INTERNATIONAL MONETARY FUND

IMF Country Report No. 17/109

REPUBLIC OF KAZAKHSTAN

SELECTED ISSUES

May 2017

This Selected Issues Paper on Kazakhstan was prepared by a staff team of the International Monetary Fund. It is based on the information available at the time it was completed on April 13, 2017.

Copies of this report are available to the public from

International Monetary Fund • Publication Services
PO Box 92780 • Washington, D.C. 20090
Telephone: (202) 623-7430 • Fax: (202) 623-7201
E-mail: publications@imf.org Web: http://www.imf.org
Price: $18.00 per printed copy

International Monetary Fund
Washington, D.C.

INTERNATIONAL MONETARY FUND

REPUBLIC OF KAZAKHSTAN

SELECTED ISSUES

April 13, 2017

Approved by:
Middle East and Central Asia Department (MCD)

Prepared by:
Matteo Ghilardi, Jonah Rosenthal, Rossen Rozenov, Azim Sadikov (MCD)

CONTENTS

TABLES

TABLES

FIGURES

TABLE

APPENDICES

KAZAKHSTAN—OIL RULES AND ANCHORING FISCAL POLICY[1]

The sharp and sustained drop of oil prices since 2014 has reduced the value of Kazakhstan's oil wealth and therefore calls for a reassessment of fiscal policy and rules. Fiscal policy in an oil-rich country should aim to: (i) promote macro-fiscal stability by cushioning the economy from short-term volatility in oil revenues; and (ii) foster long-term fiscal sustainability, consistent with saving for future generations, given the exhaustibility of oil resources. Kazakhstan's non-oil deficit path has been higher than suggested by long-term benchmarks, and adjustment is needed in the coming years to avoid fiscal sustainability risks and to promote intergenerational equity. Price-based fiscal rules—with structural fiscal balance targets guided by long-term benchmarks—can help anchor short- and medium-term fiscal policy. The non-oil deficit path introduced in the new National Fund of the Republic of Kazakhstan (NFRK) concept is broadly consistent with the proposed approach, and should be followed by timely and decisive implementation of revenue and expenditure measures.

A. Introduction

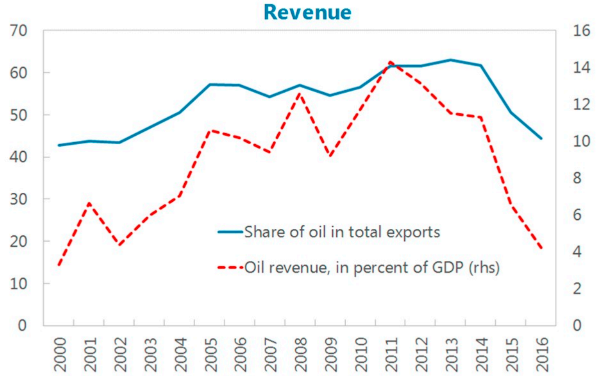
1. **Managing Kazakhstan's significant oil wealth is one of the authorities' main policy challenges.** Oil accounts for more than 50 percent of exports, while government oil-related revenues averaged 10-12 percent of GDP over the last decade—more than 40 percent of total revenues. Oil revenues have enabled a relatively high level of government spending and helped sustain high growth rates, raise living standards, and lift Kazakhstan to the ranks of the world's middle-income countries.

2. **Fiscal policy has played a central role in managing Kazakhstan's oil wealth.** The authorities' policies during the oil-price boom of the mid-2000s kept the non-oil deficit broadly unchanged and allowed for saving of a considerable share of the windfall. Later, during the global financial crisis, these savings helped finance a countercyclical stimulus and significant financial sector support, helping mitigate its impact on the Kazakh economy. The non-oil deficit declined after the crisis, but reducing it to the pre-crisis level proved difficult, and Kazakhstan entered the oil-price shock that began in 2014 with a relatively high non-oil deficit.

3. **The 2014 oil-price shock and the authorities' subsequent fiscal initiatives have further weakened the fiscal position.** Oil revenues fell by more than 70 percent in dollar terms from 2013 to 2016, although they declined by just half as much in tenge terms, thanks to the authorities' decision to allow the tenge to depreciate. The fiscal initiatives helped cushion the impact of the shock, but, together with some *ad hoc* measures, increased the non-oil deficit. As a result, the overall fiscal position reversed from an average surplus of 4½ percent of GDP in 2011-13 to a deficit of 5 percent of GDP 2015-16.

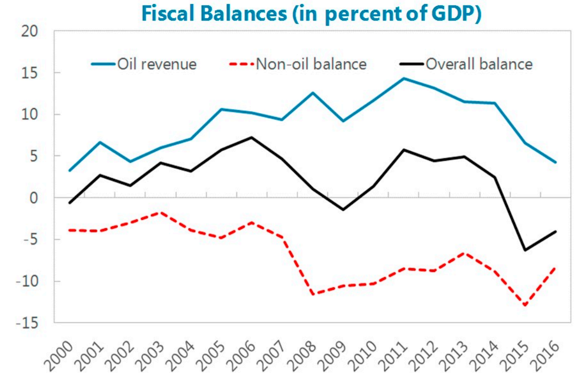
[1] Prepared by Matteo Ghilardi and Azim Sadikov.

Figure 1. Kazakhstan: Oil Exports and Revenue



Sources: National authorities; and IMF staff calculations.

Figure 2. Kazakhstan: Oil Revenue and Fiscal Balances (in percent of GDP)



Sources: National authorities; and IMF staff calculations.

4. Fiscal policy now needs to adjust to the sustained oil-price shock to preserve sustainability. While short-term fiscal support to the economy was justified, the non-oil deficit is now at a level that is too high to secure long-term sustainability. These concerns have become more pressing, as the sharp and sustained oil price drop has reduced the value of Kazakhstan's oil wealth, which informs long-term fiscal sustainability benchmarks that reflect intergenerational equity considerations. With the oil price unlikely to return to its pre-shock level, Kazakhstan needs to embark on medium-term consolidation to reduce the risk of a forced and disruptive fiscal adjustment.

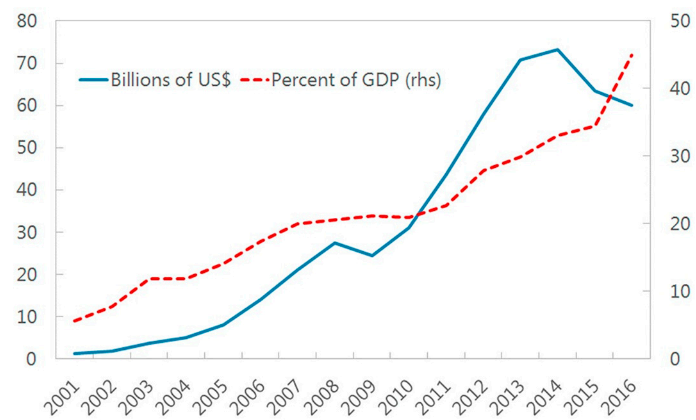
5. This paper evaluates the current fiscal stance and its long-term sustainability and presents new fiscal benchmarks. First, the paper estimates Kazakhstan's oil wealth consistent with the new normal in oil prices. Second, it introduces a set of benchmarks, securing which would support long-term sustainability and intergenerational equity. Third, it considers various price-based structural balance rules—with structural balance targets guided by long-term fiscal benchmarks—that could help anchor medium-term fiscal policies and consolidation. Finally, the paper evaluates the path of the non-oil deficit that is presented in the new concept for the National Fund of the Republic of Kazakhstan (NFRK) and assesses its consistency with the long-term sustainability targets introduced in the paper.

B. Managing Oil Wealth and Fiscal Rules in Kazakhstan

6. Kazakhstan has had in place a set of rules to govern oil revenue management and fiscal policy. The main elements include a fixed annual transfer (in U.S. dollars) from the NFRK to the budget, a floor on the NFRK's assets, ceilings on interest and debt service payments on public debt, and a medium-term target for the non-oil fiscal balance.

7. The NFRK manages the oil wealth in Kazakhstan. Established in 2000, the NFRK aims to work both as a stabilization fund and a savings fund. The NFRK receives all oil-related revenues, including: (i) the government's share of profits in oil projects; (ii) receipts from the export duty tax; and (iii) various mineral extraction taxes and fees. While the government's share of oil revenues generated in Kazakhstan has averaged 30-35 percent historically, it has also varied considerably from year to year. This reflects oil price and output volatility, as well as changes in the government's share of oil company profits, which also depend on the price and production. Earnings from investments are an additional source of NFRK revenue. "Guaranteed" and "targeted" transfers to the budget are the main expenditures of the NFRK. Under the current framework, guaranteed transfers are set at $8 billion (±15% depending on the cyclical position of the economy and the financing needs), while targeted transfers are discretionary and can be used to fund specific fiscal initiatives (e.g. the Nurly Zhol fiscal support package announced in 2014). The NFRK's assets stood at $60 billion at end-2016, equivalent to 43 percent of GDP. By contrast, public debt stood at 21 percent of GDP and total external debt at 122 percent of GDP.

Figure 3. Kazakhstan: NFRK Assets



Sources: National authorities; and IMF staff calculations.

8. In late 2016, the government adopted a new NFRK framework that will be effective from 2018. Under the new framework, guaranteed transfers will decline gradually to about KZT 2 trillion (about $6 billion at the current exchange rate) by 2020, NFRK assets cannot fall below 30 percent of GDP, and the budget will target a specific and pre-determined path for the non-oil deficit in the medium-term. The new framework aims to reduce the non-oil deficit from 8.3 percent of GDP in 2016 to 7 percent of GDP in 2020 and to 6 percent of GDP in 2025.

C. Long-term Fiscal Sustainability in the New Normal of Oil Prices

Sustainability risks at unchanged policies

9. Kazakhstan's fiscal position will be eroded further if fiscal policies are not changed. While the authorities cut the non-oil deficit (in percent of non-oil GDP) by over 5 percentage points of non-oil GDP in 2016, more effort will be needed to ensure fiscal sustainability. Under a passive policy scenario that assumes a broadly unchanged non-oil deficit going forward, the government's net financial assets—the difference between NFRK assets and government debt—would fall close to zero by 2021 (Figures 4-5). Keeping the debt-to-GDP ratio constant, thus covering government's financing needs largely from the NFRK, would exhaust NFRK assets by the mid-2020s. While the debt-to-GDP ratio would remain low, market access on favorable terms could come under question, as markets may expect Kazakhstan to accumulate financial assets, rather than to drain them, given its oil resources. A weaker financial position could also make market access more sensitive to swings in investor sentiment due to external factors (e.g., global or regional developments). Staff calculations are sensitive to long-term assumptions; accordingly, for illustrative purposes, Table 1 shows the year when net financial assets would turn negative under various combinations of the long-term oil price and the (constant) non-oil primary deficit.

Figure 4. Kazakhstan: Fiscal Balances
(In percent of GDP)

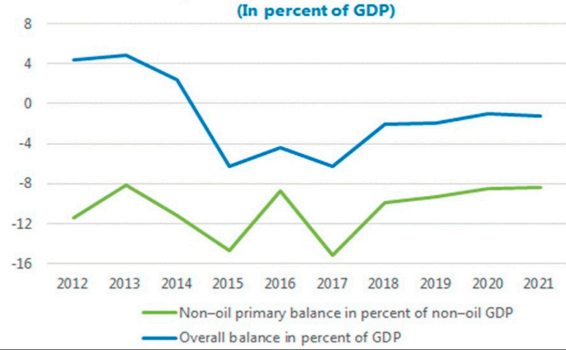


Figure 5. Kazakhstan: Net Financial Assets
(In percent of GDP)

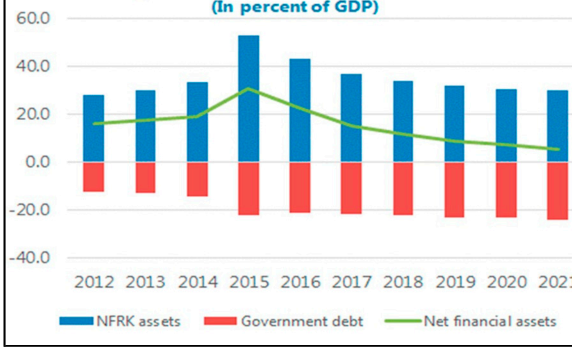


Table 1. Kazakhstan: Year Net Financial Assets Turn Negative

Non–oil primary balance (percent of non–oil GDP)	Constant long-term real oil price (starting 2021): 30	40	50	60	70	80	90
-14	2023	2023	2024	2025	2026	2027	2030
-12	2023	2024	2025	2026	2028	2031	2034
-10	2024	2025	2026	2029	2033	2037	2042
-8	2025	2027	2030	2036	2042	2048	2055
-6	2028	2033	2040	2049	> 2056	> 2056	> 2056
-4	2038	2051	> 2056	> 2056	> 2056	> 2056	> 2056

Sources: IMF staff calculations.

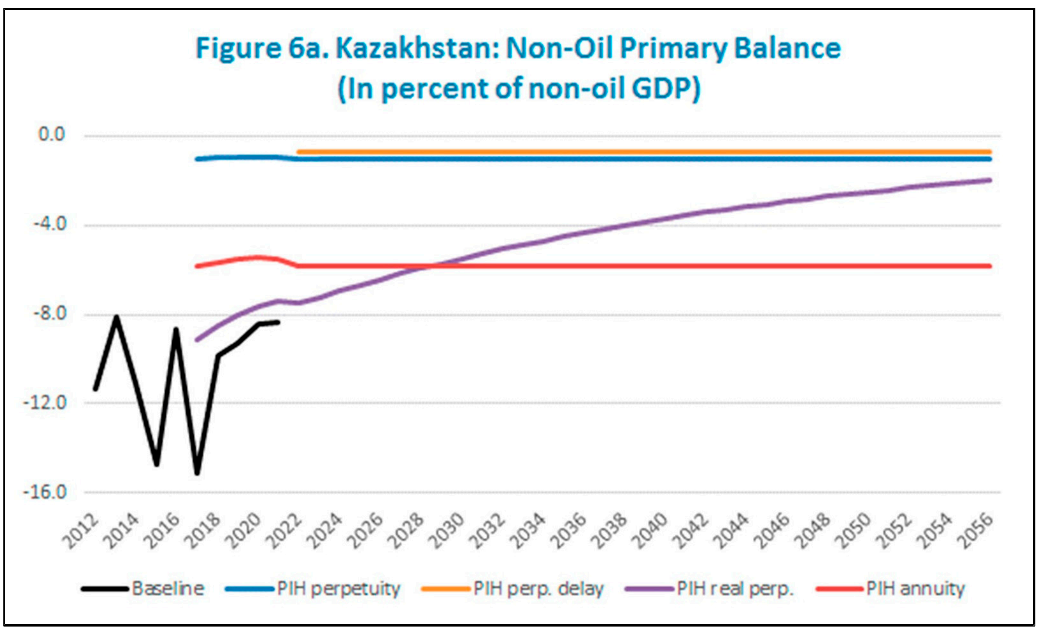
10. **Adhering to long-term fiscal sustainability benchmarks could help the government sustain spending and tax policies in the long run, while limiting financial risks and accounting for the exhaustibility of oil revenues**. Deriving these benchmarks involves, as a first step, estimating Kazakhstan's net wealth—the sum of the initial stock of net financial assets and the present value to the government of oil assets in the ground. The latter depends on a variety of uncertain factors, such as reserves and their rate of extraction, future oil prices, the exchange rate, and the government's share of oil revenues. The second step is to consider the period over which it is optimal - from a fiscal sustainability perspective - to spend oil wealth. This depends on long-term non-oil GDP growth, the real interest rate, and inflation, among other parameters. As the projection horizon is long, estimates are sensitive to changes in parameter assumptions (Box 1).

11. **We employ the Permanent Income Hypothesis (PIH), considering two cases: perpetuity and annuity.** The first case assumes that the transfer to the budget equals the revenues stemming from interest receipts on the stock of assets of the NFRK. The second case assumes a lifespan of the NFRK of forty years. In our analysis we consider four scenarios: (i) a perpetuity-non-oil primary

deficit (NOPD) constant in percent of non-oil GDP starting from 2017; (ii) delaying the adjustment to Option (i) by 5 years, i.e. a constant perpetuity-NOPD in percent of non-oil GDP starting from 2022; (iii) a constant *real* perpetuity-NOPD; and (iv) a 40-year annuity-NOPD constant in percent of non-oil GDP. Figures 6a-b present the NOPD paths and the government's net financial assets under the various cases. These benchmarks are compared to staff's latest medium-term baseline projections.

12. Long-term fiscal sustainability benchmarks under the PIH point to a need for a consolidation. In particular, the PIH finds that:

- A constant perpetuity-NOPD as a share of GDP of 1.1 percent would maximize Kazakhstan's net wealth at end of our forecasting horizon. However, this approach could be argued as being too tight for an emerging market economy like Kazakhstan with still-considerable social and investment needs as it implies a sizeable adjustment in the near-term.[2] As real GDP grows, future generations are expected to be better off, which argues in favor of higher "transfers" to (or use of oil resources by) earlier generations. One way to achieve this is to assume a constant NOPD in real terms. Under this approach, the NOPD would average 8.3 percent of GDP in the first decade of the projection but would have to decline in percent of GDP over time. Another option would be to delay the adjustment to the perpetuity benchmark: a 5-year delay would lead to a marginally lower NOPD perpetuity but much slower accumulation of assets. Figure 6a compares the PIH under the perpetuity case in the three different approaches.



[2] However, it is useful to remind that this is the approach followed by Norway in managing the oil wealth.

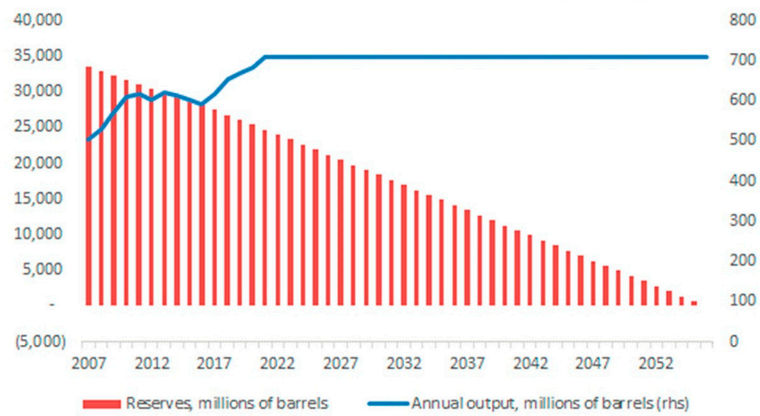
Box 1. Baseline Long-term Assumptions

Oil revenues

- Oil reserves. Kazakhstan's proven oil reserves (Figure B1) were assumed at 30 billion barrels (Source: BP Statistical Review of World Energy, June 2015).

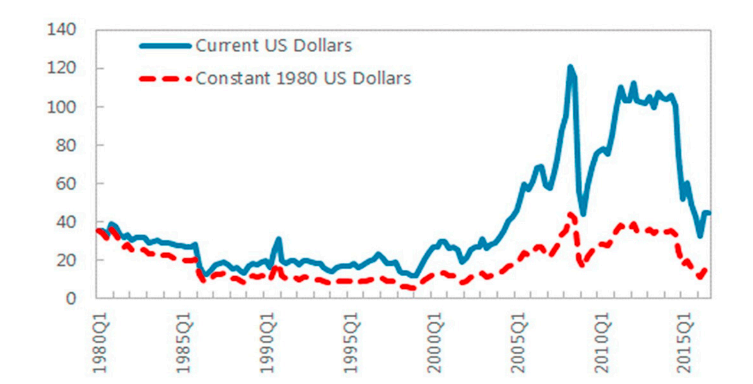
- Oil extraction. Daily production is expected to reach 2.12 million barrels by 2021, up from 1.64 million barrels in 2016 (Figure B1). Most of this expansion hinges on the large Kashagan oil field reaching its full operational capacity by 2021. Thereafter, oil output is projected flat until the reserves are exhausted.

Figure B1. Kazakhstan: Oil Reserves and Extraction



- Oil price. The oil price forecast through 2021 comes from the latest IMF World Economic Outlook. Thereafter, the oil price remains unchanged in constant U.S. dollar terms, implying 2 percent annual growth in nominal terms in line with long-term U.S. inflation (Figure B2).

Figure B2. Kazakhstan: Oil Price, 1980-2016



Net financial assets

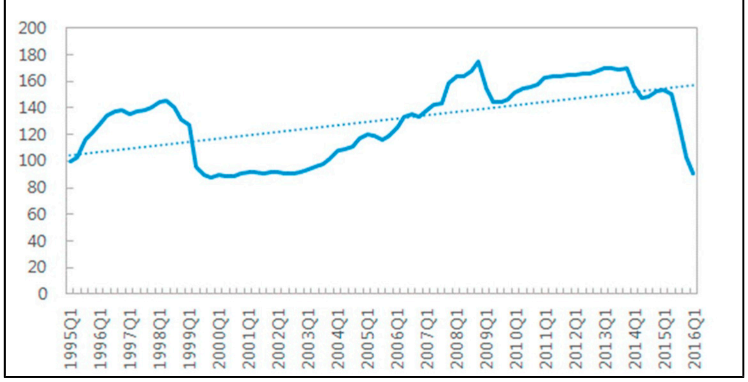
- Government net financial assets are defined as the difference between NFRK assets and the stock of government debt. They stood at 22 percent of GDP at end-2016.

Box 1. Baseline Long-term Assumptions (concluded)

Macroeconomic variables

- Long-term non-oil GDP growth is assumed at 4 percent.
- Domestic inflation is set at the NBK's long-term target of 4 percent.
- The long-term real interest rate is assumed at 4.5 percent consistent with the historic average. The long-term nominal interest rate is assumed to be the sum of the real interest rate and inflation. For simplicity, the same interest rate is assumed on assets and liabilities.
- The tenge is projected to appreciate by 0.25 percent in real terms annually against the U.S. dollar, based on the assumption that Kazakhstan will continue gaining productivity relative to its trading partners (Balassa-Samuelson effect). The tenge's historical trend real appreciation against the dollar has been higher—2 percent annually during 1995-2016, but this period includes recovery from the collapse of the U.S.S.R. and the oil boom of 2000s (Figure B3).

Figure B3. Kazakhstan: Real Exchange Rate KAZ/USD
(1995Q1=100; upward movements indicate real appreciation of tenge)



- Targeting a constant NOPD as a share of GDP of 6.2 percent over 40 years would be consistent with net wealth as of end-2016. However, under this "annuity" approach, (net) wealth—the sum of the financial assets and the value of oil in the ground—would be fully exhausted by the end of the 40-year annuity period. This option allows for a considerably higher NOPD than the perpetuity option, but would not be consistent with the authorities' stated policy intention of saving (at least part of) Kazakhstan's oil wealth for future generations. If the NOPD is assumed constant in real terms over the 40-year horizon, the 40-year NOPD annuity would average 10 percent of GDP in the first decade before declining steadily through the projection horizon (not shown in figures).

13. The results are sensitive to long-term parameter assumptions. Therefore, we extend our analysis to see how the non-oil deficit implied by the PIH hypothesis is affected by the growth rate of the economy and oil prices. Tables 2a and 2b show the NOPD and projected net financial assets in 2056 under different combinations of long-run non-oil GDP growth and the oil price under the constant perpetuity NOPD option.

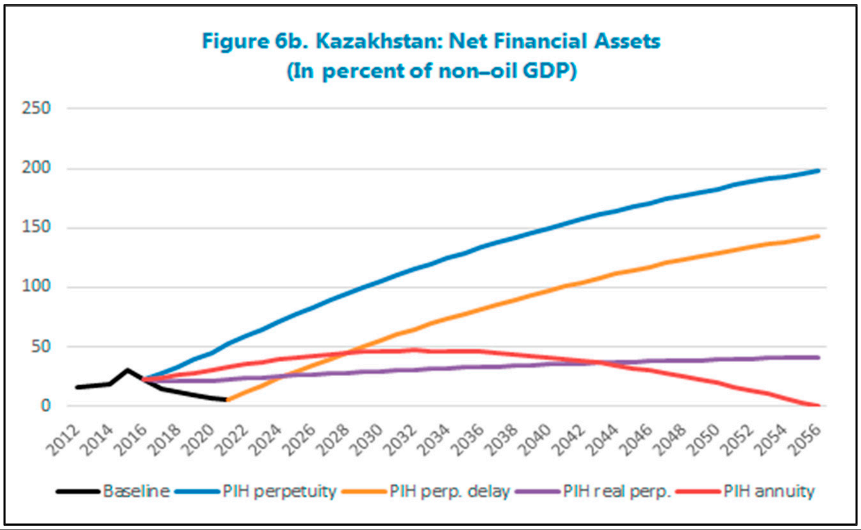


Table 2a. Kazakhstan: PIH Perpetuity: Non-oil Primary Balance (percent of non-oil GDP)

		Constant long-term real oil price (starting 2021)						
		30	40	50	60	70	80	90
Non-oil GDP growth	2.5	-2.5	-3.0	-3.4	-3.9	-4.4	-4.8	-5.3
	3.0	-1.9	-2.3	-2.6	-3.0	-3.4	-3.7	-4.1
	3.5	-1.3	-1.6	-1.8	-2.0	-2.3	-2.5	-2.8
	4.0	-0.7	-0.8	-0.9	-1.0	-1.2	-1.3	-1.4

Table 2b. Kazakhstan: PIH Perpetuity: Net Financial Assets in 2056 (percent of GDP)

		Constant long-term real oil price (starting 2021)						
		30	40	50	60	70	80	90
Non-oil GDP growth	2.5	128	152	176	200	223	247	271
	3.0	132	156	181	205	230	255	279
	3.5	135	161	186	211	237	262	288
	4.0	139	166	192	218	244	270	296

Sources: IMF staff calculations.

Price-based structural balance rules

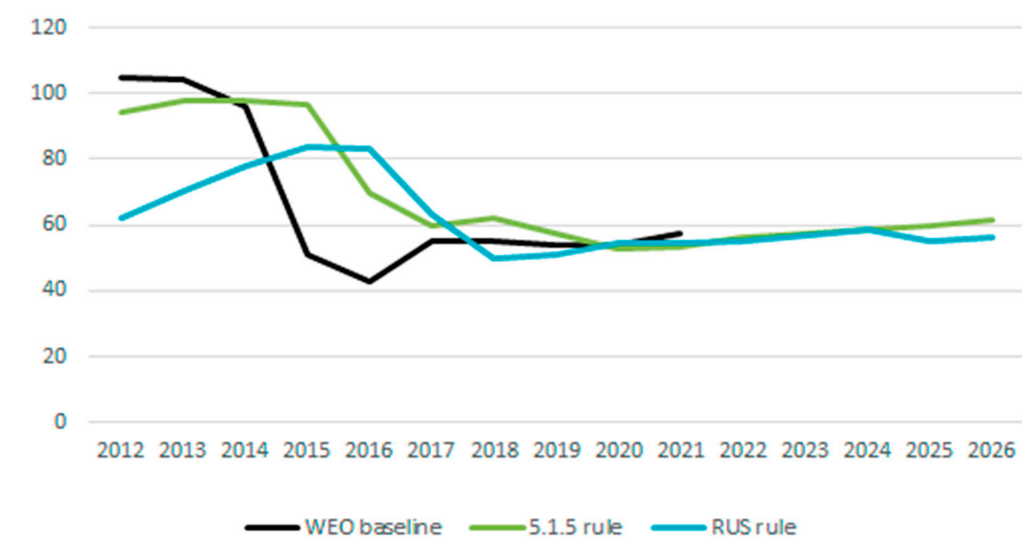
14. Price-based rules could help anchor medium-term fiscal policy.[3] Such rules target a certain level of the structural primary balance, defined as the primary balance calculated at a

[3] Chile, Mexico, Mongolia and Russia use versions of a price-based framework. The paper does not estimate expenditure-based rules (e.g., limiting growth of spending to some rate), as these are most effective when oil or other commodity prices are increasing.

predetermined benchmark oil price. This approach helps delink primary spending from the price-cyclical component of oil revenue, thus helping to ensure that oil price volatility does not contribute to cyclical swings of fiscal policy.[4] The benchmark price is usually based on long-term historical and future prices or their combination. As opposed to the PIH model, price-based rules have a short- to medium-term focus and can thus provide a near-term anchor for fiscal policy.

15. Two different oil price benchmarks are considered. In the first rule, the benchmark oil price is set to an 11-year average of the oil price that includes the past 5 years, the current year, and 5 years of the future price ("5.1.5" rule in the figures). In the second rule, the benchmark price is set to the lower of a 10-year historical average and a 3-year historical average of the oil price. This is the formula followed by Russia ("RUS rule" in the figures). The 10-year average aims to smooth the benchmark price, and therefore government spending, while the 3-year average helps avoid excessive deficits in the event of sustained oil price drop in preceding years. By forcing slower (faster) adjustment in the benchmark price to an increase (decrease) in the oil price, the minimum function builds in a bias toward savings. Figure 7 shows how the benchmark oil prices evolve over time.

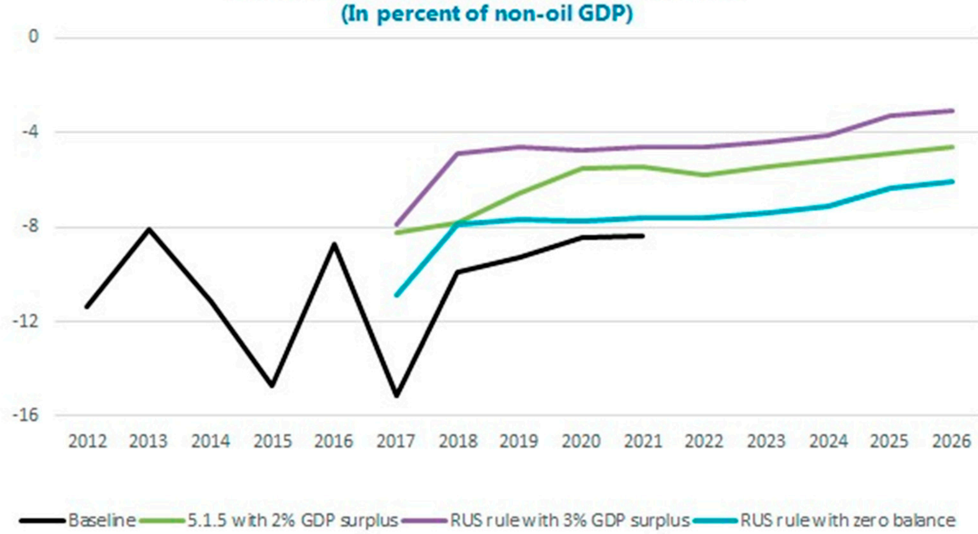
Figure 7. Kazakhstan: Benchmark Oil Price (in USD)



16. The choice of the benchmark price involves a trade-off between expenditure volatility and the level of financial savings. Using a long moving average of historical oil prices achieves the greatest degree of expenditure smoothing, but may also lead to insufficient savings or even dissaving if the oil price drops sharply. Conversely, a combination of past and future prices, or a short moving average of past prices, would generate higher spending volatility but also higher savings, thanks to faster adjustment of the benchmark to the price drop.

[4] Price-based rules however may not help delink primary spending from volatility in oil revenue arising from changes in oil extraction. Oil production is assumed to be relatively smooth over the projection horizon. If this assumption was to break, a structural balance rule would need to be based on predetermined benchmark oil price and output.

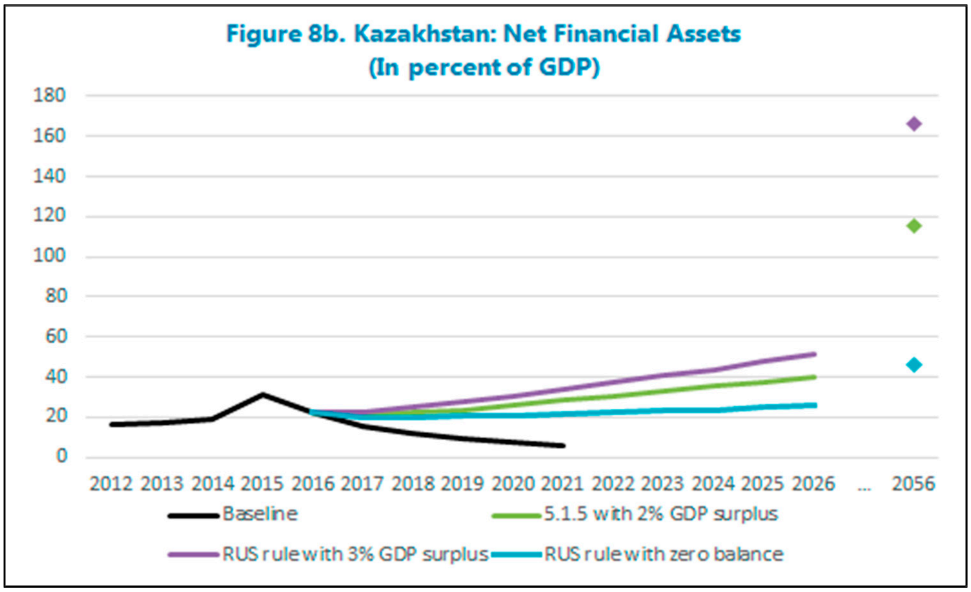
Figure 8a. Kazakhstan: Non–Oil Primary Balance
(In percent of non-oil GDP)



17. The target for the structural balance rule could be calibrated based on the savings generated by the PIH benchmarks. Under the constant perpetuity benchmark (non-oil deficit in percent of non-oil GDP), net financial assets of the government would be about 200 percent of GDP by the end of the projection period; a more gradual adjustment to this rule would yield financial assets of about 150 percent of GDP by 2056 (Figure 6b). A balanced structural balance rule (targeting zero structural balance) would be sufficient only to maintain roughly the current level of net financial assets, failing to save for future generations, even less than under the relaxed PIH option. A structural balance rule targeting a surplus of 2½-3 percent of non-oil GDP (under either of the two price benchmarks) though would generate savings in the 150-170 percent of GDP range in the long term (Figure 8b).[5]

18. Price-based structural balance rules would entail a large adjustment in the medium term. Figure 8a shows that the NOPD projected in 2017 under the staff's baseline is only slightly higher (excluding the support to the banking sector) than the NOPD resulting from the price-based rules targeting 2-3 percent of non-oil GDP structural surplus. Going forward, however, the NOPD under the baseline would remain broadly constant while the rules targeting a structural surplus of 2-3 percent of non-oil GDP would require a considerable reduction in the NOPD, as the benchmark price adjusts to the oil price drop since 2014 to a fuller extent. Over time, this would result in a striking difference in net financial assets (Figure 8b.). This again underlies the case for the authorities to commit to a sizeable medium-term fiscal consolidation.

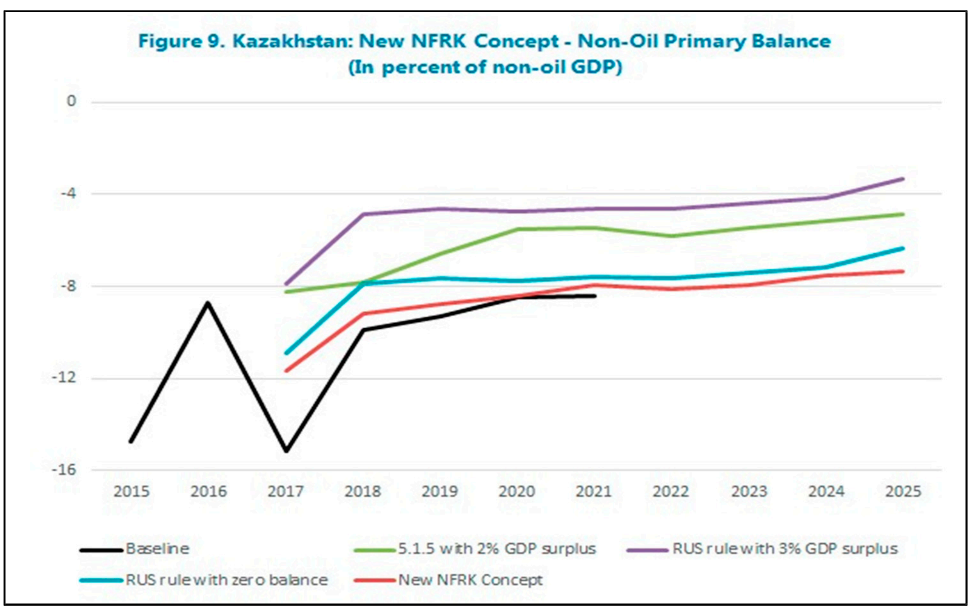
[5] Savings of 150-170 percent of GDP is illustrative. While the target for savings is a question for public policy, the authorities should aim for a sizable buffer and savings amount.



D. An Evaluation of the New NFRK Concept

19. The non-oil deficit path in the new NFRK concept adopted in late 2016 is broadly in line with the path suggested by the oil price-based rules. The new path targets a medium-term consolidation that is consistent with long-term fiscal sustainability, as it follows relatively closely the path implied by the Russian rule with zero balance (Figure 9). However, more consolidation efforts would be needed to accumulate more sizable NFRK assets. The Russian rule with zero balance would result in net financial assets of about 46 percent of GDP by the end of the projection period, well below the 150-170 percent of GDP range based on perpetuity PIH benchmarks.

20. Steadfast implementation of the new NFRK concept and the fiscal adjustment that it implies is paramount. Lack of revenue and expenditure measures and a deviation from the path



presented in the NFRK concept would result in a decline in net financial assets and could impair Kazakhstan's long-term fiscal sustainability.

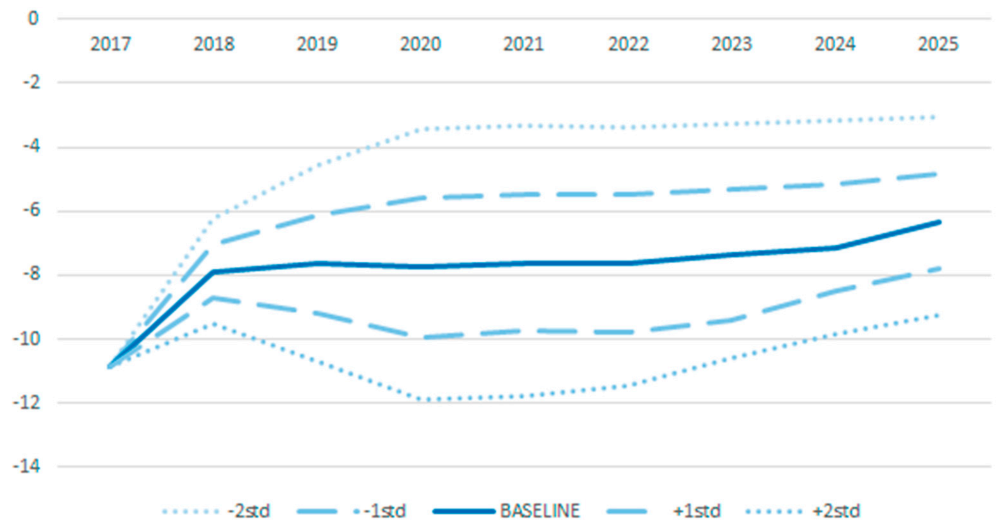
E. Oil Revenue Shocks

21. Adverse oil price shocks represent a downside risk for fiscal sustainability. The recent oil price drop led to higher non-oil primary deficits, increasing the probability of an unsustainable fiscal position. To analyze fiscal risks stemming from movements in oil prices, we compute the PIH and the RUS rule with zero balance under one- and two-standard deviation shocks in oil prices (one standard deviation corresponds to about $16). In both cases, positive and negative shocks are considered. This approach allows for a creation of confidence bands that could help guide fiscal policy to a sustainable path. The PIH-perpetuity is relatively inelastic to changes in oil prices while the PIH-annuity is highly sensitive (Table 3). This is because, in the annuity case, a finite life-span of the NFRK—which is directly affected by oil revenues—is assumed. The non-oil fiscal balance path implied by the RUS rule with zero balance is directly affected by the oil price shocks (Figure 10). Compared to the baseline case, in the case of a negative shock, a substantial fiscal consolidation is needed. In the most pessimistic scenario—an oil price shock of 2 standard deviations—the rule suggests a non-oil deficit of about 3 percent of non-oil GDP, a value that is consistent with the non-oil balance suggested by the PIH-Annuity. In turn, in the case of a positive shock, the rule allows for a higher non-oil deficit in the medium- and long-term.

Table 3. Kazakhstan: Non-Oil Balance (percent of non-oil GDP)

	Perpetuity	Annuity
Negative 2σ Shock	-0.52	-2.97
Negative 1σ Shock	-0.77	-4.4
Baseline	-1.02	-5.83
Positive 1σ Shock	-1.27	-7.25
Positive 2σ Shock	-1.51	-8.68

Figure 10. Kazakhstan: Non-Oil Balance Under the RUS Rule



F. Conclusion

22. The sharp and sustained drop in oil prices since 2014 calls for a medium-term fiscal consolidation. With a broadly unchanged non-oil deficit going forward, the government's net financial assets would fall close to zero by 2021 (see Table 1), which could put market access and fiscal sustainability at risk. To avoid this and to promote intergenerational equity, the authorities should reduce the non-oil deficit closer to the levels consistent with long-term fiscal benchmarks. The medium-term adjustment could be anchored by price-based fiscal rules targeting a structural surplus of 2-3 percent of non-oil GDP. Adopting these rules would entail a reduction of the NOPD of about 4-5 percent of non-oil GDP over the medium term.

23. The new NFRK concept introduces targets that preserve long-term fiscal sustainability; this is welcome, but the implementation of the implied adjustment is paramount. The non-oil fiscal deficit targeted by the new concept is line with the Russian rule with zero balance and in the medium-long term results in a positive accumulation of net financial assets. A deviation from this path, however, will result in higher deficits and could jeopardize long-term fiscal sustainability. Moreover, following the Russian experience, the consolidation efforts could be strengthened to allow for higher accumulation of net financial assets. This would be desirable to preserve a greater share of the oil wealth for future generations.

References

Alter, A., Ghilardi, M.F., and Hakura D.S.. 2017. Public Investment in a Developing Country Facing Natural Resource Depletion. Journal of African Economies.

Arezki, R., K. Hamilton, and K. Kazimov. 2011. "Resource Windfalls, Macroeconomic Stability and Growth: The Role of Political Institutions." IMF Working Paper 11/142, International Monetary Fund, Washington.

Calder, J. 2014. Administering Fiscal Regimes for the Extractive Industries: A Handbook. Washington: International Monetary Fund.

Celasun, O., F. Grigoli, K. Honjo, J. Kapsoli, A. Klemm, B. Lissovolik, J. Luksic, M. Moreno-Badia, J. Pereira, M. Poplawski-Ribeiro, B. Shang, and Y. Ustyugova. 2015. "Fiscal Policy in Latin America: Lessons and Legacies of the Global Financial Crisis." IMF Staff Discussion Note 15/06, International Monetary Fund, Washington.

Cherif, R., and F. Hasanov. 2013. "Oil Exporters' Dilemma: How Much to Save and How Much to Invest." World Development 52: 120–31.

Davis, J.M., R. Ossowski, and A. Fedelino. 2003. Fiscal Policy and Implementation in Oil-Producing Countries. Washington: International Monetary Fund.

Duclaud, J., and G. Garcia. 2012. "Mexico's Oil Price-Hedging Program." Chapter 15 in Commodity Price Volatility and Inclusive Growth in Low-Income Countries, edited by R. Arezki, C. A. Pattillo, M. Quintyn, and M. Zhu. Washington: International Monetary Fund.

Husain, A., K. Tazhibayeva, and A. Ter-Martirosyan. 2008. "Fiscal Policy and Economic Cycles in Oil-Exporting Economies." IMF Working Paper 08/253, International Monetary Fund, Washington.

International Monetary Fund (IMF). 2012a. "Macroeconomic Policy Frameworks for Resource-Rich Developing Countries." Washington. http://www.imf.org/external/np/pp/eng/2012/082412.pdf.

———. 2012b. "Fiscal Regime for Extractive Industries: Design and Implementation." IMF Policy Paper. Washington. http://www.imf.org/external/np/pp/eng/2012/081512.pdf.

———. 2014a. "Sovereign Asset-Liability Management Guidance for Resource-Rich Economies." IMF Policy Paper. Washington. http://www.imf.org/external/np/pp/eng/2014/061014.pdf.

Medas, P., and D. Zakharova. 2009. "A Primer on Fiscal Analysis in Oil-Producing Countries." IMF Working Paper 09/56, International Monetary Fund, Washington.

Ossowski, R., M. Villafuerte, P. Medas, and T. Thomas. 2008. "The Role of Fiscal Institutions in Managing the Oil Revenue Boom." IMF Occasional Paper 260, International Monetary Fund, Washington.

Schmidt-Hebbel, K. 2012: "Fiscal Institutions in Resource-Rich Economies: Lessons from Chile and Norway." Working Paper 416, Pontifical Catholic University of Chile.

Thomas, A., and J. Treviño. 2013. "Resource Dependence and Fiscal Effort in Sub-Saharan Africa." IMF Working Paper 13/188, International Monetary Fund, Washington.

Villafuerte, M., P. Lopez-Murphy, and R. Ossowski. 2010. "Riding the Roller Coaster: Fiscal Policies of Nonrenewable Resource Exporters in Latin America and the Caribbean." IMF Working Paper 10/251, International Monetary Fund, Washington.

World Bank. 2013. "Oil Rules: Kazakhstan's Policy Options in a Downturn." Washington, DC. https://openknowledge.worldbank.org/handle/10986/16721

KAZAKHSTAN—EQUILIBRIUM REAL INTEREST RATE AND MONETARY POLICY RULES[1]

The National Bank of Kazakhstan has moved from a monetary policy framework that was based on exchange rate stability to one that involves inflation targeting. This move calls for new approaches to monetary operations, including considerations for setting the central bank policy interest rate. The paper discusses the use of interest rate rules in monetary policy and the issues that arise in relation to their application. One of these issues pertains to uncertainty with regard to the equilibrium real interest rate and the output gap. Estimates of these variables for Kazakhstan are provided and an argument is made that due to the high uncertainty of these estimates, preference should be given to robust and multiple interest rate rules. These rules may help guide policy decisions and enhance central bank operational independence. They should be supported by further analytical work, improved communications, and efforts to strengthen the interest rate channel of monetary policy transmission.

A. Introduction

1. **The main goal of monetary policy in Kazakhstan is to ensure price stability.** This goal is pursued within the inflation targeting (IT) framework that the National Bank of Kazakhstan (NBK) put in place in 2015. In this framework, the central bank sets and announces to the public a quantitative target for inflation (a point estimate or a band) and acts to bring and maintain actual inflation close to that level. Consistent with IT principles, the NBK has communicated that it would target a band for inflation at 6-8 percent in 2017 and 5-7 percent in 2018. The medium-term goal is to reduce inflation below 4 percent.[2] The main instrument of the NBK's monetary policy is the "base" interest rate, which influences short-term money market rates and through other interest rates should have an effect on demand and inflation. A key precondition for the successful conduct of monetary policy under IT is the central bank's operational independence. This means that the central bank should have full control over the use of instruments of monetary policy with the purpose of meeting the inflation target, without outside interference that could be motivated by interests other than price stability. Limiting the scope of discretion in monetary policy could help in reducing this interference, enhancing independent decision-making, and ultimately achieving better economic outcomes.

2. **Many central banks use interest rate rules to guide monetary policy decisions.** For example, as attested by Kohn (1999), the members of the U.S. Federal Reserve Open Market Committee are provided on a regular basis with information on the predictions from various monetary policy rules, including charts that show historic and projected federal funds rates under two different rules. This information is used not so much to determine the precise numerical target

[1] Prepared by Rossen Rozenov.

[2] NBK Monetary Policy Guidelines.

for the policy rate but more as a benchmark for the monetary policy stance.[3] In general, rules-based policies are more transparent and address the time-inconsistency problem.[4] That said, the limitations of formal rules need to be recognized as well; in particular, they cannot be expected to perform well under all circumstances and are likely less useful when the economy is hit by a large shock or when it is undergoing significant structural changes. Some element of judgement is therefore inevitable.

3. This paper offers a targeted review of the literature on monetary policy rules and provides estimates of the natural rate of interest and output gap for Kazakhstan. The rest of the paper is organized as follows: Section II discusses different types of interest rate rules that have been considered in central banking and academia; Section III applies the methodology proposed by Holston and others (2016) to obtain estimates for Kazakhstan of two key variables that enter policy rules -- the equilibrium real interest rate and the output gap; Section IV highlights the importance of robustness in the choice of interest rules, and Section V concludes.

B. A Brief Overview of Interest Rate Rules

4. Various interest rate rules have been considered in the literature. Typically, they are specified as a linear feedback law that prescribes a numerical value for the policy variable (a short-term interest rate under the control of the central bank) in relation to the state of the economy. The rules differ not only in the parametrization but also in terms of the variables involved. Some include the output gap, others are based on the deviation of unemployment from its natural rate; in some the policy rate responds to contemporaneous inflation, while others include lags and expected values. There are also differences regarding how the rules are derived; their parameters can be either estimated empirically based on observed reaction functions of central banks or they may be calculated as solutions to an optimization problem, e.g., minimizing a loss function which depends on the variance of the deviation of inflation from its target and actual output from potential. Perhaps the best-known in the class of interest rate rules is the Taylor (1993) rule, which sets the short-term interest rate i_t according to the formula:

$$i_t = r^* + \pi_t + 0.5(\pi_t - \pi^*) + 0.5\tilde{y}_t, \quad (1)$$

where r^* is the equilibrium real rate of interest, π_t denotes inflation at period t, π^* stands for the desired (targeted) rate of inflation and $\tilde{y}_t$ for the output gap. A more general version has the following form:[5]

$$i_t = E_t\{(1-\rho)\left(r^* + \pi_{t+j}\right) + \rho i_{t-1} + \alpha\left(\pi_{t+j} - \pi^*\right) + \beta\tilde{y}_{t+k}\}, \quad (2)$$

[3] See Kohn's comment on the paper by Battini and Haldane in Taylor (1999), p. 195.

[4] The time-inconsistency problem arises when policy makers announce certain policies and later deviate from them to take advantage of decisions that private agents made based on the initial policy. Committing to rules rather than using discretion helps to build credibility.

[5] Taylor and Williams (2010), p. 836.

The above formulation allows for some inertia in the dynamics of the policy rate through the parameter ρ and also assumes that the central bank can react to expected values of inflation and the output gap (or lags of these variables when j and k are negative). The classical Taylor rule (1) is a special case of (2) with $\rho = 0$, $j = k = 0$ and $\alpha = \beta = 0.5$. Table A1 in the Annex presents examples of interest rate rules, either estimated empirically or calibrated based on simulations.

5. A further generalization would include additional variables in the central bank's reaction function. One such variable is the exchange rate. As noted by Ostry and others (2012), although an orthodox inflation targeter would react to the exchange rate only to the extent that it has an effect on expected inflation, in practice a number of emerging markets include implicitly the exchange rate in their reaction functions. Ostry and others (2012) estimate an augmented Taylor rule which contains the deviation of the real exchange rate from a trend and find a statistically significant impact of this variable on the policy rate. Ball (1999) argues that in an open economy, the classical Taylor-type rules need to be modified in order to perform well since monetary policy affects the economy through the exchange rate channel along with the interest rate channel. In the context of a simple model, he derives a policy rule which targets a monetary conditions index (MCI) – a weighted average of the real interest rate and exchange rate. Several central banks at the time used an MCI as their policy instrument. Battini and Haldane (1999) also underscore the open economy dimension; their Phillips curve equation includes real exchange rate terms, which reflect the impact of exchange rate changes on the prices of imported goods in the consumption basket.

C. Estimating the Equilibrium Real Interest Rate

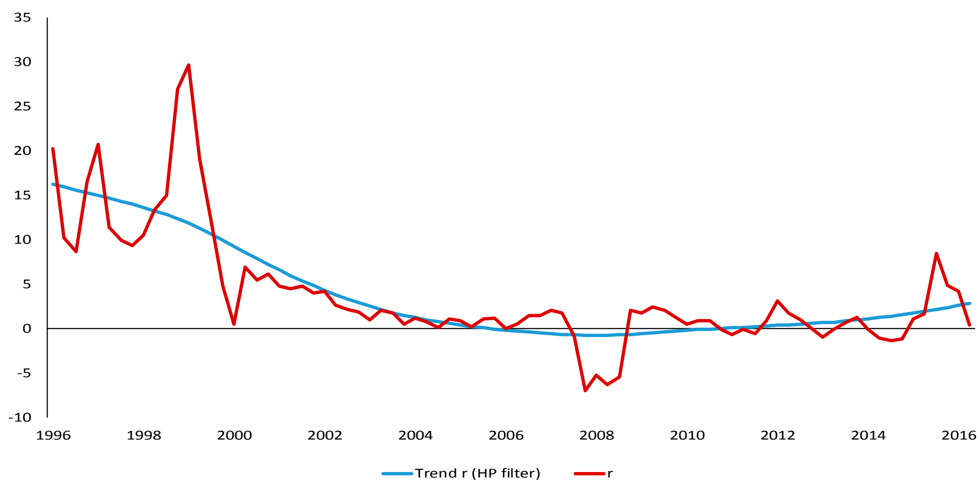
6. The above rules assume knowledge of the equilibrium real interest rate (or the "natural rate") and the output gap.[6] In reality, however, neither the natural rate, nor potential output are directly observable, and their estimation is fraught with difficulties. While measuring the output gap has been an active area of research for a long time, the interest in studying the behavior of the equilibrium real interest rate is more recent. The issue has received a lot of attention largely due to the observation that real interest rates have declined significantly since the 1980s. For instance, the average global ten-year real rate declined from 6 percent to close to zero, and for some economies, such as the core euro area countries, real rates have become negative (IMF, 2014a). To the extent that this decline reflects a downward trend in the natural rates, rather than a systematic deviation of monetary policy from a neutral stance, it has important implications for monetary policy. Two general approaches have been used in the literature to estimate the equilibrium real interest rate: (i) time series techniques (e.g., Hamilton and others, 2016) and (ii) micro-founded models incorporating optimizing behavior of households and firms (Justiniano and Primiceri, 2010).

7. The Hodrick-Prescott (HP) filter is an example of a univariate time series method for obtaining a measure of the natural rate. This approach decomposes the actual time series into a trend component and a cyclical component. The trend component of the real interest rate can be

[6] The equilibrium real interest rate is defined as the real interest rate when actual GDP equals potential and actual inflation equals the target (Taylor, 2016).

thought of as a measure of the equilibrium rate. We apply the HP filter to a calculated quarterly real interest rate for Kazakhstan in the period Q1 1996- Q2 2016. The real interest rate is obtained as the difference between the policy rate and expected inflation. The policy rate is represented by the NBK refinancing rate until August 2015 and by the base rate (the overnight repo rate) thereafter. Expected inflation is approximated by a four-quarter moving average of past inflation. The HP filter estimates suggest that the equilibrium real interest rate has declined significantly since the late 1990s to around 4 percent on average in the last year (Figure 1), likely reflecting abundant liquidity in the economy. However, as pointed out by Taylor (2016), the observed downward trend in the equilibrium rate may be due to a trend in other variables that affect the economy.

Figure 1. Kazakhstan: Actual and Trend Real Interest Rate



Source: NBK, IMF staff calculations

8. **Alternatively, the natural rate and potential output can be examined as a system.** State space methods provide a natural framework for modeling the dynamics of unobservable variables. Laubach and Williams (2003) applied the Kalman filter to jointly estimate time-varying equilibrium real interest and potential output growth in the US. Holston and others (2016) used this methodology (with a slight modification) and more recent data to document the developments in the natural rates in Canada, UK, US and the Euro area. Their methodology assumes that the equilibrium real rate of interest can be represented as a sum of two components:

$$r_t^* = g_t + z_t, \tag{3}$$

where g_t is the trend growth rate of potential output and z_t captures other determinants of r_t^* such as the rate of time preference of households. Potential output (in logarithm) is modeled as a random walk with a stochastic drift:

$$y_t^* = y_{t-1}^* + g_{t-1} + \varepsilon_{y*,t}, \tag{4}$$

where the trend g_t is also a random walk:

$$g_t = g_{t-1} + \varepsilon_{g,t}, \tag{5}$$

The same assumption is made for z_t :

$$z_t = z_{t-1} + \varepsilon_{z,t}. \tag{6}$$

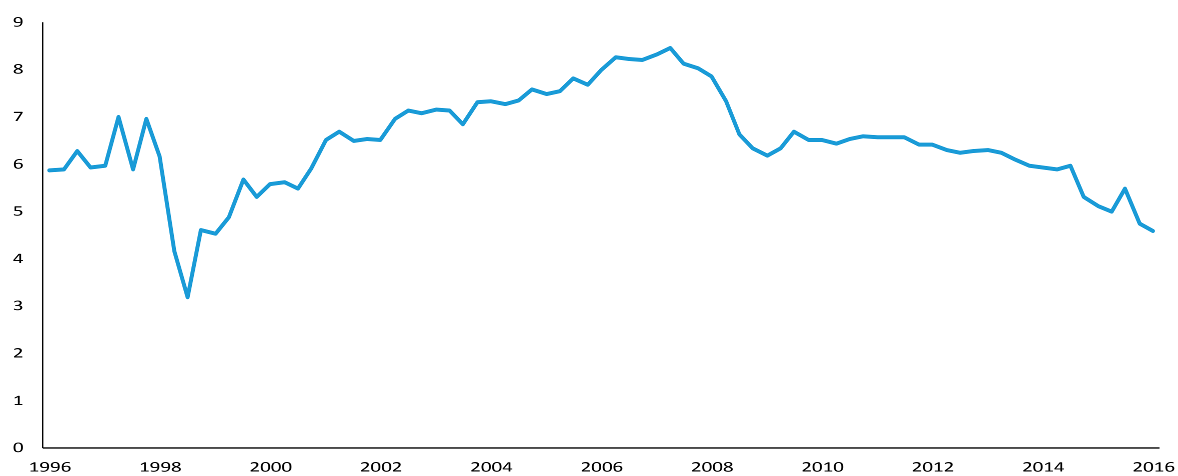
In addition to the transition equations (4)-(6), the model includes reduced form IS and inflation equations of the form:

$$\tilde{y}_t = a_1\tilde{y}_{t-1} + a_2\tilde{y}_{t-2} + \frac{a_3}{2}\sum_{j=1}^{2}\left(r_{t-j} - r_{t-j}^*\right) + \varepsilon_{\tilde{y},t}\,, \tag{7}$$

$$\pi_t = b_1\pi_{t-1} + (1 - b_1)\pi_{t-2,4} + b_2\tilde{y}_{t-1} + \varepsilon_{\pi,t}, \tag{8}$$

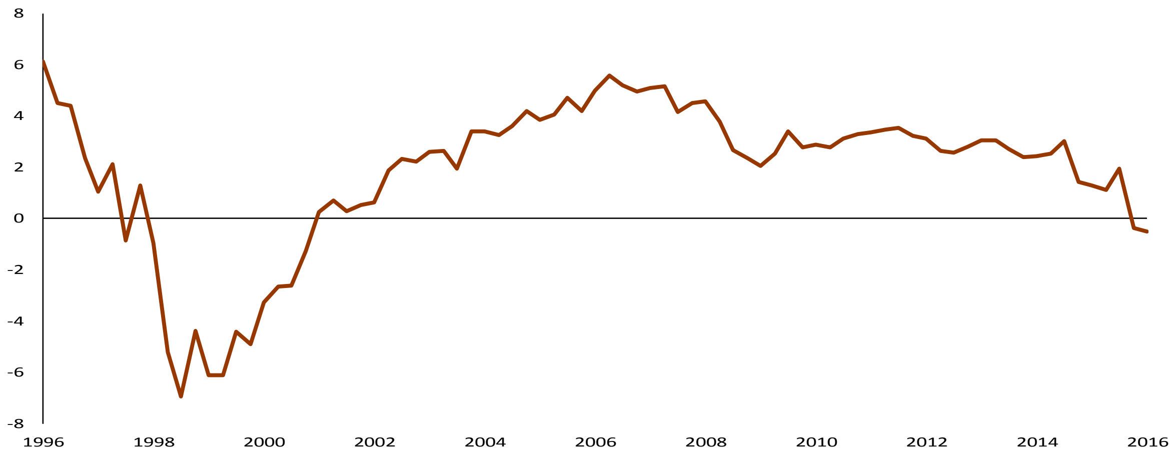
where $\tilde{y}_t = 100(y_t - y_t^*)$ is the output gap, π_t denotes consumer price inflation and $\pi_{t-2,4}$ is the average of the second through fourth lag of inflation. The real interest rate r_t is calculated as described earlier.

Figure 2. Kazakhstan: Estimated Equilibrium Real Interest Rate



Source: NBK, Ministry of Economy, IMF staff estimates

Figure 3. Kazakhstan: Estimated Output Gap



Source: NBK, Ministry of Economy, IMF staff estimates

9. **Results for Kazakhstan suggest a current natural rate of interest on the order of 4 percent.** The state space model is estimated for Kazakhstan. Since real GDP in 2005 prices is available only since 1999, we use real growth rates based on an older series (1994 prices) to extend the data backwards. As explained by Holston and others (2016), since estimates of the standard deviations of the shocks in (5) and (6) tend to be biased towards zero, estimation needs to be done in three stages, whereby after stages one and two the ratios $\lambda_g = \sigma_g/\sigma_{y*}$ and $\lambda_z = a_3\sigma_z/\sigma_{\tilde{y}}$ are obtained using the median unbiased estimator of Stock and Watson (1999).[7] These ratios are then imposed when estimating the rest of the model parameters. Figure 2 shows the dynamics of the filtered equilibrium real interest rate. Since 2007 there has been a steady decline in the natural rate and its most recent level broadly corresponds to the estimate based on the HP filter; the sharp decline in 1998 is associated with the large negative output gap at the time (Figure 3).

D. Considerations for Robustness

10. **The estimated output gap and equilibrium real interest rate are subject to considerable uncertainty.** This is a more general problem and does not only reflect the quality of the data available for Kazakhstan. Even for advanced economies often there is no consensus on the

[7] The reported results for Kazakhstan are obtained using the R codes for the paper by Holston and others (2016), available at John Williams' web page http://www.frbsf.org/economic-research/economists/john-williams/. Since the estimated λ_z in the case of Kazakhstan turned out to be very large (about ten times higher than the typical values for advanced economies) and this prevented the calculations in the final stage, we fixed it at 0.03, a value in line with the estimates in Holston and others (2016).

magnitude of these variables and different estimation methods point to different values. A number of studies have looked into the implications of measurement errors for monetary policy. For example, Orphanides and others (2000) find that mismeasurements of the output gap can result in a substantial deterioration in economic outcomes. One possible response to the problem of high uncertainty is attenuation – in this case a reduction of the coefficient on the output gap in the interest rate rule. Taylor (2016) focuses on the equilibrium interest rate and shows that perceptions about how the rate has changed recently have important consequences for interest rate setting; in the case of US, the difference can be as large as 2 percentage points. Further, he argues that the natural rate in the policy rule should not be adjusted in a discretionary way and it should be considered in conjunction with shifts in other related variables, such as changes in potential GDP as in the Laubach-Williams model, to ensure consistency. As regards possible remedies, some authors (e.g., Hamilton and others, 2016) prescribe using policy inertia in the interest rate rules, i.e., assigning a positive value to the parameter ρ in (2).

11. **Robustness is a desirable property of monetary policy rules.** In light of the measurement difficulties discussed above, efforts have focused increasingly on designing robust interest rate rules which perform well in a range of circumstances. As noted by Taylor and Williams (2010), in earlier works, robustness was assessed by comparing the performance of the candidate policy rule across a set of models; more recently the problem has been formulated in decision theoretic terms. An example of the former approach is the study by Levin and others (1999) who compute the inflation-output volatility frontier of four different models for alternative specifications of the interest rate rule and compare the results. Taylor (1999) makes a systematic evaluation of five policy rules in the context of nine models. The rules differ in the weights on inflation and the output gap, as well as the extent of policy inertia. (rules 16-20 in Table A1). Overall, placing higher weights on inflation makes the rule more robust to inflation shocks and similarly for output; including a lag in the interest rate does not necessarily improve performance and in some models can lead to instability. The search for rules that work well under model uncertainty can be formalized as a decision problem. Onatski and Williams (2003) take a small estimated macroeconomic model and derive Taylor-type policy rules that are robust to various forms of uncertainty, using Bayesian and minimax criteria. One important conclusion from their analysis is that policy rules designed to perform well under one type of uncertainty may fail if the uncertainty is of different nature. Cogley and others (2011) find an optimal simple Taylor rule that takes into account parameter uncertainty.

12. **An alternative approach to dealing with uncertainty about unobservable quantities is to consider interest rate rules in differences.** Specifically, setting $\rho = 1$ in (2) yields a class of rules that link the change in the interest rate to the deviation of inflation from the target and of actual output from potential. Levin and others (1999) argue that for the models they consider, difference rules perform better than level-based rules and are more robust to uncertainty. Another possible modification aimed at reducing the effect of measurement errors is to replace the output gap with the growth rate of output (McCallum, 1998). In the context of interest rate rules that respond to deviations of unemployment from its natural rate, Orhpanides and Williams (2002) suggest to include the change in unemployment rate instead of the unemployment gap in the central bank's reaction function. While they recognize that the two are not perfect substitutes, they argue that the

direction of response would be appropriate as rising unemployment would imply easing of monetary policy.

E. Conclusions

13. Interest rate rules can be a useful tool to inform monetary policy decisions in Kazakhstan. The main advantage of rules is that they provide a quantitative benchmark for the policy variable that is consistent with the goal of stabilizing the economy. In addition, they structure thinking about the monetary policy stance and enhance transparency and independence in decision-making. This, however, does not mean that the policies prescribed by the rule should be followed rigidly. Discretion still has a role to play for at least two reasons. First, the nature of the shock may be such that the rule would not provide an adequate response. Second, most of the interest rate rules discussed in the literature assume timely and relatively accurate knowledge of the output gap and natural rate of interest. These quantities are hard to estimate and highly uncertain. In the case of Kazakhstan, results based on a joint estimation of the two variables suggest a current level of the natural rate of interest of around 4 percent; it has been on a declining trend over the last ten years. Given the uncertainties, a case can be made for choosing robust rules. Ideally, the NBK should consider the outcomes of several alternative rules and analyze the source of the differences. This would create further incentives to develop the central banks' analytical capacity. The NBK experience with inflation targeting is still in its initial phase but as information accumulates, it would become possible to conduct formal assessments of the different rules and chose the ones that perform best. The survey of inflation expectations that NBK launched could be potentially useful in evaluating forward-looking rules.

14. A key challenge facing the NBK is to strengthen the interest rate channel of monetary policy transmission. No rule can be effective in achieving price stability if changes in the policy rate have no impact on inflation. A number of studies have documented the weak link between the policy rate, market interest rates and inflation in Kazakhstan.[8] While some improvement in the transmission from the base rate to interbank rates seems to have taken place since the introduction of IT, further efforts are needed to develop the interest channel. The NBK has started issuing securities at various maturities to help build the yield curve but it should not be alone in this endeavor; the government has an important role to play in developing the domestic bond market which calls for a strong cooperation between the central bank and the Ministry of Finance (MoF). The NBK should consider a faster unwinding of the long-term FX swaps that it undertook with local banks in 2014-15. Also, it should phase out the use of direct instruments of monetary control, such as caps on the annual growth of consumer's credit, and subsidized lending, which if needed should be part of fiscal policy and executed by the MoF through the budget, as these are not consistent with the IT framework. The relatively high degree of dollarization is another impediment to monetary policy transmission and the NBK should pursue macro and prudential policies aimed at

[8] See for example, IMF Country Report No. 14/243 (Selected Issues), IMF Country Report No. 08/288 (Box 3), and Epstein and Portillo (2014).

de-dollarizing the economy in line with the international best practices. Finally, addressing the issues in the financial sector is critical for maintaining macroeconomic stability.

References

Aizenman, J., Hutchison, M. and I. Noy (2011), "Inflation Targeting and Real Exchange Rates in Emerging Markets", *World Development*, Vol. 39, No. 5, pp. 712-724

Ball, L. (1999), "Policy Rules for Open Economies", in Taylor (Ed.), "Monetary Policy Rules", NBER Studies in Business Cycles 31, The University of Chicago Press

Ball, L. and R. Tchaidze (2002), "The Fed and the New Economy", *American Economic Review, Papers and Proceedings*, Vol. 92, pp. 108-14

Battini, N. and A. Haldane (1999), "Forward-Looking Rules for Monetary Policy", in Taylor (Ed.), "Monetary Policy Rules", NBER Studies in Business Cycles 31, The University of Chicago Press

Clarida, R., Gali, J. and M. Gertler (1998), "Monetary Policy Rules in Practice: Some International Evidence", *European Economic Review*, Vol. 42, pp. 1033-67

Cogley, T. De Paoli, B., Matthes, C., Nikolov, K. and T. Yates (2011), "A Bayesian Approach to Optimal Monetary Policy with Parameter and Model Uncertainty", Journal of Economic Dynamics and Control, No. 35, pp. 2186-2212

Gerdesmeier, D. and B. Roffia (2004), "Taylor Rules for the Euro Area: The Issue of Real Time Data", *Deutsche Bundesbank Discussion Paper Series 1: Studies of the Economic Research Centre* No 37

Hamilton, J., Harris, E., Hatzius, J. and K. West (2016), "The Equilibrium Real Funds Rate: Past, Present, and Future", *IMF Economic Review*, Volume 64, No. 4, pp. 660–707

Holston, K., Laubach, T. and J. Williams (2016), "Measuring the Natural Rate of Interest: International Trends and Determinants", Working Paper available at http://www.frbsf.org/economic-research/economists/john-williams/

International Monetary Fund (2014a), "Perspectives on Global Real Interest Rates", Chapter 3 of the *April 2014 World Economic Outlook,* International Monetary Fund, Washington DC

International Monetary Fund (2014b), "Republic of Kazakhstan: Selected Issues", *IMF Country Report* No. 14/243, International Monetary Fund, Washington DC

Justiniano, A. and G. Primiceri (2010), "Measuring the Equilibrium Interest Rate", *Economic Perspectives*, Federal Reserve Bank of Chicago

Korhonen, I. and R. Nuutilainen (2016), "A Monetary Policy Rule for Russia, Or Is It Rules?", *Bank of Finland BOFIT Discussion Paper*, No. 2

Laubach, T. and J. Williams (2003), "Measuring the Natural rate of Interest", *The Review of Economics and Statistics*, Vol. 85, No. 4, pp. 1063-1070

Levin, A., Wieland, V. and J. Williams (1999), "Robustness of Simple Monetary Policy Rules under Model Uncertainty", in Taylor (Ed.), "Monetary Policy Rules", NBER Studies in Business Cycles 31, The University of Chicago Press

McCallum, B. (1999), "Issues in the Design of Monetary Policy Rules" in Taylor and Woodford (Ed.) "Handbook of Macroeconomics", Vol. 1, Elsevier Science B.V.

Mohanty, M. and M. Klau (2004), "Monetary Policy Rules in Emerging Market Economies: Issues and Evidence", *BIS Working Paper* 149

Onatski, A. and N. Williams (2003), "Modeling Model Uncertainty", *Journal of the European Economic Association*, Vol. 1, No. 5, pp. 1087-1122

Orphanides, A. (2001), "Monetary Policy Rules Based on real-Time Data", *American Economic Review*, Vol. 91, No. 4, pp. 964-985

Orphanides, A., Porter, R., Reifschneider, D., Tetlow, R. and F. Finan (2000), "Errors in Measurement of the Output Gap and the Design of Monetary Policy", *Journal of Economics and Business*, No. 52, pp. 117-141

Orphanides, A. and J. Williams (2003), "Robust Monetary Policy Rules with Unknown Natural Rates", *Brookings Papers on Economic Activity*, No. 2, pp. 63-118

Ostry, J., Ghosh, A. and M. Chamon (2012), "Two Targets, Two Instruments: Monetary and Exchange Rate Policies in Emerging Market Economies", *IMF Staff Discussion Note*, SDN/12/01, International Monetary Fund, Washington DC

Patra, M. and M. Kapur (2012), "Alternative Monetary Policy Rules for India", *IMF Working Paper*, WP/12/118, International Monetary Fund, Washington DC

Rudebusch, G. and L. Svensson (1999), "Policy Rules for Inflation Targeting", in Taylor (Ed.), "Monetary Policy Rules", NBER Studies in Business Cycles 31, The University of Chicago Press

Stock, J. and M. Watson (1998), "Median Unbiased Estimation of Coefficient Variance in a Time-Varying Parameter Model", Journal of the American Statistical Association, Vo. 93, No. 441, pp. 349-358

Taylor, J. (1993), "Discretion versus Policy Rules in Practice", Carnegie-Rochester Conference Series on Public Policy, Vol. 39, pp. 195-214

Taylor, J. (Ed.) (1999), "Monetary Policy Rules", NBER Studies in Business Cycles 31, The University of Chicago Press

Taylor, J. and J. Williams (2010), "Simple and Robust Rules for Monetary Policy", Handbook of Monetary Economics, Vol. 3B, Elsevier B.V.

Taylor, J. and V. Wieland (2016), "Finding the Equilibrium Real Interest Rate in a Fog of Policy Deviations", *Hoover Institution Economics Working Papers*, No. 16109, Hoover Institution, Stanford CA.

Appendix

Table A1. Examples of Interest Rate Rules

No	Source	Country	Rule
			Estimated Rules
1	Taylor (1993)	US	$i_t = r^* + \pi_t + 0.5(\pi_t - \pi^*) + 0.5\tilde{y}_t,$
2	Clarida, Gali and Gertleer (2000)	US	$i_t = 0.79 i_{t-1} + 0.21(r^* - 4.12 + 2.15 E_t \pi_{t+1} + 0.93 E_t \tilde{y}_{t+1})$
3	Orphanides (2001)	US	$i_t = 0.66 i_{t-1} + 0.34(1.80 + 1.64 E_t \pi_{t+4} + 0.97 E_t \tilde{y}_{t+4})$
4	Ball and Tchaidze (2002)	US	$i_t = 1.47 + 1.54\pi_t - 1.67(u_t - u_t^*)$
5	Mohanty and Klau (2004)	Brazil	$i_t = 4.12 + 0.72 i_{t-1} + 0.08\pi_t + 0.98\tilde{y}_t - 0.33\Delta rer_t + 0.23\Delta rer_{t-1}$
6.		Chile	$i_t = 0.32 + 0.32 i_{t-1} + 0.97\pi_t + 0.32\tilde{y}_t + 0.35\Delta rer_t - 0.35\Delta rer_{t-1}$
7.		Mexico	$i_t = 1.79 + 0.50 i_{t-1} + 0.55\pi_t + 0.74\tilde{y}_t - 0.63\Delta rer_t - 0.16\Delta rer_{t-1}$
8.		Peru	$i_t = 2.57 + 0.86 i_{t-1} + 0.19\pi_t + 0.15\tilde{y}_t - 0.15\Delta rer_t - 0.23\Delta rer_{t-1}$
9.	Gerdesmeier and Roffia (2004)	EA	$i_t = 0.2 + 0.84 i_{t-1} + 0.17\pi_t + 0.11\tilde{y}_{t+4}$
10.	Aizenman and others (2011) 1/	EM panel	$i_t = 0.83 i_{t-1} + 0.29\pi_t + 0.05\tilde{y}_t + 0.07\Delta rer_t$
11.		Commodity exporters	$i_t = 0.69 i_{t-1} + 0.92\pi_t + 0.09\tilde{y}_t + 0.13\Delta rer_t$
12.	Patra and Kapur (2011)	India	$i_t = 0.58 + 0.91 i_{t-1} + 0.06(\pi_t - \pi_t^*) + 0.31\tilde{y}_{t+4} - 0.01\Delta e_t$

No	Source	Country	Rule
13.	Ostry and others (2012)	EM panel	$i_t - \pi^*_{t+4} = 0.46 + 0.73(i_{t-1} - \pi^*_{t-1}) + 0.70(\pi^e_{t+4} - \pi^*_{t+4}) - 0.03(rer_t - \overline{rer}_t) + 0.06\tilde{y}_{t-1}$
14.	IMF (2014b)	Kazakhstan	$i_t = 0.003 + 0.92i_{t-1} + 0.12\pi_{t-1} + 0.01\tilde{y}_{t-1} - 0.03\Delta e_t$
15.	Korhonen and Nuutilainen (2016)	Russia	$i_t = 0.40 + 0.95i_{t-1} + 0.03(\pi_{t-1} - \pi^*_{t-1}) + 0.02\tilde{y}_{t-1} + 0.03(rer_{t-1} - \overline{rer}_{t-1}) - 3.12\widetilde{oil}_{t-1} + 2.71\widetilde{oil}_{t-2}$
			Optimized/Simulated Rules
16.	Taylor (1999)		$i_t = i_{t-1} + 3.0\pi_t + 0.8\tilde{y}_t$
17.			$i_t = i_{t-1} + 1.2\pi_t + \tilde{y}_t$
18.			$i_t = 1.5\pi_t + 05\tilde{y}_t$
19.			$i_t = 1.5\pi_t + \tilde{y}_t$
20.			$i_t = 1.3i_{t-1} + 1.2\pi_t + 0.06\tilde{y}_t$
21.	Rudebusch and Svensson (1999)		$i_t = 0.88\pi_t + 0.30\pi_{t-1} + 0.38\pi_{t-2} + 0.13\pi_{t-3} + 1.30\tilde{y}_t - 0.33\tilde{y}_{t-1} + 0.47i_{t-1} - 0.06i_{t-2} - 0.03i_{t-3}$
22.	Orphanides and Williams (2002)		$i_t = 0.72i_{t-1} + 0.28(r^* + \pi_t) + 0.26(\pi_t - \pi^*) - 1.83(u_t - u^*) - 2.39(u_t - u_{t-1})$
23.			$i_t = 0.97i_{t-1} + 0.03(r^* + \pi_t) + 0.39(\pi_t - \pi^*) - 0.23(u_t - u^*) - 5.39(u_t - u_{t-1})$
24.			$i_t = i_{t-1} + 0.35(\pi_t - \pi^*) - 5.96(u_t - u_{t-1})$
25.	Onatski and Williams (2003)		$i_t = 0.01i_{t-1} - 0.15i_{t-2} - 0.05i_{t-3} + 0.74\pi_t + 0.77\pi_{t-1} + 0.19\pi_{t-2} + 0.25\pi_{t-3} + 0.30y_t + 0.01y_{t-1}$
26.			$i_t = 0.49i_{t-1} + 0.26i_{t-2} + 0.21i_{t-3} + 1.28\pi_t - 0.91\pi_{t-1} + 0.66\pi_{t-2} - 0.93\pi_{t-3} + 1.57y_t - 1.46y_{t-1}$
27.	Cogley and others (2011)		$i_t = 0.97i_{t-1} + 1.19\pi_t + 0.14\tilde{y}_t + 1.60(\tilde{y}_t - \tilde{y}_{t-1})$

No	Source	Country	Rule
28.			$i_t = 0.97i_{t-1} + 1.46\pi_t + 0.15\tilde{y}_t + 1.85(\tilde{y}_t - \tilde{y}_{t-1})$
29.			$i_t = 0.51i_{t-1} + 0.75\pi_t + 0.03\tilde{y}_t - 0.01(\tilde{y}_t - \tilde{y}_{t-1})$

Legend: i = policy rate, π = inflation, π^*=target inflation, $\tilde{y}$ = output gap, u =unemployment rate, u^*=natural rate of unemployment, r^*= equilibrium real interest rate, Δe = exchange rate change, rer = real effective exchange rate, $\overline{rer}$ = equilibrium real exchange rate, $\widetilde{oil}$ = deviation of oil price from a trend.

1/ An increase in the real exchange rate is real depreciation.

EXCHANGE RATE PASS-THROUGH IN KAZAKHSTAN: EMPIRICAL FINDINGS AND IMPLICATIONS FOR INFLATION TARGETING[1]

This paper examines the exchange rate pass-through (ERPT) in Kazakhstan in the context of inflation targeting. Knowledge of the timing and magnitude of ERPT is important for the conduct of monetary policy. Using both single equation and system methods, the pass-through to consumer prices is estimated in the range of 20- 30 percent. This is close to findings for other developing and emerging market economies and is consistent with Kazakhstan's own recent experience. Empirical evidence is accumulating that monetary policy can influence ERPT; putting a credible monetary policy framework in place—supported by effective communications—may anchor expectations and be associated with lower pass-through. Reducing dollarization and introducing more competition in the domestic product markets could also help reduce ERPT.

A. Introduction

1. **Kazakhstan has started a transition to inflation targeting**. On August 20, 2015, the National Bank of Kazakhstan (NBK) released a joint statement with the government laying out the key elements of a transition to inflation targeting (IT) over the medium term.[2] Among other things, the new monetary policy framework implies a change in the exchange rate regime toward greater exchange rate flexibility. Consistent with this change, the NBK announced that it would no longer intervene in the foreign exchange market, except to prevent excessive volatility that could have a destabilizing effect on the financial system.

2. **The decision to abandon the exchange rate band and allow the tenge float was followed by in a sharp depreciation**. At the close of the morning session of the Kazakhstan Stock Exchange (KASE) on August 20, the tenge traded at 255 per US dollar, up from KZT 188 per USD a day earlier. The market stabilized shortly thereafter but in mid-September, tensions reemerged in an environment of low trading volumes in the forex market (National Bank of Kazakhstan, 2015a). The NBK resumed interventions to contain volatility. However, in Q4 of 2015, against the background of falling oil prices and weakening of the Russian ruble, the pressure on the tenge intensified. The NBK continued to intervene but in early November it withdrew again from the market to preserve foreign reserve buffers (National Bank of Kazakhstan, 2015b). The exchange rate continued to depreciate and eventually stabilized at around KZT 340 per USD.

3. **Inflation accelerated noticeably.** Consumer prices increased significantly in October and November 2015, and inflation reached 13.6 percent at the end of the year (compared to 4.4 percent in September). The price increase encompassed all major groups of goods and services, with prices of non-food items, which are primarily imported, growing by the highest rate (National Bank of

[1] Prepared by Rossen Rozenov.

[2] See National Bank of Kazakhstan Press Release No. 38 of August 21st, 2015.

Kazakhstan, 2015a). 2016 saw a further acceleration of inflation which peaked at 17.7 in July – almost a year after the first depreciation episode.

4. **Gaining a better understanding of the link between exchange rates and inflation is key for the conduct of monetary policy.** The recent exchange rate developments and the subsequent inflation dynamics bring to the fore the issue of the impact of depreciation on domestic prices, usually referred to as exchange rate pass-through (ERPT). ERPT is important for at least two reasons.

- First, inflation forecasts are one of the main building blocks of IT and the exchange rate is an essential ingredient in the forecasts, especially in small open economies. In this regard, both the short-term and the long-term effects are important as exchange rate movements are usually transmitted to domestic prices with a lag. Many central banks, including well-established inflation targeters such as the Bank of England and the ECB, have explicitly reflected the potential inflationary effects of weaker exchange rates into their monetary policy decisions.

- Second, ERPT has implications for the effectiveness of monetary policy. This is related to the role of the nominal exchange rate as a shock absorber (Edwards, 2006). The impact of a nominal depreciation on the real exchange rate depends on the ERPT, and the real exchange rate is an important determinant of a country's external position. Low ERPT implies smaller expenditure-switching effect and greater effectiveness of monetary policy in stimulating the domestic economy (Campa and Goldberg, 2005). At the same time, as argued by Edwards (2006), it is important to distinguish between the pass-through into the prices of tradables and non-tradables; a high ERPT for non-tradables would reduce the effectiveness of monetary policy, while a high ERPT for tradables would increase it.

5. **Channels through which the exchange rate influences domestic prices can be described following the distribution chain.** Typically, the process comprises two stages. In the first stage, exchange rate fluctuations are reflected in import prices and in the second stage, they are transmitted to consumer prices, either directly through the imported component of the CPI, or indirectly through producer prices. From the perspective of a central bank that targets inflation, the ultimate effect of exchange rate movements on the CPI is of primary interest.

6. **There is a vast literature on the subject, including a number of survey articles.** For example, a recent paper by Aron and others (2014) contains a comprehensive review of both the theoretical underpinnings of ERPT and empirical results. Overall, nearly all studies have found evidence of incomplete ERPT. This is related to the firms' pricing strategies. The literature distinguishes two main types of such strategies: (i) producer currency pricing (PCP) where prices are set in the exporter's currency and (ii) local currency pricing (LCP). Under PCP, since exporters' prices are broadly unchanged, the ERPT to import prices would be expected to be more or less complete. In practice, however, the local prices usually do not react one to one to exchange rate changes, yielding support to the LCP hypothesis. Factors like degree of competition/segmentation of the domestic market and substitutability between domestically-produced and imported goods are likely to matter as well. The level of dollarization may also play a role. Some studies suggest that

dollarization appears to increase ERPT, supporting the claim that "fear of floating" is a more serious issue in dollarized economies (Reinhart and others, 2014). Gonzales (2003), on the other hand, finds no relationship between the degree of dollarization and the pass-through to domestic inflation for thirteen Latin American countries between 1980 and 2000.

7. Many studies have documented a decline in the degree of ERPT over time and have proposed various explanations. These include increased integration and changes in the market structure and the structure of consumer expenditures as reflected in the weights of the CPI components (Aron and others, 2014).[3] Another hypothesis, put forward by Taylor (2000), is that lower ERPT is due to the more benign inflation environment that many countries have achieved. In such an environment, firms have less pricing power, which prevents them from passing increased costs on to the consumer. Enhanced credibility of monetary policy, including through introduction of IT, has likely contributed to lower and more stable inflation.

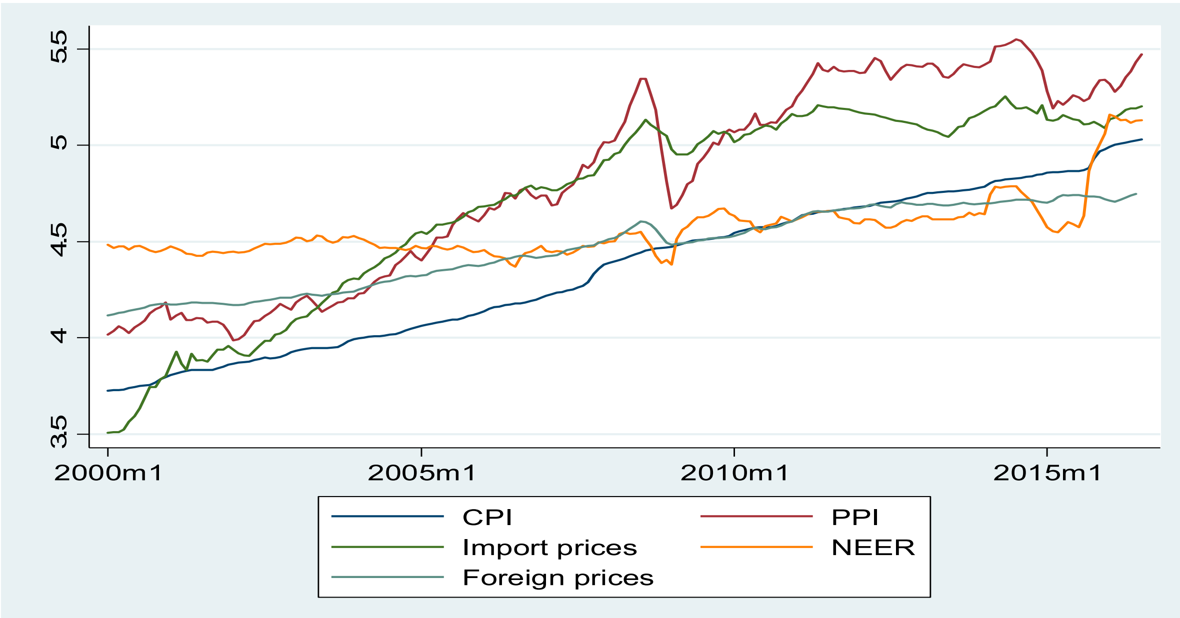
8. As regards empirical strategies, two main approaches have been used to estimate ERPT. Much of the empirical work has been carried out using single equation techniques but more recent contributions tend to rely more on system models, such as VARs and VECMs. Both approaches have advantages and disadvantages. Single equation methods can be linked to simple theoretical propositions (e.g. variations of the law of one price) and have more flexibility in terms of econometric specifications, as they allow for including asymmetric responses, structural breaks, and other types of non-linearities. On the other hand, vector based models recognize the endogenous nature of exchange rates and prices. From a policy making perspective, it is perhaps best to estimate the ERPT using an array of different techniques and compare the results, keeping in mind the potential biases of the respective methods.

9. Estimates of ERPT have varied significantly, depending on the type of country, sample period and method. For developing and emerging market countries, Frankel and others (2012) find that the ERPT to CPI is 34 percent after one year. Choudhri and Hakura (2006) have a broadly similar estimate – 27 percent after 20 quarters for the entire sample. Billmeier and Bonato (2002) estimate a pass-through of about 33 percent for the retail price index in Croatia. Beirne and Bijsterbosch (2009) examine the degree of ERPT in nine Central and Eastern European countries and report an average ERPT of 60 percent using a cointegrated VAR and 50 percent based on a VAR in differences.

10. This paper looks into the effects of exchange rate changes on price developments in Kazakhstan. Its primary objective is to assess the pass-through to consumer prices given that it is of main concern for the conduct of monetary policy. However, occasionally results for import prices are reported as well since imports prices provide a more immediate link to exchange rate developments. Following the literature, we use both single equation specifications and vector-based methods and check the sensitivity of estimates.

[3] A substantial part of the CPI basket comprises services that are not related to imports and the share of these services typically increases as per capita income grows. This is one of the factors behind the lower pass-through in advanced economies.

Figure 1. Exchange Rate and Various Price Indices (logarithmic scale)



Source: IMF staff calculations

B. Data Description and Properties

11. The empirical analysis focuses on six main variables typically considered in the ERPT literature. Specifically, we use monthly data for consumer prices (CPI), producer prices (PPI), import prices, industrial production, nominal effective exchange rate and external prices in the period January 2000 - June 2016. The sources of data are indicated in the Appendix.

12. Unit root tests indicate non-stationarity of the data in levels. A visual inspection of the original price series and the exchange rate (in logarithms) reveals a close co-movement, especially of import prices and the PPI which appear highly correlated (Figure 1). However, the data in levels are likely non-stationary, so we perform unit root tests to formally check for stationarity. Since the series are upward trending, we test the null that the data follow a random walk with a drift vs. the alternative of a stationary process around a linear trend. Both the Augmented Dickey-Fuller test and the Phillips-Perron test (which accounts for potential serial correlation and heteroscedasticity) suggest that for the level data, the null for unit root cannot be rejected (Table 1). The same tests applied to first differences strongly reject the null, indicating that all series are likely I(1).

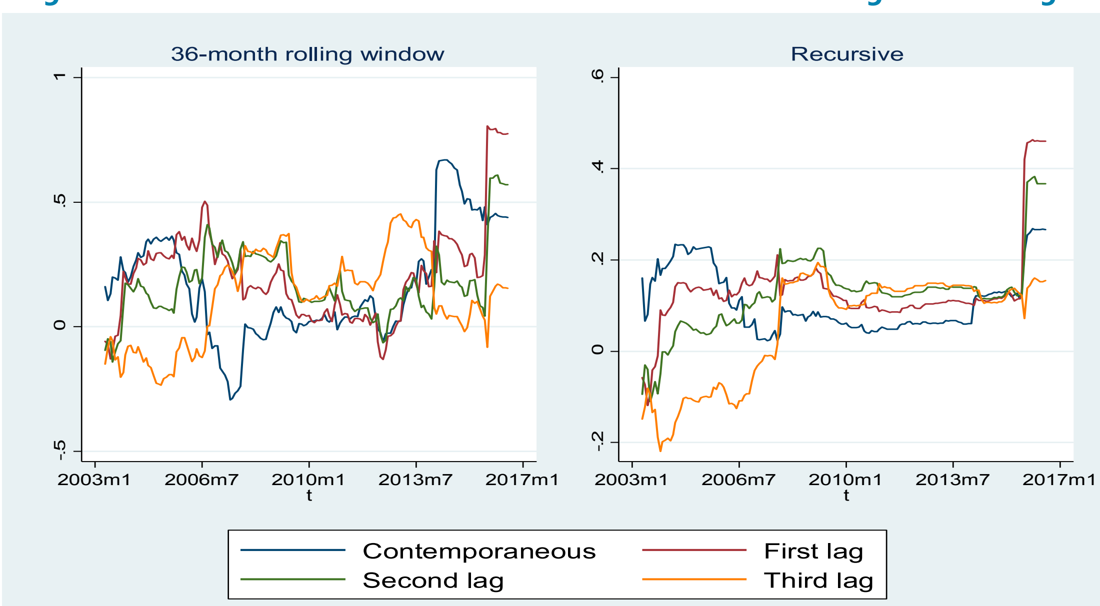
Table 1. Kazakhstan: Unit Root Tests

	Levels				First Differences			
	ADF		Phillips-Perron		ADF		Phillips-Perron	
	Test statistic	p-value	Test statistic	p-value	Test statistic	p-value	Test statistic	p-value
CPI	-1.323	0.882	-1.941	0.633	-6.668	0.000	-6.669	0.000
PPI	-1.483	0.835	-2.366	0.398	-7.807	0.000	-7.827	0.000
Import prices	-1.369	0.870	-1.416	0.856	-11.044	0.000	-11.324	0.000
Industrial output	-1.622	0.784	-1.470	0.839	-16.711	0.000	-16.719	0.000
NEER	-0.331	0.989	-1.638	0.777	-8.835	0.000	-8.931	0.000
Foreign prices	-0.795	0.966	-1.819	0.696	-5.828	0.000	-5.929	0.000

Source: IMF staff calculations

13. **Inflation appears to be significantly correlated with exchange rate movements.** As an initial step in the analysis, we look at the bilateral correlations of the main variable of interest – inflation – with the changes in the exchange rate. For the whole sample, the correlation coefficients between the change in log CPI and log NEER and its first three lags are 0.27, 0.46, 0.37 and 0.15, respectively. However, the strength of association between the two variables has changed significantly over time (Figure 2); it has become much tighter in the more recent period which is characterized with higher exchange rate and price volatility.

Figure 2. Kazakhstan: Correlations between Inflation and Exchange Rate Changes



Source: IMF staff calculations

C. Single Equation Models

14. Earlier work on ERPT has focused on import prices and has relied exclusively on single equation methods. For instance, one of the widely cited studies by Campa and Goldberg (2005) is based on estimating an equation for the differenced log import prices as a function of the exchange rate, foreign production costs and real GDP and their first four lags. In this setup, the short-run relationship between import prices and exchange rates is captured by the contemporaneous coefficient, while the long-run elasticity is given by the sum of the coefficients on the contemporaneous exchange rate and its lags. Mihaljek and Klau (2008) estimate a similar model for the CPI and include lags of the dependent variable among the regressors, as well as the equilibrium real exchange rate gap as a control variable. [4] Similar to Campa and Goldberg (2007), quarterly data are employed and up to four lags of the explanatory variables are included in the estimation.

15. With monthly series, choosing the appropriate lag length is less straightforward. Determining the number of lags involves a trade-off between capturing delayed effects and sacrificing degrees of freedom. Generally, information criteria can guide selection but without imposing any constraints, the number of possible combinations grows rapidly with the number of lags and often different information criteria point to different specifications. To make the process more manageable, we fix the number of exchange rate lags at six[5] and vary the number of lags of industrial output and foreign prices from six to one. Thus, the family of models we estimate is:

$$\Delta cpi_t = \alpha + \sum_{i=0}^{6} \Delta e_{t-i} + \sum_{i=0}^{k} \Delta y_{t-i} + \sum_{i=0}^{k} \Delta p *_{t-i} + \varepsilon_t,$$

where Δcpi_t, Δe_t , Δy_t and $\Delta p *_t$ stand for the first difference of the logarithms of CPI, NEER, industrial output and foreign prices, respectively. The Akaike Information Criterion suggests using six lags (k=6) for output and foreign prices, while the Bayesian Information Criterion (BIC) selects 1 lag (k=1). The estimated coefficients to the exchange rate and its lags are reported in Table 2 (the coefficients on the industrial output and foreign prices and the constant are not reported for brevity).

[4] The rationale for including the real exchange rate gaps is that in developing countries real exchange rate tend to appreciate as these economies grow faster.

[5] Including more lags of the log NEER does not change estimates significantly since estimated coefficients are very close to zero, with alternating signs.

Table 2. Kazakhstan: Estimated Coefficients to NEER and Its Lags

	Model A (k=6)	Model B (k=1)	Model C (k=6)	Model D (k=6)	Model E (k=6)
D.Log of NEER	0.0192	0.0205	0.0137	0.0110	0.0106
	(1.15)	(1.25)	(0.77)	(0.55)	(0.35)
D.Log of NEER (-1)	0.0770***	0.0777***	0.0751***	0.0764***	0.0774***
	(4.31)	(4.45)	(4.17)	(4.26)	(4.31)
D.Log of NEER (-2)	0.0537**	0.0423*	0.0515**	0.0550**	0.0532**
	(2.98)	(2.42)	(2.83)	(3.04)	(2.94)
D.Log of NEER (-3)	0.00548	0.000393	0.00271	0.00420	0.00601
	(0.31)	(0.02)	(0.15)	(0.24)	(0.34)
D.Log of NEER (-4)	-0.00520	-0.00339	-0.00828	-0.00476	-0.00578
	(-0.29)	(-0.19)	(-0.46)	(-0.27)	(-0.32)
D.Log of NEER (-5)	-0.00608	-0.0143	-0.0101	-0.00506	-0.00628
	(-0.34)	(-0.81)	(-0.54)	(-0.28)	(-0.35)
D.Log of NEER (-6)	0.0118	0.0175	0.00694	0.0108	0.0116
	(0.67)	(1.00)	(0.38)	(0.61)	(0.66)
IT			0.00229		
			(0.87)		
Depreciation				0.000758	
				(0.74)	
Large depreciation					0.0122
					(0.34)
R^2	0.348	0.264	0.351	0.351	0.349
RMSE	0.00541	0.00559	0.00542	0.00542	0.00543

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: IMF staff calculations

16. **The different specifications differ little in terms of estimated elasticities.** In both versions (with one and six lags), the point estimate of the short-term elasticity of inflation to exchange rate depreciation is very small – about 2 percent and the coefficient is not statistically significant. The coefficients on the first and second lag, however, are highly significant, implying that it takes at least a month for exchange rate changes to start having an impact on consumer prices. The sum of all coefficients on the exchange rate is about 0.155 in Model A and 0.141 in Model B; including more lags of the control variables has little effect on the longer-term elasticities.

17. **In addition, we test for asymmetry and non-linearities.** Models C through E take the baseline specification of model A and include additional variables to test whether the introduction of exchange rate flexibility in the context of IT has had an impact on the ERPT and whether there are asymmetries or threshold effects. Specifically, "IT" is a binary variable taking the value of 1 from August 2015; "Depreciation" is also a binary variable equal to 1 if the exchange rate depreciated in the corresponding month and 0 otherwise, and "Large depreciation" is an interaction term of the

exchange rate change and a dummy variable indicating whether depreciation was more than 3 percent in a given month (1 percent and 5 percent were also tried without qualitatively changing the results). None of these additional variables seems to have a statistically significant impact on inflation.

18. Robustness checks indicate that estimates are not very sensitive to alternative specifications. For example, replacing industrial output with an output gap proxy (calculated using the HP filter), as in Mihaljek and Klau (2008), has a marginal impact on the results. Finally, applying the baseline specification (Model A) to import prices instead of the CPI yields higher elasticities – both in the short and the long run. The estimated contemporaneous coefficient on the exchange rate is 0.065 and the sum of all coefficients on this variable is 0.247, implying a faster and larger pass-through to import prices.

D. System Methods

19. The main advantage of system methods is that they treat variables as endogenous. While univariate methods provide some flexibility as discussed above, they do not account for the potential endogeneity of the exchange rate and the price variables. This is why many studies, especially more recent ones, have resorted to system methods to make inferences about the effect of the exchange rate movements on domestic prices. The two preferred frameworks are cointegrated VAR and VAR in differences. An example of the latter is Winkelried (2014) who documents a decline in ERPT in Peru after the adoption of a fully-fledged IT regime. He considers a 6-variable SVAR which follows the price chain, with an output variable reflecting the state of the economy.[6] Identification is based on the Cholesky decomposition of the covariance matrix. Since the VAR is formulated in differences, the relevant information on ERPT is provided by the cumulative impulse responses.

20. A stationary VAR model with recursive identification can be used to examine the ERPT in Kazakhstan. Following the literature, we consider the vector (p*, e, pm, y, ppi, cpi), where the variables denote log differences of foreign prices, exchange rate, import prices, industrial output, producer and consumer prices (as defined above) in this order. The specification differs slightly from Winkelried (2014) as in his model output is placed second and a constraint on the demand shock is imposed to achieve identification. In general, the ordering of variables is important in recursive identification schemes, which essentially assume that the error term in each equation is uncorrelated with the error term in the previous equation. In our specific example, this amounts to assuming that foreign supply, exchange rate and import price shocks have a contemporaneous effect on output but a demand shock does not affect the first three variables instantaneously. This seems a plausible hypothesis in the case of Kazakhstan. Moreover, the results are not sensitive to the position of output; the impulse responses of the price variables to an exchange rate shock look very similar in alternative specifications where output is placed second or third. For the rest of the variables, the

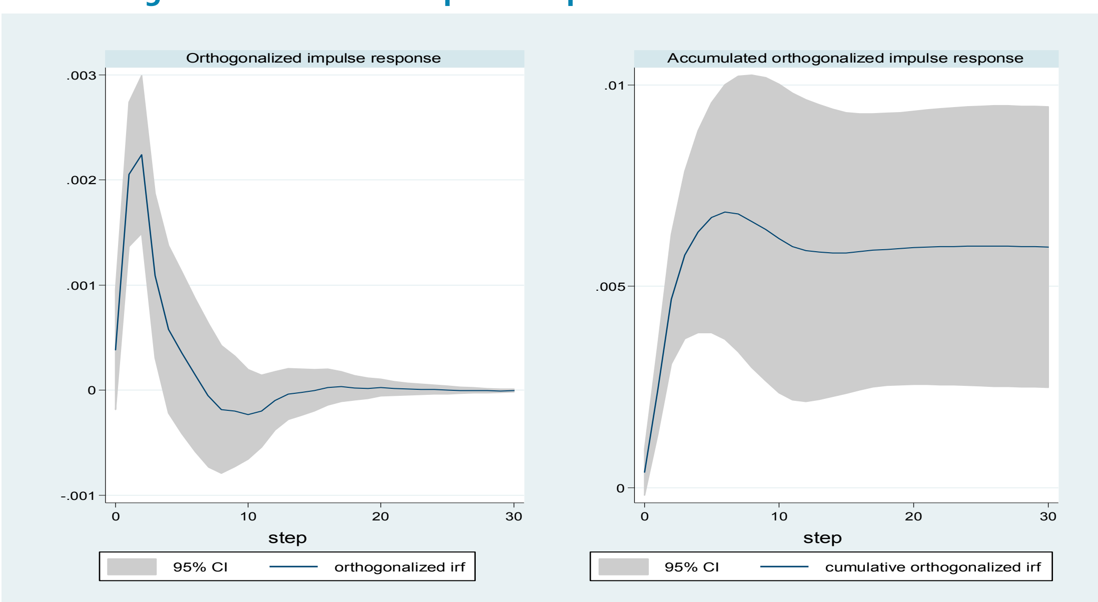
[6] Specifically, the vector comprises (i) foreign inflation; (ii) a measure of economic activity; (iii) exchange rate; (iv) import prices; (v) producer prices and (vi) consumer prices.

recursive structure is justified on economic grounds as the causal chain logically runs from foreign prices to exchange rate, import prices, producer prices and finally to consumer prices.

21. Formal lag selection criteria are used to determine the optimal number of lags. The Akaike, Hannan-Quinn and Schwarz information criteria all suggest only one lag, whereas the LR criterion points to five lags. Estimating the VAR with one lag, however, is problematic as there is significant residual autocorrelation which violates the assumption of independence. It is evident from an inspection of the correlograms and is also confirmed by formal testing. Autocorrelation is removed when five lags are selected, so we estimate a VAR (5) model.

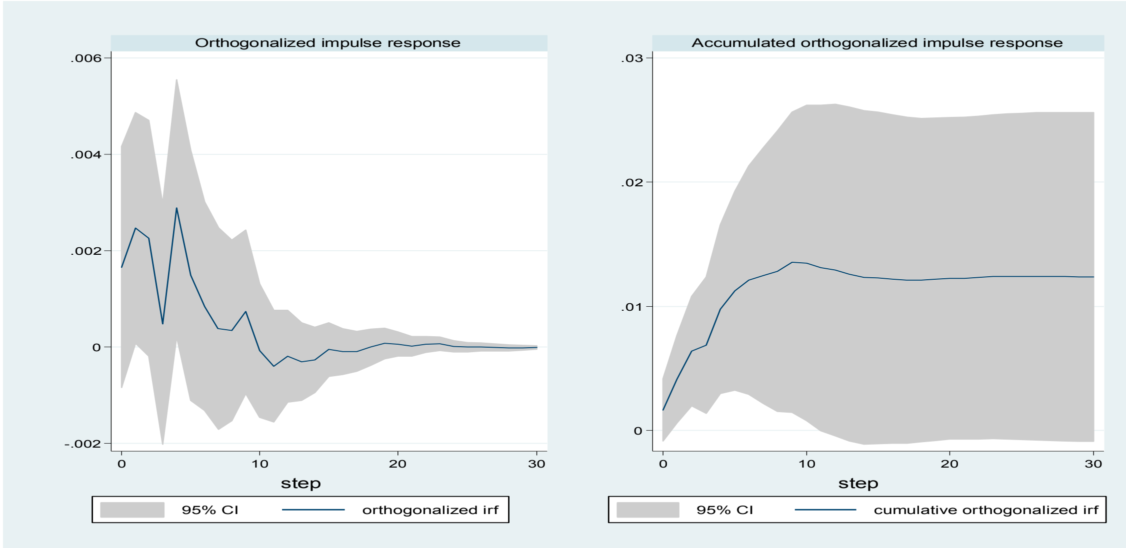
22. Results suggest that the pass-through of exchange rate changes to CPI is around 30 percent. Figure 3 (left panel) shows the orthogonalized impulse response of consumer prices to one standard deviation shock in the exchange rate in the baseline specification. The response is significant and peaks 1-2 months after the depreciation. Since the VAR model is formulated in differences, the quantity of primary interest is the accumulated impulse response (Figure 3, right panel). To obtain the ERPT, impulse responses need to be transformed, so that they correspond to a one percent shock in the exchange rate. Calculations suggest that the contemporaneous response is very small – about 2 percent; the accumulated effect increases to about 25 percent after 3 months and to 30 percent after 6 months. The reaction of prices to an ER shock, as captured by the impulse response functions, suggests some overshooting, so after the first six months the effect of the depreciation diminishes somewhat and stabilizes at around 27 percent in the long run.

Figure 3. Kazakhstan: Impulse Response of CPI to One SD of NEER



Source: IMF staff calculations

Figure 4. Impulse Response of Import Prices to One SD of NEER



Source: IMF staff calculations

23. For comparison, import prices respond more strongly to depreciation – the ERPT after 3 months is 30 percent and after 6 months it is 55 percent which is also the long-term effect (Figure 4). However, the confidence bands are much wider around these estimates. The higher pass-through to import prices is not surprising since part of the depreciation effect is dampened in the distribution phase. [7]

24. As noted above, the estimates of the ERPT are quite robust with respect to reordering of the industrial production variable. As another robustness check, we estimate the model with different numbers of lags and an output gap variable, as well as with seasonally unadjusted index of industrial production.[8] The results remain broadly unchanged (see Figure A1 in the Annex). Finally, replacing the nominal effective exchange rate with the KZT/USD exchange rate and re-estimating the model with 2 lags produces an ERPT of 28 percent in the long run – very close to the baseline estimate (Figure A2 in the Annex). The latter result is important since it is the exchange rate to the USD that is observed directly and often forms the basis for pricing decisions in domestic currency.

25. The VAR in difference provides useful insights but omits information on a possible long-term relationship between the variables in the model. Testing for such a relationship amounts to testing for cointegration – a linear combination of I(1) variables that is stationary. A

[7] According to Berger and others (2009), in US distribution margins are in the order of 50-70 percent.

[8] For both models AIC suggested three lags and tests did not indicate the presence of residual autocorrelation.

number of studies (see Coricelli and others (2006), and Beirne and Bijsterbosch (2009), among others) have addressed the ERPT problem within the cointegrated VAR framework. The cointegration approach has been tried for Kazakhstan as well but two issues have emerged – one theoretical and one related to the estimates – that prevent us from presenting it as the preferred method for ERPT assessment.

26. The theoretical challenge pertains to the interpretation of the coefficients in the cointegrating relationship. It is customary when variables are in logarithms to interpret these coefficients as long run elasticities, especially when there is a single cointegrating equation. If there are more than one cointegrating vectors, which is often the case with larger systems, the economic meaning of the coefficients is less straightforward since any linear combination of such vectors is also a cointegrating vector. This leads to indeterminacy and some authors (e.g. Beirne and Bijsterbosch, 2009) have proposed to take the first cointegrating vector which has the highest eigenvalue. However, as pointed out by Masten (2004), the correct identification of the equilibrium pass-through effect is more involving and in many cases it is not feasible unless restrictions are placed on the reactions of some of the variables. According to his Proposition 1, the equilibrium ERPT is identified if and only if the cointegrating rank of the system is equal to 1 plus the number of variables with non-zero coefficients in the vector of long-run responses. This conclusion is based on an earlier result by Johansen (2002) on the interpretation of cointegrating coefficients.

Table 3. Cointegrating Vectors and Adjustment Coefficients

	Cointegration relationship 1						Cointegration relationship 2					
	Cointegrating vector			Adjustment coeff.			Cointegrating vector			Adjustment coeff.		
	Estimate	St. error	P-value	Estimate	St. error	P-value	Estimate	St. error	P-value	Estimate	St. error	P-value
CPI	1.000	.	.	0.001	0.003	0.883	0.000	.	.	-0.002	0.004	0.604
PPI	0.000	.	.	0.023	0.020	0.265	1.000	.	.	-0.013	0.024	0.596
Import prices	-1.277	0.481	0.008	0.024	0.015	0.107	-0.065	0.385	0.866	0.022	0.018	0.208
Industrial output	0.515	0.296	0.082	0.061	0.014	0.000	0.097	0.237	0.682	0.008	0.017	0.631
NEER	-0.745	0.243	0.002	0.084	0.017	0.000	0.644	0.195	0.001	-0.144	0.020	0.000
Foreign prices	-1.527	0.387	0.000	-0.003	0.004	0.465	-3.446	0.310	0.000	0.003	0.005	0.527
Constant	9.118	.	.				7.493	.	.			

Source: IMF staff calculations

27. In the case of Kazakhstan, the Johansen test suggests two cointegrating relationships for the baseline specification. The baseline specification includes the same variables as the stationary VAR, 5 lags, a linear trend in the level data and cointegrating equations that are stationary around a nonzero mean. The same result obtains for a specification that allows for linear trends in the cointegrating equations based on the maximum eigenvalue statistic. Estimation results for the unrestricted model with the Johansen identification scheme are shown in Table 3. The first cointegration equation has the form:

$$cpi = 1.277pm - 0.515y + 0.745e + 1.527p*$$

and all coefficients, except the one on the output variable, are significant at the 5 percent level. The estimated coefficient on the nominal effective exchange rate is 0.75 but as discussed above, it does not necessarily measure the pass-through; restrictions need to be imposed to determine the elasticity of prices to changes in the exchange rate. Such restrictions could either come from theory or from the data. Theory, however, does not seem to suggest specific values for some of the long run changes as these would be expected to vary across countries. We can constrain some of the elements of the cointegrating vectors which are not statistically significant to be equal to zero, e.g. industrial output in both equations and import prices in the second one, but this would still not be enough to achieve identification.

28. The empirical issue is related to the estimates of the adjustment coefficients which are in most cases close to zero and statistically insignificant. This indicates weak exogeneity with respect to the cointegrating parameters. While it is intuitive that foreign prices would be weakly exogenous, domestic prices would be expected to adjust in a significant way to deviations from equilibrium. This, however, is not supported by the data; the only variable that adjusts significantly in a consistent manner is the exchange rate. Further, the results are rather sensitive to the model specification. For example, replacing the seasonally adjusted output variable with the unadjusted one (also with 5 lags to remove residual autocorrelation), yields a coefficient of 0.54 on the exchange rate in the first cointegration equation which is not statistically significant. Using the USD exchange rate (and 3 lags) produces an estimate of 0.34 and highly statistically significant, which is more in line with the VAR in differences results.

E. Conclusions and Policy Implications

29. Results from the empirical analysis of ERPT in Kazakhstan reveal a moderate impact of exchange rate changes on domestic inflation. A comparison across the different estimation methods employed suggests that the contemporaneous response of prices is rather small but the effect increases significantly one and two months after the exchange rate shock. Based on the estimates of the VAR model in differences, which is our preferred analytical tool, a 10 percent depreciation of the tenge would be expected to trigger an increase in consumer prices on the order of 3 percent. This is close to findings for other developing and emerging market economies and is consistent with Kazakhstan's own recent experience.

30. The timing and magnitude of ERPT has potential implications for monetary policy. In the context of inflation targeting, the inflationary effect of a weakening of the domestic currency has to be factored in when decisions about the policy rate are made. The degree of ERPT is also important for the speed of external adjustment following a shock under a flexible exchange rate regime. If the domestic currency depreciates and the pass-through to import and producer prices is high, expenditure switches toward locally produced goods as imports become relatively expensive. If then the pass-through to consumer prices is low, the nominal depreciation would also imply real depreciation and competitiveness would improve, which in turn would abate pressures on the exchange rate. Empirical evidence is accumulating that monetary policy itself can influence ERPT; putting a credible monetary policy framework in place anchors expectations and tends to be associated with lower pass-through. In this regard, besides incorporating the information on ERPT in its monetary policy decisions, the NBK would benefit from a clear communication to the public of the anticipated effects on prices following an exchange rate shock.

31. Reducing dollarization and introducing more competition in the domestic product markets could help reduce ERPT. Financial dollarization amplifies the effects of exchange rate shocks and could be associated with higher pass-through to consumer prices. Therefore, efforts to de-dollarize, including by deepening the financial markets and encouraging the development of hedging instruments is key. On the structural front, greater competition is more likely to be associated with variable markups which firms can adjust downwards in case of depreciation in order to remain in the business. In this regard, Kazakhstan can benefit from a faster implementation of the government's privatization program and reforms aimed at reducing the role of state monopolies and promoting private entrepreneurship.

References

Aron, J., Macdonald, R. and J. Muellbauer (2014), "Exchange Rate Pass-Through in Developing and Emerging Markets: A Survey of Conceptual, Methodological and Policy Issues, and Selected Empirical Findings", *Journal of Development Studies,* Vol. 50, No. 1, pp. 101-143

Beirne, J. and M. Bijsterbosch (2009), "Exchange Rate Pass-Through in Central and Eastern European Member States", *ECB Working Paper*, No. 1120

Berger, D., Faust, J., Rogers, J. and K. Steverson (2009), "Border Prices and Retail Prices", Board of Governors of the Federal Reserve System, *International Finance Discussion Papers*, No. 972

Choudhri, E. and D. Hakura (2006), "ERPT to domestic prices: Does the inflationary environment matter?", *Journal of International Money and Finance*, Vol. 25, pp. 614–639

Billmeier, A. and Bonato, L. (2002), "Exchange Rate Pass-Through and Monetary Policy in Croatia", *IMF Working Paper*, No. 02/109

Campa, J. and L. Goldberg (2005), "Exchange Rate Pass-Through into Import Prices", *Review of Economics and Statistics*, 87, pp. 379–390

Coricelli, F., Jazbec, B. and I. Masten (2006), "Exchange Rate Pass-Through in Acceding Countries: Empirical Analysis and Policy Implications", *Journal of Banking and Finance*, Vol. 30, No. 5, pp. 1375-1391

Edwards, S. (2006), "The Relationship Between Exchange Rates and Inflation Targeting Revisited", NBER Working Paper, No. 12163

Frankel, J., Parsley, D. and S. Wei (2012), "Slow Pass-Through around the World: A New Import for Developing Countries?", Open Economies Review, Vol. 23, No. 2, pp. 213–251

Gonzales, J.A. (2003), "Exchange Rate Pass-Through and Partial Dollarization: Is There a Link?", in *Latin American Economic Reforms: The Second Stage* (Gonzales, J.A., Corbo, V., Krueger, A. and A Tornell, editors)

Johansen, S. (2002), "The Interpretation of Cointegrating Coefficients in the Cointegrated Vector Autoregressive Model", *Preprint No. 14*, Department of Theoretical Statistics, University of Copenhagen.

Lutkepohl, H. (2011), "Vector Autoregressive Models", *EUI Working Papers,* ECO2011/30

Masten, I. (2004), "Identification of Exchange Rate Pass-Through Effect in Cointegrated VAR: An Application to New EU Member Countries", preprint available at http://webv1ef.ef.uni-lj.si/dokumenti/wp/clanek161.pdf.pdf

Mihaljek, D. and M. Klau (2008), "Exchange Rate Pass-Through in Emerging Market Economies: What has Changed and Why?", *BIS Papers*, 35, pp. 103–130

National Bank of Kazakhstan (2015a), "Inflation Report", The Third Quarter of 2015, Almaty, Kazakhstan

National Bank of Kazakhstan (2015b), "Inflation Report", The Fourth Quarter of 2015, *Almaty, Kazakhstan*

Reinhart, C., Rogoff, K. and M. Savastano (2014), "Addicted to Dollars", *Annals of Economics and Finance*, 15-1, pp. 1-50

Taylor, J. B. (2000), "Low Inflation, Pass-Through, and the Pricing Power of Firms", *European Economic Review*, 44, pp. 1389–140

Winkelried, D. (2014), "Exchange Rate Pass-Through and Inflation targeting in Peru", *Empirical Economics*, 46, pp. 1181-1196

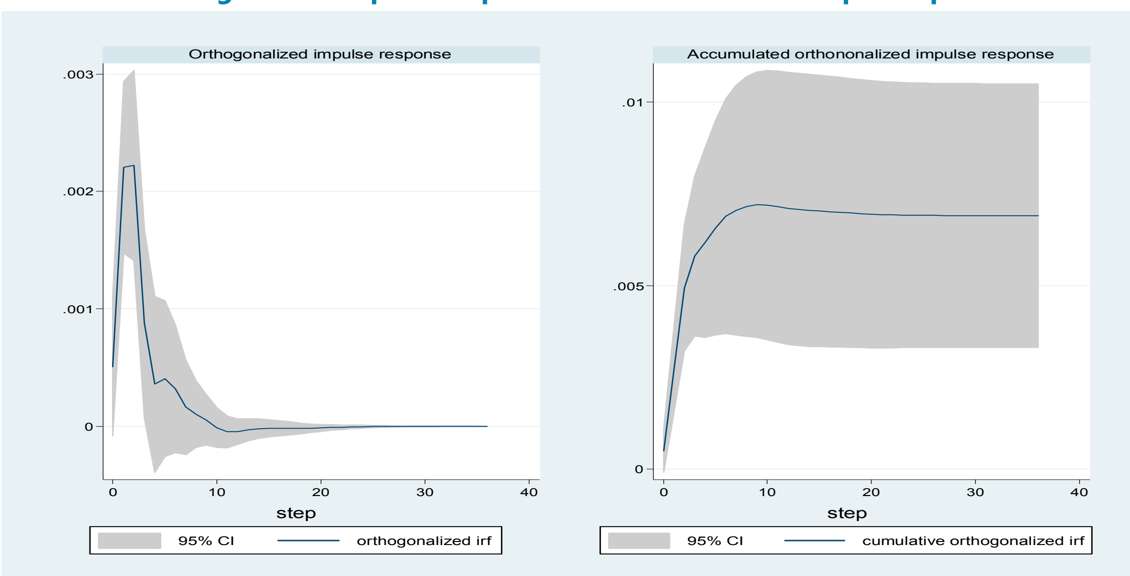
Appendix

Data Sources

Domestic CPI and PPI, as well as the nominal effective exchange rate (NEER) series come from the National Bank of Kazakhstan. For the purposes of this analysis, the inverse of the original NEER series was used, so that a positive change implies depreciation. The source of data on import prices and the industrial production index is the Committee of Statistics. Given the seasonality of industrial output, in most specifications we use seasonally adjusted series. The index of external prices is constructed as a weighted average of producer/wholesale price indices of Kazakhstan's main trading partners, applying the same weights as in the NEER calculations.[1] The primary source for individual price indices is IFS, with Haver Analytics used to gap-fill missing observations.

Robustness Checks

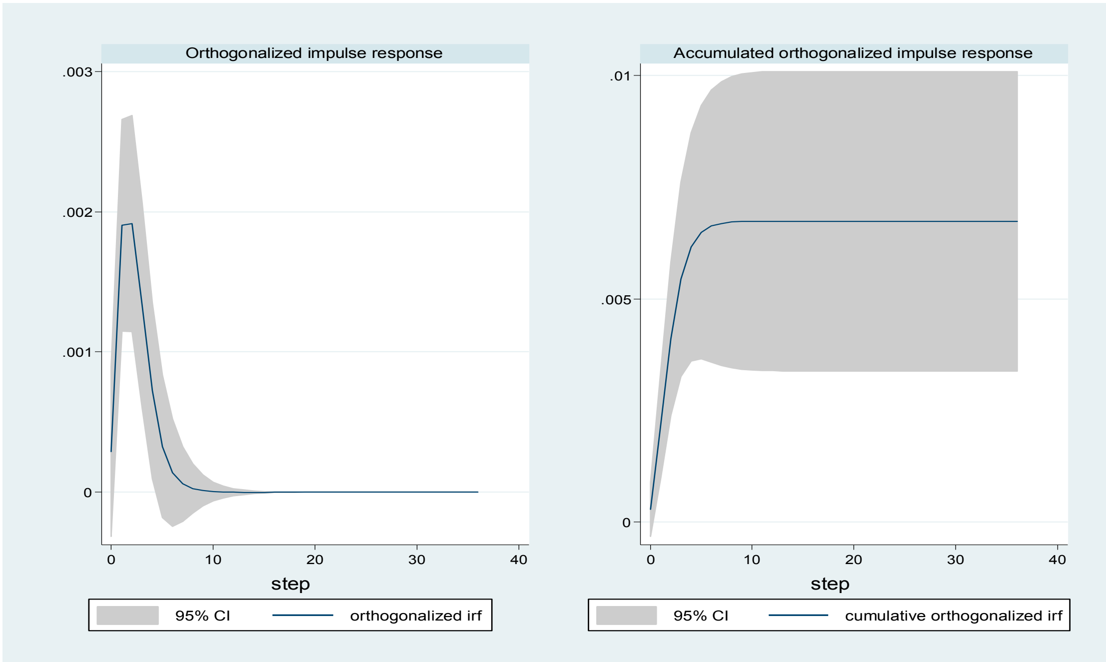
Figure A1. Impulse Reponses in a Model with Output Gap



Source: IMF staff calculations

[1] The weights are available on the National Bank of Kazakhstan website.

Figure A2. Impulse Reponses in a Model with USD



Source: IMF staff calculations

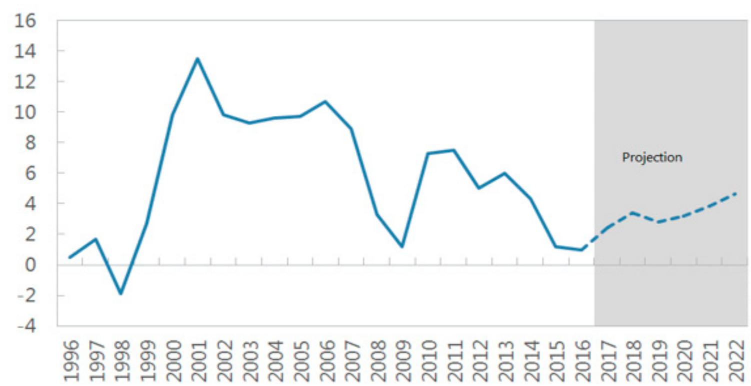
ESTIMATING POTENTIAL GROWTH IN KAZAKHSTAN[1]

This paper assesses recent evolution of potential growth in Kazakhstan using several approaches: univariate and multivariate filters, as well as a production function. The results suggest that potential growth has declined in recent years to around 3 percent in 2016, reflecting increasing reliance on the oil sector that has been hit by a large global price shock. Potential growth could pick up to approximately 4 percent over the medium term, reflecting increased oil output and the implementation of structural reforms.

A. Introduction

1. **Potential output is the level of output attainable given the underlying capacity of the economy, when all factors of production are fully utilized.** The term "potential growth" is often used in literature and in policy discussions interchangeably with the concept of the *trend* growth of output, abstracting from fluctuations of the business cycle and seasonal variation. Recent literature shows that trend growth in emerging economies is subject to substantial volatility, which drives fluctuations (see Aguiar and Gopinath, 2007). This makes it particularly difficult to disentangle shocks to the trend from a cycle in those economies. Kazakhstan is an example of this, as over the past 20 years, the country has experienced rapid expansions followed by rapid contractions, with significant volatility throughout (see Figure 1).

Figure 1. Kazakhstan: Growth Rate of Output
(In y-o-y percent change)



Sources: National authorities; and IMF staff calculations.

2. **This paper seeks to quantify the level of potential output for Kazakhstan.** To do so, three approaches are applied: a set of univariate filters that extract the trend component of a single output series; a multivariate filter that incorporates additional information from other variables linked to output by economic theory; and a production function, which decomposes growth of output into growth of inputs and total factor productivity in the economy. Despite their different premises, all three approaches find that potential growth has declined in recent years. Future prospects are somewhat more promising in light of expected increase in oil production and effects of structural reforms in the non-oil sector.

[1] Prepared by Jonah Rosenthal.

B. Univariate Filters

3. Univariate filters isolate an underlying trend in one statistical series—in this case, output—from cyclical and random variation. This paper makes use of the following filters:

- **Hodrick-Prescott (HP) filter**. This filter identifies a trend as a path that should not deviate too far from the actual data, and should remain relatively smooth from one year to the next. Different specifications of the HP filter produce different "trends" ranging from identical to the underlying series to a straight line depending on the value of a smoothing parameter.

- **Band pass filters**. Two filters are considered: Baxter-King (BK) and Christiano-Fitzgerald (CF). Both operate on the assumption that variations occurring in a time frame of 6 to 32 quarters correspond to the business cycle, whereas any fluctuation that occurs at higher or lower frequencies is filtered out on the premise that it is not cyclical.[2]

4. Univariate filter estimates should be interpreted with caution. They are based on purely statistical techniques that are not informed by relationships between output and other macroeconomic indicators. The ability of these filters to uncover statistical tendencies in a sample of data does not necessarily imply that they properly measure latent *potential*. An observed slowdown in a trend may be evidence not just of lower potential, but the existence and persistence of barriers to realizing it. For instance, the filters may fail to capture the effects from changes in capacity utilization, and they do not take into account the impact of movements in variables such as inflation and employment on growth.

5. The HP filter is widely used in economic analysis, especially when data limitations preclude the application of more elaborate techniques, but it has many shortcomings. In particular, the HP filter is susceptible to the "endpoint problem." It is not well equipped to decompose movements in the final period into trend and cyclical components, and in practice attributes too much variation to movements in the trend (see Mohr, 2005). This challenge is further exacerbated by the fact that the most recent data observations are unstable, in the sense that preliminary estimates can be prone to large revisions. To minimize the impact of the endpoint problem, in applying the HP filter to Kazakhstan, the sample was extended to include five years of forecasts.[3]

C. Multivariate Filter

6. Multivariate filters can be used to address some of the shortcomings of univariate filters. A multivariate filter proposed by Blagrave et al. (2015) features a number of advantages: (i) it incorporates economic theory; (ii) its data requirements are relatively modest (only data on GDP,

---

[2] Appendix I contains a broader discussion on the methodology. The BK filter calculates the "trend" at each point in time taking into account a fixed number of leads and lags of the actual value, which means that it cannot generate a trend at the very beginning and end of the sample period. The CF filter, though, can take into account different combinations of leads and lags for each point in time, and thus generate a trend over the entire sample period.

[3] Following the approach of Mitra et al (2015), p. 7.

inflation and unemployment are needed); (iii) the estimates of potential output it produces have narrower confidence bands compared to the standard HP filter, and (iv) it allows for incorporation of expectations, which are included to help identify shocks and also to improve the accuracy of the filter at the end of the sample. For the countries considered in Blagrave et al. (2015), the model included consensus forecasts for five years ahead. Since for Kazakhstan consensus forecasts are generally not available, annual vintages of five-year Fall IMF WEO projections are used in place of consensus forecasts. The filter also allows to incorporate judgment on potential growth, the output gap or the NAIRU, e.g., based on information from high frequency indicators.[4] It is important to note, though, that multivariate filters also remain susceptible to the endpoint problem.

D. Production Function

7. The growth accounting approach decomposes changes in output into growth of inputs and total factor productivity (TFP), using a production function. The production function, employed in this paper, is of the Cobb-Douglas type: $Y_t = A_t * K_t^{\alpha} * L_t^{1-\alpha}$, where A_t, K_t, and L_t stand for TFP, capital, and labor, respectively. This specification assumes constant returns to scale, implying that the coefficients of labor and capital (the shares of output attributable to each factor of production) sum to 1. While it is common to apply coefficients of 0.65 for labor and 0.35 for capital in advanced economies, in line with previous empirical observations, there is no reason to believe that the same values would adequately represent technologies in developing countries, such as Kazakhstan. Consequently, the use of country-specific elasticities of labor and capital seems preferable.

8. The computation of potential output using the production function approach comprises the following steps:

- *Estimation of country-specific parameters.* Estimates of the production function parameters were obtained using firm-level data. For a sample of Kazakh firms, relevant data from balance sheets and financial statements was obtained using the Orbis database, and the parameters were estimated by ordinary least squares (OLS) regression, with the following specification:

$$\ln(y_i) = \alpha_0 + \alpha \ln(k_i) + \beta \ln(l_i) + \varepsilon_i$$

where y_i, k_i and l_i stand for output (value added), capital (approximated by fixed assets) and number of employees of firm i.[5] Two models were estimated: in the first one, the parameter β was estimated freely, whereas in the second one, the restriction $\beta = 1 - \alpha$ was imposed to ensure constant returns. The two models produced very similar results for Kazakhstan;

[4] NAIRU is the non-accelerating inflation rate of unemployment.

[5] A total of 993 firms, representing about 14 percent of the gross value added in the economy, provided the necessary information for production function estimations.

approximately 0.56 for the coefficient on labor and 0.44 for the coefficient on capital. Additional details of the estimation can be found in Appendix II.

- *Extensions.* The basic Cobb-Douglas approach can be expanded to account for the quality of inputs. Specifically, the production function can be refined to account separately for changes in the number of employees and in the level of human capital. This reflects the assumption that a more educated workforce is likely to be more productive. In particular, the production function can be rewritten as $Y_t = A_t * K_t^{\alpha} * (e^{S_t r} l_t)^{1-\alpha}$, where S_t denotes the number of years of schooling and r denotes the marginal returns to a year of schooling. Data on educational attainment in Kazakhstan was obtained from the Wittgenstein Centre at five-year intervals, and the gaps were filled in by interpolation. The marginal return to schooling was set at .107, following the findings of Psacharapoulos and Patrinos (2004). Capital stock in the initial year was derived as $K_0 = I_0/(g + \delta)$, where I_0 is the initial investment expenditure, g is the average growth rate of capital over the sample period, and δ is the rate of depreciation (assumed to be 0.07, in line with findings for other emerging economies). Data on output, investment and employment come from the IMF WEO database.

- *Estimation of potential output.* Given the data and the estimated production function parameters, TFP is obtained as a residual, following the standard growth accounting procedure. Next, the HP filter was applied to the factors of production to extract their underlying trends, with a smoothing parameter of 100).[6] Finally, the value of potential output was estimated by plugging in the trend values of the factors of production into the production function. The potential growth rate of output was computed as the year-on-year change of the level. An important caveat of this method pertains to the calculation of TFP, which may reflect measurement errors as well as other factors, notably capacity utilization. Capacity utilization in Kazakhstan is heavily influenced by prevailing global oil prices and may be driven in individual years by external shocks. Indeed, the results imply that the sharp economic downturns in Kazakhstan during the global financial crisis and more recently, when oil prices dropped significantly, were associated with negative contributions from total factor productivity, which essentially reflects the fact that the existing stocks of labor and capital were used less intensively.[7]

E. Results

9. **All approaches suggest that Kazakhstan's trend growth has fallen in recent years, reaching approximately 3 percent in 2016.** The univariate filters deliver broadly similar results despite their different premises. They show that Kazakhstan's trend growth has changed substantially, peaking at around 10 percent in 2004, then falling to around 2.5 percent in 2016 and eventually rising to 3.5-4 percent by 2022. The multivariate filter, when applied to annual data from 1996-2016, produces similar results, suggesting that potential growth has been on a declining trend

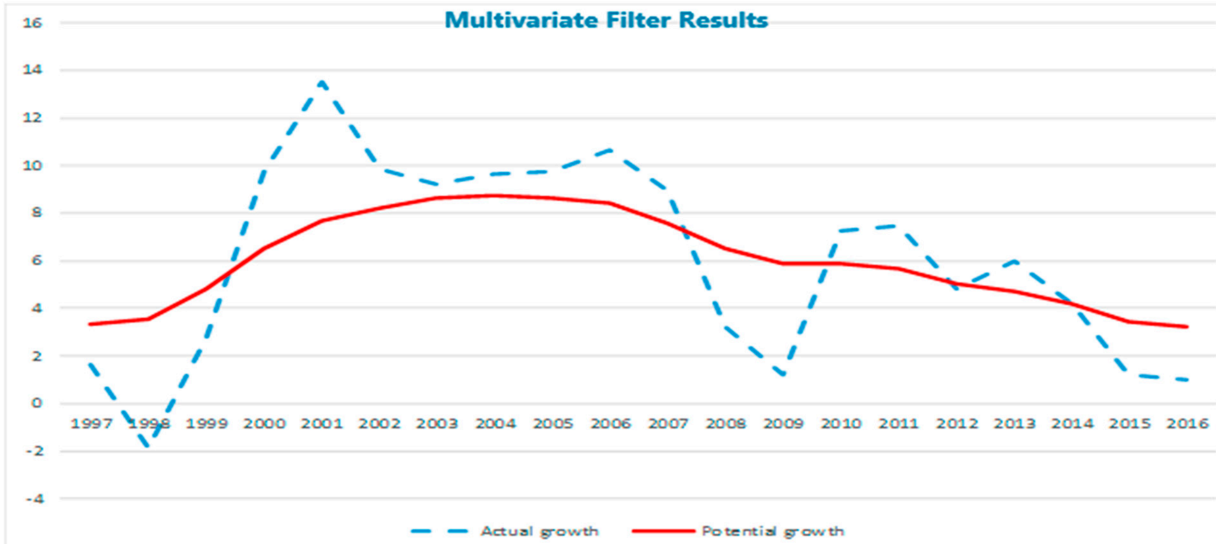
[6] Following the approach of Mitra et al (2015), p. 26.

[7] The contribution of TFP was largest in the early 2000s, when oil prices were low in absolute terms and rising steadily, but not fast.

since mid-2000s, with an estimated value in 2016 of around 3.3 percent (Figure 2). It is important to note that this value is obtained entirely based on the statistical properties of the series, without incorporating subjective judgment. Finally, the production function approach concurs in suggesting that potential growth has fallen over time, given the underlying trends in the factors of production. The estimated potential growth rate from the production function approach is 3.0 percent for 2016. Table 1 presents a summary of the results.

Figure 2. Kazakhstan: Actual and Potential GDP Growth

Multivariate Filter Results



Source: IMF staff estimates.

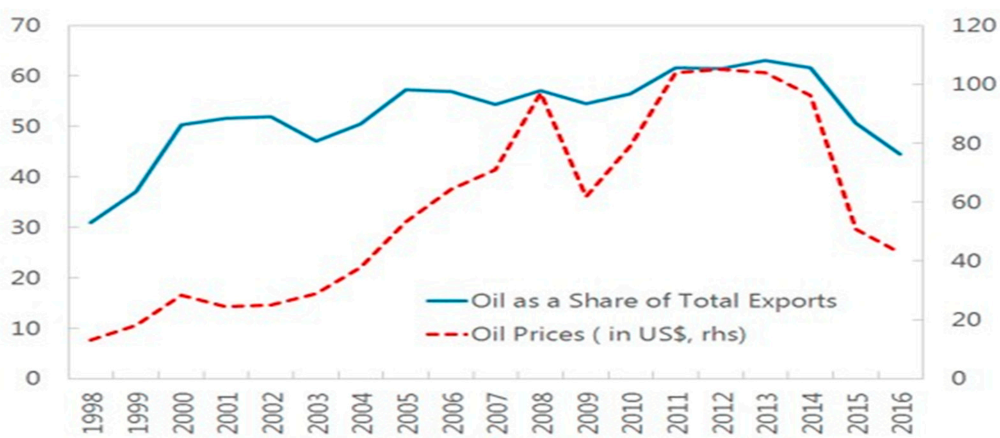
Table 1. Potential Growth Estimates
(In percent)

	SA actual	HP Filter	BK Filter	CF Filter	Multivariate Filter	Production Function
2016 growth	1.0	2.5	2.4	2.1	3.3	3.0
2022 projected growth	4.6	3.5	-	4.2	-	-
Historical Correlation with Oil Prices (annual)	0.54	0.51	-	0.47	-	-

Source: IMF staff estimates.

10. It is important to note that this assessment reflects overall GDP, which includes the oil sector. Data limitations precluded the application of the above methodologies to the non-oil sector. The evolution of Kazakhstan's potential growth has historically been closely linked to changes in global oil prices, as evidenced by the fact that correlation between the two variables is positive and relatively high over the sample period. The prominence of the oil sector in Kazakhstan's economy is a source of vulnerability, as the economy is exposed even more to oil price shocks. In particular, as oil prices rose, Kazakhstan has become increasingly dependent on oil as a source of export revenue (Figure 3); consequently, the sudden drop in oil prices had an immediate negative impact on net exports and growth.

Figure 3. Kazakhstan: Oil Share of Total Exports and Average Oil Prices



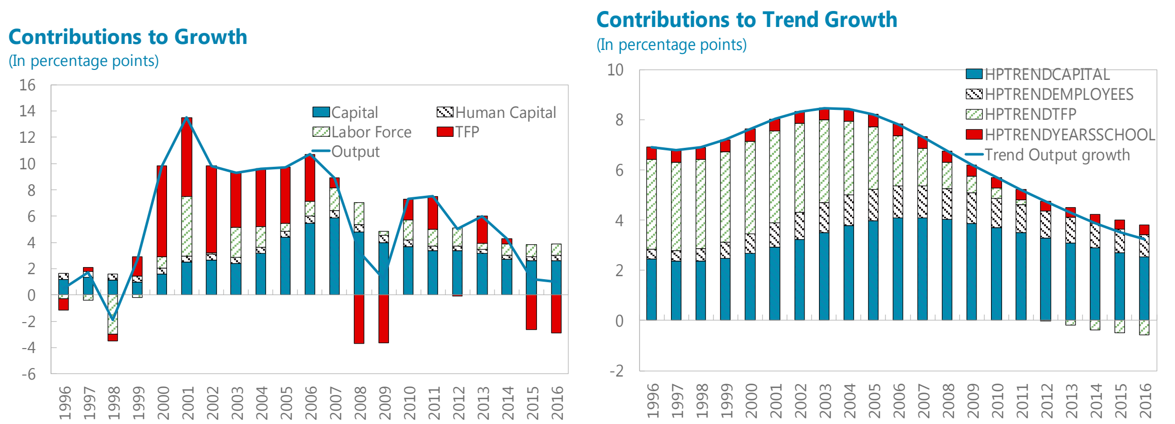
Sources: World Economic Outlook; and IMF staff calculations.

11. **The growth accounting exercise reveals that Kazakhstan's potential growth has been shaped largely by capital accumulation and TFP.** The contributions from labor and human capital have been consistent and relatively small. In the last five years, labor and human capital combined have contributed about 2.2 percentage points to growth. Capital accumulation has contributed more—over 6 percentage points, on average—although this is lower than the pre-global financial crisis period. TFP declined gradually over the sample period, and was sharply negative in the years of negative oil price shocks, which as discussed above, likely reflects lower capacity utilization and the drag created by weaknesses in the financial sector. This pattern contrasts to the early years of the 2000s, in which TFP not only contributed positively to growth but it was its main driver, likely reflecting greater openness and reforms pursued over the previous decade (Figure 4). Looking forward, while the contribution of labor is projected to continue at the previous rate, credible implementation of structural reforms and a rebound in global oil prices could pave the way for a higher contribution from TFP. Staff's baseline estimates show relatively modest contributions from capital accumulation, although this too could be larger with decisive implementation of structural reforms.

F. Conclusion

12. **The paper uses univariate and multivariate filters along with a production function to assess the magnitude and trajectory of Kazakhstan's potential growth.** In recent years, all techniques find that potential growth has slowed substantially to around 3 percent. While each approach comes with certain shortcomings, the close results that they yield suggest that these findings are plausible.

Figure 4. Kazakhstan: Growth Rates of Capital and Output, and Contributions to Growth



Sources: National authorities; Wittgenstein Centre; and IMF staff calculations.

Sources: National authorities; Wittgenstein Centre; and IMF staff calculations.

13. **The main driver of growth in Kazakhstan is oil, which creates substantial volatility from year to year as negative shocks to oil prices translate into low capacity utilization of existing capital.** Overall, the contribution to growth of physical capital inputs has been consistently high but falling, the contributions of labor (both number of employees and human capital) have been consistently low, and the contribution of total factor productivity has been highly uneven. All these aspects are consistent with the economy's growing reliance on oil in the recent past, and the oil sector's reliance on capital rather than labor as the principal input. Looking ahead, the implementation of structural reforms would greatly help to reduce the volatility of economic growth and make 4 percent growth over the medium term an attainable goal.

References

Mark Aguiar & Gita Gopinath, 2007. "Emerging Market Business Cycles: The Cycle Is the Trend," Journal of Political Economy, University of Chicago Press, vol. 115, pages 69-102.

Baxter, M., and R.G. King, 1999. "Measuring Business Cycles: Approximate Band-Pass Filters for Economic Time Series", *Review of Economics and Statistics*, 81(4), pages 575-593.

Blagrave, P., Garcia-Saltos, R., Laxton, D. and Zhang, F., 2015. "A Simple Multivariate Filter for Estimating Potential Output", IMF Working Paper WP/15/79,

Bosworth, B.P., and S.M. Collins (2003), "The Empirics of Growth: An Update", Brookings Papers on Economic Activity, vol. 34 (2003-2), pages 113-206.

Christiano, L.J. and T.J. Fitzgerald, 2003. "The Band Pass Filter", *International Economic Review* 44(2), pages 435-465.

Griliches, Z. and Mairesse, J., 1995. "Production Functions: The Search for Identification", NBER Working Paper No. 5067, March 1995

Hodrick, R.J. and E.C. Prescott, 1997. "Postwar U.S. Business Cycles: An Empirical Investigation", *Journal of Money, Credit, and Banking* 29(1): pages 1-16.

Mitra, P., Hosny, A., Abajyan, G., and Fischer, M., 2015. "Estimating Potential Growth in the Middle East and Central Asia", IMF Working Paper WP/15/62

Mohr, Matthias F., 2005. "A Trend-Cycle(-Season) Filter", ECB Working Paper No. 499.

Psacharopoulos, G. and H. Patrinos (2004). "Returns to Investment in Education: A Further Update." Education Economics 12(2): 111-134.

Appendix I. Additional Notes on Univariate Filters

For all three filters, the source data were obtained at quarterly frequency and seasonally adjusted using the X13 method in Eviews. Historical quarterly data on real GDP, not seasonally adjusted, was obtained extending back to 1999, and IMF staff projections were included to 2022. Quarterly projections for 2017-22 were estimated using the annual growth forecasts under the assumption that the growth rate was uniform over the year. Finally, the data were seasonally adjusted using the X13 method with all default settings.

The Baxter-King filter cannot generate values at the very beginning or end of the sample period because it requires the same number of leads and lags for each observation. EViews identified 12 quarters as the default number of leads and lags, given the length and frequency of the time series; consequently, the Baxter-King filter returns values from 2002 to 2019.

The Christiano-Fitzgerald filter requires that the series be stationary. To assess stationarity of seasonally adjusted real GDP, an Augmented Dickey Fuller Unit Root test was run. The null hypothesis that it has a unit root could not be rejected, so the original series was transformed prior to applying the filter.

Appendix II. Estimation of Production Function Parameters

Estimates of the production function parameters can be obtained using time series or cross-sectional data, either directly or indirectly from the related cost function. In this paper, the direct method is applied to a sample of Kazakhstani firms, and the estimation is carried out by OLS.

One potential issue with the OLS estimation method is inconsistency, due to endogeneity (see Griliches and Mairesse, 1995). Solutions to the endogeneity problem, typically proposed in the literature, are the standard ones: (i) panel data within estimators to remove the fixed effects, and (ii) instrumental variables (IV). However, in the case of Kazakhstan these solutions are not available. The use of panel data methods is precluded by the very small number of observations available for earlier years and a key challenge to the IV estimation is finding a good instrument for the endogenous variables. In this case, it is reasonable to assume that the capital input is fixed, so the only possible source of endogeneity is the labor variable. A natural candidate for instrument for the labor input is the wage; however, data on labor-related payments is not available for the vast majority of the firms in the sample. It is important to note that the original criticism of OLS was developed in relation to time series methods for production function estimation; the endogeneity argument is less relevant when enterprise data are employed.[1] In particular, this is the case if legislation or other constraints limit the possibilities for firms to shed labor in response to adverse demand shocks.

The estimated parameters of the Cobb-Douglas production function for Kazakhstan are shown in Table 1. Model A presents the estimates from an unrestricted model, while Model B imposes the restriction that the coefficients on labor and capital should sum to 1. Interestingly, even in the unrestricted model the sum of the coefficients is very close to unity, supporting the hypothesis of constant returns to scale.

Table 1. Kazakhstan: Production Function Parameter Estimates

	Model A	Model B
log_k	0.437***	0.437***
	(13.61)	(13.66)
log_l	0.559***	0.563***
	(10.48)	(17.62)
Constant	0.609**	0.591***
	(3.03)	(5.53)
N	993	993
DF	990	991
R^2	0.548	
Adj. R^2	0.547	

Robust t statistics in parentheses
* $p<0.05$, ** $p<0.01$, *** $p<0.001$

Source: Orbis database, IMF staff calculations

[1] Griliches and Mairesse (1995), p.5.