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Monetary Policy, Inflation and Dollarization in the Economies of Central Asia

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Dissertation

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Contents

Preface

The present dissertation consists of three studies on the issues of inflation, monetary policy effects and dollarization in three economies in Central Asia – Kazakhstan, the Kyrgyz Republic and Tajikistan. These economies have undergone a deep transformation from central planning to market economies. The profound economic transformation which took place after these countries became independent, combined with liberalization of prices and trade, resulted in hyperinflation, general economic instability, and large fiscal and external imbalances. Central banks in the region had managed to combine the policies and tools to take control of inflation in the late 1990s. This was the period when positive economic growth was observed in the region. A negative shock for these countries was caused by the Russian crisis in 1998, though the consequences of this financial turmoil were softened by the measures of the regional central banks concerning the flexibility of the exchange rates. Since 2000, these economies have been characterized by single-digit inflation rates and high positive economic growth. Only Tajikistan has still been experiencing double digit inflation, though the country experiences positive real growth. The monetary policy framework has evolved over the transition period. Macroeconomic stabilization has brought important developments in the financial systems of the countries while at the same time a need for elaborate and efficient monetary policy. Economic developments, financial system advances, and the recent financial crisis stipulate the

role of monetary policy as an important tool to maintain financial stability, to support local currencies' purchasing power, and to affect the external sector balance in these economies. Though there are important general trends in the development of the three countries, recent years of economic transition show that differences in the mineral resource base, initial conditions and the political situation have significantly affected recent economic achievements and the current context in all economies of Central Asia. This does not, however, preclude researchers from studying these countries together. Their geographical proximity and the need to share certain natural resources compel the countries of Central Asia to strengthen regional cooperation and coordination of economic and regional development policies. Sharing a similar historical background, commercial ties and cultural traditions, these countries make an interesting case study that allows finding similarities and comparing achievements on the grounds of regional interconnection and yet diverging levels of economic progress.

Kazakhstan consists of a vast territory which is rich in mineral resources and borders the Caspian Sea. This gives the country access to oil resources, the single factor that has largely affected economic developments there. Oil represents an important export item and accounts for a large share of export revenues. Moreover, oil exploration and production forms a considerable part of Kazakhstan's GDP and an attractive sector for foreign direct investments. This natural resource has brought a significant improvement in the living standards in Kazakhstan and has made the country the richest among its neighbors in the region. Further, the large inflows of foreign capital into mineral exploration industries to meet the demand for financial resources of local producers have contributed to rapid development of the banking system of Kazakhstan. Recent advances in banking services include a broader variety of financial services not only to

businesses but to the household sector as well. Kazakhstan is among those advanced transition economies that have experienced a credit boom and a deeper integration with world financial markets.

The Kyrgyz Republic and Tajikistan, by contrast, possess a relatively modest mineral resource base in comparison to Kazakhstan and remain the poorest countries in the transition region. The major export item of the Kyrgyz Republic is gold. Tajikistan depends on its cotton and aluminum production. The cotton industry's need for financial resources is, however, very difficult to satisfy as the country has limited access to foreign capital markets.

These two countries have important water supplies due to mountainous territories and river basins. There is thus the potential to produce enough hydroelectric power to meet the local demand and to export it. Maintenance of the electricity plants and projects to construct new facilities, however, require large investments in the long run as well as resolution of intraregional disputes on water management. These problems have so far hindered the countries from effectively using their water resources.

The latter two countries have experienced important advances in their banking and financial systems, though rather modest in comparison to those in Kazakhstan. Moreover, foreign banks are represented by Kazakh banks in the Kyrgyz Republic and Tajikistan. The two countries are dependent on remittance inflows from labor emigrants to Kazakhstan and Russia as well as to other countries further West. These inflows have become an important financial resource for the residents, but mostly serve short term needs.

In the present dissertation, the monetary transmission mechanism and the potential obstacles for an effective monetary policy in Central Asian economies are examined.

Among the potential impediments for an effective conduct of the monetary policy are weak financial sectors and dollarization. The importance and magnitude of currency substitution and dollarization are examined together with their effects on the seigniorage revenue of central banks and welfare implications. These studies contribute to the overall understanding of monetary policy effects in the context of transition, the potential issues that arise due to currency substitution and dollarization in transition economies, and the factors that should be taken into consideration by policy makers when managing domestic inflation.

The first chapter examines monetary policy efficiency in Central Asian economies by investigating the monetary transmission mechanism in the region's economies. The study investigates the main transmission channels: interest rate channel, exchange rate pass-through, and bank lending channel. All three economies rely heavily on foreign exchange interventions to affect the exchange rate and the price level. This is due to ineffective financial intermediation and thin financial markets.

The empirical investigation is performed in a reduced form Vector Autoregression framework (VAR) which allows for the investigation of monetary policy effects without specifying a structural model. Results show that the most important channel is the exchange rate pass-through. Analysis of other transmission channels does not yield results to draw conclusions about their magnitude and importance. The potential factors that might impede effective transmission are high levels of dollarization, weak financial sectors, underdeveloped capital markets, and low monetization of economies. Though Kazakhstan has the most advanced financial system, there is still room to increase the effectiveness of the central bank's policy. The financial sector of Kazakhstan is, however, more sensitive to external shocks as it is more integrated into international

capital markets. The other two economies' financial systems are mostly affected through Kazakh banks operating in the Kyrgyz Republic and Tajikistan. It would not be wrong to predict that Kazakhstan's central bank has at present the most potential to affect economic developments through its policy making. Recent developments in its financial systems have made it possible to improve the transmission channels performance. Tajikistan has the smallest financial system and the least number of financial institutions. It is a laggard in comparison to its regional neighbors, a situation can be explained by the fact that the country suffered a severe civil war that began just after achieving independence and that continued till the end of the 1990s.

To study the potential of the interest rate channel, an empirical investigation of the pass-through from the official rates of central banks to different market rates was performed by estimating an autoregressive distributed lag model (ARDL). Nearly complete pass-through has been established in most cases. The pass-through from interest rates to prices and output has, however, been found to be almost non-existent. These empirical results demonstrate the limited ability of central bankers in the region to affect the real sector and prices due to the ineffective functioning of major transmission channels. The findings confirm the general outcomes of previous studies on the MTM in transition economies about strong exchange rate pass-through and a weak interest rate channel. The study thus contributes to an understanding of the monetary policy transmission channels in a specific group of transition economies. It emphasizes the importance of further development of financial sectors in the Central Asian countries. Deeper financial markets, developed financial intermediation, and competition will promote the effectiveness of the interest rate and credit channels of monetary transmission. Maintaining the financial stability of the economy will restore

the public's confidence in the local currency. Dollarization and currency substitution pose less risk of financial instability in a fundamentally stable economic environment.

The second chapter follows up with a close analysis of currency substitution in the same group of economies. The time period covered in the study spans from 2000 until the end of 2008. Though dollarization remained at high levels at the beginning of the 2000s in all Central Asia, its trends have varied across countries. Dollarization has been decreasing in Kazakhstan, while it has been quite volatile in Kyrgyz Republic and has been increasing in Tajikistan. Recent developments in the economy of Kazakhstan, increasing income from oil exports, and improved living standards have contributed to rising credit of the local currency. It is not too early to suppose that foreign currency (in particular, the U.S. dollar) has started to lose its value as a hedge against inflation of local money. One could argue, however, that there are still important dollar holdings in cash by residents. Though the banking system has achieved record developments, local residents are in the process of learning about the financial services provided by the banks. While there might be less concern about currency substitution in the economy of Kazakhstan, it is still an important feature of the economies of the Kyrgyz Republic and Tajikistan. These countries are catching up with its larger neighbor and have made significant steps forward. Yet they remain the poorest economies among the former Soviet Union republics. Moreover, the political situation in the Kyrgyz Republic in 2005 had a negative effect on the state of affairs. In Tajikistan, a long memory of the civil unrest from the 1990s, a poor economic record, and the magnitude of the shadow economy (due to drug trafficking) have undermined people's trust in the local currency. Significant inflows of remittances denominated in foreign currency (usually in dollars) have contributed to persisting currency substitution and dollarization in both countries.

The second chapter sheds light on the importance of currency substitution in terms of its substitutability for local currencies and its ability to affect seigniorage revenues of central banks and economic welfare in Central Asia.

For this purpose, I use the dynamic optimization framework proposed by Imrohoroglu (1994) with a classical money-in-the-utility model with two currencies. Optimality conditions are used in the estimation of the major model parameters. To estimate the parameters a Generalized Method of Moments (GMM) is performed. The GMM framework allows for explicit estimation of all parameters of the structural model. The results testify to the high substitutability between domestic and foreign money balances, and an important share of foreign currency in providing monetary services.

To examine the implications of currency substitution for seigniorage revenues and welfare a hypothetical steady state is considered. The approach used follows Eckstein and Leiderman (1992), who studied the welfare implications and seigniorage losses due to inflation. A similar framework was used by Friedman and Verbetsky (2001) to study the implications of dollarization for seigniorage revenue of the government and for welfare. The comparison is made between steady states with different inflation rates and dollarization levels. To define the depreciation rate dynamics, two scenarios on foreign inflation rate are suggested. In the first scenario, it is assumed that the foreign inflation rate is zero, while in the second scenario, foreign inflation is 5 percent. Results show that the seigniorage revenue of central banks is quite sensitive to changes in dollarization level since higher dollarization decreases the revenue from seigniorage. Currency substitution and dollarization also affect the welfare of households who hold foreign money balances. Dollarization affects households' wealth from two sides: it decreases lump-sum transfers from the government and provides a hedge against inflation. Welfare analysis shows

that residents in fact gain from holding foreign currency in an inflationary environment. Only when the foreign currency is less stable than the domestic currency might holding dollars bring a welfare loss. These findings contribute to a general knowledge about the importance of currency substitution in transition economies and its potential effects on the wealth of the resident households via the effect it has on the seigniorage revenues of the government and on the value of the foreign currency holdings. Since dollarization has important implications for seigniorage and welfare, there should be a discussion on policy directions and recommendations. It is evident that de-dollarization is important for the countries in the region. This should, however, be remedied indirectly by improving the macroeconomic situation, achieving long term price and exchange rate stability, and supporting developments in the financial sectors.

The final chapter provides a study on the behavior of inflation in two economies in Central Asia: Kazakhstan and the Kyrgyz Republic. Tajikistan was not included in the study due to short time span of the available data since this empirical investigation is based on quarterly data. The proposed model of inflation builds on the model suggested by Goujon (2006). Here, a standard inflation index comprising the level of prices of tradable and non-tradable goods is considered. In the tradable goods sector, prices are affected by external factors such as foreign inflation, prices for foreign goods, and exchange rate movements. In the non-tradable sector, prices are affected by the equilibrium conditions in the internal markets. Deviations from equilibrium in a monetary sector are chosen to affect inflation since there was a significant growth in the demand for money. Additional money is absorbed by the growing consumption needs. Thus, the money supply might no longer appear to be an appropriate factor to include in the inflation equation. Instead, excess money measured as deviations of the

money demand from equilibrium money demand is included in the model. Exchange rate changes can affect the prices of non-tradable goods as some of them are indexed to prices in the tradable goods sector. In the context of dollarization, the exchange rate pass-through becomes stronger.

Cointegration relationships in the internal money demand are examined by performing Johansen cointegration analysis. Analysis of the money demand is performed using the approach of Johansen and Juselius (1990). The error correction model is used as an additional factor in a short-run inflation equation. The empirical estimation of the final inflation equation is done using an instrumental variables estimation to account for possible endogeneity of the exchange rate. Results show that the major factors affecting inflation in Central Asia are exchange rate depreciation and past inflation. Deviations from long run money demand are found to significantly affect inflation as well. The international prices of oil and gold affect inflation in Kazakhstan and the Kyrgyz Republic respectively. The empirical findings do not, however, provide much evidence that inflation is more reactive to a broader definition of monetary aggregate, i.e. when money comprises foreign currency denominated assets. The model developed for the empirical estimation is a general model, and thus similar findings were established in both cases. This points to the fact that both economies are small open economies and can be more sensitive to external shocks.

System estimation was performed as well to increase the power of the tests if the countries are subject to similar shocks. This analysis supports the earlier finding regarding the strong pass-through from the exchange rate changes to inflation and the importance of past inflation in explaining variation in the current inflation rate.

Analysis of the stability of parameters over time is necessary since during transition

relationships between different economic variables might have changed. Two approaches are employed for this purpose: a moving window estimation and the Kalman filter. Results indicate that the parameters in the model were stable during the whole period, though there might be some important changes due to the recent financial crisis. An important finding is a growing magnitude of the coefficient on changes in world oil prices for inflation in Kazakhstan, and a decreasing value of the parameter on gold prices for the Kyrgyz Republic. This reflects the increasing role of oil export revenues and oil production for the Kazakh economy, while a decreasing role of gold exploration in the Kyrgyz Republic. The findings of this empirical investigation contribute to an understanding of the inflationary processes and underlying factors in small open economies using as an example of transition countries in Central Asia.

Most of the present dissertation was completed before the global financial crisis hit the region. Nevertheless, it is important to indicate what these effects are and how the recent context would affect the results of the studies presented here. First of all, the importance of monetary policy in coping with the financial turmoil faced by these countries should not be underestimated. The banking system of Kazakhstan has suffered the most, as its involvement in external financial borrowing between local and foreign banks was the greatest in comparison to the other two countries. The Kyrgyz Republic and Tajikistan experienced the negative effects of the crisis a bit later through mostly two channels: a sharp drop in the remittance inflows from the labor migrants to neighboring countries and decreasing demand for exports from these countries. Degradation of the economic situation of their main trading partners, a decline in world oil prices, a food crisis, and regional energy disputes have put pressure on the local currencies and exchange rates. These countries have seen an increase in

inflation rates and a devaluation of the national currencies. This, in turn, may have a negative effect on the residents' perception of the local financial systems and local currencies, and may bring another round of dollarization and currency substitution. These effects are, however, not captured in the present dissertation and are yet to be explored.

Chapter 1

Monetary Policy Efficiency in the Economies of Central Asia*

Abstract

This study examines monetary policy efficiency in Central Asia by investigating the monetary transmission mechanism in the region's economies. To examine the efficiency of the monetary policy, it is necessary to take into account factors that might impede the transmission, such as high levels of dollarization, weak financial sectors, underdeveloped capital markets, and low monetization of economies. Empirical findings confirm the importance of the exchange rate pass-through in transition economies with high dollarization. The findings also provide an empirical case for deepening the local financial sectors to improve the efficiency of the monetary policy, and to improve resilience to external and other shocks.

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1 Introduction

Knowing that the monetary transmission mechanism (MTM) is necessary to conduct an effective monetary policy, this study aims to contribute to the understanding of monetary policy effects in emerging market economies by examining the transmission channels of monetary policy in three CIS economies in Central Asia – Kazakhstan, the Kyrgyz Republic and Tajikistan. These countries share a common economic history, and have overcome a period of large macroeconomic instability and deep recession. The profound economic transformation which took place after these countries achieved independence, combined with a liberalization of prices and trade, resulted in hyperinflation and large external imbalances in the first half of the 1990s. The ultimate objective for the macroeconomic policy of the central banks in these states became price stabilization and external balance.[1] Monetary authorities managed to achieve overall macroeconomic stability in the late 1990s. Since 2000, the economies have been characterized by single digit inflation rates and positive economic growth. Macroeconomic stabilization has brought advances in their financial systems, together with a need for an elaborate and efficient monetary policy.

The main objective of central bankers in the countries of Central Asia is to maintain price stability and the purchasing power of the local currencies. By using various tools of monetary policy the banks achieve and stimulate economic growth and financial stability. Achieving the goals depends on the functioning of different transmission channels of monetary policy. The present study seeks to estimate the impact of monetary policy on the output growth and price levels in these economies. Three

[1]For details on the economic development and monetary policy framework in the Central Asian states in the 90s see Gürgen, et al. (1999).

major channels of the monetary policy transmission are in the focus of this empirical investigation: interest rate channel, exchange rate pass-through, and credit channel.[2] These three channels are considered in a vector autoregression (VAR) framework through an analysis of the impulse response functions of prices and output to shocks in the policy variables. The exchange rate pass-through (ERPT) is found to be a strong channel of monetary policy transmission, while the interest rate does not prove to be an important monetary transmission channel. Results on the bank lending channel are inconclusive, since the reaction of creditors to changes in the policy rate was not found to be statistically significant. Though financial sectors are not formally studied in the present dissertation, it is still possible to explain the weakness of the lending channel as due to the underdeveloped financial intermediation in Central Asian economies. An empirical investigation of the pass-through from the official rates of central banks to different market rates was performed through estimating an autoregressive distributed lag model (ARDL). A nearly complete pass-through has been established in most cases. The pass-through from interest rates to prices and output have, however, been found to be almost non-existent.

The empirical results witness to the limited ability of central bankers in the region to affect the real sector and prices due to ineffective functioning of major transmission channels. The findings confirm the general outcomes of previous studies on MTM in transition economies about strong exchange rate pass-through and weak interest rate channel.

The paper is organized as follows. Section 2 discusses the factors that potentially impede effective monetary policy in the Central Asian economies. Section 3 outlines the methodology and describes the data, while Section 4 presents the results. Section

[2]In the present study, the credit channel is represented by the bank lending channel.

5 investigates the completeness of the interest rate channel in the three economies and discusses these results. Section 6 concludes.

2 Barriers to Effective Monetary Policy in Central Asia

This study is motivated by the literature on monetary policy transmission channels.[3] As monetary policy has gained in importance in emerging market economies, there has been a growing interest in its transmission channels and its efficiency in the context of transition.[4] The central banks and monetary policy frameworks have been gradually evolving in the countries of Central Asia over the period considered. In the earlier period of transition, hyperinflation, large budget deficits and the support of state enterprises by the central banks made it clear that control over the money supply was necessary. After the Russian crisis in 1998, the local currencies came under pressure and central bankers chose to devalue the national money to support the countries' competitiveness and external balance. The monetary authorities also became largely concerned with foreign exchange stability, which was important for overall price stability. An important tool of stabilization has become foreign exchange interventions. Central banks report managed floating exchange regimes and use operations on the foreign exchange market whenever they consider it to be important for foreign exchange stabilization.

The interest rate pass-through is the first transmission mechanism to be modeled, and is found to be a strong transmission channel in advanced economies. To maintain

[3] A comprehensive description of the MTM functioning can be found in Mishkin (1996), who provides an exhaustive explanation of the existing transmission channels.

[4] Égert and MacDonald (2006) provide a metareview of empirical studies on transmission channels in transition economies.

price stability, monetary authorities have to understand how fast and to what extent the policy instruments affect aggregate demand and inflation. In simple terms, lower interest rates lead to an increase in aggregate demand, and therefore promote output growth. Besides including interest rates in a VAR framework to examine this channel, it is important to study the first stage of the interest rate pass-through: the transmission from policy rates to different market rates.[5]

The effective functioning of other transmission channels is related to the interest rate pass-through. An increase in interest rates leads to an appreciation of local currency, and thus affects the ERPT. This will have an impact on output insofar as it affects the competitiveness of domestic goods vis-à-vis foreign goods. Central Asian economies are small, open, and substantially affected by external shocks. Kazakhstan's economy depends, for example, on its oil exports, and has benefited from oil sector revenues.[6] Previous literature has found that exchange rate shocks in emerging market economies tend to feed into the aggregate price level faster than in advanced economies.[7] It is important to take into account the mechanism through which the ERPT is put into effect in the context of transition. In most cases, central bankers have to directly influence the exchange rate by undertaking foreign exchange interventions.[8] This is directly related to the weak response of the value of the national currency to changes in interest rates, and a practically absent interest rate pass-through.

Recent economic developments characterized by the expansion of economic activity and advances in the banking sector could have an impact on developments in the credit

[5] See, for example, Égert and MacDonald (2006), Crespo-Cuaresma et al. (2004)

[6] Oil sector production accounts for more than 50 percent of total export revenues of the country (see IMF, 2009). Some analysts and researchers have been concerned with the problem of Dutch disease in the economy of Kazakhstan (see Kutan and Wyzan (2005)).

[7] See, for example, Calvo and Reinhart (2002).

[8] More discussion on nominal anchors and exchange rate regimes in CIS economies can be found in Keller and Richardson (2003).

channel of monetary policy transmission. The bank lending channel, which represents the credit channel in a narrow sense, is related to the ability of commercial banks to provide finance to the private sector. An increase in the credit available leads to an increase in aggregate demand and thus promotes economic activity.[9] Dabla-Norris and Floerkemeier (2006) argue that the effectiveness of this channel is related to the ability of economic agents to substitute loans available from banks with other sources of finance. The results of empirical studies on credit channel performance in transition economies vary from country to country.[10]

The functioning of monetary policy transmission channels in the economies of Central Asia is strongly influenced by several factors that should be taken into account when examining the effects of monetary policy and monetary policy framework.

High levels of dollarization resulting from periods of high inflation and economic instability continue to characterize these countries (see Figure B 2 in Appendix B).[11] Ize and Levy Yeyati (2003) suggest that financial dollarization displays high persistence if the expected volatility of the inflation rate remains high in relation to the expected volatility of the real exchange rate, even after price stabilization has been achieved.[12] Significant inflows of foreign capital and remittances from abroad also contribute to

[9] Mishkin (1996) explains that expansionary monetary policy, which increases bank reserves and bank deposits, should increase the quantity of bank loans available.

[10] See Héricourt (2006), Dabla-Norris and Floerkemeier (2006), Égert and McDonald (2006).

[11] The estimated dollarization indices (DI) for the Central Asian economies are available from the study by Havrylyshyn and Beddies (2003), who calculate the dollarization indices (DI) as the ratio between foreign currency denominated deposits and broad money. However, their estimates are only available till 2001. Therefore, a newly available dataset was used to calculate the DI for the three economies.

[12] Horváth and Maino (2006) report that dollarization will decline reflecting the agents' preference to switch from foreign currency when its purchasing power in terms of domestic currency is no longer more stable than the purchasing power of the domestic currency. Therefore, an important driving force of dollarization is the expected volatility of the real exchange rate relative to the expected volatility of inflation.

growing levels of currency substitution and asset dollarization.[13] Havrylyshyn and Beddies (2003) argue that exchange rates are more volatile in dollarized economies, money demand is unstable, and thus, interest rates do not constitute an effective instrument of monetary policy. Therefore, currency substitution and dollarization can potentially affect the monetary transmission channels.[14] Horváth and Maino (2006) argue that ERPT grows stronger in the context of a highly dollarized economy.

The efficiency of monetary policy in Central Asian economies is also affected by the state of their financial sectors. Dabla-Norris and Floerkemeier (2006) claim that monetary policy transmission depends on the extent of financial intermediation, on the size, concentration, and health of the banking system, and on the development of capital markets. Tables B2-B3 in Appendix B present selected financial indicators in a group of transition economies. The degree of monetization in these economies is lower than in more advanced transition economies. Moreover, the size of the banking systems measured as a ratio of bank assets to GDP is smaller in these economies than in those of Eastern and Central Europe, including the Baltic states. Other indicators, such as bank deposits to GDP and bank credit to private sector, show that financial intermediation is still low and that banks do not constitute an important source of financing real activity. Though Kazakhstan has seen rapid credit growth in recent years, its level of credit to the economy is still inferior to economies in CEE. Large inflows of remittances from abroad might constitute an important financial source in the region, especially in Kyrgyz Republic and Tajikistan.[15] In such a context the efficiency of the interest rate, bank lending, balance sheet and asset price channels of monetary transmission can

[13] See Table B 1 in Appendix B.

[14] See Baliño, Bennett, and Borensztein (1999) and Sahay and Végh (1995) for a discussion of dollarization and the conduct of monetary policy.

[15] Tajikistan has one of the highest remittances- to-GDP ratio in the world by IMF staff estimates (see IMF Country Report No. 07/144).

be seriously challenged. It is evident that dollarization together with underdeveloped financial sectors can pose a serious obstacle to the effective implementation of monetary policy decisions in the countries of Central Asia.

3 Methodology and Data Description

To empirically investigate the effects of monetary policy through policy-related variables on prices and output, a five-variable Vector Autoregression (VAR) model has been estimated. The present VAR system includes the following endogenous variables: real income *(y),* price indices *(p)*, policy rates *(r)*, monetary aggregates *(m)*, and nominal exchange rate to the U.S. dollar *(x)*. The world prices of oil, gold and cotton are included as exogenous variables in the case of Kazakhstan, the Kyrgyz Republic, and Tajikistan, respectively. Moreover, the U.S. Federal Funds Rate is included as an exogenous variable to account for uncovered interest rate parity, and seasonal dummies are used to account for seasonality in the data.[16] All variables are transformed into natural logarithms except interest rates. The ADF test results show that all variables are non-stationary and I(1), except for interest rates. Therefore, first differences of these series are used in the VAR estimation.

The following VAR model is estimated:

$$\Delta Y_t = A(L)\Delta Y_{t-1} + B(L)\Delta X_{t-1} + u_t, \tag{1}$$

where Y is a vector of endogenous variables, and X is a vector of exogenous variables. $A(L)$ and $B(L)$ correspond to the matrices of coefficients to be estimated, and u is a vector of impulses. Using the VAR will also allow U.S. to analyze the short dynamics

[16] A more detailed description of the data is given in Table A 1 in Appendix A.

based on variance decompositions and impulse response functions.

The following ordering is used in estimation:

$$Y = \{y_t, p_t, r_t, m_t/c_t, x_t\}$$

Using alternative orderings shows that the results are robust to changes in the order of the variables. To capture the effect of shocks in bank lending available, a variable measuring credit volume is included in the VAR specification instead of the variable measuring money supply.[17]

Price indices are represented by the producer price and consumer price indices (PPI and CPI). Industrial production volume is measured in units of national currencies. Due to the unavailability of data on the volume of industrial production in the case of Kazakhstan, the industrial production index is used. Nominal exchange rates are measured as units of domestic currency per one U.S. dollar. Monetary aggregates are represented by two measures: money and broad money. An important difference between money and broad money is that the latter includes foreign currency deposits in local banks.

VAR estimation is a popular methodology to investigate monetary policy transmission mechanisms. Though it is an atheoretic approach, it can still provide evidence of the relationships between variables and shed light on the responsiveness of variables in the system to shocks in policy variables in the system. In the case of transition economies, the VAR estimation is a useful methodological approach with

[17] In this study, the methodology used by Héricourt (2006), Dabla-Norris and Floerkemeier (2006) is used. Data for domestic credit in a VAR model is used instead of monetary aggregates to study the bank lending channel. Bernanke and Gertler (1995) argue that a shift in the banks' loan supply will affect the external finance premium and the real activity. The empirical methodology proposed in the present study will allow establishing whether there is such a relationship between the supply of bank loans and output, i.e. whether domestic banks constitute an important source of finance to local businesses.

good predictive power.[18]

4 Empirical Results

The exchange rate transmission to prices and output is investigated by examining the impulse response functions of changes in the producer price and the consumer price inflation after a shock to the nominal exchange rate. This shock is represented as a 1 percent change in the nominal exchange rate. The impulse responses show percentage changes in inflation rates and output growth. The period under investigation spans 24 months after the shock occurs.

Impulse response functions are depicted in Figure C1 in Appendix C. The results show that in Kyrgyz Republic, inflation reacts rather strongly and statistically significantly to shocks in the depreciation rate. A one-percent change in the nominal exchange rate will lead to an almost 0.4 percent increase in PPI inflation and about a 0.12 percent change in CPI inflation after 2 to 3 months. Producer prices are more strongly affected by the exchange rate variation than are consumer prices. After 3 months, inflation approaches its original level but does not reach it even after 24 months after the shock.

In Kazakhstan, inflation seems to be less sensitive to exchange rate shocks. The PPI reaches its highest peak after 3 months at about 0.2 percent, while consumer price inflation won't increase by more than about 0.05 percent.

[18] Several authors have expressed concerns with the problem of asymmetric monetary policy effects. For example, Cover (1992) found that in the U.S. economy, positive money supply shocks did not have effects on output, while negative shocks did. Garcia and Schaller (1999) found that the magnitude of monetary policy effects also depends on whether there is a boom or a recession in a given economy. To account for this non-linearity in monetary policy effects empirically, a General Method of Moments (GMM) estimation might be employed. This discussion is, however, beyond the scope of the present study, and leaves a prospect for further research.

In Tajikistan, the behavior of producer prices and consumer prices does not differ substantially. However, quantitatively prices in Tajikistan are the most sensitive to nominal depreciation. Inflation would rise by 0.4 percent if the nominal exchange rate depreciates by 1 percent. The shock to exchange rates brings more volatility to the inflation rate.

The results obtained show that prices in the three economies exhibit different magnitudes in reacting to foreign exchange depreciation. In the Kyrgyz Republic and Tajikistan, nominal depreciation shocks have a significant effect on the price level. In Kazakhstan, the quantitative change in price level is smaller than in neighboring countries. A weaker exchange rate pass-through might be a consequence of a successful exchange rate stabilization policy. Indeed, though all three countries report having floating exchange rate regimes, the central banks are very much concerned about the stability of exchange rates, as reflected in their active policies to control the rate of depreciation of the domestic currencies.[19] Moreover, during the period observed, prices on certain items were still regulated in transition economies.[20]

The analysis of the effect of a shock to the nominal exchange rate on output indicates that increased volatility in the exchange rates leads to an increased volatility in the output growth rate in all three economies (see Figure C2 in Appendix C). Such a cyclical fluctuation of the impulse response function is somewhat unusual and difficult to interpret. The output growth rate varies within one percent, which is a relatively small pass-through from nominal depreciation of the local currency to the real sector.[21]

[19] See Keller and Richardson (2003).

[20] See Šošić and Kraft (2006).

[21] These results can probably be explained by the poor quality of industrial production as a proxy to real output. As Héricourt (2006) argues industrial production offers only a partial view of the economy's productive abilities, and it exhibits more pronounced "procyclicity" and instability than GDP, for example.

The analysis of the effects of unanticipated changes in the policy rate reveals that the interest instrument is still ineffective in Central Asian states (see Figures C 3 and C 4 in Appendix C). A 1 percent increase in the repo rate in Kyrgyz Republic leads to an increase in CPI inflation by less than 0.03 percent at most. This is a tiny effect that dies out after 5 months. In Kazakhstan, the inflation rate rises by about 0.06 percent after a shock to the policy rate. In Tajikistan, the policy rate has a tangible effect on price level as after a 1 percent shock the inflation rate decreases by 0.2 percent almost immediately after the shock. These results, however, are not conclusive enough to make strong claims about the interest rate channel in the Central Asian states. The completeness of the interest rate transmission is analyzed in the next section.

To establish whether shocks to money represented by different aggregates have an impact on inflation rates and output, the impulse response functions of the CPI and the PPI, together with output to shocks in the money growth rate, were considered as well (see Figures C 5 – C 6 in Appendix C). In the Kyrgyz Republic and Kazakhstan, prices appear to be more sensitive to changes in the money supply that includes foreign currency deposits.

Findings about the credit channel suggest that a shock to credit brings increased volatility in the output growth. The cyclical behavior of the output growth does not help establish results about the performance of the bank lending channel. The results are, however, statistically significant in Kyrgyz Republic and Kazakhstan. Inflation does not change significantly in response to a positive shock in credit growth (see Figures C 7 – C 8 in Appendix C).

The time span covered in the present analysis might contain a structural change. Hence, it is necessary to check the robustness of the results over different sub-periods in the sample. Due to the short time period in the case of Tajikistan, testing for the

stability of the system during different periods was not possible. In the case of Kyrgyz Republic and Kazakhstan, the sample was divided into two sub-samples: from the beginning of the sample until December 2000, and from January 2001 until the end of the sample. Starting from 2001 the economies are characterized by relatively stable inflation and exchange rates, and this allows for an examination of whether a relatively stable context reinforces the effect of the monetary policy. The results on different sub-samples are presented in Appendix C.

The analysis of impulse response functions indicates that prices react less to shocks in the nominal depreciation rate after stabilization had been achieved. There is no significant evolution in the interest rate or bank lending channel over the entire period.

5 More on the Interest Rate Channel

5.1 Methodology

The role of the interest rate pass-through is crucial since it represents a potentially important transmission channel, and because other channels of the MTM are related to the performance of this transmission mechanism. However, the results of the VAR estimation in the previous section show that the policy rate does not constitute an effective tool to affect aggregate demand in the economies of Central Asia. In this section, the pass-through from the official interest rates of central banks to other rates is examined.

Despite recent advancements in the regional banking systems, financial intermediation remains weak. This contributes to the weakness of the interest rate channel and, thus, to ineffective credit, asset price, and balance sheet channels.[22]

[22]Financial sectors remain small especially in Kyrgyz Republic and Tajikistan. Tables B 2 and B 3

Moreover, monetary policy operations are very limited in scope and in their ability to affect economic activity.

The key questions about the interest rate pass-through in Kazakhstan, the Kyrgyz Republic and Tajikistan that will be answered in this section are: *(i)* whether the pass-through from official rates to various market rates is complete, and *(ii)* how the reaction of market rates to changes in the key rate changes over time. For the purpose of this investigation, the methodology proposed by Crespo-Cuaresma et al. (2004) is employed.

The data used is of monthly frequency and includes a range of interest rates.[23] Central banks' rates on refinance operations and on repo operations are used as official rates in the investigation.[24] Graph representations of the interest rate time series for the three economies are shown in Appendix D.

High rates on bank loans could reflect the willingness of banks to pay the interest on the deposits, while higher volatility of lending rates might be explained by the presence of credit risk and a credit risk premium. Underdeveloped financial systems and the local banks' constrained capacity to borrow abroad as well as limited competition in the banking sector may also be reasons for much higher loan rates and banks' exposure to credit risk.

The Crespo-Cuaresma et al. (2004) methodology consists in representing the

in Appendix B comprise several financial sector indicators.

[23] Data description is in Table D 1 in Appendix D. Data on interest rates with different maturities is not available for the whole period of investigation in Kyrgyz Republic and Tajikistan.

[24] The choice of refinancing rate as the main policy rate is not completely justifiable, as in the context of transition economies central banks' policies are mostly concerned with absorbing liquidity rather than with providing it. Central bank's deposit rates could constitute a more relevant interest rate for the purpose of the actual study. The data on central banks' deposit rates was not readily available at the time the study was conducted. Using refinance and repo operations rates can nevertheless give important insights about the functioning of the interest rate channel. Central banks' deposit rate can be used in prospective studies on the MTM in Central Asia.

relationship between the policy rate and a given market rate as an autoregressive distributed lag (ARDL) model such as

$$i_t^m = \alpha_0 + \sum_{j=1}^{p} \alpha_j i_{t-j}^m + \sum_{k=0}^{q} \beta_k i_{t-k}^p + \epsilon_t, \tag{2}$$

where i_t^m is the market interest rate, i_t^p is the official rate, which is represented by the official rates of central banks in this study, and ϵ_t is a white noise disturbance with constant variance σ_t. Equation (2) can be rewritten using the lag operator as

$$A(L) i_t^m = \alpha_0 + B(L) i_t^p + \epsilon_t, \tag{3}$$

where

$$A(L) = 1 - \sum_{j=1}^{p} \alpha_j L^j, \text{ and } B(L) = \beta + \sum_{k=0}^{p} \beta_k L^k.$$

The long run relationship between the market rate and the official rate is thus given by

$$i^m = \frac{\alpha_0}{A(1)} + \frac{B(1)}{A(1)} i^p. \tag{4}$$

The error correction (EC) representation of equation (2) can be written as

$$\Delta i_t^m = \delta_0 + \sum_{j=1}^{p-1} \mu_j \Delta i_{t-j}^m + \sum_{k=0}^{q} \kappa_k \Delta i_{t-k}^p + \gamma (i_{t-1}^m - \lambda i_{t-1}^p) + \epsilon, \tag{5}$$

where the term in brackets represents the long run equilibrium. All the data series were subject to the unit root test through an ADF procedure. Due to the existence of a unit root in the autoregressive representation of some series included in the analysis,

γ is interpreted as the speed of adjustment to the cointegration relationship given by equation (4).

To choose the lag length in the ARDL representation, certain selection criteria can be used. The most standard are the Schwarz Bayesian Criterion (SBC) and the Akaike Information Criterion (AIC). The more an identified model fits the data, the lower the AIC and SBC will be. As the fit of the model improves, the AIC and SBC will approach $-\infty$. These criteria can be used to select the most appropriate model; one model is said to fit better than another model if AIC or SBC for the first model is smaller than for the second model.[25]

To examine whether there is any change in the elasticity between different market rates and the official rate over the whole period, the time span is divided into the same subsamples as in the VAR estimation in the previous sections.

5.2 Empirical Results: Interest Rate Pass-Through in the Central Asian Economies

Table D 2 in Appendix D displays the results of the estimation of the interest rate channel for the three countries. The results show estimators of the long run multiplier and the speed of adjustment, λ and γ, respectively. The lag length of the ARDL models was chosen so that the Schwarz information criterion is minimized. All the estimations were preformed including a policy rate and a given market rate. For each

[25]Koehler and Murphree (1988) study the identification abilities of both criteria, applying them to real time series in forecasting models. They found that the AIC and BIC indicate different results in choosing model orders in 27 percent of cases. The authors compare the accuracy of the cases where both criteria indicate the same results, and they conclude that it is preferable to use the SIC, which leads to a lower order model for forecasting.

Another study by Neftci (1982) also showed that both AIC and SBC criteria can choose different order models. The authors established that Schwarz' criterion usually would favor a lower dimensional model.

chosen specification, a full interest rate pass-through, corresponding to the restriction $\lambda = 1$, was tested.

In the case of the Kyrgyz Republic, a nearly complete pass-through is exhibited in the case of interbank money rates, i.e. an increase in the policy rate by 1 percent leads to an increase in interbank rates by 0.99 percent. The average household deposit rates exhibit close to a complete pass-through coefficient. There is evidence of an overshooting effect of lending rates and lombard rates. This effect is rather significant, and could be explained by the overreaction of creditors to rising interest rates in the economy in order to hedge their credit risks in the face of uncertainty and underdeveloped financial markets.

The second coefficient of interest, γ, constitutes an adjustment coefficient of the given retail rate to the deviations of the financial markets from equilibrium in the long run. High statistical significance of the adjustment coefficients confirm that the error correction term belongs to the specification chosen. The diagnostic tests of the estimated residuals show no autocorrelation and homoscedasticity among residuals. This is a sign of the robustness of the chosen specification.

To check how the pass-through has evolved over time, the period was divided into two sub-periods. The results of these analysis are shown in Appendix D in Tables D 3 – D 5. The recent period in Kyrgyz Republic is characterized by a higher responsiveness of interbank market rates and average deposit rates to shocks in the policy rate. The reaction of the lombard rates has somewhat decreased. In the case of lending rates, the coefficient estimated shows that the lending rates would grow by more than 5 percent if the key rate is increased by 1 percent. This result would be evidence that no regular relationship exists between the official rates of the central bank and the lending rates charged by the commercial banks.

In the case of Kazakhstan, all rates exhibit an overshooting effect in reaction to changes in the policy rate. Average interest rates on credits by commercial banks appear to be cointegrated with the central bank's rate if the year 1998 is excluded from the sample. This can be explained by the significant effect of the financial crisis in Russia on the economy of Kazakhstan after August 1998. Excluding the financial crisis period from the sample helps to find the cointegration between different rates and the policy rate. The lending rate changes overshoot the changes in the policy rate almost twice. This might be caused by the desire of banks to hedge themselves from the credit risks and to be able to pay the interest rates to households on their deposit accounts.

Another explanation could be a greater integration of Kazakhstan into foreign financial markets, which makes local market rates more sensitive to external shocks. A high degree of dollarization, especially the rising amount of deposits and credits denominated in foreign currency, could also possibly affect the ability of the central bank to influence the domestic financial market rates. A robustness check illustrates that market rates still tend to overshoot changes in the policy rate in the recent period. In the case of household deposits with maturity from 3 months to 1 year, the pass-through has declined and constitutes 0.95 percent.

The estimated adjustment coefficients are only statistically significant in the case of lending rates. Moreover, when the period from 1996 to 2000 is examined, no cointegration is found between the key rate and other rates in the economy.

The results for Tajikistan are rather contradictory, as no cointegration was established between the central bank's refinance rate and the deposit and lending rates. This could be explained by the short time series, structural breaks in the data, and the general economic context of the country. The only rate cointegrated with the official rate is the money market rate. It is not only cointegrated but also exhibits a

near complete pass-through, which also occurs in the more recent period. The results obtained should be taken only as suggestive, since the data available cover a relatively short period of time. Moreover, due to political unrest, the economy of Tajikistan was in a distress for a longer period than its neighbors. This situation explains why financial sector development in this country lags behind that of other transition economies the region.

6 Conclusion

This paper studies monetary policy transmission in the transition economies of Central Asia. Monetary policy should have gained more importance in these emerging market economies given the recent advances and economic developments in the region. Certain factors have, however, impeded the effective conduct of monetary policy. A significant level of dollarization and financial sector underdevelopment both pose serious obstacles to the smooth functioning of monetary transmission channels in these countries.

The present study has established that the exchange rate pass-through is the strongest channel of MTM in all three economies. The stabilization period brought a decline to the exchange rate channel to prices, but this pass-through still represents a major force affecting the price level. This decline is reflected in a smaller magnitude of the reaction function of prices to the exchange rate shocks. The decline can be explained by several factors, such as less volatility of exchange rates and prices, more resilience of the economies to external shocks, and possibly more vigilant policies of central banks in maintaining exchange rate stability.

Empirical results show that changes in interest rates have little effect on prices or output, i.e. the interest rate channel has been weak.

The high degree of dollarization in these economies is a likely explanation for the sizable effect of the ERPT and a weak interest rate channel. In heavily dollarized economies, the scope for an independent interest rate policy can be limited. Central banks are constrained in their ability to control domestic interest rates that appear to be influenced by interest rates on dollar denominated assets. The analysis of the completeness of the interest rate channel has, however, confirmed the nearly complete pass-through from official rates to other interest rates. Limited real effects of the interest rate policy found in the empirical investigation might be related to weak financial intermediation and low sensitivity of economic agents to changes in the cost of borrowing.

The credit channel has proved to have a very small effect on prices, while a positive shock to credit growth would bring more volatility in output. The cyclical behavior in output growth rate after a credit shock - it falls following the shock and recovers within the next few months - is difficult to interpret and thus should be considered with caution.

Shocks to the money supply appear to have tangible effects on output and prices. Including foreign currency components into the definition of money can help to establish a stronger relationship between prices and money. Overall, the empirical analysis confirms the results of previous studies' regarding monetary transmission in transition and developing economies as having a dominant exchange rate pass-through and a weak interest rate channel.

In terms of policy implications, further development of financial sectors in the Central Asian countries is necessary. Deeper financial markets, developed financial intermediation, and competition should promote the effectiveness of the interest rate and credit channels of monetary transmission. Maintaining financial stability in turn

should restore the public's confidence in the local currency. Dollarization and currency substitution pose less risk of financial instability in a fundamentally stable economic environment.

A valuable extension to the present study would include a rate of crawl as a policy variable used by central banks in the region. Rate of crawl is the rate at which central banks periodically adjust the exchange rate in response to changes in selective quantitative indicators. Exchange rate regimes in Central Asian economies are described as managed floating rates with no predetermined path for the exchange rate. The central banks do, however, adjust the exchange rate whenever it is necessary to support the stability of national currencies and to keep competitiveness vis-à-vis their major trade partners. Including this new variable could contribute to a better understanding of monetary policy developments and improve the interpretability of the empirical results.

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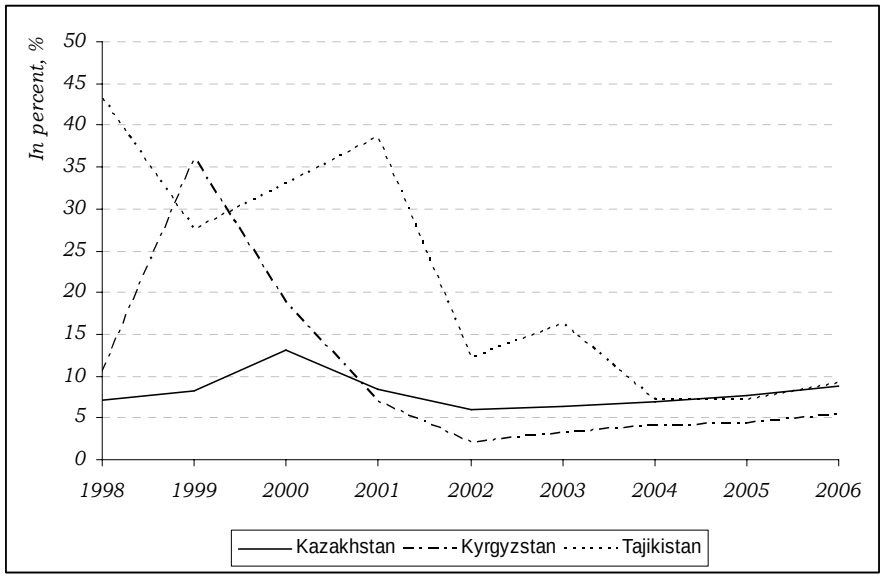
APPENDIX A

Table A 1. Data Description

Series	Time span	Number of obs.	Source
	Kyrgyz Republic		
Consumer Price Index *(in percent*)	1995:9 till 2006:12	136	IMF
Producer Price Index (*in percent*)	1995:9 till 2006:12	136	IMF
Monetary aggregates (money and broad money) (*in mln soms*)	1995:9 till 2006:12	136	IMF
Credit (in mln soms)	1996:1 till 2006:12	132	NBKR
Industrial Production *(in mln soms*)	1995:9 till 2006:12	136	NSC
Rate on repo operations of the NBKR (*in percent*)	1995:9 till 2006:12	136	Global Financial Data
Nominal exchange rate (som to U.S. dollar) *(in soms*)	1995:9 till 2006:12	136	IMF
	Kazakhstan		
Consumer Price Index *(in percent*)	1995:1 till 2006:12	144	IMF
Producer Price Index (*in percent*)	1995:1 till 2006:12	144	IMF
Monetary aggregates (money and broad money) (*in mln tenge*)	1995:1 till 2006:12	144	IMF
Credit (in mln tenge)	1996:1 till 2006:12	132	NBK
Industrial Production Index *(in percent)*	1995:1 till 2006:12	144	Statistical Agency
Refinancing Rate of the National Bank	1995:1 till 2006:12	144	Global Financial Data
Nominal exchange rate (tenge to U.S. dollar) *(in tenge*)	1995:1 till 2006:12	144	IMF
	Tajikistan		
Consumer Price Index *(in percent*)	2000:1 till 2006:12	96	NBT
Producer price Index *(in percent)*	2000:1 till 2006:12	96	NBT
Monetary aggregates (money and broad money) (*in mln somoni*)	2000:1 till 2006:12	96	IMF
Credit (in thousand somoni)	2000:1 till 2006:12	96	NBT
Industrial Production *(mln somoni*)	2000:1 till 2006:12	96	State Statistical Committee
Official Rate of the NBT (*in percent*)	2000:1 till 2006:12	96	NBT
	External Sector Variables		
Oil price (U.S. dollars per barrel)	1995:1 till 2006:1	144	Global Financial Data
Gold Price (U.S. dollars per ounce)	1995:1 till 2006:12	144	Global Financial Data
Cotton Price Index (Year 2000 = 100)	2000:1 till 2006:12	96	UNCTAD Handbook of Statistics
Federal Funds Rate (*in percent)*	1995:1 till 2006:12	144	Global Financial Data

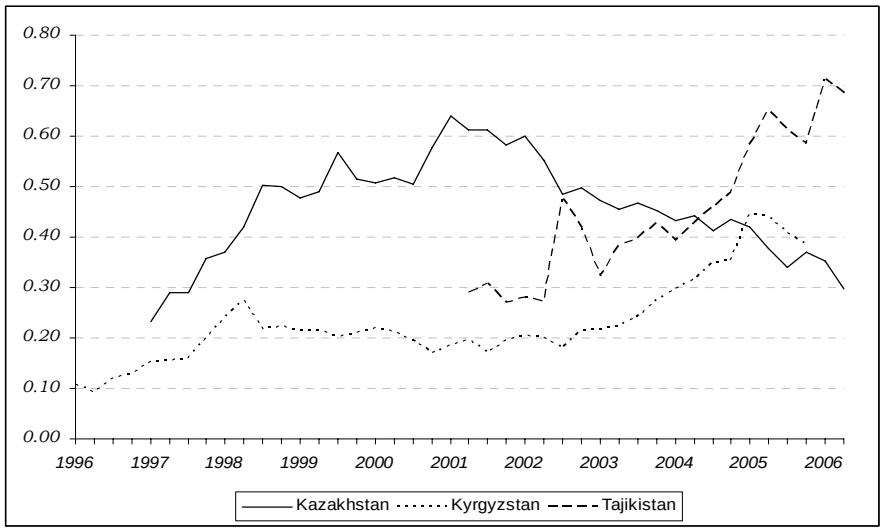
APPENDIX B Inflation and Dollarization

Figure B 1. Inflation in Central Asia



Source: EBRD Transition Report 2006

Figure B 2. Dollarization Indices in Central Asia



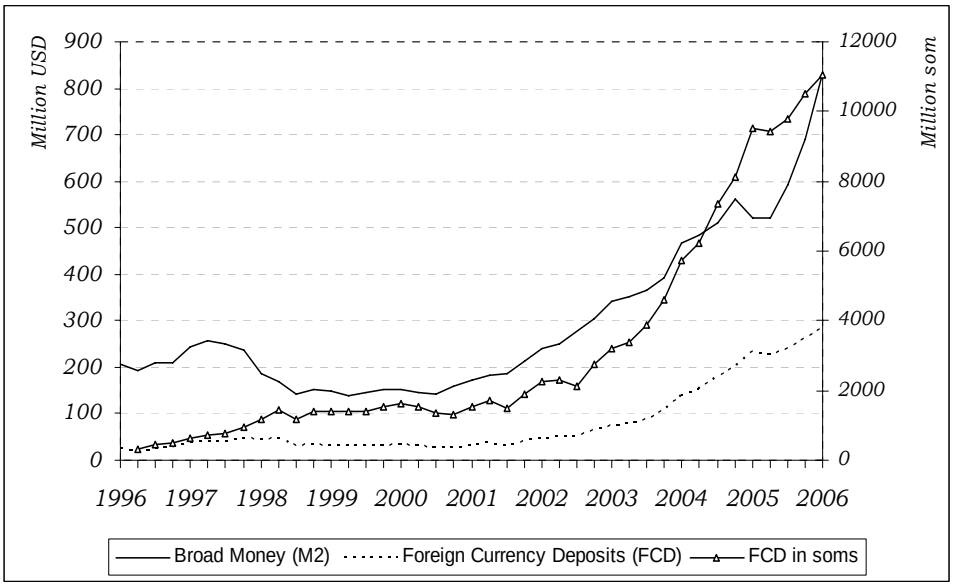
Source: Data from National banks, IMF.

Notes. 1. Author computations (Dollarization Index (DI) = Foreign Currency Deposits (FCD)/Broad Money (M2))

2. Data on deposits in Tajikistan is only available from 2002

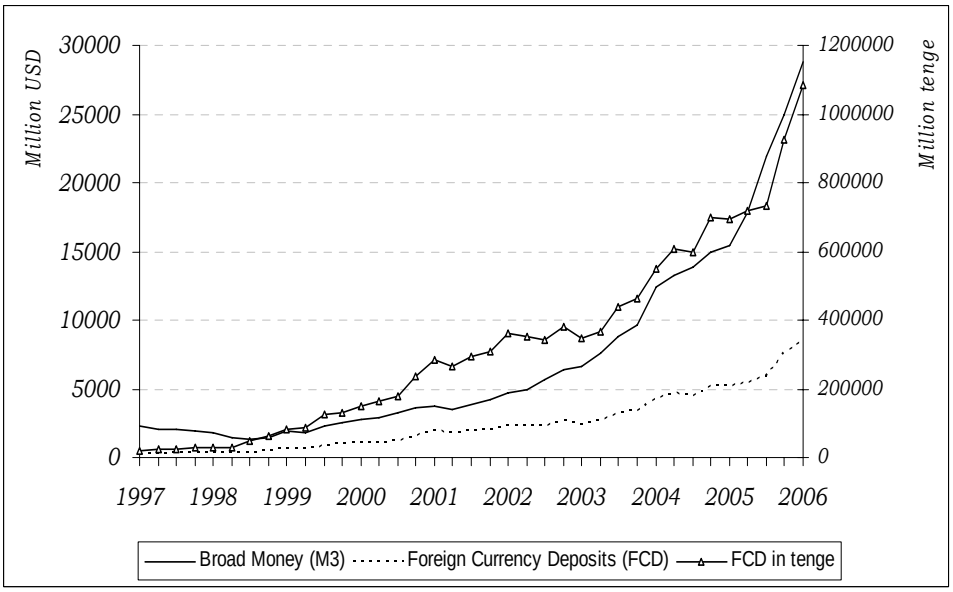
Figure B 3. Foreign Currency Deposits Measured in Local Currencies and U.S. dollars

a) Kyrgyz Republic



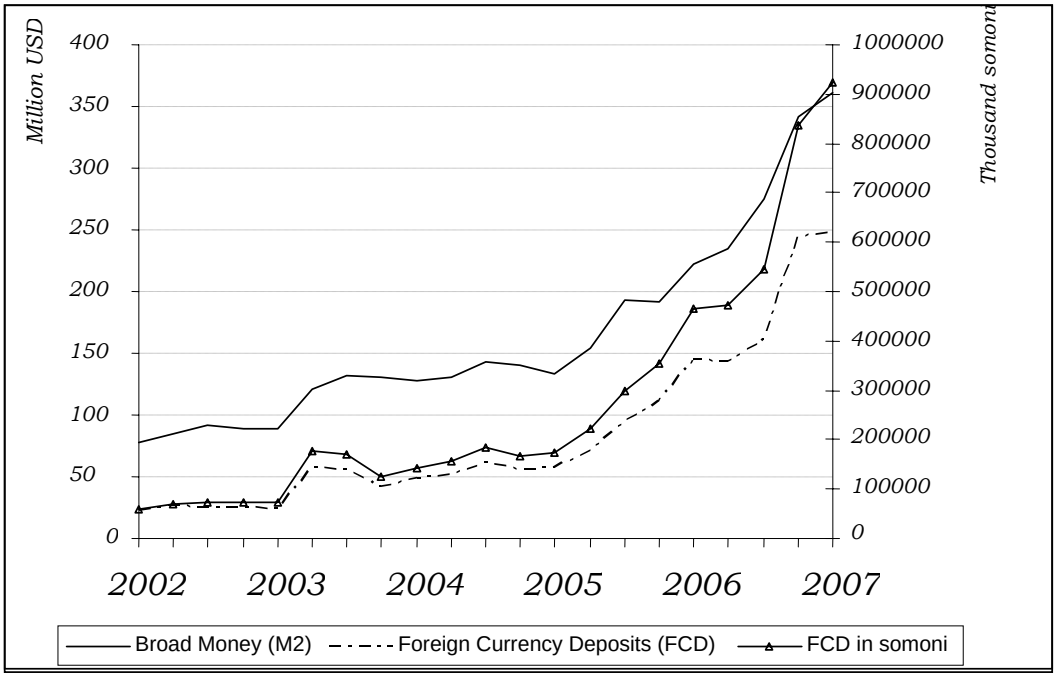
Source: National Bank of Kyrgyz Republic

b) Kazakhstan



Source: National Bank of Kazakhstan

c) Tajikistan



Source: National Bank of Tajikistan

Table B 1. Capital Inflows in Central Asia

	1998	1999	2000	2001	2002	2003	2004	2005	2006
Remittances* (mln. USD)									
Kazakhstan	72	64	122	171	205	147	166	178	187
Kyrgyz Republic	25	18	9	11	37	78	189	322	481
Tajikistan	…	…	…	…	79	146	252	467	1019
FDI (mln. USD)									
Kazakhstan	1143	1468	1278	2861	2164	2213	5436	2123	6630
Kyrgyz Republic	87	38	-7	-1	5	46	132	43	182
Tajikistan	25	21	24	10	36	32	272	55	66

Source: * World Bank Migration and Remittances Factbook, 2008
** EBRD Transition Report, 2006: Finance in Transition

Table B 2. Selected Financial Indicators

	M2/GDP	Bank assets/GDP	Bank deposits/GDP	Bank credit to private sector
Kazakhstan	26.6	63.3	25.6	26.7
Kyrgyz Republic	21.3	51.3	9.2	6.2
Tajikistan	7.0	20.7	8.9	12.9
Armenia	16.4	20.2	10.7	8.2
Azerbaijan	18.0	26.8	12.7	9.1
Estonia	29.5	112.6	44.8	60.0
Latvia	23.1	123.2	36.7	60.1
Czech Rep.	69.8*	99***	56***	36**
Hungary	49.9*	80***	34***	50**
Poland	44*	61***	34***	29**

Notes. Figures are taken from Dabla-Norris and Florkemeier (2006) with data for 2005 if not specified otherwise.

Other sources:

* IFS, World Bank Financial Indicators

** EBRD Transition Report 2007 (data for 2005)

*** National Banks

Table B 3. Credit Growth in Selected Transition Economies

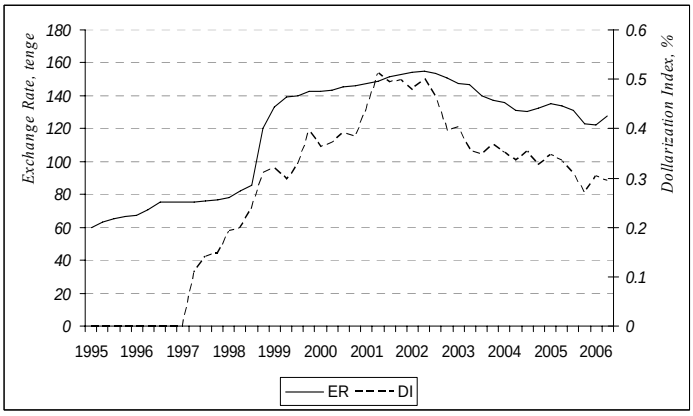
	Credit growth Average 2001-05	Credit to GDP	
		2001	2005
Kazakhstan	56.9	16.8	38.1
Kyrgyz Republic	26.7	3.8	7.8
Tajikistan*	18.1	-	17.8
Armenia	13.8	7.8	8.6
Azerbaijan	33.8	5.0	9.1
Bulgaria	41.0	14.9	45.0
Czech Republic	1.7	39.6	36.6
Romania	42.5	7.7	11.7
Russia	43.6	16.5	26.0
Ukraine	47.7	12.9	33.6

Source: IMF Staff Report, 2006

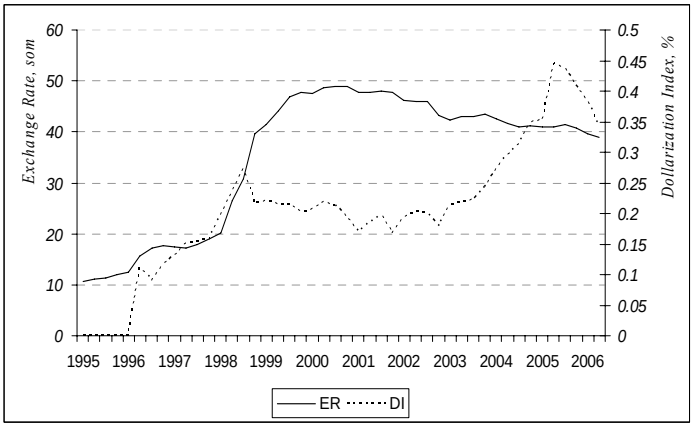
* Author's estimation

Figure B 5. Foreign Exchange Rate (national currency/USD) and Dollarization Index

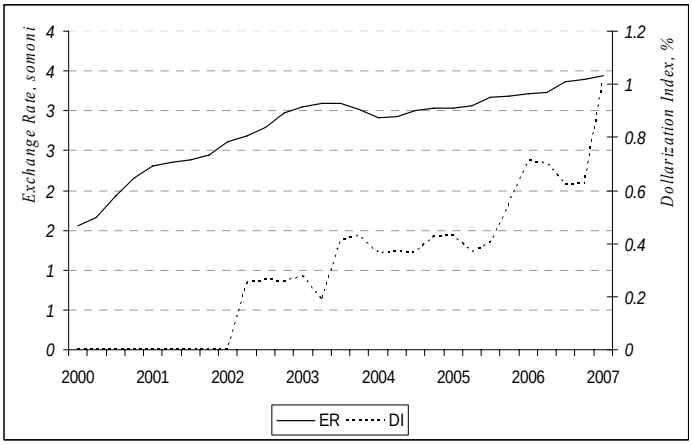
a) Kazakhstan



b) Kyrgyz Republic



c) Tajikistan

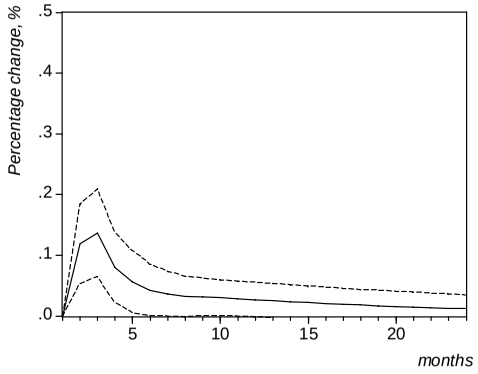


APPENDIX C VAR estimation results

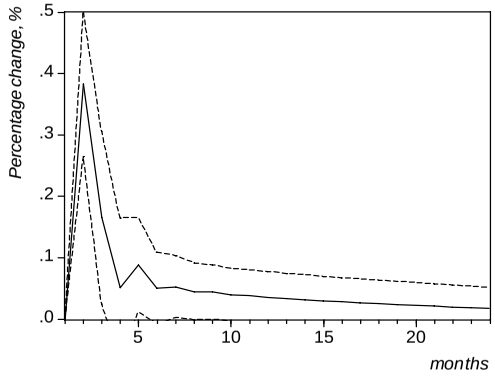
Figure C 1. Response of CPI Inflation Rate to One Percentage Change in Nominal Depreciation Rate

a) Kyrgyz Republic

CPI

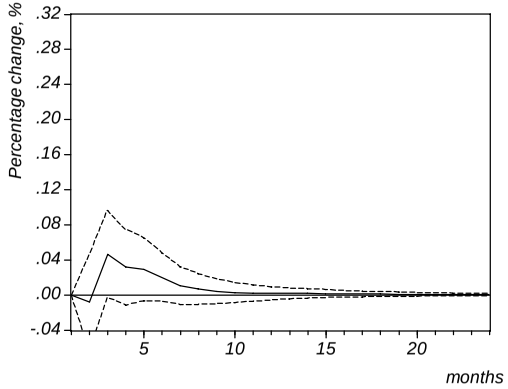


PPI

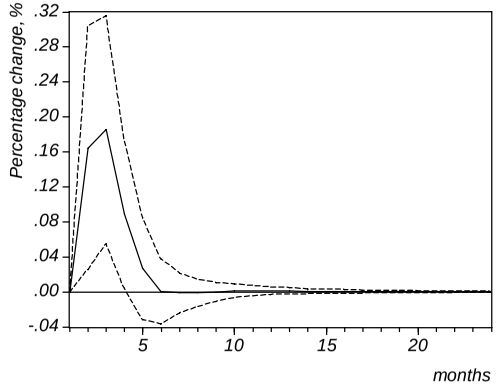


b) Kazakhstan

CPI

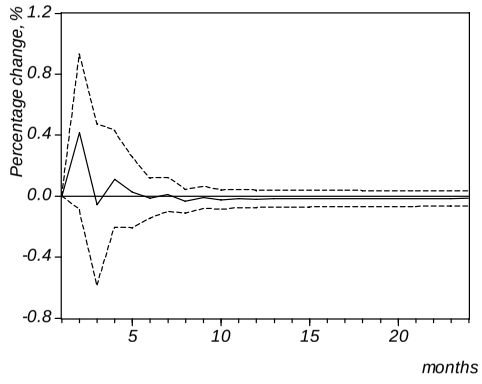


PPI



c) Tajikistan

CPI



PPI

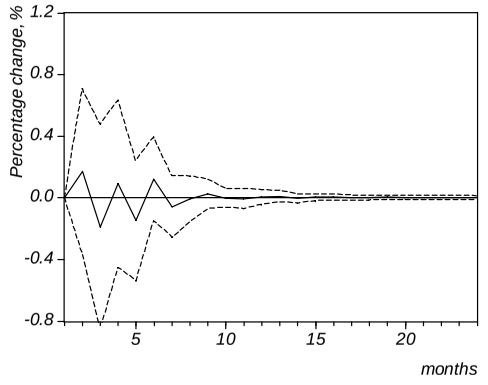
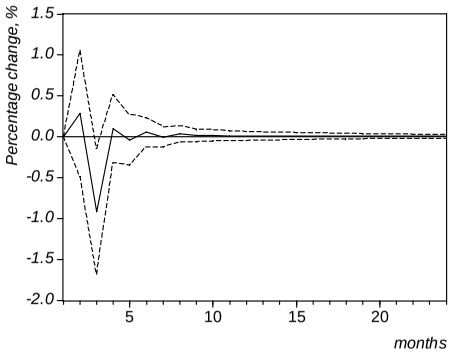
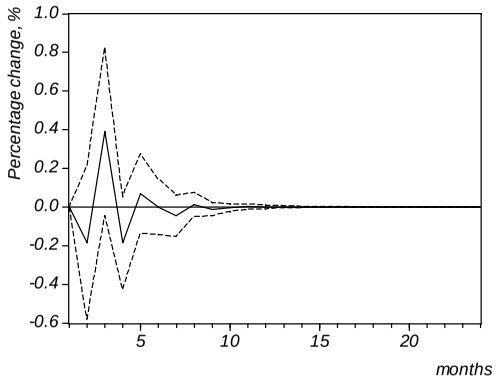


Figure C 2. Response of Output Growth Rate to One Percentage Change in Nominal Depreciation Rate

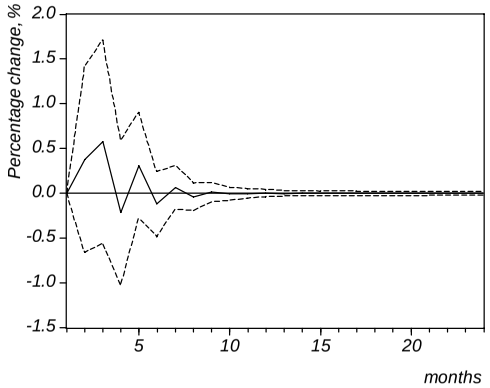
a) Kyrgyz Republic
VAR with money



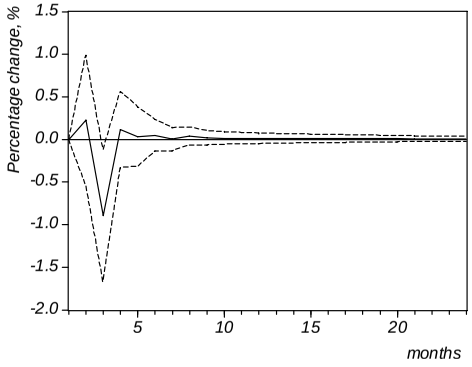
b) Kazakhstan
VAR with money



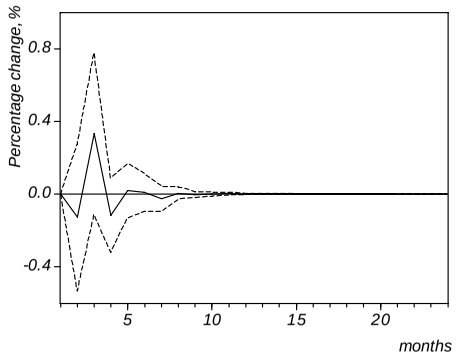
c) Tajikistan
VAR with money



VAR with broad money



VAR with broad money



VAR with broad money

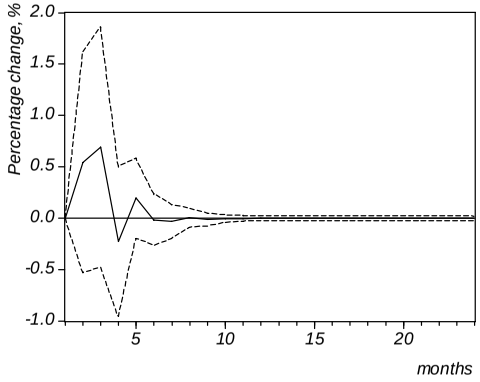
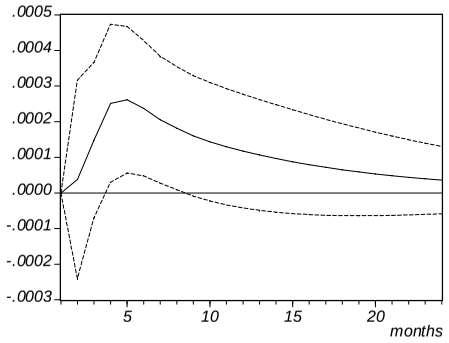
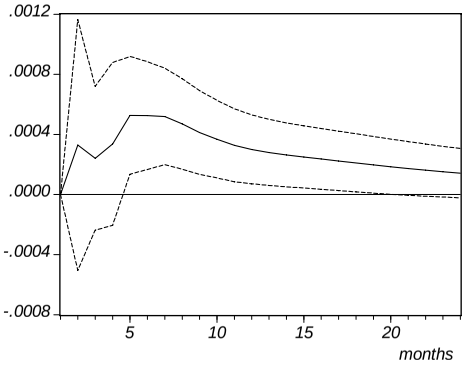


Figure C 3. Response of CPI Inflation Rate to Shocks in the Official Rate (VAR with CPI and money)

a) Kyrgyz Republic



b) Kazakhstan



c) Tajikistan

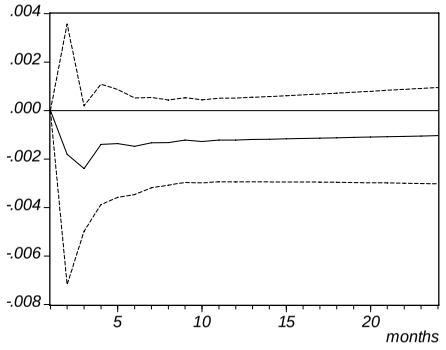
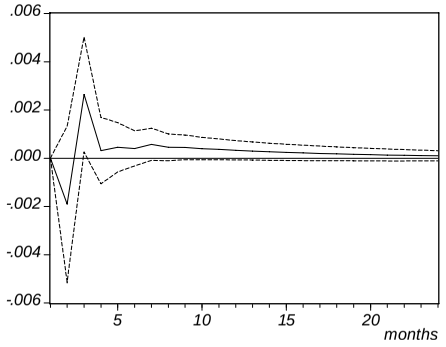
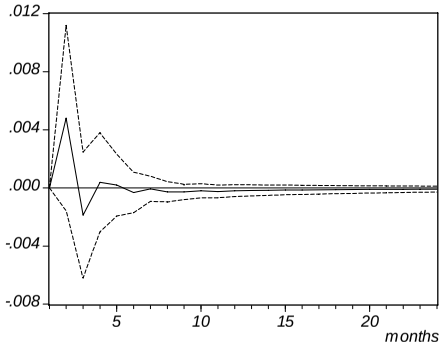


Figure C 4. Response of Output Growth to Shocks in the Official Rate (VAR with CPI and money)

a) Kyrgyz Republic



b) Kazakhstan



c) Tajikistan

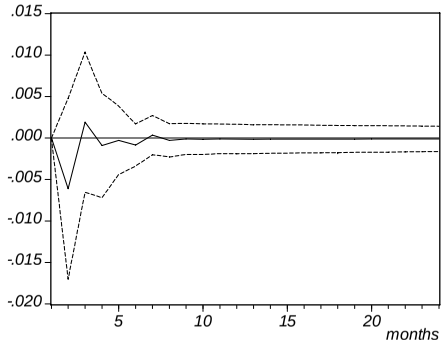
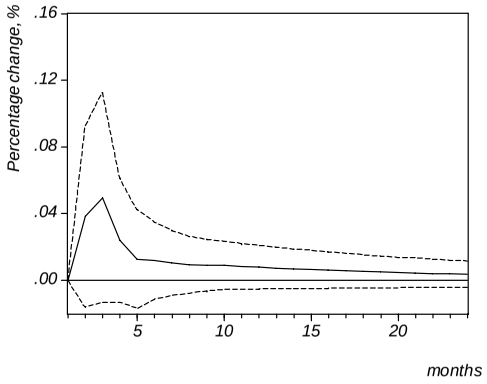


Figure C 5. Response of CPI Inflation Rate to Changes in Money Growth Rate

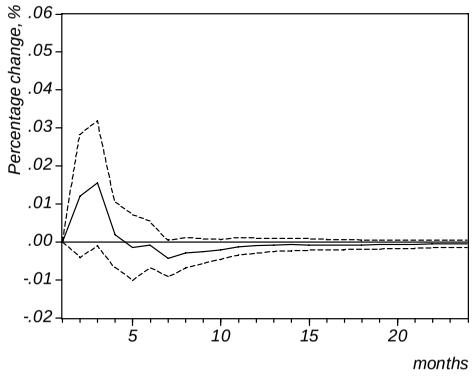
a) Kyrgyz Republic

VAR with money



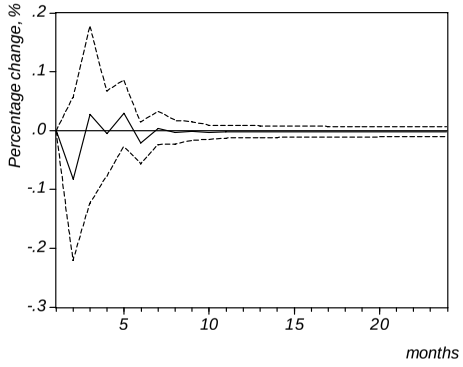
b) Kazakhstan

VAR with money

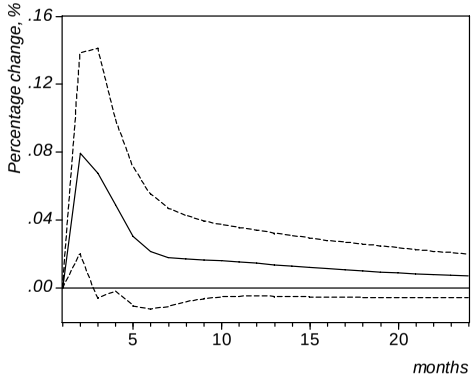


c) Tajikistan

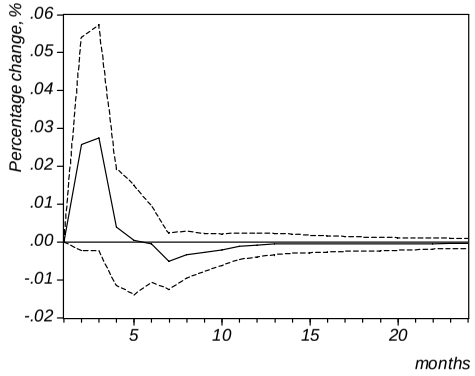
VAR with money



VAR with broad money



VAR with broad money



VAR with broad money

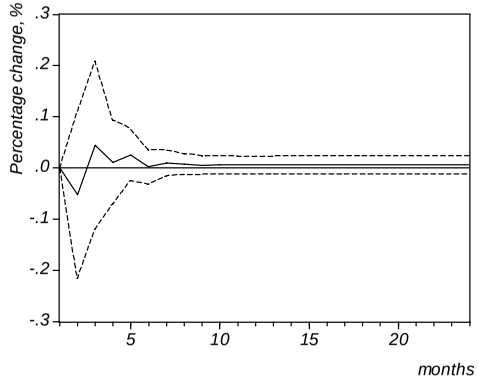
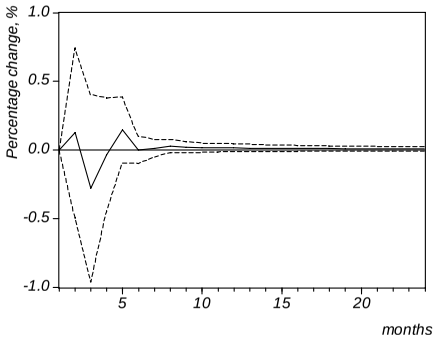
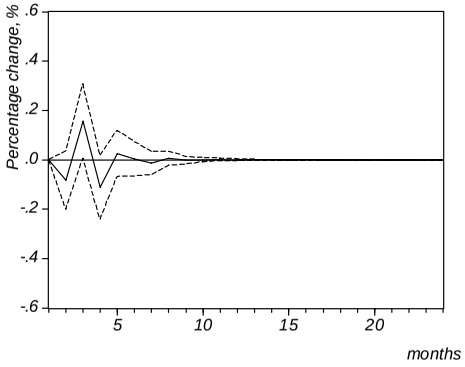


Figure C 6. Response of Output Growth Rate to Shocks in Money Growth Rate (VAR with CPI)

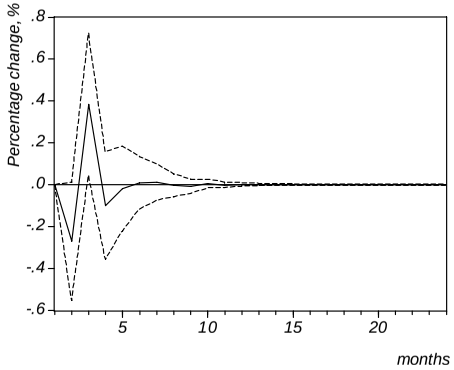
a) Kyrgyz Republic
VAR with money



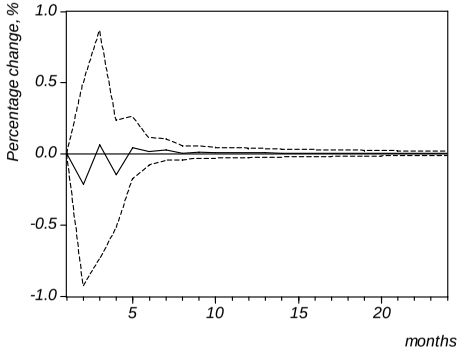
b) Kazakhstan
VAR with money



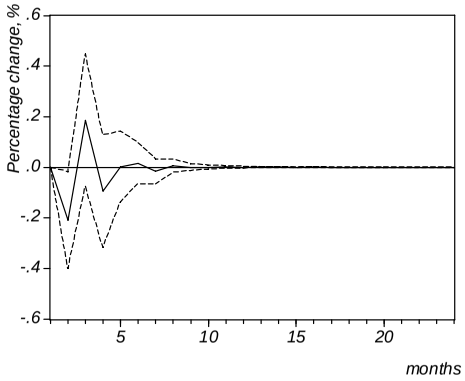
c) Tajikistan
VAR with money



VAR with broad money



VAR with broad money



VAR with broad money

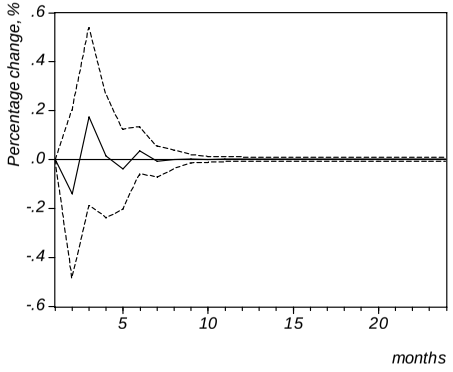
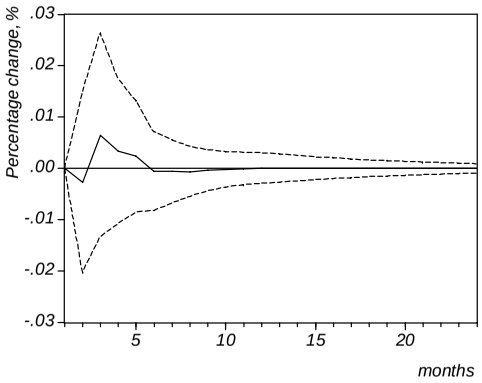
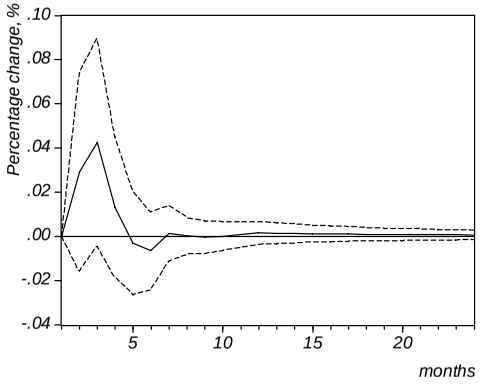


Figure C 7. Response of CPI Inflation Rate to Shocks in Credit Growth

a) Kyrgyz Republic



b) Kazakhstan



c) Tajikistan

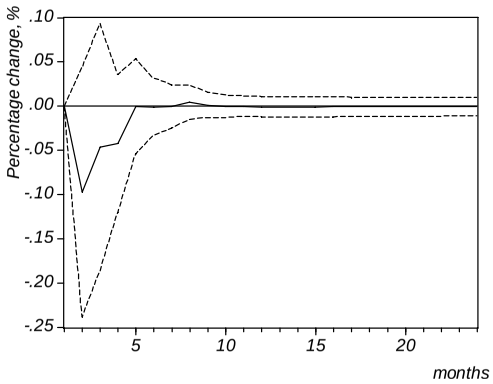
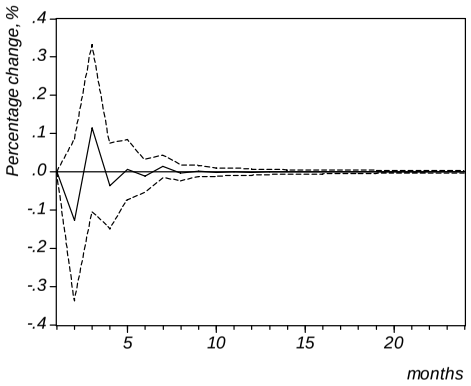
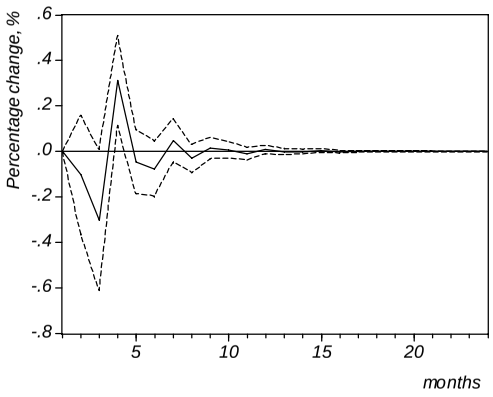


Figure C 8. Response of Output Growth Rate to Shocks in Credit Growth

a) Kyrgyz Republic



b) Kazakhstan



c) Tajikistan

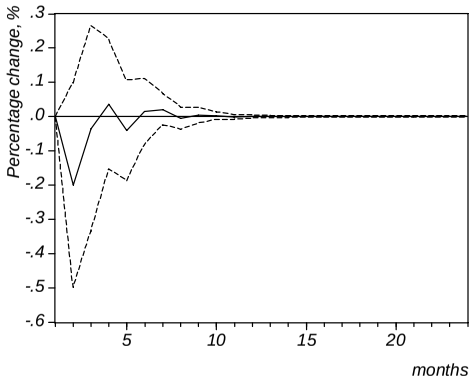
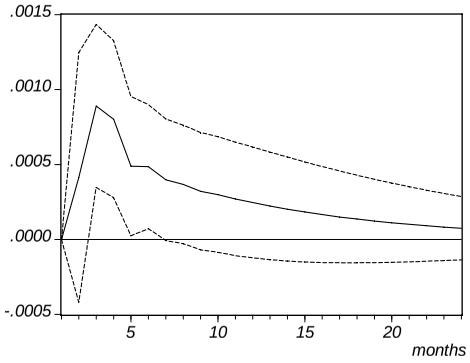
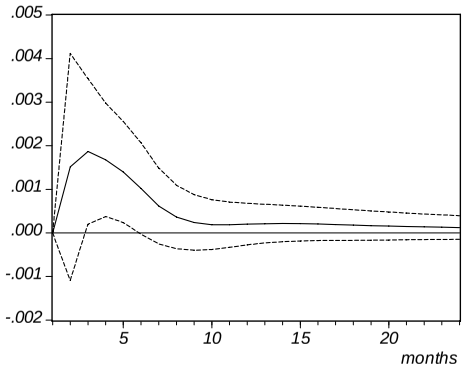


Figure C 9. Response of the Exchange Rate to Shocks in the Official Rate

a) Kyrgyz Republic



b) Kazakhstan



c) Tajikistan

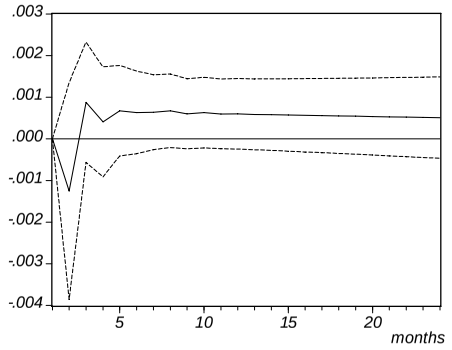
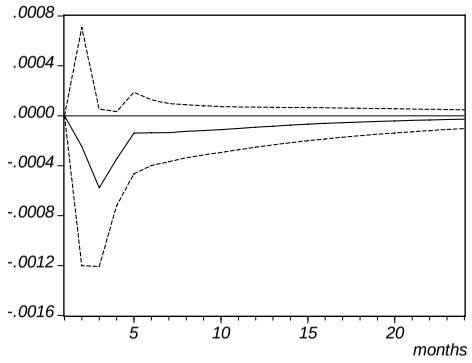
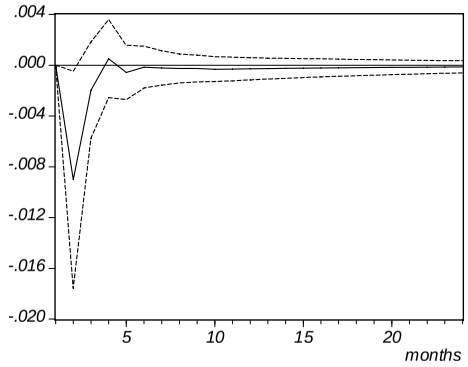


Figure C 10. Response of the Money Growth Rate to Shocks in the Official Rate

a) Kyrgyz Republic



b) Kazakhstan



c) Tajikistan

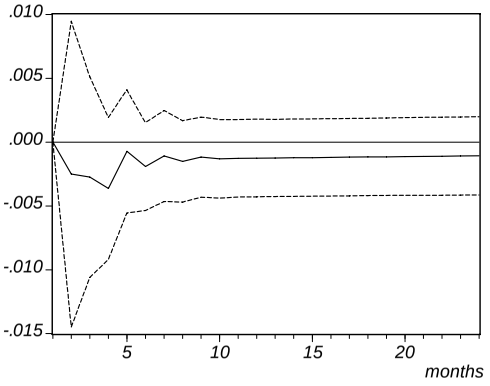
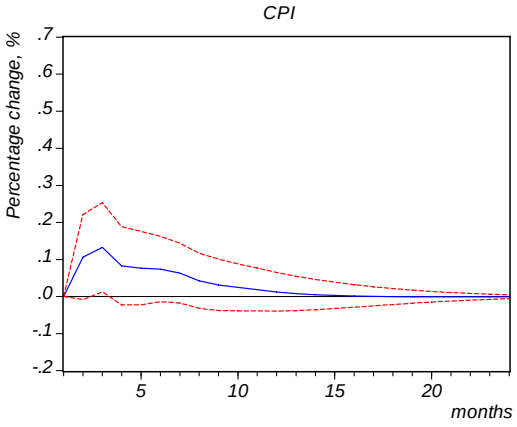
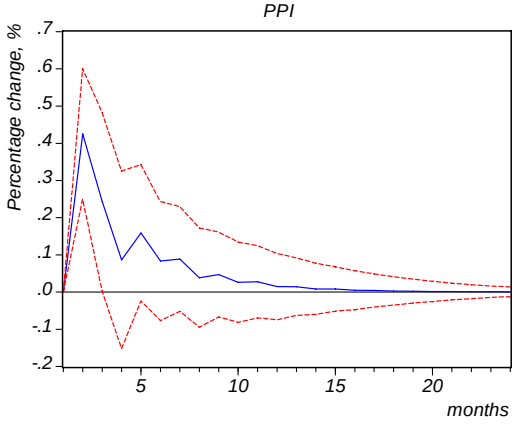


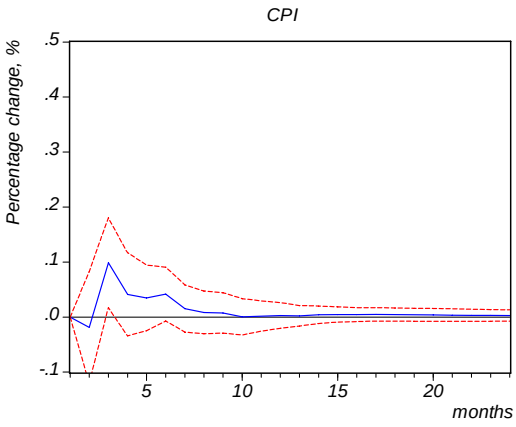
Figure C 11. Response of CPI Inflation Rate to One Percentage Change in Nominal Depreciation Rate (Period 1996:1 to 2000:12)

a) Kyrgyz Republic





b) Kazakhstan



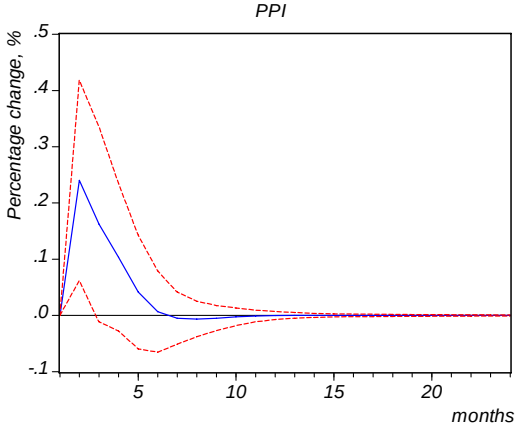
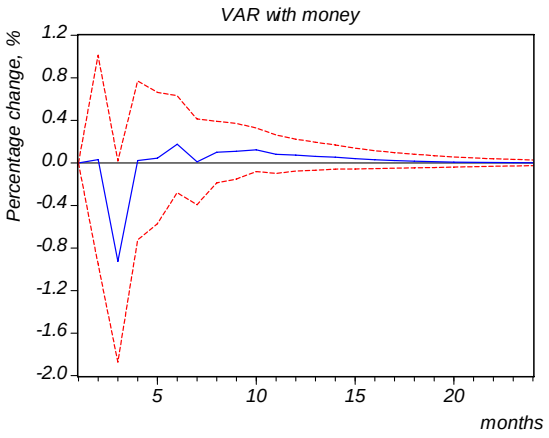
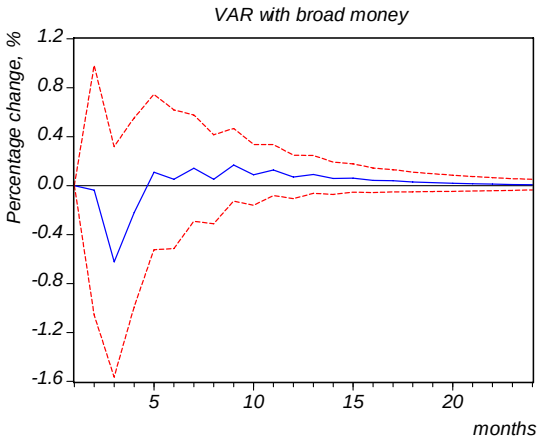


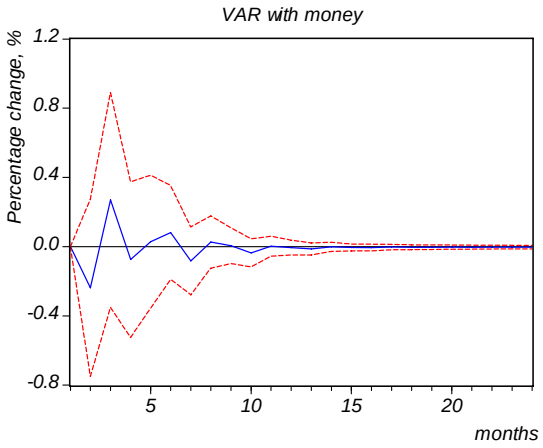
Figure C 12. Response of Output Growth Rate to One Percentage Change in Nominal Depreciation Rate (Period 1996:1 to 2000:12)

a) Kyrgyz Republic





b) Kazakhstan



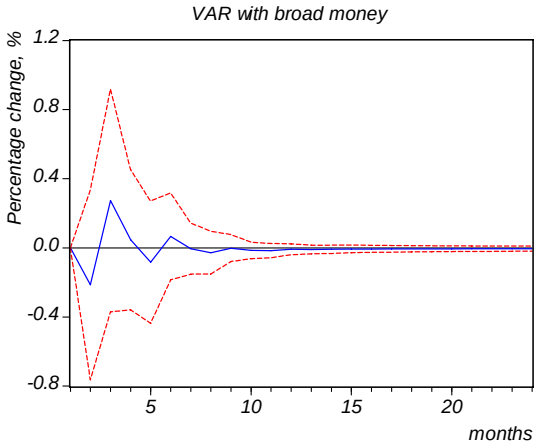
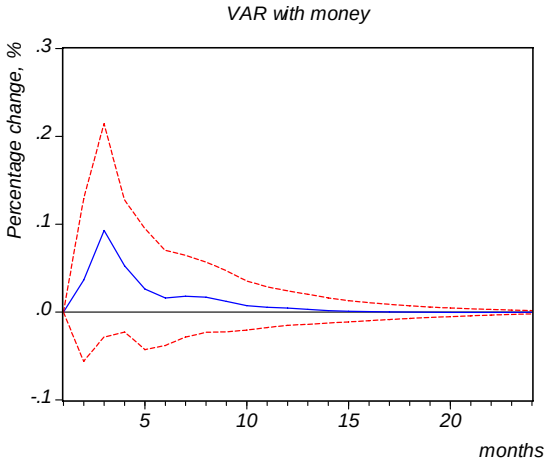
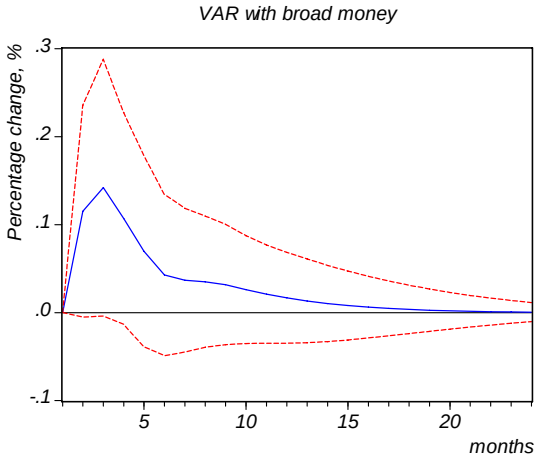


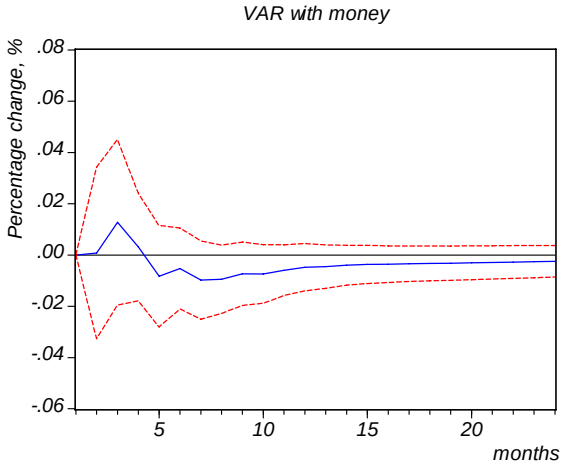
Figure C 13. Response of CPI Inflation Rate to Changes in Money Growth Rate (Period 1996:1 to 2000:12)

a) Kyrgyz Republic





b) Kazakhstan



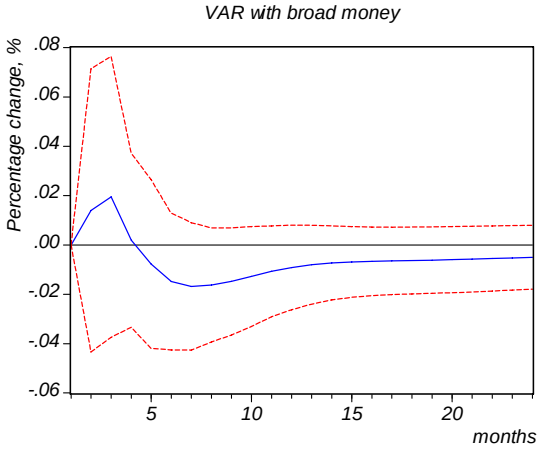
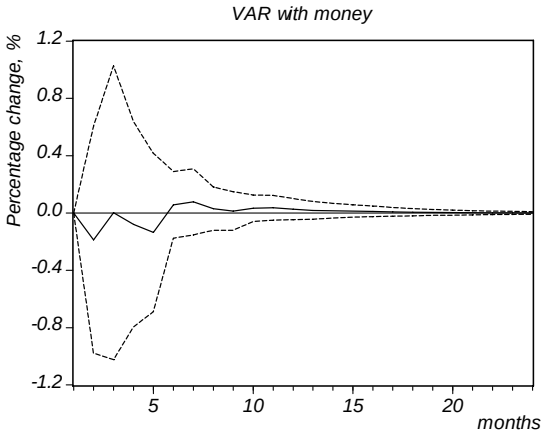
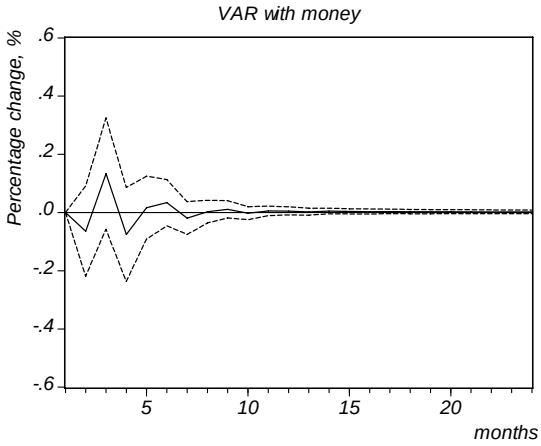


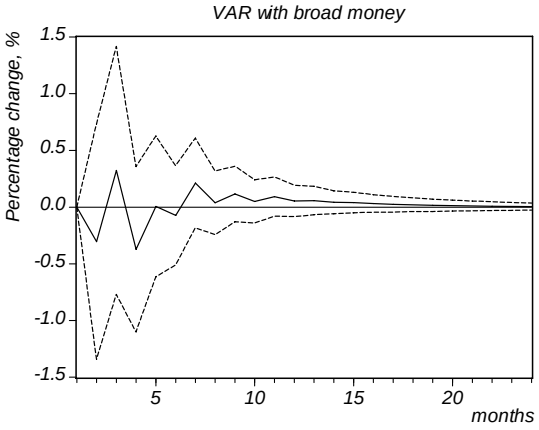
Figure C 14. Response of Output Growth Rate to Shocks in Money Growth Rate (VAR with CPI) (Period 1996:1 to 2000:12)

a) Kyrgyz Republic



b) Kazakhstan





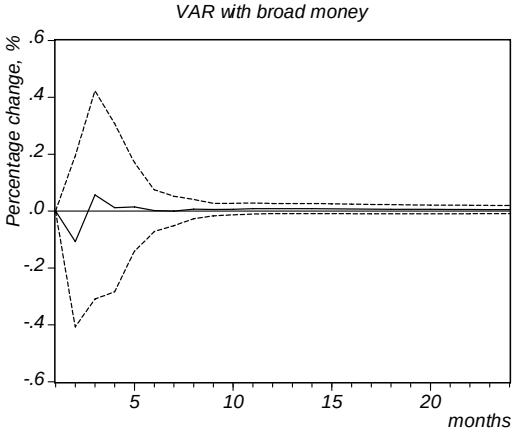
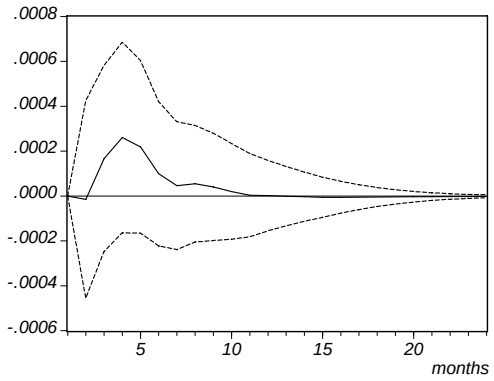


Figure C 15. Response of CPI Inflation Rate to Shocks in the Official Rate (VAR with CPI and money) (Period 1996:1 to 2000:12)

a) Kyrgyz Republic



b) Kazakhstan

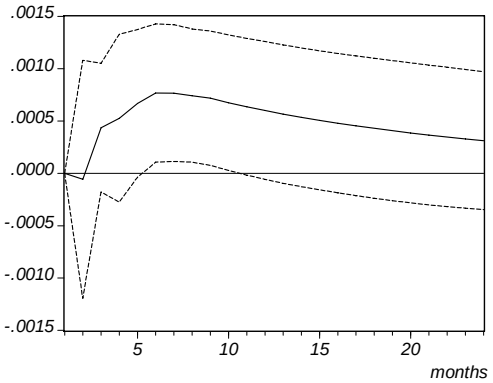
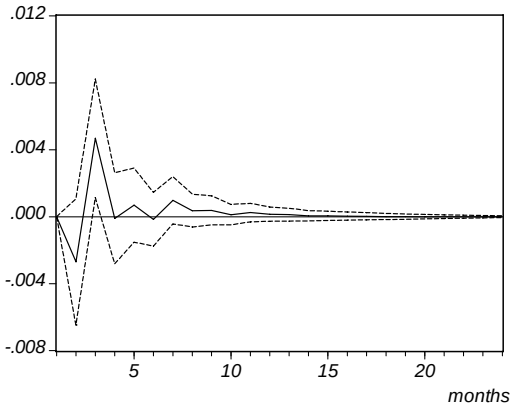


Figure C 16. Response of Output Growth to Shocks in the Official Rate (VAR with CPI and money) (Period 1996:1 to 2000:12)

a) Kyrgyz Republic



b) Kazakhstan

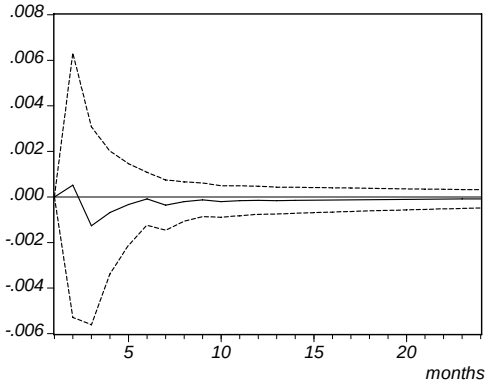
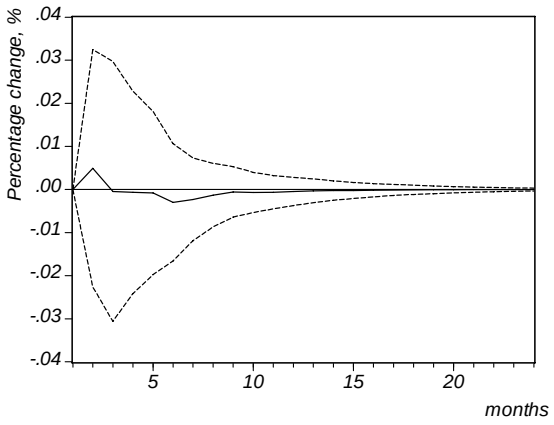


Figure C 17. Response of CPI Inflation Rate to Shocks in Credit Growth (Period 1996:1 to 2000:12)

a) Kyrgyz Republic



b) Kazakhstan

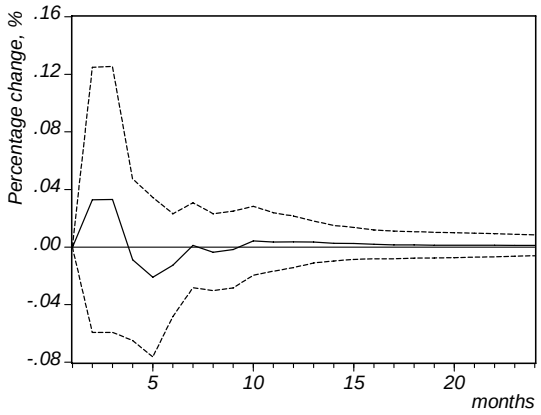
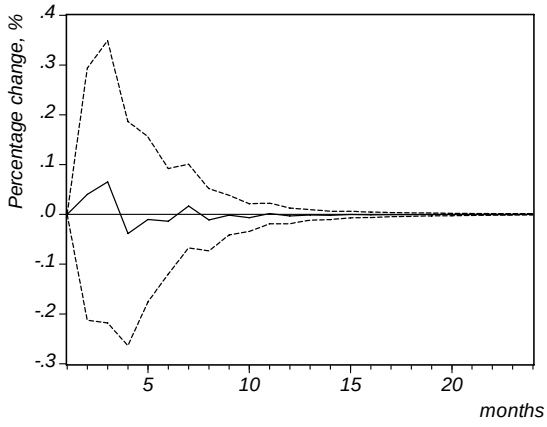


Figure C 18. Response of Output Growth Rate to Shocks in Credit Growth (Period 1996:1 to 2000:12)

a) Kyrgyz Republic



b) Kazakhstan

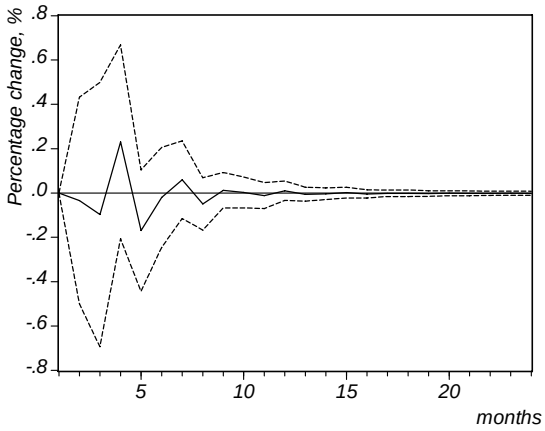
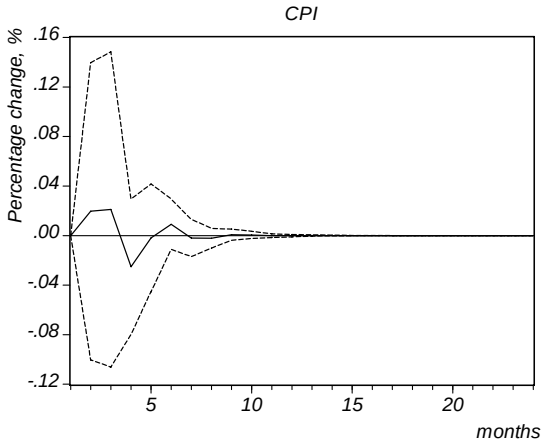
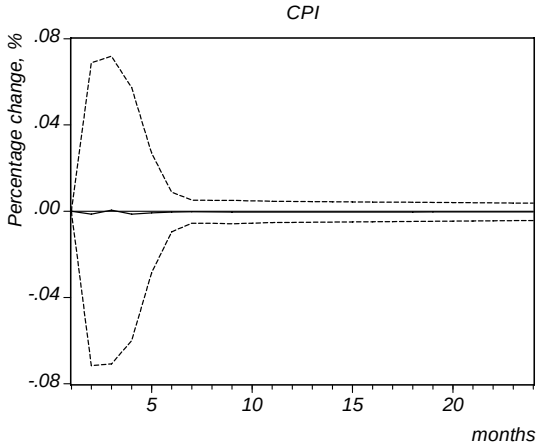


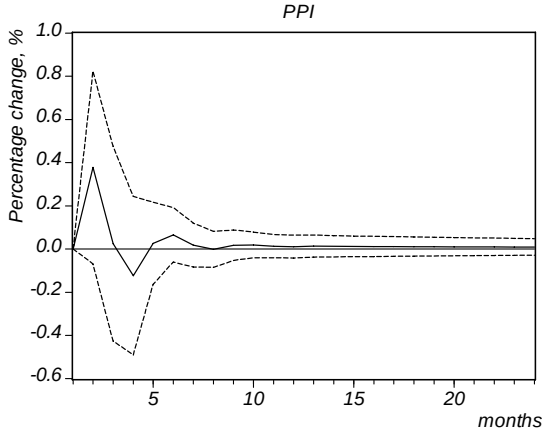
Figure C 19. Response of CPI Inflation Rate to One Percentage Change in Nominal Depreciation Rate (Period 2001:1 to 2006:12)

a) Kyrgyz Republic



b) Kazakhstan





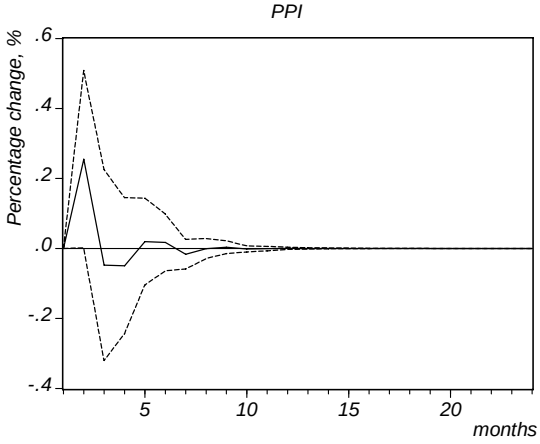
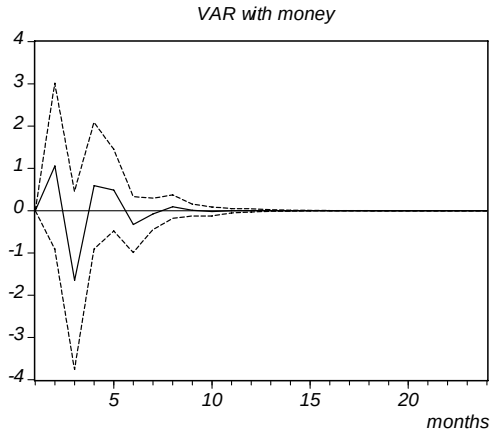
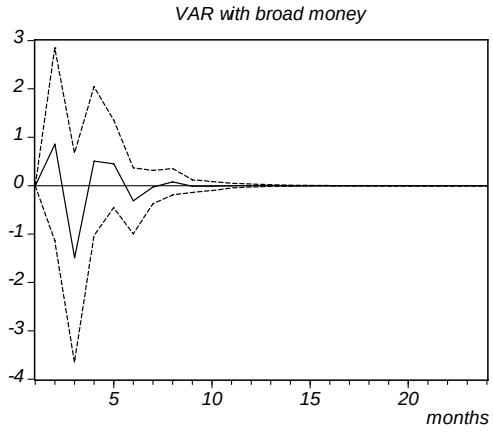


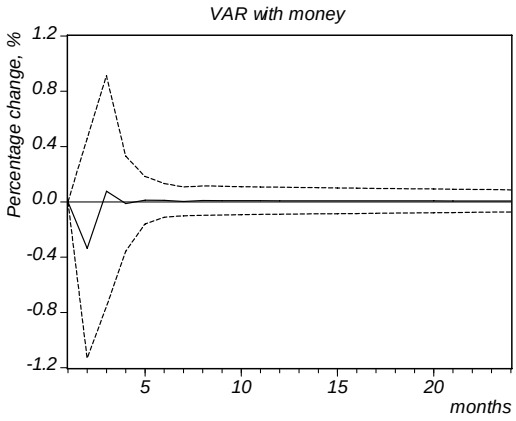
Figure C 20. Response of Output Growth Rate to One Percentage Change in Nominal Depreciation Rate (Period 2001:1 to 2006:12)

a) Kyrgyz Republic





b) Kazakhstan



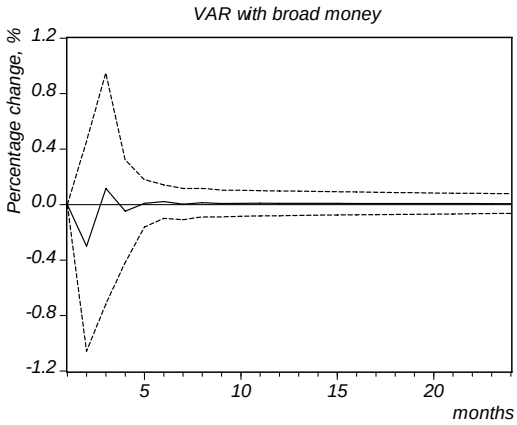


Figure C 21. Response of Inflation Rate to Shocks in the Official Rate (VAR with CPI and money) (Period 2001:1 to 2006:12)

a) Kyrgyz Republic *b) Kazakhstan*

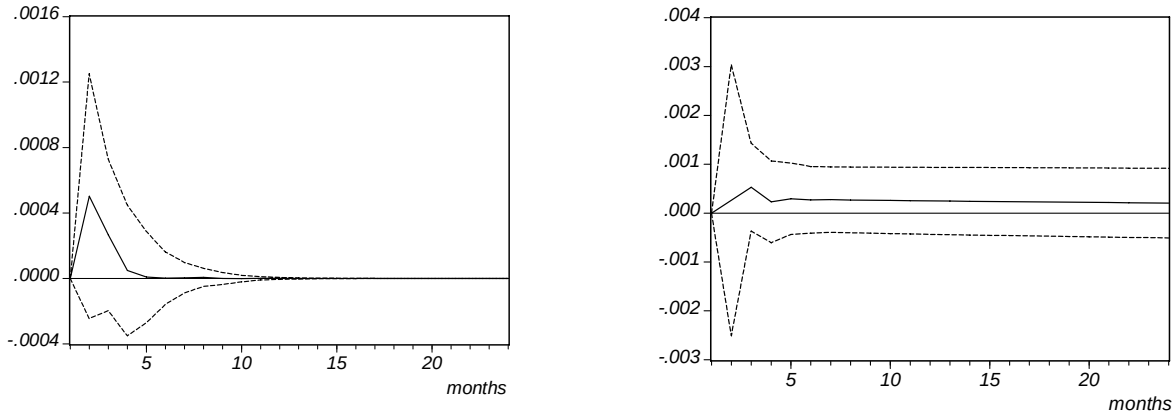


Figure C 22. Response of Output Growth Rate to Shocks in the Official Rate (VAR with CPI and money) (Period 2001:1 to 2006:12)

a) Kyrgyz Republic *b) Kazakhstan*

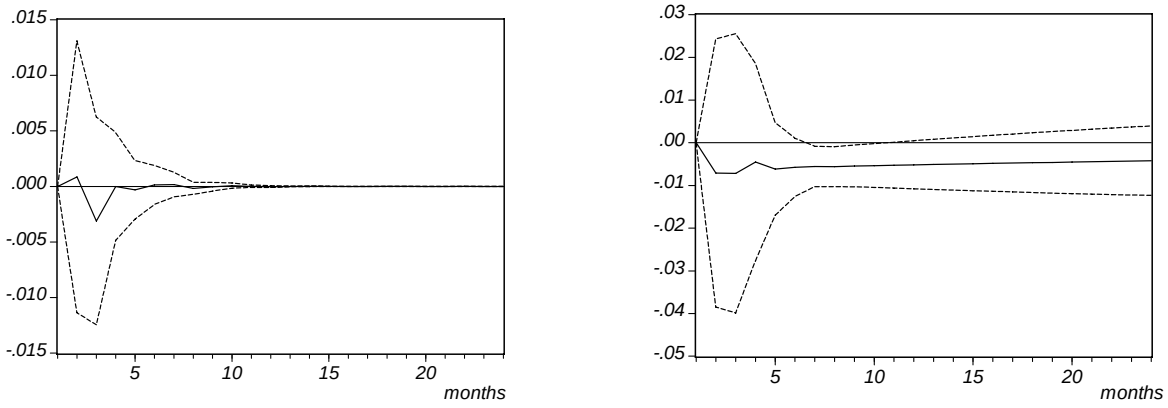
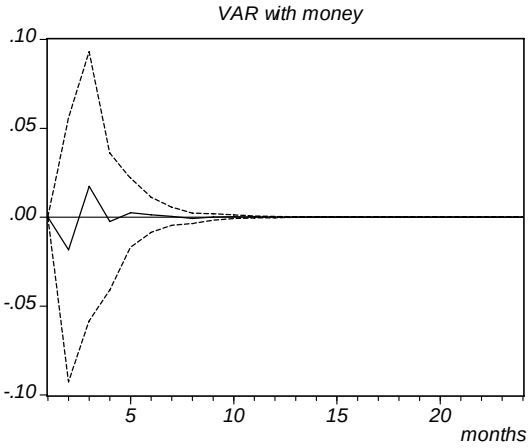
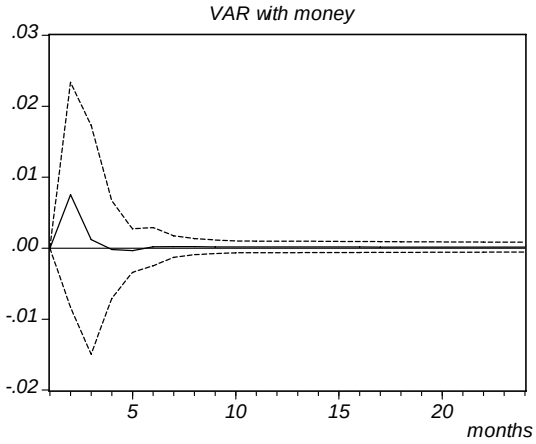


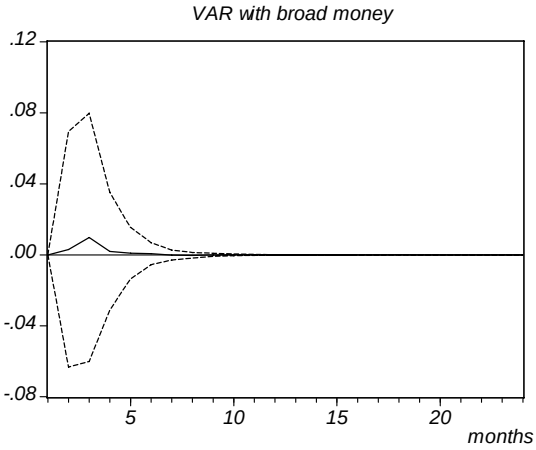
Figure C 23. Response of CPI Inflation Rate to Changes in Money Growth Rate (Period 2001:1 to 2006:12)

a) Kyrgyz Republic



b) Kazakhstan





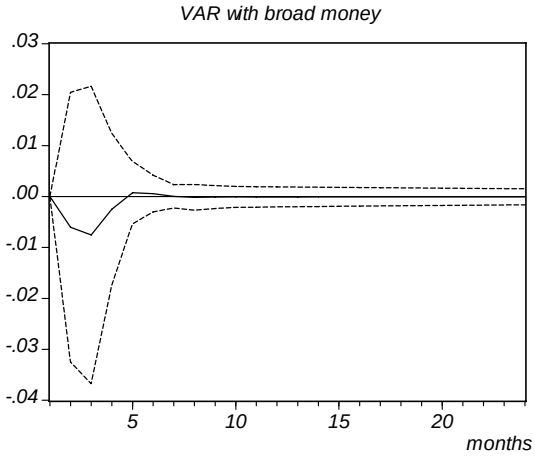
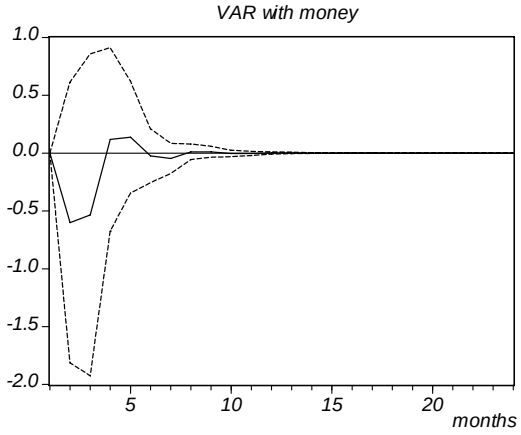
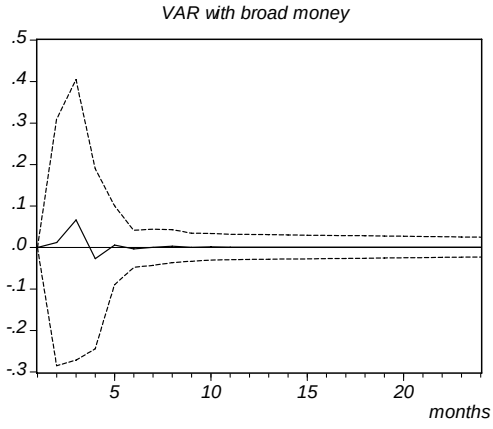


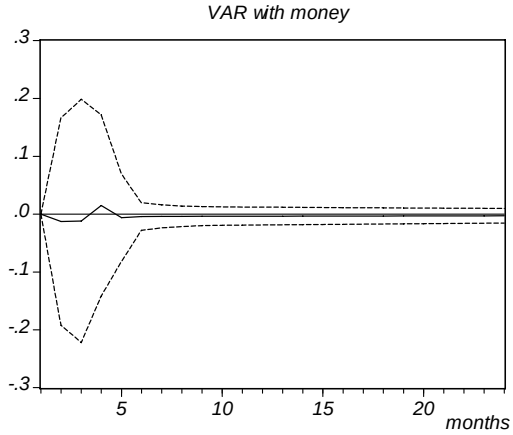
Figure C 24. Response of Output Growth Rate to Changes in Money Growth Rate (Period 2001:1 to 2006:12)

a) Kyrgyz Republic





b) Kazakhstan



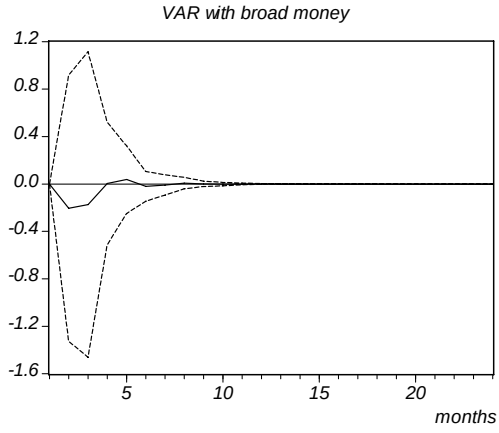


Figure C 25. Response of CPI Inflation Rate to Shocks in Credit Growth (Period 2001:1 to 2006:12)

a) Kyrgyz Republic *b) Kazakhstan*

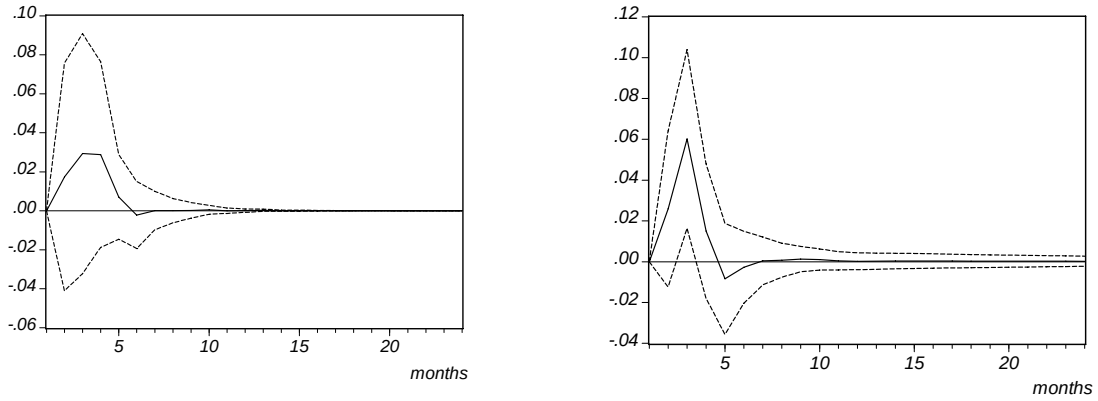


Figure C 26. Response of Output Growth Rate to Shocks in Credit Growth (Period 2001:1 to 2006:12)

a) Kyrgyz Republic *b) Kazakhstan*

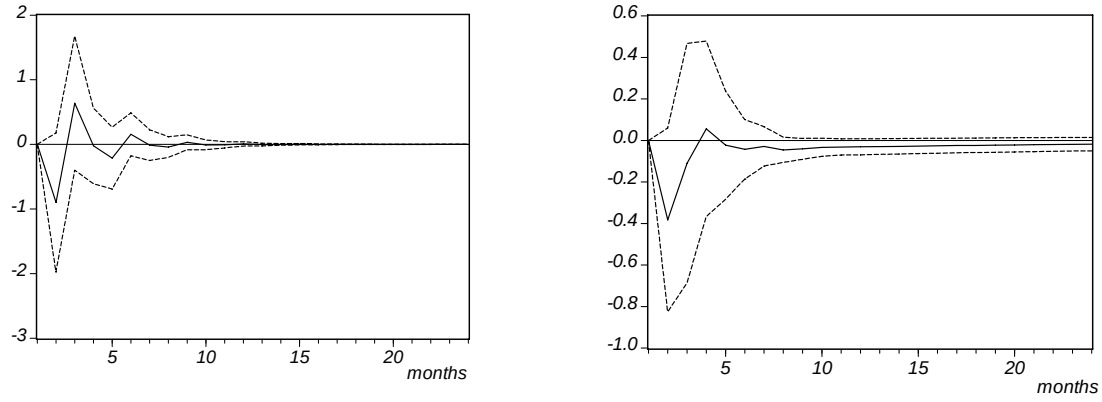


Figure C 27. Accumulated Response of CPI Inflation Rate to One Percentage Change in Nominal Exchange Rate Depreciation rate (VAR with broad money)

a) Kyrgyz Republic *b) Kazakhstan* *c) Tajikistan*

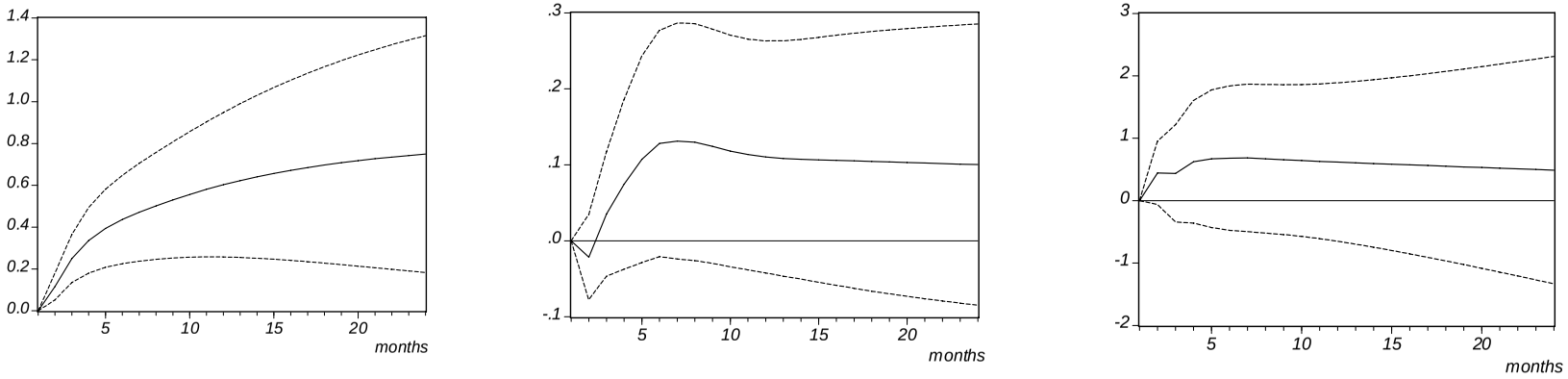
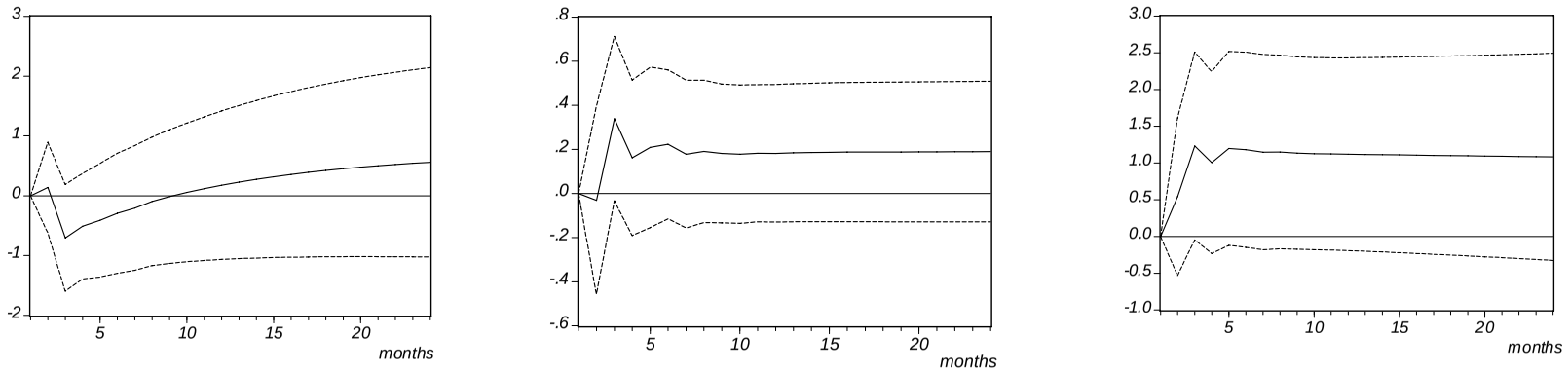


Figure C 28. Accumulated Response of Output Growth Rate to One Percentage Change in Nominal Exchange Rate Depreciation rate (VAR with broad money)

a) Kyrgyz Republic *b) Kazakhstan* *c) Tajikistan*



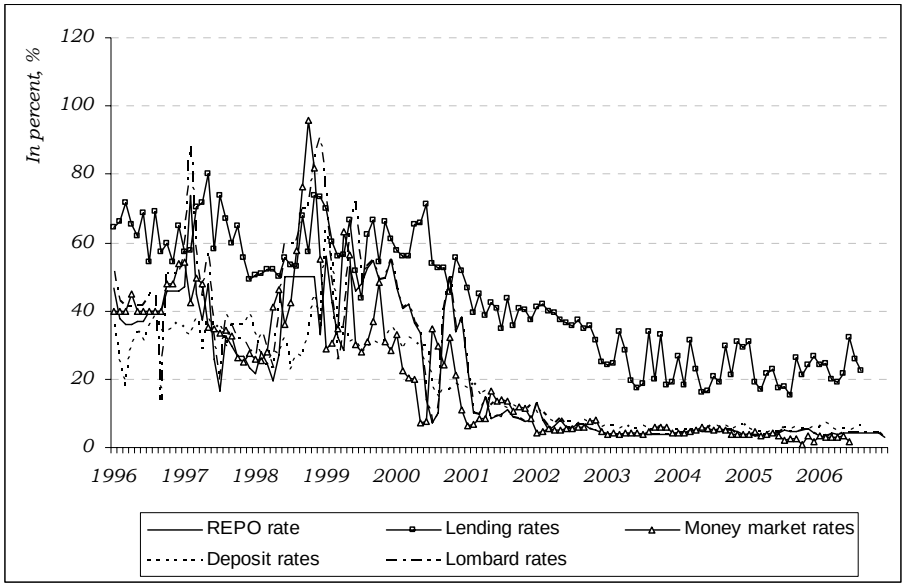
Appendix D Interest Rates in Central Asia

Table D 1. Data on Interest Rates

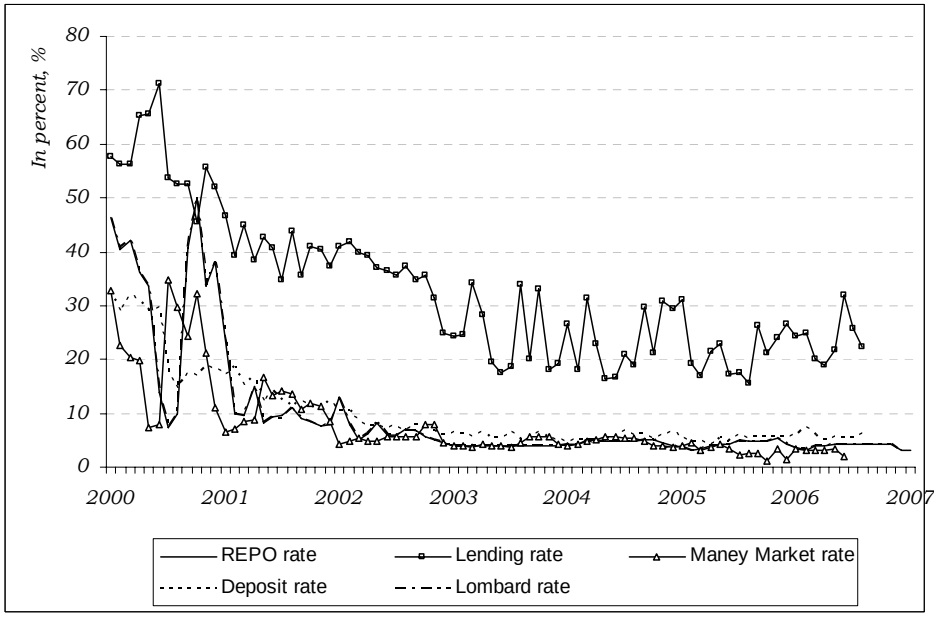
Series	Time span	Number of obs.	Source
	Kyrgyz Republic		
Repo rate of the NBKR	1996:1 till 2006:12	132	Global Financial Data
Money market rate	1996:1 till 2006:12	132	IMF
Deposit rate	1996:1 till 2006:12	132	IMF
Lending rate	1996:1 till 2006:12	132	IMF
Lombard rate	1996:1 till 2006:12	132	IMF
	Kazakhstan		
Refinance rate of the NBK	1996:1 till 2006:12	132	Global Financial Data
Household deposit rate (< 1year)	1996:1 till 2006:12	132	NBK
Household deposit rate (> 1 year)	1996:1 till 2006:12	132	NBK
Lending rate	1996:1 till 2006:12	132	NBK
	Tajikistan		
Refinance rate of NBT	1997:7 till 2007:3	117	NBT
Deposit rate	1997:7 till 2007:3	117	NBT
Lending rate	1997:7 till 2007:3	117	NBT
Interbank money market rate	1997:7 till 2007:3	117	NBT

Figure D 1. Interest Rate Behavior in Kyrgyz Republic

a) January 1996 until January 2007

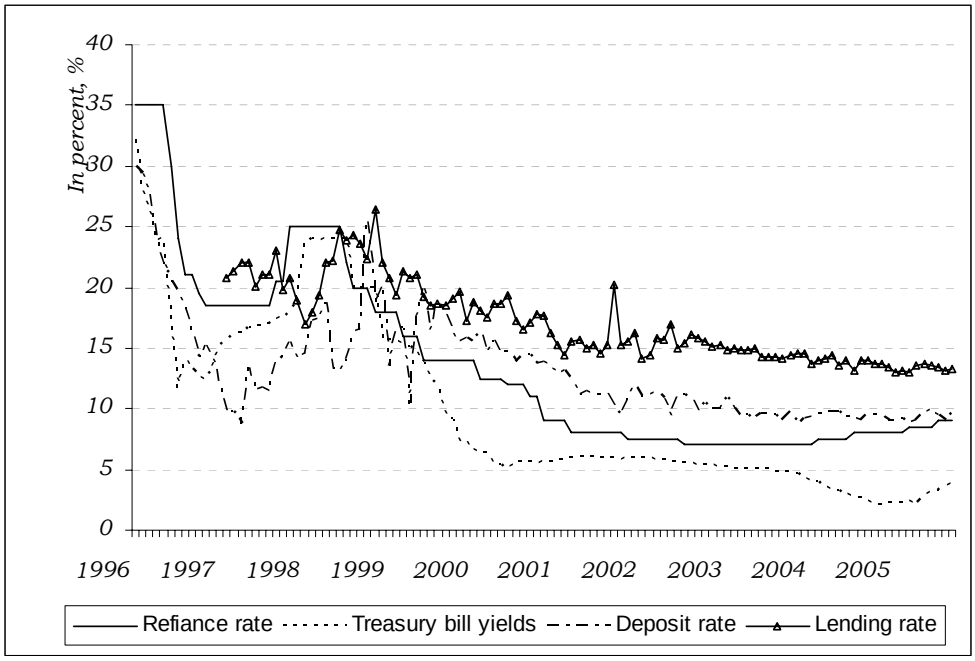


b) January 2001 until January 2007



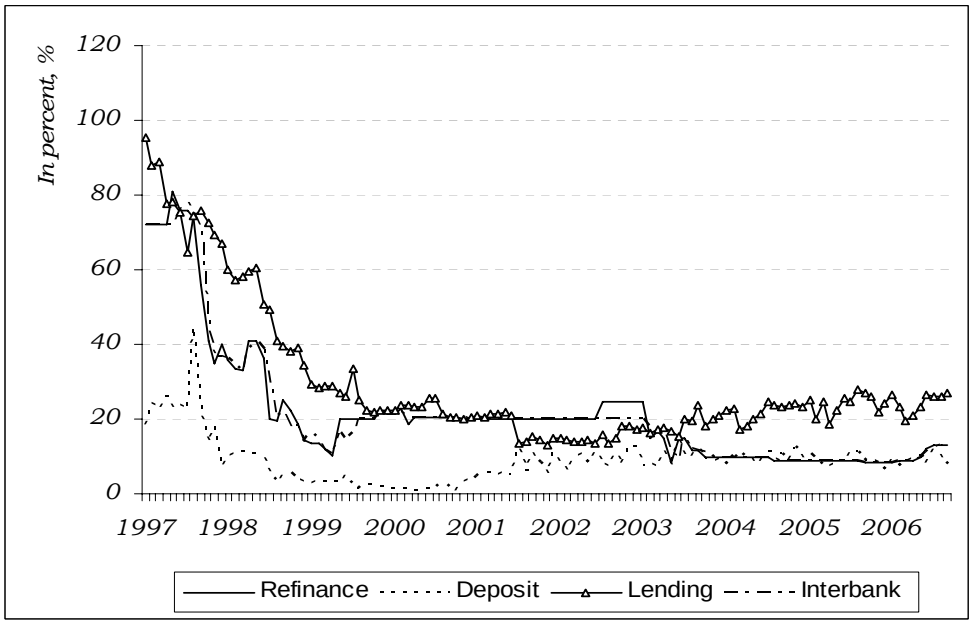
Source: Global Financial Data

Figure D 2. Interest Rate Behavior in Kazakhstan (January 1995 until August 2006)



Source: Global Financial Data, National Bank of Kazakhstan

Figure D 3. Interest Rate Behavior in Tajikistan (July 1997 until March 2007)



Source: National Bank of Tajikistan

Table D 2. Long Run Responses and Adjustment Coefficients in the Three Economies

Specification estimated: $\Delta i_t^m = \delta_0 + \sum_{j=1}^{p-1} \mu_j \Delta i_{t-j}^m + \sum_{k=0}^{q} \kappa_k \Delta i_{t-k}^p + \gamma(i_{t-1}^m - \lambda i_{t-1}^p) + \varepsilon_t,$

	λ	σ_λ	γ	σ_γ	(p,q)
Kyrgyz Republic					
Interbank Money Market	*0.99****	*0.05*	*-0.25****	*0.07*	*(2,0)*
Deposit Rates	*0.83****	*0.04*	*-0.28****	*0.05*	*(1,2)*
Lending Rates	*1.62****	*0.17*	*-0.11****	*0.03*	*(2,0)*
Lombard Rates	*1.16****	*0.04*	*-0.49****	*0.08*	*(1,0)*
Kazakhstan					
Deposit Rates (average)	*1.44****	*0.26*	*-0.01*	*0.02*	*(1,4)*
Household Deposit Rate (3 months – 1 year)	*1.33****	*0.08*	*-0.05*	*0.08*	*(1,4)*
Household Deposit Rate (1 – 5 years)	*1.70****	*0.17*	*-0.04*	*0.03*	*(1,0)*
Lending Rates (average)	*1.92****	*0.16*	*-0.06 ****	*0.02*	*(4,3)*
Tajikistan					
Interbank Rates (average)	*0.98****	*0.01*	*-0.43****	*0.08*	*(2,2)*

Notes. (1) ***, ** and * stand for statistical significance at the 1, 5 and 10 percent level, respectively.
(2) No cointegration has been found between the policy rate of the Bank of Tajikistan and the deposit and lending rates.

Table D 3. Kyrgyz Republic: Long Run Responses and Adjustment Coefficients

a) 1995:9 to 2000:12

	λ	σ_λ	γ	σ_γ	(p,q)
Interbank Money Market VAR 1	*0.99****	*0.07*	*-0.31****	*0.10*	*(1,0)*
Deposit Rates VAR 2	*0.82****	*0.06*	*-0.29****	*0.08*	*(1,2)*
Lending Rates VAR 2	*1.50****	*0.08*	*-0.28****	*0.06*	*(2,2)*
Lombard Rates VAR 1	*1.16****	*0.06*	*-0.51****	*0.12*	*(1,0)*

b) 2001:1 to 2006:6

	λ	σ_λ	γ	σ_γ	(p,q)
Interbank Money Market VAR 4	*1.14****	*0.05*	*-0.23***	*0.09*	*(3,2)*
Deposit Rates VAR 2	*1.28****	*0.03*	*-0.36****	*0.09*	*(1,2)*
Lending Rates VAR 2	*5.37****	*0.18*	*-0.14**	*0.08*	*(1,0)*
Lombard Rates VAR	*0.97****	*0.01*	*-0.32***	*0.13*	*(3,2)*

Table D 4. Kazakhstan: Long Run Responses and Adjustment Coefficients

a) 1996:1 to 2000:12

	λ	σ_λ	γ	σ_γ	(p,q)
Deposit Rates (average) (VAR 1)	*0.87****	*0.10*	*-0.11[-1.22]*	*0.09*	*(1,0)*
Household Deposit Rate (3 months – 1 year) (VAR 4)	*No cointegration*				
Household Deposit Rate (1 – 5 years) (VAR 4)	*No cointegration*				
Lending Rates (average) (VAR 1)	*No cointegration*				

b) 2001:11 to 2006:8

	λ	σ_λ	γ	σ_γ	(p,q)
Deposit Rates (average) (VAR 1)	*1.08****	*0.08*	*-0.11****	*0.03*	*(2,0)*
Household Deposit Rate (3 months – 1 year) (VAR 4)	*0.95****	*0.09*	*-0.10****	*0.02*	*(2,0)*
Household Deposit Rate (1 – 5 years) (VAR 2) from 2000:01	*1.54****	*0.06*	*-0.26****	*0.07*	*(2,2)*
Lending Rates (average) (VAR 1)	*2.01****	*0.11*	*-0.01*	*0.04*	*(2,1)*

Table D 5. Tajikistan: Long Run Responses and Adjustment Coefficients

	λ	σ_λ	γ	σ_γ	(p,q)
Interbank Rates (average) (VAR 2) 1998:7 till 2001:12	*0.99****	*0.01*	*-0.86****	*0.16*	*(2,2)*
Interbank Rates (average) (VAR 4) 2002:1 till 2007:3	*0.98****	*0.02*	*-0.13**	*0.06*	*(1,2)*

Chapter 2

Currency Substitution in the Economies of Central Asia: How Much Does It Cost?*

Abstract

Underdeveloped financial markets and periods of high inflation have stimulated dollarization and currency substitution in the economies of Central Asia. Some authors argue that the latter can pose serious obstacles for the effective conduct of monetary policy and can affect households' welfare. This study uses a model with money-in-the-utility function to estimate the elasticity of substitution between domestic and foreign currencies in three economies of Central Asia – Kazakhstan, the Kyrgyz Republic and Tajikistan. Utility derived from holding money balances is represented by a CES function with money holdings denominated in two currencies. The residents are assumed to diversify their monetary holdings due to instability of the domestic currency. The steady state analysis reveals that though currency substitution decreases governments' seigniorage revenue, holding foreign money can be welfare generating if domestic currency depreciates vis-à-vis the currencies in which households' foreign balances holdings are denominated. De-dollarization can only be achieved through further macroeconomic stabilization that will bring price and exchange rate stability. Financial sector development will also decrease currency substitution through the provision of reliable financial instruments and the gaining of public confidence.

*A short version of this article will be published in autumn 2010 by Edward Elgar in "Euro and Economic Stability: Focus on Central, Eastern and South-eastern Europe" (edited by Nowotny, E., P. Mooslechner and D. Ritzberger-Grünwald)

1 Introduction

Currency substitution, or the use of foreign currency to finance transactions,by domestic residents has been a widespread phenomenon in emerging market and transition economies. During the 1990s, currency substitution and dollarization started to increase rapidly in former centrally planned economies, and remained an important characteristic of these economies for most of the 1990s and 2000s.[1] This study investigates the importance of currency substitution in a group of transition economies in Central Asia and estimates the degree of substitutability between domestic currency and foreign currency in these economies. This empirical analysis contributes to an understanding of the economic importance of currency substitution in three economies - Kazakhstan, the Kyrgyz Republic and Tajikistan.Moreover, the study examines the implications of currency substitution for seigniorage revenues of the government and its welfare cost.

The countries of Central Asia have experienced important structural socio-economic and political transformation related to the demolition of old administrative systems and building new institutions of the free market.[2] Building a market economy required economic liberalization, including price liberalization and gradual capital markets decontrol. Price liberalization resulted in an accelerated pace of inflation and rapid depreciation of newly introduced national currencies. The weak positions of domestic legal tenders and their decreasing purchasing power led to a flight from national money and an increase in foreign currency holdings by residents. Currency substitution was a result of the general economic instability and undermined the credibility of the domestic

[1] See, for example, Baliño, Bennett and Borensztein (1999), Feige (2003)
[2] See, Gürgen, et al. (1999)

money.[3] Moreover, the rudimentary financial sector institutions were not able to provide households with reliable financial instruments for saving in domestic currency.Holding foreign currency (mostly U.S. dollars) thus became a way to hedge against the risk of inflation and depreciation of the local currency.

Macroeconomic stabilization in Central Asian economies at the end of the 1990s brought down inflation rates and thus helped local currencies regain credibility. This has not, however, reversed the process of dollarization. There is no estimated measure of the cash holdings denominated in U.S. dollars in Central Asia.The level of foreign currency denominated deposits is thus used to reflect the importance of currency substitution. Several factors have influenced the population's decision to hold foreign currency.[4] Among them are the memory of past inflation and instability, uncertainty about future economic developments, underdeveloped financial markets and weak confidence towards local commercial banks. For example, only 5 percent of the population in the Kyrgyz Republic hold deposits in banks.[5] The income and wealth of the population is also an important factor affecting dollarization. Tajikistan and Kyrgyz Republic remain the poorest countries in the transition region. The data on foreign currency denominated assets, foreign capital flows, and inflows of remittances from abroad indicate that there is a significant inflow of foreign currency in the economies of Central Asia. [6] The inflows of remittances constitute not only a source of foreign currency but also an

[3]Currency substitution and dollarization are faced by most developing and transition economies. For example, Sahay and Végh (1995), Savastano (1996), Feige (2003), Havrylyshyn and Beddies (2003) studied groups of countries in Latin America, Central and Eastern Europe, and former Soviet republics and provided evidence that macroeconomic instability and high rates of inflation are major reasons for currency substitution and dollarization in these economies.

[4]The factors that motivate holding a foreign currency are based on evidence from surveys done by the Austrian National Bank in CESEE countries (see Ritzberger-Grünwald and Stix, 2007, Dvorsky et al., 2008, Stix, 2008) and the study by Zoryan (2005) on dollarization in Armenia.

[5]EBRD Transition Report, 2008

[6]See Table B 1 in Appendix B.

important source of finance. Households use foreign money as a savings instrument, keeping certain amounts in cash. Very often the foreign currency (in particular, the U.S. dollar) is a currency of denomination for prices on big ticket items (eg. real estate, cars, equipment). The issue of currency substitution and its policy implications thus remain important.

In the present study the elasticity of substitution between domestic and foreign currencies in Central Asian economies is estimated. For this purpose an empirical estimation of an optimizing model with money-in-the-utility function is performed. The nonlinear Euler equations that characterize the first-order-conditions of optimization by a representative consumer are estimated using the General Method of Moments (GMM) procedure as proposed by Hansen (1982). After the key parameters are estimated, they are used for further comparison of steady states with different degrees of dollarization and different inflation rates in order to examine the implications for seigniorage revenues and the welfare loss incurred by households due to holding foreign money balances.

The paper is organized as follows. Section 2 discusses the literature on currency substitution. Section 3 briefly presents the economic background and recent developments in the economies of Central Asia. Section 4 presents the theoretical model. Section 5 discusses the data used in the study. Section 6 presents the empirical results. Sections 7 and 8 examine the seigniorage losses and welfare implications of currency substitution in Central Asia, and Section 9 concludes.

2 Currency Substitution: Theoretical Background and Empirical Evidence

The problem of currency substitution and dollarization has been extensively studied in the economic literature. Many developing economies have experienced high levels of dollarization following periods of macroeconomic instability.[7] In this study, no formal distinction is made between dollarization and currency substitution and the two terms are used interchangeably.[8]

Dollarization in transition economies is an important issue to address for several reasons. First, dollarization might pose obstacles for an effective monetary policy by influencing the monetary transmission mechanism. Sahay and Végh (1995), Baliño, Bennett, and Borensztein (1999), Havrylyshyn and Beddies (2003) and other authors argue that dollarization makes the conduct of monetary policy more challenging as it influences the stability of the money demand and makes exchange rates more volatile. Horváth and Maino (2006) study the transmission mechanism of monetary policy in Belarus, and discuss the ways in which dollarization affects different channels of monetary policy transmission. On the one hand, a high level of dollarization brings more volatile exchange rates and a stronger pass-through from exchange rates to prices. On the other hand, the interest rate channel might become weaker as holding foreign currency denominated assets makes local economic agents less sensitive to changes in interest rates on domestic currency assets.

Furthermore,dollarization affects the ability of governments to earn revenue from

[7] See, for example, Rennhack and Nozaki (2006) who discuss the magnitude and trends in dollarization in different developing regions.

[8] Calvo and Végh (1992) report that currency substitution is very often referred to as dollarization in economies with high inflation episodes.

seigniorage. Bufman and Leiderman (1992) study dollarization in Israel, and find that dollarization and currency substitution may affect the ability of a government to finance its budget deficit. They show that small increases in dollarization have resulted in large seigniorage losses in Israel. Harrison and Vymyatnina (2007) argue that currency substitution can also preclude a government from using an inflationary tax to finance its expenditure programs, as the spending power is limited by the willingness of domestic residents to hold domestic currency. They claim that foreign currency cash transactions can encourage tax evasion and shift the economy to underground activities.

Finally, some authors argue that currency substitution might affect the ability of central banks to provide accurate macroeconomic forecasts. Thus, in the context of dollarization and currency substitution effective implementation of an inflation targeting regime might be affected as well. Though Leiderman, Maino and Parrado (2006) find that in Latin American economies dollarization can still allow an inflation targeting regime to be implemented, the latter might still be an important argument against dollarization in the economies of Central Asia due to their underdeveloped financial sectors and weak monetary transmission channels. The effect of dollarization on monetary stability and monetary policy depends on its size and substitutability between foreign and local currencies, and the development of financial sectors.

Numerous studies have examined currency substitution in developing and transition economies. Some authors base their studies on the so-called portfolio balance model, where agents allocate their wealth in domestic and foreign money, and domestic and foreign bonds. A linear demand for money and foreign money is then estimated using a simple Ordinary Least Squares (OLS) regression or other appropriate empirical methodology. The demand for foreign currency as a measure of currency substitution

is represented as a function of interest rates on domestic and foreign bonds and other variables. Komárek and Melecký (2003) apply this approach to the case of the Czech economy. Mongardini and Mueller (1999) examine currency substitution in the Kyrgyz economy. More recently, Harrison and Vymyatnina (2007) have used this methodology to study currency substitution in Russia.

Other authors employ a dynamic optimization framework with a money-in-the-utility model with two currencies. In this literature, estimation of the structural parameters is based on estimating the Euler equations derived from the optimality conditions. This approach allows for explicit estimation of the main parameters of the model such as the level of dollarization, the elasticity of substitution between the domestic and foreign currency, as well as the magnitude of relative risk aversion and intertemporal substitution. Estimation of the non-linear equations is performed using a Generalized Method of Moments (GMM) framework. This approach was employed by İmrohoroğlu (1994), who examines currency substitution in Canada, and Bufman and Leiderman (1992), who use a model of the same type to investigate currency substitution in Israel. In the case of transition economies, a similar framework can be found in Friedman and Verbetsky (2001), who study the economy of Russia, and Selçuk (2003), who investigates currency substitution in some economies of Central and Eastern Europe – the Czech Republic, Hungary, Poland, and the Slovak Republic.

In the present study, the second methodology is used. The value added of this approach is that by explicitly estimating the parameters of the model, the implications of dollarization for seigniorage revenues and households' welfare can be analyzed. Bufman and Leiderman (1992) examine how changes in the level of dollarization affect the seigniorage revenue of the Israeli government, while Friedman and Verbetsky (2001)

examine seigniorage loss and changes in economic welfare due to changes in dollarization in the Russian economy. In the present study, this approach will be used to examine three Central Asian economies.

3 Institutional Framework and Currency Substitution in Central Asia

The dissolution of the Soviet Union at the beginning of the 1990s led to a deep socio-economic crisis in Central Asia: a severe output decline, general macroeconomic instability, and hyperinflation. Economic relations with other republics in the FSU were demolished.This had a negative impact on living standards and caused a deep recession in the economies of the region.[9]

Although the beginning of the transformation process appeared to be a painful experience for the countries of Central Asia, they managed to restore positive economic growth in the late 1990s and have even demonstrated impressive growth rates in the 2000s.High prices for hydrocarbons, rapid structural reforms, large inflows of foreign investments, and political stability have spurred the economy of Kazakhstan and improved considerably the living standards in this country in recent years. High energy prices and increasing investments in the oil and gas sectors were the main factors that drove economic growth in Kazakhstan.[10] Two other economies have experienced relatively modest developments in comparison to their big neighbor. Kyrgyz Republic's growth was driven mainly by gold production and investments in the gold sector, while

[9] See Pomfret (2006)

[10] IMF Staff estimates that in Kazakhstan oil accounts for more than 50 percent of exports and 40 percent of government revenues. (IMF Country Report, 2009)

the economy of Tajikistan could only start to recover from its recession at the end of the last decade due to the civil war that persisted even after the peace accord was signed in 1997. Real economic recovery could only start in 2000.[11]

A period of hyperinflation in the first half of the 1990s was a consequence of price liberalization and overall economic decontrol in Central Asian countries. Moreover, newly established central banks were heavily financing state enterprises' losses and government deficits. A rapid growth in money supply contributed to high levels of inflation in all countries. With the introduction of national currencies, the central banks in the region gradually took control of prices and could achieve price stability by the end of the 1990s. Economic developments of the 2000s stimulated rapid developments in the financial markets in Central Asian states. Large inflows of capital and foreign exchange into these economies in the form of export receipts, remittances, foreign direct investment, and external borrowing by banks have supported economic growth and financial markets developments. Remittances have recently developed into an important source of foreign exchange for the Kyrgyz Republic and Tajikistan.[12] They have contributed to growth and poverty reduction, but also have turned into a policy challenge. One of the issues arising from large inflows of remittances is that the latter contribute to the growing inflow of foreign currency in the Central Asian economies that is beyond the control of monetary authorities.[13]

Central banks in the region have recently gained more importance and control

[11] See Pomfret (2006)

[12] IMF Country Report (2007) estimates that Tajikistan has one of the highest remittances to GDP ratio among former FSU economies.

[13] IMF Regional Outlook (September 2006) analyzes remittances inflows in the region of Central Asia. IMF staff states that remittances discourage domestic saving because they are used to finance consumption and housing construction rather than for investing in productive capacity. Moreover, remittances inflows might contribute to exchange rate appreciation and fuel inflation.

and the framework of monetary policy has evolved over the period of transition in these economies. In the earlier period, central banks' policies were characterized by targeting money growth by means of conducting a tight monetary policy to take control of inflation through managing the money supply. As local currencies continued depreciating in the late 1990s, the countries' policy makers became concerned with the external balances and the stability of local money relative to major currencies (mainly the U.S. dollar). Gradual liberalization of exchange rate regimes and capital account caused higher volatility of the exchange rates. An important means of supporting stable exchange rates proved to be foreign exchange interventions. Thus, the monetary policy framework became more concerned with exchange rate stability. The instruments employed by central bankers together with the monetary policy framework, have been evolving over the last several years, yet the most effective instrument remains interventions in the foreign exchange markets and control over the money supply. At this stage of development, currency substitution might largely impede the effects of the monetary policy in Central Asian economies, as large amounts of foreign currency in circulation increase the part of money supply that is not under the control of central banks. As this affects domestic money demand, exchange rates become more volatile.[14] Such instruments as official interest rates have limited efficiency due to thin financial sectors and underdeveloped financial intermediation.

It is worth reiterating the motives to hold foreign currency in the three economies. First of all, a memory of macroeconomic instability and high inflation explains people's

[14] One might argue that money growth targeting and exchange rate interventions are not important instruments of monetary policy in developed and advanced transition economies. Today, central bankers can use interest rate setting and inflation targeting frameworks to achieve their goals. The practice, however, shows that the monetary authorities in the economies of Central Asia continue to rely heavily on foreign exchange interventions to provide price and exchange rate stability.

concern about the stability of local currencies. This is particularly true for Tajikistan, where actual macroeconomic stabilization started only in the 2000s. In Kyrgyz Republic, some political unrest in 2005 followed by a revolution undermined the building sentiment of credit to national policies and added to the feeling of uncertainty about future economic developments. Second, Kyrgyz Republic and Tajikistan remain among the countries with the lowest income per capita. Labor emigration is a widespread phenomenon in these countries. Thus, remittances constitute an important source of foreign currency in circulation. Furthermore, underdeveloped financial markets and a lack of confidence in local banking institutions hinders households from taking their foreign cash holdings to a bank. In Kyrgyz Republic, for example, only 5 percent of the population have a bank account. A similar situation can be attributed to Tajikistan. In Tajikistan, the situation is aggravated by the considerable size of the shadow economy (due to drug trafficking), where monetary transactions are most probably performed in a foreign currency.[15]

The situation in Kazakhstan differs as this country has a lot more developed financial markets and a high income per capita. Integration into world financial markets, presence of foreign banks and oil dependence do however constitute the factors that drive dollarisation though in a slightly different form, that is financial dollarisation. This situation reflects importance of foreign currency in economic transactions in Kazakhstan.

[15] Pomfret (2006) estimates trade in drugs and weapons to account for around 30-50% of all economic activity in Tajikistan.

4 A Model of Currency Substitution

The model presented in this section is based on a standard money-in-the-utility function model with two currencies. This framework has been employed by several other studies which examine substitution between domestic and foreign currencies in different countries.[16] The model represents a situation in which residents hold foreign currency as a simple and natural hedge against local inflation due to the motives and contexts described in the previous section. The foreign currency is thus assumed to be stable and trustworthy. In fact, in Central Asian economies, foreign currency is easily disposable and very often held as a store of value, i.e. the foreign currency yields utility in terms of households' confidence towards the latter. Local and foreign currencies can be easily exchanged in the market at the market exchange rate. The model is rather standardized and simplified. There is no production activity in the economy. Agents receive an endowment every period that constitutes their wealth together with holdings of real balances that are unspent in the previous period, the interest rate earned on the bond, and a lump-sum transfer from the government.

The economy consists of a continuum of infinitely lived identical individuals with total measure one. A representative agent is assumed to derive utility from the consumption of a single good and from the liquidity services provided by holdings of domestic and foreign money. Thus, an agent maximizes the expected value of the discounted utility:

$$E_0 \sum_{t=0}^{\infty} \beta^t U(c_t, x_t), \tag{1}$$

where β is the discount factor and c is consumption, and x denotes liquidity holdings.

[16] See İmrohoroğlu (1994), Bufman and Leiderman (1993), Friedman and Verbetsky (2001), Selçuk (2006)

Money services are produced by using a combination of domestic and foreign real balances in a CES production function:

$$x = [(1-\alpha)m^{-\rho} + \alpha m^{*-\rho}]^{-\frac{1}{\rho}} \tag{2}$$

where m denotes domestic real money balances and m^* denotes foreign money balances. Coefficient α is a share of foreign money balances in producing money services. Parameter ρ is used to compute the elasticity of substitution between domestic and foreign currency, and represents the substitutability between the two currencies. The money services part of the utility function reflects the willingness of residents to diversify their money holdings portfolio to lower the risk of losing their monetary assets due to economic instability and inflation in the home country. The foreign country is assumed to be more stable in an economic sense, i.e. its inflation rate is zero or lower than in the domestic economy. The budget constraint of a representative household is as follows:

$$c_t + m_t + m_t^* + b_t = y_t + \tau_t + \frac{m_{t-1}}{(1+\pi_t)} + \frac{m_{t-1}^*(1+\epsilon_t)}{(1+\pi_t)} + \frac{b_{t-1}(1+r_{t-1})}{(1+\pi_t)}, \tag{3}$$

where r_t is a nominal interest rate on one period bonds between period $t-1$ and t. Variables π_t and ϵ_t represent the inflation rate and rate of depreciation of the national currency, respectively. The nominal exchange rate is the ratio between the domestic price level and foreign price level: $E_t = \frac{P_t}{P_t^*}$. The residents care about the stability of the exchange rate and the relative value of the domestic currency to foreign currency. As they assume that the foreign currency is more stable, holding it gives them a certain confidence about conserving the value of their monetary assets. Each

period every individual receives an endowment y, and a lump-sum transfer from the government τ.Moreover, agents hold financial assets b, that give the nominal interest rate r_t between period t and $t+1$.

Rearranging the first order conditions we obtain the following Euler equations:

$$\beta E_t \left[\frac{u_{c_{t+1}}}{u_{c_t}} \frac{1+r_t}{(1+\pi_{t+1})} \right] = 1, \tag{4}$$

$$\frac{u_{m_t}}{u_{c_t}} = 1 - \beta E_t \left[\frac{u_{c_{t+1}}}{u_{c_t}} \frac{1}{(1+\pi_{t+1})} \right], \tag{5}$$

$$\frac{u_{m_t^*}}{u_{c_t}} = 1 - \beta E_t \left[\frac{u_{c_{t+1}}}{u_{c_t}} \frac{1+\epsilon_{t+1}}{(1+\pi_{t+1})} \right] \tag{6}$$

Euler equation (4) is the standard condition for optimal allocation of consumption between periods t and $t+1$. It equates the marginal utility cost of giving up one unit of consumption in period t to the expected utility gain from shifting that unit to consumption in the next period. Equations (5) and (6) equate the expected utility costs and benefits of reducing consumption in the current period by one unit and allocating that unit to money holdings and then to consumption in the next period.

To estimate the model and analyze the implications for seigniorage revenue and welfare cost of dollarization, the following utility function specification is used:

$$U(c_t, x_t) = \frac{(c_t^{1-\gamma} x_t^{\gamma})^{1-\sigma} - 1}{1-\sigma}, \tag{7}$$

where x_t is represented by equation (2).

It is assumed that the coefficient γ lies in the interval between 0 and 1, and reflects the transaction requirement of money, and parameter σ represents the coefficient of relative risk aversion (RRA) and should be positive. The situation $\sigma = 1$ is considered

as a logarithmic specification of the utility function. The parameter ρ measures the degree of currency substitution and should be more than -1. Then the elasticity of substitution between domestic and foreign money is computed as $1/(1+\rho)$.

Using the specified utility function, the following optimality conditions are derived:

$$\beta E_t \left(\frac{c_{t+1}}{c_t}\right)^{\sigma(\gamma-1)-\gamma} \left(\frac{x_{t+1}}{x_t}\right)^{\gamma(1-\sigma)} \frac{1+r_t}{1+\pi_{t+1}} = 1 \tag{8}$$

$$\begin{aligned}(1-\alpha)\frac{\gamma}{1-\gamma}\frac{c_t}{x_t} \times [(1-\alpha)m_t^{-\rho} + \alpha m_t^{*-\rho}]^{-\frac{1}{\rho}-1} \times m_t^{-\rho-1} + \\ +\beta E_t \left\{ \left(\frac{c_{t+1}}{c_t}\right)^{\sigma(\gamma-1)-\gamma} \left(\frac{x_{t+1}}{x_t}\right)^{\gamma(1-\sigma)} \frac{1}{(1+\pi_{t+1})} \right\} - 1 = 0,\end{aligned} \tag{9}$$

$$\begin{aligned}\alpha\frac{\gamma}{(1-\gamma)}\frac{c_t}{x_t} \times [(1-\alpha)m_t^{-\rho} + \alpha m_t^{*-\rho}]^{-\frac{1}{\rho}-1} m_t^{*-\rho-1} + \\ +\beta E_t \left\{ \left(\frac{c_{t+1}}{c_t}\right)^{\sigma(\gamma-1)-\gamma} \left(\frac{x_{t+1}}{x_t}\right)^{\gamma(1-\sigma)} \frac{(1+\epsilon_{t+1})}{(1+\pi_{t+1})} \right\} - 1 = 0.\end{aligned} \tag{10}$$

The optimality conditions are transformed into the following estimation equations:

$$\begin{aligned}d_{1,t+1} = \beta \left(\frac{c_{t+1}}{c_t}\right)^{\sigma(\gamma-1)-\gamma} \left(\frac{m_{t+1}}{m_t}\right)^{\gamma(1-\sigma)} \times \\ \left[\frac{1-\alpha+\alpha\left(\frac{m^*_{t+1}}{m_{t+1}}\right)^{-\rho}}{1-\alpha+\alpha\left(\frac{m^*_t}{m_t}\right)^{-\rho}}\right]^{\gamma(\sigma-1)/\rho} \frac{1+r_t}{1+\pi_{t+1}} - 1,\end{aligned} \tag{11}$$

$$d_{2,t+1} = \frac{\gamma(1-\alpha)\left(\frac{c_t}{m_t}\right)}{1-\alpha+\alpha\left(\frac{m_t^*}{m_t}\right)^{-\rho}} - (1-\gamma)\times$$
$$\left\{\left[1-\beta\left(\frac{c_{t+1}}{c_t}\right)^{\sigma(\gamma-1)-\gamma}\left(\frac{m_{t+1}}{m_t}\right)^{\gamma(1-\sigma)}\right]\times \right. \tag{12}$$
$$\left.\times\left[\frac{1-\alpha+\alpha\left(\frac{m_{t+1}^*}{m_{t+1}}\right)^{-\rho}}{1-\alpha+\alpha\left(\frac{m_t^*}{m_t}\right)^{-\rho}}\right]^{\gamma(\sigma-1)/\rho}\times\frac{1}{1+\pi_{t+1}}\right\},$$

$$d_{3,t+1} = (1-\alpha)\left(\frac{m_t^*}{m_t}\right)^{1+\rho} - \alpha - \beta\left(\frac{c_{t+1}}{c_t}\right)^{\sigma(\gamma-1)-\gamma}\left(\frac{m_{t+1}}{m_t}\right)^{\gamma(1-\sigma)}\times$$
$$\times\left[\frac{1-\alpha+\alpha\left(\frac{m_{t+1}^*}{m_{t+1}}\right)^{-\rho}}{1-\alpha+\alpha\left(\frac{m_t^*}{m_t}\right)^{-\rho}}\right]^{\gamma(\sigma-1)/\rho}\times$$
$$\times\left((1-\alpha)\left(\frac{m_t^*}{m_t}\right)^{1+\rho}(1+\epsilon_{t+1})-\alpha\right)\times\frac{1}{(1+\pi_{t+1})}. \tag{13}$$

The utility function in equation (7) can be considered a special case of the utility function with habit formation in consumption:

$$U(c_t, x_t) = \frac{[(c_t - \delta c_{t-1})^{1-\gamma} x_t^{\gamma}]^{1-\sigma} - 1}{1-\sigma}, \tag{14}$$

where an introduced parameter δ measures the intensity of habit persistence in the consumption decision of the agent. If $\delta > 0$, the model exhibits habit formation in a traditional sense. In this case, the larger the δ, the less pleasure from a given amount of consumption, and the larger must be the purchases to generate the same utility. In

the case when $\delta < 0$, the household's decisions are subject to durability in the sense that not only current, but also past consumption generates utility. c_{t-1} is the "habit stock", i.e. the reference level to which the consumer compares her current consumption level. When $\delta = 0$, habits do not play any role and the consumer cares only about her present consumption level. If $\delta = 1$, habits are very strong and consumer derives utility only from consumption growth rate. Under habit persistence, an increase in current consumption lowers the marginal utility of consumption in the current period and increases it in the next period. The derived estimation equations for the case when $\delta \neq 0$ are presented in Appendix C. In this study, habit formation in consumption is introduced to improve the fit of the theoretical model.

5 Data and Estimation Procedure

The GMM procedure is applied to estimate the system of equations derived in the previous section. This procedure was developed by Hansen (1982) who formulated the estimation problem as follows.[17] Let w_t be an $(h \times 1)$ vector of variables that are observed at date t, let θ denote an unknown (a$\times$1) vector of coefficients, and let $h(\theta, w_t)$ be an $(r \times 1)$ vector-valued function, h: $(\mathbb{R}^a \times \mathbb{R}^h) \rightarrow \mathbb{R}^r$. Since w_t is a random variable, so is $h(\theta, w_t)$. Let θ_0 denote the true value of θ, and the true value is characterized by the property that

$$E\left\{h(\theta_0, w_t)\right\} = 0. \tag{15}$$

Further, denote $Y_T \equiv (w_T', w_{T-1}', ..., w_1')'$ be a $(Th \times 1)$ vector containing all the

[17] Procedure description follows Hamilton (1994).

observations in a sample of size T, and suppose that $g(\theta; Y_T)$ is the sample average of $h(\theta, w_t)$:

$$g_T(\theta; Y_T) \equiv \frac{1}{T} \sum_{t=1}^{T} h(\theta, w_t). \tag{16}$$

The idea of the GMM is to choose θ so as to make the sample moment $g(\theta, Y_{\mathrm{T}})$ as close as possible to the population moment of zero. Thus, the GMM estimator $\hat{\theta}_T$ is the value of θ that minimizes the scalar:

$$Q(\theta; Y_T) = \left[g(\theta; Y_T)\right]' W_T \left[g(\theta; Y_T)\right], \tag{17}$$

where $\{W_T\}_{T=1}^{\infty}$ is a sequence of $(r \times r)$ positive definite weighting matrices which may be a function of Y_T.Hansen (1982) describes this procedure for obtaining a consistent and efficient estimator for W_T.

In the present study, the unknown parameters to be estimated are denoted as $\theta_1 = (\alpha, \beta, \gamma, \sigma, \rho)'$ or $\theta_2 = (\alpha, \beta, \gamma, \sigma, \delta, \rho)'$. To account for endogeneity it is necessary to use instruments. The instruments used are the lagged values of the variables in the estimated equations[18]:

$$I_t = \left\{1, \frac{m_{t-p+1}}{m_{t-p}}, \frac{m^*_{t-p}}{m_{t-p}}, \frac{c_{t-p+1}}{c_{t-p}}, \frac{c_{t-p}}{m_{t-p}}, 1 + r_{t-p}\right\}.$$

[18]Lagged values of the explanatory variables represent good instruments to use in GMM estimation. This type of instruments are usually used by authors who peform GMM estimation in the optimization framework. For example, Hansen and Singleton (1982), Eckstein and Leiderman (1992), İmrohoroğlu (1994) and others. Fuhrer, Moore and Schuh (1995) analyze the quality of the instruments used in the GMM estimation and state that the GMM estimates are biased in small samples and this bias persists even in large samples due to irrelevance of the instrumental variables. Therefore, the authors propose using lagged values of the variables as instruments and argue that the lags are usually well-correlated with the right-hand side variables and should represent a solution to the problem associated with poor instrument relevance.

The monthly data used for estimation span from 2000 to 2008 in the case of Kazakhstan and the Kyrgyz Republic, and from 2002 to 2008 for Tajikistan.

The variables employed include consumer price indices (CPI), nominal exchange rates of national currencies to the U.S. dollar, interest rates, industrial production volume or average real wages as a proxy for consumption, and data on deposits in the second-tier banks. The data on deposits include deposits denominated in foreign and local currencies and is used as a proxy for foreign and domestic money balances respectively.

The data on interest rates include the official rates of central banks, deposit rates, lending rates, money market rates, and a Federal Funds rate of the Fed. The main sources of the data are central banks and statistical offices of these countries, and the IMF International Financial Statistics database.[19]

6 Empirical Results

The estimation results for each country are reported in Table 1. Results are reported for different interest rates. In each case, the minimal value of the objective function J_T is presented in the table as well. This is a chi-square test statistic for the validity of the model's overidentifying restrictions.

Table 1 presents results for the case of utility function without habit formation in consumption. The parameter estimates for β are economically meaningful and are below unity for every country. Thus, households in these economies value future consumption less than consumption in the present period. In some cases, the value of β is less than the value of 0.98 usually assumed in the economic literature. In Tajikistan, β is less than

[19] A more detailed desciption of the data can be found in Table A 1 in Appendix A.

0.9 for those cases when refinance and interbank rates are used in the estimation. This result might suggest that the residents in these economies are very "present-oriented" and put less value on future consumption. This might also be due to the data on interest rate dynamics. The values of the estimates for γ vary from 0.01 to 0.18 among countries depending on the choice of interest rate. Thus, the share of money in providing utility is significantly lower than the share of consumption. This result is in line with other similar studies. The share of foreign money holdings in providing monetary services α is estimated between 0.47 and 0.62. This implies quite high efficiency of foreign money and therefore a high level of currency substitution in all three economies.

The elasticity of substitution parameter s is of particular interest. It is assumed to be positive from 0 to infinity. If it equals 0, then the two currencies are complements, but if it is more than 0, then there is substitutability between the two currencies. İmrohoroğlu (1994) studied dollarization in Canada and finds that the elasticity of substitution between the U.S. dollar and the Canadian dollar is less than 1. The author explains that this implies little substitution between the two currencies, as the implicit demand for the U.S. dollar does not appear to be responsive to the relative currency price. In the studies by Friedman and Verbetsky (2001) and Selçuk (2006) the elasticity is found to be greater than 1. In the present study the elasticity of substitution between the U.S. dollar and local currencies significantly exceeds 1 several times. In the manner of Imrohoroglu (1994), this implies that holding foreign currency is highly responsive to the relative currency price in Central Asia. In the Kyrgyz Republic and Tajikistan, ρ was estimated between -0.31 and -0.94, which implies that the elasticity of substitution between domestic and foreign currencies $s = \frac{1}{(1+\rho)}$ is between 1.45 and 17. The parameter estimates for ρ could only be estimated in the restricted range of

values for Kazakhstan when habit formation in consumption is assumed. These results show that the two currencies are very good substitutes in the Central Asian states, and residents can easily switch from one currency to the other.

Finally, the RRA parameter σ could not be estimated precisely in most cases and its estimates were sometimes negative. The negative parameter of relative risk aversion implies non-convexity of preferences, which poses a difficulty in interpreting the model. The problem of negative values of RRA parameters and imprecision of its estimates has been studied in the economic literature.[20] This discussion is, however, beyond the subject of the present study.

The J-test statistic for testing the overidentifying restrictions of the model indicate that the data provide support for the considered model, or in other words that the overidentifying restrictions are valid.[21] The null hypothesis of validity of overidentifying restrictions could not be rejected in any of the considered cases. Hence, the instruments chosen proved to be valid.

[20] Negative and sometimes statistically insignificant values of the estimated parameter of relative risk aversion (RRA) and intertemporal elasticity of substitution (IES) have been obtained and discussed to different extents in studies on consumption behavior through estimating the Euler equations by GMM. See, for example, Hansen and Singleton (1982), Hall (1988), Mao (1990), Holman (1998) and others. In his study, Pozzi (2002) proposed an explanation for the imprecision in estimating the RRA parameter and its estimates' negative values.

[21] Since the number of orthogonality conditions exceeds the number of parameters, the validity of overidentifying restrictions should be tested. The test suggested is a J_T test, where J_T statistics is a minimized value of the objective function times the number of observations. Under the null hypothesis the overidentifying restrictions are valid, and the J_T-statistics is asymptotically distributed as χ^2 with degrees of freedom equal to the number of overidentifying restrictions.

Table 1. GMM Estimates (No Habit Formation)

a)Kazakhstan

	Refinance rate	Treasury bill	Deposit rate	FFR
β	0.92***(0.00)	0.96***(0.00)	0.97***(0.00)	0.98***(0.00)
α	0.51***(0.01)	0.52***(0.01)	0.51***(0.01)	0.53***(0.01)
γ	0.18***(0.01)	0.11***(0.00)	0.08***(0.01)	0.06***(0.00)
σ	-0.16* (0.09)	-0.05 (0.06)	-0.13 (0.07)	0.04 (0.03)
ρ	-1.13***(0.03)	-1.14*** (0.05)	-1.18***(0.04)	-1.16***(0.07)
$J-statistics$	8.42 [0.59]	7.11 [0.71]	7.99 [0.63]	7.90 [0.64]
$No.obs$	105	105	105	105

b)Kyrgyz Republic

	Repo rate	MMR	Deposit rate	FFR
β	0.95*** (0.00)	0.96***(0.01)	0.94***(0.00)	0.99***(0.00)
α	0.55***(0.01)	0.56***(0.01)	0.56***(0.01)	0.62***(0.03)
γ	0.05*** (0.00)	0.06***(0.00)	0.06***(0.00)	0.02***(0.00)
σ	0.02 (0.03)	0.03 (0.08)	0.005 (0.03)	-0.04 (0.01)
ρ	-0.76***(0.08)	-0.72*** (0.08)	-0.67***(0.06)	-0.31*(0.17)
$J-statistics$	5.87 [0.75]	6.60 [0.68]	6.16 [0.72]	5.91 [0.75]
$No.obs$	94	90	95	95

c)Tajikistan

	Refinance rate	Interbank rate	Deposit rate	FFR
β	0.89***(0.00)	0.89***(0.00)	0.92***(0.00)	0.98***(0.00)
α	0.54***(0.00)	0.53***(0.00)	0.53***(0.01)	0.47***(0.01)
γ	0.08***(0.00)	0.07***(0.00)	0.06***(0.00)	0.01***(0.00)
σ	0.05 (0.04)	0.07** (0.03)	0.01 (0.03)	-0.02 (0.00)
ρ	-0.69*** (0.01)	-0.68*** (0.02)	-0.70*** (0.01)	-0.94***(0.03)
$J-statistics$	5.63 [0.86]	5.26 [0.87]	4.97 [0.89]	5.78 [0.83]
$No.obs$	71	61	71	71

Notes: a) Standard errors are in parentheses; P-values are in brackets; b) $\beta-$discount factor, $\alpha-$ share of foreign money balances in producing money services; s=$\frac{1}{(1+\rho)}-$elasticity of currency substitution

Table C 1 in Appendix C presents the results for the case of Kazakhstan when the utility function assumed exhibits habit formation, or the parameter of habit persistence $\delta \neq 0$. In the case of Kazakhstan, this specification helped restore the meaningful values of the parameter ρ. For the other two countries, the introduction of habit persistence does not change the magnitude of the major parameters in most cases. In Kazakhstan, consumption exhibits a strong persistence with the values of $\delta = 0.78$. The values of ρ vary between -0.70 and -0.87, indicating that substitutability between national and foreign currencies is very high. The estimates of RRA coefficient σ are again negative. The share of dollars in providing money transactions is 0.5. This result confirms the previous specification results on effective foreign currency and high substitutability between domestic and foreign currencies in Kazakhstan. J-statistics values cannot reject the validity of the overidentifying restrictions, i.e. the model provides a good fit for the data.

In the case of the Kyrgyz Republic, the value of the parameter α was estimated at a lower level than in the first model specification. A strong habit persistence was found in this country as well. The parameter measuring habit formation $\delta = 0.7$. The elasticity of substitution between the currencies remains high. In Tajikistan, the habit formation parameter values vary from negative to positive numbers depending on the interest rate chosen.

Empirical results in this section provide strong support for the presence of currency substitution in the economies of Central Asia, and highlight the role of foreign currency as a substitute for domestic money in economic transactions.

7 Implications for Seigniorage Revenue

One of the major concerns for policy makers related to currency substitution is its effect on the seigniorage revenue of central banks. Official dollarization, or full replacement of the domestic currency by some foreign currency (for example, the U.S. dollar), thus directly affects the ability of the government to earn revenue from issuing money. Partial, or unofficial dollarization, can affect seigniorage revenue as well. Some have argued that this effect may be of large.[22] In the context of transition and developing economies, then, the loss of seigniorage revenue is an important issue.[23]

In this study, the implications for seigniorage revenue are derived from analyzing a hypothetical steady state of the model. Steady states with different inflation rates (π) and dollarization (α) are compared. In the steady state, consumption and real money balances' holdings grow at some constant rate $\phi > 0$. The population grows at the rate $n = 0$. The real return on the market portfolio, R, is invariant with respect to both time and inflation rate. Under these conditions, the steady state demand for domestic real money balances can be derived using the optimality conditions from equations 8 to 10. First, the expression for the ratio between foreign and domestic real money balances in terms of model parameters, inflation, and dollarization can be computed following the expression:

[22] Bufman and Leiderman (1992) studied currency substitution in Israel and showed that even small increases in dollarization can have significant effect on the seigniorage income of the monetary authorities. Friedman and Verbetsky (2001) examined seigniorage loss for the case of Russia.

[23] Fischer (1982), for example, calculates average seigniorage rates during the 1960s and 1970s for a cross-section of countries and finds that seigniorage accounts for more than 10% of total government revenue in many less developed countries, especially those with high inflation rates. Click (1998) reports average seigniorage as a share of government spending for a set of 90 countries. He finds that the seigniorage revenue share ranges from 5% in Honduras to 62% in Argentina. Lange and Sauer (2005) calculated the seigniorage for the period 1995 till 2000 for 15 Latin American countries, and found that seigniorage accounts for almost 12 % of government revenue in these economies even though inflation rates were reduced in the 1990s.

$$h = \left(\frac{(1-\alpha)}{\alpha} \frac{1 - \beta \frac{(1+\epsilon)(1+\phi)^{-\sigma}}{(1+\pi)}}{1 - \beta \frac{(1+\phi)^{-\sigma}}{(1+\pi)}} \right)^{-\frac{1}{1+\rho}} \tag{18}$$

Further, the demand for domestic money balances in terms of model parameters is derived as follows:

$$m = \frac{\gamma}{1-\gamma} \frac{R_b c}{(R_b - R_m) + (R_b - R_{mf}) \left(\frac{\alpha}{1-\alpha} \frac{R_b - R_m}{R_b - R_{mf}} \right)^{1/(1+\rho)}}, \tag{19}$$

where the notations from Friedman and Verbetsky (2001) are used for simplification: $R_b = (1+R)/(1+\pi)$, $1+R = (1+\pi)(1+\phi)^{\sigma}/\beta$, $R_m = 1/(1+\pi)$ and $R_{mf} = (1+\epsilon)/(1+\pi)$.

In the case with habit formation in consumption there is a slight difference in the money demand equation:

$$m = \frac{\gamma}{1-\gamma} \frac{(1+\phi-\delta) R_b c}{(R_b - R_m) + (R_b - R_{mf}) \left(\frac{\alpha}{1-\alpha} \frac{R_b - R_m}{R_b - R_{mf}} \right)^{1/(1+\rho)}}, \tag{20}$$

where δ is a parameter of habit persistence.[24]

The money growth rule is assumed as follows:

$$M_t = (1+\mu) M_{t-1}, \tag{21}$$

where μ is the growth rate of the domestic money supply.

For simplicity, the government's budget constraint is assumed to be:

$$M_t = M_{t-1} - T_t, \tag{22}$$

[24] The results of the simulated seigniorage-to-GDP ratio for the case of habit formation are presented in Appendix C.

The fiscal policy assumed implies that the government rebates seigniorage revenues to the public through lump-sum transfers T_t.

To compute the seigniorage, different approaches can be found in the literature. Here the monetary concept of seigniorage computation is used due to the fact that dollarization affects to an important extent the ability of the central bank to receive revenue from increasing the money supply. Furthermore, this approach is suitable for calculating seigniorage revenue in the framework of the present model's setup and is simple in computation.[25]

The monetary concept determines seigniorage as follows:

$$\frac{S_t}{Y_t} = \frac{M_t - M_{t-1}}{M_t} \frac{M_t}{P_t Y_t}, \tag{23}$$

where M_t is the monetary base, S_t is the seigniorage revenue and Y_t is GDP. Therefore, the seigniorage ratio to GDP is:

[25] Though monetary definition of seigniorage is the most widespread concept of seigniorage, other definitions can be found in the recent literauture. Fiscal seigniorage refers to the yield on the counterparts of the monetary base after deduction of costs. Lange and Sauer (2005) distinguish an opportunity cost seigniorage that can be computed as follows:
$S = i\frac{M}{P}$,
where i is a market interest rate, M is a monetary base and P is a price level.
Under rational inflation expectations, the Fischer equation implies that opportunity seigniorage can be calculated as follows:
$S = (\pi + r)\frac{M}{P}$,
where π is the inflation rate, and r is a real rate of interest. This definition of seigniorage can be related to monetary seigniorage:
$S = \frac{dM}{P} = \frac{dM}{M}\frac{M}{P} = \mu\frac{M}{P}$,
where μ is the growth rate of base money. Assuming that velocity and the money multiplier are constant, the quantity theory of money implies that money growth equals the sum of the inflation rate (π) and the real economic growth rate (g):
$S = (\pi + g)\frac{M}{P}$.
Hochreiter and Rovelli (2002) add to these two concepts a concept of inflation tax seigniorage:
$S = \pi\frac{M}{P}$.

$$\frac{S_t}{Y_t} = \mu \frac{M_t}{P_t Y_t},$$

where μ is the growth rate of money supply and

$$\frac{M_t}{P_t Y_t} = \frac{M_t / p_t N_t}{Y_t / N_t} = \frac{m}{y},$$

where m is the steady state per capita real money balances and y is the per capita GDP. The seigniorage revenue-to-GDP ratio can be computed as follows:

$$\frac{S}{Y} = \mu \frac{c}{y} \frac{m}{c}. \tag{24}$$

For the calculation of seigniorage loss the values of the parameters are calibrated on the basis of the estimation results in the previous section. The following values are assumed: $\gamma = 0.07$ and $\beta = 0.98$.The parameter α will be given values from 0.4 to 0.7, and ρ is assumed to be -0.7. The ratio of consumption over income is assumed to be 0.8.[26] The RRA parameter σ is assumed to be 0, since it was not estimated precisely and its estimated value was negative in some cases. In the steady state, the growth rate of money μ is equal to the steady state inflation rate π.The underlying assumption of Purchasing Power Parity (PPP) is used to consider two scenarios of the domestic currency depreciation. In the first scenario, I assume that the foreign inflation rate $\pi^* = 0$ while the domestic inflation rate changes from 0.2 to 50 percent. In this scenario, the depreciation rate, ϵ_t moves together with the domestic inflation rate and $\epsilon = \pi$. In the second scenario, the foreign inflation rate is constant but equals 5 percent. This scenario implies that the domestic currency depreciates at a slower rate than does

[26]This is an average ratio of consumption to GDP or total income across three countries and the period.

the domestic inflation rate.

Table 2 presents the results of the seigniorage revenue simulation. The simulated values are presented as the ratio to GDP in percent. This ratio was calculated for different values of the domestic inflation rate π and for different values of the share of foreign money balances α.

The results in Table 2 (a) show that the ratio of seigniorage-to-GDP ratio increases with the rate of inflation, but only to a certain level of the inflation rate. The seigniorage revenue reaches its peak when the inflation rate is 2 percent in the case when the dollarization level $\alpha = 0.4$. After that it gradually decreases. This result is similar to those obtained by Friedman and Verbetsky (2001) who found that the government achieves its highest seigniorage revenue at an inflation rate of 1-3 percent depending on the level of dollarization. More important is the relation between dollarization and seigniorage revenue. The results show that the latter is a decreasing function of dollarization. The higher α is, the lower is the seigniorage revenue-to-GDP ratio.

In scenario 2, if the dollarization level is 0.4, the seigniorage revenue increases until the inflation rate reaches 5 percent. In this scenario, the ratio of government revenue from seigniorage to GDP is higher than in the first scenario for each level of dollarization and each inflation rate. The agents prefer to hold more domestic money when there is inflation abroad. Moreover, they hold more domestic currency when the domestic inflation rate is lower than the foreign inflation rate. From equation 18, it can be seen that if consumption is constant, the demand for domestic money balances will be higher when there is inflation in the foreign country. Results from the second scenario thus support the previous finding that seigniorage revenue is a decreasing function of the level of dollarization. In this scenario, however, the seigniorage-to-GDP ratio is less

sensitive to the increases in dollarization.

Table 2. Simulated Seigniorage/GDP Ratios (%)

a) *Scenario 1*: $\epsilon = \pi(\pi^* = 0\%)$

$\pi, \%$	α			
	0.4	0.5	0.6	0.7
0.2	0.48	0.28	0.11	0.03
0.5	0.98	0.53	0.19	0.05
1.0	1.42	0.67	0.22	0.05
2.0	1.58	0.61	0.18	0.04
3.0	1.41	0.48	0.14	0.03
4.0	1.19	0.38	0.10	0.02
5.0	0.98	0.30	0.08	0.02
6.0	0.82	0.24	0.06	0.014
8.0	0.59	0.16	0.04	0.010
10	0.44	0.12	0.03	0.007
20	0.16	0.04	0.01	0.003
30	0.09	0.02	0.006	0.001
50	0.05	0.01	0.003	0.0008

b) *Scenario 2*: $\pi^* = 5\%$

$\pi, \%$	α			
	0.4	0.5	0.6	0.7
0.2	0.62	0.59	0.49	0.28
0.5	1.36	1.27	1.01	0.52
1.0	2.25	2.03	1.48	0.66
2.0	3.30	2.75	1.67	0.60
3.0	3.83	2.91	1.51	0.48
4.0	4.07	2.81	1.28	0.37
5.0	4.15	2.61	1.07	0.29
6.0	4.11	3.37	0.90	0.24
8.0	3.86	1.91	0.65	0.16
10	3.51	1.53	0.48	0.12
20	2.03	0.65	0.18	0.04
30	1.31	0.38	0.10	0.02
50	0.76	0.21	0.06	0.01

Notes: $\beta = 0.98, \gamma = 0.08, \rho = -0.7, \sigma = 0, c/y = 0.8$

Introduction of a habit formation in consumption changes the numerical results of the seigniorage computation, since the demand for real domestic money balances is represented by equation 21. If the estimated value of δ is positive and $\phi > 0$ but $\phi < \delta$, then in the habit formation economy the seigniorage-to-GDP ratio will be lower for every level of dollarization and for each inflation rate than in the economy with no habit formation. Results of the simulated ratio of seigniorage revenue to GDP for the utility function with habit formation are presented in Appendix C.

The findings in this section provide support for the hypothesis that decreasing seigniorage revenue is due to increasing dollarization.

For further analysis, actual seigniorage-to-GDP ratios were calculated using data from the central banks of the countries examined in the study. The actual seigniorage-to-GDP ratio was calculated using data on the monetary base following the monetary seigniorage concept. Results are presented in Table 3. Both simulated and actual ratio of seigniorage to GDP decrease when the dollarization level α increases. There is, however, no significant variation in actual annual seigniorage revenue over time.

Table 3. Actual and Simulated Seigniorage/GDP Ratios (in %)

a)Kazakhstan

Period	Inflation rate (in%)	Dollarization level, α	Simulated seigniorage/GDP ratio	Actual seigniorage/GDP ratio
2000	13	0.51	0.07	0.05
2001	8	0.64	0.02	0.05
2002	6	0.60	0.06	0.05
2003	6	0.47	0.35	0.06
2004	7	0.43	0.48	0.08
2005	8	0.42	0.46	0.06
2006	9	0.35	0.94	0.096
2007	11	0.32	1.07	0.07

b)Kyrgyz Republic

Period	Inflation rate (in%)	Dollarization level, α	Simulated seigniorage/GDP ratio	Actual seigniorage/GDP ratio
2000	19	0.58	0.02	0.014
2001	7	0.59	0.06	0.005
2002	2	0.62	0.14	0.002
2003	3	0.64	0.08	0.003
2004	4	0.70	0.02	0.005
2005	4	0.73	0.01	0.005
2006	6	0.66	0.03	0.009
2007	10	0.52	0.09	0.0016

c)Tajikistan

Period	Inflation rate (in%)	Dollarization level, α	Simulated seigniorage/GDP ratio	Actual seigniorage/GDP ratio
2002	12.3	0.49	0.10	0.01
2003	16.3	0.49	0.07	0.01
2004	7.1	0.60	0.05	0.003
2005	7.1	0.56	0.09	0.003
2006	10	0.70	0.007	0.004
2007	13.1	0.75	0.002	0.015

This implies that actual seigniorage revenues were quite stable over the period considered. Time aggregation in calculating the seigniorage revenue might generate

more variability in the seigniorage revenues of the local governments. Nevertheless, the results of the present section support the negative relationship between the revenue that central banks derive from money issuance and the amount of foreign money holdings by the residents. A simple correlation analysis shows that the correlation between dollarization level α and simulated and actual seigniorage-to-GDP ratios is around -0.82 and -0.71 respectively.

8 Economic Welfare and Dollarization

By affecting the seigniorage revenues of the government and thus the amount of lump-sum transfers paid to the public, currency substitution impacts the welfare of households. It is important to note that dollarization itself stems from several factors that have an effect on economic welfare, i.e. high rates of inflation, rapid depreciation of domestic money, etc. These factors stimulate dollarization because economic agents aim to hedge the value of their financial assets and money holdings by switching to foreign currency. Holding foreign money thus becomes a way for households to preserve their wealth.

In this section, the potential implications of dollarization and currency substitution for welfare are discussed. These implications involve the different channels through which holding of foreign money balances by households can affect their welfare. This analysis, though cumbersome, yields some important insights on the economic role of dollarization in transition economies.

The baseline assumption is that the welfare of a household changes if dollarization α increases, i.e. $\alpha_0 < \alpha_1$ and $u(\alpha_0) > u(\alpha_1)$. To calculate the welfare costs of dollarization in a steady state with a given rate of inflation, one needs to compute the percentage decrease in consumption per capita that would generate the same welfare change as that from moving from the original level of dollarization α_0 to a higher level of dollarization α_1. Or it is necessary to find such Δc that would return the household to its original level of utility: $u(c, \alpha_0) = u(c + \Delta c, \alpha_1)$. For this purpose, the utility function in equation 7 is rewritten in the following way:

$$u(c_t, x_t) = \frac{\left(c_t^{1-\gamma} m^{\gamma} \left(1 - \alpha + \alpha h^{-\rho}\right)^{-\frac{\gamma}{\rho}}\right)^{1-\sigma}}{1-\sigma} - 1, \tag{25}$$

where $h = \frac{m^*}{m}$. Plugging in the expression for h from equation 17, and equating utilities for different levels of dollarization through including consumption compensation, Δc, the following equality is obtained:

$$c^{(1-\gamma)} m_1^{\gamma} \left(1 - \alpha_1 + \alpha_1 \left(\frac{1-\alpha_1}{\alpha_1} \left(\frac{1 - \beta \frac{(1+\epsilon)(1+\phi)^{-\sigma}}{(1+\pi)}}{1 - \beta \frac{(1+\phi)^{-\sigma}}{(1+\pi)}}\right)^{\frac{\rho}{1+\rho}}\right)\right)^{-\frac{\gamma}{\rho}} - 1 =$$

$$= (c + \Delta c)^{(1-\gamma)} m_2^{\gamma} \left(1 - \alpha_2 + \alpha_2 \left(\frac{1-\alpha_2}{\alpha_2} \left(\frac{1 - \beta \frac{(1+\epsilon)(1+\phi)^{-\sigma}}{(1+\pi)}}{1 - \beta \frac{(1+\phi)^{-\sigma}}{(1+\pi)}}\right)^{\frac{\rho}{1+\rho}}\right)\right)^{-\frac{\gamma}{\rho}} - 1, \Leftrightarrow$$

$$\Leftrightarrow \quad c \left(\frac{m_1}{c}\right)^{\gamma} \left(1 - \alpha_1 + \alpha_1 \left(\frac{1-\alpha_1}{\alpha_1} \left(\frac{1 - \beta \frac{(1+\epsilon)(1+\phi)^{-\sigma}}{(1+\pi)}}{1 - \beta \frac{(1+\phi)^{-\sigma}}{(1+\pi)}}\right)^{\frac{\rho}{1+\rho}}\right)\right)^{-\frac{\gamma}{\rho}} = \tag{26}$$

$$= \quad (c + \Delta c) \left(\frac{m_2}{c + \Delta c}\right)^{\gamma} \left(1 - \alpha_2 + \alpha_2 \left(\frac{1-\alpha_2}{\alpha_2} \left(\frac{1 - \beta \frac{(1+\epsilon)(1+\phi)^{-\sigma}}{(1+\pi)}}{1 - \beta \frac{(1+\phi)^{-\sigma}}{(1+\pi)}}\right)^{\frac{\rho}{1+\rho}}\right)\right)^{-\frac{\gamma}{\rho}}$$

Defining the expression in parentheses as $f(\alpha)$, a simpler representation of the previous equality is as follows:

$$c \left(\frac{m_1}{c}\right)^{\gamma} f(\alpha_1) = (c + \Delta c) \left(\frac{m_2}{c + \Delta c}\right)^{\gamma} f(\alpha_2), \Longleftrightarrow \tag{27}$$

$$\iff \left(\frac{c+\Delta c}{c}\right) = \frac{\left(\frac{m_1}{c}\right)^{\gamma} f(\alpha_1)}{\left(\frac{m_2}{c+\Delta c}\right)^{\gamma} f(\alpha_2)}, \iff$$

$$\iff \frac{\Delta c}{c} = \frac{\left(\frac{m_1}{c}\right)^{\gamma} f(\alpha_1)}{\left(\frac{m_2}{c+\Delta c}\right)^{\gamma} f(\alpha_2)} - 1$$

This consumption compensation can be expressed as a ratio of GDP:

$$\frac{\Delta c}{y} = \frac{c}{y}\left[\frac{\left(\frac{m_1}{c}\right)^{\gamma} f(\alpha_1)}{\left(\frac{m_2}{c+\Delta c}\right)^{\gamma} f(\alpha_2)} - 1\right]. \tag{28}$$

To compute consumption compensation, the money demand expression from equation 18 is plugged into equation 26. Derived consumption compensation in equation 27 consists of two parts: a decrease in the lump-sum transfer from the government due to its loss of seigniorage revenue, and direct changes in households' utility due to holding foreign money.

Using the same parameter values as in the calculation of seigniorage loss in the previous section, the consumption compensation is calculated using equation 27. The welfare loss is computed for a change in dollarization α from 0.5 to 0.6 for different rates of inflation. Two scenarios of exchange rate determination from the previous section are analyzed. Table 4 presents the results of the simulated changes in welfare represented as percentage in GDP. Negative values of the consumption compensation imply welfare gains, while positive values imply welfare loss.

Table 4. Consumption Compensation for Increasing Dollarization

π, %	ΔC/GDP, %	
	Scenario 1: $\epsilon = \pi$	Scenario 2: $\pi^* = 5\%$
0.2	-0.56	1.56
0.5	-0.77	1.42
1	-1.01	1.17
2	-1.28	0.68
3	-1.42	0.24
4	-1.49	-0.11
5	-1.53	-0.40
6	-1.56	-0.62
8	-1.59	-0.93
10	-1.61	-1.12
20	-1.639	-1.47
30	-1.644	-1.56
50	-1.647	-1.61

Notes: α changes from 0.5 to 0.6, $\beta = 0.98, \rho = -0.7, \gamma = 0.08, c/y = 0.8$

The results in Table 4 reveal that dollarization in fact brings gains in welfare that can be as large as 1.65 percent of GDP if the domestic inflation rate reaches 50 percent. The welfare gain is an increasing function of inflation. This finding can be explained by the fact that an increase in foreign money holdings hedges households from incurring loss due to depreciating domestic money. The higher the inflation rate, the higher the gain from an increase in foreign currency holdings. This also implies that the loss in seigniorage revenue due to increasing dollarization is exceeded by the gains from holding foreign currency. In the second scenario, holding foreign money brings welfare loss if the domestic inflation rate is lower than the inflation rate in the foreign economy. In this scenario, holding dollars is not optimal since the domestic currency is stronger when foreign inflation exceeds inflation at home. Thus, the welfare loss occurs due

to uncertainty about the foreign inflation rate and about the exchange rate between local and foreign currencies. The seigniorage loss is greater than the gain in household consumption as a result of switching to foreign currency. Hence, dollarization in an inflationary environment with depreciating local currency vis-à-vis foreign currency becomes welfare generating. Currency substitution is thus a transitory phenomenon that might result in negative as well as positive changes in welfare. The welfare cost depends on the ability of resident households to diversify their money holdings in such a way as to avoid the risk of sudden depreciation of either currency.

9 Conclusion

In the present study currency substitution in three transition countries of Central Asia was examined. Findings show that foreign and domestic currencies are good substitutes in all three economies - Kazakhstan, the Kyrgyz Republic and Tajikistan. The elasticity of substitution between the two currencies is more than unity in all cases. The share of foreign currency in providing money services exceeds 0.5 for all three economies. Currency substitution and dollarization are shown to be of significant magnitude and importance in these transition countries. The study was conducted using a simple dynamic model of money-in-the-utility function with two currencies, where holding money balances denominated in different currencies serves as a hedge against domestic instability and inflation. The steady state implications for seigniorage revenues of the government and household welfare were analyzed. Seigniorage revenue was found to be a decreasing function of dollarization. An increase in dollarization index from 0.4 to 0.5, decreases seigniorage revenue to GDP ratio by almost half. Seigniorage revenues will however depend on the inflation rate abroad. The higher the inflation rate abroad, the higher is the seigniorage ratio in the domestic economy due to increasing local demand for domestic real money balances. Increasing dollarization still results in loss of seigniorage revenue for each dollarization level and inflation rate.

The welfare analysis comprises the loss of seigniorage and a change in welfare due to switching to a foreign currency. The findings of the welfare analysis are sensitive to the scenario of domestic currency depreciation. If foreign inflation is zero, then switching to holding dollars is a welfare generating decision. Though the government loses its revenues from money issuance, the overall effect of currency substitution can be positive. In the second scenario, where the foreign inflation rate was fixed at 5

percent, holding dollars decreases households' wealth if inflation in the home country is lower than inflation abroad. Residents choose to hold foreign currency which in fact has less purchasing power and depreciates at a higher rate than does the domestic currency. Once the domestic inflation rate outpaces foreign inflation, switching to dollars starts bringing gains in welfare. Dollarization thus affects household wealth from two sides: decreasing lump-sum transfers from the government and hedging motives against domestic inflation.

Currency substitution and dollarization thus constitute transitory phenomena that do not necessarily bring welfare loss. Governments willing to dedollarize local economies should be concerned with the stability of local currencies rather than with restricting foreign money holdings.

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Appendix A Data Description

Table A 1. Data Sources

Series	Time span	Source
a) Kazakhstan		
Consumer Price Index	2000:1 - 2008:12	IMF
Deposits denominated in domestic and foreign currency (in mln tenge)	2000:1 - 2008:12	NBK
Industrial Production (in mln. tenge)	2000:1 - 2008:12	Statistical Agency of Kazakhstan
Refinancing Rate of the National Bank (in percent)	2000:1 - 2008:12	IMF
Treasury bill rate (in percent)	2000:1 - 2008:12	IMF
Average deposit rate (in percent)	2000:1 - 2008:12	NBK
Nominal exchange rate (tenge to US dollar) (in tenge)	2000:1 - 2008:12	IMF
b) Kyrgyz Republic		
Consumer Price Index	2000:1 - 2008:3	IMF
Deposits denominated in domestic and foreign currency (in mln som)	2000:1 - 2008:3	NBKR
Industrial Production (in mln. som)	2000:1 - 2008:3	Statistical Agency of Kyrgyz Republic
Rate on repo operations of the NBKR	2000:1 - 2008:3	NBKR
Money market rate	2000:1 - 2008:3	IMF
Deposit rate	2000:1 - 2008:3	IMF
Nominal exchange rate (som to US dollar) (in som)	2000:1 - 2008:3	IMF

c) Tajikistan		
Consumer Price Index	2002:1 – 2008:2	IMF
Deposits denominated in domestic	2002:1 – 2008:2	NBT
and foreign currency (in mln somoni)		
Industrial Production (in mln. somoni)	2002:1 – 2008:2	NBT
Wages (in somoni)	2002:1 – 2008:2	NBT
Official Rate of the NBT (in percent)	2002:1 – 2008:2	NBT
Interbank Rate (in percent)	2002:1 – 2007:3	NBT
Deposit Rate (in percent)	2002:1 – 2008:2	IMF
Nominal exchange rate (somoni to US dollar)	2002:1 – 2008:2	IMF
(in somoni)		

Notes: NBK -National Bank of Kazakhstan, NBKR - National Bank of the Kyrgyz Republic, NBT - National Bank of Tajikistan

Appendix B Inflation and Dollarization

Table B 1. Capital Inflows in Central Asia

	2000	2001	2002	2003	2004	2005	2006	2007	2008
Remittances* (mln. USD)									
Kazakhstan	122	171	205	147	166	178	187	223	192
Kyrgyz Republic	9	11	37	78	189	322	481	715	1232
Tajikistan	...	...	79	146	252	467	1019	1691	2544
FDI (mln. USD)**									
Kazakhstan	1278	2861	2164	2213	5436	2123	6630	6900	10732
Kyrgyz Republic	-7	-1	5	46	132	43	182	208	265
Tajikistan	24	10	36	32	272	55	66	160	190

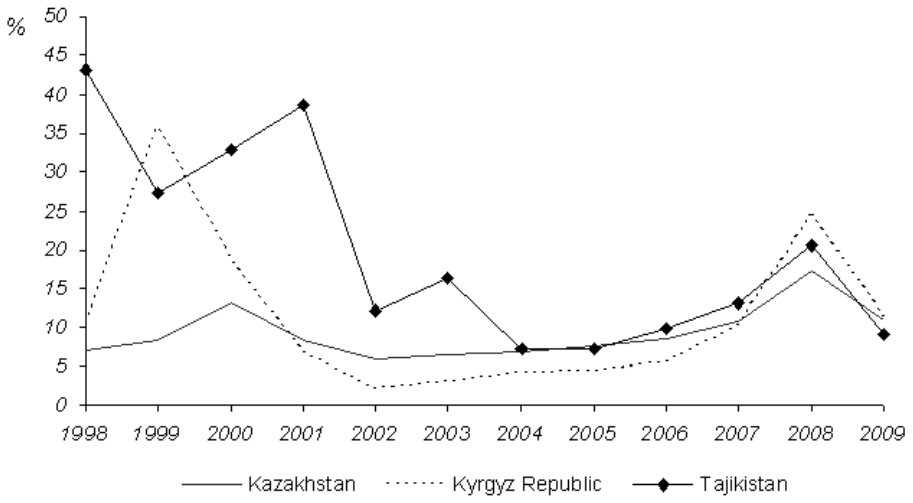
Source: * World Bank Migration and Remittances Factbook, 2008.

Data retrieved from the website of the World Bank.

** EBRD Transition Report, 2008

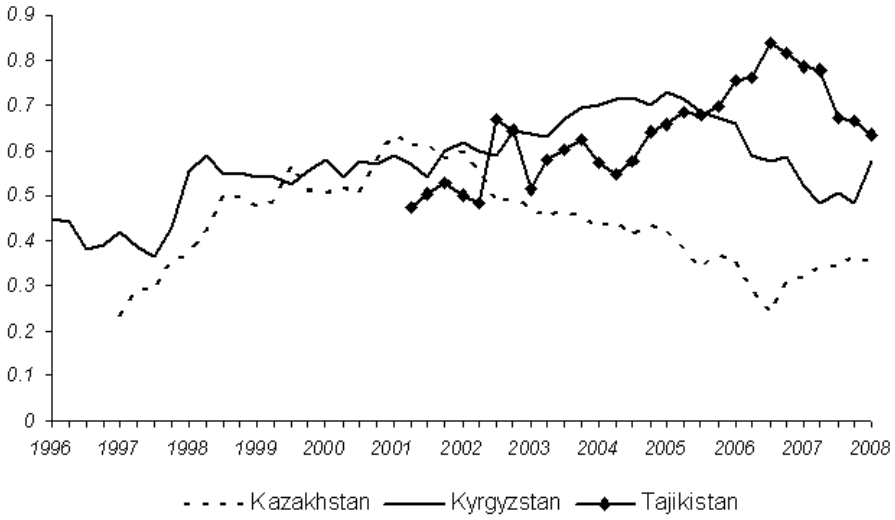
Notes: Data for FDI in 2008 are estimates

Figure B 1. Inflation in Central Asia



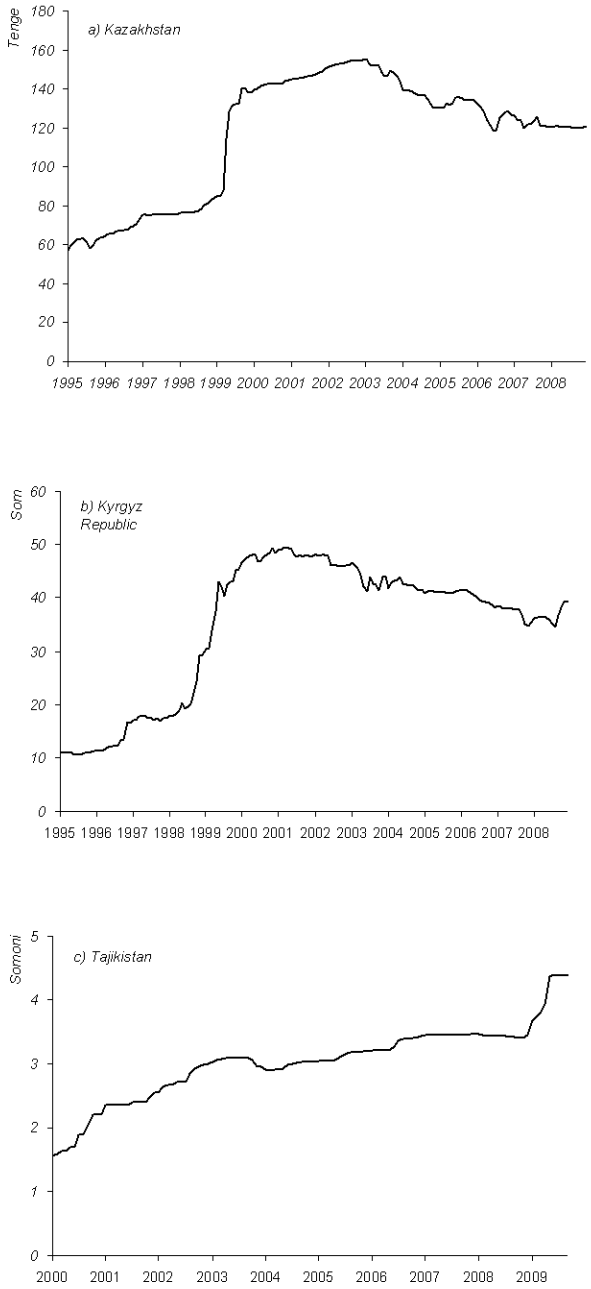
Note: Figures for 2009 are estimates Source: EBRD Transition Report, 2008

Figure B 2. Dollarization in Central Asia



Note: Dollarization Index is computed as a ratio of foreign currency denominated deposits to total deposits

Figure B 3. Exchange Rates: Units of Local Currency to U.S. Dollar



Source: IMF International Financial Statistics

Appendix C Habit Formation in Consumption

Derived estimation equation for the case with habit formation are as follows:

$$d_{1,t+1} = \beta \left\{ C_t^{\sigma(\gamma-1)-\gamma} \left(\frac{C_{t+1}-\delta}{C_t-\delta} \right)^{\sigma(\gamma-1)-\gamma} M_{t+1}^{\gamma(1-\sigma)} \left(\frac{1-\alpha+\alpha H_{t+1}^{-\rho}}{1-\alpha+\alpha H_t^{-\rho}} \right)^{\frac{\gamma}{\rho}(\sigma-1)} \left(\frac{1+r_t}{1+\pi_{t+1}} + \delta \right) \right\} - \quad \text{(eq. B1)}$$

$$-\delta\beta^2 \left\{ C_t^{\sigma(\gamma-1)-\gamma} C_{t+1}^{\sigma(\gamma-1)-\gamma} \left(\frac{C_{t+2}-\delta}{C_t-\delta} \right)^{\sigma(\gamma-1)-\gamma} M_{t+1}^{\gamma(1-\sigma)} \right\} \times$$

$$\times \left\{ M_{t+2}^{\gamma(1-\sigma)} \left(\frac{1-\alpha+\alpha H_{t+2}^{-\rho}}{1-\alpha+\alpha H_t^{-\rho}} \right)^{\frac{\gamma}{\rho}(\sigma-1)} \left(\frac{1+r_t}{1+\pi_{t+1}} \right) \right\} - 1,$$

$$\text{where } C_t = \frac{c_t}{c_{t-1}}, M_t = \frac{m_t}{m_{t-1}}, H_t = \frac{m_t^*}{m_t}.$$

$$d_{2,t+1} = \left(\frac{\frac{\gamma}{1-\gamma}(1-\alpha)\frac{c_{t-1}}{m_t}(C_t-\delta)}{(1-\alpha+\alpha H_t^{-\rho})} \right) + \quad \text{(eq. B2)}$$

$$+\beta \left\{ C_t^{\sigma(\gamma-1)-\gamma} \left(\frac{C_{t+1}-\delta}{C_t-\delta} \right)^{\sigma(\gamma-1)-\gamma} M_{t+1}^{\gamma(1-\sigma)} \left(\frac{1-\alpha+\alpha H_{t+1}^{-\rho}}{1-\alpha+\alpha H_t^{-\rho}} \right)^{\frac{\gamma}{\rho}(\sigma-1)} \times \right.$$

$$\times \left(1 - \delta\beta C_{t+1}^{\sigma(\gamma-1)-\gamma} \left(\frac{C_{t+2}-\delta}{C_{t+1}-\delta} \right)^{\sigma(\gamma-1)-\gamma} M_{t+2}^{\gamma(1-\sigma)} \left(\frac{1-\alpha+\alpha H_{t+2}^{-\rho}}{1-\alpha+\alpha H_{t+1}^{-\rho}} \right)^{\frac{\gamma}{\rho}(\sigma-1)} \right) \frac{1}{1+\pi_{t+1}} -$$

$$\left. - \left(1 - \delta\beta C_t^{\sigma(\gamma-1)-\gamma} \left(\frac{C_{t+1}-\delta}{C_t-\delta} \right)^{\sigma(\gamma-1)-\gamma} M_{t+1}^{\gamma(1-\sigma)} \left(\frac{1-\alpha+\alpha H_{t+1}^{-\rho}}{1-\alpha+\alpha H_t^{-\rho}} \right)^{\frac{\gamma}{\rho}(\sigma-1)} \right) \right\},$$

$$d_{3,t+1} = (1-\alpha)H_t^{1+\rho} - \alpha - \quad \text{(eq. B3)}$$

$$-\beta \left\{ C_t^{\sigma(\gamma-1)-\gamma} \left(\frac{C_{t+1}-\delta}{C_t-\delta} \right)^{\sigma(\gamma-1)-\gamma} M_{t+1}^{\gamma(1-\sigma)} \left(\frac{1-\alpha+\alpha H_{t+1}^{-\rho}}{1-\alpha+\alpha H_t^{-\rho}} \right)^{\frac{\gamma}{\rho}(\sigma-1)} \times \right.$$

$$\times \left(1 - \delta\beta C_{t+1}^{\sigma(\gamma-1)-\gamma} \left(\frac{C_{t+2}-\delta}{C_{t+1}-\delta} \right)^{\sigma(\gamma-1)-\gamma} M_{t+2}^{\gamma(1-\sigma)} \left(\frac{1-\alpha+\alpha H_{t+2}^{-\rho}}{1-\alpha+\alpha H_{t+1}^{-\rho}} \right)^{\frac{\gamma}{\rho}(\sigma-1)} \right) \frac{1}{1+\pi_{t+1}} \times$$

$$\times \left(1 - \delta\beta C_t^{\sigma(\gamma-1)-\gamma} \left(\frac{C_{t+1}-\delta}{C_t-\delta} \right)^{\sigma(\gamma-1)-\gamma} M_{t+1}^{\gamma(1-\sigma)} \left(\frac{1-\alpha+\alpha H_{t+1}^{-\rho}}{1-\alpha+\alpha H_t^{-\rho}} \right)^{\frac{\gamma}{\rho}(\sigma-1)} \right) \times$$

$$\left. \times \left((1-\alpha)H_t^{1+\rho}(1+\epsilon_{t+1}) - \alpha \right) \right\}.$$

Table C 1. GMM Estimates (Utility with Habit Formation in Consumption) for Kazakhstan

	Refinance rate	Treasury Bill	Deposit Rate	FFR
β	0.92***(0.00)	0.95***(0.00)	0.96***(0.00)	0.98***(0.00)
α	0.49***(0.00)	0.50***(0.00)	0.50***(0.00)	0.50***(0.00)
γ	0.10***(0.00)	0.12***(0.01)	0.10***(0.01)	0.07***(0.01)
σ	-0.12***(0.01)	-0.13***(0.01)	-0.11***(0.01)	-0.08***(0.01)
δ	0.79***(0.00)	0.78***(0.01)	0.78***(0.03)	0.78***(0.01)
ρ	-0.70***(0.06)	-0.87***(0.02)	-0.85***(0.02)	-0.87***(0.02)
$J-statistics$	8.49 [0.75]	7.28 [0.84]	7.28 [0.84]	7.85 [0.80]
$No.obs$	103	103	103	103

Notes: a) Standard errors are in parentheses; P-values are in brackets; b) $\beta-$discount factor, $\alpha-$ share of foreign money balances in producing money services; s=$\frac{1}{1+\rho}-$elasticity of currency substitution

Table C 2. Simulated Seigniorage/GDP Ratios (%)

a) Scenario 1: $\epsilon = \pi(\pi^* = 0\%)$

$\pi, \%$	α		
	0.4	0.5	0.6
0.2	0.14	0.08	0.03
0.5	0.29	0.16	0.06
1.0	0.43	0.20	0.07
2.0	0.47	0.18	0.05
3.0	0.42	0.14	0.04
4.0	0.36	0.11	0.03
5.0	0.30	0.09	0.02
6.0	0.25	0.07	0.019
8.0	0.18	0.05	0.012
10	0.13	0.04	0.009
20	0.05	0.01	0.003
30	0.03	0.007	0.002
50	0.01	0.004	0.001

b) Scenario 2: $\pi^* = 5\%$

$\pi, \%$	α		
	0.4	0.5	0.6
0.2	0.19	0.18	0.15
0.5	0.41	0.38	0.30
1.0	0.68	0.61	0.44
2.0	0.99	0.83	0.50
3.0	1.15	0.87	0.45
4.0	1.22	0.84	0.39
5.0	1.24	0.78	0.32
6.0	1.23	0.71	0.27
8.0	1.16	0.57	0.19
10	1.05	0.46	0.15
20	0.61	0.20	0.05
30	0.39	0.12	0.03
50	0.23	0.06	0.02

Appendix D Derivation of the Estimated Equations

The specification of the utility function:

$$u(c_t, s_t) = \frac{(c_t^{1-\gamma} x_t^{\gamma})^{1-\sigma} - 1}{1-\sigma} \qquad \text{(eq. A1)}$$

where

$$x_t = [(1-\alpha) m_t^{-\rho} + \alpha m_t^{*-\rho}]^{-\frac{1}{\rho}} \qquad \text{(eq. A2)}$$

We maximize

$$\max \sum_{t=0}^{\infty} \beta^t U(c_t, x_t)$$

s.t. the budget constraint

$$c_t + m_t + m_t^* + b_t = y_t + \tau_t + \frac{m_{t-1}}{1+\pi_t} + \frac{m_{t-1}^*(1+\epsilon_t)}{1+\pi_t} + \frac{b_{t-1}(1+r_{t-1})}{1+\pi_t}, \qquad \text{(eq.A3)}$$

F.O.C.:

$[c_t]$:

$$(1-\gamma)(c_t^{1-\gamma} x_t^{\gamma})^{-\sigma} c_t^{-\gamma} x_t^{\gamma} - \lambda_t = 0, \qquad \text{(eq. A4)}$$

$[m_t]$:

$$\gamma(c_t^{1-\gamma} x_t^{\gamma})^{-\sigma} c_t^{1-\gamma} x_t^{\gamma-1} \times [(1-\alpha)\, m_t^{1-\rho} + \alpha m_t^{*-\rho}]^{-\frac{1}{\rho}-1} \times$$
$$\times (1-\alpha)\, m_t^{-\rho-1} + \beta E_t \lambda_{t+1} \frac{1}{1+\pi_{t+1}} - \lambda_t = 0, \qquad \text{(eq. A5)}$$

$[m_t^*]$:

$$\gamma(c_t^{1-\gamma} x_t^{\gamma})^{-\sigma} c_t^{1-\gamma} x_t^{\gamma-1} \times [(1-\alpha) m_t^{-\rho} + \alpha m_t^{*-\rho}]^{-\frac{1}{\rho}-1} \times$$
$$\times \alpha m_t^{*-\rho-1} + \beta E_t \lambda_{t+1} \frac{1+\epsilon_{t+1}}{1+\pi_{t+1}} - \lambda_t = 0, \qquad \text{(eq. A6)}$$

$[b_t]$:

$$\beta E_t \lambda_{t+1} \frac{1+r_t}{1+\pi_{t+1}} - \lambda_t = 0, \qquad \text{(eq. A7)}$$

Using eq. A4 and eq. A7, we get:

$$(c_t^{1-\gamma}x_t^{\gamma})^{-\sigma}c_t^{-\gamma}x_t^{\gamma} = \beta E_t\left\{(c_{t+1}^{1-\gamma}x_{t+1}^{\gamma})^{-\sigma}c_{t+1}^{-\gamma}x_{t+1}^{\gamma}\frac{1+r_t}{1+\pi_{t+1}}\right\}, \quad \Longleftrightarrow$$

$$\Longleftrightarrow \quad \beta E_t\left\{\left(\frac{c_{t+1}}{c_t}\right)^{-\sigma(1-\gamma)}\left(\frac{c_{t+1}}{c_t}\right)^{-\gamma}\left(\frac{x_{t+1}}{x_t}\right)^{-\sigma\gamma}\left(\frac{x_{t+1}}{x_t}\right)^{\gamma}\frac{1+r_t}{1+\pi_{t+1}}\right\} = 1, \quad \Longleftrightarrow$$

$$\Longleftrightarrow \quad \beta E_t\left\{\left(\frac{c_{t+1}}{c_t}\right)^{\sigma(\gamma-1)-\gamma}\left(\frac{x_{t+1}}{x_t}\right)^{\gamma(1-\sigma)}\frac{1+r_t}{1+\pi_{t+1}} = 1\right\}, \qquad \text{(eq. A8)}$$

We plug definition of x in eq. A2 into eq. A8, and we obtain the following expression:

$$\beta E_t\left\{\left(\frac{c_{t+1}}{c_t}\right)^{\sigma(\gamma-1)-\gamma}\left(\frac{[(1-\alpha)m_{t+1}^{-\rho}+\alpha m_{t+1}^{*-\rho}]^{-\frac{1}{\rho}}}{[(1-\alpha)m_t^{-\rho}+\alpha m_t^{*-\rho}]^{-\frac{1}{\rho}}}\right)^{\gamma(1-\sigma)}\frac{1+r_t}{1+\pi_{t+1}}\right\} - 1 = 0, \quad \Longleftrightarrow$$

Take out m_t and m_{t+1} from the parentheses to get:

$$\Longleftrightarrow \quad \beta E_t\left\{\left(\frac{c_{+1}}{c_t}\right)^{\sigma(\gamma-1)-\gamma}\left(\frac{[1-\alpha+\alpha\left(\frac{m_{t+1}^*}{m_{t+1}}\right)^{-\rho}]^{-\frac{1}{\rho}}\times m_{t+1}}{[1-\alpha+\alpha\left(\frac{m_t^*}{m_t}\right)^{-\rho}]^{-\frac{1}{\rho}}\times m_t}\right)^{\gamma(1-\sigma)}\frac{1+r_t}{1+\pi_{t+1}}\right\}-1 = 0, \quad \Longleftrightarrow$$

Define $h = \frac{m^*}{m}$ and we have the first equations to be estimated:

$$\Longleftrightarrow \quad \beta E_t\left\{\left(\frac{c_{t+1}}{c_t}\right)^{\sigma(\gamma-1)-\gamma}\left(\frac{m_{t+1}}{m_t}\right)^{\gamma(1-\sigma)}\left(\frac{1-\alpha+\alpha h_{t+1}^{-\rho}}{1-\alpha+\alpha h_t^{-\rho}}\right)^{-\frac{\gamma(1-\sigma)}{\rho}}\frac{1+r_t}{1+\pi_{t+1}}\right\}-1 = 0. \qquad \text{(eq. A9)}$$

Further, divide eq. A5 by the definition of λ from equation A4.:

$$\frac{(c_t^{1-\gamma}x_t^{\gamma})^{-\sigma}\gamma c_t^{1-\gamma}x_t^{\gamma-1}(1-\alpha)[(1-\alpha)m_t^{-\rho}+\alpha m_t^{*-\rho}]^{-\frac{1}{\rho}-1}\times m_t^{-\rho-1}}{(1-\gamma)(c_t^{1-\gamma}x_t^{\gamma})^{-\sigma}c_t^{-\gamma}x_t^{\gamma}}+$$
$$+\beta E_t\left\{\frac{(1-\gamma)(c_{t+1}^{1-\gamma}x_{t+1}^{\gamma})^{-\sigma}c_{t+1}^{-\gamma}x_{t+1}^{\gamma}}{(1-\gamma)(c_t^{1-\gamma}x_t^{\gamma})^{-\sigma}c_t^{-\gamma}x_t^{\gamma}}\frac{1}{(1+\pi_{t+1})}\right\}-1=0, \quad \Longleftrightarrow$$

$$\Longleftrightarrow \quad \frac{\gamma}{(1-\gamma)}(1-\alpha)c_t x_t^{-1}[(1-\alpha)m_t^{-\rho}+\alpha m_t^{*-\rho}]^{-\frac{1}{\rho}-1}\times m_t^{-\rho-1}+$$
$$+\beta E_t\left\{\left(\frac{c_{t+1}}{c_t}\right)^{\sigma(\gamma-1)-\gamma}\left(\frac{x_{t+1}}{x_t}\right)^{\gamma(1-\sigma)}\frac{1}{(1+\pi_{t+1})}\right\}-1=0 \quad \Leftrightarrow$$

Plug the definition of x into the equation, and take m out of the parentheses:

$$\Leftrightarrow \quad \gamma(1-\alpha)c_t\frac{[1-\alpha+\alpha(\frac{m_t^*}{m_t})^{-\rho}]^{-\frac{1}{\rho}-1}\times m_t^{1+\rho}m_t^{-\rho-1}}{[1-\alpha+\alpha\left(\frac{m_t^*}{m_t}\right)^{-\rho}]^{-\frac{1}{\rho}}\times m_t}-$$
$$-(1-\gamma)\left(1-\beta E_t\left\{\begin{array}{c}(\frac{c_{t+1}}{c_t})^{\sigma(\gamma-1)-\gamma}\left(\frac{m_{t+1}}{m_t}\right)^{\gamma(1-\sigma)}\times \\ \times\left(\frac{1-\alpha+\alpha\left(\frac{m_{t+1}^*}{m_{t+1}}\right)^{-\rho}}{1-\alpha+\alpha\left(\frac{m_t^*}{m_t}\right)^{-\rho}}\right)^{\frac{\gamma(\sigma-1)}{\rho}}\times\frac{1}{(1+\pi_{t+1})}\end{array}\right\}\right)=0, \quad \Longleftrightarrow$$

As $h=\frac{m*}{m}$, we obtain the next equation to be estimated:

$$\gamma(1-\alpha)\frac{c_t}{m_t}\frac{1}{(1-\alpha+\alpha h_t^{-\rho})}=(1-\gamma)\times$$
$$\times\left(1-\beta E_t\left\{\left(\frac{c_{t+1}}{c_t}\right)^{\sigma(\gamma-1)-\gamma}\left(\frac{m_{t+1}}{m_t}\right)^{\gamma(1-\sigma)}\left(\frac{1-\alpha+\alpha h_{t+1}^{-\rho}}{1-\alpha+\alpha h_t^{-\rho}}\right)^{\frac{\gamma(\sigma-1)}{\rho}}\times\frac{1}{(1+\pi_{t+1})}\right\}\right) \quad \text{(eq. A10)}$$

Now, to derive the third estimation equation, equation A6 has to be divided by λ:

$$\frac{(c_t^{1-\gamma}x_t^{\gamma})^{-\sigma}\gamma c_t^{1-\gamma}x_t^{\gamma-1}[(1-\alpha)m_t^{-\rho}+\alpha m_t^{*-\rho}]^{-\frac{1}{\rho}-1}\times\alpha m_t^{*-\rho-1}}{(1-\gamma)(c_t^{1-\gamma}x_t^{\gamma})^{-\sigma}c_t^{-\gamma}x_t^{\gamma}}+$$
$$+\beta E_t\left\{\frac{(1-\gamma)(c_{t+1}^{1-\gamma}x_{t+1}^{\gamma})^{-\sigma}c_{t+1}^{-\gamma}x_{t+1}^{\gamma}}{(1-\gamma)(c_t^{1-\gamma}x_t^{\gamma})^{-\sigma}c_t^{-\gamma}x_t^{\gamma}}\frac{(1+\epsilon_{t+1})}{(1+\pi_{t+1})}\right\}-1=0,\quad\Longleftrightarrow$$

Following the same manipulation as in equation A8, we obtain the following equation:

$$\Longleftrightarrow\quad\frac{\gamma}{(1-\gamma)}\alpha c_t x_t^{-1}[1-\alpha+\alpha h_t^{-\rho}]^{-\frac{1}{\rho}-1}\times m_t^{1+\rho}m_t^{*-\rho-1}+$$
$$+\beta E_t\left\{\left(\frac{c_{t+1}}{c_t}\right)^{\sigma(\gamma-1)-\gamma}\left(\frac{x_{t+1}}{x_t}\right)^{\gamma(1-\sigma)}\frac{(1+\epsilon_{t+1})}{(1+\pi_{t+1})}\right\}-1=0;\quad\Longleftrightarrow$$

$$\alpha\gamma\frac{c_t}{m_t^*}\frac{1}{((1-\alpha)h_t^{*\rho}+\alpha)}=$$
$$=(1-\gamma)\left(1-\beta E_t\left\{\begin{array}{c}\left(\frac{c_{t+1}}{c_t}\right)^{\sigma(\gamma-1)-\gamma}\left(\frac{m_{t+1}}{m_t}\right)^{\gamma(1-\sigma)}\times\\ \times\left(\frac{1-\alpha+\alpha h_{t+1}^{-\rho}}{1-\alpha+\alpha h_t^{-\rho}}\right)^{\gamma(\sigma-1)/\rho}\times\frac{(1+\epsilon_{t+1})}{(1+\pi_{t+1})}\end{array}\right\}\right)\qquad\text{(eq. A11)}$$

Dividing eq. A11 by eq. A10, we first consider the LHS. We manipulate the expression in the denominator taking $\left(\frac{m_t^*}{m_t}\right)^{-\rho}$ out of the parentheses:

$$\frac{(1-\alpha)}{\alpha}\frac{m_t^*}{m_t}\frac{\left((1-\alpha)\left(\frac{m_t^*}{m_t}\right)^{\rho}+\alpha\right)}{\left(1-\alpha+\alpha\left(\frac{m_t^*}{m_t}\right)^{-\rho}\right)}=\frac{(1-\alpha)}{\alpha}\frac{m_t^*}{m_t}\frac{\left((1-\alpha)\left(\frac{m_t^*}{m_t}\right)^{\rho}+\alpha\right)}{\left(\left(\frac{m_t^*}{m_t}\right)^{-\rho}\left[(1-\alpha)\left(\frac{m_t^*}{m_t}\right)^{\rho}+\alpha\right]\right)}=\qquad\text{(eq. A12)}$$
$$=\frac{(1-\alpha)}{\alpha}\left(\frac{m_t^*}{m_t}\right)^{1+\rho},$$

In the RHS, denote:

$$Z = \left(\frac{c_{t+1}}{c_t}\right)^{\sigma(\gamma-1)-\gamma} \left(\frac{m_{t+1}}{m_t}\right)^{\gamma(1-\sigma)} \times \left(\frac{1-\alpha+\alpha h_{t+1}^{-\rho}}{1-\alpha+\alpha h_t^{-\rho}}\right)^{\gamma(\sigma-1)/\rho} \times \frac{1}{(1+\pi_{t+1})}$$

This notation simplifies the representation while deriving the next estimation equation. Thus, dividing the RHS term of eq. A11 by the RHS term of eq. A10 and equaling to the expression from equation A12, we obtain:

$$\frac{(1-\alpha)}{\alpha} h_t^{1+\rho} = \frac{1-\beta E_t\left[Z\right]}{1-\beta E_t\left[Z\right](1+\epsilon_{t+1})}, \quad \Longleftrightarrow$$

$$\Longleftrightarrow \quad \frac{(1-\alpha)}{\alpha} h_t^{1+\rho} \times (1-\beta E_t\left(Z\right)(1+\epsilon_{t+1}) = 1-\beta E_t\left[Z\right], \quad \Longleftrightarrow$$

$$\Longleftrightarrow \quad \frac{(1-\alpha)}{\alpha} h_t^{1+\rho} - \frac{(1-\alpha)}{\alpha} \beta E_t\left[Z\right](1+\epsilon_{t+1}) h_t^{1+\rho} = 1-\beta E_t\left[Z\right], \quad \Longleftrightarrow$$

$$\Longleftrightarrow \quad \frac{(1-\alpha)}{\alpha} h_t^{1+\rho} = 1-\beta E_t\left[Z\right]\left(1+\frac{(1-\alpha)}{\alpha}(1+\epsilon_{t+1}) h_t^{1+\rho}\right), \quad \Longleftrightarrow$$

$$\Longleftrightarrow \quad (1-\alpha) h_t^{1+\rho} - \alpha = \beta E_t\left[Z\right]((1-\alpha)(1+\epsilon_{t+1}) h_t^{1+\rho} - \alpha). \qquad \text{(eq. A13)}$$

Thus, eq. A9, eq. A10 and eq. A13 will be estimated by the GMM method in the following form:

$$d_{1,t+1} = \beta E_t \left\{ \begin{array}{l} \left(\frac{c_{t+1}}{c_t}\right)^{\sigma(\gamma-1)-\gamma} \left(\frac{m_{t+1}}{m_t}\right)^{\gamma(1-\sigma)} \times \\ \times \left(\frac{1-\alpha+\alpha h_{t+1}^{-\rho}}{1-\alpha+\alpha h_t^{-\rho}}\right)^{-\frac{\gamma(1-\sigma)}{\rho}} \frac{1+r_t}{1+\pi_{t+1}} \end{array} \right\} - 1, \qquad \text{(eq. A14)}$$

$$d_{2,t+1} = \frac{c_t}{m_t} \frac{\gamma(1-\alpha)}{(1-\alpha+\alpha h_t^{-\rho})} - (1-\gamma) \times$$
$$\times \left(1 - \beta E_t \left\{ \begin{array}{l} \left(\frac{c_{t+1}}{c_t}\right)^{\sigma(\gamma-1)-\gamma} \left(\frac{m_{t+1}}{m_t}\right)^{\gamma(1-\sigma)} \times \\ \times \left(\frac{1-\alpha+\alpha h_{t+1}^{-\rho}}{1-\alpha+\alpha h_t^{-\rho}}\right)^{\frac{\gamma(\alpha-1)}{\rho}} \times \frac{1}{(1+\pi_{t+1})} \end{array} \right\} \right), \qquad \text{(eq. A15)}$$

$$d_{3,t+1} = (1-\alpha)h_t^{1+\rho} - \alpha - \beta E_t \times$$
$$\times \left[\left(\frac{c_{t+1}}{c_t} \right)^{\sigma(\gamma-1)-\gamma} \left(\frac{m_{t+1}}{m_t} \right)^{\gamma(1-\sigma)} \times \left(\frac{1-\alpha+\alpha h_{t+1}^{-\rho}}{1-\alpha+\alpha h_t^{-\rho}} \right)^{\gamma(\sigma-1)/\rho} \right] \times \tag{29}$$
$$\times \frac{(1-\alpha)\,(1+\epsilon_{t+1})h_t^{1+\rho} - \alpha}{(1+\pi_{t+1})} \qquad \text{(eq. A16)}$$

Derivation of the Demand for Domestic Real Money Balances

To derive the money demand for the domestic money balances, we need the F.O.C.:
$[c_t]$:

$$(1-\gamma)(c_t^{1-\gamma}x_t^{\gamma})^{-\sigma}c_t^{-\gamma}x_t^{\gamma} - \lambda_t = 0, \qquad \text{(eq. A 4)}$$

$[m_t]$:

$$\gamma(c_t^{1-\gamma}x_t^{\gamma})^{-\sigma}c_t^{1-\gamma}x_t^{\gamma-1} \times \left[(1-\alpha)\,m_t^{1-\rho} + \alpha m_t^{*-\rho}\right]^{-\frac{1}{\rho}-1} \times (1-\alpha)\,m_t^{-\rho-1} +$$
$$+\beta E_t \lambda_{t+1} \frac{1}{1+\pi_{t+1}} - \lambda_t = 0, \qquad \text{(eq. A5)}$$

$[m_t^*]$:

$$\gamma(c_t^{1-\gamma}x_t^{\gamma})^{-\sigma}c_t^{1-\gamma}x_t^{\gamma-1} \times \left[(1-\alpha)m_t^{-\rho} + \alpha m_t^{*-\rho}\right]^{-\frac{1}{\rho}-1} \times \alpha m_t^{*-\rho-1} + \beta E_t \lambda_{t+1} \frac{1+\epsilon_{t+1}}{1+\pi_{t+1}} - \lambda_t = 0, \qquad \text{(eq. A6)}$$

$[b_t]$:

$$\beta E_t \lambda_{t+1} \frac{1+r_t}{1+\pi_{t+1}} - \lambda_t = 0, \qquad \text{(eq. A7)}$$

We assume a hypothetical steady state, where real consumption (c) and real money holdings (x) grow at a constant rate ϕ. Using equations A 4 and A5, we obtain:

$$\frac{\gamma}{(1-\gamma)}\frac{c}{x}[(1-\alpha)m^{-\rho}+\alpha m^{*-\rho}]^{-\frac{1}{\rho}-1}(1-\alpha)\,m^{-\rho-1}+$$
$$+\beta\frac{1}{(1+\pi)}(1+\phi)^{-(1-\gamma)\sigma}(1+\phi)^{-\gamma\sigma}(1-\phi)^{-\gamma}(1-\phi)^{\gamma}-1=0, \qquad \Longleftrightarrow$$

Plugging the definition of x we obtain:

$$\frac{\gamma}{(1-\gamma)}c\frac{[(1-\alpha)m^{-\rho}+\alpha m^{*-\rho}]^{-\frac{1}{\rho}-1}}{[(1-\alpha)m^{-\rho}+\alpha m^{*-\rho}]^{-\frac{1}{\rho}}}\times(1-\alpha)m^{-\rho-1}+ \qquad \text{(eq. A17)}$$
$$+\beta\frac{1}{(1+\pi)}(1+\phi)^{-\sigma}-1=0 \quad \Longleftrightarrow$$

Taking the term $(1-\alpha)m$ out of the parentheses, we obtain:

$$\frac{\gamma}{(1-\gamma)}\frac{c}{m}\frac{1}{\left[1+\frac{\alpha}{1-\alpha}h^{-\rho}\right]}(1-\alpha)m^{-\rho-1}=1-\beta\frac{(1+\phi)^{-\sigma}}{(1+\pi)}, \qquad \text{(eq. A18)}$$

where $h=\frac{m^*}{m}$. Further, dividing eq. A6 by eq. A4, we get:

$$\frac{\gamma}{(1-\gamma)}c\frac{[(1-\alpha)m^{-\rho}+\alpha m^{*-\rho}]^{-\frac{1}{\rho}-1}}{[(1-\alpha)m^{-\rho}+\alpha m^{*-\rho}]^{-\frac{1}{\rho}}}\times\alpha m^{*-\rho-1}+$$
$$+\beta\frac{(1+\epsilon)\,(1+\phi)^{-\sigma}}{(1+\pi)}-1=0 \quad \Longleftrightarrow$$

$$\frac{\gamma}{1-\gamma}\frac{c}{m}\frac{1}{\left[1+\frac{\alpha}{1-\alpha}h^{-\rho}\right]}\alpha m^{*-\rho-1}=1-\beta\frac{(1+\epsilon)\,(1+\phi)^{-\sigma}}{(1+\pi)}. \qquad \text{(eq. A19)}$$

Dividing equation A19 by equation A18, we get:

$$\frac{\alpha}{(1-\alpha)}h^{-\rho-1}=\frac{1-\beta\frac{(1+\epsilon)(1+\phi)^{-\sigma}}{(1+\pi)}}{1-\beta\frac{(1+\phi)^{-\sigma}}{(1+\pi)}}$$

Deriving the ratio denoted by h, we obtain:

$$h = \left(\frac{(1-\alpha)}{\alpha} \frac{1-\beta\frac{(1+\epsilon)(1+\phi)^{-\sigma}}{(1+\pi)}}{1-\beta\frac{(1+\phi)^{-\sigma}}{(1+\pi)}} \right)^{-\frac{1}{1+\rho}}. \qquad \text{(eq.A20)}$$

Plugging the derived expression for h from equation A20, into equation A18, we get:

$$\frac{\gamma}{(1-\gamma)}\frac{c}{m}\frac{1}{\left[1+\frac{\alpha}{1-\alpha}\left(\frac{(1-\alpha)}{\alpha}\frac{1-\beta\frac{(1+\epsilon)(1+\phi)^{-\sigma}}{(1+\pi)}}{1-\beta\frac{(1+\phi)^{-\sigma}}{(1+\pi)}}\right)^{\frac{\rho}{1+\rho}}\right]} + \beta\frac{(1+\phi)^{-\sigma}}{(1+\pi)} - 1 = 0,$$

From this expression, we can derive m:

$$m = \frac{\gamma}{(1-\gamma)}\frac{c}{\left(1-\frac{\beta(1+\phi)^{-\sigma}}{(1+\pi)}\right)\left[1+\frac{\alpha}{1-\alpha}\left(\frac{(1-\alpha)}{\alpha}\frac{1-\beta\frac{(1+\epsilon)(1+\phi)^{-\sigma}}{(1+\pi)}}{1-\beta\frac{(1+\phi)^{-\sigma}}{(1+\pi)}}\right)^{\frac{\rho}{1+\rho}}\right]} \qquad \text{(eq. A21)}$$

Following Friedman and Verbetsky (2001), we define the following terms:
$R_b = (1+R)/(1+\pi)$, $1+R = (1+\pi)(1+n)(1+\phi)^{\sigma}/\beta$, $R_m = 1/(1+\pi)$ and
$R_{mf} = (1+\epsilon)/(1+\pi)$.
In this paper, I assume the population growth rate to equal 0. Following Walsh (2003), the steady state inflation π should be equal to the steady state money growth. First plugging the defined terms into the denominator of equation A21, we obtain:

$$(1-\beta(1+\phi)^{-\sigma}R_m)\left(1+\frac{\alpha}{(1-\alpha)}\left(\frac{(1-\alpha)}{\alpha}\frac{1-\beta(1+\phi)^{-\sigma}R_{mf}}{1-\beta(1+\phi)^{-\sigma}R_m}\right)^{\frac{\rho}{1+\rho}}\right)=$$

$$=(1-\beta(1+\phi)^{-\sigma}R_m)\left(1+\frac{\alpha}{(1-\alpha)}\left(\frac{(1-\alpha)}{\alpha}\frac{1-\frac{(1+\pi)}{1+R}R_{mf}}{1-\frac{(1+\pi)}{(1+R)}R_m}\right)^{\frac{\rho}{1+\rho}}\right)=$$

$$=(1-\beta(1+\phi)^{-\sigma}R_m)\left(1+\frac{\alpha}{(1-\alpha)}\left(\frac{(1-\alpha)}{\alpha}\frac{1-\frac{1}{R_b}R_{mf}}{1-\frac{1}{R_b}R_m}\right)^{\frac{\rho}{1+\rho}}\right)=$$

$$=(1-\frac{R_m}{R_b})\left(1+\frac{\alpha}{(1-\alpha)}\left(\frac{(1-\alpha)}{\alpha}\frac{R_b-R_{mf}}{R_b-R_m}\right)^{\frac{\rho}{1+\rho}}\right)=$$

$$=\frac{1}{R_b}(R_b-R_m)\left(1+\frac{\alpha}{(1-\alpha)}\left(\frac{(1-\alpha)}{\alpha}\frac{R_b-R_{mf}}{R_b-R_m}\right)^{\frac{\rho}{1+\rho}}\right)=$$

$$=\frac{1}{R_b}(R_b-R_m)\left(1+\left(\frac{\alpha}{1-\alpha}\right)^{\frac{1}{1+\rho}}\left(\frac{R_b-R_{mf}}{R_b-R_m}\right)^{\frac{\rho}{1+\rho}}\right)=$$

$$=\frac{1}{R_b}(R_b-R_m)+\frac{1}{R_b}(R_b-R_m)\left(\frac{\alpha}{1-\alpha}\right)^{\frac{1}{1+\rho}}\left(\frac{R_b-R_{mf}}{R_b-R_m}\right)^{\frac{\rho}{1+\rho}}=$$

$$=\frac{1}{R_b}(R_b-R_m)+\frac{1}{R_b}(R_b-R_m)\left(\frac{\alpha}{1-\alpha}\right)^{\frac{1}{1+\rho}}\left(\frac{R_b-R_{mf}}{R_b-R_m}\right)^{\frac{\rho}{1+\rho}}=$$

$$=\frac{1}{R_b}(R_b-R_m)+\frac{1}{R_b}(R_b-R_{mf})\left(\frac{\alpha}{1-\alpha}\frac{R_b-R_m}{R_b-R_{mf}}\right)^{\frac{1}{1+\rho}}$$

Plug the last derived equation into the denominator of eq. A21:

$$m=\frac{\gamma}{(1-\gamma)}\frac{R_b c}{(R_b-R_m)+(R_b-R_{mf})\left(\frac{\alpha}{1-\alpha}\frac{R_b-R_m}{R_b-R_{mf}}\right)^{\frac{1}{1+\rho}}} \qquad \text{(eq. A22)}$$

To compute seigniorage loss, we need a definition of seigniorage. Following Walsh (2003), the seigniorage revenue s can be computed as follows:

$$s_t=\frac{M_t-M_{t-1}}{P_t} \qquad \text{(eq.A23)}$$

Then the ratio of seigniorage-to-GDP can be represented as follows:

$$\frac{s_t}{Y_t} = \frac{M_t - M_{t-1}}{P_t Y_t} = \frac{M_t - M_{t-1}}{P_t Y_t}\frac{M_t}{M_t} \iff$$

Assuming that money supply grows at the following rate:

$$M_t = (1+\pi)(1+\phi)(1+n)M_{t-1} \qquad \text{(eq. A24)}$$

Therefore, the seigniorage- to-GDP ratio will be calculated in the following way:

$$\frac{s_t}{Y_t} = \frac{M_t}{P_t Y_t}\left(1 - \frac{1}{(1+\pi)(1+\phi)(1+n)}\right),$$

In per capita terms:

$$\frac{s_t}{Y_t} = \frac{m_t}{y_t}\left(1 - \frac{1}{(1+\pi)(1+\phi)(1+n)}\right) \qquad \text{(eq. A25)}$$

Assuming that n=0, and in steady state $M_t = (1+\pi)(1+n)(1+\phi)M_{t-1}$, while $1+\pi = 1+\phi$, the seigniorage to GDP ratio is:

$$\frac{s}{Y} = \frac{m}{y}\left(1 - \frac{1}{(1+\phi)}\right) \qquad \text{(eq. A26)}$$

Now the seigniorage ratio can be calculated by plugging the expression for m from eq. A22.

Derivation of Welfare Loss

$$\begin{aligned} u(c,x) &= \frac{(c^{1-\gamma}\left((1-\alpha)\,m^{-\rho} + \alpha m^{*-\rho}\right)^{-\frac{\gamma}{\rho}})^{(1-\sigma)} - 1}{(1-\sigma)} = \\ &= \frac{(c^{1-\gamma} m^{\gamma}\left((1-\alpha) + \alpha\frac{m^{*-\rho}}{m^{-\rho}}\right)^{-\frac{\gamma}{\rho}})^{(1-\sigma)} - 1}{(1-\sigma)} \end{aligned}$$

Plug the derived expression for the ratio h from equation A20:

$$u(c,x)=\frac{c^{(1-\gamma)(1-\sigma)}m^{\gamma(1-\sigma)}\left(1-\alpha+\alpha\left(\frac{1-\alpha}{\alpha}\left(\frac{1-\beta\frac{(1+\epsilon)(1+\phi)^{-\sigma}}{(1+\pi)}}{1-\beta\frac{(1+\phi)^{-\sigma}}{(1+\pi)}}\right)^{\frac{\rho}{1+\rho}}\right)\right)^{-\frac{\gamma(1-\sigma)}{\rho}}-1}{(1-\sigma)}.$$

To calculate the welfare costs of various steady state levels of inflation, we need to compute the percentage decrease in consumption per capita that would generate the same welfare loss as that from moving from the original level of dollarization α_1 to a higher level of dollarization α_2.
So assume that $c_1 \succ c_2$ and $c_1 = c_2 + \Delta c$, and $\alpha_1 \prec \alpha_2$.

$$\frac{c_1^{(1-\gamma)(1-\sigma)}m_1^{\gamma(1-\sigma)}\left(1-\alpha_1+\alpha_1\left(\frac{1-\alpha_1}{\alpha_1}\left(\frac{1-\beta\frac{(1+\epsilon)(1+\phi)^{-\sigma}}{(1+\pi)}}{1-\beta\frac{(1+\phi)^{-\sigma}}{(1+\pi)}}\right)^{\frac{\rho}{1+\rho}}\right)\right)^{-\frac{\gamma(1-\sigma)}{\rho}}-1}{(1-\sigma)}=$$

$$=\frac{(c_1+\Delta c)^{(1-\gamma)(1-\sigma)}m_2^{\gamma(1-\sigma)}\left(1-\alpha_2+\alpha_2\left(\frac{1-\alpha_2}{\alpha_2}\left(\frac{1-\beta\frac{(1+\epsilon)(1+\phi)^{-\sigma}}{(1+\pi)}}{1-\beta\frac{(1+\phi)^{-\sigma}}{(1+\pi)}}\right)^{\frac{\rho}{1+\rho}}\right)\right)^{-\frac{\gamma(1-\sigma)}{\rho}}-1}{(1-\sigma)} \Leftrightarrow$$

$$\Leftrightarrow \quad c_1^{(1-\gamma)(1-\sigma)}m_1^{\gamma(1-\sigma)}\left(1-\alpha_1+\alpha_1\left(\frac{1-\alpha_1}{\alpha_1}\left(\frac{1-\beta\frac{(1+\epsilon)(1+\phi)^{-\sigma}}{(1+\pi)}}{1-\beta\frac{(1+\phi)^{-\sigma}}{(1+\pi)}}\right)^{\frac{\rho}{1+\rho}}\right)\right)^{-\frac{\gamma(1-\sigma)}{\rho}} =$$

$$= \quad (c_1+\Delta c)^{(1-\gamma)(1-\sigma)}m_2^{\gamma(1-\sigma)}\left(1-\alpha_2+\alpha_2\left(\frac{1-\alpha_2}{\alpha_2}\left(\frac{1-\beta\frac{(1+\epsilon)(1+\phi)^{-\sigma}}{(1+\pi)}}{1-\beta\frac{(1+\phi)^{-\sigma}}{(1+\pi)}}\right)^{\frac{\rho}{1+\rho}}\right)\right)^{-\frac{\gamma(1-\sigma)}{\rho}}$$

Defining the expression in parentheses as $f(\alpha)$, we then obtain:

$$c_1^{(1-\gamma)}m_1^{\gamma}f(\alpha_1) = (c_1+\Delta c)^{(1-\gamma)}m_2^{\gamma}f(\alpha_2), \Longleftrightarrow$$

$$\iff \left(\frac{c_1 + \Delta c}{c_1}\right)^{(1-\gamma)} = \frac{m_2^\gamma f(\alpha_2)}{m_1^\gamma f(\alpha_1)}, \iff$$

$$\iff \frac{c_1 + \Delta c}{c_1} = \left(\frac{m_2^\gamma f(\alpha_2)}{m_1^\gamma f(\alpha_1)}\right)^{\frac{1}{1-\gamma}}, \iff$$

$$\iff \frac{\Delta c}{c_1} = \left(\frac{m_2^\gamma f(\alpha_2)}{m_1^\gamma f(\alpha_1)}\right)^{\frac{1}{1-\gamma}} - 1$$

As a ratio of GDP per capita, the consumption compensation is:

$$\frac{\Delta c}{y} = \frac{c}{y}\left[\left(\frac{m_2^\gamma f(\alpha_2)}{m_1^\gamma f(\alpha_1)}\right)^{\frac{1}{1-\gamma}} - 1\right].$$

Chapter 3

Modelling Inflation in the Economies of Central Asia

Abstract

This study examines inflation in two Central Asian economies - Kazakhstan and the Kyrgyz Republic. The period covered spans from 1995 to 2008. Stabilizing inflation became a major challenge for the central banks of these countries after they achieved independence. An empirical model of inflation is developed in order to investigate the main factors affecting inflation in these countries. The model accounts for dollarization through assumptions on some of the factors and by examining the use of different monetary aggregates as a measure of money supply. Estimation of the short run inflation equation shows that exchange rate pass-through to prices together with past inflation are important factors of inflation. Moreover, inflation reacts to long term deviations of the money demand from its equilibrium. The empirical methodology is comprised of case by case as well as system estimation. The study also takes into account the possibility of instability of the model's parameters.

1 Introduction

Maintaining price stability by keeping control of inflation has been the primary goal of central bankers in transition economies. Stable prices serve as an indicator of economic health and financial stability, and are an important step towards sustainable growth. This makes the problem of understanding inflationary processes important, especially in the economies that are overcoming deep economic transformation. This study examines inflationary processes in two countries in Central Asia: Kazakhstan and the Kyrgyz Republic. These countries have overcome a period of macroeconomic instability and high inflation. The objective of this empirical investigation is to establish the main factors that affect inflation in these economies. The empirical model presented accounts for dollarization as it potentially affects the pass-through to inflation.

There is a great body of literature on inflation, which investigates the main factors that affect inflation in different regions and economies. Such studies can help understand the main macroeconomic relationships and forecast inflation in the future.

Inflation developments in transition economies have come under active scrutiny as well. It is standard to construct an empirical model which includes those factors assumed to explain inflation in a particular country. Among such studies on inflation in developing countries are Fischer, Sahay, and Végh (2002), who consider hyper and high inflations in various countries, including transition ones in their sample. Golinelli and Orsi (2002) study inflation factors in three new EU member countries: the Czech Republic, Hungary, and Poland. Lissovolik (2003) studies the determinants of inflation in Ukraine for the period after its independence. Several studies on inflation also address the issue of dollarization in transition economies. Some argue that taking dollarization into account will help better understand the relationship between inflation and money.

For example, Oomes and Ohnsorge (2005) study money demand in Russia, and argue that in a country with a high degree of dollarization, accounting for foreign cash in circulation and foreign currency deposits helps restore the stable relationship between money and inflation. Goujon (2006) proposes a methodology to study inflation in the dollarized economy of Vietnam. The present study is an attempt to overcome some of the shortcomings of previous studies by constructing a model that accounts for dollarization, variation in the model's parameters over time, the endogeneity problem, and similarity in the external shocks that the region is subject to.

Central Asian economies have overcome a period of high levels of inflation and dollarization. Depreciating national currencies have lost attractiveness due to weak purchasing power and unstable exchange rates. Taking dollarization into account when studying inflation therefore is important for the empirical modeling of inflation. The active use of the foreign exchange interventions as a policy tool causes the endogeneity problem in the estimation that requires instrumental variable estimation. Choosing a model to fit the data in a transition period should account for instability of the parameters in this model.

The methodology used in the present study follows that of Goujon (2006) who studied inflation in the dollarized economy of Vietnam. This empirical model is built to account for the high level of dollarization in Vietnam. The model thus can be applied to Central Asian states characterized by a high level of dollarization as well. Two measures of money are used for the present investigation: monetary aggregates with and without foreign currency denominated deposits. It is argued that inflation reacts not only to current changes in the economic situation, but is equally responsive to the deviations of different sectors from their equilibrium conditions. These are the long

term factors of inflation. For example, Juselius (1992) studies inflation in Denmark and suggests that in the long run prices react to imbalances in the internal labor market, monetary, and external sectors. Lissovolik (2003) proposes that inflation in Ukraine is affected by long run deviations in the money market and changes in the total unit costs. Goujon (2006) proposes a monetary sector imbalance as an important factor affecting inflation in a dollarized economy. To account for these effects, the author performs cointegration analysis on the money demand equation in order to calculate the deviations of the demand for money from its equilibrium values. This error correction model is subsequently included in the short run inflation equation along with other factors. The final section estimates inflation for two countries within a system what might improve the analysis by accounting for possibly similar shocks experienced by the economies in the region and increasing the power of the tests. Moreover, the stability of parameters in the model is called into question and different methodologies are proposed to determine whether the coefficients remain stable over the period covered.

The chapter is organized as follows. Section 2 discusses inflation developments in Kazakhstan and the Kyrgyz Republic. Section 3 presents the model of inflation. Section 4 discusses the empirical method. Section 5 presents the results. Section 6 presents the system estimation. Section 7 discusses the issue of parameter instability, and Section 8 concludes.

2 Inflation Developments in Central Asian Economies

Kazakhstan and the Kyrgyz Republic are transition economies that began the transformation from centrally planned to market economies in 1991 after the collapse of the Soviet Union. The first years of transition were very painful for these economies as they experienced sharp drops in production output, hyper inflation, disruption of economic and commercial relations with other former SU republics, and a deep economic recession. Gürgen, et al. (1999) give a comprehensive account of the economic developments, structural reforms and macroeconomic policies in the countries of Central Asia for the period from 1992 to 1998. I follow Gürgen et al. (1999) in describing the situation in the region before 1999.

The inflation developments in these countries can be divided into five periods. Four periods are similar to those described by Lissovolik (2003) in his study on inflation processes in Ukraine. The first period is the period of hyperinflation that lasted from 1992 to 1993, in which the newly established central banks were financing the losses of state enterprises and the deficit of the government. Strong monetary growth, price liberalization, and increasing import prices were the factors that brought accelerating rates of domestic inflation. In 1992, inflation was nearly 3000 percent in Kazakhstan and around 700 – 800 percent in the Kyrgyz Republic.

The second period started in 1994, after these countries took on stabilization as their major policy objective. In the Kyrgyz Republic inflation dropped sharply to less than 100 percent. In Kazakhstan, the stabilization program brought inflation down to 60 percent in 1995. During this period, stabilization was achieved mainly through a tight

monetary policy supported by fiscal discipline and flexible exchange rate regimes. In the following years, exchange rate stabilization became an ever-more important aspect of stabilization policy. As stable exchange rates were an indicator of effective monetary policy, the central banks of these two economies practiced the so-called managed float regime. Such policies brought positive results. In Kazakhstan, the inflation rate was the lowest among Central Asian economies already in 1996.

The third phase started after the Russian financial crisis in 1998, and lasted about two years. Large devaluation of the Russian ruble in 1998 brought pressure upon the national currencies in Central Asia as they became stronger vis-à-vis the currency of their main trade partner - Russia. Domestic goods were no longer competitive with the countries' major trade partners. In this situation the National Bank of Kazakhstan prepared for devalue the national currency – the Kazakh tenge - in April 1999 and to reconsider its exchange regime to a managed float. This led the National Bank of the Kyrgyz Republic to gradually decrease the exchange rate of the Kyrgyz som. Inflation increased sharply in both countries during this period.

In 2000, a new phase of economic development in Central Asia began. The exchange rate policies undertaken in 1999, yielded results in 2000. A favorable situation in the economies of the main trade partners, increasing world prices for oil, and further structural reforms resulted in an outstanding economic growth record in Kazakhstan and in the Kyrgyz Republic. Inflation rates have remained stable since 2000. This period was characterized by rapid developments of the domestic financial systems, a credit boom, and macroeconomic stability.

Recent developments in the world economy have had their impact on the economies of the Central Asia as well. As a result of the global financial crisis, the booming

banking sector of Kazakhstan had limited access to foreign financial sources. This has had a negative effect on banking sector growth. Furthermore, decreasing world prices for hydrocarbons, growth in world production of alternative types of fuel, and shocks in the world food market have brought a decline in the economic growth of the economy of Kazakhstan. The economy of Kyrgyz Republic has suffered negative shocks as well, but through different channels. The country was also affected by the increasing prices on food products, but negative effects were more specifically related to the regional energy crisis. These factors have had a destabilizing effect on the domestic price levels as inflation has increased in both economies.

In the Kyrgyz Republic and Kazakhstan high rates of inflation in the first years of transition undermined the position of young national currencies. Dollarization became widespread and served as protection for the public against the risk of losing assets denominated in domestic currency due to high inflation. Even after stabilization was achieved and positive economic growth was observed, dollarization remained significant. It was found in the previous chapter that there was a high level of substitutability between foreign and local currencies. It should be noted, however, that while instability encourages dollarization, stabilization does not result in immediate de-dollarization. This could be due to several factors. Havrylyshyn and Beddies (2003) argue that persistence of dollarization is caused by the fact that once people have adjusted to macroeconomic instability by switching to a foreign currency, they are reluctant to switch back to the local currency even if the situation in the economy has markedly improved. Moreover, the growing openness of the economy, availability of financial instruments denominated in foreign currency, and growing inflows of foreign currency contribute to an increasing amount of foreign currency denominated assets. An

important source of foreign money is also the remittances of relatives who emigrate to Western countries in search of jobs. This situation is very close to the situation discussed in Šošić and Kraft (2006) about Croatia during transition.

Though this section described inflation behavior from the very beginning of transition, the study itself covers the period when first successful results of the stabilization policies were achieved: from 1996 until the end of 2008.

3 A Model of Inflation

In developing a model to examine the inflation behavior in Kyrgyz Republic over the transition period, I follow the methodology proposed by Goujon (2006), who studied inflation in the dollarized Vietnamese economy. In the model, Goujon takes the standard price-taking small open economy, where a distinction is made between tradable (T) and non-tradable goods (NT) when calculating a consumer price index (CPI), which is defined as the geometric weighted average of price indices of both types of goods. Thus, the domestic inflation rate is given by:

$$\Delta p_t = \theta \Delta p_t^T + (1 - \theta) \Delta p_t^{NT}, \tag{1}$$

where small letters denote logarithms, p is the log of the CPI, p^T and p^{NT} are the logs of the prices of tradable and of non-tradable goods, respectively, Δ is the first difference operator, and θ is the weight of the prices of tradable goods in the CPI with $0 < \theta < 1$. For simplicity, it is first assumed that the weights of both tradable and non-tradable goods in the overall price index is constant during the period examined, as well as all other parameters in the model. Time varying parameters will be discussed

in subsection 3.1.

Following the methodology proposed, I first consider the relationship between exchange rate policy and the change in the prices of tradable goods. The price of the tradable goods can be derived from the equilibrium condition in the foreign exchange market.

The purchasing power parity (PPP) concept can come in handy when analyzing the exchange rate determination.[1] In the present model a concept of relative purchasing power parity is used, i.e. that a percentage change in the exchange rate is equal to the difference between the percentage changes in prices in two countries. The Law of One Price represents an important building block of the PPP concept. Equation 2 is a regression equation of tradable inflation for a price taking economy in case the Law of One Price holds:

$$\Delta p_t^T = \Delta e_t + \Delta p_t^W + \delta^T, \tag{2}$$

where e denotes the log of the nominal exchange rate, defined in terms of domestic currency, p^W are the international prices of tradable goods in foreign currency, δ^T is a constant capturing the evolution of other factors, e.g., transportation and transaction costs or trade policy. However, empirical investigations on the determination of the exchange rate which utilize the PPP produce contradictory results about the plausibility of the latter.[2] Such factors as trade barriers (e.g. tariffs) or transportation costs can cause PPP to fail. Therefore, equation 2 is transformed as follows:

[1] Though PPP is not a theory to determine exchange rates, it is an important building block in many international financial models. The main idea of PPP is that the nominal exchange rates are set in a way that the real purchasing power of currencies is constant over time (see the Handbook of International Economics, vol. 2).

[2] For more information see the Handbook of International Economics, vol. 2.

$$\Delta p_t^T = \lambda \Delta e_t + \mu \Delta p_t^W + \delta^T. \qquad (2^*)$$

In this case, λ and μ are the coefficients to be estimated. The parameter λ constitutes the exchange rate pass-through. If $0 < \lambda < 1$ then the pass-through is incomplete, and the Law of One Price does not hold. Thus, λ measures the variable mark-up of the prices of tradable goods over international prices following a change in the exchange rate. In reality, prices and exchange rates are determined endogenously and, thus, conceptually PPP is an equilibrium condition rather than a concept to determine the exchange rate. Empirically, including the nominal exchange rate as an explanatory variable can lead to an endogeneity problem, i.e. not only is inflation dependent on exchange rate variability, but the exchange rate can be managed by a central bank which seeks to stabilize inflation. Thus, a simple ordinary least squares (OLS) regression will result in a biased estimation. It is therefore necessary to use the instrumental variable (IV) estimation method to obtain unbiased estimators of coefficients in the inflation equation.[3]

The prices of non-tradable goods are determined by equilibrium conditions in the domestic markets. Goujon (2006) chooses the equilibrium condition in the monetary sector represented by the long run demand for money. A classical Lucas (1988) money demand equation is used to capture the dependence of real money holdings on real income and the opportunity costs of holding money. However, the stability of money demand has been called into question since Lucas first identified the relationship between the variables in the specified equation. One of the reasons is increasing

[3]Krugman (1978) uses a trend and Frenkel (1981) uses a constant and lagged dependent and explanatory variables as instrumental variables to account for endogeneity problem.

dollarization of financial assets and currency substitution. Teles and Zhou (2005) argue that a stable relationship can still be found if the right monetary aggregate is chosen for empirical analysis. In transition economies it might be important to include foreign currency denominated assets into a measure of money supply.[4] Empirically, the use of the broadest monetary aggregate to establish a stable relationship between money and the factors that potentially influence the demand for money.

In this study, two measures of money supply are used: with and without foreign currency deposits. It is important to note that growing money supply does not necessarily induce inflation because additional money might be absorbed by increasing money demand. Kumah (2006) explains the significant increase in money growth and low inflation rate in Kyrgyz Republic, using the argument of the growing demand for money. Therefore, excess money is considered, defined as the difference between actual money holdings and the long run level of money desired by individuals. In this framework, excess money (EC) is defined as:

$$EC_t = (m-p)_t - (m-p)_t^*, \tag{3}$$

where m is the log of nominal money denoted M. Desired money balances given by $(m-p)^*$ is defined as the long run demand for money, which depends on a vector of variables X, so that we have:

$$(m-p)_t^* = \beta' X_t, \tag{4}$$

where β is a vector of long run parameters and X is a vector of determinants of the

[4]For example, Oomes and Ohnsorge (2005) find that using broader monetary aggregates in the empirical analysis helps restore the relationship between prices and money.

demand for money. To analyze the long run relationships between the variables, the Johansen maximum likelihood procedure is applied to test for the cointegration among them.

Further, Goujon (2006) states that exchange rate variations have an impact on the prices of non-tradable goods as well. The pass-through to the non-tradable sector operates through price indexation for certain non-traded goods. Therefore, a specification for the equation describing the change in the non-tradable goods price is:

$$\Delta p_t^{NT} = \alpha EC_{t-1} + \eta \Delta e_t + \delta_t^{NT}, \tag{5}$$

where η measures the impact of the indexation of the dollar denominated price of particular non-tradable goods. EC is an estimated error correction term that measures deviations in the money demand from equilibrium, or excess money. Plugging equations 2* and 6 into equation 1 yields the following inflation equation:

$$\Delta p_t = [\lambda\theta + (1-\theta)\phi]\, \Delta e_t + \theta\mu\Delta p^W + (1-\theta)\alpha EC_{t-1} + \delta_t, \tag{6}$$

The final equation of inflation shows that variation in inflation can be explained by variation in the nominal depreciation, foreign inflation and deviations for the equilibrium in monetary sector. The regression equation will also comprise the changes in prices of those goods that constitute an important source of export revenues, i.e. gold prices for Kyrgyz Republic and oil prices for Kazakhstan. Equation 7 can be written in reduced form as:

$$\Delta p_t = \phi_1 \Delta e_t + \phi_2 \Delta p^W + \phi_3 EC_{t-1} + \delta_t. \tag{7}$$

where ϕ_1, ϕ_2, and ϕ_3 are the coefficients to be estimated. This reduced-form inflation equation is estimated using the two-step procedure described in the following section.

3.1 Variation of Parameters over Time

It was assumed that the weights of both tradable and non-tradable goods in the overall price index were constant over the period covered in the study, as well as all other parameters in the model. This assumption might be questioned in the context of transition and developing economies due to large structural changes in these countries' economic systems, macroeconomic reforms and changing policy regimes. The economies of Central Asia have become more open in terms of trade relations, and this might affect the importance of the tradable sector when constructing the price index. Moreover, the exchange rate pass-through to prices might become more important as well. Therefore the final inflation equation from equation 7 should be written in a time varying form:

$$\Delta p_t = \phi_{1t}\Delta e_t + \phi_{2t}\Delta p^W + \phi_{3t}EC_{t-1} + \delta_t, \tag{8}$$

where ϕ_1, ϕ_2, and ϕ_3 are the coefficients that can vary over time.

To estimate the time varying coefficients, two methods are used: moving window and the Kalman filter. Both approaches are presented in the next section.

4 Estimation Procedure and Results

4.1 Data Description

The data used in the present study is of quarterly frequency and covers the period 1996:Q1 to 2008:Q4 for both Kazakhstan and the Kyrgyz Republic. The main sources of data are the International Financial Statistics database of the IMF, and Global Financial Data. The time series used include Consumer Price Index (CPI), official nominal exchange rate to the U.S. dollar, and monetary aggregates: M2 and M2x (M3).[5] To proxy data on real income, data on real GDP is employed in the case of Kazakhstan and the Kyrgyz Republic. To measure external sector influence data on the U.S. CPI are used. The world price of oil is included in the final equation for inflation in Kazakhstan, while in the case of the Kyrgyz Republic the data on world gold prices are used. An average deposit rate is used for the Kyrgyz Republic and a refinance rate for Kazakhstan. All data except interest rates are transformed into natural logarithms. Moreover, the data on GDP, inflation and oil and gold prices were deseasonalized using standard methods.

The time series on real money balances is computed as a difference between logarithm of money and logarithm of the price index.

4.2 Estimation Procedure

First, all variables were subject to unit root tests. The Augmented Dickey-Fuller (ADF) unit root test that formulates the null hypothesis as the presence of a unit root was

[5] M2 is a broad monetary aggregate that does not include foreign currency deposits. The broadest monetary aggregate that does contain a foreign component is M2x in Kyrgyzstan and M3 in Kazakhstan.

performed on all time series. Results of the test show that the null hypothesis was accepted for all variables except interest rates. Results are presented in Table 2 in Appendix.

Further, the cointegration procedure developed by Johansen (1991) is used to estimate the money demand equation. It is assumed that the long run demand for money depends on real income and on the opportunity cost of holding money. Together with the interest rate, the actual inflation rate is used.

A vector error-correction model (VECM) of the following general form is estimated using the maximum likelihood method. This approach allows testing for the number of cointegrating vectors and the endogeneity of variables by examining the rank of the matrix $\Pi = \alpha\beta'$. The following specification is used:

$$\Delta Y_t = \alpha\beta' Y_{t-k} + \sum_{i=1}^{k-1} \Gamma_i \Delta Y_{t-i} + D_t + \epsilon_t, \tag{9}$$

where $Y = \{(m-p), y, \Delta p, i\}$, $(m-p)$ is real money holdings, y is the real income, Δp is inflation, and i is the nominal interest rate. β denotes the matrix of parameters of the cointegrating vectors, $\beta' Y_{t-k}$ are error correction terms, and α is the matrix of equilibrium correction or feedback effects. The matrix Γ_i consists of the short run parameters and D_t denotes the deterministic components that consist of a vector of centered seasonal dummies, constants, trends and a dummy for 1999:Q2. A lag length of the VAR system was chosen on the basis of the Schwarz Information Criterion.[6] The industrial production and computed real money balances have grown during the period examined, therefore a linear trend is included in the VAR system.

Further, the estimated error correction terms are included in the main inflation

[6] Analysis of the money demand follows the empirical investigation by Johansen and Juselius (1990).

equation 7, which is estimated using an IV method.

The time varying parameter estimation is first done by performing a so-called "moving window" estimation. The sample is divided into many overlapping subsamples consisting of 30 observations each, and an instrumental variable estimation is performed on every subsample.

The second methodology used to allow for time varying parameters is the Kalman filter, which is a recursive procedure for calculating the optimal estimator of the state vector given all the information which is currently available. To employ the Kalman filter, the model should be presented in a state space form. Using the notation of Harvey (1993), the $N \times 1$ vector of observed variable y at time t, y_t, is related to an $m \times 1$ vector a_t, known as a state vector, via a measurement equation:

$$y_t = Z_t a_t + \xi_t, \qquad t = 1, ..., T \tag{10}$$

where Z_t is a $N \times m$ matrix, and ξ_t is an $N \times 1$ vector of serially uncorrelated disturbances with zero mean and covariance matrix H_t.

The elements of a_t are not observable, but they are known to be generated by a first-order Markov process:

$$a_t = T_t a_{t-1} + \zeta_t, \qquad t = 1, ..., T \tag{11}$$

where T_t is an $m \times m$ matrix, and ζ_t is a $g \times 1$ vector of serially uncorrelated disturbances with zero mean and covariance matrix Q_t. Equation 11 is the transition equation, and it describes the evolution of the parameters. The initial state vector a_0 has a mean of a_0 and a covariance matrix $\mathrm{P}_{0,}$.

The Kalman filter recursively updates the estimate of a_t and its variance, using the new information in y_t and Z_t for each observation, so it can be viewed as a Bayesian method. The priors used are estimated from the OLS regression on the first observations and supplied to the Kalman filter estimation. The method of estimation for each time period is maximum likelihood conditional on the data observed to that point.[7]

4.3 Empirical Results

4.3.1 Inflation in Kazakhstan

The long run money demand in Kazakhstan is examined first. It is assumed that the demand for real money balances depends on the real income, nominal interest rates, and inflation rate. The first order VAR system is used in the cointegration analysis. Among the deterministic components are centered seasonal dummies, a dummy for the second quarter of 1999, and a trend in the VAR system. The trend is included since the data on real money balances and real income exhibit an increasing trend over time. A visual inspection of the graphs shows that there was a possible trend break in the data in the second quarter of 1999. This is explained by the large devaluation of the national currency that took place in Kazakhstan in April 1999. No deterministic term is included in the cointegration vector. Moreover, two measures of money are used for estimation of the money demand. Results of the cointegration analysis are shown in Table 5 in Appendix.

The maximum likelihood procedure used for cointegration revealed one cointegrating vectors in the monetary sector in both cases. Normalizing the vector to the coefficient of the real money balances gives the following equilibrium relationships:

[7] See Harvey (1993) for more details.

$$m2 = 0.74y + 0.09\pi + 0.03i$$

for the case of the monetary aggregate that does not include a foreign component. And

$$m3 = 0.83y + 0.13\pi - 0.002i$$

for the monetary aggregate that includes deposits in foreign currency.

Both equations show a positive correlation between the real income and the demand for money. In the case of a broader definition of money, this correlation is larger. Economic agents are probably willing to deposit more money denominated in foreign currency once they observe an increase in their real income. The actual inflation rate is positively correlated to demand for money as well. Again, in the case of M3, the coefficient on inflation is somewhat larger. This result might be related to the dollarization issue. Higher prices make consumers more vigilant in managing their monetary holdings. Thus, they would prefer to store a larger part of their incomes in foreign currency.

The coefficient on the interest rate is positive in the case of M2, and is negative in the case of M3. In the case of Kazakhstan the rate on the refinance operations of the National Bank is used in the estimation. Consumers seem to be more sensitive to interest rates when deciding whether to hold money in bank deposits in foreign currency. This result is plausible if dollar denominated deposits serve as a way to store monetary assets and to earn some interest on them. These equations are used for calculation of the equilibrium money demand and the error correction terms.

After analysing the long run relationships, further steps can be taken to estimate short run inflation in Kazakhstan. The variables from equation 7 are used as the basic variables for the analysis. A general autoregressive distributed-lag (ADL) specification is estimated with a vector of stationary variables represented by $V = \left\{\Delta p_{t-1}, \Delta e_t, ECm_{t-1}, \Delta p^{oil}_{t-1}\right\}$. All variables are used in first differences as they were found to be *I(1)*. Since Kazakhstan is an oil-producing and oil-exporting country, its economy is dependent on the world oil prices. Oil prices are therefore included in the short run equation of inflation in Kazakhstan. The instruments used are a lagged exchange rate and a dummy for the second quarter of 1999.[8] The inclusion of the dummy is to account for the trend break.

[8] As Greene (1993) suggests, lagged variables of those variables that are believed to be endogenous are used as instruments. In a multiple regression framework, if only one variable is deemed to be endogenous, its lagged value can be used as an instrument and the remaining variables can serve as their own instruments.

The results of the estimation are presented in Table 1.

Table 1 consists of four columns, and each column reports results for different measures of the monetary factor used in the estimation. In the first two columns, an error correction model is included as a regressor. In the second two columns, money supply is represented by the monetary aggregates, M2 and M3. It is evident from the results that past inflation and nominal depreciation are the main factors driving inflation in Kazakhstan. For example, if inflation in the previous period increased by 1 percent, it will increase by about 0.6 percent in the present period. The estimated coefficient on the nominal depreciation of the exchange rate is highly statistically significant, though the magnitude of the coefficient is not very high. It is, however, important to note that variation in the nominal exchange rate helps explain the variation in inflation. It justifies as well the concern of the local central bankers about the stability of the exchange rate. The price of oil plays a marginal role in explaining inflation behavior, though the coefficient has the right sign. Oil production and exports have only started to play a major role since 2000, and world oil prices have remained quite stable during the last several years apart from the recent financial crisis. This might account for the relative weakness of oil prices in explaining inflation in Kazakhstan. Money does play an important role in affecting inflation. Excess money results in an increase in inflation. Moreover, an increasing money supply in the last period will speed up inflation. These results are not sensitive to the measure of money employed. Inflation reacts to growth in either monetary aggregate. This finding might be related to the measure of broad money as foreign currency in circulation is not included. The model with money growth explains inflation better in terms of the R^2. The coefficients on excess money are, however, more statistically significant that those on money growth.

Table 1. Inflation Equation Estimates: Dependent Variable Δln_CPI (t-statistics in square brackets)

a) Kazakhstan

	Models with excess money		**Models with money supply**	
Specification	**Model A: ECm3**	**Model B: ECm2**	**Model C: M3**	**Model D: M2**
Δln_CPI_{t-1}	0.64 [8.89]***	0.62 [8.20]***	0.68 [8.67]***	0.68 [8.73]***
Δln_ER_t	0.18 [14.26]***	0.18 [14.16]***	0.18 [4.92]***	0.18 [5.00]***
Δln_oil_t	0.02 [1.72]*	0.02 [1.71]*	0.02 [1.62]	0.02 [1.63]
$ECm2_{t-1}$	0.007 [4.10]***	-	-	-
$ECm1_{t-1}$	-	0.006 [3.92]***	-	-
Δln_m3_{t-1}	-	-	0.04[2.00]**	-
Δln_m2_{t-1}	-	-	-	0.04 [2.18]**
R^2	0.56	0.56	0.60	0.61
No. of obs.	51	51	52	52

b) Kyrgyz Republic

	Models with excess money		**Models with money supply**	
Specification	**Model A: ECm2x**	**Model B: ECm2**	**Model C: M2x**	**Model D: M2**
Δln_CPI_{t-1}	0.19 [0.92]	0.18 [0.85]	0.32 [1.71]*	0.30[1.45]
Δln_ER_t	0.53 [4.94]***	0.54 [4.92]***	0.47 [4.92]***	0.49 [4.71]***
Δln_gold_{t-4}	0.17 [1.68]*	0.17 [1.67]*	0.19 [2.30]**	0.19 [2.41]**
$ECm2_{t-1}$	0.006 [1.71]*	-	-	-
$ECm1_{t-1}$	-	0.005 [1.72]*	-	-
Δln_m2x_{t-2}	-	-	0.08 [1.26]	-
Δln_m2_{t-2}	-	-	-	0.08 [1.24]
R^2	0.37	0.37	0.42	0.40
No. of obs.	49	49	49	49

Notes. (1) ***, ** and * stand for statistical significance at the 1, 5 and 10 percent level, respectively.

(2) Instruments used include lagged values of changes in the nominal exchange rate and D99:4 together with all the exogenous variables on RHS.

4.3.2 Inflation in the Kyrgyz Republic

In the case of the Kyrgyz Republic, the same two step estimation was performed. In the first step, the long term money demand was estimated. The only difference with the previous case is that the average deposit rate was used in the demand for money. A similar set of deterministic regressors was used: centered dummy variables, a dummy for the second quarter of 1999, and an unrestricted trend. The following equations of the equilibrium money demand were estimated:

$$m2 = 0.34y - 0.15\pi + 0.07i$$

in the case when demand for foreign money is not included, and

$$m2x = 0.50y - 0.09\pi + 0.05i$$

for a broader definition of money when foreign currency deposits are included as well.

The results of the cointegration procedure reveal one cointegrating vector in the case of a demand for money that includes a foreign component and two cointegrating vectors in the case of a demand for money balances in national currency. The presence of two cointegrating vectors can complicate the interpretation of the results, and requires preforming a series of tests on the coefficients in the cointegrating vectors by imposing structural restrictions. Such tests are, however, beyond the scope of the present study. Since cointegration in the money demand equation is the focus, in the second case the first cointegrating vector is taken as a true cointegration relationship, and will be used to estimate error correction model.

The estimated coefficients in the cointegrating vectors show that the income elasticity of the money demand is positive, though has a larger magnitude if a broader definition of money is used. The demand for real money balances is negatively correlated with the inflation rate, which is a plausible result, as depreciating currency will compel people to switch from holding domestic money. In fact, changes in inflation rate have a larger impact on the demand for domestic money. The coefficient of the interest rate elasticity has a positive sign, which seems to contradict to what the theory predicts. This may reflect either underdevelopment of the financial markets and low sensitivity of economic agents to developments in the interest rates; or, since the average deposit rate is used, the found coefficient may indicate that higher interest rates make deposits which constitute a part of both monetary aggregates more attractive.

Estimation results are shown in the part (b) of Table 1. A vector of stationary variables represented by $V = \left\{ \Delta p_{t-1}, \Delta e_t, ECm_{t-1}, \Delta p_{t-4}^{gold} \right\}$ is used in estimation. The price of gold is included as the Kyrgyz Republic has a large share of gold in its industrial production and exports. As in the case of Kazakhstan, the instruments used are a lagged exchange rate and a dummy for the second quarter of 1999.

In the Kyrgyz Republic, inflation is primarily affected by the nominal depreciation rate. Past inflation does not explain the variation in the present period inflation. At the same time, changes in the nominal exchange rate have a considerable effect on inflation. An increase in the depreciation rate by 1 percent results in an increase of inflation by around 0.5 percent. Therefore, the exchange rate pass-through in the Kyrgyz Republic is very strong. Excess money does help explain inflation behavior, while money growth rate does not. The prices of gold was found to affect the domestic inflation rate with a lag of four periods. Similarly to the case of Kazakhstan, the model with money growth

has a higher value of R^2 but the estimated coefficients on excess money are statistically significant, while the money growth coefficients are not.

The empirical findings in this section support the conclusions of other studies that exchange rate pass-through matters for transition economies. Moreover, as these are small open economies, they have to cope with the influence of external factors and are very sensitive to changes in both regional and global markets. Though the use of different measures of money has not yielded unambiguous results about the importance of dollarization, a strong exchange rate pass-through to prices nevertheless indicates high levels of dollarization in these economies.

5 System Estimation: Seemingly Unrelated Regressions (SUR)

Seemingly Unrelated Regressions (SUR) is a class of multivariate regression models which normally belong to the sub-class of linear regression models. A distinctive feature of SUR models is that they consist of several unrelated systems of equations. "Unrelated" here means that any variable, dependent or independent, is present in only one equation; in other words, the systems have no common variables.

It is possible to solve such systems of equations independently, by using the least squares method for each system separately. But the error terms from different equations in SUR ca turn out to be correlated. At the same time, according to the general theory of the least squares method, which takes the covariances of errors into account, such systems should be solved as a whole set of equations. Otherwise, the minimal variance of errors in the estimated regression parameters cannot be achieved. Thus, although

separate OLS estimation would give unbiased and consistent estimators, the advantage of the SUR estimation is in its efficiency gain. However, if disturbances of different equations in the system are not correlated, then there is no difference between OLS and SUR estimation. Such system estimation augments the power of tests which is necessary due to the short time span and small number of observations.

Generally, the SUR model is represented as follows:

$$\Delta p_{m,t} = \sum_{i=1}^{k} \omega_i \Delta p_{m,t-i} + \sum_{j=0}^{k} K_j V_{m,t-j} + seas + u_{m,t} \tag{12}$$

The subscript m stands for country, and $m = 1, 2$.

Tables 2 and 3 present the results of the system estimation. In Table 2, the equations with a lagged measure of money supply are used, while in Table 3, the error correction terms are used. The SUR method still shows the parameters on lagged inflation and on the change in nominal exchange rates to be statistically significant. Further, the coefficients on the error correction term appear to be more statistically significant when the two equations are estimated in the system.

Though a wide range of possible factors that could affect inflation were included in the estimation, the major factors to have an impact on inflation in both economies are past inflation and nominal depreciation. The error correction terms also appear to be statistically significant in the system estimation, which could signal the influence of deviations in the monetary sector on inflation as well.

In the context of dollarization, the high statistical significance of nominal depreciation is an indicator of the high exchange rate pass-through to inflation. This result is not surprising as the economies can be characterized as open, and the high degree of dollarization may indeed contribute to a faster transmission of external

shocks to domestic prices through exchange rate variations. Results of the system estimation lend support to the findings of the previous section regarding the significance of exchange rate pass-through to prices. The results for Kazakhstan have not changed significantly, while for the Kyrgyz Republic some changes are observed. For instance, past inflation has proved to have a strong influence on current inflation in the Kyrgyz Republic. Such findings are suggestive that economic developments in the countries of Central Asia have a tendency to converge in the long run.

The estimated coefficients on oil and gold prices however lose their significance in the SUR estimation. This might be due to the fact that these countries are exporters of different commodities.

6 Parameter instability

Empirical investigation of transition economies is complicated by the many problems related to data, unstable relationships between economic variables and the considerable structural changes in these countries. Results obtained for such economies should hence be interpreted with caution. Parameter instability is one such caution.

Results of the estimation using methodologies that allow for time variation in the parameters are presented in Figures 1-2 in Appendix.[9] The findings show that the parameters were rather stable over the period examined in the study. In Kazakhstan, only the coefficient on oil price has increased in the most recent period. The estimation loses significance in the last subsamples. This might be related to the recent financial crisis and its effects on Central Asian economies. The Kalman filter estimation, however,

[9] The figures in Appendix only present estimations with a monetary component measured as M2. Other results do not differ significantly, and are available upon request from the author.

Table 2. Results of System Estimation – Money Supply

a) SUR estimation – 3SLS estimation (monetary aggregate without foreign component)

Specification	Kyrgyz Republic	Kazakhstan
Δln_CPI_{t-1}	0.51 [3.66]***	0.62 [5.69]***
Δln_ER_t	0.29 [2.92]***	0.17 [3.73]***
Δln_gold_{t-4}	0.04 [0.76]	-
Δln_oil_t	-	-0.001 [-0.14]
$\Delta M2_{t-1}$	0.05 [1.13]	0.04 [3.08]***
R^2	0.46	0.33

b) SUR estimation – 3SLS estimation (monetary aggregate with foreign component)

Specification	Kyrgyz Republic	Kazakhstan
Δln_CPI_{t-1}	0.50 [3.78]***	0.61 [5.49]***
Δln_ER_t	0.28 [2.94]***	0.16 [3.65]***
Δln_gold_{t-4}	0.03 [0.65]	-
Δln_oil_{t-1}	-	-0.001 [-0.12]
$\Delta M2x_{t-2}$	0.05 [1.28]	-
$\Delta M3_{t-1}$	-	0.04 [2.91]***
R^2	0.47	0.32

Notes. (1) ***, ** and * stand for statistical significance at the 1, 5 and 10 percent level, respectively.

(2) Instruments used are lagged values of exchange rate, dummy for 1999:Q2, and all the exogenous variables on the RHS.

Table 3. Results of System Estimation – ECM

a) SUR estimation – 3SLS estimation (monetary aggregate without foreign component)

Specification	Kyrgyz Republic	Kazakhstan
Δln_CPI_{t-1}	0.43 [3.08]***	0.40 [3.57]***
Δln_ER_t	0.37 [3.54]***	0.14 [4.90]***
Δln_gold_{t-4}	0.03 [0.48]	-
Δln_oil_{t-1}	-	0.01 [0.18]
$ECM2_{t-1}$	0.005 [2.05]**	0.002 [4.46]***
R^2	0.43	0.36

b) SUR estimation – 3SLS estimation (with foreign component)

Specification	Kyrgyz Republic	Kazakhstan
Δln_CPI_{t-1}	0.43 [3.14]***	0.41 [3.58]***
Δln_ER_t	0.36 [3.50]***	0.14 [4.64]***
Δln_gold_{t-4}	0.02 [0.44]	-
Δln_oil_{t-1}	-	0.01 [0.22]
$ECM2x_{t-1}$ *(M3)*	0.006 [1.96]*	0.002 [4.23]***
R^2	0.43	0.36

Notes. (1) ***, ** and * stand for statistical significance at the 1, 5 and 10 percent level, respectively.
(2) Instruments used are lagged values of exchange rate, dummy for 1999:Q2 and all the exogenous variables on the RHS.

is not affected by recent developments. As this methodology recursively estimates the parameters each time including a new available data point, the past observations are still included in the estimated sample and play a role for predicting new state estimates. This explains the smoothness of the parameters' behavior, and the difference between the two methodologies.

Similar findings are observed for the case of the Kyrgyz Republic. There is not much variation in the parameters over time, though the coefficient on international gold prices has decreased in the recent period. This might be true, as the country relies less on its gold production now than it did in the 1990s, and there are more factors that could have become important in affecting prices (e.g. recent energy crisis). In general, stable parameters can be considered an indicator of the good fit of the model given that it can take into account the major parameters of inflation during a rather long period. This also indicates that the links between different variables was quite stable due to the macroeconomic stability achieved by these economies.

7 Conclusion

This study focuses on factors affecting inflation in two transition economies in Central Asia – Kazakhstan and the Kyrgyz Republic. The period covered reflects the time when the first results of macroeconomic stabilization were achieved, and positive economic growth was about to take off. The presented model considers several factors that might impact inflation and allows us to account for dollarization. The model starts from the price index as a composite index for tradable and non-tradable goods. The tradable sector is assumed to be dependent on external factors such as exchange rate

depreciation and world prices. The non-tradable sector prices are affected by the equilibrium condition in the local markets and external sector. Factors assumed to affect non-tradable sector inflation are excess money and the exchange rate. The latter is expected to have a strong effect due to the fact that Central Asian economies are highly dollarized. To determine whether inclusion of foreign currency denominated assets helps explain inflation developments, different specifications were compared using two measures of money: domestic money M2 and broad money M3 in Kazakhstan and M2x in Kyrgyz Republic.

Central bank policies in Central Asia rely on foreign exchange interventions. Therefore, the issue of endogeneity may arise when including foreign exchange rate as an explanatory variable. An instrumental variables estimation is hence performed.

Empirical findings show that the estimation model fits the data in Kazakhstan rather well, as all the factors included in the model help explain the variation in inflation. The coefficient on changes in world oil prices, however, appears to be only marginally significant. In the case of the Kyrgyz Republic, the most important factor of inflation was found to be nominal depreciation of the exchange rate. The lagged values of changes in world gold prices and excess money do have an impact on inflation behavior in the Kyrgyz Republic as well. In both countries, results did not differ whether regardless of whether a broader monetary aggregate was used as a measure of money supply or for estimating money demand in the error correction model. Thus, dollarization might play a role in strengthening the exchange rate pass-through to prices. It might be impossible to find its effect through monetary factors, as the true measure of dollarization is not available.

The empirical analysis was also extended to system estimation, in which the data for

both economies was estimated in a SUR framework. In general, the system estimation results support the findings of the individual country cases. In the case of the Kyrgyz Republic, the coefficients on past inflation became more statistically significant in the system estimation. This may be due to the fact that inflation processes have recently started to converge across the economies in the region.

The issue of parameter instability was examined in the last section. These results indicate that there have not been major changes in parameters over most of the period examined. Oil price changes have gained more importance in affecting inflation in Kazakhstan, while world prices for gold have had less of an effect on inflation in Kyrgyz Republic.

The results of the present study support the general findings in the literature regarding the strong pass-through from the exchange rate to prices in small open economies and economies with dollarization. The strong effect of exchange rate depreciation on inflation can justify the use of foreign exchange interventions as an important tool of monetary policy in these countries. Moreover, in the case of Kazakhstan, significant effects of the monetary sector shocks on inflation may call for a more restrictive monetary policy.

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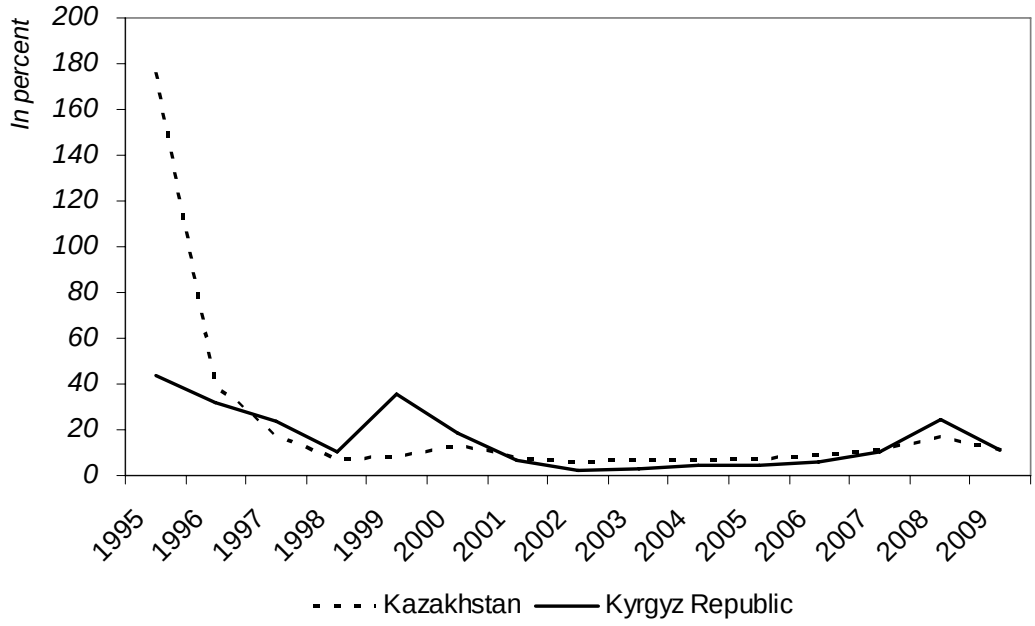
APPENDIX

Table A 1. Data Sources

Series	Time span	Source
	a) Kazakhstan	
Consumer Price Index (in percent)	1995:Q3 till 2008:Q4	IMF
Monetary aggregates (in mln tenge): M2, M3	1995:Q3 till 2008:Q4	National Bank of Kazakhstan
GDP (in mln tenge, current prices)	1995:Q3 till 2008:Q4	IMF
Refinance Rate of the NBK (in percent)	1995:Q3 till 2008:Q4	IMF
Nominal exchange rate (to US dollar) (in tenge)	1995:Q3 till 2008:Q4	IMF (official rate, averages)
Oil price (US dollar per barrel)	1995:Q3 till 2008:Q4	IMF
	b) Kyrgyz Republic	
Consumer Price Index (in percent)	1995:Q3 till 2008:Q4	IMF
Monetary aggregates (in mln som): M2 , M2x	1995:Q3 till 2008:Q4	National Bank of the Kyrgyz Republic
Gross Domestic Product (in mln som)	1995:Q3 till 2008:Q4	National Bank of the Kyrgyz Republic
Deposit rate (in percent)	1995:Q3 till 2008:Q4	IMF
Nominal exchange rate (som to US dollar) (in soms)	1995:Q3 till 2008:Q4	IMF (official rate, averages)
Gold Bullion Price-New York (US$/Ounce)	1995:Q3 till 2008:Q4	Global Financial Data

Figure 1. Inflation in the Economies of Central Asia



Source: EBRD Transition Report 2008

Table 2. Stationarity Test Results: H_0: unit root

Series	ADF
CPI	Cannot reject
Differenced CPI	Reject
M2x (M3)	Cannot reject
Differenced M2x (M3)	Reject
GDP	Cannot reject
Differenced GDP	Reject
Nominal exchange rate	Cannot reject
Differenced exchange rate	Reject
Deposit rate	Reject
Refinance rate	Reject
Gold price	Cannot reject
Differenced gold price	Reject
Oil price	Cannot reject
Differenced oil price	Reject

Notes: The results hold for both countries if not indicated otherwise

Table 3. Cointegration Analysis (1996:1 to 2008:4)

a) monetary aggregate with foreign component

	Kazakhstan					**Kyrgyz Republic**			
	Eigenvalues (λ)					Eigenvalues (λ)			
	0.409	0.301	0.073	0.007		0.544	0.371	0.091	0.040
	Eigenvectors (β)					Eigenvectors (β)			
m3	-4.11	-5.89	8.17	-0.12	*m2x*	-4.31	5.06	2.44	-2.31
y	3.42	5.47	-6.44	-0.48	*y*	2.15	-3.22	-3.25	1.19
π	0.53	0.51	0.56	0.21	π	-0.41	-0.34	-0.11	0.02
i^{ref}	-0.009	-0.25	-0.15	0.07	i^{depo}	0.21	-0.07	0.16	0.02
	Weights (α)					Weights (α)			
m3	0.01	0.03	-0.01	-0.002	*m2x*	0.01	0.006	-0.02	-0.004
y	-0.007	0.01	0.004	-0.006	*y*	-0.006	-0.004	0.001	-0.011
π	-0.82	-0.19	-0.4	-0.003	π	0.59	1.26	0.27	0.098
i^{ref}	-0.59	0.72	0.29	0.03	i^{depo}	-1.90	0.86	-0.07	0.17

b) monetary aggregate without foreign component

	Kazakhstan					**Kyrgyz Republic**			
	Eigenvalues (λ)					Eigenvalues (λ)			
	0.431	0.197	0.162	0.010		0.516	0.430	0.099	0.016
	Eigenvectors (β)					Eigenvectors (β)			
m2	-3.76	1.37	7.36	0.51	*m2*	-2.87	3.85	2.76	1.22
y	2.77	-1.66	-5.51	-0.99	*y*	0.98	-2.18	-2.94	0.30
π	0.33	-0.78	0.37	0.22	π	-0.43	-0.31	-0.08	0.04
i^{ref}	0.10	0.26	-0.15	0.08	i^{depo}	0.21	-0.07	0.13	-0.10
	Weights (α)					Weights (α)			
m2	0.02	-0.02	-0.03	-0.001	*m2*	0.013	-0.001	-0.014	0.004
y	-0.007	-0.01	-0.005	-0.007	*y*	-0.006	-0.008	0.004	0.007
π	-0.74	0.30	-0.072	-0.01	π	0.694	1.431	0.195	-0.051
i^{ref}	-0.92	-0.56	0.24	0.02	i^{depo}	-1.807	1.008	-0.143	-0.068

Table 4. Cointegration Test Statistics

a) monetary aggregate with foreign component

Kazakhstan					Kyrgyz Republic				
H_0	λ_{trace}	λ_{trace} (0.95)	λ_{max}	λ_{max} (0.95)	H_0	λ_{trace}	λ_{trace} (0.95)	λ_{max}	λ_{max} (0.95)
$r \leq 3$	0.33	3.76	0.33	3.76	$r \leq 3$	2.02	3.76	2.02	3.76
$r \leq 2$	4.07	15.41	3.74	14.07	$r \leq 2$	6.71	15.41	4.69	14.07
$r \leq 1$	21.61	29.68	17.54	20.97	$r \leq 1$	29.47	29.68	22.76	20.97
$r = 0$	47.38	47.21	25.77	27.07	$r = 0$	68.05	47.21	38.57	27.07

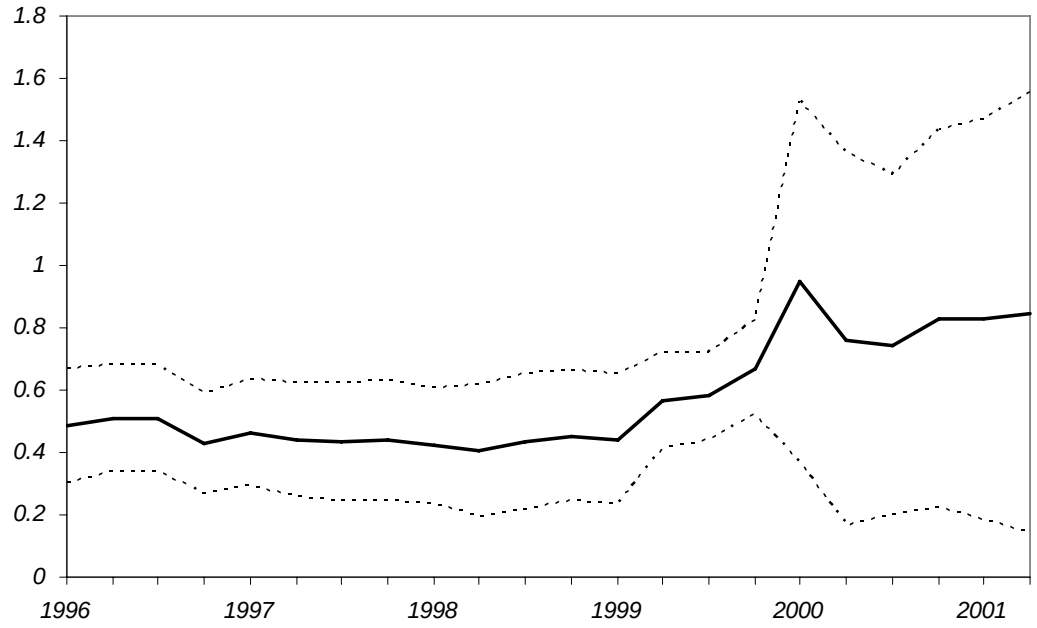
b) monetary aggregate without foreign component

Kazakhstan					Kyrgyz Republic				
H_0	λ_{trace}	λ_{trace} (0.95)	λ_{max}	λ_{max} (0.95)	H_0	λ_{trace}	λ_{trace} (0.95)	λ_{max}	λ_{max} (0.95)
$r \leq 3$	0.53	3.76	0.53	3.76	$r \leq 3$	0.80	3.76	0.80	3.76
$r \leq 2$	9.18	15.41	8.65	14.07	$r \leq 2$	5.94	15.41	5.15	14.07
$r \leq 1$	19.94	29.68	10.76	20.97	$r \leq 1$	33.45	29.68	27.51	20.97
$r = 0$	47.60	47.21	27.66	27.07	$r = 0$	68.96	47.21	35.51	27.07

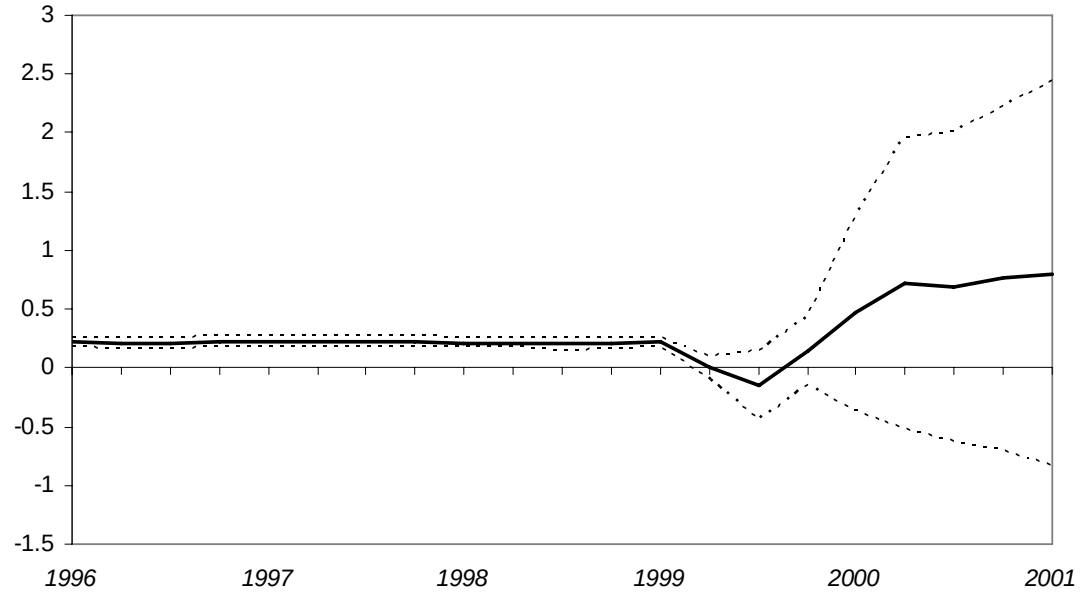
Figure 1. Parameters Stability: Inflation in Kazakhstan

I. Moving window estimation

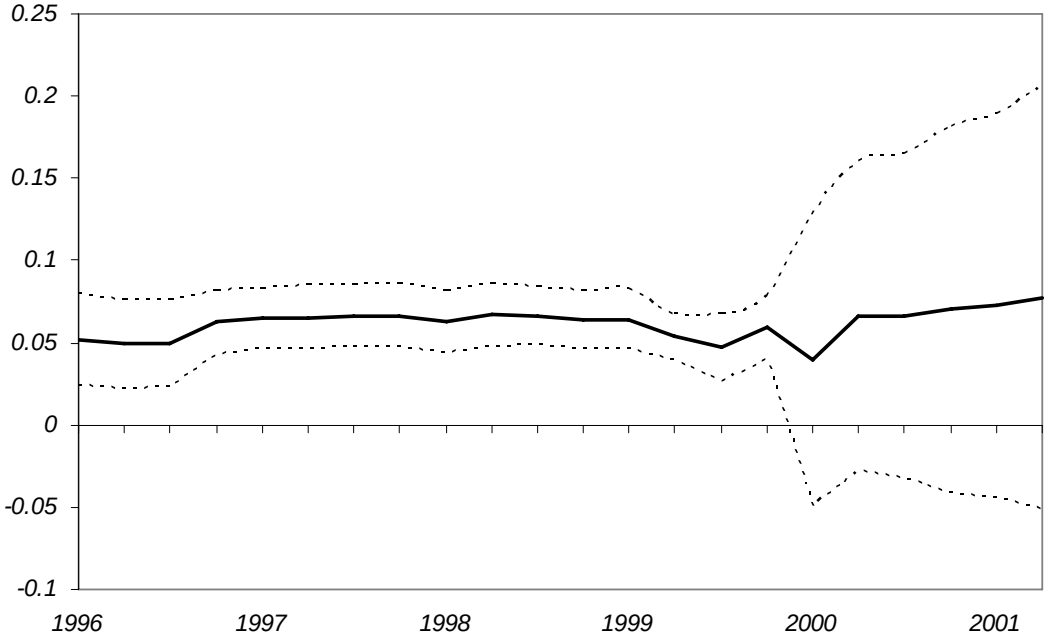
a) Past inflation



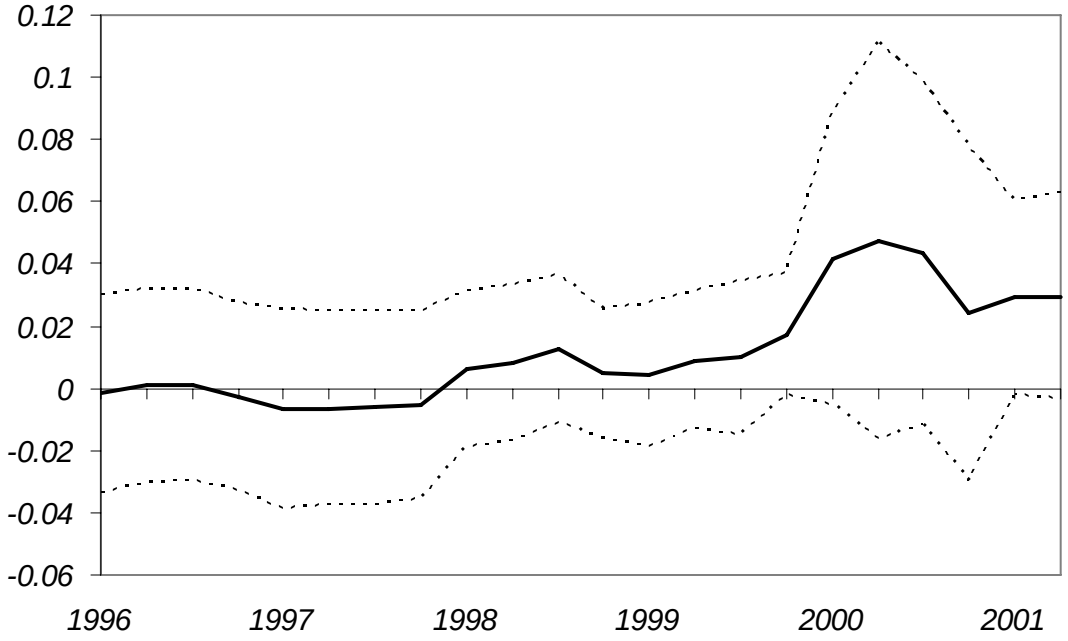
b) Depreciation of the nominal exchange rate



c) Money supply

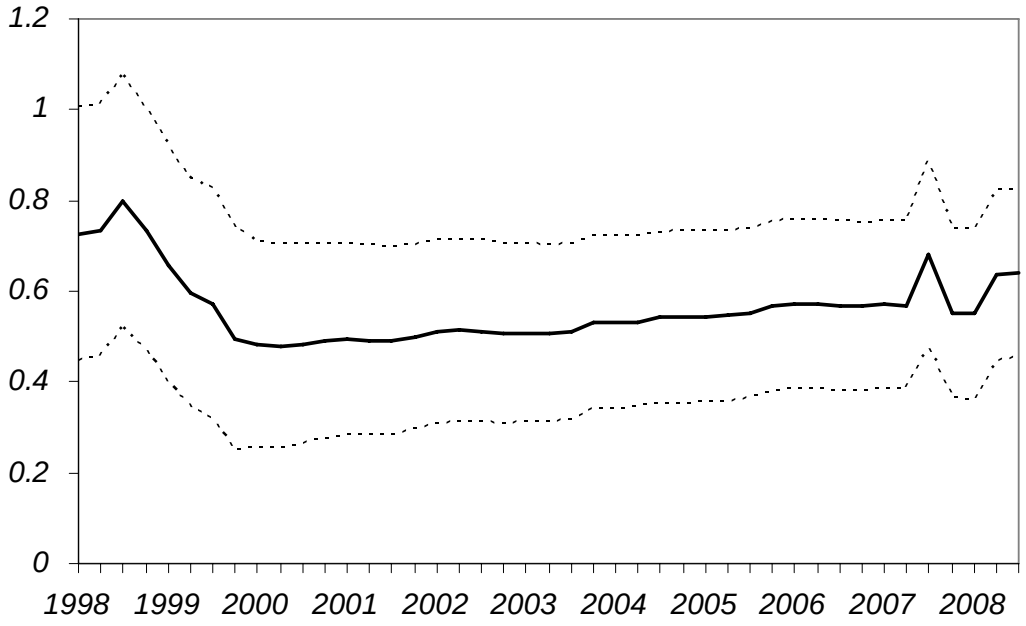


d) Changes in the oil price

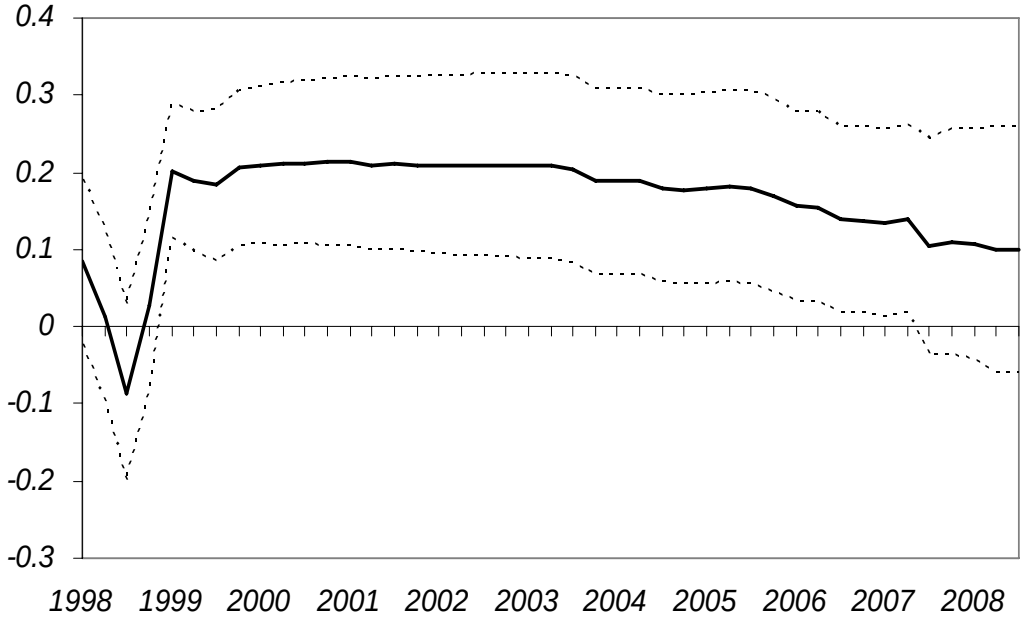


II. Kalman filter

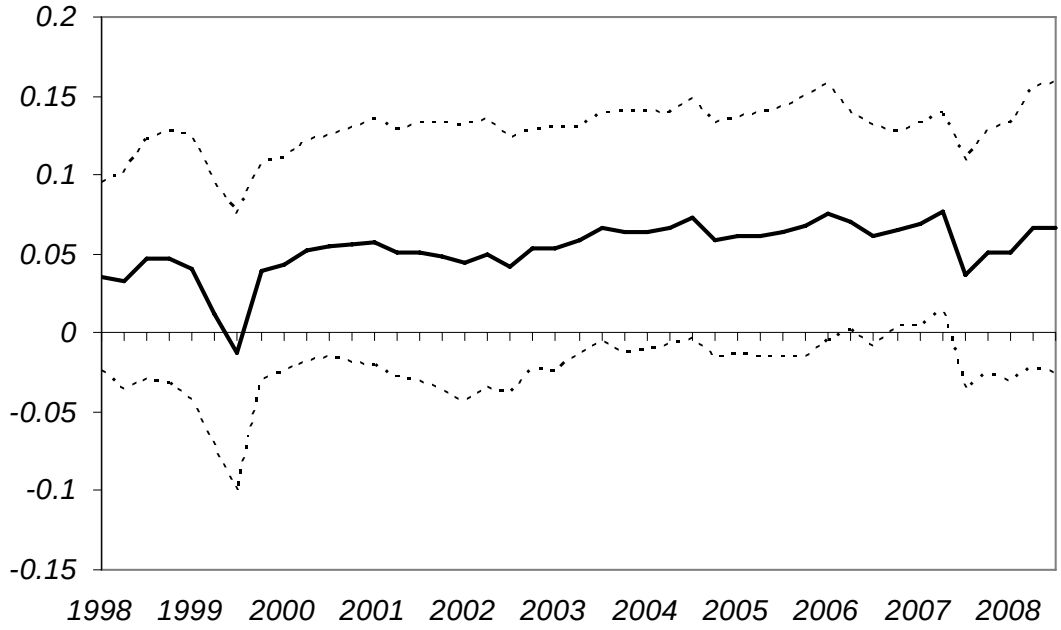
a) Past inflation



b) Depreciation of the nominal exchange rate



c) Money supply



d) Change in the oil prices

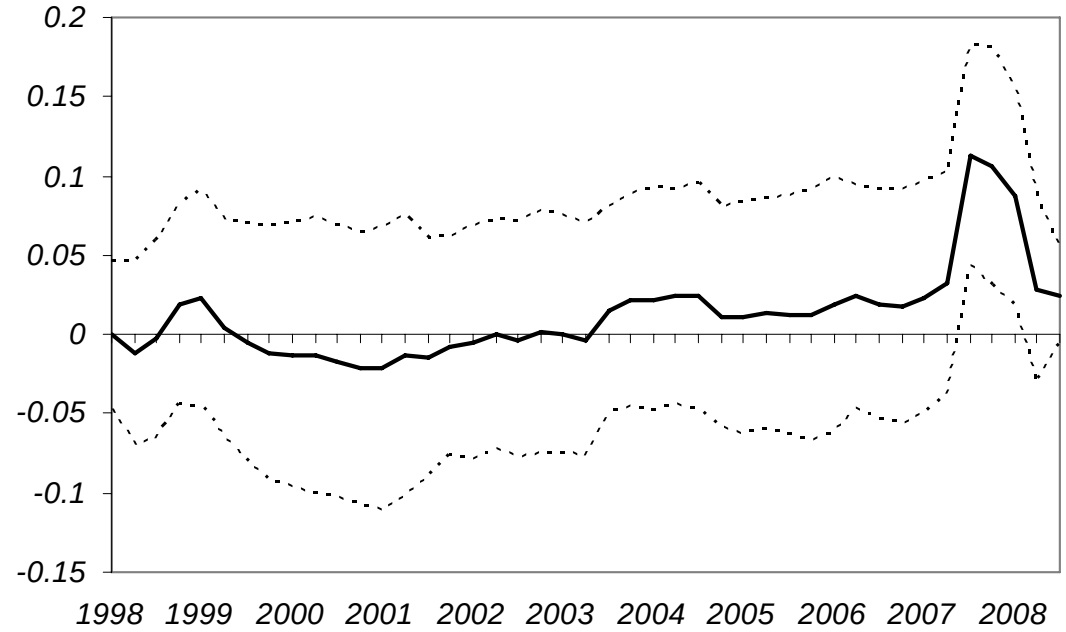
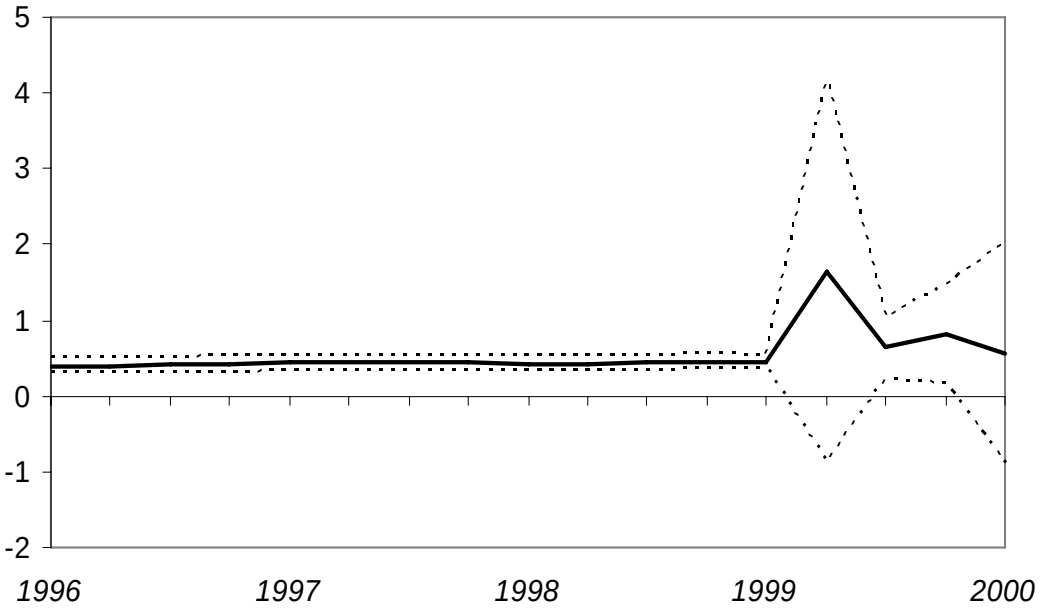


Figure 2. Parameter Stability: Inflation in the Kyrgyz Republic

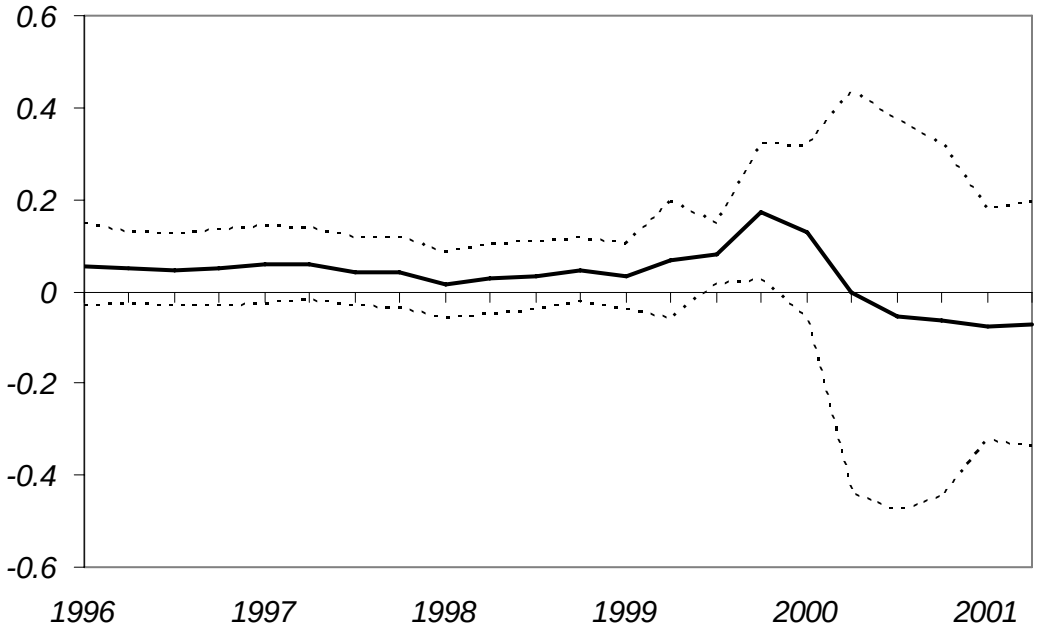
I. Moving window

a) Past inflation

b) Depreciation of the nominal exchange rate



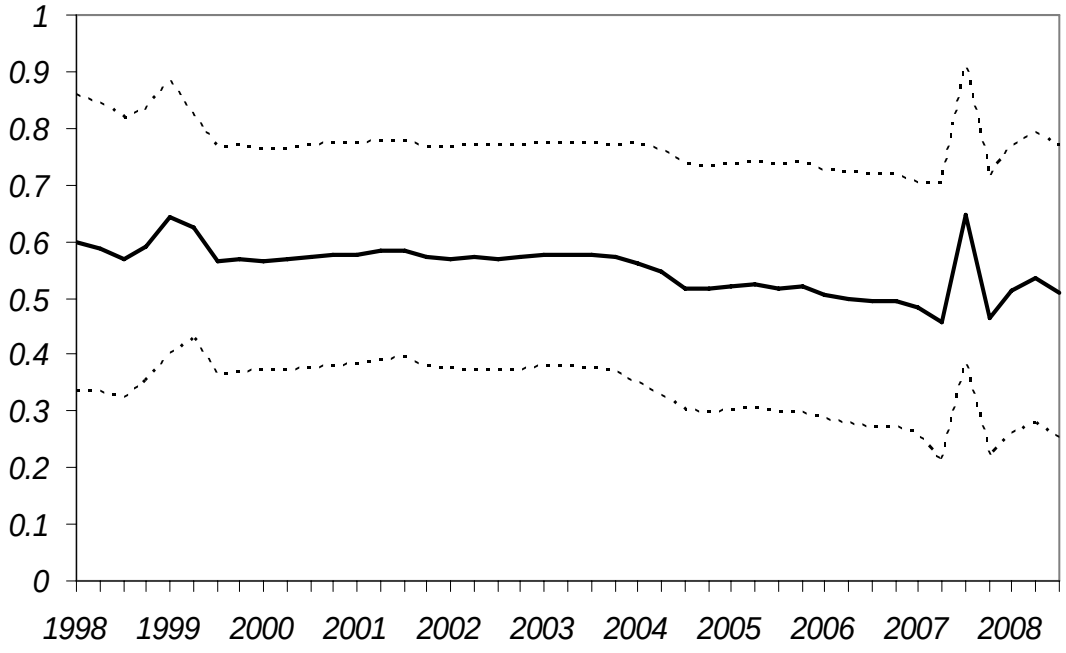
c) Money supply



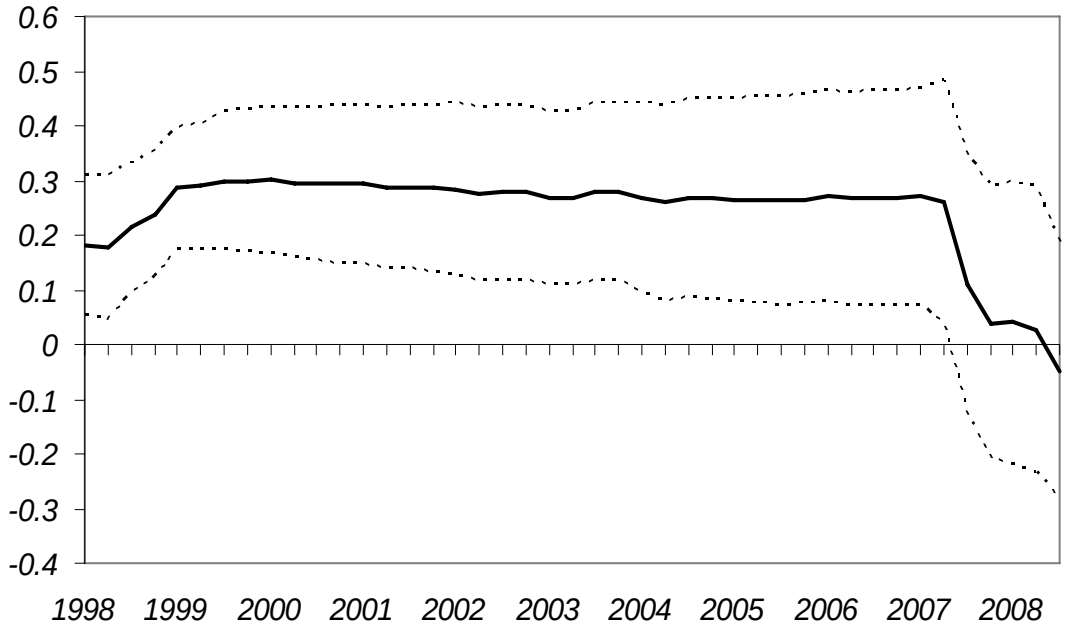
d) Changes in gold prices

II. Kalman filter

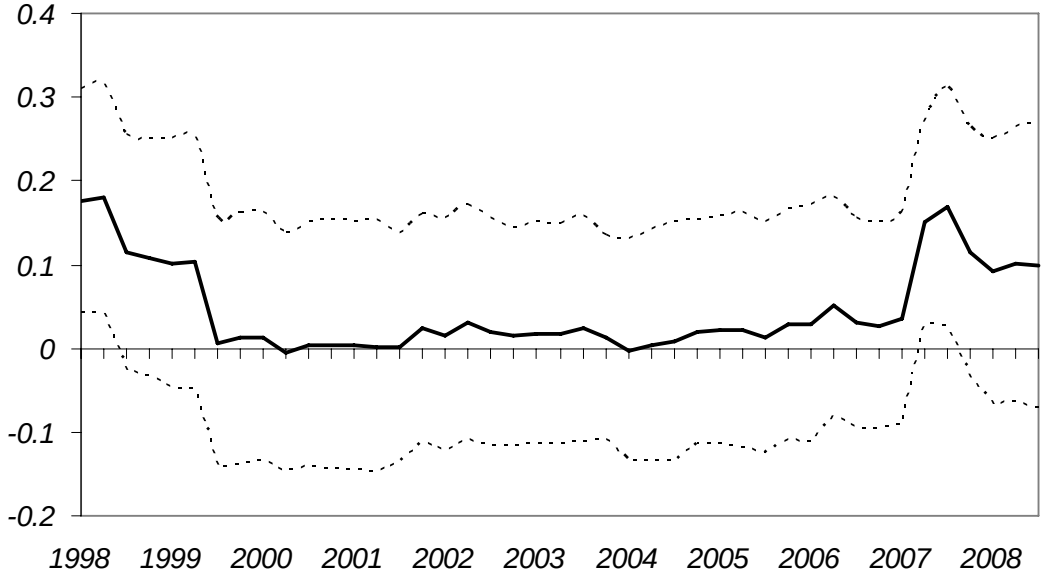
a) Past inflation



b) Depreciation of the nominal exchange rate



c) Money supply



d) Changes in the gold prices