“The equilibrium model of demand and supply at the Ukrainian Interbank Foreign Exchange Market: disclosure of problematic aspects”

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THE EQUILIBRIUM MODEL OF DEMAND AND SUPPLY AT THE UKRAINIAN INTERBANK FOREIGN EXCHANGE MARKET: DISCLOSURE OF PROBLEMATIC ASPECTS

Abstract

This article is devoted to building of the equilibrium model between demand and supply on foreign currency at the Ukrainian Interbank Foreign Exchange Market (non-cash share). The authors discussed that appeared trade-offs are a product of established current foreign arrangement, administrative measures provided by the National Bank of Ukraine and range of fundamental variables, which are traditionally significant for Ukrainian economy. By means of FAVAR modeling model of demand and supply equlibrium on non-cash foreign currency was built on empirical data of Ukrainian Interbank Foreign Exchange Market, splitted into the periods, proposed by the authors. Next, it was discussed disconnection properties in the model and shown log-linearized specification of the one. The efficiency of fulfillment hypothesis on decointegrating of the fundamental variables' time series has been provided in form of critical statistics values. Also, instrument of GAP analysis of deviation from equilibrium state was proposed and the further analysis of a regulation style of monetary authority was provided. In conclusion, it was summarized that increased share of the cash out of the banks has significantly jeopardized the price stability in Ukraine and the NBU interventions would become more effective if the flexible foreign exchange rate will be accompanied with flexible regime of inflation targeting.

Keywords equilibrium model, factor-augmented VAR-modelling, demand and supply, interbank foreign exchange market, exchange rate arrangements

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INTRODUCTION

Tightening or easing of foreign exchange market regulation makes influence not only on forming optimal distribution of resources at the interbank market, but also makes significant impact on the trade balance and capital flows. Under free capital flows and unrestricted foreign currency purchasing spillover effect appears between emerging and advanced economies, which results in serial currency devaluations in the first group of countries. But when the central bank imposes tough restrictions, the shortage of foreign currency takes place and exchange rate volatility has risen.

Developing countries during many years have been pursued economic policies aimed to achieving realistic exchange rates for their domestic currencies. There are two ways of it: the first one – is to enforce administrative controls on the foreign exchange market and, the second one – is to allow free interplay of market forces. But dilemma appears,

because these two options cannot simultaneously work out well on a common purpose of getting equilibrium at foreign exchange market. Currency overvaluation reduces price advantages for the national exporters and discourages capital inflows. On the other hand, devaluation raises inflation rate and transmits into gradual lowering of the economic agents purchasing power and reducing consumption, thus output gradually slides. Under these conditions soon foreign exchange demand surpasses its supply. The fallout is emergence of parallel shadow foreign exchange markets striving to fill the gap of foreign currency, infiltrating the official market, and a chase after arbitrage opportunity in exchange rate differences. Especially, market speculations fuelled by risen concerns about possibility of monetary policy changes are heightened. We have experienced commitment of central bank actions at open market due to failing meeting market agents' rational expectations. Therefore, the central bank should impose strong restrictions on the foreign exchange transaction and much intervene on the interbank market.

1. LITERATURE REVIEW

The empirical literature contains many researches devoted to the measuring impact of foreign exchange management on money market equilibrium and the whole financial sustainability.

So, the impact of imposing severe restrictions on foreign exchange legal market on derivative pricing is well discussed by Yi David Wang (2017) as an example of China, where the most impactful factor of increasing volatility of foreign exchange rate and price of foreign currency derivatives was recognized the strict mode of regulative measures and thus jeopardizes sustainability and solvency of the whole financial market. Kubo (2017) focuses on empirically discovering the efficiency of the foreign exchange intervention on the Thai economy by simulation analyses. The author has found that foreign reserves are determinants of exchange rate dynamics, whereas the uncovered interest parity condition does not hold.

Taojun Xie, Jingting Liu, Joseph D. Alba, and Wai-Mun Chia (2017) have shown a strong relationship between monetary policy regime, foreign exchange market interventions and volatility of nominal exchange rate. The regime of joint wage inflation targeting with price inflation targeting improves welfare for cases with and without sterilized foreign exchange market interventions.

The relation between growth of trapped cash in multinational corporations, permanently unreinvested earnings and foreign cash was described in paper provided by Laplante et al. (2017), where they had proved the great impact of above mentioned endogenous variables on fueling trade-offs between cash and non-cash shares of the interbank foreign exchange market.

Berganza and Broto (2012) concluded that positive sign foreign exchange market interventions contribute to lowering exchange rate volatility for the Eastern Europe countries in post financial crisis period and, thus, leveling off demand on foreign currency.

In order to determine causalities between exchange rate arrangements and demand-supply equilibrium many economists have used balance-of-payments constraint growth model (Dixon & Thirwall, 1979), vector autoregressive models (Berganza & Broto, 2012), dynamic stochastic general equilibrium macroeconomic models – DSGE (Kubo, 2017), dynamic ordinary least squares method developed by Stock and Watson (2012). But each mentioned modeling tool has conducted its own specific task according to the selected aims.

In this article, we are setting the task to define how will be balancing supply and demand on foreign currency if monetary authority imposes restrictions on transactions and capital flows. Also, it will be considered the influence of the National Bank of Ukraine's interbank market operations on the foreign exchange market equilibrium. In our modelling, we will use VAR model augmented by additional factors as dummy variables massive of using by National Bank of Ukraine restrictions at foreign exchange market and factor variable of existed exchange rate regime and monetary policy regime, because it would help us to find out whether overregulated market support settling

down demand and supply of foreigns currency trade-off or not.

The goals which we have set in this article are the following:

- to define the qualitative and quantitative assessment of causalities, which appear between factors influential on demand-supply trade-off within different periods of the Ukrainian interbank foreign exchange market (hereinafter – UIFEM) functioning;
- to determine the impact of the particular foreign exchange restrictions implemented by NBU on market dynamics;
- to create the model of delivering equilibrium at foreign exchange market and reaction of variables of foreign exchange transmission channel.

2. CORRELATION ANALYSIS OF THE UIFEM TRENDS

First of all, by means of using "Stata" software we have created the correlation matrix of the Ukrainian interbank market and external sector selected indicators based on monthly data for 2007–2016 years. The obtained correlation coefficients are shown in Table 1. Herewith the correlation indices traditionally vary from "–1" to "1" and represent the direction and consistence of the interconnections. Tending to negative levels indicates a controversial relationship between variables, while level from zero to 1 demonstrates the direct relationship. The absence or pure relationship appears in case of zero level or near to it (0-33.3%).

The obtained correlation coefficients (see Table 1) encourage us to make the following conclusions:

- a significant direct correlation between export of goods and services volumes and supply of non-cash foreign currency at the interbank market (r = 0.6081) indicates that export earnings is one of the main sources of the foreign currency supply appearance;
- a significant direct correlation exists between import of goods and services volumes and demand of non-cash foreign currency at the interbank market (r =0. 6140) which is confirmed by the necessity of the foreign exchange payments according to conditions of the import contracts with non-residents (the quota of such payments in USD is 55.7% and in Euro is 37.3% of the total amount for 2016 year);
- deep direct correlation between volumes of the cash foreign currency outside banking system in Ukraine and amounts of foreign currency, which was sold in cash to individuals (r = 0.8153), explains that cash foreign currency has been "settled" outside the banking system as a mean of money and capital value saving in conditions of high dollarization level of the Ukrainian economy and the valid exchange rate depreciation risks.

Table 1. The correlation matrix of the Ukrainian interbank market, external sector selected indicators within 2007–2016 years

Source: estimated by the authors using statistics of NBU official website. External sector statistics of NBU. Retrieved from http://www.bank.gov.ua/control/uk/publish/article?art_id=44502&cat_id=44446

Parameter	Export of goods and services	Import of goods and services	Foreign cash in Ukraine outside the banking system
Foreign exchange demand on the non-cash share of UIFEM	0.5743	0.6140	0.2457
Foreign exchange supply on the non-cash share of UIFEM	0.6081	0.6422	0.2116
Foreign exchange demand on the cash share of UIFEM	0.6588	0.6631	0.8153
Foreign exchange supply on the cash share of UIFEM	0.6177	0.6140	0.5538
NBU interventions for the sale of foreign exchange	0.1483	0.1642	0.5336
NBU interventions for the purchase of foreign exchange	0.3870	0.2920	0.1119

It must be emphasized that foreign exchange transactions in cash make pressure on average foreign exchange interbank rate as certainly and on each point of depreciation rate lead to increase in a scarcity of money supply on 83 percentage point. Thus, each point of increasing supply of foreign currency needs to rise international reserves on 83.51 percentage points.

3. REGRESSION ANALYSIS OF THE UIFEM TRENDS AND THE FAVAR MODEL

In order to make deeper research we have proposed to divide the observation period within 2007–2016 years into 5 stages according to the UIFEM features such as appeared crises, changes of the exchange rate arrangements and monetary policy framework in Ukraine, which have been shown in Table 2.

For getting estimates, which determine the main developments of forming demand and supply at the non-cash share of UIFEM, we have built multiple regression models for demand and supply side during appointed stages of the interbank market development.

The general mathematical form of regression equation augmented by factor variables (in our case these are regulation arrangements and restrictions, crises existence at the UIFEM) is the following:

$$y = \alpha_1 x_1 + \alpha_2 x_2 + \ldots + \alpha_k x_k + \varepsilon, \quad (1)$$

where y – demand and supply volumes; $x_1, x_2, \ldots, x_k$ – regressors and factors' massive; $\alpha_1, \alpha_2, \ldots, \alpha_k$ – unbiased estimators of the model; ε – residuals, which appear as unobservable shocks of various nature as in Eliasz (2002); k – number of factors.

As in Bernanke et al. (2003) FAVAR model we have enlarged with additional factor vector, which mostly explained the forecast error:

$$X_t = [f_t^{'}, fundamental\ var_t, regulation\ var_t]', \quad (2)$$

where $f_t^{'}$ is a factor with a most explaining power of variance of the series in our enlarged database.

In this analysis, we assume that the missing factor with most explanation power must be the variable of switching from one foreign arrangement to another and dummy variable array of crisis and foreign regime alone, $fundamental\ var_t$ – massive of fundamental variables, which is described in Table 1A, $regulation\ var_t$ – massive of regulative variables, which describe measures of National Bank of Ukraine (see also Table 1A).

The foreign arrangement variable indicates the no changes in demand and supply side of interbank foreign exchange market if fixed arrangement exists with the mixed target rule and further switching to managed floating, and changes on the size, which correlates with result of NBU net interventions in case of flexible arrangement with inflation targeting regime. To this end, we

Table 2. Exchange rate arrangements and monetary policy framework in Ukraine during 2007–2016 years by the IMF rating

Source: constructed on International Monetary Fund, Annual Reports on Exchange Arrangements and Exchange Restrictions (2016).

Period	Exchange rate arrangement	Monetary policy framework
Precrisis (2007 – September 2008)	Other managed arrangement	Monetary aggregate target
Crisis period (October 2008 – 2009)	Other managed arrangement	
Stabilization period (2010–2011)	Stabilized arrangement (it is maintaining a de-facto exchange rate anchor to the U.S. dollar)	
Recession period (2012–2013)		
Crisis period (2014–2016)	Floating	2014, 2015 – monetary aggregate target 2016 – other (it is no explicitly stated nominal anchor, but rather monitoring various indicators in conducting monetary policy)

calculate this variable as a multiplication of a dummy of foreign regime (equals 0 from start of the sample to November 2008, when IMF reclassified foreign exchange regime to managed floating, and 1 in other cases) and dummy inflation targeting existence (unity assigns from February 2014) and net intervention of NBU. Such analytical tool was successfully employed in works by Eliasz (2002), Berganza et al. (2012), and last-mentioned group of scientists used this econometric framework in assessing influence of foreign exchange and monetary regime mix on the price stability mandate. The dummies of crisis set according to proposed periodization (Table 2) and when the real effective exchange rate devaluated more than 1 point.

We have checked the reliable capacity of the model by means of conducting normality tests (t- and F-statistics), which has shown whether hypothesis on insignificance of model coefficients and coefficient of determination has been rejected. Reliable estimation of R^2 gives the answer to reliable capacity of the model: values, which exceeded 70% of the total sum squares of residuals, demonstrate the higher reliability level of obtained values and the lower level of unobserved shocks and innovations, that is featured for the interbank market as with high volatility clustering (Dickey & Fuller, 1979).

According to the obtained results of augmented Dickey and Fuller (1979) test (it can be provided upon request) and Johansen test (1990) (obtained test resuls can be provided by inquiry), most of variables (i.e. demand and supply at UIFEM, foreign exchange rate, import and export size, growth of cash outside banks) are non-stationary time series with ARIMA (1,1,1) process, time drift and cointegration. Such drawback of model leads to biased estimates of forecast via using model (2), and wide predictive interval assessments.

Ramsey (1969) test has proven the sustainability of chosen factors and the alternative hypothesis is approved at 95% of goodness level. The test of Breusch – Pagano rejects heteroscedasticity of residuals of the model, thus the interval of variation estimators is narrow and reliable and almost explains time drift trend of reer monthly and annual change and inflation rate. This is a guarantee of reliability of designed empirical summarization on appeared disequilibrium at the UIFEM under observed shocks.

In order to avoid cointegration, at the model levels we have used log-linearized modelling technique on model specification proposed above. This method was successfully employed in works Ascari & Sbordone (2013) and Alves S. (2014) in modeling of stochastic macroeconomic equilibrium state.

In our assessments, we have used natural logarithm of monthly change rate of demand (d_{int}) and supply volumes on foreign currency (s_{int}), net result of NBU interventions (NBU_{net}), level of international reserves (*reserv*), foreign exchange rate dynamics (*exch*), export (*exp*) and import (imp) of goods and services volumes, capital inflows and outflows. This procedure helps to settle down model to stationary form.

Therefore, after log-linearization the equilibrium model between demand and supply at the UIFEM will be as follows:

$$Ln\left(\frac{d_{int_t}}{d_{int_{t-1}}}\right) = Ln(\beta_0) + \sum_{i=1,p=1}^{12,2} \beta_i res_{i_{t-p}} + \beta_{i+1} Ln\left(\frac{reserv_{t-p}}{reserv_{t-p-1}}\right) + \beta_{i+2} Ln\left(\frac{NBU_{net_{t-p}}}{NBU_{net_{t-p-1}}}\right) +$$
$$+\beta_{i+3} Ln\left(\frac{exch_{t-p}}{exch_{t-p-1}}\right) + \beta_{i+4} Ln\left(\frac{exp_{t-p}}{exp_{t-p-1}}\right) + \beta_{i+5} Ln\left(\frac{imp_{t-p}}{imp_{t-p-1}}\right) + \beta_{i+6} Ln\left(\frac{inflow\ capital_{t-p}}{inflow\ capital_{t-p-1}}\right) + \quad (3)$$
$$+\beta_{i+7} Ln\left(\frac{outflow\ capital_{t-p}}{outflow\ capital_{t-p-1}}\right) + \sum_{i=13,n=1,p=1}^{12,14,2} \beta_{i+n} Ln\left(\frac{other\ fundamental\ var_{i_{t-p}}}{other\ fundamental\ var_{i_{t-p-1}}}\right),$$

$$Ln\left(\frac{s_{int_t}}{s_{int_{t-1}}}\right) = Ln(\beta_0) + \sum_{i=1,p=1}^{12,2} \beta_i res_{i_{t-p}} + \beta_{i+1} Ln\left(\frac{reserv_{t-p}}{reserv_{t-p-1}}\right) + \beta_{i+2} Ln\left(\frac{NBU_{net_{t-p}}}{NBU_{net_{t-p-1}}}\right) +$$
$$+\beta_{i+3} Ln\left(\frac{exch_{t-p}}{exch_{t-p-1}}\right) + \beta_{i+4} Ln\left(\frac{exp_{t-p}}{exp_{t-p-1}}\right) + \beta_{i+5} Ln\left(\frac{imp_{t-p}}{imp_{t-p-1}}\right) + \beta_{i+6} Ln\left(\frac{inflow\ capital_{t-p}}{inflow\ capital_{t-p-1}}\right) + \quad (4)$$
$$+\beta_{i+7} Ln\left(\frac{outflow\ capital_{t-p}}{outflow\ capital_{t-p-1}}\right) + \sum_{i=13,n=1,p=1}^{12,14,2} \beta_{i+n} Ln\left(\frac{other\ fundamental\ var_{i_{t-p}}}{other\ fundamental\ var_{i_{t-p-1}}}\right),$$

where β_0 – non-observed financial shocks at the foreign exchange market, β_{i+n} – beta coefficient of log under fundamental variables, p – lag operator (1_2), $res_{i_{t-p}}$ – regulatory variables massive, n – subset of fundamental variables – other fundamental var (1_14).

The estimates of log-linearized model will be proposed further, and the results will be discussed.

Results of modelling are further on. The variable of foreign arrangement demonstrated persistent result in making positive influence on disregarding shortage at the non-cash share of UIFEM. Under floating regime with committing flexible inflation targeting (Berganzo & Broto, 2012) the supply raises by 6441.25 against demand decrease by 1699.01 mln US dollars. The variable of foreign arrangement is reliable for demand and supply model at 99.9% and 95% levels of confidence respectively, while another supporting dummy variable of foreign regime switching appears to be inconsistent.

Under approving the null hypothesis, we may make the error of second type, thus non-restricted model specification will be tested on fitness to F-statistics distribution. But this result brings us hypothesis, which proclaims that under hard fixing of foreign exchange rate without persuading inflation targeting rule the interbank foreign exchange market operations provided by NBU will have no sufficient effect on maintaining price stability (Table 3).

Next the variable of crisis tension has no effect on demand and supply forming, thus equilibrium between demand and supply functions poorly depends on depreciation of the real effective exchange rate. Such phenomenon was researched by Rogoff (1996), Fama (1984) and Itskhoki (2017). These economists have proved that pure correlation between volumes in the foreign exchange market and fundamental variables related to great share of impact of preference shock, shock of substitution, price complementarity, shocks at labor market and aggregate production, etc. At the same time, the disequilibrium state was the key factor, which make influence on serial devaluations of nominal and real exchange rate.

Among regulative factor panel, described in equation (2), the most significant were restrictions, which obligated to sell proceedings obtained from commercial activity – res 1 (obligatory sales of proceedings in foreign currency) – and one causes the rising of shortage on 640.4 mln in dollar equivalent. Such empirical conclusion was controversial in economic sense, because obligatory sell off proceedings from international economic activity is an important foreign exchange restriction, which serves to widen supply of foreign currency at the market. Then res 2 – prolonging of settlement period from 90 to 180 days in foreign currency – at 95 confidence level reduces the shortage at the market by 4.5 mln dollars. The restriction on exchanging foreign currency within one classification group (res 3) leads to demand increase by 5,594 mln dollars, which we may account as amount of delayed demand in the future. The shortening of settlement period in buying cash only evokes proceedings on 771.7 mln dollars. The ban on arbitrary exchange operation will lead to reduction of demand and supply by 5,933.1 and 4,575 mln dollars, respectively.

Unconventional result has been obtained with regards to NBU interbank market operation

Table 3. Properties of demand-supply model on non-cash foreign exchange currency in Ukraine

Source: calculated by authors.

Variable	Model of demand	Model of supply
Dfarr2015	3.986*** (1.100)	3.149** (1.113)
Dfreg2014	–1702.973 (3995.700)	6438.104 (3708.836)
Dcrisis	–302.010 (1469.993)	–1632.099 (1491.928)
Dres1	15090.487*** (3314.312)	14450.083*** (3695.728)
Dres2	48.468** (18.020)	52.966** (19.287)
Dres3	5594.004* (2685.275)	–749.633 (2572.877)
Dres4	7531.765** (2741.896)	8303.478** (2721.175)
Dres5	–5933.057** (2075.908)	–4574.986* (2127.257)
Dres6	–1525.502 (1576.352)	–1187.976 (1609.050)
Dres7	–9283.751** (3020.264)	–9787.987** (3018.415)
Dres8	–3505.797 (2388.218)	–1905.664 (2450.343)
Dres9	12871.039*** (3640.007)	7841.077* (3882.043)
Dres10	–2878.396 (2558.743)	–2223.544 (2577.680)
Dres11	–7716.383* (3058.408)	–6305.483* (3112.874)
Dres13_dividends	–8009.629 (5177.512)	–2998.712 (5326.340)
cash	1.583** (0.594)	1.329* (0.610)
disc_r (–1)	–148.734 (161.711)	–194.506 (158.752)
neer	17649.317*** (4163.511)	16942.553*** (4141.037)
NBU_s	3.742*** (0.639)	1.978** (0.706)
Direct_inv_ass (–1)	2.860 (2.851)	1.818 (2.657)
NBU_d	–2.257** (0.785)	–
Exch_of	81.890 (301.323)	244.292 (1155.680)
reer_year	13.270 (40.796)	11.559 (40.845)
Reserv (–1)	–0.415 (0.248)	–0.643* (0.247)
Trade_credits	–1.920* (0.757)	–
Trade_credits (–1)	–0.812 (0.811)	0.363 (0.845)
BOP (–1)	–0.106 (0.415)	0.376 (0.497)
Cab (–1)	–1.146 (0.625)	–1.066 (0.717)
Fin (–1)	0.061 (0.374)	0.072 (0.391)
Cab	–0.675 (0.635)	–0.206 (0.652)
Reserv	–0.126 (0.253)	–0.190 (0.256)
Fin	0.246 (0.341)	0.006 (0.334)
Portf_inv_liab (–1)	1.194* (0.590)	1.130 (0.609)
Direct_inv_ass	–0.816 (2.740)	1.691 (2.851)
Direct_inv_liab	2.149* (0.960)	0.779 (1.000)
Other_inv_ass (–1)	–0.011 (0.536)	–0.139 (0.538)
Portf_inv_ass	–19.122 (28.007)	4.373 (29.178)
Other_inv_liab (–1)	0.027 (0.394)	0.233 (0.421)
Inflows_cab (–1)	3.494** (1.163)	–
Sell_cash	–	–292.757 (1089.491)
Exp	–	1.176* (0.565)
reer_mon (–1)	–	10.819 (60.364)
Cash_outside_banks	–	2.314* (0.986)
NBU_d (–1)	–	–0.130 (0.856)
Coefficient of determination, %	94.9	88.5

Note: standard errors of beta coefficient are in round brackets written; superscripts identify confidence levels (1–α): * –0.05, ** –0.01, *** –0.001.

significance on supporting equilibrium state at UIFEM. The variable of NBU's long position in foreign currency was insignificant on supply forming at the market, although we have expected the approving of negative sign correlation. But reliable outcomes were obtained in explaining NBU short open position on mitigating the shortage of foreign currency. The one percent of rising NBU selling position at the interbank market operations the shortage might be widen by 1.8% at the same observable period, which corresponds to negative tensions of economic agents about price stability in the future.

But we have also experienced a problem in model specification due to that fact the nominal exchange rate follows a volatile random walk process, which is not robustly correlated, even

Source: built by authors using Zeileis (2004) NBU external sector statistics.
Retrieved from http://www.bank.gov.ua/control/uk/publish/article?art_id=44502&cat_id=44446

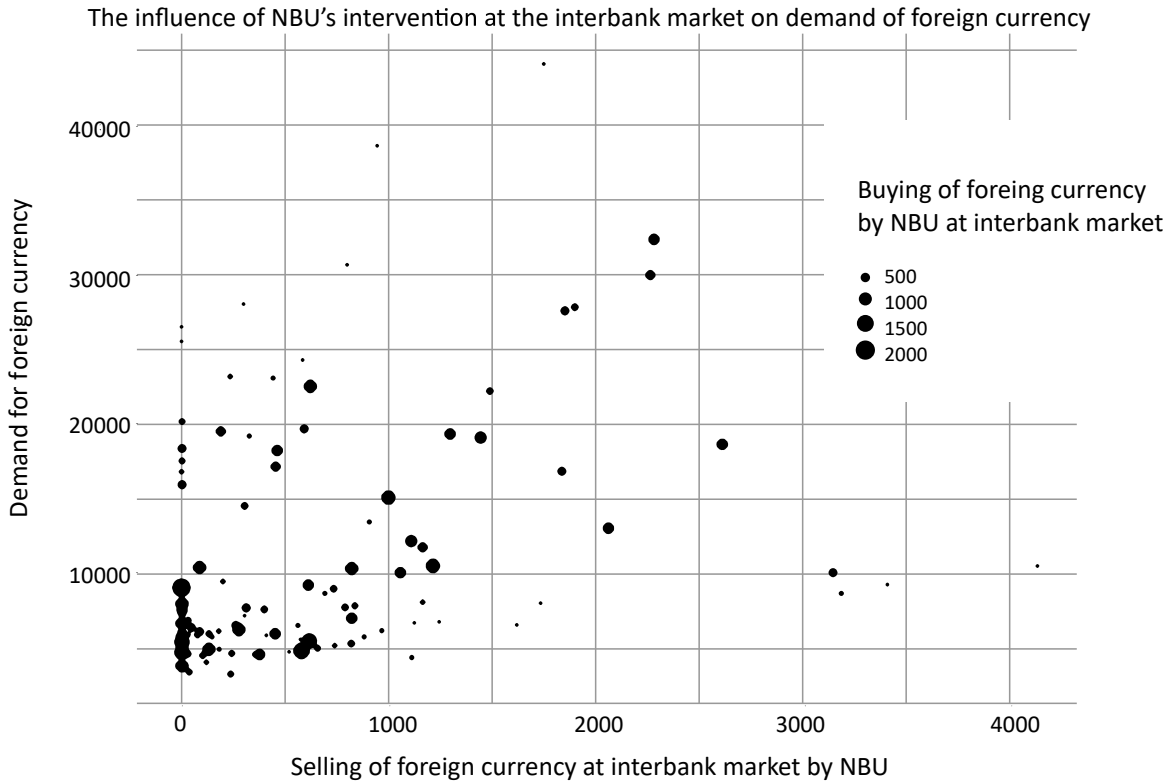

Figure 1. Influence of NBU intervention on demand of non-cash foreign currency in Ukraine, in ths dollars

contemporaneously, with macroeconomic fundamentals (Engel & West, 2005).

Nevertheless, to real exchange rate disconnection, we found out next peculiarity with regards to relationship between the real effective exchange rate (reer) movement and net result of NBU intervention. In case of devaluation of reer by 1%, then on $5.987 \cdot e^{0.8}$ times improve NBU intervention result. At the same time, negative result of intervention will cause pure changes in reer trend only on $2.22 \cdot e^{-0.7}$ times on each point of negative net interventions. This pure transmission is explained by a very low level of correlation between these variables (8.8%).

As we can see in the graph above (Figure 1), the highest demand value at the market was supported by very low supply from monetary authority. It supports the main Keynesian paradigm. But such policy is very costly for NBU and taxpayers in form of negative result of the interbank market interventions. For instance, the most demand on foreign currency in size of 44 mln dollars was completed by negative interventions on 1742.3 mln dollars. That's why the relationship between demand and intervention result was with opposite sign of correlation.

In Figure 2 the situation for supply side at the interbank foreign exchange market and net interventions was shown.

The most frequent NBU interbank foreign exchange market operations were seen in third quarter of 2011, when supply volume was near to 10 mln dollars (1 July, 2011) under foreign exchange rate devaluation by 10.4%, what is very poor exchange rate depreciation comparatively to 33% monthly in 2008 and 2014. The highest devaluation movement was experienced in fact within 2014 and the first half of 2015 under supply of foreign currency, which is amounted 4.7 mln dollars, versus to demand in size of 4.9 mln dollars, i.e. we have deficit in 235 ths dollars. And in that time (1 February, 2015) NBU provided intervention at negative result in 506.6 mln dollars.

Source: built by authors using Zeileis (2004) NBU external sector statistics.
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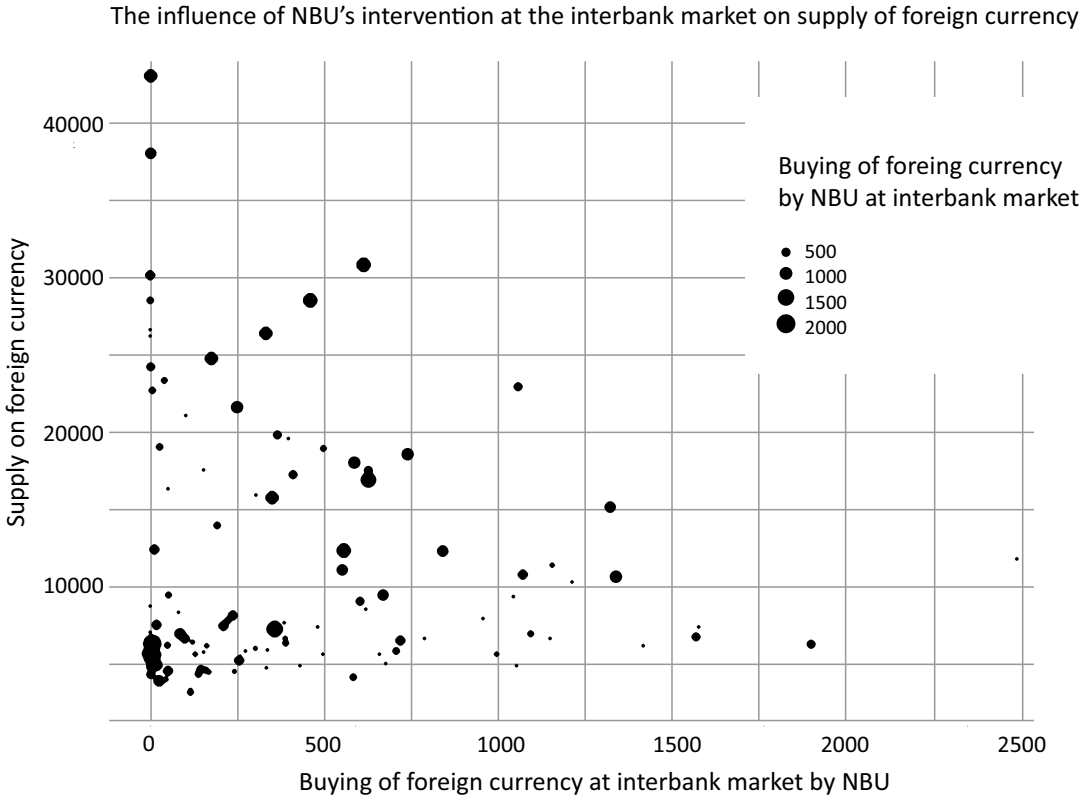


Figure 2. Influence of NBU intervention on supply of non-cash foreign currency in Ukraine, in ths dollars

In order to mitigate cointegration in levels of fundamental factor variables, which translate their impact in reducing adequacy and efficiency of proposed model assessments (2), we estimated log-linearized model in first differences of fundamental variables time series like as proposed in equations (3) and (4). The most significant and consistent factors, which force demand

Table 4. The models of the foreign currency exchange demand at the UIFEM (non-cash segment). The foreign currency exchange demand is the dependent variable

Source: estimated by the authors.

Period of UIFEM functioning	Impactful factors (regressors)	Coefficients	t-statistics critical value	R^2
Precrisis (2007 – September 2008)	Import Dres2(–1) fin(–2)	0.9439 –0.0027 0.0233	0.000 0.030 0.141	R^2=0.6558 Adj R^2=0.5913
Crisis period (October 2008–2009)	Import Cash_outside_banks Sell_cash	0.5381 0.1463 –0.2633	0.001 0.014 0.065	R^2=0.7866 Adj R^2=0.7226
Stabilization period (2010–2011)	Import portf_inv_liab(–1) Cash_outside_banks Sell_cash	0.9668 –0.0547 0.0576 0.7083	0.000 0.003 0.004 0.000	R^2=0.9053 Adj R^2=0.8854
Recession period (2012–2013)	Dres2 Sell_cash	–0.0026 0.6691	0.028 0.000	R^2=0.6437 Adj R^2=0.6098
Crisis period (2014–2016)	Import Direct_inv_liab Portf_inv_ass Other_inv_liab Dres12(–1) Sell_cash	0.6251 0.0646 0.1131 –0.0772 –0.2556 0.2796	0.002 0.008 0.000 0.002 0.043 0.000	R^2=0.8540 Adj R^2=0.8227

Note: Dl indicates that variable was obtained in logarithmic form.

Table 5. The models of the foreign currency exchange supply at the UIFEM (non-cash segment). The foreign currency exchange supply is the dependent variable

Source: estimated by the authors.

Period of UIFEM functioning	Impactful factors (regressors)	Coefficients	t-statistics critical value	R^2
Precrisis (2007 – September 2008)	DlExp Buy_cash Nbu_d(–2)	0.5276 0.5045 0.1200	0.046 0.009 0.015	R^2=0.7107 Adj R^2=0.6528
Crisis period (October 2008–2009)	DlExp Exch_of Buy_cash	2.0875 1.0844 –0.6899	0.000 0.011 0.003	R^2=0.8326 Adj R^2=0.7907
Stabilization period (2010–2011)	DlExp dres4 Fin Cash_outside_banks	1.0634 0.4832 –0.0806 0.0656	0.024 0.005 0.055 0.050	R^2=0.6638 Adj R^2=0.5930
Recession period (2012–2013)	DlExp res1 Other_inv_liab Nbu_s	1.3166 0.3474 0.0333 0.0001	0.000 0.055 0.076 0.001	R^2=0.7542 Adj R^2=0.6927
Crisis period (2014–2016)	Exp Direct_inv_liab Portf_inv_ass Cash_outside_banks Exch(–1)	0.7769 0.0904 0.0908 –0.0543 –0.6366	0.003 0.023 0.000 0.072 0.049	R^2=0.6250 Adj R^2=0.5604

Note: Dl indicates that variable was obtained in logarithmic form.

function on foreign currency at the UIFEM of non-cash segment have shown in Table 4.

Second modification has shown that in the crisis period cash outside banks forces the rising of demand for foreign currency by 14.6% and in recession by 5.8%. In previous model specification, cash in non-formal parallel market makes its impact in the form of surging supply side of the UIFEM's equilibrium on 231% on each percent.

The most consistent factors, which force supply function on foreign currency at the UIFEM of non-cash segment were shown in Table 5.

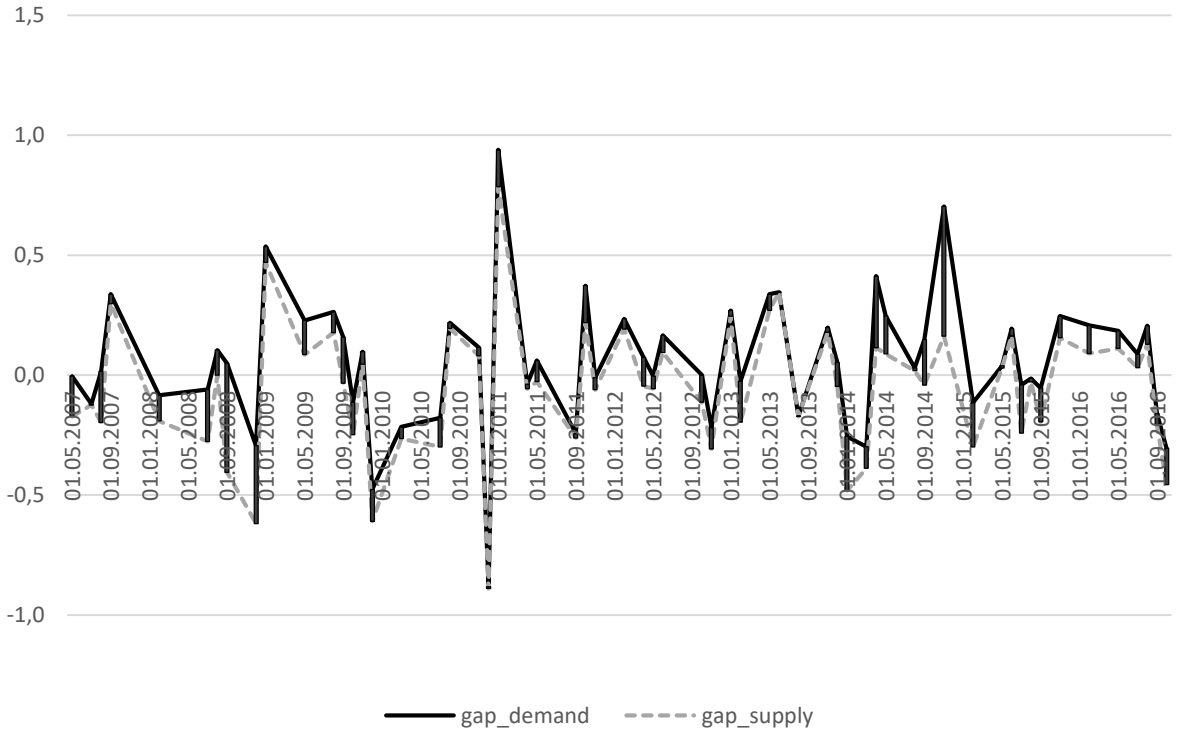
Proposed log-linearized model was robust to autocorrelation and cointegration, therefore obtained statistical test results could be given by inquiry.

Also, we can use our model in assessing gap, which is actually appeared in demand and supply at the market in times of risen negative expectations.

In Figure 3 we plotted the size of difference between demand gap and supply gap arisen under regulative and fundamental shocks. Under regulative shocks we mean the factor of changing foreign arrangement and set administrative regulations by the National Bank of Ukraine. The fundamental factors are the variables of cash market, non-cash share of UIFEM, macroeconomic and financial variables, which provides significant development at settling down the short-term equilibrium in demand-supply model for non-cash interbank foreign exchange market.

The gap for demand as well as for supply has illustrated the size of dispersion logarithm of potential and real demand and supply at the interbank market. Potential value is a fitted value obtained under proposed model and obtained assessments was robust to autocorrelation and heteroscedas-

Source: built by the authors.



Note: Black stacks show the shortage. In the graph only difference more than 0 is displayed with the aim to focus on appeared deficit at the market; difference measured in log terms.

Figure 3. The difference between gap of demand and supply function at the UIFEM

ticity as in Zeileis (2004). The difference between demand and supply gap can obtain values, in the first case, which more than one in module term: $|gap(d^*/s^*)|>1$, excepted the [0;1] interval. And in the second case, when ones' values vary from 0 to 1. The first case has described a momentum of very high speed of arisen exceedance and shortage at the interbank market, and in second case we have the very slow disequilibrium level.

The economic sense of this gap analysis is that risen difference between potential and actual value illustrates speed of increasing delayed demand or undervalued supply at the UIFEM or decreasing unrealized demand accompanied with overvalued supply. At a highest level of uncertainty, the difference of demand and supply will rise, and at higher level of confidence of economic agents the difference will decrease.

CONCLUSION

We have obtained good results by widening VAR model by factor's massive, which give answer whether intervention and regulations of NBU are effective and shock smoothed at the market. And the answer is when foreign exchange regime will be flexible accompanied with flexible mode of inflation targeting.

Proposed FAVAR model of demand-supply equilibrium has significantly increased prediction reliability of equilibrium at non-cash forex market under transformation of foreign exchange regime and will be useful in constructing adequate foreign exchange regulation of the regulator. And Gap-analysis helped to determine shifting moments in developing foreign exchange market and understand key reasons of appearing such gaps, which mostly underlies in negative expectations of economic agents. Also, such model specification will be useful in enlarging foreign exchange impulse channel of monetary transmission mechanism.

In our opinion, we must outline, that positive fact is declaration of monetary policy development, which comprises also foreign exchange policy in direction of prioritization of committing price stability in the country, which goes from persuading main responsibility of National Bank of Ukraine in maintaining the stability of the national currency.

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APPENDIX

Table 1A. Description of data sample variables

Source: built by the authors.

Variable	Variable description
Demand	Demand for non-cash foreign currency at Interbank foreign exchange market in Ukraine (in mln dollars)
Supply	Supply on non-cash foreign currency at Interbank foreign exchange market in Ukraine (in mln dollars)
Imp	Import of goods and services into Ukraine (in mln dollars)
Exp	Export of goods and services from Ukraine (in mln dollars)
Nbu_d	NBU intervention long position – supplying of hryvnia (in mln dollars)
Nbu_s	NBU intervention short position – supplying of foreign currencies (in mln dollars)
Exch_of	Official bilateral foreign exchange rate (hryvnia per US dollar)
Exch	Average bilateral foreign exchange rate at Interbank forex market (hryvnia per US dollar)
neer	Nominal effective foreign exchange rate (hryvnia per US dollar)
reer_year	Real effective foreign exchange rate in yearly basis change (hryvnia per US dollar)
Reserv	International reserves (on the end of period in mln dollars)
Buy_cash	Size of foreign currency in cash bought in households by banks (in mln dollars)
Sell_cash	Size of foreign currency in cash sold in households by banks (in mln dollars)
cash	Net position of banks in buying or selling foreign currency in cash in households (in mln dollars)
Cash_outside_banks	Cash outside banks (in mln dollars)
Trade_credits	Liabilities of non-resident before residents on commercial credits (in mln dollars)
Cab	Net current account in balance of payments of Ukraine (in mln dollars)
Fin	Net financial account in balance of payments (in mln dollars)
BOP	Balance of payments (in mln dollars)
Inflows_cab	Incomes by the balance of payments of Ukraine (in mln dollars)
Outflows_cab	Expenditure by the balance of payments of Ukraine (in mln dollars)
Direct_inv_ass	Foreign direct investments assets (in mln dollars)
Direct_inv_liab	Foreign direct investments liabilities (in mln dollars)
Portf_inv_ass	Foreign portfolio investment assets (in mln dollars)
Portf_inv_liab	Foreign portfolio investment labilities (in mln dollars)
Other_inv_ass	Other investments assets (in mln dollars)
Other_inv_liab	Other investments labilities (in mln dollars)
Dres1	Obligatory selling of proceeds obtained in foreign currency
Dres2	Changing in the law of duration of resident's settlements in foreign currency
Dres3	Restriction on exchanging foreign currency within a single Classification group
Dres4	Decreasing period of dealing regarding buying foreign currency
Dres5	Prohibition on arbitrary operations of agent banks (dealers at Interbank forex market authorized by NBU)
Dres6	Pension Fund fees from buying foreign currency
Dres7	Prohibition on buying foreign currency for making payments for import of goods without transporting into Ukraine's custom area
Dres8	Own operation of banks from trade operations in foreign currency only with having liabilities in such currency
Dres9	Required of the price valuation report to governmental body Derzhzovnishinform – state enterprise, which provides research and information center for monitoring international commodity markets and fairness of price setting by exporters and importers
Dres10	Requirement of the certificate from State Fiscal body
Dres11	Required approval from NBU on buying currency
Dres12	Restriction on size of buying foreign currency
Dres13_dividends[1]	Restriction on size of dividends non-resident outflow
Dfreg2008[2]	Dummy variable of introducing the managed floating exchange rate regime of hryvnia
Dfreg2014[1]	Dummy variable of introducing the free floating exchange rate regime of hryvnia
Dfarr2015	Dummy variable of foreign arrangement in Ukraine, which is a product of binnary variable Dfreg2014 and *NBU_net x diflation_targeting*, where dinflation_targeting is a dummy variable of introducing inflation targeting regime de-jure
Dcrisis1[2]	Period of crisis appeared at forex market in Ukraine in September 2008
Dcrisis2[2]	Period of crisis appeared at forex market in Ukraine in April 2014
Dcrisis3[2]	Period of crisis appeared at forex market in Ukraine in February 2015

Notes: [1] Used in model, specified by equation (2). [2] Used in log-linearized model of demand (3) and supply (4) at the UIFEM.