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DETERMINANTS OF THE DEMAND FOR INTERNATIONAL RESERVES IN UKRAINE

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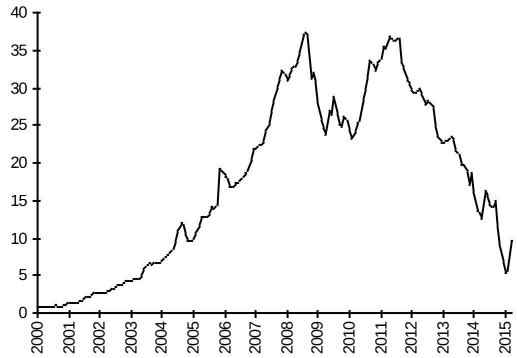
Abstract: This study investigates the demand for international reserves in Ukraine and its structural change in the wake of the 2008-2009 financial crisis in the context of a univariate error correction model (ECM). We find a time-invariant demand for international reserves in the short-run, with the inverse relationship with the volatility of international transactions, exchange rate depreciation and the excessive money stock and the positive link to imports and crisis developments. However, the long-term relationships are not stable over time, except for the effects of the money disequilibrium and crisis disturbances. The exchange rate depreciation and electoral cycle contribute to a depletion of reserves during the post-crisis period only. The adjustment of actual reserves to their long-run relationships is quite rapid.

Keywords: international reserves, imports, exchange rate, money stock

INTRODUCTION

As of August 2011, Ukraine held international reserves totaling 38.4bn USD but the level of reserves has shrunk to just 5.2bn USD by February 2015 (Figure 1). Following a short-lived depletion of reserves in the wake of a 2004 presidential campaign, international reserves rose sharply between 2005 and the middle of 2008, being bolstered mainly by significant capital inflows into the banking sector. However, a third of the international reserves has been lost in 2009–2010 as a result of the sudden stop in capital flows. Then the level of reserves had recovered to its pre-crisis level by the middle of 2011, but it was mainly the result of intense external borrowings. In what followed, a combination of the current account deficit, the burden of foreign debt service payments and political turmoil has resulted in a gradual loss of 85 percent of Ukraine's international reserves.

Figure 1. The level of international reserves in Ukraine (bn of USD), 2000–2015



Source: The IMF on-line *International Financial Statistics*

Empirical studies of the demand for international reserves are usually based on the buffer stock model or the monetary approach to the balance of payments. According to Frenkel and Jovanovic [1981], reserves serve as a buffer stock, with optimal reserves balancing the adjustment costs with the opportunity cost of holding reserves. As suggested by Johnson [1965], accumulation of international reserves is proportional to the net demand for money. For a stable demand for money, Edwards [1984] provided with a synthesis of both theoretical approaches. Recent self-insurance models explain the build-up of reserve holdings by exposure to volatile capital flows thus shifting focus of reserve adequacy assessments from flows of goods to flows of assets [Aizenman and Genberg 2012].

The purpose of this paper is to estimate the determinants of Ukraine's international reserves taking into account both the long-run and short-run relationships. The remainder of the paper proceeds as follows. Section THEORETICAL ISSUES provides a review of the theoretical approaches for the demand of international reserves. In Section DATA AND STATISTICAL METHODOLOGY, the Johansen cointegration test and the Engle-Granger two-step procedure are presented. Section EMPIRICAL RESULTS contains the econometric estimates of the determinants of international reserves in Ukraine. The last Section concludes.

THEORETICAL ISSUES

The buffer stock model implies that the level of international reserves is a stable function of just a few variables – a scale of international transactions, the adjustment cost, the opportunity cost and reserve volatility [Aizenman and Marion 2004]. Average reserves depend negatively on the exchange rate flexibility and depend positively on GDP and adjustment costs [Aizenman and Genberg 2012]. The monetary model of international reserves is based on the assumption that changes in the reserves reflect the difference between the demand for money and the domestic money supply [Frenkel and Johnson 1976; Edwards 1984].

Accounting for the monetary factors, the extended demand function for international reserves could be presented as follows:

$$\ln\left(\frac{R_t}{X_t}\right) = \alpha_0 + \alpha_1 \ln S_t + \alpha_2 \sigma_t + \alpha_3 \ln C_t + \alpha_4 (r_t^* - r_t) + \alpha_5 \ln E_t + \alpha_6 (\ln M_t - \ln \overline{M}_t) + \varepsilon_t, \quad (1)$$

where R_t is the actual reserve holdings, valued in US dollars and expressed as a ratio of X, where X could be the US GDP deflator, the domestic GDP, the total foreign debt or the money stock, S_t is a scaling variable, σ_t is the volatility of international transactions, C_t is for adjustment costs, r_t and r_t^* are domestic and foreign interest rates, respectively, E_t is the exchange rate (defined as units of domestic currency per unit of foreign currency), M_t and $\overline{M}_t$ are the actual and equilibrium stocks of money, ε_t is the stochastic factor.

The scaling variable (S_t) reflects a positive relationship ($\alpha_1 > 0$) between the reserves and the size of international transactions, usually proxied by real GDP, population size or the level of imports. The volatility of international receipts and payments (σ_t) as measured by the standard deviation of the trend-adjusted changes in reserves or the volatility of export receipts or macroeconomic fundamentals should positively correlate with the level of international reserves ($\alpha_2 > 0$).

The effect of the marginal (average) propensity to imports (C_t) is ambiguous ($\alpha_3 <> 0$). Initially, the central bank financing of the external deficit with its international reserves was considered as a standard measure of adjustment costs and thus the alternative for a loss in output. Assuming implementation of expenditure-reducing policies, the coefficient on imports is expected to be negative. However, a positive relationship between the propensity to import and international reserves in many empirical studies suggested that imports reflect greater external vulnerability.

Interpreting an interest rate differential between foreign and domestic rates as the opportunity cost of holding international reserves, an increase in $r_t^* - r_t$ should contribute to accumulation of reserves, because earnings on the liquid reserves reduce the opportunity costs of holding those reserves ($\alpha_4 > 0$).

As exchange rate depreciation is expected to improve the balance-of-payments, it is likely to reduce the need for international reserves ($\alpha_5 < 0$). The negative elasticity of the reserve demand with respect to the real) exchange rate is found for 13 industrial countries by Bahmani-Oskooee and Niroomand [2008]. Among country studies, a statistically significant relationship between international reserves and exchange rate is found for Turkey [Kasman and Ayhan 2008].

If the excessive money stock increases, the demand for international reserves would decrease ($\alpha_6 < 0$), though for a different reason. Assuming that M_{t-1} stands for the money supply and $\overline{M}$ is the proxy for money demand, excessive spending by domestic residents leads to a loss in international reserves; if the demand for money exceeds the money supply, there is an increase in reserves. As suggested by Edwards [1984], the term $M_{t-1} - \overline{M}_t$, henceforth denoted by M_t^{DE}, captures the effect the monetary disequilibrium on international reserves.

Among other factors, the demand for international reserves depends on the level of external debt [Alfaro and Kanczuk 2014], political business cycle [Dreher and Vaubel 2009], concerns about competitiveness [Delatte and Fouquau 2012], attempts to diminish real exchange rate volatility [Hviding, Nowak and Ricci 2004]. Obstfeld, Shambaugh and Taylor [2010] explain hoarding of international reserves by (i) the “fear of floating”, (ii) expansion of domestic banking and financial system relative to GDP and (iii) an increase in the financial integration with international markets. Finally, the “keeping up with the Joneses” (regional imitation) motive implies that a country tries to build-up its reserves in order not to be seen to have lower reserves than a neighboring country and thereby become more susceptible to a loss of investor confidence [Aizenman and Genberg 2012, Cheung and Qian 2009]. Cheung and Ito [2009] found that the relationship between international reserves and their determinants is significantly different between developed and developing economies and is not stable over time. For Ukraine, the presence of precautionary and mercantilist motives of reserve holdings is found for short-term relationships, but the former does not hold over the long term [Makarenko and Gordieieva 2015].

DATA AND STATISTICAL METHODOLOGY

The sample comprises monthly data from 2000 to 2014. All data are obtained from the IMF *International Financial Statistics* online database. The variables used in the reserve demand function are: the value of imports, $IMPORT_t$ (in millions of 2000 US dollars), the volatility of reserves, σ_{t-1}, the nominal effective exchange rate, E_t (index, 2010=100), the excess money stock, M_{t-1}^{DE}, as specified in Eq. (1). Except for the excess money stock and reserves volatility, the variables are transformed into natural logarithms. The electoral dummy, PBC_t, meant to capture electoral effects, equals 1 in six pre-election months and 0 otherwise. Another dummy, $CRISIS_t$, controls for crisis developments.

Since the Ukraine’s domestic interest rate contains a significant risk premium, it is rather difficult to estimate the opportunity cost of holding international reserves. Similar to other studies, for example, Badinger [2004], the average propensity to imports as measured by scaling the value imports with the level of income is excluded from the analysis, as there is a potential multicollinearity problem. Finally, the reserve demand model is reduced to a function of scale (the value of real import), uncertainty (volatility of reserves), competitiveness (exchange rate) and the monetary disequilibrium.

The volatility applied is the estimated conditional variance of the reserves from a univariate GARCH(1,1) model:

$$\Delta \ln R_t = \eta + \xi_t, \qquad \xi_t / \Omega_{t-1} \approx N(0, \sigma_t), \tag{2}$$

$$\sigma_t = \omega + \alpha \xi_{t-1}^2 + \beta \sigma_{t-1}, \quad \omega > 0, \quad \alpha \geq 0, \quad \beta \geq 0, \tag{3}$$

where Δ is the operator of first differences, η is the mean $\Delta \ln R_t$ conditional on past information (Ω_{t-1}), and ε_t is the stochastic factor.

The estimated σ_t (conditional variance) from the GARCH(1,1) model is applied in the estimation of the demand function for reserves as a measure of the volatility of international transactions. Table 1 presents the result from the GARCH(1,1) model for the international reserves, indicating a significant ARCH process. Compared to other studies [Choudhry and Hasan 2008], the ARCH effect is not very large, but the coefficient on α is statistically significant at the 1% level.

Table 1. Univariate GARCH results

Coefficients			
η	ω	α	β
0.466 (6.22***)	0.0003 (3.29***)	0.289 (3.71***)	0.684 (10.96***)

Note: z-statistic in parenthesis; ***, **, * imply statistical significance at the 1, 5 and 10% level, respectively.

Source: own calculations

Given that all series are nonstationary in levels (these results are not provided in order to save space and are available on request), the cointegration tests are conducted. The Johansen cointegration tests are presented in Tables 2 and 3. As indicated by the likelihood ratio test and the Akaike Information Criterion (AIC) test, eight and three lags were used in the cointegration test for the baseline model and the extended model, respectively. Both the trace test and the eigenvalue test indicate that changes in Ukraine's international reserves do form a cointegrating relationship with changes in its volatility, imports, nominal exchange rate and excessive money stock in either baseline or extended models (the cointegration tests are conducted with the inclusion of a linear trend with intercept).

As implied by the Engle-Granger two-step methodology, cointegration of the data containing unit roots in the individual time series allows to estimate the long-run relationship (in levels) by standard least-squares techniques and then use the lagged residuals to estimate a short-run dynamics (in first differences). The standard error-correction starts with positing long-run relationships between a dependent variable, and one or more independent variables, with lag structures to be empirically determined. In the second step, the short-run dynamics is estimated using the long-run result as an error-correction mechanism.

Table 2. Johansen Test Statistics for international reserves, its volatility and imports

Number of cointegrating equations		Trace statistic	0.05 Critical value	Prob.	Max-Eigen Statistic	0.05 Critical value	Prob.
H0: $r = r_0$	$r = 0$	53.74***	49.91	0.00	33.95***	25.82	0.00
	$r = 1$	19.79	25.87	0.23	14.65	19.38	0.21
	$r = 2$	5.13	12.51	0.57	5.12	12.51	0.57

Note: * denotes rejection of the null hypothesis at the 10 percent level (** at the 5 percent level, *** at the 1 percent level).
Source: own calculations

Table 3. Johansen Test Statistics for international reserves, its volatility, imports, nominal effective exchange rate and excessive money stock

Number of cointegrating equations		Trace statistic	0.05 Critical value	Prob.	Max-Eigen Statistic	0.05 Critical value	Prob.
H0: $r = r_0$	$r = 0$	105.10***	88.80	0.00	41.80***	38.33	0.01
	$r = 1$	63.29*	63.87	0.06	33.13**	32.11	0.03
	$r = 2$	30.16	42.91	0.49	15.39	25.82	0.59
	$r = 3$	14.76	25.87	0.59	7.93	19.39	0.82
	$r = 4$	6.83	12.51	0.36	6.83	12.51	0.36

Source: own calculations

Following suggestions from economic theory, the long-run relationship between international reserves and its key determinants may be written as follows:

$$\ln R_t = \alpha_0 + \alpha_1 \ln R_{t-1} + \beta_i \mathbf{X}_{it} + \nu_t, \tag{4}$$

where $\mathbf{X}_{it}$ is the vector of explanatory variables and ν_t is the stochastic factor.

The short-run dynamics around the long-run relationship (4) is defined as:

$$\Delta \ln R_t = \gamma_0 + \gamma_1 \Delta \ln R_{t-1} + \eta_i \Delta \mathbf{X}_{it} + \phi \nu_{t-1} + \varepsilon_t, \tag{5}$$

where ε_t is the error term.

The parameter ϕ on z_{t-1} is the error-correction coefficient, which reflects the speed of short-run adjustment. According to the Engle-Granger specification, if the lagged error-correction term carriers a negative and statistically significant coefficient, all variables are converging towards their long-run equilibrium.

EMPIRICAL RESULTS

Table 4 presents the results of the estimated long-run relationships, representing Eq. (3). We estimate two different time periods: the pre-crisis period (2000M1:2008M8) and the post-crisis period (2009M5:2015M2). For both the baseline and extended models, the ADF test indicates the stationarity of residuals, as required for the validity of the results.

Table 4. Determinants of international reserves (long-run coefficients)

Variables	Baseline model		Extended model	
	Pre-crisis	Post-crisis	Pre-crisis	Post-crisis
$\ln R_{t-1}$	0.927 (52.79***)	1.106 (38.70***)	0.919 (36.23***)	1.125 (39.77***)
$\ln IMPORT_{t-1}$	0.090 (4.33***)	–0.127 (–3.73***)	0.091 (1.78*)	–0.039 (–0.93)
σ_{t-1}	–3.093 (–3.10***)	–3.079 (–2.54**)	–3.342 (–3.36***)	1.340 (0.74)
$CRISIS_t$	0.267 (3.89***)	0.104 (3.16***)	0.256 (3.75***)	0.101 (3.31***)
$\ln E_{t-6}$	–	–	0.014 (0.29)	–0.203 (–3.01***)
M_{t-1}^{DE}	–	–	–0.329 (–1.78*)	–0.968 (–2.75***)
PBC_t	–	–	0.006 (0.37)	–0.075 (–3.05***)
R^2	0.98	0.97	0.98	0.97
ADF	–5.31***	–8.06***	–5.34***	–8.12***

Note: the numbers in parenthesis are *t* statistics.
Source: own calculations

The significant coefficient on the lagged imports is found to be positive for the pre-crisis period in both specifications, but it is not the case for the post-crisis period. The coefficient on $\ln IMPORT_{t-1}$ is negative and statistically significant in the baseline model, while it is not statistically different from zero in the extended model. Contrary to what is predicted by the buffer-stock model, a higher variability in international reserves reduces the level of reserves in the pre-crisis period. If control for a wider set of macroeconomic variables, the coefficient on σ_t becomes positive (but not significant) for the post-crisis period. The demand for reserves is stimulated by the crisis developments. In absolute term, the coefficient on $CRISIS_t$ is much larger in specifications for the pre-crisis period.

The nominal effective exchange rate has no effect on the demand for international reserves in the pre-crisis period, but a moderate and long-delayed (five months) impact is found for the post-crisis period. As depreciation of the exchange rate contributes to a depletion of the reserves, it is in line with the argument linking a weakening of the exchange rate and improvement in the balance-of-payments. On the other hand, it is not ruled out that a negative link between the exchange rate depreciation and international reserves reflects a strong demand for foreign exchange on the domestic market.

There is the very strong negative effect that the lagged excessive money stock has on the level of international reserves, especially in the post-crisis period. Much higher value of the estimated coefficient on M_{t-1}^{DE} may be due to the fact that the money variable reflects also the impact of a very low inflation over the 2011–2013 period. An exchange rate depreciation is neutral in respect to reserves during the pre-crisis period, but it clearly contributes to a depletion of the reserves in the pre-crisis period. It is worthwhile to note that the money lag is much shorter than the exchange rate lag. Given the results from regression for the post-crisis period, appreciation of the *hryvna* and a restrictionary monetary stance could be recommended as policy instruments for accumulation of international reserves.

Specifications of a dynamic error-correction model follow closely those of the long-run regressions. Both regression models explain about 20% of the variation in the dependent variable for the pre-crisis period but the value of R^2 becomes twice as large for the post-crisis period (Table 5). Considering that regressions explain the rate of changes in the reserve demand, the R^2 value can be considered quite good. The extended model performs slightly better than the baseline model but the differences in the value of R^2 are rather marginal.

Table 5. Determinants of international reserves (short-run coefficients)

Variables	Baseline model		Extended model	
	Pre-crisis	Post-crisis	Pre-crisis	Post-crisis
$\Delta \ln R_{t-1}$	0.779 (5.60^{***})	0.963 (6.47^{***})	0.818 (5.96^{***})	0.875 (7.07^{***})
$\Delta \ln IMPORT_t$	0.162 (1.86^{*})	0.176 (1.72^{*})	0.169 (1.99^{*})	0.216 (2.19^{**})
$\Delta\sigma_{t-1}$	–2.500 (-1.83^{*})	–4.291 (-2.24^{**})	–2.596 (-1.96^{*})	–3.707 (-1.99^{*})
$CRISIS_t$	0.246 (3.91^{***})	0.056 (2.01^{**})	0.244 (3.99^{***})	0.085 (2.75^{***})
$\Delta \ln E_t$	–	–	–0.644 (-1.71^{*})	–0.662 (-2.69^{***})
ΔM_{t-1}^{DE}	–	–	–0.722 (-1.80^{*})	–1.061 (-1.88^{*})
Error-correction term	–0.843 (-5.05^{***})	–0.808 (-3.95^{**})	–0.873 (-5.34^{***})	–0.918 (-5.28^{***})
R^2	0.18	0.38	0.20	0.40
ADF	-9.81^{***}	-8.98^{***}	-10.61^{***}	-7.53^{***}

Source: own calculations

While the long-run reserve response to the level of imports is heterogeneous across specifications and time span, the short-run effects are about the same for the pre- and post-crisis periods. An increase in imports has a somewhat stronger (and significant) effect on international reserves in the post-crisis period. Also, short-run import elasticity has slightly increased in the extended model.

Contrary to the estimates of the long-run coefficients, the inclusion of the monetary variables to the dynamic model has not changed the impact of reserves volatility in the post-crisis period. However, the coefficient on the lagged volatility remains negative which is not consistent with the buffer stock model.

Other variables perform as expected. It is confirmed that crisis developments are associated with an increase in the international reserves. Demand for reserves seems to react symmetrically to exchange rate and money stock changes. The size of the coefficients on $\Delta \ln E_t$ shows large and immediate effect of a change in the exchange rate on reserves demand. The same negative effect is obtained for the changes in the excessive money stock, being in full accordance with the estimates of the long-run coefficients on the monetary variable. This suggests that the dynamics of international reserves is exchange rate and money stock sensitive, similar to the long-run relationships.

The coefficient of the lagged error correction term is very large and highly significant at the 1% level, pointing to a very fast adjustment of the short-run dynamics of international reserves to the deviation from its long-run equilibrium. Our results are in sharp contrast to those by Makarenko and Gordieieva [2015], who obtained that the speed of adjustment is rather slow (just 8% over a quarter).

CONCLUSIONS

Using monthly data for the period 2000:1 to 2014:12, this paper analyzes the dynamic relationship between the value of Ukraine’s international reserves and its determinants in the context of a multivariate error-correction model. The results reported in this paper indicate that international reserves maintain a stable time-invariant long-run relationship with crisis developments and excessive money stock, suggesting that the monetary disequilibrium plays a significant role in reserve movements even in the long-run. Contrary to the theoretical explanations, the variability of international transactions is negatively correlated with the reserves. The relationship between the levels of international reserves and imports seems to be asymmetrical for the pre- and post-crisis periods. The exchange rate depreciation and political business cycle contribute to a depletion of international reserves during the post-crisis period only.

Our results indicate a rapid correction of disequilibrium situations between desired and actual reserves. Ukraine’s international reserves maintain a uniform short-run positive relationship with changes in imports and the negative relationship with changes in variability of reserves, exchange rate depreciation and excess money stock. It is further confirmed that crisis disturbances lead to a loss of international reserves. All short-run relationships are robust across specifications and sub-periods chosen.

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