Estimating Kazakhstan's neutral interest rate and its implications for monetary policy

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1 Introduction

Kazakhstan joined the list of countries that implemented inflation targeting regime in 2015. Before that, central bank was de-facto targeting USD/KZT exchange rate. National currency was devalued thrice in the period between which 2009 and 2015 which led to decrease in exchange rate from 120 to 300 KZT per US dollar. International reserves were put under pressure every time the central bank - National Bank of Kazakhstan, hereinafter called NBK - tried to intervene to stabilize the exchange rate. NBK had decided that going forward focusing on a price stability mandate would be more beneficial for the economy. The central bank's "base rate" become the main tool of conducting monetary policy.

In such regimes having understanding of "natural" or "neutral" interest rate, rate that neither stimulates nor restricts the economy, is of great importance. It is a rate that equates output to its potential. However, this variable is not observed directly. This paper provides additional estimates for Kazakhstan's economy. Terms "neutral" and "natural" are often used interchangeably and will be used in this paper as such, albeit some authors distinguish them, e.g. depending on the term for which they will get their estimation for. Since author heavily relies on methodology by Laubach and Williams (2003), this paper leans towards meaning that estimates produced here represents medium to long term interest rate.

Author's motivations to produce an estimates of neutral interest rate are several. Not counting aforementioned reason of evaluating monetary policy, it also helps to understand state of the economy. And because Kazakhstan is developing country and, for now, highly unlikely to hit effective lower bond ELB(or zero lower bound - ZLB), there is room for a central bank to impact the economy with its policy rate decision. It is also variable of interest for a general public as it can be used to understand what the range of possible central bank's decisions is, how far regulator is from reaching its target inflation rate and whether this target is reasonable at all. Non-surprisingly, successfully reaching or at least moving towards target rate should reinforce inflation expectations and make achieving this target easier.

Official estimates of neutral rate are not provided on a regular basis therefore having alternative estimates should lead to a better understanding and accuracy of forecasting Kazakhstan's economy.

This paper's structure is following. The extensive research dealing with this topic has evolved over the years because several methods have been used and developed, and section 2 will cover those. Section 3 gives brief description of data and lay out methodology. Section 4 presents and discusses the results. Summary of the findings will conclude.

2 Literature review

Often, Wicksell, 1898, is cited as one who gave the definition of a natural interest rate associated with stable prices and the output at its potential. Obstfeld, 2023, points out to Hayek, 1939, and his linkage of Wicksell rate to Thornton's speeches in 1810 where stipulation, that mismatch between Bank of England's rate and "the more current rate of the merchants" will lead to increased demand, is made. Although what this rate is or should be was not specified. This topic was forgotten for a while but gained traction since inflation targeting regimes started to become more prevalent.

Nakano, Sugioka and Yamamoto conducted one of the recent wrap-ups on this topic and categorized method estimations in 4 groups: Time series model, Term structure model, Semi-structural model, Structural model. First group is based on extracting trends from the interest rate time-series and treating it as a natural rate. Second group tries to extract short-term implied forward rate from the term structure and remove associated risk premium to get to the risk free interest rate. Semi-structural model employs structural equations such IS and Philips curve to capture relations between key macroeconomic variables, while structural model try to include all agents present in the market and simulate their behaviour.

In 2001 Laubach and Williams wrote one of the most prominent papers on a topic estimating the US neutral interest rate. In continuation of their work, Holston, Laubach and Williams 2017 applied LW methodology to 3 other developed economies to determine common factors influencing downward movement in natural interest rates. In principle, they specify neutral interest rate as $r_t^* = c*g_t + z_t while relating output gap, interest rate gap, inflati$

Benati, 2023 proposed very different method from those described above. He relates M1 velocity (inverse

of M1 aggregate to GDP) and natural interest rate and unlike the other models this simple relation makes real interest rate "observable" as M1 velocity basically represents stochastic trend of the neutral interest rate.

However, estimates for developing economies are less abundant. Ruch estimated neutral interest rates for 20 developing economies using several methods, and confirmed that the dynamics of their neutral interest rates trends downward similarly to advanced economies. However, such movements are less likely to be explained by global trends than domestic characteristics. Estimates are also more volatile in developing economies. Credibility of the central bank was also tested and the less credible monetary policy was connected to higher neutral interest rate estimates

Lahura E. and Vega M., 2023, produce estimates of natural interest rate for Chile and Peru. They compare 2 methodologies and come up with a conclusion that in their case time varying parameter vector autoregression model with stochastic volatility (TVP-VAR-SV) performs better than one developed using methology from Benati (2023). TVP-VAR metholody was introduced by Primiceri, (2005) with a later corrigendum brought forward by Del Negro, M. and Primicerio, G.E. (2015).

Teodoru, I.R. and Toktanalieva, A. (2020) estimated neutral interest rate using projection model used by Kyrgyz Republic's central bank. They have determined that neutral interest rate is mostly determined by the risk premium and real exchange rate dynamics.

The publicly available estimations of neutral interest rate in Kazakhstan are mentioned by IMF in their Article IV reports. IMF's working paper (2017) gives overview of estimating neutral in Kazakhstan by several methods. National bank of Kazakhstan also regularly publish survey of professional market participants where they express their opinions regarding several economic indicators, neutral interest rate among them, however without providing own estimates

None of the methods are perfect and have their own limitations. Estimations based on time-series methods might change as new observations become available. Model-based estimations are heavily dependent on assumptions and model specifications.

3 Estimation

3.1 Methodology

The first estimate is built on simplified version of the Laubach-Williams model. Author follows the Laubach-Williams 2023 implementation of their model from 2001 with small adjustments. The measure correcting for COVID-2020 is removed from the model.

Following equation is used first

$$r_t^* = cg_t + z_t \tag{1}$$

Key equations: specifications of IS and Phillip's curves are preserved.

$$\tilde{y}_t = A_y(L)\tilde{y}_{t-1} + A_r(L)(r_{t-1} - r_{t-1}^*) + \epsilon_t \tag{2}$$

$$\pi_t = B_\pi(L)\pi_{t-1} + B_y(L)\tilde{y}_{t-1} + \eta_t \tag{3}$$

In the Phillip's curve consumer prices index is used as an inflation rather than core inflation, difference between import inflation and oil inflation from core inflation are excluded from the equation due to lack of data .

Alternative estimate will be produced using TVP-VAR-SV method from Primiceri (2005) replicated by Lahura E., Vega M., (2023). Theoretically, this method should be able to better deal with nonlinearity of the data. The model consists of inflation, output growth and ex ante real interest rate which is nominal rate less inflation expectations. Model is 2nd order VAR model with time varying parameters of lagged variables and stochastic volatility in variances matrix. Inflation expectations are modelled as 4 period moving average. In this model neutral interest rate is estimated for the period from 1Q2021 until 1Q2025. TVP-VAR has following general form

$$y_t = c_t + B_{1,t}y_{t-1} + \ldots + B_{k,t}y_{t-k} + u_t \tag{4}$$

where parameters $\tilde{B}$ and $\tilde{u}$ are time varying

3.2 Data description

Nominal GDP and 12-month deflator provided by Bureau of National statistics, where quarterly value of nominal GDP is difference between consecutive periods' values. Real value then obtained by dividing by GDP deflator for appropriate quarter and then log of that is taken. First available data starts in 1994, but until 1998 national accounts the system used in the Soviet union. First several years of independence were characterized with hyperinflation. During first years of independence monetary aggregates and exchange rate were targeted. Therefore including first 4 years significantly distorts the estimation results. There is also clear seasonality where 1st quarter of the year is almost always produces lowest amount of product, while 4th produces the most. Author has obtained data prior to 2010 via central bank. While this time period is tried for estimation, the results are only produced using publicly available time-series.

The log of output is then processed with X12-ARIMA. It removes undesired seasonality while preserving enough information to identify both output gap and neutral interest rate. For inflation time series CPI provided by Bureau of National statistics is taken, unlike core CPI of LW. For each quarter, last month's inflation with respect to previous 12 months, e.g. (2010-Q1 is change between March 2010 and March 20) For short term interest rate: history of central bank's decision on a key interest rate - refinancing rate and later called base rate (since 2017). If several decisions made during the quarter, the rate is averaged.

4 Results

First and foremost, these are not robust estimations as low t-statistics for most of the parameters show.

There are significant differences in estimations between US and Kazakhstan. Coefficient *a1*, which is IS curve slope is smaller in magnitude for Kazakhstan meaning current output gap depends less but still positively on output last quarter. However 2nd order lag is also positive unlike in US which. There is also a stronger reaction to deviation from natural rate in Kazakhstan perhaps pointing to a higher importance of getting policy decision right. For Kazakhstan, inflation strongly depends on its first lag but joint effect of lags from 2nd to to 8th period ago is relatively small.

	US		Kazakhstan	
	Coeff.	T-stats	Coeff.	T-stats
a_1	1.38	12.72	0.37	1.89
a_2	-0.43	3.81	0.20	1.05
a_3	-0.08	4.37	-0.54	1.28
b_1	0.59	12.80	1.16	7.34
b_2	0.37	6.79	-0.35	1.79
b_3	0.04	1.77	0.025	0.32
b_4	0.00	2.88		
b_5	0.04	4.98		
c	1.05	2.66	0.47	0.85
sigma_1	0.45	4.41	2.92	7.45
sigma_2	0.76	27.64	2.05	11.39
sigma_4	0.51	5.86	0.34	1.27

Now change the lower bound constraint on the Philips curve from 0.025 to 0.1 and 0.3 which were taken from the IMF (2024) is estimated. Interestingly, constraint is hit when it is set to 0.01 and 0.025 but once constraint increased to 0.03, coefficient estimated at higher level of 0.0539, albeit with approximately same low level of T-statistics.

Neutral interest rate and output gaps estimates received from these specifications while differ at levels display very similar dynamics.

	0.01		0.025		0.03	
	Coeff.	T-stats	Coeff.	T-stats	Coeff.	T-stats
a_1	0.40	2.17	0.37	1.89	-0.22	0.75
a_2	0.20	1.07	0.20	1.05	-0.12	0.59
a_3	-0.53	1.35	-0.54	1.28	-0.75	1.88
b_1	1.15	8.10	1.16	7.34	1.17	7.88
b_2	-0.35	1.91	-0.35	1.79	-0.36	1.83
b_3	0.01	0.12	0.025	0.32	0.0539	0.22
c	0.44	0.86	0.47	0.85	0.17	0.20
sigma_1	2.97	7.78	2.92	7.45	1.91	4.55
sigma_2	2.04	11.88	2.05	11.39	2.03	9.30
sigma_4	0.26	0.89	0.34	1.27	1.11	3.49

Up until 2014 neutral rate is relatively stable. After that it declines throughout 2015 and 2016. Start of the decline coincides with devaluation of the currency. Next episode of devaluation happens in 2015. Neutral rate starts to pick up again up until global pandemics hits in 1st quarter of 2020 up. It starts to accelerate in 2022 and stay elevated until present. Real rate follows the output gap almost one-to-one.

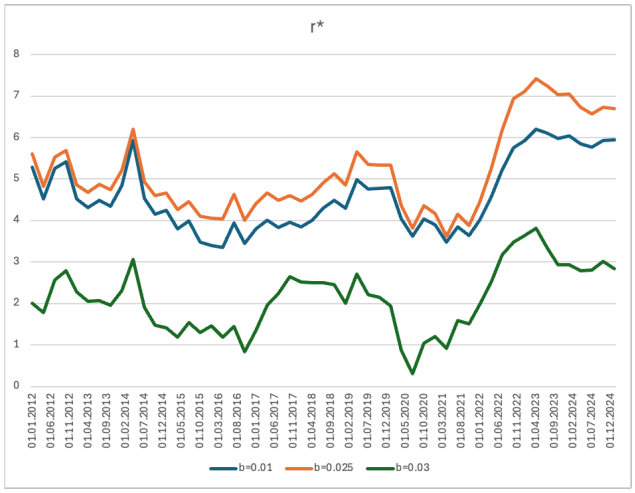

Figure 1: r* with different Phillip's curve slope constraint

The real rate expressed as nominal less inflation, or as nominal less inflations expectations, also started to rise as central bank kept interest rates high to combat inflation. And yet, according to the model over the most of the period real interest rate gap was negative implying that policy rate was not high enough and the monetary environment was stimulative.

This estimation of the model does not adjust for the COVID pandemic. Significant pressure exerted in the fiscal space from government spending and support. The government conducted several actions to support the economy during that time, such as a one time-payment to all individuals, initiating lending financing program via central bank's subsidiary, effectively printing money. In fact, if last 3 years excluded from the analysis estimate produced starts at 4.3 percent in 2012 and gets to 2.9 at the end of 2021 year. This result is far closer to what had been previously estimated by other authors such as IMF (2017).

Second method produces following estimates. Figure 3 displays the parameters values estimated by the model for the real interest rate variable. They are not static but have very low time variation, very similar to simple VAR model.

Neutral rate estimated by this model goes negative in 2022. This seems highly unlikely and most likely happens that model tracks real interest rate too closely.

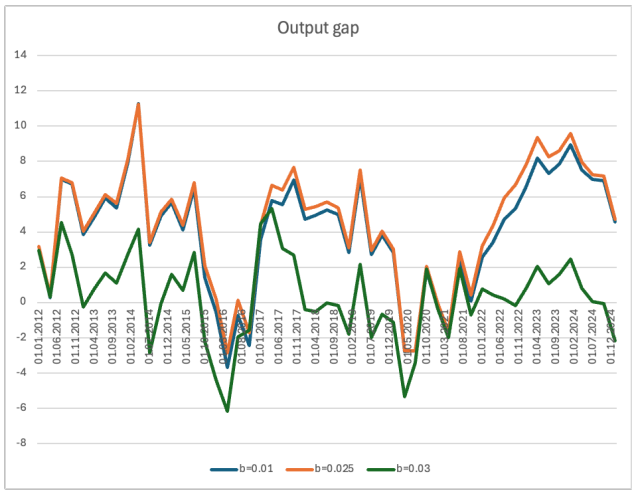

Figure 2: Output gap with different Phillip's curve slope constraint

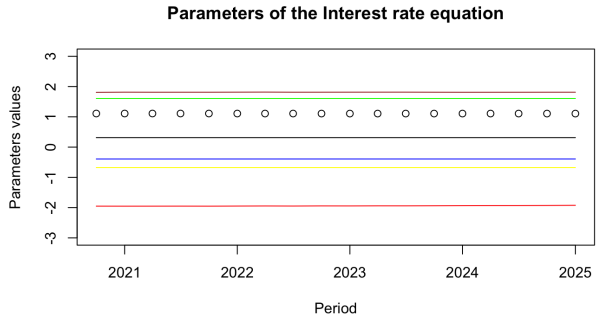

Figure 3: TVP-VAR parameters

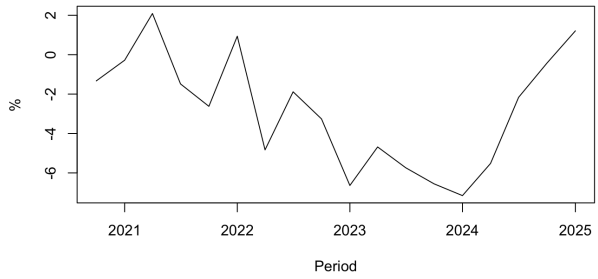

Figure 4: TVP VAR estimation of neutral rate

All series are tested for stationarity using Augmented Dickey–Fuller test and all time series are non stationary at their level, and stationary at first difference. Author also conducts pairwise Engle-Granger test with no trends and Johansen test, confirming that they are cointegrating.

5 Conclusion

Now we have obtained the results they should be explained carefully. Per LW specification, this estimate is not the one obtaining NBK's inflation target, but the one that will help to stabilize the inflation at undetermined level. LW methodology is not able to produce robust estimates of neutral interest rate and associated output gap for Kazakhstan data. However dynamics of the indicators are plausible.

Estimations produced by TVP-VAR-SV model are also heavily influenced by priori choices of the modeller. In our case, period from which priori extracted spans 10 years but half of it is in the period before inflation targeting was introduced and the aftermath of the GFC was still noticeable. Likely, with an addition of new observation a better priori can be assumed which will improve the estimation process.

It is also needed to be remembered that central bank neither blindly follows reaction function implied in the model nor any other specific rule, Taylor's or otherwise, for that matter. Any estimate cannot be a sole and deciding factor in determining monetary policy. Uncertainty with which it produced cannot be overlooked. Despite this, estimation provided can used in ensemble with others with a goal to provide an more accurate measure of the natural interest rate. The decision to set policy rate, while acknowledges the rules, still takes bigger picture into account. In author's opinion the aim is not hit on target perfectly all of the time but moving closer to target.

The analysis that lies herein is not conclusive and warrants further research on application of methods of estimating the natural rate and factors that influence neutral interest rates such as determinants, technological advancements, economic structure, financial conditions, and trade balance and asset values. However, it should provide additional information to both decision makers in the central bank and those who are interested in the developments of Kazakhstan's economy.

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Appendix.

Table 1: Johansen Cointegration Test Results

Null Hypothesis	Test Statistic	10%	5%	1%
$r \leq 2$	1.32	6.50	8.18	11.65
$r \leq 1$	9.64	15.66	17.95	23.52
$r = 0$	39.68*	28.71	31.52	37.22

Notes: Trace test statistics with linear trend specification. Eigenvalues: $\lambda_1 = 0.399$, $\lambda_2 = 0.131$, $\lambda_3 = 0.022$. * denotes significance at 5% level.

The Johansen trace test indicates one cointegrating relationship among the variables, as the test statistic for $r = 0$ (39.68) exceeds the 5% critical value (31.52).