THE EFFECT OF MONETARY POLICY REGIME ON THE DEVELOPMENT OF THE ECONOMY

BY

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THESIS

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1. Abstract

This work investigates how the Kazakhstani economy is affected by the monetary regimes, given the susceptibility to volatile oil prices and foreign capital flows. Dynamic Stochastic General Equilibrium Model (DSGE) was utilized to analyze the effect of shocks on real GDP, consumption, investment, wages, exports, imports, prices, and real exchange rates. Next, the effectiveness of fixed exchange rates, inflation targeting, strict inflation targeting, and hybrid inflation targeting monetary policy regimes in smoothing the impulse of shocks on the above-mentioned variables. The results suggest that hybrid inflation targeting regime has relatively better performance.

2. Introduction

The focus on how monetary policy drives economic outcomes is critical, especially for a small, open, oil-exporting economy like Kazakhstan. The National Bank plays a crucial role in maintaining the macroeconomic balance through its monetary policy instruments. Kazakhstan switched to free floating exchange rate and inflation targeting monetary policy regime (National Bank of the Republic of Kazakhstan, 2021). Despite this fact, Kazakhstani economy has been experiencing instability and high inflation during the last four years. As a result, studies on the optimal forms of monetary policy have become a priority of interest to most policymakers and academicians.

As a country heavily dependent on oil exports, Kazakhstan demonstrates a need for robust monetary policies since oil price volatility seriously impacts its economy. This is due to the country's reliance on oil earnings and foreign capital flows. Research by Paranavithana et al. (2021) and Algozhina (2016) examines the effectiveness of different monetary regimes in similar contexts and suggests that inflation targeting and an exchange rate regime with minimum intervention could reduce the impact of external factors.

This thesis attempts to evaluate the performance of different monetary policies on Kazakhstani economic development using the Dynamic Stochastic General Equilibrium Model (DSGE). The model presented in this work was inspired by the studies of Drygalla (2023) and Justiniano & Preston (2010). It includes very important features of Kazakhstan, such as the oil sector, exchange rate interventions, and the impact of foreign capital flows. The thesis targets identifying an optimal monetary policy regime that balances economic stability and growth by simulating various shocks. As a result of simulations, considering output growth along with inflation while setting policy rates might be optimal.

3. Literature Review

The report about Kazakhstani monetary policy provides the history of its evolution and current situation (National Bank of Kazakhstan, 2021). There we can observe the dynamics of various monetary policy regimes. Also, it reports the challenges that Kazakhstan faces today, for example, susceptibility to external shocks, pro-cyclical fiscal policy and weak transmission of monetary policy.

The importance of the role of central banks in maintaining macroeconomic stability could rarely be overestimated. Research about the optimal monetary policy regime in different types of economies is a popular topic among scholars. Paranavithana et al. (2021) concentrated their research on Sri Lanka, a small open economy like Kazakhstan. They consider supply, demand, external shocks, inflation targeting, nominal GDP targeting, monetary aggregate targeting, and Taylor rule regimes. The authors argue that the inflation-targeting regime could maintain the lowest volatility in welfare following all the above-mentioned shocks happening separately and simultaneously. Also, this regime can tackle the effect of external shocks on output, while nominal GDP targeting achieves the lowest volatility when all the shocks are combined.

On the contrary, Alba et al. (2020), who consider several small open economies such as Hong Kong, Taiwan, South Korea, Singapore, and Israel, found that following the Taylor rule can produce higher welfare in countries that have flexible prices and lower shares of oil imports in world oil consumption.

Taking into account the fact that Kazakhstan is an oil-exporting country, Algozhina (2016) used a DSGE model to observe the effect of various shocks on macroeconomic variables such as output, consumption, foreign direct investment, etc. The results reveal that the floating exchange rate allows the economy to adjust without central bank interventions, CPI inflation targeting, and countercyclical fiscal policy to offset the impact of oil price shocks on macroeconomic variables.

Moreover, the work of Drygalla (2023) has given a framework for locating the development implications of monetary regimes. The paper examines in detail the effects of monetary policy in Russia and underlines that optimal policy design depends upon external conditions. Similarly, Justiniano & Preston (2010) show how the choice of prior distributions and model specifications, especially when estimating Bayesian models, influences the robustness of DSGE models for monetary policy analysis. These works together will provide a theoretical and methodological basis for the investigation into the specific features of monetary regimes in oil-exporting countries such as Kazakhstan.

4. Methodology

The model was inspired by the benchmark study by Drygalla (2023). Dynamic Stochastic General Equilibrium (DSGE) model was used in order to find the most optimal monetary policy for Kazakhstan in the presence of several shocks, oil price shock and foreign capital flows shock particularly. The model specifies equilibrium conditions for households' consumption, savings, investment, capital accumulation, labor supply, importers, exporters, and other producers. Given pre-defined prior values of parameters following the research of Justiniano & Preston (2010), the software estimates posterior values using real data and simulates shocks. MATLAB pre-processor Dynare was used for estimation and simulations.

An initial estimate of the posterior mode is derived by using Chris Sims' optimization routine, CSMINWEL, with prior distributions and observed time series for the model's endogenous variables. Estimates of latent variables, like the central bank interventions, are computed through the Kalman filter. The distribution of the parameters is approximated using a single Markov chain of 1,000,000 draws, where the first 50% is discarded as burn-in. Finally, it uses 100 subdraws to calculate the posterior distribution of several quantities.

The author used a standard small open economy considering rigidities, habit formation, and partial indexation. The model includes oil exports since it has a strong influence on state revenues and central banks can intervene in the foreign exchange market by selling and purchasing both foreign and domestic assets.

Foreign economy is assumed to have an impact on the domestic economy and macroeconomic variables. Drygalla (2023) defines the foreign sector as VAR (2) model which includes world output, foreign inflation, oil prices, and foreign interest rates.

$$A_0 \begin{bmatrix} y_t^* \\ \pi_t^* \\ p_{o,t} \\ r_t^* \end{bmatrix} = \begin{bmatrix} \rho_{11}^* & \rho_{12}^* & \cdots & \rho_{18}^* \\ \rho_{21}^* & \rho_{22}^* & \cdots & \rho_{28}^* \\ \rho_{31}^* & \rho_{32}^* & \cdots & \rho_{38}^* \\ \rho_{41}^* & \rho_{42}^* & \cdots & \rho_{48}^* \end{bmatrix} \begin{bmatrix} y_{t-1}^* \\ \pi_{t-2}^* \\ p_{o,t-1} \\ \vdots \\ r_{t-2} \end{bmatrix} + \begin{bmatrix} \eta_t^{y^*} \\ \eta_t^{\pi^*} \\ \eta_t^{o} \\ \eta_t^{r^*} \end{bmatrix}$$

The model is specified by the matrix above. $A_{0\text{Is}}$ a lower triangular matrix, it is required to state that the global economy depends on lagged inflation, oil prices, and interest rates, while current global inflation is a function of current, lagged output, and other lagged variables. Interest rates respond to current output, inflation, and oil prices while they do respond only to past interest rates. $\eta_t^{y*}, \eta_t^{\pi*}, \eta_t^{o}, \eta_t^{r*}$ are independent and identically distributed shocks with zero mean and standard deviations. The distributions of the latter will be specified in the next section.

Oil export volume is given in the following way:

$$o_t = \rho_{oild} * o_{t-1} + (1 - \rho_{oild})(\phi_{y^*} y^*) + \eta_t^{oild},$$

where ρ_{oild} is a smoothing parameter and η_t^{oild} is an independently and identically distributed shock with zero mean and estimated standard deviation. Here it is assumed that the export volume of oil is dependent on the exports in the previous quarter and foreign output since the latter causes the growth in demand for oil.

The central bank possesses two ways of maintaining its policies: setting base rates and making interventions by selling/purchasing foreign and domestic assets.

Base rate rule:

$$r_t = \rho_r r_{t-1} + (1-\rho_r)\left(\phi_\pi \pi_t + \phi_{gdp} gdp_t + \phi_{\Delta e}\Delta e_t\right) + \eta_t^r.$$

Foreign bond sale orders:

$$\omega_{CB,t}^* = \phi_{\Delta e,int}\Delta e_t + \eta_t^{int}.$$

ρ_r is an interest rate smoothing parameter, ϕ_π, ϕ_{gdp} and $\phi_{\Delta e}$ are the reaction coefficients of the changes in CPI inflation, real output, and exchange rate fluctuations. $\phi_{\Delta e,int}$ is a reaction coefficient to the fluctuation of the exchange rate with respect to foreign exchange market interventions. Shocks are again independently and individually distributed with a mean of 0 and an estimated standard deviation.

The base interest rate reacts to the inflation rate, GDP, and currency depreciation/appreciation. Also, monetary authorities are consistent in making decisions about base rates, in other words, they are likely to change the base rate gradually unless there are extraordinary events. Therefore, the rate of a previous quarter matters when deciding a current rate.

Modified UIP condition:

$$E_t e_{t+1} - e_t = r_t - r_t^* + \gamma \sigma_{\Delta e}^2 \left(\omega_t^* + \omega_{CB,t}^* \right).$$

Foreign capital flows:

$$\omega_t^* = \rho_{\omega^*} + \omega_{t-1}^* + \eta_t^{\omega^*}$$

This condition takes into account central bank interventions and foreign capital flows. Central bank interventions and foreign capital flows have a direct effect on the exchange rate. A higher share of foreign assets in the portfolio of a central bank may lead to a smaller proportion of domestic assets among dealers' portfolios. Therefore, the effect of the interventions is magnified by the risk aversion γ and nominal exchange rate volatility $\sigma_{\Delta e}^2$.

Overall, there are 40 log-linearized equations of endogenous variables which are presented in Appendix. All of the them were taken from Drygalla (2023) study.

5. Data and priors

Estimation of the model required 13 quarterly time series from 2016 until 2022. Data for GDP, households' consumption, investment, consumer price index, and average wages were obtained from the Bureau of National Statistics. Real exchange rate and capital flows data were retrieved from the National Bank website. World oil demand was proxied by world oil consumption which was provided by Bloomberg along with oil prices time series. Foreign GDP, interest rates, and inflation were taken from corresponding local statistics data providers, such as Eurostat and the Federal Reserve Bank of St. Louis (FRED). Finally, the domestic interest rate Tenge OverNight Index Average (TONIA) was found on the KASE website.

The data was seasonally adjusted via the X12-ARIMA tool. Further, GDP and its components were scaled by the number of active labor force in order to get per capita values. TONIA was transformed from an annual basis to a quarterly one. Quarterly inflation was obtained by log differencing consumer price indices. Capital flows series was scaled by Nominal GDP in US Dollars. Foreign variables, real exchange rates, and prices of oil were expressed in terms of a dual-currency basket. Weights were justified by the share of economies in trade turnover. Since the share of the European Union in the turnover is approximately 35%, the weight of the Euro in the currency basket was set at 0.35 and USD constitutes 0.65. Finally, level series were log differenced.

All the above-mentioned steps were inspired by the benchmark study (Drygalla, 2023).

The proportions of consumption, investment, non-oil export, oil and gas export, and import in total GDP are set according to the average proportions in the sample period.

The priors mostly were chosen in accordance with the academic studies of Drygalla (2023) and Justiniano & Preston (2010). The choices of the former were prioritized due to the similarities of Russian and Kazakh economies. The parameters for the proportion of consumption, investment, non-fuel exports, imports, and fuel exports were derived from real data obtained from the Bureau of National Statistics. The ratio of fuel exports to output includes both oil and gas products exports. According to Fitch Ratings (2024) commentary on the decision about Kazakhstan's credit rating, combined reserves saved in the National Fund of RK and Foreign Exchange reserves constitute up to 38% of GDP (Table 1). The rest of the calibrated parameters remained unchanged.

Parameter		**Value**
Discount parameter	β	0.99
Depreciation rate	δ	0.025
Share of capital in production	ψ	1/3
Net wage markup	λ^w	0.15
Share of foreign goods in consumption	α	0.23
Nominal ER depreciation variance	$\sigma^2_{\Delta e}$	0.0065
Risk aversion parameter	γ	200
Portfolio adjustment cost	ψ^b	0.1
Steady-state consumption to GDP	ϕ_c	0.6
Steady-state investment to GDP	ϕ_i	0.41
Steady-state non-fuel exports to GDP	ϕ_x	0.1474
Steady-state imports to GDP	ϕ_m	0.34
Steady-state fuel exports to GDP	ϕ_o	0.19
Steady-state reserves to GDP	ϕ_ω	0.38

Table 1. Calibrated parameters and steady-state values

Regarding estimated parameters, the distributions were fully motivated by the choice of Drygalla (2023). Drygalla (2023) and Justiniano & Preston (2010) agree on the types of the distribution of estimated parameters. Also, they have chosen identical means and variances for relative risk aversion, inverse labor supply elasticity, Calvo parameters, indexation of goods, interest rate smoothing, Taylor coefficients, and most of the AR(1) parameters. Drygalla (2023) set the elasticity of home/foreign goods η at the mean of 1.00 and s.d. of 0.75. Also, the standard deviations of shocks mostly have means of 0.01 and s.d. of 2.00, while Justiniano & Preston (2010) decided to set them at means of 0.5 and s.d. of infinity. S.d. of oil demand and s.d. oil price shocks have means of 0.15 and s.d. of 2.00. The author explains this decision by the actual estimates of AR(1) processes. All of the distributions of estimated parameters are provided in Table 3 below.

Parameter		**Distribution**	**Mean**	**St. Dev.**
Inverse intertemporal elasticity of substitution	σ	Gamma	1.20	0.40
Inverse labor supply elasticity	ϕ	Gamma	1.50	0.75
Habit persistence	h	Beta	0.50	0.25
Fixed cost	φ	Gamma	1.45	0.25
Capital utilization adj. Cost	ω	Gamma	0.20	0.08
Investment adj. Cost	κ_v	Gamma	4.00	0.75
Elasticity of home/foreign goods	ϵ	Gamma	1.00	0.75
Elasticity of foreign/home goods	ϵ^x	Gamma	1.00	0.75
Calvo domestic goods	θ^h	Beta	0.50	0.10
Calvo exported goods	θ^x	Beta	0.50	0.10
Calvo imported goods	θ^m	Beta	0.50	0.10
Calvo wages	θ^w	Beta	0.50	0.10
Indexation domestic goods	δ^h	Beta	0.50	0.25
Indexation exported goods	δ^x	Beta	0.50	0.25
Indexation imported goods	δ^m	Beta	0.50	0.25

Parameter		Distribution	Mean	St. Dev.
Indexation wages	δ^{w}	Beta	0.50	0.25
Interest rate smoothing	ρ_r	Beta	0.50	0.25
Taylor coefficient inflation	ϕ_{π}	Gamma	1.50	0.50
Taylor coefficient output	ϕ_{gdp}	Gamma	0.25	0.15
Taylor coefficient exch. Rate	$\phi_{\Delta e}$	Gamma	0.25	0.15
Intervention coefficient exch. Rate	$\phi_{\Delta \mathrm{e,int}}$	Gamma	0.25	0.45
Oil demand world econ. activity reaction	ϕ_{y^*}	Gamma	0.35	0.15
Government spending oil price reaction	$\phi_{g,po}$	Gamma	0.25	0.15
AR(1) parameter capital flows	ρ_{w^*}	Beta	0.40	0.15
AR(1) parameter oil demand	ρ_{oild}	Beta	0.40	0.15
AR(1) parameter technology	ρ_a	Beta	0.80	0.10
AR(1) parameter gov. spending	ρ_g	Beta	0.80	0.10
AR(1) parameter preferences	ρ_b	Beta	0.80	0.10
AR(1) parameter labor supply	ρ_l	Beta	0.80	0.10
AR(1) parameter investment	ρ_i	Beta	0.80	0.10
S.d. monetary policy shock	η^{m}	Inv. Gamma	0.01	2.00
S.d. capital flow shock	η^{ω^*}	Inv. Gamma	0.05	2.00
S.d. intervention shock	η^{int}	Inv. Gamma	0.15	2.00
S.d. price shock	η^{po}	Inv. Gamma	0.15	2.00
S.d. oil demand shock	η^{oild}	Inv. Gamma	0.01	2.00
S.d. technology shock	η^{a}	Inv. Gamma	0.01	2.00
S.d. gov. spending shock	η^{g}	Inv. Gamma	0.01	2.00
S.d. preference shock	η^{b}	Inv. Gamma	0.01	2.00
S.d. labor supply shock	η^{l}	Inv. Gamma	0.01	2.00
S.d. investment shock	η^{i}	Inv. Gamma	0.01	2.00
S.d. foreign output shock	η^{y^*}	Inv. Gamma	0.01	2.00
S.d. foreign inflation shock	η^{π^*}	Inv. Gamma	0.01	2.00
S.d. foreign interest shock	η^{r^*}	Inv. Gamma	0.01	2.00

Table 3. Prior means and standard deviations

6. Results

The findings might be limited due to the fact that the time period of observations was relatively short, there were 28 quarters of observations. Also it was impossible to set some of the parameters to high values in order to imitate infinity because it made the whole model unstable.

According to the posterior estimates, Kazakhstani oil export reacts to the changes in foreign output less than expected, since the posterior estimate of the mean of reaction coefficient to the corresponding variable is 0.22, while the primary mean was 0.35, the smoothing coefficient is 0.28. Monetary policy, on average, reacts by a 1.63% increase in the interest rates to a 1% increase in inflation. Estimates of the mean of reaction coefficients to output and exchange rate depreciation are 0.16 and 0.15 respectively. The posterior estimate of the reaction coefficient to exchange rate depreciation in the intervention rule is approximately 4 times bigger (1.1) than its prior mean, which reveals the active role of the National Bank in stabilizing exchange rates.

The shock decomposition of real GDP (Figure 1) reveals a significant contribution from preference shock (η^b), particularly during periods between quarters 9 and 17, which corresponds to 2018-2020. Foreign output shock (η^{y^*}) plays a crucial role, with a sharp negative impact observed in the post-2020 period, coinciding with Covid-19 and war in Ukraine. Government expenditure shock positively affected real GDP in the first quarter of 2020 coinciding with the beginning of Covid-19 pandemic, the government managed to distribute money to the individuals who became unemployed. Technology shock (η^a) had a positive influence during the last 8 quarters, while labor supply shock (η^{l}) put a downward pressure.

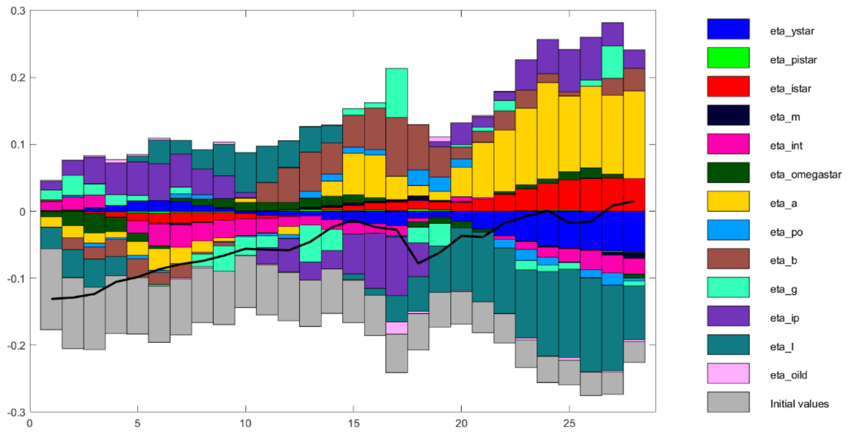

Figure 1. Historical decomposition of Real GDP

Intervention shock (η^{int}) and foreign capital flow shock (η^{ω^*}) were significant factors in the variance of CPI inflation during very initial periods (Figure 2). Later, the dominance of foreign output (η^{y^*}) became noticeable, especially starting from the end of 2020.

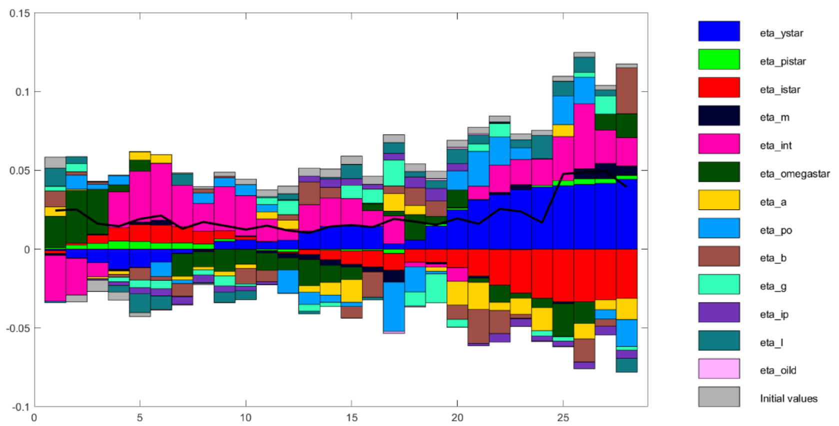

Figure 2. Historical decomposition of CPI inflation

Preference shock (η^b) plays a visible role in certain periods, contributing both positively and negatively to the fluctuation of real exchange rate depreciation (Figure 3). Similarly, intervention shock (η^{int}) shows consistently notable contributions throughout the entire timeframe, often as a driving factor in both upward and downward directions. This suggests that the central bank's interventions are still important in foreign exchange markets.

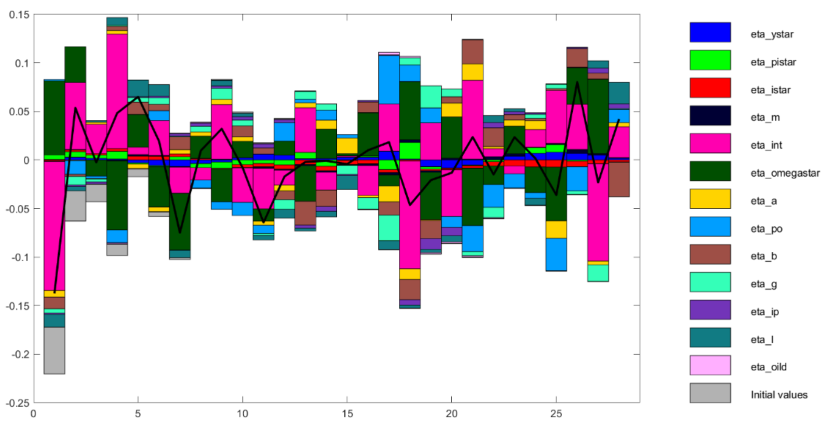

Figure 3. Historical decomposition of the real exchange rate depreciation

Forecast error variance decomposition (Table 4) provides insights into the roles of different shocks on the variance of key economic variables over the horizons of 1, 4, 8 quarters and in the long run (100 quarters).

In the short run government spending, technology, investment, and labor supply shocks are the primary drivers of GDP fluctuations reflecting the importance of fiscal policy in the Kazakhstani economy. Exports are heavily dependent on foreign output as the country's main exports are oil and gas. Whereas the variation in imports is mainly caused by preference and oil price shocks. Variances of real exchange rate and inflations are the variables which are more explained by central bank intervention shocks in comparison with other variables.

Over the medium horizons (4-8 quarters), the influence of technology shocks on domestic output growth substantially, while government expenditure shock's importance vanishes. This emphasizes the importance of technological development in maintaining the country's future economic outlook. Export variances become more reliant on oil price shocks reflecting Kazakhstan's reliance on oil. Regarding inflation variability, the policies of monetary authority remain important, however, external factors such as foreign output, interest rates, and oil price shocks gain more importance.

In the long run, technology shock appears as the most significant contributor to GDP volatility, emphasizing the importance of innovation and productivity growth in driving sustainable economic performance. Also, investment and labor supply shock reveal the significance of those factors in the Kazakhstani context. The sensitivity of inflation and real exchange rates to foreign capital flows and oil price shocks highlight the vulnerability of the local economy to such external factors.

1 quarter	η^{y*}	$\eta^{\pi*}$	η^{r*}	η^{m}	η^{int}	$\eta^{\omega*}$	η^{a}	η^{po}	η^{b}	η^{g}	η^{i}	η^{l}	η^{oild}
GDP	0.1	0.0	0.2	0.0	2.2	1.0	20.8	0.2	0.2	35.1	19.5	19.7	1.1
Consumption	0.0	0.0	0.0	0.2	0.7	0.3	3.9	5.2	58.3	4.2	23.3	3.8	0.0
Investment	0.0	0.0	0.0	0.0	0.0	0.0	1.3	1.2	9.5	0.6	85.9	1.5	0.0
Export	74.2	1.3	0.0	0.0	5.2	2.2	2.3	8.7	2.5	1.5	0.1	2.0	0.0
Import	1.2	0.1	0.1	0.6	3.0	1.5	1.1	43.6	47.1	0.4	0.7	0.6	0.1
Wages	3.2	0.2	1.1	0.9	15.1	8.0	0.4	17.3	26.9	1.8	1.5	23.5	0.0
Inflation	6.2	0.4	2.8	1.2	29.6	16.0	8.6	14.5	10.2	3.6	0.0	7.0	0.0
Domestic prices	5.6	0.3	2.2	1.1	23.8	12.9	10.0	19.4	12.0	4.7	0.0	8.1	0.0
Real Exch Rate	0.2	0.9	0.1	0.0	65.4	25.0	1.2	3.8	1.6	0.9	0.1	1.0	0.0

4 quarters	η^{y*}	$\eta^{\pi*}$	η^{r*}	η^{m}	η^{int}	$\eta^{\omega*}$	η^{a}	η^{po}	η^{b}	η^{g}	η^{i}	η^{l}	η^{oild}
GDP	1.4	0.0	0.9	0.2	2.7	1.6	25.0	1.0	6.5	7.5	23.8	29.2	0.2
Consumption	0.2	0.0	0.2	0.1	0.3	0.1	6.0	4.4	38.0	5.0	38.9	6.9	0.0
Investment	0.1	0.0	0.1	0.0	0.0	0.0	2.7	2.2	15.4	0.9	75.7	2.9	0.0
Export	38.7	0.7	0.1	0.1	8.7	4.8	3.3	35.5	1.9	2.0	0.2	4.0	0.0
Import	1.1	0.0	0.0	0.2	3.5	1.7	0.6	76.8	13.5	0.3	1.5	0.7	0.1
Wages	3.0	0.1	1.2	0.6	12.3	6.7	15.4	16.9	15.5	1.8	3.6	22.8	0.0
Inflation	9.2	0.3	5.0	1.3	30.2	17.2	5.4	13.5	8.8	3.2	0.7	5.4	0.0
Domestic prices	7.8	0.3	3.9	1.1	25.4	14.3	6.5	18.7	11.1	4.0	0.6	6.4	0.0
Real Exch Rate	0.2	0.5	0.5	0.1	44.7	21.0	2.8	22.4	2.2	2.0	0.3	3.3	0.0

8 quarters	η^{y*}	$\eta^{\pi*}$	η^{r*}	η^{m}	η^{int}	$\eta^{\omega*}$	η^{a}	η^{po}	η^{b}	η^{g}	η^{i}	η^{l}	η^{oild}
GDP	1.6	0.0	0.9	0.1	1.8	1.1	27.0	0.9	6.4	5.1	26.3	28.6	0.1
Consumption	0.2	0.0	0.2	0.1	0.3	0.2	6.5	5.0	33.9	4.5	42.1	7.0	0.0
Investment	0.2	0.0	0.2	0.0	0.1	0.0	4.6	3.9	19.0	1.1	66.4	4.5	0.0
Export	25.6	0.5	0.1	0.2	6.4	3.6	2.9	53.8	1.8	1.6	0.3	3.2	0.0
Import	0.7	0.0	0.0	0.2	2.4	1.2	0.4	83.7	9.8	0.2	0.9	0.4	0.1
Wages	2.9	0.1	1.1	0.5	10.4	5.7	21.9	16.0	13.2	1.7	3.8	22.6	0.0
Inflation	10.7	0.3	5.6	1.3	27.6	15.7	5.3	14.4	8.9	3.1	2.0	5.1	0.0
Domestic prices	8.7	0.3	4.3	1.1	23.6	13.3	6.2	19.4	11.2	4.0	2.0	6.1	0.0
Real Exch Rate	0.6	0.4	1.0	0.3	35.8	16.9	2.5	35.0	2.5	1.7	0.3	2.9	0.0

Long run	η^{y*}	$\eta^{\pi*}$	η^{r*}	η^{m}	η^{int}	$\eta^{\omega*}$	η^{a}	η^{po}	η^{b}	η^{g}	η^{i}	η^{l}	η^{oild}
GDP	1.5	0.0	0.8	0.1	1.4	0.9	33.1	1.7	6.9	3.9	23.6	26.2	0.1
Consumption	0.2	0.0	0.2	0.1	0.4	0.2	10.6	5.2	30.2	3.8	41.2	7.9	0.0
Investment	0.2	0.0	0.2	0.0	0.2	0.1	7.8	4.9	19.3	1.1	60.4	5.8	0.0
Export	21.2	0.4	0.4	0.2	5.2	2.9	3.0	60.1	1.8	1.3	1.0	2.6	0.0
Import	0.6	0.0	0.0	0.1	2.0	1.1	0.3	86.6	7.8	0.1	0.9	0.4	0.0
Wages	2.2	0.1	0.8	0.4	7.6	4.2	28.1	14.9	12.8	1.4	9.7	17.8	0.0

Inflation	10.8	0.3	5.5	1.3	26.6	15.1	6.1	14.9	8.9	3.0	2.2	5.4	0.0
Domestic prices	8.7	0.3	4.2	1.1	22.8	12.8	6.7	20.2	11.2	3.8	2.1	6.2	0.0
Real Exch Rate	0.8	0.4	1.0	0.3	31.8	15.0	2.6	40.8	2.4	1.5	0.7	2.6	0.0

Table 4. Forecast error variance decomposition (%)

Small open economies are highly susceptible to various shocks occurring in the economy. While shocks emerging inside of the economy might be controlled, small open economies have limited capacity to counteract them. Based on the information from Table 4, there is a serious long-term impact on capital flow (η^{ω^*}) and oil price (η^{po}) shocks. The comparison of several monetary policy regimes was based on the variance of key macroeconomic variables followed by simultaneous oil price and capital flow shocks in the long run.

	FIX	SIT	IT	HIT
GDP	0.066	0.732	0.184	0.044
Consumption	0.391	1.243	0.349	0.402
Investment	1.493	16.646	2.693	2.566
Export	1.808	1.404	7.316	0.123
Import	8.077	155.578	5.822	9.930
Wages	0.318	3.122	0.397	0.267
Inflation	0.056	0.749	0.096	0.047
Domestic prices	0.094	1.247	0.147	0.056
Real Exch Rate	0.637	13.012	1.364	0.756

Table 5. Variances following simultaneous oil price and capital flows shock

The fixed exchange regime is a monetary policy in which the central bank is devoted to fixing its currency's nominal exchange rate by conducting interventions on the foreign exchange market. The base rate is not considered a tool of monetary policy, therefore, all of the reaction coefficients in the interest rate rule were set at zero, meanwhile, there is an unlimited reaction of the regulator to the change in the nominal exchange rate ($\phi_{\Delta e,int} = 1000$). This policy regime implies neutralization of the effect of capital flow shocks on the economic variables because they are balanced with the interventions of the central bank. This regime has the lowest variance of real exchange rate and consumption. Since the wages and real exchange rates are affected by the shocks in the long run the inflation and domestic prices remain at a substantially low level. Overall, this monetary policy regime effectively tackles the effect of shocks causing relatively low variance in GDP and its aggregates as well as in consumer prices.

The inflation targeting regime implies that monetary authorities are responsible for maintaining price growth in the plausible range. The main objective is to target interest rates in the economy by setting policy rates under which second-tier banks can borrow from the central bank. Under the inflation targeting regime the central bank sets the policy rate by considering only the deviations of inflation. In this framework, ϕ_{π} is set at its estimated posterior mean. The policy maintains the lowest variances of consumption and import. However, if the shocks are negative, export volatility will decrease significantly.

The strict inflation targeting regime implies that the central bank will make unlimited efforts to combat any deviation of the inflation rate from its target. Therefore, the reaction coefficient to inflation (ϕ_{π}) is set at 1000. Theoretically, the variance of inflation and domestic prices should be at zero, however, setting a higher value to the reaction coefficient to let it be a proxy of infinity made the software unable to find equilibrium. Here we can see that under this regime many of the variables have the highest variances following the simultaneous oil price and capital flow shocks. Especially, high variation in the real exchange regime led to the increased variance of imports. This most probably occurs due to the increased domestic prices of foreign goods. Considering these results if the shocks appear to be positive the situation could bring a sharp increase in the economy, however, it will drive inflation up. Observing the effect of the inflation targeting and the strict inflation targeting regimes, it might be deducted that the central bank could pay attention to the output growth as well in order to keep the economy relatively stable.

The hybrid inflation targeting regime focuses on the variation in inflation, but also it pays attention to the output. It implies that central banks while making an effort to maintain inflation within their target range, the rationale for setting the policy rate is based not only the inflation growth but also on the changes in the output. Paying attention to the output is connected to the significance of the latter in inflationary processes. Dramatic increases in the economy may lead to its overheating causing inflationary pressure. In this framework, the reaction coefficient to the CPI inflation is set at 1.5 and the reaction coefficient to the output (ϕ_{gdp}) is equal to 0.5. This regime maintains the lowest volatility of inflation and domestic prices following simultaneous shocks in comparison to other policies. In addition, this could be said about the variances in the real GDP, exports, and wages. However, we cannot observe drastic distinction with the fixed exchange rate regime. This might either come from the insufficiency of the data collected for this research or from the effectiveness of monetary policies in general.

The report by the National Bank (2021) admits that there is weak transmission of monetary policy, in other words, the base rate set by the monetary authorities has a little impact on interest rates in the economy. This stems from the subsidy programs initiated by the government which allow cheap borrowing opportunities in business and mortgage sectors. Thus, the distorted credit market is not strongly related to the monetary policies of the National Bank. Although, National Bank (2021) and Algozhina (2016) both point to the importance of countercyclical fiscal policy for the sake of economical stabilization, government expenditures appear pro-cyclical which lead to amplification of the cycles.

7. Conclusion

The importance of monetary policy in Kazakhstan, a small, open, oil-exporting economy, could not be underestimated. Macroeconomic balance, which implies steady output growth and low inflation, could be achieved by adequately implementing monetary policy instruments. Therefore, the relevance of studies in selecting the optimal regime might be highly relevant.

The effects of external shocks emerging from foreign capital flows and oil price fluctuations on macroeconomic volatility were analyzed using the DSGE model, which considers the features of the Kazakhstani economy. It demonstrated that government expenditure and technology shocks initially explain much of the variation in the economic variables. However, the domination of technological advancement becomes more visible in the long run.

The thesis compares fixed exchange rates, inflation targeting, and strict and hybrid inflation targeting regimes. The metrics of evaluation effectiveness of regimes were based on the ability to minimize the variances following the foreign capital flows and oil price shocks.

In conclusion, the hybrid inflation targeting regime, which considers output growth, has demonstrated that it can lead to less volatile inflation and output after the above-mentioned shocks. The hybrid inflation targeting regime offers an opportunity to achieve the objective of the protection of stable output growth and low inflation. Nevertheless, disagreement with the fiscal policy hinders the stabilization potential of monetary measures. The adjustment of the government expenditures would lead to the situation when these conditions might be considered a favorable background for future economic development.

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Appendix

Marginal utility of consumption:

$$\lambda_t = \left(-\left(\frac{\sigma_c}{1-h} \right) \right) \, (c_t - h\, c_{t-1}) + \varepsilon_t^b$$

Marginal utility of savings:

$$\lambda_t = r_t + \lambda_{t+1} - \pi_{t+1} - \psi_b b_t$$

Wage dynamics:

$$\begin{aligned} w_t = \quad & \tfrac{\beta}{1+\beta}\, w_{t+1} + \tfrac{1}{1+\beta}\, w_{t-1} + \pi_{t+1}\, \tfrac{\beta}{1+\beta} + \tfrac{1+\beta\, \delta^w}{1+\beta}\, \pi_t + \tfrac{\delta^w}{1+\beta}\, \pi_{t-1} - \tfrac{1}{1+\beta}\, \tfrac{(1-\beta\, \theta^w)\,(1-\theta^w)}{\theta^w \left(1+\frac{(1+\lambda^w)\,\varphi}{\lambda^w}\right)} \\ & \times \left(w_t - \varphi\, l_t - \tfrac{\sigma}{1-h}\, (c_t - h\, c_{t-1}) - \varepsilon_t^l \right) \end{aligned}$$

Shadow price of capital:

$$t_t = \psi_b b_t + \pi_{t+1} - r_t + \beta \, \left(\bar{r}^k\, r_{t+1}^k + (1-\delta)\, t_{t+1} \right)$$

Investment Euler equation:

$$i_t = t_t \, \frac{1}{(1+\beta)\kappa_v} + \frac{1}{1+\beta}\, i_{t-1} + \frac{\beta}{1+\beta}\, i_{t+1} + \frac{1}{1+\beta}\, \left(\beta\, \varepsilon_{t+1}^i - \varepsilon_t^i \right)$$

Capital law of motion:

$$k_t = (1-\delta)\, k_{t-1} + \delta\, i_t$$

Labor demand:

$$l_t = k_{t-1} + (1+\omega)\, r_t^k - w_t$$

Marginal cost:

$$mc_t = w_t\, (1-\psi) + r_t^k\, \psi - a_t$$

Marginal cost exported goods:

$$mc_t^x = mc_t - q_t - p_t^x$$

Marginal cost imported goods:

$$mc_t^m = q_t - p_t^m$$

Domestic goods inflation:

$$\pi_t^h - \delta^h\, \pi_{t-1}^h = \kappa_h \, \left(mc_t - p_t^h \right) + \beta \, \left(\pi_{t+1}^h - \pi_t^h\, \delta^h \right)$$

with:

$$\kappa_h = \frac{\left(1-\theta^h\right)\, \left(1-\theta^h\, \beta\right)}{\theta^h}$$

Exported goods inflation:

$$\pi_t^x - \delta^x\, \pi_{t-1}^x = mc_t^x\, \kappa_x + \beta \, \left(\pi_{t+1}^x - \pi_t^x\, \delta^x \right)$$

with:

$$\kappa_x = \frac{(1-\theta^x)\, (1-\beta\, \theta^x)}{\theta^x}$$

Imported goods inflation:

$$\pi_t^m - \delta^m\,\pi_{t-1}^m = mc_t^m\,\kappa_m + \beta\,\left(\pi_{t+1}^m - \pi_t^m\,\delta^m\right)$$

with:

$$\kappa_m = \frac{(1-\theta^m)\,(1-\beta\,\theta^m)}{\theta^m}$$

Consumer price inflation:

$$\pi_t = \alpha\,\pi_t^h + (1-\alpha)\,\pi_t^m$$

Price level domestic goods:

$$p_t^h = p_t^m\,\left(-\left(\frac{1-\alpha}{\alpha}\right)\right)$$

Price level exported goods:

$$p_t^x = \pi_t^x + p_{t-1}^x - \pi_t^*$$

Price level imported goods:

$$p_t^m = \pi_t^m + p_{t-1}^m - \pi_t$$

GDP deflator:

$$p_t^y = \phi_x\,\left(q_t + p_t^x\right) + \phi_o\,\left(q_t + p_t^O\right) - p_t^m\,\phi_m$$

Domestic production:

$$y_t = a_t + k_{t-1}\,\psi + r_t^k\,\omega\,\psi + l_t\,(1-\psi)$$

Demand for domestic goods:

$$y_t^h = (-\eta)\,p_t^h + \left(\frac{\phi_c}{\phi_c+\phi_i}\right)c_t + \left(\frac{\phi_i}{\phi_c+\phi_i}\right)i_t$$

Demand for exported goods:

$$x_t = (-\eta^x)\,p_t^x + y_t^*$$

Demand for imported goods:

$$m_t = (-\eta)\,p_t^m + \left(\frac{\phi_c}{\phi_c+\phi_i}\right)c_t + \left(\frac{\phi_i}{\phi_c+\phi_i}\right)i_t$$

Government consumption:

$$g_t = \rho_g g_{t-1} + (1-\rho_g)\,(e_t + p_{o,t}) + \eta_t^g$$

Non-oil GDP:

$$y_t = \frac{1}{1-\phi_o}\,\left(\phi_c c_t + \phi_i i_t + \phi_x\,x_t - \phi_m\,m_t\right) + g_t$$

Total GDP:

$$gdp_t = \phi_o\,\left(q_t + p_t^o\right) + (1-\phi_o)\,\left(y_t + p_t^h\right) - p_t^y$$

Total economy budget constraint:

$$\phi_b\left(b_t - \frac{1}{\beta}\,b_{t-1}\right) = \phi_o\,\left(q_t + p_t^O\right) + \phi_x\,\left(q_t + p_t^x + x_t\right) - \phi_m\,\left(p_t^m + m_t\right) + \frac{\phi_b}{\beta}\,\left(r_{t-1} - \pi_t\right)$$

Real exchange rate:

$$q_t = \pi_t^* + q_{t-1} + \Delta e_t - \pi_t$$

Uncovered interest parity condition:

$$\Delta e_{t+1} = r_t - r_t^* + \gamma \sigma_{\Delta e}^2 \left(\omega_t^* + \omega_t^{*,CB} \right)$$

Monetary policy rule:

$$r_t = \rho_r r_{t-1} + (1 - \rho_r) \left(\phi_\pi \pi_t + \phi_{gdp} gdp_t + \phi_{\Delta e} \Delta e_t \right) + \eta_t^m$$

Central bank intervention rule:

$$\omega_t^{*,CB} = \phi_{\Delta e, int} \Delta e_t + \eta_t^{int}$$

Foreign capital flows:

$$\omega_t^* = \rho_{\omega^*} \, \omega_{t-1}^* + \eta_t^{\omega^*}$$

Oil demand:

$$o_t = \rho_{oild} o_{t-1} + (1 - \rho_{oild}) \left(\phi_{y^*} y^* \right) + \eta_t^{oild},$$

Technology shock

$$a_t = \rho_a \, a_{t-1} + \eta_t^a$$

Preference shock:

$$\varepsilon_t^b = \rho_b \, \varepsilon_{t-1}^b + \eta_t^b$$

Government spending shock:

$$\varepsilon_t^g = \rho_g \, \varepsilon_{t-1}^g + \eta_t^g$$

Investment shock:

$$\varepsilon_t^i = \rho_i \, \varepsilon_{t-1}^i + \eta_t^i$$

Labor supply shock:

$$\varepsilon_t^l = \rho_l \, \varepsilon_{t-1}^l + \eta_t^l$$