

EFFECTIVENESS OF THE FOREIGN
EXCHANGE INTERVENTIONS IN
UKRAINE

by

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Abstract

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The paper tests the effect of the foreign exchange interventions conducted by NBU during 1995-2001 on the level and volatility of the UAH/USD exchange rate applying GARCH technique to the portfolio balance and balance of payments theories. Estimation based on the portfolio balance theory shows effect of interventions on level of exchange rate opposite to the intended by NBU but intended effect on the volatility of exchange rate. Opposite to the intended sign of the effect of intervention on the level of exchange rate is explained by the endogeneity of interventions: central bank is intervening only if exchange rate is moving away from the targeted level. Portfolio balance theory estimation may be not the most appropriate to the analysis of Ukrainian interventions because it assumes high mobility between Ukrainian and international capital markets, what is certainly not the case in Ukraine. Moreover, portfolio balance theory is widely used for the analysis of sterilized interventions, while in Ukraine interventions are largely unsterilized or partially sterilized. Therefore, the paper turns to the

estimation of the effectiveness of foreign exchange interventions based on the balance of payments approach. Estimation shows effectiveness of the interventions in decreasing volatility of exchange rate; interventions are also found to affect the level of exchange rate in the desired direction; however, the effect is statistically insignificant.

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GLOSSARY

Depreciation – reduction in the value of the currency in terms of other currencies

Federal Reserve System (FRS) – US monetary authority responsible for the conduct of monetary policy. FRS together with US Treasury conducts US foreign exchange interventions

Foreign exchange intervention - sales or purchases of foreign exchange by monetary authorities aimed to influence exchange rates

Herding – purchase or sale of financial assets by uninformed traders in response to observed behavior of supposedly informed traders or group of traders

G3 – Germany, Japan and USA

Indirect intervention - the use of administrative controls and banking regulation aimed at influencing exchange rate

Oliver-Tanzi effect – reduction in the real value of the tax income that results from high inflation

Resident – legal entity or person that is officially allowed to operate on the Ukrainian territory and pays taxes in Ukraine

Sterilization – open-market operations conducted after intervention with the aim of leaving monetary base unchanged

Sterilized foreign exchange intervention – foreign exchange intervention accompanied by open-market operation that fully offsets change in monetary base.

Unsterilized foreign exchange intervention – foreign exchange intervention that changes monetary base

Chapter 1

INTRODUCTION

Foreign exchange intervention is probably the most important instrument of exchange rate management. Intervention can be defined as sales or purchases of foreign exchange conducted by monetary authorities to influence exchange rates. There are two types of interventions: unsterilized and sterilized. Empirical studies are inconclusive in examining effectiveness of foreign exchange interventions but many central banks still heavily use it.

Central banks also conduct indirect interventions. Indirect interventions involve the use of administrative controls and banking regulation aimed at influencing exchange rate. According to the survey conducted by Christopher J. Neely¹, 23.8% of monetary authorities that answered the question acknowledged use of indirect methods of intervention such as moral suasion and changes in banking regulation. According to Neely, indirect methods seem to be used predominantly by central banks without a long history of free capital movements or a convertible currency.

Unsterilized foreign exchange interventions affect exchange rate via change in monetary base and resulting change in inflationary expectations. Effect of sterilized foreign exchange operations is more uncertain. Theory distinguishes three main channels of impact of unsterilized intervention on exchange rate: signaling channel, portfolio balance channel and noise trader channel². Empirical studies are contradictory in assessing the effectiveness of sterilized foreign

¹ Neely (2000)

² Frenkel, Michael, Georg Stadtmann, Christian Pierdzioch (2001)

exchange interventions. Notwithstanding many central banks are still heavily relying on sterilized interventions.

In my study I am considering period of 1995-2001. National bank of Ukraine has been actively conducting interventions during the whole period under investigation. During 1996-1997 supply of foreign exchange was greater than demand for most of the time and NBU was increasing its foreign exchange reserves by buying out excess supply. At the beginning of the 1998 the trend has reversed, demand for the foreign exchange was greater than supply. NBU was still trying to keep exchange rate within narrow band (1.8 – 2.25 UAH/USD) and was intervening to strengthen the Hryvnia. Interventions have slowed down depreciation of the Hryvnia but have not reversed the trend. National bank reserves were gradually decreasing. Numerous business experts were warning against interventions as they were viewing Hryvnia being overvalued.

In Russia situation was similar to the one in Ukraine but crisis struck there earlier. After the ruble fell 3-fold people in Ukraine rushed to buy foreign exchange anticipating depreciation of the Hryvnia. NBU applied administrative controls limiting access to the foreign exchange operations. Apparently equilibrium value of the exchange rate perceived by the central bank was too far from the market view. Exchange rate went up more than 50% but the National bank was still intervening and losing foreign exchange reserves. Only at the March 1999 central bank NBU has stopped sale of the foreign exchange to support hryvnia.

Qualitative analysis shows that interventions that National bank of Ukraine is conducting since January 2000 have been much more successful so far. Central bank is targeting stability of the exchange rate and moderate devaluation (up to 5% annually). Unlike 1998, this time exchange rate pressure is coming from the opposite direction. Hryvnia tends to appreciate and NBU is slowing the trend by buying out excess supply of the foreign exchange. Interventions are only partially

sterilized and monetary base is increasing. Foreign exchange reserves have been increasing and NBU can conduct that policy for a long time, as long as the domestic market is willing to absorb additional liquidity provided by the central bank.

I have tested effect of the foreign exchange interventions conducted by NBU during 1995-2001 on the level and volatility of exchange rate using portfolio balance and balance of payments approaches and employing GARCH technique. Estimation according to the portfolio balance theory shows opposite to the intended effect of interventions on level of exchange rate (purchase of foreign exchange is associated with appreciation rather than depreciation which is expected if intervention is successful) but has intended effect on volatility of exchange rate (increase in intervention activity is associated with decreased volatility). These results may be explained by the fact that portfolio balance theory assumes high capital mobility between the markets, which is certainly not true for Ukraine. There are a number of restrictions on capital inflow and outflow in Ukraine that prevent free flow of capital. Moreover, portfolio balance theory is widely used for the analysis of sterilized interventions, while in Ukraine interventions are largely unsterilized or partially sterilized. Under these conditions portfolio balance theory may be unsuitable for Ukraine. So I estimate effectiveness of foreign exchange interventions using modified balance of payments theory. Estimation shows effectiveness of the interventions in decreasing volatility of the exchange rate. Interventions also affect the level of the exchange rate, however effect is statistically insignificant.

So, my econometrical estimation proves effectiveness of foreign exchange interventions conducted by NBU in decreasing volatility of the exchange rate. Effect of interventions on the level of exchange rate is weak.

Chapter 2

UKRAINIAN CONTEXT

National Bank of Ukraine (NBU) has been an active player in the Ukrainian foreign exchange market during the entire period of its existence. During the last two years, National bank is constantly present at the interbank foreign exchange market equating demand and supply of the foreign exchange by buying out excess supply and selling foreign exchange in the case of unsatisfied demand. By carrying out that practice NBU is pursuing exchange rate stabilization policy. Because of positive trade balance supply of the foreign exchange outweighs demand and in the absence of NBU interventions that would lead to the appreciation of the hryvnia. Since January 2000 UAH/USD exchange rate is more or less stable. During that time nominal exchange rate has appreciated 5%; real effective exchange rate has appreciated more than 15%³.

In the present paper, I will focus on the period from 1995 onward. In 1995-1996 Ukraine officially had floating exchange rate. From 1997 to 1999 National bank was using exchange rate band. In February 2000 NBU officially introduced floating exchange rate again, but central bank remains an active participant in the foreign exchange market.

Brief history of Ukrainian financial sector

Unsystematic beginning: 1991-1994

National bank of Ukraine was established in 1991. In January 1992 national currency, kuponno-karbovanets was introduced. It was designed as a temporary currency for the transitional period. Kuponno-karbovanets was allowed to float freely at the beginning since central bank had no foreign exchange reserves. During 1991-1994, a system of multiple exchange rates existed with official exchange rate lower than the market exchange rate. For the period of the first half of the 1992, kuponno-karbovanets was circulating together with the ruble. Russian ruble went out of circulation in the end of 1992, but it was not illegal for retail outlets to quote prices in foreign currency and accept payments in them. Exchange rates were not fully liberalized until October 1994. Since October 1994 exchange rates are liberalized; Ukrainian kuponno-karbovanets is the only legal medium of exchange in Ukraine.

Liberalization: 1995-1997

Liberalization of the foreign exchange market was continued in 1995. Banks were allowed to trade US dollars, Deutsche Marks, Russian and Belarus rubles on the interbank market⁴. National bank of Ukraine was overseeing operations of the banks; in order to conduct operations with foreign currencies banks are required to hold special license from NBU. At the same time Ukrainian residents were allowed to buy currency on the exchange with the purpose of profit repatriation. Ukrainian residents were allowed to trade foreign exchange subject to obligatory sale on exchange or via bank. Banks were allowed to trade foreign exchange within the limit of open position. Foreign cash trades were initiated at the

³ IFS, own calculations

⁴ Baranovskyy, p.20-21

Ukrainian interbank exchange. In September 1996 denomination was conducted, 100 000 kuponno-karbovanets was exchanged for 1 hryvnia. In 1997 National bank of Ukraine cancelled restrictions on current account convertibility of the hryvnia according to the 8th article of the IMF statute. That was an important step in liberalization of the Ukrainian economy. In June 1997 obligatory sale of part of the foreign exchange arriving to the Ukrainian residents was cancelled.

Switch to debt financing of the budget deficit

Prior to 1995 state budget deficit was for the most part financed by direct credits of the Central bank and foreign credits. Since 1995 structure of the budget deficit financing had changed dramatically. Starting March 1995 Ukrainian treasury began issuing bonds in order to finance budget deficit. Share of the direct credits by NBU fell from more than 70% in 1995 to almost zero in 1997. Government has switched to the debt financing instead⁵.

Table 1. Sources of financing the budget deficit, percent

	Direct NBU credits	Foreign credits	T-bills
1995	72.7	19.8	7.4
1996	40.2	22.8	37.0
1997	1.6	26.7	71.7
1998	0.8	68.0	31.2
1999	0.1	13.7	86.2

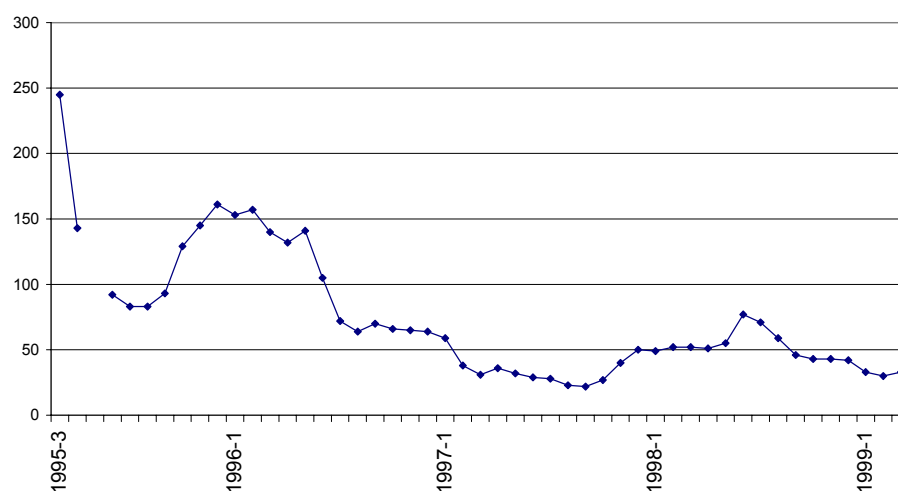
Source: UEPLAC.

Yields on the Ukrainian government debt were extremely high, reaching several hundred percent on the annual basis. High yields attracted Ukrainian banks and foreign portfolio investors. At the end of 1995 Ukrainian treasury has only UAH

⁵ However, it should be noted that starting 1998 National bank was indirectly crediting government via purchase of Treasury bills. Yields on T-bills bought by NBU were often below market interest rate.

26mn of outstanding debt, while at the end of 1996 Ukrainian government accumulated UAH 2219mn of outstanding debt, and in the end of 1997 this number rose to the UAH 7628mn (more than \$4bn)⁶. To ensure foreign investors in exchange rate stability NBU introduced a policy of exchange rate band starting 1997. For the 1997 exchange rate was allowed to fluctuate within UAH/USD 1.7 – 1.9 limit, for 1998 – within UAH/USD 1.8 – 2.25 limit.

Chart 1. Effective rate of return on T-bills (% yearly)



Source: UEPLAC.

It was often argued that heavy state borrowing in 1996-1997 crowded out private investment. Banks were actively involved in the T-bills market, which they regarded as a more profitable and less risky business than direct borrowing to the

⁶ Source: UEPLAC

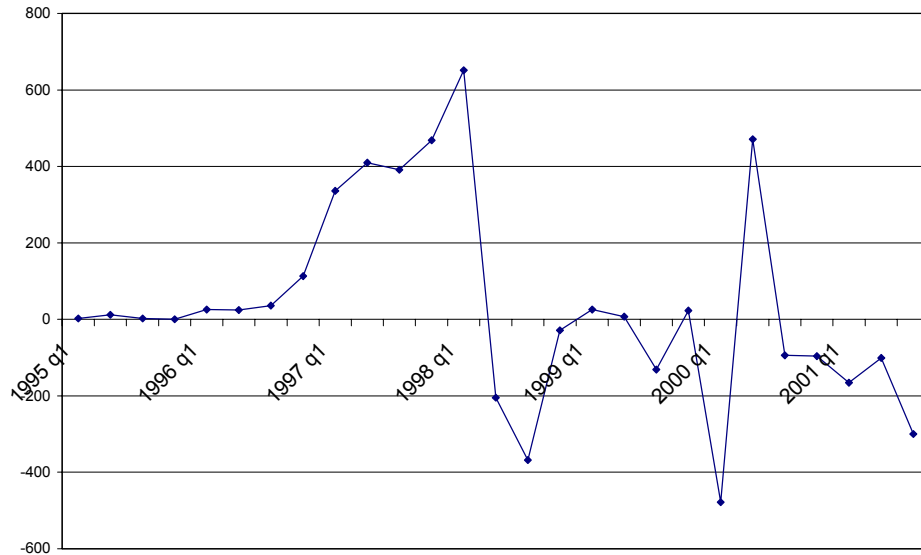
private sector. At the beginning of 1998, the T-bill portfolio of domestic commercial banks reached UAH 1.7 billion⁷.

Effective annual rate of return on Ukrainian bonds (hryvnia denominated) was gradually decreasing from 245% in the March 1995 to the 22% in the September 1997. In July 1997 Asian crisis has broken out setting uncertainty on the world financial markets. Perceived risk of the investment in emerging markets had risen up and foreign portfolio investors started to withdraw their money from Ukraine. In October 1997 interest rate on T-bills began to rise, reflecting falling confidence of the foreign investors. Share of the T-bills held by foreign investors decreased from 60% in the mid-1997 to 16% in the August 1998⁸. National bank of Ukraine sharply increased its holdings of T-bills, up to 62% of the all T-bills outstanding in the August 1998. Exodus of foreign investors put strong pressure on the hryvnia. It can be seen on the graph that net portfolio investment fell sharply in second quarter 1998.

⁷ Dean and Ivaschenko

⁸ Bereslavska 1998

Chart 2. Net portfolio investment, USD million



Source: UEPLAC

Russian crisis and its impact on Ukraine

On 17th August 1998 Russian government announced moratorium on repayment on state debt. Russian ruble was probably even more overvalued than hryvnia since Russia state started issuing debt earlier and inflow of foreign speculative capital into Russia was greater. Simultaneously with default announcement Russian central bank announced switch to the free float regime. Russian ruble fell from around 6 to 22 RUR/USD in a couple of days.

Russian financial crisis has a tremendous impact on Ukraine. Ukrainian and Russian economies were developing in a similar way with Ukrainian government repeating Russian reforms with a lag. Expecting sharp depreciation in Ukraine

public rushed to exchange hryvnia into foreign cash. Private investors stopped purchasing T-bills and NBU became the sole buyer on the market.

In response to Russian crisis NBU applied administrative action to prevent hryvnia from depreciating. Since August 22nd 1998 Ukrainian banks are temporarily banned from buying foreign exchange for own purposes (that restriction is still in force). The same day NBU banned advance payment on import contracts. At September 5th 1998 NBU changed exchange rate band from 1.8 – 2.25 to 2.5 – 3.5. These administrative actions failed to stabilize situation on the foreign exchange market, public was expecting further depreciation of the hryvnia. Foreign exchange reserves of the National bank of Ukraine were quickly diminishing. NBU introduced additional measures aimed at restricting access to the foreign exchange operations. Interbank trade of the foreign exchange was temporarily stopped. Obligatory sale of 50% of export earnings was introduced (still in force). Trades on all currencies except Deutsche Mark and US dollar were stopped. 10% maximum deviation from official exchange rate for all non-cash currency trades (except Deutsche Mark and US dollar) was introduced, for cash exchange maximum deviation was 5% (including margin).

Administrative action by NBU limited access to the foreign exchange, but it does not eliminated excess demand for foreign exchange. Unsatisfied demand for foreign exchange persisted in Ukraine till the beginning of 1999.

The fundamental causes of financial crisis of 1998 were continual budget deficit and lack of structural reforms in real sector. High yields on government debt attracted large foreign capital inflows. High supply of foreign exchange helped to stabilize exchange rate. At the same time monetary base was growing at high rates. It grew 231% during 1996, 54% during 1997 and 26% during the first half of 1998. The market absorbed part of the growth of the monetary base without increase in inflation due to remonetization of the economy. But inflation in

Ukraine was still higher than in the USA and hryvnia was appreciating in real terms. Asian crisis caused fall in confidence of portfolio investors in emerging markets and they started to withdraw money from Ukraine. NBU supported hryvnia and intervened to keep exchange rate within pre-announced band. Russian crisis created anticipation of hryvnia depreciation and despite NBU resistance value of the hryvnia fell almost by half.

Contemporary exchange rate policy of the NBU

Ukraine is deeply involved into the world economy. Export of the goods account for the 50%⁹ of the official GDP with export of services accounting for another 12% of the official GDP¹⁰. That puts great importance on the exchange rate policy of the central bank. Exporting industries often call for the devaluation of the hryvnia to boost exports. Importers resist devaluation, but they are more dispersed and their voice is not so powerful. National bank's management is unwilling to devalue national currency citing stability of the exchange rate as the main goal of its exchange rate policy. In addition, high exchange rate provides better conditions for the repayment of the country's debt. Exchange rate is in fact country's terms of trade and stronger national currency means better terms of trade. With the higher exchange rate country is exchanging less of its good for the unit of foreign good.

⁹ Share of export in GDP is often viewed as too high for a country like Ukraine. In fact this share is probably much lower due to the widespread shadow economy. Shadow economy is often estimated at 50% or more of the official economy. Almost 100% of goods and services produced in the shadow are consumed at the domestic market (illegal CD's are probably the only significant exception). So, with shadow economy taken into account share of the goods exported in GDP is much lower. However, situation is not so clear with the export of services. Several millions of Ukrainians work abroad, earning several billions of US dollars annually. Majority of them work illegally in Russia and Poland. Taking into account illegal labour force working abroad share of services export to GDP may be even higher.

¹⁰ For the year 2000, source - UEPLAC

NBU management¹¹ regards stable exchange rates as one of the main causes of the rise of exports in 2000-2001 and is going to continue present policy of exchange rate stabilization. NBU predicts exchange rate at the end of 2002 at the level of 5.45 UAH/USD¹² (the number was recently revised downward from 5.6 UAH/USD) .

Apart from direct foreign exchange interventions, National Bank of Ukraine uses indirect ways of influencing exchange rates. In 1998-1999, it was actively using administrative restrictions on foreign exchange transactions. Those restrictions were eased later but some of them are still in force. According to NBU regulations Ukrainian exporters must sell 50% of export revenues on the interbank market. Ukrainian hryvnia is not traded yet on the FOREX market, so banks can only trade it on the interbank market. Banking regulation allows banks to buy or sell foreign exchange in the interbank market only for the clients that have import/export contract and for retail exchange outlets. A bank can only be a seller or a buyer on the Ukrainian foreign exchange market within a single day. All clients' orders for the purchase/sale of the foreign exchange must be settled within a bank; the bank can go into the interbank market only with the net demand for or supply of the foreign exchange. Trade with foreign exchange at the interbank market was conducted from 13:00 till 15:00. Starting April 2002 trade session was extended to three hours, from 12:30 till 15:30. Foreign exchange trade regulation poses a significant barrier to the speculative activity of the banks. Introduction of the abovementioned restrictions resulted in significant reduction in daily volatility of exchange rate. Since 2000 at the end of the trading

¹¹ Stelmah and Petryk, 2001

¹² <http://www.unian.net/ukr/news/news-6918.html>, accessed 18.05.2002 at 16:40

session NBU usually closes the difference between demand and supply of the foreign exchange¹³.

¹³ According to the currency dealer. <http://www.unian.net/phorum/read.php?f=2&i=4&t=4> accessed 9.02.2002 at 16-30

Chapter 3

THEORY CHAPTER

There are two types of foreign exchange interventions: sterilized and unsterilized. Selling or buying of foreign exchange by monetary authority changes domestic monetary base by the amount of sale/purchase. If monetary authority compensates this change in monetary base by open market operations then intervention is sterilized. Central bank may sterilize sale (purchase) of foreign exchange by purchase (sale) of securities denominated in domestic currency. Otherwise intervention is unsterilized. Unsterilized foreign exchange interventions alter money supply while sterilized does not. In this light unsterilized foreign exchange intervention may be viewed as part of monetary policy. By unsterilized purchase (sale) of foreign exchange Central bank is conducting expansionary (contractionary) policy. Central banks of advanced economies usually conduct only sterilized interventions. For example, foreign exchange interventions conducted by US and EU monetary authorities are always fully sterilized. In Ukraine interventions are only partially sterilized and it is the major difference of Ukrainian foreign exchange interventions from that of US, European union and other developed countries.

There are several reasons for foreign exchange intervention. The first reason why central bank may interfere is willingness to influence trend movements in exchange rates. Central bank may perceive long-run equilibrium value of the exchange rate higher or lower than the actual value. The second reason is to stabilize the market, to “calm disorderly markets” as Dominguez puts it. In

Ukrainian case it is probably the most important reason for intervention as National bank of Ukraine is officially targeting stability of the exchange rate as the main objective of its exchange rate policy. The third reason is support of other central banks in their interventions. One more reason is adjustment of foreign exchange reserves, but usually it is not considered to be a direct intervention.

Theories of exchange rate determination

Different theories of exchange rate determination may be used in estimation of foreign exchange intervention. The most popular one is *portfolio balance theory*. It was founded by McKinnon and Oates (1996) who modified Mundell-Fleming model. In McKinnon and Oates specification capital flows are caused by adaptations of the market to the changes in financial assets. At portfolio balance theory national and foreign assets are imperfect substitutes; market participants are holding both types of assets at equilibrium. Macroeconomic shocks are affecting expected returns of national and foreign assets and changes relative asset demands. Assets markets are balanced with a change in exchange rate. Current and capital accounts surpluses/deficits are among the most important macroeconomic shocks affecting relative asset demand. In portfolio balance theory a sterilized sale of foreign currency denominated bonds by Central bank creates an excess supply for foreign currency denominated bonds and an excess demand for domestic currency denominated bonds. For market to come to the equilibrium price of the domestic bonds must rise and price of foreign bonds must fall. That means that domestic interest rate must fall and foreign interest rate must rise. Domestic currency must appreciate in order to equalize real returns on both assets.

Purchasing power parity theory of exchange rate determination is one of the oldest theories and is widely used for the evaluation of long-term movements of

exchange rates¹⁴. According to the PPP theory changes in the exchange rates between currencies will tend to reflect changes in price levels of these countries. Absolute version of the PPP theory is based on the “law of one price”, which states that price of goods must be the same in all countries if converted into common currency. That is

$$P = E * P^*$$

where P is price index of home country, E is exchange rate and P* is price index of foreign country. Because of the existence of transportation costs and trade barriers relative PPP theory is often used:

$$\dot{P} = \dot{E} + \dot{P}^*$$

where \dot{P} is percentage change in home price level \dot{E} is percentage change in exchange rate and \dot{P}^* is percentage change in foreign country price level.

Another important theory of exchange rate determination is *balance of payments theory*. Basic form of the balance of payments theory hypothesizes that equilibrium exchange rate is determined when net inflow (outflow) of the foreign exchange arising from current account transactions just matches net outflow (inflow) of the foreign exchange arising from capital account transactions¹⁵. In the balance of payments flow model exchange rate elasticities of the supply of and demand for exports and imports determine changes in exchange rate necessary to balance payments. Different versions of balance of payments model were used for the analysis of devaluations and revaluations in the Bretton Woods system.

¹⁴ Mikko Spolander, 1999

¹⁵ Mikko Spolander, 1999

Mundell-Fleming model was the most popular in theoretical and empirical studies.

Supporters of *monetary theory of exchange rate determination* criticize basic form of the balance of payments theory of exchange rate determination. They argue that equilibrium exchange rate is determined by the stock supply and demand of the foreign exchange as opposed to the flow supply and demand assumed by the balance of payments theory. According to them flow supply and demand determine equilibrium price only for the non-durable goods, while equilibrium price for durable goods including foreign exchange is determined by current and expected future supply and demand. Outstanding stocks of foreign and domestic currencies willingly held by the market participants determine equilibrium exchange rate.

Channels of the effect of foreign exchange interventions on exchange rate

Unsterilized foreign exchange interventions affect exchange rate via change in monetary base and resulting change in inflationary expectations. This type of intervention also has an effect on interest rate. Effect of sterilized foreign exchange operations is more uncertain. Sterilized interventions are ineffective within conventional monetary model of exchange-rate determination. Empirical studies are inconsistent in examining effectiveness of sterilized foreign exchange interventions. Researchers point out at 3 main channels of the effect of sterilized foreign exchange intervention on exchange rate: the signaling channel, the portfolio balance channel, and the noise trader channel.

Signaling approach assumes competitive and informationally efficient foreign-exchange markets (Frenkel, Stadtmann, Pierdzioch 2001). Informational

efficiency means that all available relevant information is instantly included into the valuation of currencies. According to the signaling approach foreign exchange intervention affects exchange rate by changing expectations of the public. Sterilized intervention would have an effect only if monetary authority is better informed than the other market participants. If the market already expects future policy change intervention would be useless as a signal. There is a considerable doubt whether Central banks officials are better informed about equilibrium value of exchange rate than the market. But Central bank clearly has informational advantage in the part of its own actions. That is why foreign exchange market actors react in a different way to the foreign exchange interventions of the central bank than to the trades of the same magnitude conducted by dealers or brokers. Intervention has a stronger effect on exchange rate than a simple statement of the Central bank because in the case of intervention Central bank “puts money where its mouth is”. Market is more likely to believe to the monetary authority if it backs its words with money. Humpage (1998) suggests that interventions are more likely to be successful during periods of uncertainty. Central bank should clearly state the goal of intervention for the market to understand the signal correctly. If the market is unsure about the Central bank’s objective the intervention may have unanticipated effects. Signaling approach explains interventions conducted with prior notice of the public. It does not explain secret interventions, which are quite often employed by monetary authorities.

Portfolio balance approach assumes that assets denominated in domestic and foreign currency are imperfect substitutes. Investors diversify their holdings among foreign and domestic asset based on expected returns and risk. Model assumes risk averse asset holders. Sterilized intervention alters relative supply of the domestic and foreign bonds. Investors rebalance their portfolios; since relative

supplies of domestic and foreign assets change a change in expected returns is needed, so exchange rates may be affected.

The third channel of the impact of sterilized intervention is *noise trading approach*. Noise traders use technical (statistical) analysis to forecast future price of the asset. Unlike traders who try to figure out fundamental value of the asset and buy/sell asset if they consider it undervalued/overvalued noise traders try to identify price trends and consider the behavior of other traders as a source of information, giving rise to the tendency towards herding.

Sterilized foreign exchange intervention may break short-run trends and influence decisions taken by noise traders. According to the approach noise traders incorporate changes caused by the intervention into their forecasts and perceiving change in the trend magnify and perpetuate initial impact of the intervention. Immediate conclusion from that theory is that the central bank should conduct secret interventions because with the information that the central bank is intervening noise traders would not change their forecasts.

Previous research.

Effects of foreign exchange interventions were estimated in a number of ways. Dominguez (1999) uses high-frequency spot market data to examine the mechanics of the impact of foreign exchange intervention on exchange rate. She discusses two approaches to the analysis of price formation process: inventory approach and the information approach. Inventory approach analyses effect of the change in the inventory of the dealer on the price of financial commodity. Simple version of the inventory model assumes symmetric information and predicts that optimal bid and ask prices increase/decrease with the decrease/increase in inventory position. Evidence in favor of inventory effects is

found in foreign exchange markets (Lyons 1996). The information approach to the market microstructure assumes information asymmetry between traders. Informed traders buy and sell if they believe that the price is too low or too high, respectively. The uninformed traders pay profits of the informed traders.

Dominguez finds that effect of intervention depends “on the volume of trading (proxied by time-of-day), day-of-the week, and proximity to the release of other macroeconomic news¹⁶”. Her results show that interventions of the G3 central banks significantly influence USD/DM and USD/JPY returns and volatility. She also finds evidence of the informed traders. According to her study “some traders know at least one hour prior to the Reuters’ report that a central bank is intervening, and the effect of interventions generally persist, at least to the end of the day”.

Cheung and Chinn (1999) conducted a survey of the foreign exchange traders in United States and found that short-term exchange rate dynamics are believed by practitioners to depend largely on non-fundamental forces rather than fundamentals. About 30% of traders acknowledge utilization of technical trading rules. Over the longer horizons exceeding six months fundamentals are seen to exert more and more influence. However, traders have only an imprecise knowledge of what these fundamentals are; the relative importance of macroeconomic fundamentals appears to vary over time. Traders contend that while both speculation and interventions usually increase daily volatility, they are likely to restore equilibrium by moving exchange rates toward their long run values. Speculation is generally perceived positively as increasing market efficiency and liquidity. Traders are also found to not view purchasing power parity as a important measure of macroeconomic fundamentals, even though about 40% of them believe it influences exchange rates at the very long horizon.

¹⁶ Dominguez (1999) p.8

Hopkins and Murphy (1997) estimated effectiveness of interventions conducted by the Reserve Bank of Australia in August-October 1993 and tested signaling impact of interventions. They regressed daily change in the spot exchange rate of Australian dollar on intervention and its lagged effect. Results indicate presence of relationship between change in exchange rate and interventions, but small – the adjusted R-squared is equal to 0.19. The sign and significance of the contemporaneous and one day lagged intervention variables point to desired effect of interventions. Following approach suggested by Dominguez and Frankel (1993) authors examined the effect of newspaper reports concerning exchange rate policies of the central bank on daily changes in exchange rate. They have found strong relationship between newspaper reports of intervention activity by the Reserve Bank of Australia and changes in the spot exchange rate. The R-squared is low – 0.13. It should be noted that this study is examining effect of interventions during only one specific episode of intervention activity.

Humpage (1999) counted successful interventions to test whether Federal Reserve System had informational advantage in exchange rate forecasting. He found that the probability of a successful US intervention was low, less than 50% of all cases. However, assuming binomial distribution he found that the number of observed successes was greater than one would expect to see randomly. When it seemed successful, intervention tended only to slow rates of appreciation or depreciation, it did not alter the direction of exchange rate movement. Successful interventions were also found by Humpage to be concentrated in periods of extreme volatility, such as after the October 1987 stock-market crash or immediately after 1985 Plaza Accord. However, coordinated interventions and to smaller extent greater amount of intervention were found to be associated with higher probability of success.

Rasmus Fatum (2000) estimates short-term effects of the sterilized foreign exchange intervention on the movements in DEM/USD exchange rate. Also paper investigates possibilities for the central bank to increase the likelihood of success of interventions. Paper recognizes ineffectiveness of the standard time-series techniques in estimating effect of interventions on exchange rates. He quotes high day-to-day volatility of the exchange rates and sporadic nature of interventions as the main reason for the failure of time-series studies in finding systematic link between foreign exchange interventions and exchange rate changes. He proposes to use event study approach instead. Cluster of intervention operations is considered to be a single event. Choice of incorporation of interventions into a single event is discretionary and depends on the author. Behavior of the exchange rate before and after intervention is considered. Fatum discusses several definitions of the successful event. One of the approaches is to test whether the direction of the movement is the same as the direction in which central bank was intervening. The other criterion defines intervention to be successful if it is associated with the smoothing of the exchange rate movement. This definition is broader than the first one because it incorporates episodes of exchange rate moving in the opposite direction from intervention but at a slower rate than before. Both definitions are valid only if the central bank pursues “leaning against the wind policy”, i.e. e. if the central bank is trying to break the ongoing trend. If the central bank is intervening trying to reinforce the ongoing trend of the exchange rate movement this criteria would show success even in the absence of the one. To overcome these restrictions Fatum distinguishes between interventions intended to reverse the trend or slow it -“leaning against the wind” from “leaning with the wind”.

Fatum uses two statistical tests. Non-parametric test for the median verifies whether successful events are systematic or random. Matched sample test checks if there is a significant shift in the exchange rate change between pre- and post-

event periods. Results confirm evidence in support of short-term effectiveness of the interventions. Direction of the change in exchange rate is consistent with associated intervention in 27 out of 32 events. All 26 events of the “leaning against the wind” were successful according to the smoothing criterion.

Event-study approach has important features that researchers must be aware of. It examines the effect of interventions but does not confirm or reject hypothesis about the channel of the effect. Event study approach does not control for the changes in other variables, so its results should be analyzed taking important financial and macroeconomic announcements into account.

In order to explore the possibilities for the central banks to increase likelihood of the success of the intervention, Fatum estimates logit functions over the subsample of interventions. He finds out that coordinated interventions are more likely to have success and that the first day of the intervention in an event or cluster of daily interventions is more likely to be successful. Higher probability of the success of the coordinated intervention can be attributed to the higher importance attached by the central bank to those interventions. Central bank should be really concerned with exchange rate to bother other central banks with request for the coordinated intervention. First day of the intervention is more likely to have effect than subsequent days because if the market does not follow the central bank in the first day it is unlikely to follow it in the next days.

Although the evidence shows effectiveness in the short-run of the foreign exchange intervention Fatum warns that sterilized interventions are unlikely to have an enduring effect on its own, without accompanying changes in monetary or macroeconomic variables.

Unfortunately event-study approach is impossible to apply in analyzing foreign exchange interventions in Ukraine. Event-study approach requires presence of

discrete intervention episodes separated by periods of no intervention activity. In Ukraine central bank is present on the foreign exchange market every day, regularly intervening. So I am turning to the GARCH technique. GARCH models are frequently applied in analyzing effectiveness of the interventions (see Aguilar and Nydahl 1998, Diebold and Nerlove 1989, Dominguez 1993). Application of GARCH model also enables me to estimate effect of the interventions on volatility of the exchange rate.

Chapter 4

EMPIRICAL CHAPTER

In its exchange rate policy National bank of Ukraine is targeting stability of the exchange rate against major currencies. In 1995-1996 Ukraine officially had floating exchange rate. During 1997-1999 NBU was trying to keep hryvnia/US dollar exchange rate within the pre-announced exchange rate band. Since the year 2000 hryvnia is floating but NBU sets target for the hryvnia/US dollar exchange rate at the end of the year.

Two most widely used approaches to the estimation of the effect of foreign exchange interventions are event-study approach and econometric analysis based on portfolio balance theory of exchange rate determination using GARCH model. Unfortunately, because of continuous character of interventions event-study approach is impossible to apply in Ukraine. Event-study approach requires presence of discrete intervention episodes with periods of no intervention activity before and after the intervention. So, I am turning to the estimation based on the GARCH technique. GARCH models with Student t-distribution are found to be useful for modeling the conditional volatility of exchange rate changes (Ballie and Bollerslev 1989) – the estimated conditional volatility addresses the observed volatility very closely.

In order to test the effect of foreign exchange interventions on the volatility and level of exchange rate I am using portfolio balance and balance of payments theories of exchange rate determination employing GARCH specification.

Portfolio balance theory based estimation.

In testing of effect of the foreign exchange interventions in portfolio balance framework I am running GARCH regression using monthly data on UAH/USD exchange rate, intervention volume and interest rate difference. Estimation period: January 1995 – October 2001 (82 observations).

Mean equation:

$$DEX_P_t = \alpha_1 + \alpha_2 IRD_t + \alpha_3 INT_t + \alpha_4 DUM_SEPT + \varepsilon_t$$

DEX_P – percentage change in Hryvnia/US dollar official exchange rate, UAH/USD, $DEX_P = (EX - EX_{-1}) / EX_{-1} * 100$

IRD – difference between average of deposit and lending interest rates of Ukrainian banks and fed funds interest rate

INT – intervention volume, USD million, positive sign indicates purchase of the foreign exchange by the National bank of Ukraine

DUM_SEPT – dummy for September 1998, takes value of “1” for September 1998, “0” otherwise

Variance equation:

$$\sigma_t^2 = w + a_1 \varepsilon_{t-1}^2 + a_2 \varepsilon_{t-2}^2 + \alpha_3 \sigma_{t-1}^2 + \alpha_4 IRD_t + \alpha_5 INT_ABS_t$$

w – mean

$\varepsilon_{t-1}^2, \varepsilon_{t-2}^2$ - ARCH terms - news about volatility from the previous periods, measured as the lag of the squared residual from the mean equation

σ_{t-1}^2 - GARCH term – last period’s forecast variance

IRD – difference between average of deposit and lending interest rates of Ukrainian banks and fed funds interest rate

INT_ABS – absolute intervention volume

Table 2. Estimation Results for portfolio balance theory. Dependent variable is a percentage change in UAH/USD official exchange rate.

	Coefficient	Std. Error	z-Statistic	Prob.
C	-0.547071	0.327388	-1.671019	0.0947
INT	-0.002834	0.000903	-3.139156	0.0017
IRD	0.040894	0.011098	3.684913	0.0002
DUM_SEPT	49.64856	0.281224	176.5446	0.0000
Variance Equation				
C	2.593191	2.227014	1.164426	0.2443
ARCH(1)	0.154747	0.063280	2.445432	0.0145
ARCH(2)	-0.130827	0.053025	-2.467281	0.0136
GARCH(1)	0.293559	0.128565	2.283344	0.0224
IRD	0.131350	0.055429	2.369679	0.0178
INT_ABS	-0.020428	0.009654	-2.116014	0.0343
R-squared	0.812057	F-statistic		34.08595
Adjusted R-squared	0.788233	Prob(F-statistic)		0.000000
Bollerslev-Wooldrige robust standard errors & covariance				

ARCH LM test (Appendix A) developed by Engle (1982) shows that null hypothesis of no further GARCH effects in the squared residuals of the GARCH (2,1) cannot be rejected. The significance of the Jarque-Bera test statistic (Appendix B) indicates that it is not possible to retain the assumption of standardized residuals of the GARCH model being normally distributed. To account for the departure from normality the quasi-maximum likelihood method developed by Bollerslev and Wooldrige (1992) was used to compute robust standard errors.

Interest rate differential has expected sign; increase in interest rate differential is associated with increase in pace of depreciation of exchange rate and increased volatility of the exchange rate. Foreign exchange intervention seems to have opposite to the intended effect on the level of exchange rate (purchase of foreign exchange is associated with appreciation rather than depreciation, which is expected if intervention is successful) but has intended effect on volatility of exchange rate (increase in intervention activity is associated with decreased volatility). However, it does not mean that foreign exchange interventions have opposite effect on the level of exchange rate. There is a problem of endogeneity in central bank interventions. Central bank is intervening if exchange rate deviates from the targeted level, hence intervention should be treated not as a policy shock but rather as a policy response. Since most of the time NBU was trying to smooth exchange rate movements but still allow some appreciation or depreciation caused by the market forces, intervention is associated with the opposite to the direction of intervention movement in exchange rate. Of course, interventions are not fully endogenous; it is central bank's discretion whether to intervene or not and to what extent. Alas, literature does not suggest suitable instrumental variables for the intervention. In order to deal with endogeneity I try to construct specification that would include market variables that cause intervention. Hence I turn to the balance of payments theory.

Unlike portfolio balance theory that is well suited for the analysis of sterilized interventions balance of payments theory of exchange rate determination is better in dealing with unsterilized foreign exchange interventions. Majority of the central banks in developed countries conduct only sterilized interventions. For example US and German/EU interventions are always fully sterilized. In Ukraine foreign exchange interventions were only partially sterilized. So, balance of payments theory of exchange rate determination is more appropriate for the analysis of the effect of interventions in Ukraine. Moreover, unlike portfolio balance theory it does not assume high mobility between Ukrainian and US capital markets. In Ukraine capital markets are only at the initial stage of development; only a limited number of shares is quoted, trade volumes are very low and corporate debt market is almost non-existent.

Balance of payments theory based estimation.

Since future supply and demand of foreign exchange are unknown I am applying specification using net inflows/outflows of foreign exchange arising from current and capital account transactions.

In testing effect of interventions on volatility and level of UAH/USD exchange rate in balance of payments framework I employ GARCH specification. Quarterly data for the period of 1 quarter 1995 – second quarter 2001 is used (26 observations).

Mean equation:

$$DEX_P_t = \alpha_1 + \alpha_2 CA_t + \alpha_3 FA_t + \alpha_4 INT_t + \alpha_5 DUM_3_98 + \varepsilon_t$$

DEX_P – percentage change in Hryvnia/US dollar official exchange rate, UAH/USD, $DEX_P = (EX - EX_{-1}) / EX_{-1} * 100$

CA – current account, mn USD

FA – financial account, mn USD

INT – intervention volume, USD million, positive sign indicates purchase of the foreign exchange by the National bank of Ukraine

DUM_3_98 – dummy for the third quarter 1998, takes value of “1” for third quarter 1998, “0” otherwise

Variance equation:

$$\sigma_t^2 = w + a_1 \varepsilon_{t-1}^2 + a_2 \varepsilon_{t-2}^2 + \alpha_3 \sigma_{t-1}^2 + \alpha_4 INT_ABS_t$$

w – mean

$\varepsilon_{t-1}^2, \varepsilon_{t-2}^2$ - ARCH terms - news about volatility from the previous periods, measured as the lag of the squared residual from the mean equation

σ_{t-1}^2 - GARCH term – last period’s forecast variance

INT_ABS – absolute intervention volume

This specification like all other econometric specifications involving interventions in the literature does not avoid the problem of endogeneity. Unfortunately, literature suggests no way of dealing with it. Intervention aimed at smoothing exchange rate movements is a response to the change in fundamentals, so it is endogenous in that sense. Of course, foreign exchange interventions are not fully

endogenous since it is central bank that decides whether to intervene or not. Furthermore, current account is affected by the change in exchange rate as well, but in that case endogeneity is probably weak because export and import volumes are adjusted with lag to the changes in exchange rate. There is also an identity: current account + capital account + change in reserves = 0¹⁷. However, in Ukraine direct interventions on the foreign exchange market does not constitute 100% or close to 100% of a change in foreign exchange reserves of the central bank. According to the theory¹⁸ change in reserves consist of all operations of central bank with currency including net direct interventions, net borrowing, that latter including any repayment of loans with minus sign. It may also include active operations with reserves: interest obtained on holdings of reserves on accounts abroad, other capital gains, net inflows of foreign assets. In Ukraine two the most important components of the change in foreign exchange reserves were IMF loans and direct interventions on the foreign exchange market. Outstanding IMF loans range from SDR 250 million (USD 370 million) in January 1995 to SDR 2200 million (USD 3050 million) in September 1999. So, changes in reserves are only partially attributed to the direct foreign exchange interventions of the National bank of Ukraine on the foreign exchange market. Other part of the change in foreign exchange reserves is attributed to the “passive interventions” of the central bank, that largely consisting of IMF loans and interest payments. It is active interventions on the foreign exchange market that are considered by the literature to affect exchange rate so I am using them as a determinant of the exchange rate changes. And, since direct interventions are only a part of a change in foreign exchange reserves of the central bank, my specification avoids multicollinearity problem.

¹⁷ In fact the identity is a bit different: current account + capital account + change in reserves = errors and omissions, the latter being a good proxy for capital flight.

¹⁸ Frenkel, Michael, Georg Stadtmann, Christian Pierdzioch, 2001

Table 3. Estimation results for balance of payments theory. Dependent variable is a percentage change in UAH/USD official exchange rate.

	Coefficient	Std. Error	z-Statistic	Prob.
C	3.060879	0.649458	4.712973	0.0000
CA	-0.005936	0.001530	-3.879015	0.0001
FA	-0.004337	0.001461	-2.969033	0.0030
INT	0.001932	0.001819	1.061906	0.2883
DUM_SEPT	53.83372	2.773677	19.40879	0.0000
Variance Equation				
C	26.26625	5.863582	4.479557	0.0000
ARCH(1)	-0.137216	0.081264	-1.688531	0.0913
ARCH(2)	-0.074129	0.037394	-1.982408	0.0474
GARCH(1)	0.853414	0.131301	6.499659	0.0000
INT_ABS	-0.048490	0.015616	-3.105132	0.0019
R-squared	0.813427	F-statistic		7.266406
Adjusted R-squared	0.701484	Prob(F-statistic)		0.000444
Bollerslev-Wooldrige robust standard errors & covariance				

ARCH LM test (Appendix C) shows that null hypothesis of no further GARCH effects in the squared residuals of the GARCH (2,1) cannot be rejected. However, the significance of the Jarque-Bera test statistic (Appendix D) indicates that null hypothesis of normal distribution of the residuals can be rejected at 5% significance level but cannot be rejected at 1% significance level. To account for the departure from normality I use the quasi-maximum likelihood method developed by Bollerslev and Wooldrige (1992) to compute robust standard errors.

Signs for all variables are expected, current and financial account surpluses are associated with appreciation of hryvnia, and interventions have desired (by the Central bank) effect both on the level and volatility of exchange rate. Purchase of

the foreign exchange by the National bank of Ukraine is associated with depreciation of exchange rate; however effect of interventions on the level of exchange rate is statistically insignificant. Interventions decrease volatility of the exchange rate. Decrease in volatility is significant; USD 250 million intervention decreases volatility approximately by half from that implied by the constant term.

Therefore estimation results show effectiveness of the foreign exchange intervention in decreasing volatility of the exchange rate and limited success of the intervention in affecting the level of the spot exchange rate.

CONCLUSIONS

The aim of this paper is to determine whether foreign exchange interventions of the National bank of Ukraine were successful in affecting the level of exchange rate and in reducing its volatility. Estimation based on the portfolio balance theory shows effect of interventions on level of exchange rate opposite to the intended (purchase of foreign exchange is associated with appreciation rather than depreciation which is expected if intervention is successful) but intended effect on the volatility of exchange rate (increase in intervention activity is associated with decreased volatility). Opposite to the intended sign of the effect of intervention on the level of exchange rate is explained by the endogeneity of interventions: central bank is intervening only if exchange rate is moving away from the targeted level. Portfolio balance theory estimation may be not the most appropriate to the analysis of Ukrainian interventions because it assumes high capital mobility between the markets, what is certainly not the case in Ukraine. Moreover, portfolio balance theory was developed for the analysis of sterilized interventions, while in Ukraine interventions are largely unsterilized or partially sterilized. Therefore, the paper turns to the estimation of the effectiveness of foreign exchange interventions based on the balance of payments approach. Estimation shows effectiveness of the interventions in decreasing volatility of exchange rate; interventions are also found to affect the level of exchange rate in the desired direction; however, the effect is statistically insignificant.

Therefore, my econometrical estimation proves effectiveness of foreign exchange interventions conducted by National bank of Ukraine in decreasing volatility of the exchange rate. Effect of interventions on the level of exchange rate is weak.

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APPENDICES

Appendix A.

ARCH LM Test for Portfolio Balance Equation

ARCH Test:

F-statistic	0.268365	Probability	0.991956
Obs*R-squared	3.752187	Probability	0.987504

Test Equation:

Dependent Variable: STD_RESID²

Method: Least Squares

Date: 05/23/02 Time: 17:33

Sample(adjusted): 1996:02 2001:10

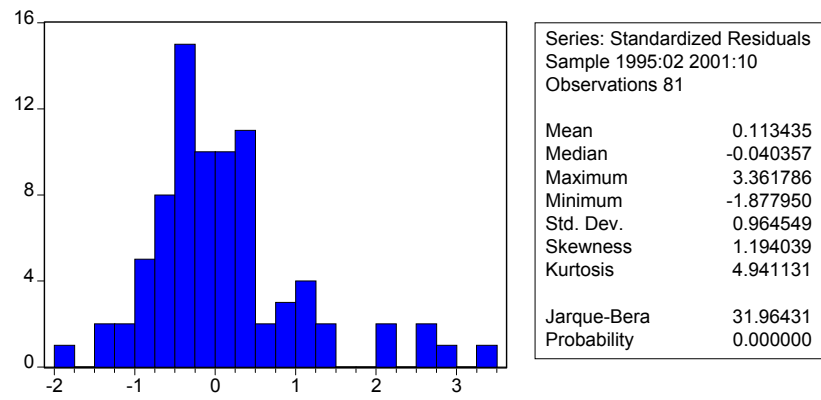
Included observations: 69 after adjusting endpoints

White Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.604221	0.399945	1.510758	0.1365
STD_RESID ² (-1)	0.032794	0.069948	0.468832	0.6410
STD_RESID ² (-2)	-0.074128	0.079616	-0.931076	0.3558
STD_RESID ² (-3)	0.045787	0.114983	0.398205	0.6920
STD_RESID ² (-4)	0.070992	0.150311	0.472302	0.6385
STD_RESID ² (-5)	0.128105	0.157443	0.813661	0.4193
STD_RESID ² (-6)	0.035385	0.110686	0.319689	0.7504
STD_RESID ² (-7)	0.052177	0.119675	0.435988	0.6645
STD_RESID ² (-8)	-0.002419	0.070853	-0.034135	0.9729
STD_RESID ² (-9)	0.102698	0.219635	0.467587	0.6419
STD_RESID ² (-10)	-0.059703	0.073213	-0.815467	0.4183
STD_RESID ² (-11)	-0.046219	0.072957	-0.633512	0.5290
STD_RESID ² (-12)	0.006380	0.075824	0.084145	0.9332
R-squared	0.054380	Mean dependent var		0.887984
Adjusted R-squared	-0.148253	S.D. dependent var		1.940961
S.E. of regression	2.079868	Akaike info criterion		4.470543
Sum squared resid	242.2476	Schwarz criterion		4.891461
Log likelihood	-141.2337	F-statistic		0.268365
Durbin-Watson stat	2.007945	Prob(F-statistic)		0.991956

Appendix B.

Normality Test for Portfolio Balance Equation



Appendix C.

ARCH LM Test for Balance of Payments Equation

ARCH Test:

F-statistic	0.809731	Probability	0.537024
Obs*R-squared	3.535405	Probability	0.472515

Test Equation:

Dependent Variable: STD_RESID^2

Method: Least Squares

Date: 05/24/02 Time: 13:37

Sample(adjusted): 1996:2 2001:2

Included observations: 21 after adjusting endpoints

White Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.182837	0.112280	1.628403	0.1230
STD_RESID^2(-1)	0.277607	0.363680	0.763328	0.4564
STD_RESID^2(-2)	-0.110216	0.287018	-0.384003	0.7060
STD_RESID^2(-3)	0.182431	0.101963	1.789185	0.0925
STD_RESID^2(-4)	-0.119895	0.139034	-0.862344	0.4012
R-squared	0.168353	Mean dependent var		0.247089
Adjusted R-squared	-0.039559	S.D. dependent var		0.410337
S.E. of regression	0.418375	Akaike info criterion		1.299380
Sum squared resid	2.800602	Schwarz criterion		1.548075
Log likelihood	-8.643486	F-statistic		0.809731
Durbin-Watson stat	2.051455	Prob(F-statistic)		0.537024

Appendix D.

Normality Test for Balance of Payments Equation

