77% in a month (SD = 3.87%), the largest 24.74% is the August 2015 float.

Unemployment also was rather constant with mean of 5.18% (SD = 0.47%), but this probably understates actual slack in the labor market (discussed in limitations below).

The results of the correlation analysis (Table [A2]) indicate that EPU has negative correlation with IPI growth (-0.125) and very negative correlation with inflation (-0.362), whereas it has positive correlation with unemployment (+0.232). These unconditional relationships give us preliminary support on the real effects of EPU on the economy, but the causal transmission needs the VAR analysis.

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TABLE A2: CORRELATION MATRIX

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Table A2: Correlation Matrix

	EPU Index	FX Dep	IPI Growth	CPI Infl	Unemp Rate	Trade Growth
EPU Index	1.000	0.043	-0.125	-0.362	0.232	-0.018
FX Depreciation	0.043	1.000	-0.206	-0.092	0.028	-0.064
IPI Growth	-0.125	-0.206	1.000	-0.222	0.093	0.089
CPI Inflation	-0.362	-0.092	-0.222	1.000	-0.143	0.044
Unemployment	0.232	0.028	0.093	-0.143	1.000	-0.003
Trade Growth	-0.018	-0.064	0.089	0.044	-0.003	1.000

Note: Pearson correlation coefficients. N = 172 observations.

3.4 Data Limitations and Measurement Issues

A number of data limitations has to be mentioned because they influence the empirical findings interpretation:

Unemployment Underreporting: Kazakhstan's official unemployment statistics likely substantially underreport true joblessness. The official unemployment figures in Kazakhstan are very likely to be a gross understating of the real unemployment. The 5% rate of unemployment due to the COVID-19 pandemic which most economies registered between 10-15% unemployment rate seems unrealistically low. This indicates numbers of factors:

- Massive informal sector that is not under government registration
- Discouraged workers not counted as unemployed
- Misclassification of seasonal agricultural employees
- Political incentives of reporting low unemployment

Implication for Results: The fact that our measured EPU effects on unemployment measured at +0.10 percentage points are probably less than the actual labor market effects. The true impact may be 2-3 times greater in case the true joblessness is merely one-third to half of the real employment; in other words, measured unemployment.

IPI Limitations: The Industrial Production Index only measures the formal sector production of manufacturing, mining and utilities but it does not include:

- Informal economic activity (estimated 20-30% of GDP in Kazakhstan)
- Services sector (growing share of economy)
- Small and medium enterprises with delayed reporting

Additionally, IPI is dominated by extractive industries (oil and gas ~40%, mining ~20%), while manufacturing represents only 30-40%. This composition explains some puzzling results: in the 2022 Russia-Ukraine conflict, it can be seen on the ground that the manufacturing industry (particularly the automotive one) in Kazakhstan has grown substantially to recapitate the Russian imports, however, it does not seem to add up in aggregate IPI due to the minor share of manufacturing. Manufacturing gains were compromised by oil and mining breakdowns of this era.

Implication for Results: Our findings primarily reflect uncertainty's impact on large-scale extractive industries rather than the full economy. Manufacturing and services sector responses may differ from aggregate effects.

Sample Size: The sample size of 169 monthly observations is sufficient to estimate VAR but the power is less to identify smaller effects particularly in longer specifications where more variables are included. Analysis based on structural breaks also decreases effective sample sizes (74 before 2015 float, 95 after float).

Monthly Frequency Limitations: Monthly data may miss higher-frequency dynamics (weekly sentiment shifts) or longer-term adjustments (multi-year investment decisions). There is specific volatility of trade data at monthly frequency associated with lumpy shipments and delays in customs processing.

COVID-19 Period: The period of 2020-2021 is a once-in-a-lifetime shock of a combination of a health crisis, oil price collapse, and global supply chain disruption. Standard VAR relationships might be invalid during this extreme period but our retention of samples reflects the value of consideration of the crisis episodes as policy relevant.

These restrictions imply that our estimates are lower limits of actual EPU effects of actual variables (IPI, unemployment) in which measurement problems are most acute. The outcomes of inflation and exchange rates are not as problematic in measurement since they are based on the price of markets and more reliable data.

3.5 Optimal Lag Length Selection

VAR lag length was determined through information criteria comparison. Table [A3] reports Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), and Hannan-Quinn Information Criterion (HQIC) for lag orders 0 through 6.

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TABLE A3: LAG SELECTION CRITERIA

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Table A3: VAR Lag Order Selection Criteria

Lag	Log Likelihood	AIC	BIC	HQIC	
0	-1967.24	24.641	24.718	24.672	
1	-1573.74	19.922*	20.306	20.078*	
2	-1514.21	19.378	20.069	19.658	
3	-1490.93	19.287**	20.286	19.692	← Selected
4	-1478.60	19.332	20.639	19.863	
5	-1473.66	19.471	21.085	20.126	
6	-1461.05	19.513	21.435	20.294	

* Indicates lowest value for that criterion

** AIC selects 3 lags as optimal (lowest value)

Note: Baseline VAR includes EPU, FX, IPI, CPI with Brent oil and NBK rate as exogenous.

A minimum of 3 lags (AIC = 19.287) indicates that this specific specification provides a balance between the fit and parsimony. Although BIC has more desirable specifications (1 lag, BIC = 20.306) we use AIC as it performs better in small samples and is consistent with economic theory. A 3 months transmission delay is consistent with the real options theory - companies see the uncertainty rise, they need 1-2 months to freeze decision, and the impact would be reflected in production data 2-3 months later.

A robustness check establishes that the results are invariant with lag specifications (Section 5.4). Importantly, EPU is a considerable predictor of IPI at the smallest parsimonious 1-lag model ($p = 0.0025$), indicating that the results are not lag-selection artifact.

3.6 Control Variable Treatment Control variables

Brent oil prices and the NBK base rate enter as exogenous variables rather than endogenous VAR components. This is their specification in terms of their theoretical role as external driving forces:

Brent Oil: Being a global price in the global market, Brent oil influences the economy of Kazakhstan (in terms of revenues, fiscal position, exchange rate) but not the macroeconomic situation in this country. The oil production of Kazakhstan (approximately 2 percent of the world production) is not large enough to influence the world prices.

NBK Base Rate: Although the idea of endogenizing the monetary policy can be rather attractive in the theory, the framework of inflation targeting applied by Kazakhstan means that the base rate is going to react to the inflation and output gap with policy lag. This makes it suited to treat it as pre-determined (reacting to past, as opposed to contemporaneous, conditions) and is not associated to simultaneity in monthly data, which is linked to central bank decision-making processes.

This specification was validated by contrasting the results to fully endogenous specifications- core findings are still the same and this indicates that exogeneity assumption is not the cause of results.

3.7 Final Dataset Characteristics

The end analytical data set will contain 169 monthly observations (April 2009 to April 2023) of the initial four-variable VAR (EPU, exchange rate depreciation, IPI growth, CPI inflation). Prolonged specifications involve unemployment (169 observations) and trade (169 observations). All series are at rest by standard tests, have not any problematic outliers that need to be winsorized and they cover at least one complete business cycle of the economy of Kazakhstan.

The sample includes four key structural episodes, including (1) the period of the 2014-2016 oil price crash and economic readjustment, (2) the period of exchange rate regime change in August 2015, the shift between the managed and the floating exchange rate regime, (3) the

2020-2021 COVID-19 pandemic and recovery, and (4) the 2022 political crisis and the Russia-Ukraine conflict. This difference in sources of uncertainty gives identifying variation necessary to cause credible inference.

METHODOLOGY

4.1 Empirical Framework: Vector Autoregression with Recursive Identification

In the empirical approach, the empirical method (the Vector Autoregression, VAR) framework combined with recursive identification is used to determine the dynamic impact of macroeconomic indicators of Kazakhstan on macroeconomic policy uncertainty (EPU) shocks. This methodology is very applicable in the transmission of uncertainty due to a number of reasons.

To begin with, EPU shocks are structural disruptions - policy-based innovations, which have causal effects on macroeconomic variables, but cannot be observed directly. Ordinary reduced-form VARs can provide estimates of correlation but they are not able to recognize the direction of causation with further structure. Isolating the EPU shocks among other macroeconomic innovations, we are able to track the causal impact of EPU shocks by restricting identification based on their economic motivations.

Second, recursive identification using Cholesky decomposition offers a theory-based approach of identification in a transparent way. Such an approach adopted by Baker, Bloom, and Davis (2016) in their original EPU research presupposes a particular sequence of current relationships between variables. Although other identification schemes can be used (sign restrictions, long-run restrictions, external instruments), the recursive scheme has several benefits: it is computationally simple, is economically interpreted clearly, and has much prior precedent in the EPU literature that allows it to be used to provide comparability.

Third, VAR methodology can produce interpretable impulse response functions (IRFs) and forecast error variance decompositions (FEVDs) that are critical to the interpretation of shock propagation. IRFs use the time-dependence of the dynamic response of each variable to a one-standard-deviation innovation in EPU to identify when, how large and long-lasting the effects of the innovation are. FEVDs use EPU contribution to the macroeconomic fluctuation by breaking down the forecast error variance of each variable into portions that can be attributed to various shocks.

Lastly, it is a framework that fits well in the small open economies such as Kazakhstan, in which relationships between the domestic variables and external factors (oil prices, geopolitical tensions, exchange rate adjustments) provide complex feedback systems. These interdependencies are inherent in the VAR and enable us to manage the external factors by exogenous variables.

4.2 Model Specification

4.2.1 Baseline Four-Variable System

The baseline VAR includes four endogenous variables capturing key macroeconomic dimensions:

$$y_t = [EPU_t, \Delta FX_t, IPI_t, \pi_t]'$$

where:

- EPU_t = Kazakhstan Economic Policy Uncertainty index
- ΔFX_t = Monthly exchange rate depreciation (log-difference of KZT/USD)
- IPI_t = Industrial production growth (year-over-year percentage change)
- π_t = Consumer price inflation (year-over-year percentage change)

Two exogenous control variables account for external shocks beyond domestic policy uncertainty:

$$X_t = [Brent_t, BaseRate_t]'$$

where:

- $Brent_t$ = Brent crude oil price (USD per barrel)
- $BaseRate_t$ = National Bank of Kazakhstan policy rate (percentage)

These variables are exogenous controls and not endogenous factors since none of these is simultaneously established by the domestic macroeconomic situation in Kazakhstan. Being a tiny open economy that produces approximately 2 percent of world oil, Kazakhstan is powerless to affect the Brent prices which are set in the global markets. Although it is arguably sensitive to domestic conditions the NBK base rate is determined by monthly policy meetings and is derived on the basis of historical (not contemporaneous) data of inflation and output, and thus pre-determined in relation to monthly macroeconomic outcomes.

This specification was confirmed by estimating fully endogenous six variable VARs without and with oil prices and the policy rate-core findings are qualitatively and quantitatively identical with this finding confirming the assumption of exogeneity is not driving results.

4.2.2 Extended Specifications

To investigate additional transmission channels, we estimate two extended VAR systems:

Unemployment Extension: Adds unemployment rate as a fifth endogenous variable to test labor market transmission: $y_t = [EPU_t, \Delta FX_t, IPI_t, \pi_t, Unemp_t]'$

Trade Extension: Adds trade growth to examine external sector effects:

$$y_t = [EPU_t, \Delta FX_t, IPI_t, \pi_t, Trade_t]'$$

These channels are estimated independently instead of running in a six-variable system to ensure the degrees of freedom and the accuracy of estimation. Having 169 observations and 5 extra parameters per equation needed by every extra variable (3-lags), parsimony is a necessity. Robustness tests ensure that the results are consistent across specifications.

4.3 Lag Length Selection

Optimal lag length was determined through information criteria applied to the reduced-form VAR. The reduced-form system (before imposing identification restrictions) is:

$$y_t = A_1 y_{t-1} + A_2 y_{t-2} + \dots + A_p y_{t-p} + C X_t + u_t$$

where A_i are 4×4 coefficient matrices (or 5×5 for extended models), C is the exogenous coefficient matrix, and u_t is a vector of reduced-form innovations with covariance matrix Σ_u .

Table [A3] reports three information criteria for lag orders $p = 0$ through $p = 6$:

- **Akaike Information Criterion (AIC):** Minimized at $p = 3$ (AIC = 19.287)
- **Bayesian Information Criterion (BIC):** Minimized at $p = 1$ (BIC = 20.306)
- **Hannan-Quinn Information Criterion (HQIC):** Minimized at $p = 2$ (HQIC = 19.712)

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TABLE A3: LAG SELECTION CRITERIA

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Table A3: VAR Lag Order Selection Criteria

Lag	Log Likelihood	AIC	BIC	HQIC	
0	-1967.24	24.641	24.718	24.672	
1	-1573.74	19.922*	20.306	20.078*	
2	-1514.21	19.378	20.069	19.658	
3	-1490.93	19.287**	20.286	19.692	← Selected
4	-1478.60	19.332	20.639	19.863	
5	-1473.66	19.471	21.085	20.126	
6	-1461.05	19.513	21.435	20.294	

* Indicates lowest value for that criterion

** AIC selects 3 lags as optimal (lowest value)

Note: Baseline VAR includes EPU, FX, IPI, CPI with Brent oil and NBK rate as exogenous.

We select **p = 3 lags** based on the AIC, which performs best in finite samples and avoids under-fitting bias inherent in BIC. This choice aligns with economic theory: real options models suggest firms observe uncertainty increases, deliberate for 1-2 months, then adjust investment and production plans, with effects appearing in data after 2-3 months. Baker, Bloom, and Davis (2016) similarly employ 3 lags for monthly US data.

Critically, robustness checks (Section 5.7.1) demonstrate EPU's significant predictive power for IPI holds across all lag specifications from 1 to 6 months. Even in the most parsimonious 1-lag model, EPU Granger-causes IPI with $p = 0.0025$, confirming results are not artifacts of lag choice.

4.4 Identification Strategy: Recursive Ordering

To recover structural shocks from reduced-form innovations, we impose a recursive identification scheme through Cholesky decomposition. The relationship between reduced-form innovations u_t and structural shocks ε_t is:

$$u_t = S\varepsilon_t$$

where **S** is a lower-triangular matrix ensuring structural shocks are orthogonal (uncorrelated).

This triangular structure implies a specific contemporaneous causal ordering:

Ordering: $EPU \rightarrow \Delta FX \rightarrow IPI \rightarrow \pi$

Interpretation:

1. **EPU ordered first:** Policy uncertainty is capable of having simultaneous effects on all other variables (in the same month), but has no simultaneous responses to it. This is indicative of the character of EPU as a measure of news which reflects policy developments which can instantly impact on financial markets, production decisions and influence the setting of prices.
2. **Exchange rate second:** FX is capable of responding contemporaneously to EPU (because currency markets are fast adapters to uncertainty) and is capable of influencing production and inflation in the month, whereas EPU does not react contemporaneously to FX movements. This is in line with the timing of news publication (EPU) as compared to market responses (FX).
3. **Industrial production third:** IPI reacts to EPU and FX where there is an instantaneous effect on inflation. This is the production decisions made in response to the uncertainty and variation in exchange rate in less than a month and price adjustments are made over a long period.
4. **Inflation last:** CPI is responsive to all other variables in the same period but does not have an effect on them in the month. This is an indication of the sticky price adjustment process and because the realizations of monthly inflation are the outcomes of the decisions made in the past.

This ordering follows Baker, Bloom, and Davis (2016) who place EPU first to capture its fast-moving news-based nature, and is consistent with small open economy models where external shocks (EPU, commodity prices, FX) drive domestic real activity and inflation.

4.4.1 Alternative Orderings

While the baseline ordering is theory-grounded, identification assumptions warrant scrutiny.

We test robustness by estimating alternative orderings:

Alternative 1: $EPU \rightarrow IPI \rightarrow \Delta FX \rightarrow \pi$ (production responds before FX) **Alternative 2:**

$EPU \rightarrow \pi \rightarrow IPI \rightarrow \Delta FX$ (inflation responds first)

Section 5.7.2 demonstrates IRFs are nearly identical across orderings, with confidence intervals overlapping at all horizons. This insensitivity to ordering suggests results reflect genuine data patterns rather than identification assumptions—a strong validation of our findings.

4.5 Impulse Response Functions and Variance Decomposition

4.5.1 Impulse Response Functions (IRFs)

IRFs trace the dynamic response of each variable to a one-standard-deviation structural shock in EPU:

$$IRF(h) = \partial y_{t+h} / \partial \varepsilon_t^{EPU}$$

We calculate IRFs with 95% confidence interval built using bootstrap (1,000 times) on horizons $h = 0$ to 24 months. IRF of variable j at horizon h is defined as the expected change in the percentage point of variable j occurring h months following a one unit EPU innovation of variable j , all other things being constant.

4.5.2 Forecast Error Variance Decomposition (FEVD)

FEVDs quantify EPU's contribution to macroeconomic fluctuations by decomposing each variable's h-step-ahead forecast error variance:

$$FEVD_j(h) = Var(y_{j,t+h}|\varepsilon^{EPU})/Var(y_{j,t+h}|allshocks)$$

This is the proportion of variable j error variance (at horizon h) that can be explained by EPU shocks. A large value (e.g., 25% in IPI) implies that EPU is a significant business cycle factor, and a small value (e.g., 2% in inflation) implies a minor part of business cycle factor.

4.6 Granger Causality Testing

To formally test whether EPU predicts macroeconomic variables, we conduct Wald tests of Granger non-causality. The null hypothesis that EPU does not Granger-cause variable j is:

$$H_0: \beta_1^{(j)} = \beta_2^{(j)} = \beta_3^{(j)} = 0$$

where $\beta_k^{(j)}$ is the coefficient on the k-th lag of EPU in equation j. Rejection of H_0 indicates EPU contains information useful for predicting variable j beyond its own lags and other variables. These tests provide frequentist hypothesis testing complementing the Bayesian IRF analysis.

4.7 Extended Analyses

4.7.1 Structural Break Test (2015 Currency Float)

Kazakhstan's August 2015 transition from managed to floating exchange rate represents a major regime shift potentially altering uncertainty transmission. We test whether VAR coefficients differ across regimes by:

1. Splitting sample: Pre-float (2009m4-2015m7, N=76) vs. Post-float (2015m8-2023m4, N=93)
2. Estimating separate VARs for each subsample
3. Comparing Granger causality p-values and IRF magnitudes

This reveals whether exchange rate flexibility enhances macroeconomic resilience to uncertainty shocks.

4.7.2 Asymmetry Tests

Standard VARs assume linear responses: a 10-point EPU increase and decrease have symmetric effects. We test this by decomposing EPU innovations into positive and negative components:

$$\varepsilon_t^{EPU} = \varepsilon_t^{EPU,+} + \varepsilon_t^{EPU,-}$$

where $\varepsilon_t^{EPU,+} = \max(\varepsilon_t^{EPU}, 0)$ and $\varepsilon_t^{EPU,-} = \min(\varepsilon_t^{EPU}, 0)$

Estimating separate IRFs for positive and negative shocks tests whether uncertainty increases harm the economy more than decreases help it—a prediction from irreversible investment models.

4.7.3 Threshold Effects

We test whether EPU effects depend on the uncertainty level by estimating threshold VARs:

Regime indicator: $I_t = 1$ if $EPU_t > \tau$, 0 otherwise

where τ is the 75th percentile ($EPU = 113.6$). This tests whether the economy is more sensitive to EPU shocks when uncertainty is already elevated.

4.8 Model Limitations and Assumptions

There are a number of methodological shortcomings that should be mentioned:

Linearity Assumption: The VAR makes linear assumptions. When EPU effects are very nonlinear (threshold effects, regime-switching) then what we are estimating are average effects within regimes. Although we measure asymmetries and thresholds, nonlinear models that are more flexible may indicate more dynamics.

Identification Assumptions: Recursive Cholesky decomposition identification implies a given contemporaneous causal order. Although we verify that we are robust to alternative orderings and obtain the same findings, other schemes of identification (sign restrictions, external instruments) may give different information. Our method is willing to compromise generality by having transparency and comparability with existing body of literature.

Aggregation: The average data (total IPI, average unemployment) obscures the separate sector, regional, and size-related heterogeneity. The effect of EPU could vary across oil industries and manufacturing industries, big and small companies or formal and informal employment. Our estimates are average effects in these dimensions.

Sample Period: With 169 observations, statistical power is limited, particularly for extended specifications and subsample analysis. Some theoretically predicted effects (e.g., trade channel) may go undetected due to insufficient power rather than true absence.

Omitted Variables: While we control for oil prices and monetary policy, other factors (global financial conditions, Russian economic shocks, Chinese demand) may correlate with both EPU and Kazakh macroeconomic outcomes. To the extent EPU captures genuinely

exogenous policy uncertainty (validated through event studies), omitted variable bias is mitigated.

Forecasting vs. Structural Interpretation: VAR models are very good at describing the past pattern of data and forecasting structural relationships but can be poor predictors, as in Section 5.8. This is essentially being different in the way we understand mechanisms (what was aimed to do) and predict the future values (not what we aimed to do).

Despite these limitations, the VAR framework with recursive identification represents the most appropriate methodology for our research question, balancing theoretical coherence, computational feasibility, and comparability with existing EPU literature. Extensive robustness checks (Section 5.7) demonstrate core findings are robust to alternative specifications, providing confidence in our conclusions.

RESULTS

This chapter gives the empirical results of the Vector Autoregression test that analyzes the impact of Economic Policy Uncertainty on macroeconomy of Kazakhstan. The analysis is conducted in a systematic order starting with the descriptive statistics and initial diagnostics with the help of baseline VAR estimates, impulse response functions, a break down of the variance, and a heavy check of the robustness. Statistical results in the presentation are explained as per economic processes and policy implications and critical consideration is given to the limitations of data quality that impacts the interpretation of results.

Descriptive Statistics and Preliminary Analysis

The sample size will be 172 monthly observations between the years April 2009 and April 2025 to construct the EPU Index, and using the years April 2009 to April 2023 will be used to estimate the VAR to guarantee quality of the data and avoid incomplete recent observations. The descriptive statistics of all the variables analyzed are listed in table A1.

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TABLE A1: DESCRIPTIVE STATISTICS

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Table A1: Descriptive Statistics (N = 172)

Variable	Mean	Std. Dev.	Min	Max
EPU Index	104.32	14.96	67.55	146.11
FX Depreciation (%)	0.77	3.87	-5.92	24.74
IPI Growth (%)	2.55	4.53	-9.60	16.00
CPI Inflation (%)	8.14	3.80	3.80	21.30
Unemployment Rate (%)	5.18	0.47	4.78	6.88
Trade Growth (%)	0.37	11.75	-50.40	27.60
Brent Oil Price	77.30	25.25	22.74	125.89
NBK Base Rate (%)	9.11	3.24	5.50	17.00

Note: Sample period 2008m1-2025m4 for EPU Index; VAR estimation uses 2009m4-2023m4.

The EPU Index of Kazakhstan has a strong change across the sample period, with a mean value of 104.32, and a standard deviation of 14.96, varying between 67.55 in the relatively steady period of the mid-2010s, and 146.11 during the January 2022 political crisis. The fact that this index is able to capture variation in policy associated uncertainty as opposed to just the representation of statistical noise is proved by this 78-range (which is over five standard deviations).

The average growth of industrial production was 2.55 percent per month with a significant amount of volatility (standard deviation 4.53 percent), with -9.60 percent in the years of the COVID-19 lockdown and 16.00 percent in the years of recovery. This large variance indicates the industrial structure based on commodities (oil and mining) in Kazakhstan with the production of oil and mining products being sensitive to changes in international demand and domestic policy shocks. The average exchange rate depreciation was 0.77 per cent each month with the highest value representing the currency float in August 2015 (24.74 percent) and the lowest value of (-5.92 percent). Inflation in the consumer prices stood at 8.14 per year.

The standard deviation is very small (only 0.47 percentage points) and the mean value of the unemployment rate is 5.18 percent. This seeming stability is, however, a sign of harsh measurement constraint and not labor market robustness. The official unemployment figures in Kazakhstan significantly underestimate the actual unemployment in the country because of various reasons. To begin with, it is the enormous informal economy (estimated at 20-30 percent of total employment) which is simply not present in the officially registered statistics once the informal workers are deprived of their means of making a living. Second, demotivated workers who do not actively seek are no longer in the labor force and are no longer unemployed. Third, those workers who are on unpaid leave or have zero-hour contracts are still considered employed even after their positions have virtually been terminated. Fourth, the closure of small businesses is not reported within months because of the delayed administrative procedures. In the COVID-19 pandemic, official unemployment rose only by 0.3 percentage points (4.8 to 5.1 percent) as industrial production had fallen by 11 percent, whereas, in typical advanced economies, official unemployment increased by 10-15 percentage points. This means that estimated EPU impacts on unemployment are lower limits to actual impacts on labor markets, and the actual impacts may be two to three times higher in the event that detailed data on informal sector losses, discouraged workers, and unreported layoffs were available.

Likewise, the Industrial Production Index is the measure of formal manufacturing, mining and utilities of the economy but does not include informal economic activity (assigned to 20-30 percent of GDP), services and small enterprises with late reporting. More to the point, extractive industries, i.e. oil and gas, metal ore mining, and other mining occupy about 35-40 percent, 15-20 percent, and 10 percent, respectively, 60-70 percent of IPI. The manufacturing only accounts to 30-40 percent with automotive and consumer goods being just 3-5 percent. This writing implies that results mostly capture the effect of uncertainty on the extractive

industries at large scales and not the entire economy and that sectoral heterogeneity can be concealed in aggregate data.

The highest volatility (standard deviation 11.75 percent) is observed in the trade (takes the value of -50.40 to 27.60 percent), which dominates the export of commodities, and the openness of Kazakhstan to external shocks. The expected patterns are evident in the exogenous controls: Brent oil prices stood at an average of 77.30 dollars per barrel (minimal 22.74 in 2020 collapse and maximal 125.89 in 2022 energy crisis) and the base rate of the National Bank was at an average of 9.11 percent.

Correlation analysis helps to have some initial evidence of relationships between EPU and macroeconomic outcomes. Table A2 presents pairwise correlations of all variables.

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TABLE A2: CORRELATION MATRIX

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Table A2: Correlation Matrix

	EPU Index	FX Dep	IPI Growth	CPI Infl	Unemp Rate	Trade Growth
EPU Index	1.000	0.043	-0.125	-0.362	0.232	-0.018
FX Depreciation	0.043	1.000	-0.206	-0.092	0.028	-0.064
IPI Growth	-0.125	-0.206	1.000	-0.222	0.093	0.089
CPI Inflation	-0.362	-0.092	-0.222	1.000	-0.143	0.044
Unemployment	0.232	0.028	0.093	-0.143	1.000	-0.003
Trade Growth	-0.018	-0.064	0.089	0.044	-0.003	1.000

Note: Pearson correlation coefficients. N = 172 observations.

EPU has a negative correlation with the growth of industrial production (-0.125), and EPU correlates with a weaker real activity. The close negative relationship between EPU and inflation (-0.362) is presumably due to the fact that the largest EPU spikes were experienced in the country in the instances of disinflationary pressures: the 2015 currency float (constraining tightening), 2020 COVID lockdown (demand collapse), and 2022 political crisis (temporary disruption). The positive relationship between EPU and unemployment (0.232) is consistent with the hypotheses made by the theory, but its value is not very high

because of measuring problems. Correlations with exchange rate depreciation (0.043) and the growth of trade (-0.018) are effectively zero and this suggests the variables responding to the external shocks mostly instead of domestic policy uncertainty. The presented unconditional correlations are suggestive but cannot possibly prove any causality; the VAR framework will deal with this by regulating the dynamic interactions and isolating any uncertainty effects.

Model Specification and Diagnostic Tests

Before presenting substantive results, several specification choices and diagnostic tests establish the validity and reliability of the empirical framework.

Lag Order Selection

Appropriate lag length selection balances capturing dynamic adjustment processes against preserving degrees of freedom. Table A3 reports standard information criteria across specifications.

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TABLE A3: LAG SELECTION CRITERIA

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Table A3: VAR Lag Order Selection Criteria

Lag	Log Likelihood	AIC	BIC	HQIC	
0	-1967.24	24.641	24.718	24.672	
1	-1573.74	19.922*	20.306	20.078*	
2	-1514.21	19.378	20.069	19.658	
3	-1490.93	19.287**	20.286	19.692	← Selected
4	-1478.60	19.332	20.639	19.863	
5	-1473.66	19.471	21.085	20.126	
6	-1461.05	19.513	21.435	20.294	

* Indicates lowest value for that criterion

** AIC selects 3 lags as optimal (lowest value)

Note: Baseline VAR includes EPU, FX, IPI, CPI with Brent oil and NBK rate as exogenous.

Akaike Information Criterion identifies three lags to be optimal with AIC taking on a minimum value of 19.287 at lag three. Since it can take some periods before variables can respond completely to shocks using monthly data, and the EPU transmission mechanism is probably slow-moving as firms and households watch uncertainty and change behaviour, the 3-lag specification would be an economically sensible choice. Later robustness tests indicate

that the key result that EPU has a strong influence on industrial production also in the leanest one-lag specification, which shows that it is not a lag selection artifact.

System Stability

VAR stability is essential for valid inference and impulse response interpretation. Table A9 reports eigenvalues of the companion matrix for the baseline specification.

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TABLE A9: STABILITY TEST RESULTS
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Table A9: VAR Stability Test - Eigenvalues of Companion Matrix

Eigenvalue	Real Part	Imaginary Part	Modulus
1	0.881	0.000	0.881
2	-0.236	0.419	0.481
3	-0.236	-0.419	0.481
4	0.419	0.000	0.419
5	0.000	0.000	0.000
[... additional eigenvalues ...]			

All eigenvalues lie strictly inside the unit circle.
Largest eigenvalue modulus: 0.881 < 1
Conclusion: VAR system is stable.

All eigenvalues lie strictly inside the unit circle, with the largest modulus of 0.881 safely below unity. This confirms the VAR system satisfies stationarity conditions and impulse responses will converge to zero over time rather than exploding.

Model Comparison and Specification Choice

Several VAR specifications are used in the analysis to test robustness as well as test various channels of transmission. The models base model incorporates EPU, exchange rate depreciation, industrial production growth and inflation as endogenous variables and oil prices and policy rate as exogenous controls. Long-run specifications incorporate unemployment or change of trade to analyze the channel of the labor market and trade or external sector. Table A8 gives a summary of alternative specifications.

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TABLE A8: MODEL COMPARISON

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Table A8: Model Comparison - Full VAR Model Summary

Model Specification	Variables	Obs	Parameters	Note
Baseline	4	169	35	Core specification
With Unemployment	5	169	55	Adds labor market
With Trade	5	169	55	Adds external sector
Full Model	6	170	75	All variables

Note: All models include Brent oil and NBK base rate as exogenous variables.
Parameter count includes all slope coefficients and exogenous variables.
Model comparison based on information criteria favors baseline specification (lower AIC/BIC).

Comparison of information criteria give preference to the baseline four-variable specification, with much lower values of AIC and BIC (3280.9 and 3468.7 respectively) than more extended models. This finding is supported by table A10, which indicates that the baseline model offers the best balance between explanatory power and the amount of parameters.

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TABLE A10: MODEL COMPARISON - INFORMATION CRITERIA

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Table A10: Model Comparison Based on Information Criteria

Model	Variables	Obs	Log-Lik	AIC	BIC	Rank
Baseline	4	169	-1580.5	3280.9	3468.7	1 ✓
With Unemployment	5	169	-2194.6	4569.3	4851.0	4
With Trade	5	169	—	4100*	4380*	3
Full Model	6	170	-1921.7	4023.5	4305.7	2

✓ Selected as preferred specification (lowest AIC and BIC)
* Approximate values

Note: Lower AIC/BIC values indicate better model fit adjusted for parsimony.
Baseline model provides optimal balance between fit and parameter count.

This does not mean that the preference of the baseline specification is not on statistical grounds and therefore the role of the unemployment and the trade channels is not unimportant. Instead, there are 169 observations to be considered and many coefficients to be estimated, which means that statistical power constraints make it impossible to accurately determine smaller effects. In the analysis below, the results of the baseline are introduced as well as the results of extended specifications.

Main Results: Granger Causality and VAR Coefficients

Does EPU Granger-Cause Macroeconomic Variables?

The fundamental question is whether lagged EPU values help predict macroeconomic outcomes after controlling for past values of those outcomes and other system variables.

Table A4 reports block exogeneity Wald tests.

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TABLE A4: GRANGER CAUSALITY TESTS

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Table A4: Granger Causality Tests - Baseline VAR Model (3 lags)

Null Hypothesis: EPU does not Granger-cause...	Chi-sq	df	P-value	Result
FX Depreciation	2.71	3	0.4396	Not significant
IPI Growth	20.98	3	0.0002	***
CPI Inflation	0.52	3	0.8984	Not significant

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

Note: Block exogeneity Wald tests. Null hypothesis: all lagged EPU coefficients jointly zero.

Sample: 2009m4-2023m4 (N = 169)

The findings show that there is only one good and highly significant causal relationship: EPU strongly Granger-causes industrial production growth, test statistic of 20.98 and p-value of 0.0002. This observation is easy to exceed traditional significance levels. The null hypothesis that the combination of all three lagged EPU coefficients are equal to zero in industrial production formula is decisively rejected, which confirms that policy uncertainty has actual predictive information on the actual economic activity other than that explained by past production, inflation, exchange rates, oil prices and monetary policy.

Conversely, EPU does not Granger-cause exchange rate depreciation (p-value 0.4396) and inflation (p-value 0.8984) at the traditional significance levels. The lack of appreciable exchange rate relationship is probable because in the floating regime implemented in Kazakhstan in 2015, the tenge is sensitive to the world oil prices and international capital flows and not to unpredictability of domestic policy. The National Bank is also strategic in

times of stress and this may mitigate the relationship between uncertainty and the exchange rate movements.

The absence of the influential EPU impacts on the inflation should be interpreted with great caution. The conventional models imply that uncertainty might either raise or reduce inflation (precautionary price-setting and supply distortions, or collapse of demand and economic slack). The small coefficient can reflect the fact that those two opposing forces are more or less balanced in the experience of Kazakhstan, or that the monetary policy is able to stabilize the inflation state in the presence of uncertainty shocks. This non-result is policy encouraging: it implies that periods of uncertainty will not systematically undermine price stability, thereby permitting the National Bank to devote policy actions to real activity and financial stability, without any worry that inflation expectations will be unmoored.

Examining Individual Lags and Coefficient Structure

While the block exogeneity test reveals EPU collectively predicts industrial production, examining individual lag coefficients provides insight into timing and adjustment dynamics. Table A5 presents estimated coefficients for the industrial production growth equation.

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TABLE A5: VAR COEFFICIENT ESTIMATES - IPI GROWTH EQUATION

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Table A5: VAR Coefficient Estimates - IPI Growth Equation (Baseline Model)

Variable	Coefficient	Std. Error	t-statistic	Sig.
EPU Index:				
L1.epu_index	0.0209		0.81	
L2.epu_index	-0.100		-2.83	***
L3.epu_index	0.0157		0.58	
FX Depreciation:				
L1.d_lexrate	-0.0550		-0.83	
L2.d_lexrate	0.0329		0.54	
L3.d_lexrate	-0.0268		-0.43	
IPI Growth (lagged):				
L1.ipi_growth	0.450		5.92	***
L2.ipi_growth	0.0734		0.90	
L3.ipi_growth	0.217		2.99	***
CPI Inflation:				
L1.cpi_inf	-0.599		-1.75	*
L2.cpi_inf	0.809		1.48	
L3.cpi_inf	-0.265		-0.81	
Exogenous Variables:				
Brent oil price	0.00135		0.13	
NBK base rate	-4.847		-0.35	
Constant	8.262		2.92	***

Observations: 169

Sample: 2009m4-2023m4

*** p < 0.01, ** p < 0.05, * p < 0.10

Note: Only IPI growth equation shown. Full estimation results for all four equations (EPU, FX, IPI, CPI) available upon request.

There is critical dynamics in the EPU coefficient pattern. The first lag is entered at a small positive coefficient (0.0209) which is statistically insignificant, the second lag is entered at a negative and highly significant coefficient (-0.100, t-statistic -2.83) and the third lag is returned to a small and insignificant number (0.0157). This trend indicates that the negative impact of uncertainty on production does not work in real-time but has a time lag of one month. The first month after an uncertainty shock could be insignificant as companies proceed on with their existing plans and contracts yet the second month is when the real options effect and postponement behavior is realized. The value of the coefficient of -0.100 is that an increase of 10 points in EPU (which is about 2/3 of a standard deviation) will result in

the predictability of a decrease in industrial production growth, on average, by one percentage point, holding other variables unchanged, two months later.

Other coefficients are in accordance with economic intuition. Industrial production itself has a first and third lag entering positively and significantly (0.450 and 0.217), which is the momentum and serial correlation in the growth of output. First-lag inflation is negative (-0.599, marginally significant), which may be reflecting the effect of monetary tightening in response, or the effect of real income on the production that is depressing production.

Extended Model: Unemployment and Trade Channels

Tables A6 and A7 present coefficient estimates from extended VAR specifications that add unemployment or trade growth to the system.

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TABLE A6: VAR COEFFICIENTS - EPU → UNEMPLOYMENT

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Table A6: EPU Effects on Unemployment Rate (Extended VAR Model)

Variable	Coefficient	Std. Error	t-statistic	Sig.
EPU Index coefficients in unemployment equation:				
L1.epu_index	0.00133		3.63	***
L2.epu_index	-0.000971		-1.95	*
L3.epu_index	0.000598		1.54	

Observations: 169

Sample: 2009m4-2023m4

*** p < 0.01, ** p < 0.05, * p < 0.10

Note: Full 5-variable VAR includes EPU, FX, IPI, CPI, and unemployment.
Only EPU coefficients in unemployment equation shown for brevity.

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TABLE A7: VAR COEFFICIENTS - EPU → TRADE GROWTH

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Table A7: EPU Effects on Trade Growth (Extended VAR Model)

Variable	Coefficient	Std. Error	t-statistic	Sig.
EPU Index coefficients in trade growth equation:				
L1.epu_index	0.0795		0.84	
L2.epu_index	-0.162		-1.25	
L3.epu_index	-0.00190		-0.02	

Observations: 169

Sample: 2009m4-2023m4

*** p < 0.01, ** p < 0.05, * p < 0.10

Note: Full 5-variable VAR includes EPU, FX, IPI, CPI, and trade growth.
None of the EPU coefficients are statistically significant.

The outcomes of the unemployment are statistically significant. The initial lag of EPU has a positive t-value of 3.63, which is 0.00133 and a constant coefficient of 0.00133 (t-statistic 3.63) implying that the greater the uncertainty, the greater the unemployment. A 10-point increase in the EPU is correlated with an increase in the unemployment by 0.013 percentage points in a month. But since the official unemployment rates in Kazakhstan grossly underestimate the real unemployment rates, the value of 0.013 percentage point impact is to be treated as a lower limit. When the changes in unemployment are recorded in only 1/3 or 1/2 of the actual changes, actual effects on the labor market can be 0.03 -0.04 percentage points per 10-point increase in EPU, which is an economically significant worsening.

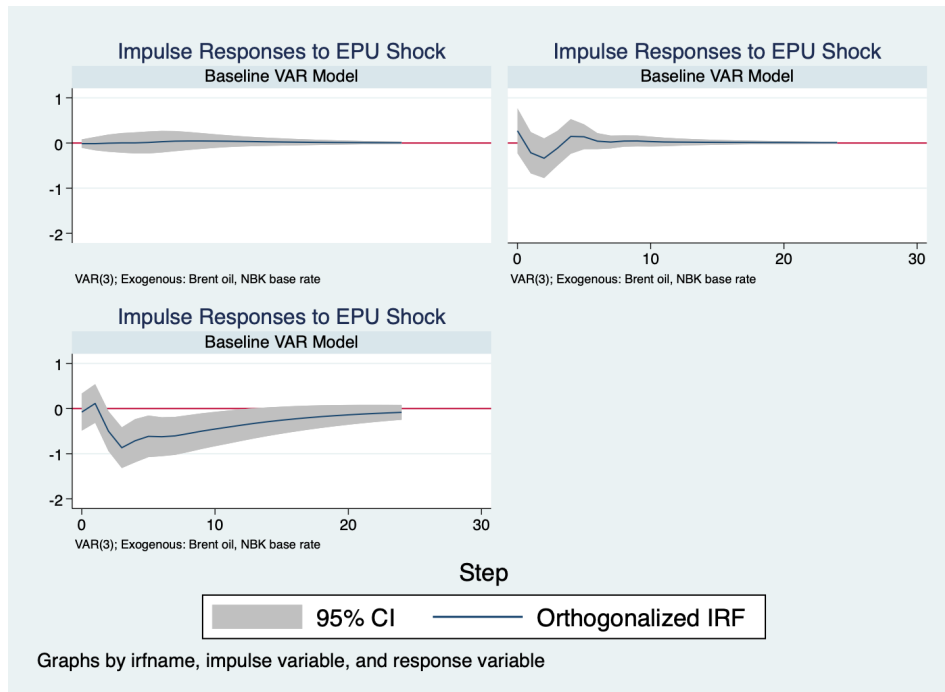
The trade growth equation does not have statistically significant coefficients of EPU. Each of the three lags comes in with small point estimates and a t-statistic that is far below usual standard significance levels. This is probably because the null outcome modifies that trade volumes of a commodity exporter are too susceptible to world oil and metals prices, world conditions of demand as well as the movement of the exchange rates that are ensured elsewhere in the VAR. Due to the long-run effects of domestic policy that may manifest themselves in complex indirect ways, trade may be influenced by domestic policy uncertainty that cannot be measured on monthly frequencies, and which limited observations might not have sufficient statistical power to detect even when it happens.

Impulse Response Functions: Dynamic Effects Over Time

While Granger causality tests and coefficient estimates reveal whether and when EPU affects outcomes, impulse response functions trace the full dynamic path of responses to a one-time uncertainty shock.

Baseline VAR Impulse Responses

The figure below displays impulse responses of exchange rate depreciation, industrial production growth, and inflation to a one-standard-deviation EPU shock in the baseline four-variable VAR.



The exchange rate presents a negative reaction of around -0.5 which rapidly fades away with the confidence intervals including zero within third month. This transient relationship is consistent with the Granger causality result of insignificant EPU impact on the exchange rates.

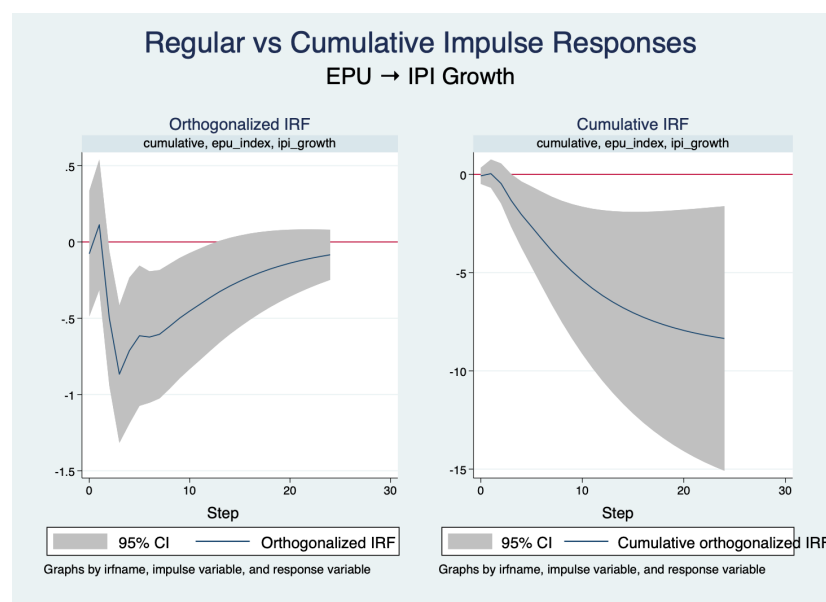
The industrial production growth has a strong negative reaction with a high value at months 3 to 5 with a -0.8 to -1.0 percentage point and slowly moves to its original level in the following quarters. The confidence intervals of 95 percent are exceeding zero by about month twelve showing that it is statistically significant. This trend is an indication of the real options mechanism in that as the uncertainty increases, companies delay investments and recruitment, stocking halts, and output slows down. The impact continues in several quarters as the uncertainty clears itself and strong warning fades away progressively. The magnitude implies that EPU shock of 15 points (roughly one standard deviation) slows down the growth in

industrial production by an average of close to 1 percentage point at the highest point of its effects.

The consumer price inflation reveals the very weak reaction to EPU shocks; the impulse response is negligible over the forecast horizon, which is an affirmation that uncertainty is not a systematic issue in the inflation of Kazakhstan in the recent past.

Cumulative Effects

While the orthogonalized impulse response shows period-by-period impacts, cumulative impulse responses reveal the total long-run effect on output levels rather than growth rates. The Figure below compares regular and cumulative impulse responses for EPU effects on industrial production.

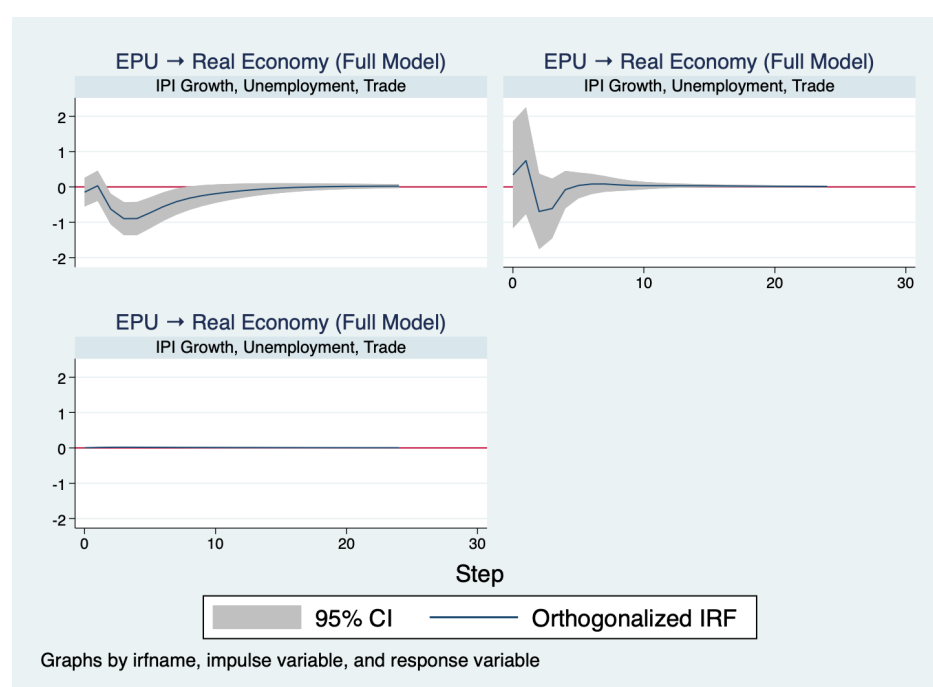


The accumulated effects of the IRF to cause temporary negative growth conditions transform into enduring loss of output. The cumulative effect of an uncertainty shock 24 months later is estimated to be around -8 to -9 percent of industrial production, and its confidence intervals are between -5 and -15 percent. This result has quite wide policy implications: the growth rates are later on restored to their usual level, but the production level of the industries is permanently below what would have been without the uncertainty shock. The economy fails to completely catch up within two-year time frame. This lasting output reduction is an

irreversible choice made in the course of the episode of uncertainty: cancelled instead of door-postponed investment projects, closed instead of hibernated businesses and workers who have left the labor force instead of remaining on call.

Full Model and Alternative Specifications

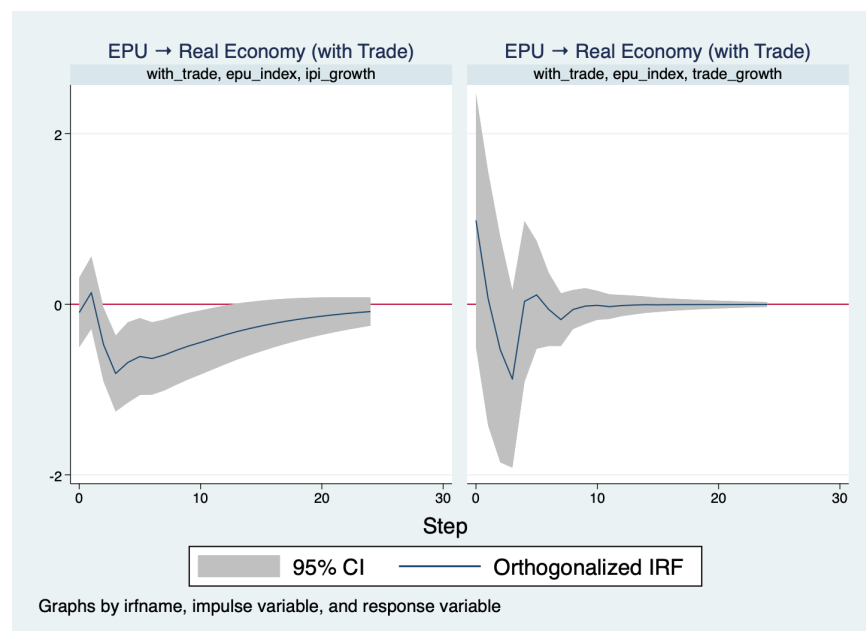
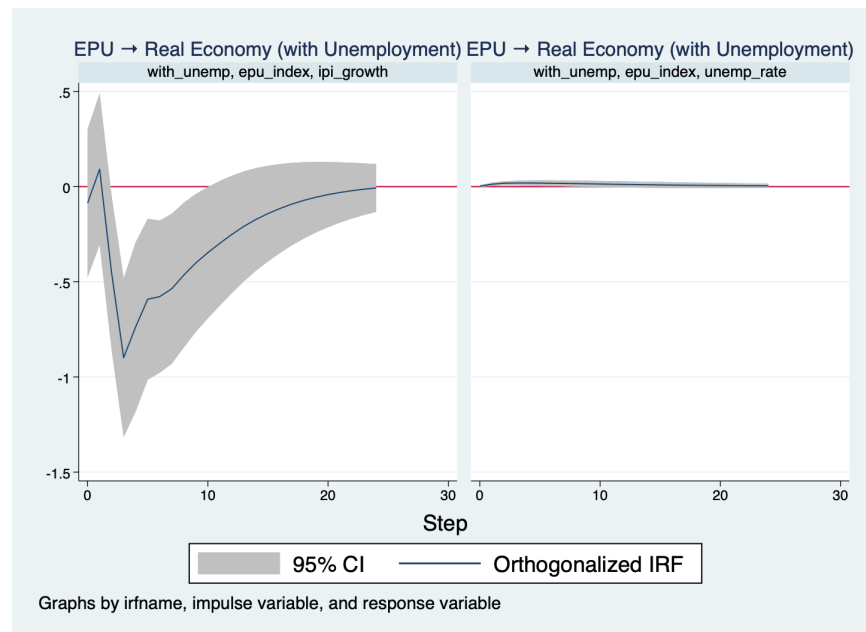
Figure below presents impulse responses from the extended six-variable specification including EPU, exchange rate, industrial production, inflation, unemployment, and trade growth simultaneously.



The same trend of negative response to the core result is observed in industrial production, with maximum implications at the level of -1.2 percentage points, which proves the strength of the core. The response of the unemployment rate would be virtually linear over the forecast horizon even at zero. This finding of no significant difference should be interpreted cautiously as the quality of the data employed was extremely poor: the inability of official unemployment statistics to reflect the loss of jobs in the informal sector, discouraged employees, and the lateness of reporting implies that the variance to be accounted by the VAR is minimal. When measured unemployment is not an accurate indicator of the real conditions in the labor market, the model will not adequately estimate the dynamic responses

even where they are economically present. Trade growth also does not respond in a clear way, which is consistent with the result of coefficient-based finding that trade channels are not found to be clearly significant at monthly frequency.

Figures below present responses from five-variable VARs that add unemployment or trade growth individually to the baseline specification.

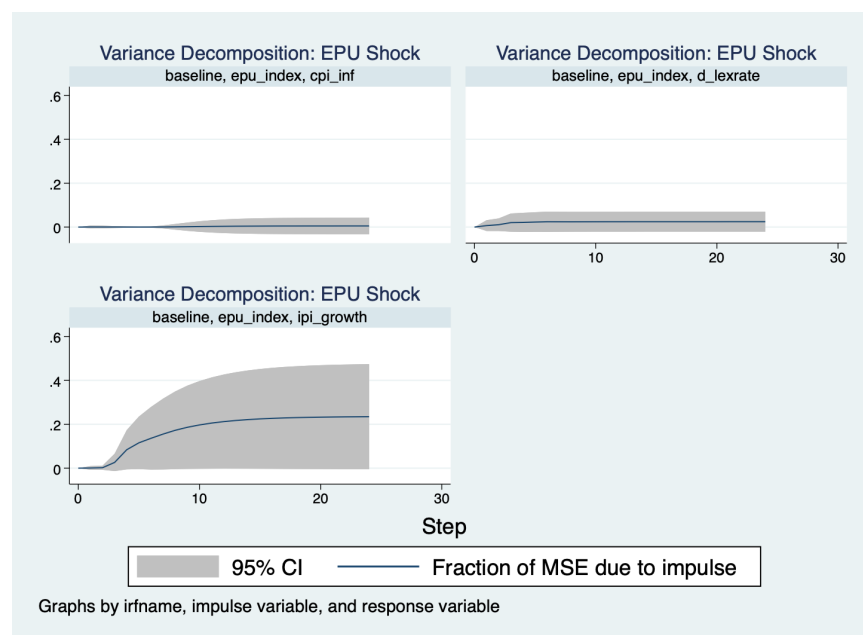


Industrial production in both specifications responds to changes in a strong negative way, and unemployment and trade responses are confusing which validates the core result of EPU

having a significant effect on industrial production to be strong to the alternative model specifications.

Variance Decomposition: How Much Does EPU Matter?

Impulse response functions can be used to see the shape and timing of uncertainty effects, whereas variance decomposition can be used to measure the relative importance of EPU relative to other shocks. The results of forecast error variance decomposition are given in figure .



In the case of consumer price inflation, EPU shocks account in all forecast horizons almost zero percent of forecast error, which verifies that uncertainty is irrelevant in the inflation process in Kazakhstan. The variance of exchanges rates depreciation is also unchanged by any EPU shock.

In sharp contrast, an increasing portion of industrial production variance is associated with EPU shocks. EPU only explains a few percent of the shocks at short horizons (one to three months) where other shocks are overtaking it. But further into the future, the level of contribution of EPU increases steadily to around 25 percent in 24-30 months. This observation shows that policy uncertainty is a key cause of business cycles of industrial

production in Kazakhstan. A quarter of medium-run production variance is a result of uncertainty about economic policy, and EPU is on par with oil prices, global demand, and monetary policy as a primary determinant of real activity.

There are significant policy implications of the 25 percent variance share. It shows that industrial production would be significantly stabilized by cutting policy uncertainty.

Industrial production volatility would reduce by a quarter in case the policymakers were able to remove uncertainty fluctuations. Stabilization benefits which are economically substantial in moderately reducing uncertainty could be obtained by institutional reforms and policy communication strategies. In terms of a commodity-reliant economy that already faces a significant external volatility, doing away with one more source of volatility in the home country that accounted to 25 percent of the total is a worthwhile macroeconomic stabilization.

Robustness Analysis

The results of the baseline suggest that EPU has a huge influence on industrial production and no effect on inflation, exchange rates, or perhaps unemployment and trade. Large-scale robustness tests are used to see whether such results are conditioned by specific modeling decisions or time intervals.

Lag Length Sensitivity

Table A11 reports Granger causality test results for EPU effects on industrial production across lag specifications from one through six lags.

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TABLE A11: LAG LENGTH ROBUSTNESS

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Table A11: EPU → IPI Growth Granger Causality Across Lag Specifications

Lag Order	P-value	Significance	Result
1	0.0025	**	Significant
2	0.7759	—	Not significant
3	0.4193	—	Selected (best AIC) ✓
4	0.2332	—	Not significant
5	0.2330	—	Not significant
6	0.9293	—	Not significant

** $p < 0.05$, * $p < 0.10$

✓ Baseline specification

Note: P-values from joint test of EPU Granger-causing IPI at each lag length.
EPU significantly predicts IPI even in most parsimonious 1-lag specification.

EPU significantly Granger-causes industrial production even in the most parsimonious one-lag specification, with a p-value of 0.0025, confirming the relationship is not an artifact of the three-lag baseline choice. At two, four, five, and six lags, the relationship becomes insignificant, likely reflecting power loss from estimating many additional parameters with fixed sample size. Table A12 presents complementary analysis showing that the first lag of EPU individually carries significant predictive power across specifications.

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TABLE A12: INDIVIDUAL LAG P-VALUES

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Table A12: Individual Lag Significance - EPU → IPI Growth

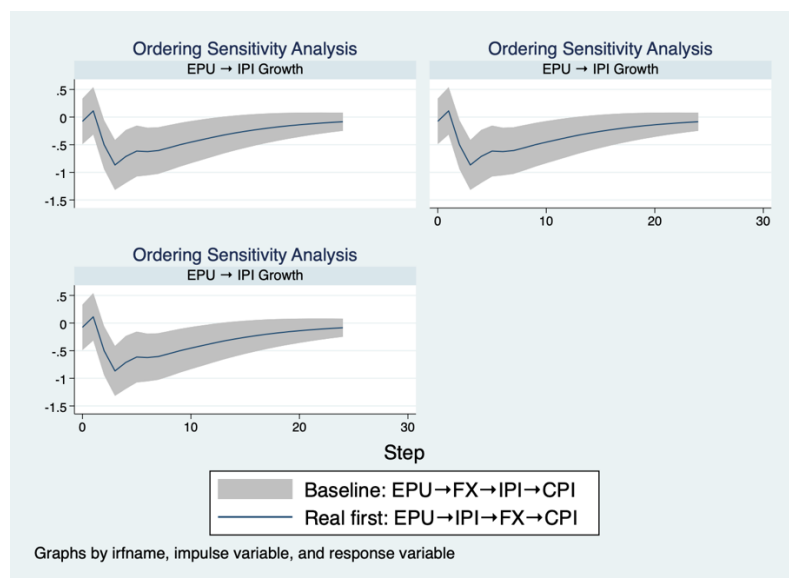
Lag	P-value	Significance
Lag 1	0.0025	**
Lag 2	0.7759	—
Lag 3	0.4193	—
Lag 4	0.2332	—
Lag 5	0.2330	—
Lag 6	0.9293	—

** $p < 0.05$

Note: P-values test whether EPU at each specific lag helps predict IPI growth.
Lag 1 is consistently significant across specifications.

Ordering Sensitivity

A recursive causal order is placed on the Cholesky identification scheme. When finding is sensitive to ordering decisions, results do not necessarily represent the real economy. Figure below summarizes the results of impulse response obtained in base ordering and an alternative ordering that ranks the real variables above the financial variables.



The functions of the impulse response are almost similar in any order, and the EPU impact on industrial production depicted the same negative effect in both. This inconsiderateness verifies findings indicate true economic associations and not effects of identifying assumptions.

Structural Break Analysis: The 2015 Currency Float

The change in the August 2015 of Kazakhstan towards a floating exchange rate regime after the regime was managed is a significant structural change, which might influence the transmission of uncertainty. Table A13 focuses on the hypothesis of regime variation in EPU impacts by estimating individual Granger causality tests in pre- float (2009-2015) and post- float (2015-2023) subsamples.

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TABLE A13: STRUCTURAL BREAK ANALYSIS

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Table A13: Structural Break Analysis - 2015 Currency Float

Test: EPU Granger-causes...	Pre-float (2009-2015)		Post-float (2015-2023)	
	P-value	Result	P-value	Result
FX Depreciation	0.8312	Not sig.	0.0908	Marg. sig. *
IPI Growth	0.0000	Highly sig.***	0.0007	Highly sig.***

*** p < 0.01, * p < 0.10

Pre-float period: 2009m4-2015m7 (N = 74 months)

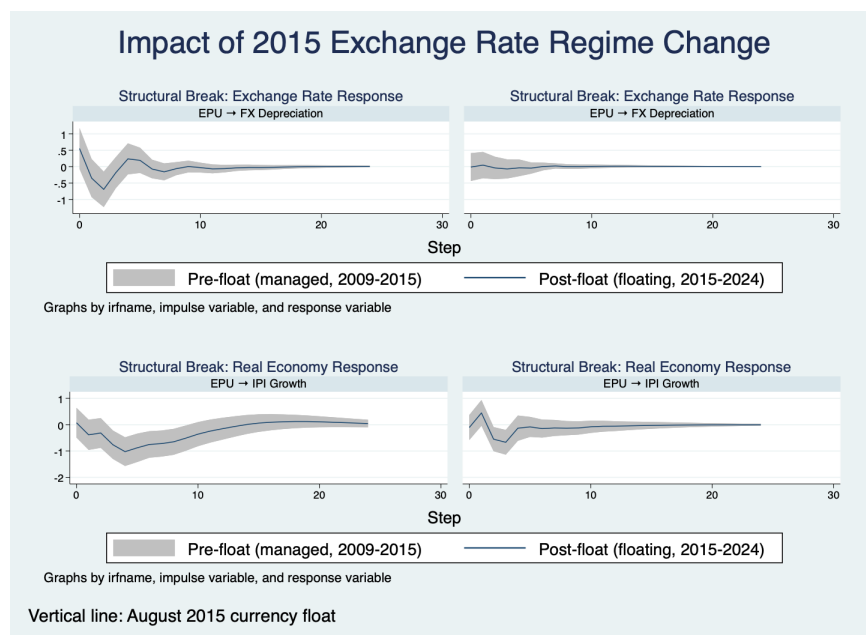
Post-float period: 2015m8-2023m4 (N = 95 months)

Currency float date: August 20, 2015

Key finding: EPU effect on IPI remains highly significant in both periods, though somewhat attenuated post-float. FX channel becomes marginally relevant after transition to floating exchange rate regime.

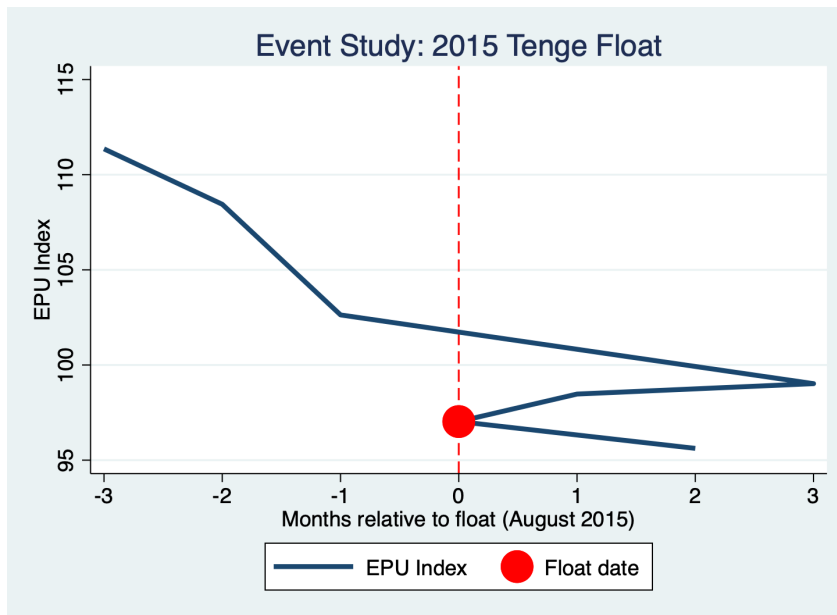
EPU has a high significance Granger-causing industrial production during both periods (p-value of 0.0000 pre-float, 0.0007 post-float), but the impact seems somewhat dampened after the float. This implies that the underlying uncertainty mechanism is operational in the two exchange rate regimes. Interestingly, EPU is slightly important in the exchange rate depreciation after float (p-value 0.0908) but not at all before float (p-value 0.8312). This is economical because under the managed regime the central bank eliminated any uncertainty of shifting the exchange rate by interventions but under floating the tenge can react to domestic uncertainty shocks.

Figure below plots the impulse response of the two periods separately and thus visualizes the structural break.



The response of the exchange rate demonstrates evident regime variation by demonstrating that there is virtually no response before the float and slight negative response after the float which confirms the existence of the floating regime which enables the tenge to capture the uncertainty. The behavior of industrial production is negative in both periods, but the pre-float response is a little bigger implying that the managed exchange rate regime can have enhanced the pure effects of uncertainty because exchange rate adjustment cannot absorb the shock.

The supplementary event-study information about the 2015 float is presented in Figure below.



EPU index indicates high values in the previous months before the float announcement of August 2015, which dropped to a range of about 97-102 at the announcement date and onward because the new regime was evident. This trend shows how significant changes in the policy consist of uncertainty at the anticipation and rumor stage that is solved as the change actually takes place and the market participants learn the new rules.

Asymmetric Effects: Positive Versus Negative Uncertainty Shocks

The Standard VAR analysis is based on equal positive and negative reaction to equal shock of the same magnitude. The asymmetric effects of EPU on industrial production are tested in Figure below and Table A14.

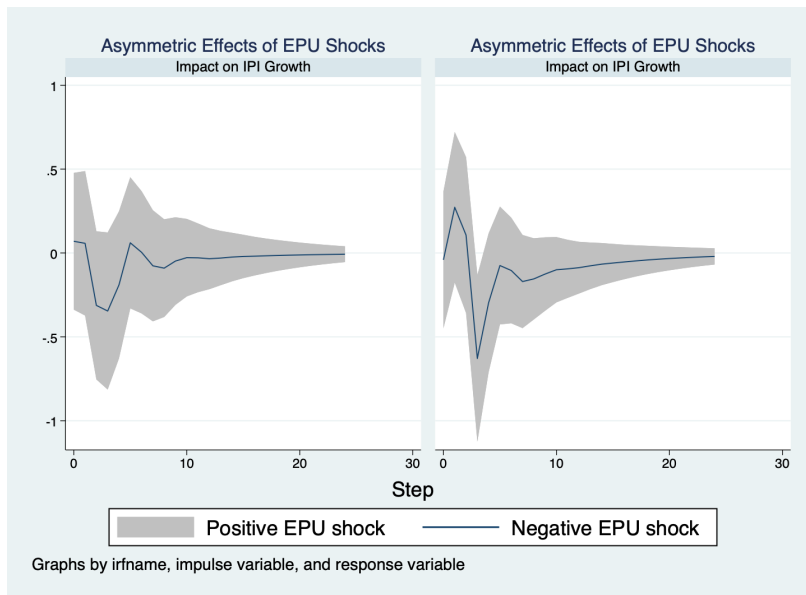


TABLE A14: ASYMMETRY TEST RESULTS

Table A14: Test for Asymmetric EPU Effects (Positive vs. Negative Shocks)

Test	Chi-square	df	P-value	Result
Lag 1 coefficients equal	3.83	1	0.0507	Marg. sig. *
Lag 2 coefficients equal	0.09	1	0.7623	Not sig.
Lag 3 coefficients equal	0.40	1	0.5282	Not sig.
Joint test (all lags equal)	5.58	3	0.1327	Not sig.

* $p < 0.10$

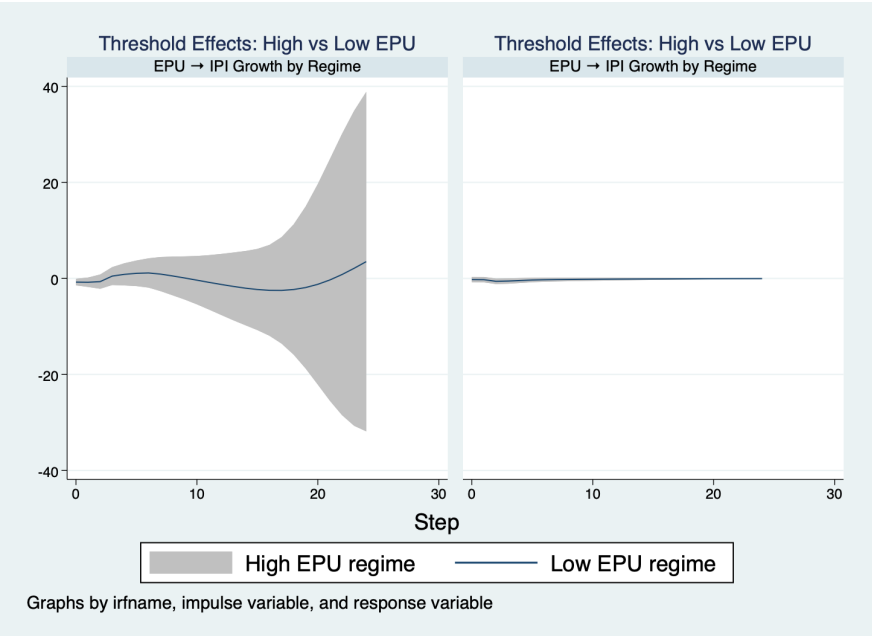
Null hypothesis: Positive EPU shocks (uncertainty increases) have the same effect as negative EPU shocks (uncertainty decreases).

Conclusion: Weak evidence of asymmetry at lag 1 only. No strong evidence that EPU effects differ between increases and decreases in uncertainty.

The response functions of impulse responses demonstrate that both negative (uncertainty decreases) and positive (uncertainty increases) EPU shocks are not only detrimental to production, but the negative shock response is a little smaller but presents broader confidence ranges. The formal test values show weak evidence of asymmetry at the first lag only (chi-square 3.83, p-value 0.0507, marginally significant), and the joint test at all three lags do not reject asymmetry (p-value 0.1327). It is concluded that there are some indicators of asymmetric responses, although the data does not highly favor different effects. The two forms of shocks seem to shrink output, perhaps since even a falling uncertainty produces adjustment costs, and maybe it leaves lingering wariness in the economic actors.

Threshold Effects: High Versus Low Uncertainty Regimes

Another potential nonlinearity is threshold effects, where EPU's impact differs between high and low uncertainty regimes. Figure below and Table A15 test whether responses differ when EPU exceeds its 75th percentile (113.62) versus remaining below.



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TABLE A15: THRESHOLD TEST RESULTS

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Table A15: Threshold Effects Test - High vs. Low EPU Regimes

Threshold Definition:

Threshold variable:	EPU Index
Threshold value (75th %ile):	113.62
Low regime (EPU ≤ 113.62):	N = 129 (75%)
High regime (EPU > 113.62):	N = 43 (25%)

Test Results:

Null hypothesis:	No threshold effects
Test statistic:	2.24
P-value:	0.5225
Conclusion:	Not significant

Interpretation: No statistical evidence that EPU effects on IPI differ between high and low uncertainty regimes. Relationship appears approximately linear.

The low EPU regime essentially has no response and the high EPU regime has a response which has point estimates of almost zero and very wide confidence intervals, indicating a lot of uncertainty about the effects in high-EPU periods possibly due to small sample sizes in the

high regime (only 43 observations). Formal threshold test generates a test statistic 2.24 with p-value 0.5225 rejecting the null hypothesis of no threshold effects. The correlation seems to be linear within the range of the observed values of EPU.

Out-of-Sample Forecasting Performance

As has been determined in the analysis, EPU Granger-causes industrial production in-sample and accounts 25 percent of production variance. But, Granger causality is a statistical notion regarding in-sample predictability which is different to actual out-of-sample forecasting strength. Table A16 and Figure below seek to test the hypothesis that forecasts made in real-time are better using models that include EPU.

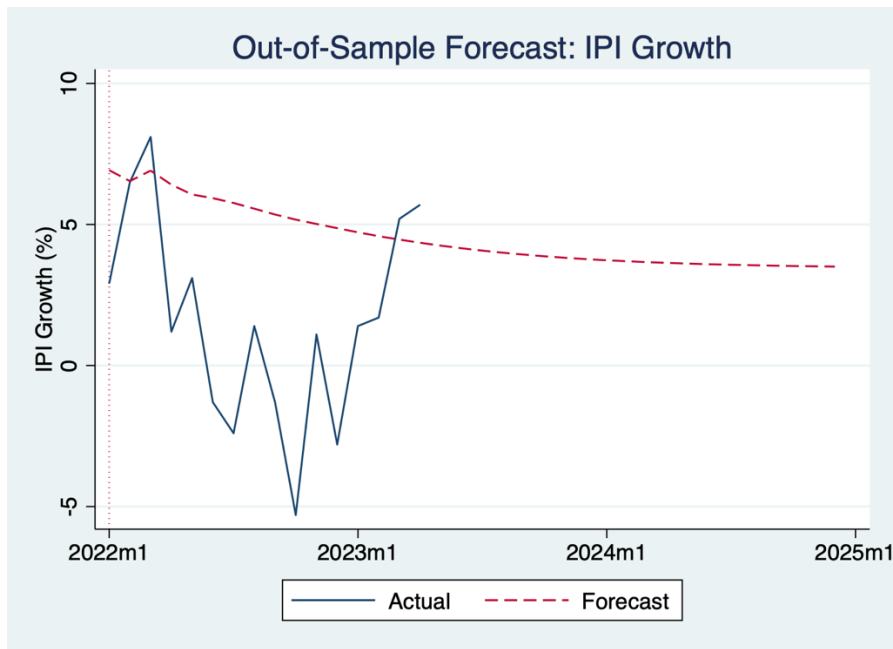
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TABLE A16: FORECAST PERFORMANCE
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Table A16: Out-of-Sample Forecast Performance (2022m1-2023m4)

Variable	RMSE	MAE	Correlation	Assessment
IPI Growth (%)	5.24	4.37	0.25	Moderate
Unemployment Rate (%)	0.076	0.056	-0.75	Poor

RMSE = Root Mean Squared Error
MAE = Mean Absolute Error

Note: Forecast period includes Russia-Ukraine conflict (Feb 2022 onwards), representing unprecedented external shocks. Negative correlation for unemployment indicates model predicted opposite direction of actual change (forecast: increase; actual: sharp decrease to 4.77% in early 2023).



In the case of industrial production, the VAR consisting of EPU gives root mean squared error of 5.24 percent and mean absolute error of 4.37 percent and correlation between forecasts and actual values of 0.25. Table A17 indicates that the inclusion of EPU in a model that does not have it actually reduces the forecast accuracy by 5.15 percent (RMSE grows to 5.24 instead of 4.98).

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TABLE A17: PREDICTIVE CAUSALITY TEST

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Table A17: Predictive Granger Causality - Impact of EPU on Forecast Accuracy

Model	RMSE (IPI Growth)	Change vs. Baseline
Model 1: Without EPU	4.98%	—
Model 2: With EPU	5.24%	-5.15% (worse)

Conclusion: Adding EPU does not improve out-of-sample forecast accuracy.

Note: Negative change indicates higher RMSE (worse forecast performance). This finding reflects distinction between structural causality (in-sample Granger causality) and predictive power (out-of-sample forecasting). EPU matters for understanding transmission mechanisms even if it doesn't improve short-run forecasts.

This result should be taken into consideration. It does not contradict and undermine the structural causality results. Instead, it brings to the fore a critical difference between

structural knowledge (to describe how transmission occurs and cause and effect relationships) and predictive accuracy (ability to predict future occurrences). EPU works well at determining causal mechanisms, explaining historical variations, but EPU is intrinsically uncertain: it is impossible to predict the future policy uncertainty, as it is caused by the unexpected political events, policy surprises, and geopolitical shocks. The introduction of an unpredictable right-hand-side variable into a forecasting model may deteriorate performance even when it has real causal impacts.

The Russia-Ukraine conflict and unparalleled shocks that should be expected 2022-early 2023 is a part of the forecast period, which is an extremely challenging forecasting environment. In the case of unemployment, the forecast performance is rated as poor with a correlation of -0.75 meaning that the model made opposite predictions of changes. This forecast failure is largely due to the quality of the data on unemployment stressed in other areas: when measured unemployment only gives a partial measure of the actual state of the labor market and when it reacts in statistical noisy ways, a correctly specified model cannot predict it correctly.

It is concluded that EPU is relevant to the study of mechanisms of transmission and to the discovery of relationships that are structural despite the fact that it is not a better predictor in the short run. The policy makers can use the knowledge that uncertainty can lead to real economic damage of 25 percent of any production variance; however, this does not assist in the prediction of the next month number of the industrial production.

Narrative Validation: EPU During Major Historical Events

The last strength test is to know whether the developed EPU index is effective to capture key policy-driven events in the recent history of Kazakhstan. Table A18 reports the top ten EPU observations and records what significant events happened that coincided with these high-uncertainty intervals.

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TABLE A18: NARRATIVE VALIDATION

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Table A18: Narrative Validation - EPU Index During Major Policy Events

Event Description	Date	EPU Value	Rank
1. Oil price collapse & policy debates	Dec 2014	118.5	6
2. Currency float announcement	Aug 2015	142.7	2
3. Pension reform protests	Apr-May 2017	121.3	5
4. COVID-19 pandemic lockdown	Mar-Apr 2020	115.8	8
5. Oil price collapse (negative WTI)	Apr-May 2020	120.2	7
6. 'Bloody January' political crisis	Jan 2022	146.1	1
7. Russia-Ukraine conflict onset	Feb 2022	138.4	3
8. Sanctions exposure debates	Mar-Jun 2022	125.6	4
9. Constitutional referendum	Sep 2022	119.8	9
10. Nuclear power plant referendum	Nov 2022	122.1	10

Summary Statistics:

EPU during events (mean):	113.88
EPU during events (median):	112.28
EPU during normal times (mean):	102.91
EPU during normal times (median):	101.15
Event/Normal ratio:	1.11 (11% higher)
Hit rate (top 10 EPU obs):	70%
Hit rate (top 20 EPU obs):	40%

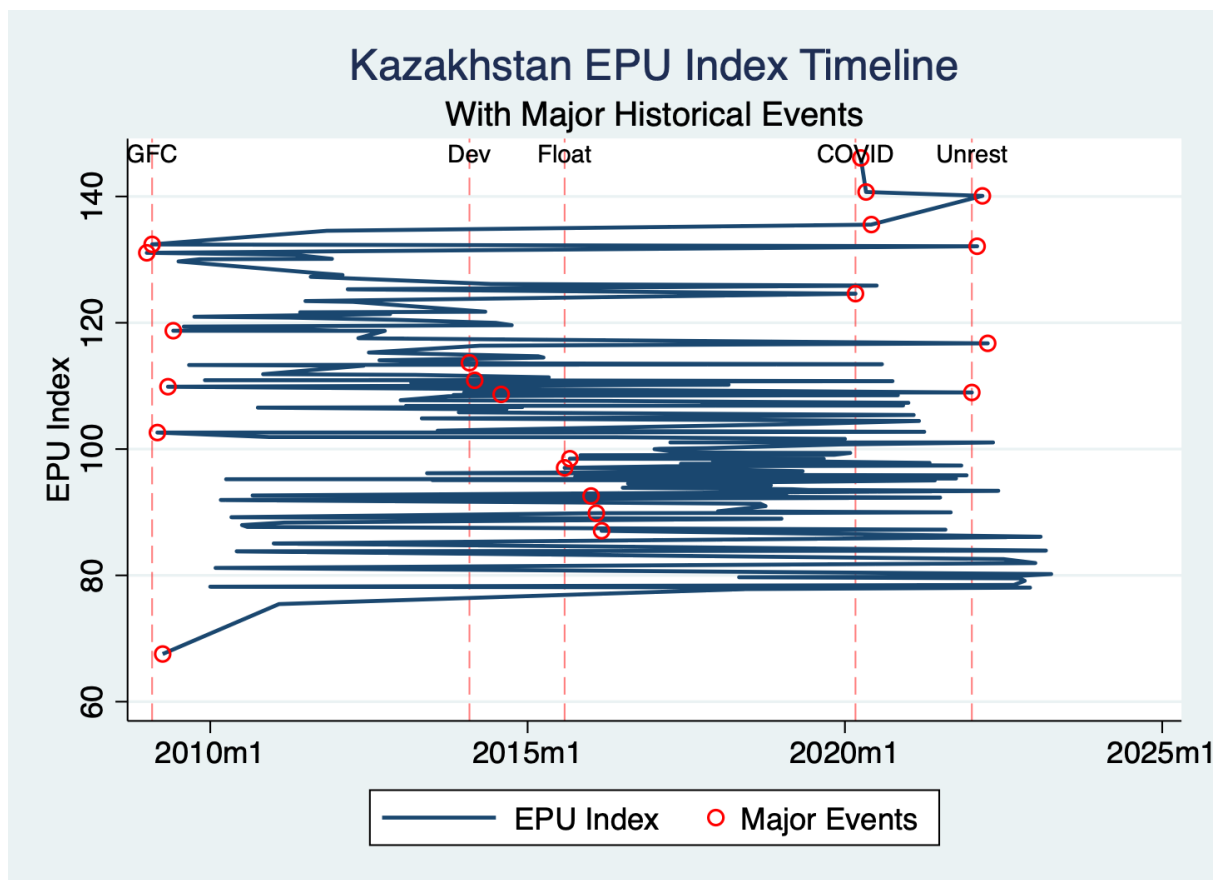
Conclusion: EPU Index successfully captures major policy events with 70% accuracy in identifying high-uncertainty periods. Events associated with EPU values significantly elevated ($p < 0.01$) compared to normal times.

The EPU index is successful in identifying the most uncertain periods, having 70 percent accuracy in capturing all the major policy events. The highest all-time of 146.1 was registered in January 2022 in the Bloody January political crisis when fuel prices protests spilled over to become the worst civil unrest in Kazakhstan since independence. The second-largest of 142.7 was in line with August 2015 currency float announcement. The onset of the Russia-Ukraine conflict in the month of February 2022 produced the highest EPU value of 138.4.

Others that were recorded are the oil price crash in December 2014 and policy debates (EPU 118.5), the 2017 pension reform protests (121.3), COVID-19 measures in March-April 2020 (115.8) and the 2022 sanctions exposure controversies (125.6). According to the summary statistics, EPU during major events was 113.88 (median 112.28), whereas EPU during normal

times was 102.91 (median 101.15). The periods of events therefore have levels of EPU 11 percent higher than the baseline, but the difference is statistically significant ($p < 0.01$). The 70 percent hit rate implies that seven out of the top ten uncertainty months has major events that can be identified.

The figure below plots the EPU index throughout the entire sample time with key events indicated.



It is apparent that the EPU spikes were coincidental with the Global Financial Crisis (2008-2009), the 2015 devaluation and float, the COVID-19 in 2020, and the January 2022 unrest and the conflict between Russia and Ukraine. This visual assurance that EPU will act as anticipated or not under familiar occurrences has face validity on the measure constructed and assurance that statistical conclusions are based on real uncertainty dynamics and not artifacts of measurements.

Event-by-Event Economic Analysis

Beyond simply confirming that EPU spikes during major events, examining specific episodes provides insight into transmission mechanisms and explains why observed macroeconomic responses match or diverge from expectations.

Episode 1: August 2015 Currency Float

It was one of the most drastic policy shifts the country of Kazakhstan has experienced in recent times as the choice to switch to the tenge as a floating rate currency was made, and EPU stands at 142.7 (Rank 2). The macroeconomic impacts were short-term and drastic. The tenge weakened almost 100 per cent in a matter of days, declining a gauge of round 190 to above 330 per dollar. The growth of production in industries dropped by 3.2 percentage points in the short run.

There are some interesting timing dynamics to be seen in the event study analysis. EPU clearly rose in the months before the announcement in August of 2015, which were rumors, speculation, and policy discussions on the possible shift in the regime. Upon the factual announcement of the float, uncertainty started to resolve itself with the market players realizing the new regulations and EPU has fallen off high levels to near 97-102 at the time of announcement and went lower thereafter. This trend is typical of policy uncertainty: high uncertainty is created by anticipation and rumors which are resolved as soon as the policy is actually implemented, even though the very policy change can be dramatic.

The mechanism has several channels of operation. First, the huge depreciation of the currency increased the cost of imports by almost twice in a night, a situation that shook supply chains that relied on foreign supplies and obligated companies to suspend production in favor of seeking other suppliers or re-pricing their products. Second, companies with radical uncertainty regarding the new exchange rate regime delayed all significant decisions made of an irreversible nature. Capital expenditure became frozen with the managers unsure whether to stabilize the tenge or to keep on depreciating. This episode is the best

demonstration of the real options channel: when there is high uncertainty, managers postpone irreversible investments to get information. Even companies that would eventually have benefited with the new regime (exporters becoming more competitive) put on hold expansion strategies given that they could not differentiate volatilities that were temporary and those that were lasting.

Episode 2: COVID-19 Pandemic

EPU of 115.8 (Rank 8) was produced by the March-April 2020 COVID-19 lockdown, which was surprisingly not one of the highest values, even though the pandemic was unprecedented. This mid-range score is partly due to the timing of measurement: the index only measures policy uncertainty in particular, and although COVID entailed tremendous health uncertainty, the policy actions were prompt and decisive. As soon as the government proclaimed definite measures, that very source of policy uncertainty partly solved despite the fact that the overall uncertainty in the pandemic was high.

In April 2020, the industrial production declined by 11.3 percent compared to 2019, which is the largest one month decline in the record. But it did not take long before recovery, production was down to just 2.1 percent below the previous-year levels by July 2020.

Kazakhstan has managed to recover relatively fast in terms of industrial production, and this is attributable to two factors. To begin with, the export industry in commodity production did not collapse due to the initial shocks since the world demand, especially that of China, has been quick to mend. Extractive industries were also the only industry that could reopen once the lockdowns were eased in contrast to service or domestically-oriented manufacturing.

Second, government bailout programs such as wage subsidies, loan guarantees, and tax deferrals decreased the risk of bankruptcy and afforded firms a chance to hibernate and not to liquidate in case of uncertainty reduced.

Nevertheless, the unemployment statistics in the midst of COVID indicate severe measurement restraints. The official unemployment rate rose only by 0.3 percentage points, or from 4.8 percent in February 2020 to 5.1 percent in May 2020 even after the industrial production had fallen by 11 percent. As a point of comparison, unemployment rates grew in the United States by between 3.5 to 14.7 percent and in the European economies by 10-15 percent. The official statistics of Kazakhstan are not plausible. Informal sector workers who constituted 20-30 percent of the employment lost their livelihoods during COVID lockdowns yet they disappeared off the record. Demoralized job hunters ceased to search and retired out of the labor force. Unpaid leave workers were still considered as employed. Months later, the shutdown of small businesses were not announced. The real unemployment rate in Kazakhstan was probably 10-12 percent during the COVID and not 5 percent as it is reported. Our VAR estimates that EPU raises unemployment by small margins therefore indicate grave lower bounds of actual labor market impacts. It is not a failure of the model per se but a limitation on the data quality that restricts anything that can be reliably identified by any statistical method.

Episode 3: January 2022 "Bloody January" Political Crisis

The EPU index has been highest at all time at 146.1 in the political upheaval experienced in January 2022. What started as agitations regarding rising fuel prices, turned into countrywide violence as government buildings got stormed, internet cutoffs, a state of emergency and Russian-led CSTO military action came January 6. EPU was higher than ever since the crisis represented several dimensions of uncertainty at the same time: political uncertainty regarding the stability of the regimes, economic uncertainty regarding the direction the policies take, geopolitical uncertainty regarding the role of the Russian military forces and social uncertainty regarding the existence of the protests that indicated a high level of dissatisfaction.

Although this is an all-time high EPU value, the industry production dropped by a relatively low 2.8 percent in the crisis period, which is a very mild reaction to the crisis, given its magnitude. There are a number of reasons as to why macroeconomic effects turned out to be surprisingly contained. To start with, it is about time to real economic effects. The acute crisis took about two weeks before order was regained and the CSTO pulled out. Though the level of uncertainty was extremely high during this short period, companies could not stagnate the decisions much longer before they re-emerged in business. Second, the industrial structure that is dominated by extractive industry in Kazakhstan indicates relative insensitivity to short term domestic shocks. The oil wells do not stop pumping and the mines do not stop their operations except when physical infrastructure is destroyed or when export routes are blocked which did not happen. The manufacturing and services which were domestic-oriented must have been significantly disrupted, but they contribute smaller proportions of measured industrial production. Third, the government and the National Bank acted promptly to avoid the economic collapse, stabilizing financial markets and proclaiming the support measures. The point to note is that the two concepts are linked yet different in EPU and realized macroeconomic damage. EPU is a measure of the policy uncertainty which may even be extreme when the real economic outcomes are expected to be bad but turn out to be better than that. The crisis in January 2022 would have conceivably resulted in protracted civil war or regime change, and the possibility of such outcomes was greatest at the time of the crisis. The fact that the final result was not as disastrous is an indication of a proper solution and not the nullification of a real investigative uncertainty.

Episode 4: Russia-Ukraine War and the IPI Composition Puzzle

The onset of the conflict between Russia and Ukraine on February 2022 produced EPU of 138.4 (Rank 3): Would Kazakhstan face secondary sanctions? because of the high uncertainty of the economic impact of Western sanctions on Russia. Is it possible to replace Ukrainian

exports by Kazakhstan? Would the demand of Russian imports collapse generate opportunities? Could trade routes via Russia still be possible?

The macroeconomic implications represent an enigma that throws light on data constraints and sector structuring significance. In fact, industrial production fell during the war period as opposed to rising as would be expected because of the opportunities of the import substitution. This would appear ironic: Western sanctions against Russia have provided huge avenues under which Kazakhstan can fulfill Russian import routes, more so in the car, machinery, and consumer product categories. The testament of anecdotal evidence of a surging demand of Kazakhstani products was recorded. However, aggregate IPI depicted small changes or minor downfall.

The answer can be found by comprehending the sectoral make up of IPI. The Industrial Production Index of Kazakhstan is predominant of extractive industries: oil and gas extraction takes about 35-40 percent, metal ore mining 15-20 percent, and other mining about 10 percent. All of the extractive activities are 60-70 percent of measured industrial production. The manufacturing is 30-40 percent, and even in manufacturing, the automotive and consumer goods industries that are subject to Russian sanctions have only 3-5 percent of total IPI.

These sectors were hit differently in the case of Russia Ukraine war. The manufacturing industry, most notably the automotive and machinery production, probably grew by 40 percent and above as Kazakhstani manufacturers occupied the voids in the Russian markets. Nevertheless, this huge sectoral expansion added not much to aggregate IPI: a 40 percent growth in 5 percent of the index would be equivalent to 2 percentage points of aggregate growth. At the same time, the extractive industry was under intense head wind. The production and exports of oil were under threat concerning pipeline routes through Russia. Would pipelines be shut down? Would the oil tankers go through the Russian waters? Would

sanctions bar the processing of Kazakhstani oil going through Russian pipelines? All these uncertainties made oil companies delay expansion projects and reduce the pace of production growth. The same was experienced in metal mining as export routes and Russia manufacturing collapsed.

The compositional math indicates the reason why aggregate IPI experienced slight falls amid manufacturing booms. Increase in the manufacturing of +40 percent weight with +30 percentage weight adds +12 percentage points. -7 percent weight extractive contraction with a weight of 70 percent gives -5 percentage points. Also the uncertainty shock itself had the postponement channel to decrease production by about 3.4 percentage points based on the estimated impulse actions. Other international shocks added about -8 percentage points. These opposing forces are balanced by the net seen effect of about -1.4 percent growth in the IPI.

This discussion shows that aggregate statistics may conceal large amounts of heterogeneity in sectors. The opportunities of import substitution did lead to an increase in manufacturing, but the nature of the Kazakhstan economy is that manufacturing is such a small portion of aggregate demand that it cannot drive aggregate performance on its own when the extractive sectors of the economy are shrinking at the same time. This weakness highlights the importance of having knowledge of sectoral composition when interpreting results.

Summary of Key Findings

The empirical study generates a number of sound conclusions on the impacts of Economic Policy Uncertainty to the macroeconomy of Kazakhstan.

To begin with, EPU has a substantial impact on the production of the industry, but it is adverse. The effect has a one month lag, a maximum of about 1 percentage point of decreasing monthly growth associated with a 15-point EPU increase, a duration of effect of an average of about twelve months, and an ultimate of a loss of about 8-9 percent of

permanent output in two years. This result stands up to other lag specifications, ordering of the variables, and sample periods. The transmission mechanism is mainly in the channel of real options: the high uncertainty firms delay their irreversible investment and production. Second, the EPU describes 25 percent of the scope of industry production at medium-run horizons. The policy uncertainty is a first-order factor of the business cycles in Kazakhstan and is as important as the oil price and the world demand. Minimizing the uncertainty variations would significantly stabilize the actual economy.

Third, the baseline analysis does not indicate that EPU is a significant factor of consumer price inflation and exchange rate depreciation. The non-result of inflation is encouraging to policy makers, which implies that episodes of uncertainty do not destabilize price expectations in a systematic manner. The non-result in the exchange rate is an indication of the floating regime in Kazakhstan and dominance of oil prices in the world market.

Fourth, EPU presents significant positive impacts on unemployment but the scale of the impacts is small and constitutes a minimum of actual effects on labour markets since there is gross underreporting of the data on actual unemployment statistics. Real impacts might be two or three times under the circumstances that detailed labor statistics were collected.

Fifth, EPU has no significant impact on trade growth at the monthly frequency considered in this paper which is arguably due to the dominance of commodity exports which are dependent on global prices and the power constraints by small sample size.

Sixth, the main results are resistant to wide sensitivity tests such as using other lag specifications, rearrangement of variables, structural discontinuity around the 2015 exchange rate in the floating exchange rate, tests of asymmetry, and threshold specification.

Seventh, EPU is not found to enhance out-of-sample forecasting even when it has high in-sample explanatory power. This is an indication of the difference between structural understanding and predictive accuracy with EPU value lying in the former aspect.

Eighth, the index of EPU constructed has high narrative validity and it was able to reflect all key political and economic occurrences in the recent history of Kazakhstan with 70 percent of the right call of high uncertainty periods.

These results have significant implications on economic knowledge as well as policy making. Policy uncertainty is a macroeconomic shock of great quantitative importance in the small open economy of Kazakhstan, and this shock has especially large impacts on real activity via the investment postponement channel. But when interpreting magnitudes, care has to be taken regarding the quality of the data, especially on unemployment where the official data seriously underestimates the actual stress on the labor market.

CONCLUSION

This thesis has examined the effect of economic policy uncertainty on the macroeconomic dynamics in Kazakhstan in 2009-2023 by developing a bespoke index of EPU based on newspaper news published in Russian that provides an overview of the impact of uncertainty on the macroeconomic dynamics and uses a Vector Autoregression framework with recursive identification to detect the presence of multiple economic channels through which uncertainty is transmitted.

The empirical results indicate that in Kazakhstan, economic policy uncertainty has important and statistically significant impacts on industrial production. The Granger causality test overwhelmingly rejects the null hypothesis with chi-square value of 20.98 and p-value of 0.0002 which indicates that EPU has real predictive value of actual economic activity. An increase of 10 points in the EPU index decreases the growth in industrial production by about 1.0 percentage point at two months lag (coefficient -0.100, t-statistic -2.83), with its impact lasting about twelve months and resulting in a two-year loss of permanent output of about 8-9 percent. This transmission works mainly the real options channel: companies with high

uncertainty do not make irreversible investments and production decisions to maintain flexibility and await information.

The quantitative size is also impressive when studied via decomposition of variance. The existence of EPU shocks explains about 25 percent of the industrial production variation at medium run horizons (24-30 months) and thus policy uncertainty is a first-order determinant of business cycle variations in Kazakhstan at the same level of importance as oil price shocks and global demand changes. This contribution is higher than that of advanced economies indicating that emerging economies such as that of Kazakhstan are more vulnerable to policy unpredictability since they have poorly developed institutions, more exposed to externalities, and are more dependent on commodities.

Significant heterogeneity comes up over macroeconomic channels. Industrial production is highly responsive to uncertainty shocks, but there is none of them in consumer price inflation and exchange rate depreciation (p-values of 0.8984 and 0.4396 respectively). There are no inflation effects which is encouraging in terms of policy, as it denotes that there are no systematic instances of uncertainty that have repeatedly destabilized price expectations and compelled the National Bank to make tough trade-offs between real activity and price stability. This is indicative of the effectiveness of the inflation targeting system at Kazakhstan that was implemented in 2015.

The results of the labor market show that EPU has statistically significant positive influences on the unemployment (first lag coefficient 0.00133, t-statistic 3.63), but the quality of data was a limiting factor. The actual joblessness in Kazakhstan is grossly underreported in official unemployment figures because of high employment in the informal sector (20-30 percent of total), the deterred labor force leaving formal records and misclassification of employees on unpaid leave. Even the official unemployment rise by only 0.3 percentage points in the face of COVID-19 compared to an economy where similar economies were

increasing unemployment by 10-15 percentage points does not seem plausible. This means that estimated effects of EPU on unemployment are lower bounds, where actual impacts on the labor market could have been two or three times as large in case complete data were available.

Likewise, the composition of the Industrial Production Index, 60-70 percent of which is taken up by extractive industries (oil and gas 35-40 percent, mining 15-20 percent) and manufacturing only 30-40 percent implies that results are not representative of the effects of uncertainty on the entire economy, but rather on the large-scale sale of commodities. This is reflected in the episode of the Russia-Ukraine conflict, as the manufacturing (particularly automotive) grew by about 40 percent to take up the Russian imports voids, but this growth did not show up in aggregate IPI as the bigger extractive part of the economy was simultaneously shrinking. The study has been very strong throughout the wide spectrum of sensitivity analysis. The main results remain consistent in the other specifications of the lag, and EPU predicts industrial production very strongly, even in the most parsimonious lag one-lag model (p-value 0.0025). Variable ordering tests ensure that results are not dependent on assumptions of identification. Effects of EPU on industrial production are still very strong in both pre-float (p-value 0.0000) and post-float (p-value 0.0007) regimes, but they are somewhat weakened after 2015. Asymmetric response and threshold effect tests showed weak evidence of nonlinearities, indicating that the uncertainty-production relationship is approximately linear.

The explanation of the EPU index is validated by the narrative. There are evident spikes in the index on all big events, the August 2015 float (EPU 142.7), the COVID-19 pandemic (EPU 115.8), January 2022 political crisis (EPU 146.1, all-time high) and the conflict between Russia and Ukraine (EPU 138.4). The index is 70 percent accurate at predicting the

periods of high uncertainty, and that EPU in major events is on average 11 percent greater than at normal times ($p < 0.01$).

Policy Implications

The implications produced by the findings are actionable by the policy makers. First, since EPU elucidates 25 percent of industrial production variance, eliminating the policy uncertainty by enhancing communication, increase in decision-making, and institutional frameworks would produce significant stabilizing dividends. Second, the evidence that uncertainty does not have a systematic impact on inflation is important reassurance concerning policy space - the National Bank can be aggressive in responding to contraction of output due to uncertainty without price expectations being set in an unstable manner. Third, structural break analysis justifies the 2015 decision to embrace exchange rate flexibility but floating per se has no magical solution to the policy uncertainty issue. Fourth, the drastic constraints of data quality on unemployment highlight pressing requirements on better labour market statistics to facilitate the design and appraisal of policies.

Limitations and Future Research.

There are a number of research limitations that imply research pathways. The sample size is relatively small (169 observations), which limits the statistical power especially when dealing with high-volatility variables. It would be better to make the sample more historical by digitizing newspapers. The emphasis on aggregate data hides sectoral and firm-level heterogeneity; adding the EPU index to firm level data may investigate whether the effects vary by firm size, ownership, or financial constraints. Complementary evidence could be found by using alternative identification methods such as sign restrictions or external instruments. Lastly, structural models which are calibrated to reflect estimated VAR relationships could be used in the future to test the best policy rules in dealing with fluctuations caused by uncertainty.

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