ЭКОНОМИКА

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STATISTICAL ASSESSMENT OF CYCLICAL EXCHANGE RATE FLUCTUATIONS IN LEBANON

The article analyzed the change in the Euro/US dollar exchange rate in Lebanon for the period from 2012 to 2019. The study developed a statistical model for the decomposition of time series, which is leaded to the identification of the trend, seasonal, cyclical and random components. The simulation results made it possible to establish the patterns of changes in cross-rate of the Euro/US dollar, which, due to the tight binding of the Lebanese pound to the US dollar, is determined the volumes of export and import country. The length and depth of short-period cycles in the studied indicator time series were measured.

Keywords: *exchange rate; statistical analysis; decomposition of time series; short-period cycles.*

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СТАТИСТИЧЕСКАЯ ОЦЕНКА ЦИКЛИЧЕСКИХ КОЛЕБАНИЙ ВАЛЮТНОГО КУРСА В ЛИВАНЕ

В статье анализируется изменение обменного курса евро/доллар США в Ливане за период с 2012 по 2019 гг. Исследование предлагает статистическую модель декомпозиции временных рядов, позволяющую выявить тренд, сезонный, циклический и случайный компоненты. Результаты решения модели позволили установить закономерности изменения кросс-курса евро/доллар США, который в связи с жестким закреплением курса ливанского фунта к доллару определяет объемы экспорта и импорта страны. Измерены продолжительность и глубина малых циклов в динамических рядах исследуемого показателя.

Ключевые слова: *обменный курс; статистический анализ; декомпозиция временных рядов; малые циклы.*

Introduction. In this article we focus our analysis on the exchange rate Euro/US dollar during the period 2012 till 2019. The choice for the analysis of the exchange rate Euro/US dollar is determined to the fact that the rate of the Lebanese pound has been pegged at 1507.5 pounds per US dollar since December 1997. So the movement of the Lebanese pound is related to the movement of the US dollar and especially the exchange rate Euro/US dollar. Due to being pegged to the USD, the Lebanese pound (LBP) became sometimes more expensi-

ve against many foreign currencies, thus, the competitiveness of Lebanese goods and the trade balance was affected negatively. The euro is used in Lebanon to settle international transactions, to issue debt in international financial markets and to store value in the form of official reserve holdings or private international bank deposits.

Many countries that use a US dollar peg have significant exports to the United States. Based on a sample of 75 developing countries during the period between 1973 and 1996, C. Broda [1] demonstrates that countries using fixed exchange rate regimes suffer more from trade shocks, which is a consequence of inadequate real exchange rate adjustment. As stated by the European Central Bank in an analysis conducted by Winkler, Mazzaferro, Nerlich, and Thimann (2004) [2], the majority of dollarized countries face difficulty in relation to the sustainability of the balance of trade. C. Dunis et al. [3] studied the forecasting and trading of the daily (EUR/USD) exchange rate using the European Central Bank (ECB) fixing series with only autoregressive terms as inputs. A. Bénassy-Quéré et al. [4] propose an illustration for the euro/dollar exchange rate and suggest that the various approaches should be combined to provide useful benchmarks for exchange-rate policies. The subject was approached theoretically too, by L. Wenhao [5], who analyzed the determinants of EUR/USD exchange rate, the competition between Euro and Dollar after the emergence of Euro, concluding he made some brief predictions about the future or Euro, as well as for our exchange rate. Also, there exist several studies, such as F. Genc [6], who indicates that there is a negative relationship between exports and exchange rates. In theory, according to R. Frey [7], the risk arising from exchange rate volatility is the link between trade volume and exchange rate fluctuations.

Statistical analysis is a combined (qualitative and quantitative data) analysis. Statistical methodology refers to a system of techniques, methods, and methods aimed at studying quantitative patterns in the dynamics and relationships of socio-economic phenomena. The most important task of statistical research of time series is to study the patterns of development (trend). In order to study correctly the trend, it is necessary to establish random and periodic fluctuations and find the residual deviations of the actual data from the estimated trend.

Model of decomposition time series. Cyclic fluctuations are estimated based on the following statistical model of small cycles (short-period cycles)

$$Y - Y_t = (Y - Y_k) + (Y_k - Y_c) + (Y_c - Y_t), \quad (1)$$

where Y — the initial observed values; Y_k — the smoothed value; $Y - Y_k$ — the random components; Y_c — the seasonally adjusted values; $Y_k - Y_c$ — the residuals of the seasonal component; Y_t — the estimated value by the trend estimation; $Y_c - Y_t$ — the residuals of the cyclic fluctuations.

In order to smooth the actual data Y and eliminate the randomness, we use the Fourier series to find the smoothed data Y_k then calculate the random component E by subtracting the Fourier smoothed data from the actual data ($Y - Y_k = E$).

Another technique used in this study to exclude a random component is piecewise linear function or piecewise nonlinear function. This technique involves the construction of the best functions (trends) for each period for the studied period of time. Therefore, for monthly data, the number of such functions was 12. To smooth the data for each month, various types of functions (linear, logarithmic, second and third order polynomials, etc.) is tested. The selection of the best functions is carried out according to the criterion of the maximum reliability of the approximation (R^2). The initial data for applying the piecewise model is presented in the form of a matrix of individual observations. Years are presented by line, and months by column. Each individual observation refers to the k-th month of the j-th year. Thus, there are 12 time series, each of which contains data for a separate month of the year. When modeling the dynamics of monthly indicators in the time factor scale, the co-

ding of the time attribute in months is combined with annual units. Thus, in the time factor scale, the time is represented by both integer and fractional numerical designations (time gap 0.083). It should be expected that dynamics of monthly indicator is closely consistent with the general trend characteristic of the analyzed season.

In order to remove the seasonal fluctuations of the data and exclude their influences on the forecasting procedure, the methodology for eliminating the seasonality factor involve calculating the seasonality index following the formula (2)

$$I_{\tilde{n}_i} = \overline{Y}_i / \overline{Y}, \tag{2}$$

where $\overline{Y}_i$ — the average level for the each month ($i = 1 : 12$); $\overline{Y}$ — the average level of the series for the entire period as a whole.

The elimination of the seasonality factor is done by dividing the smoothed value (Y_k) by the seasonality index corresponding to each month. The result is data adjusted for the seasonality index, that is, free from the influence of the random and seasonality factors. However, such adjustment should not be limited if the received data do not coincide with the initial data for years. As a rule, such discrepancies are observed, and secondary correction is used to eliminate them. For this, the correction factor is calculated by dividing the actual (observed) annual profit indicators by the annual indicators of the adjusted levels. Mathematically, this adjustment is as follows

$$Y_c = Y_{c_1} \cdot k = Y_{c_1} \cdot \frac{\sum Y_k}{\sum Y_{c_1}} = \frac{Y_{c_1}}{\sum Y_{c_1}} \cdot \sum Y_k, \tag{3}$$

where Y_c — the values after the secondary adjustment; Y_{c_1} — the initially adjusted levels ($Y_{c_1} = Y_k / I_c$); Y_k — the smoothed value; I_c — the seasonality index; k — coefficient of secondary adjustment; $\sum Y_k$ — annual sum of the smoothed values; $\sum Y_{c_1}$ — the annual sum of the seasonally adjusted data in first time.

The seasonally adjusted data are used to determine the linear regression equation and to find the values Y_t that helps us to identify the cycles by calculating residues ($\varepsilon_{ij} = Y_c - Y_t$).

The cyclic variation is due to the repeating up and down movements due to interactions of factors influencing economy. Before determine short term cycles, we prove that our residues are not random with the turning point test for residues Jeff B. Cromwell, Walter C. Labys, Michel Terraza 1994 [8]. If there is no enough evidence to support the claim that the residues are independent (random), we determine the length short term cycles and derive their average depth by the following formula (4)

$$s_i^2 = \frac{\sum (\varepsilon_{ij} - \varepsilon_{i\min})}{n_i - 1}, \tag{4}$$

where ε_{ij} — residues values; $\varepsilon_{i\min}$— minimum residual value in the cycle; n_i — the length of the short-term cycle.

The occurrence of these cycles is also proved by considering the moving average (MA) of the residuals.

The calculation in this article is done using Microsoft Office Excel.

Results and discussions. The results of the time series decomposition are presented in the Application: the actual Euro/USD exchange rate at monthly time basis (Y), the Fourier smoothed data (Y_k), the seasonally adjusted values (Y_c), and the estimated value by the linear trend estimation (Y_t). The choice of the Fourier series as the smoothing method was due to the fact that the cyclic component was detected more clearly than with the piecewise functional method.

Application

Date	Actual value Y	Smoothed value Y_k	Adjusted seasonal value Y_c	Trend value Y_t $Y = -0.0024x + 1.3169$	Date	Actual value Y	Smoothed value Y_k	Adjusted seasonal value Y_c	Trend value Y_t $Y = -0.0024x + 1.3169$
1	2	3	4	5	1	2	3	4	5
Jan-12	1.3078	1.3083	1.2930	1.3145	Jan-16	1.0837	1.0744	1.0715	1.1967
Feb-12	1.3326	1.3247	1.3249	1.3121	Feb-16	1.0873	1.0937	1.0810	1.1943
Mar-12	1.3344	1.3496	1.3288	1.3096	Mar-16	1.138	1.1354	1.1333	1.1918
Apr-12	1.324	1.3066	1.3061	1.3072	Apr-16	1.1456	1.1470	1.1302	1.1894
May-12	1.2358	1.2551	1.2439	1.3047	May-16	1.1132	1.1146	1.1205	1.1869
Jun-12	1.266	1.2503	1.2627	1.3022	Jun-16	1.1105	1.1095	1.1077	1.1844
Jul-12	1.2304	1.2429	1.2313	1.2998	Jul-16	1.1174	1.1191	1.1183	1.1820
Aug-12	1.2577	1.2517	1.2581	1.2973	Aug-16	1.1158	1.1164	1.1162	1.1795
Sep-12	1.2858	1.2885	1.2869	1.2949	Sep-16	1.1241	1.1230	1.1251	1.1771
Oct-12	1.296	1.2970	1.3051	1.2924	Oct-16	1.0981	1.1018	1.1059	1.1746
Nov-12	1.2986	1.2997	1.3181	1.2900	Nov-16	1.0588	1.0557	1.0747	1.1722
Dec-12	1.3196	1.3141	1.3299	1.2875	Dec-16	1.0516	1.0536	1.0598	1.1697
Jan-13	1.3579	1.3576	1.3423	1.2851	Jan-17	1.0798	1.0880	1.0672	1.1673
Feb-13	1.3056	1.3015	1.2979	1.2826	Feb-17	1.0577	1.0494	1.0512	1.1648
Mar-13	1.282	1.2888	1.2765	1.2802	Mar-17	1.0652	1.0713	1.0604	1.1624
Apr-13	1.3167	1.3123	1.2988	1.2777	Apr-17	1.0897	1.0898	1.0746	1.1599
May-13	1.2999	1.3026	1.3082	1.2752	May-17	1.1243	1.1202	1.1313	1.1574
Jun-13	1.301	1.3034	1.2974	1.2728	Jun-17	1.1426	1.1514	1.1393	1.1550
Jul-13	1.3302	1.3257	1.3310	1.2703	Jul-17	1.1842	1.1756	1.1847	1.1525
Aug-13	1.3222	1.3301	1.3224	1.2679	Aug-17	1.191	1.1988	1.1910	1.1501
Sep-13	1.3526	1.3460	1.3535	1.2654	Sep-17	1.1814	1.1793	1.1820	1.1476
Oct-13	1.3584	1.3641	1.3678	1.2630	Oct-17	1.1646	1.1618	1.1724	1.1452
Nov-13	1.3591	1.3592	1.3793	1.2605	Nov-17	1.1904	1.2006	1.2079	1.1427
Dec-13	1.3746	1.3685	1.3851	1.2581	Dec-17	1.1998	1.1844	1.2087	1.1403
Jan-14	1.3487	1.3281	1.3337	1.2556	Jan-18	1.2421	1.2228	1.2282	1.1378
Feb-14	1.3802	1.3927	1.3725	1.2532	Feb-18	1.2194	1.2333	1.2125	1.1354
Mar-14	1.3771	1.3756	1.3716	1.2507	Mar-18	1.2323	1.2259	1.2273	1.1329
Apr-14	1.3867	1.3808	1.3682	1.2483	Apr-18	1.2079	1.2098	1.1918	1.1305
May-14	1.3631	1.3766	1.3723	1.2458	May-18	1.1692	1.1727	1.1770	1.1280
Jun-14	1.3692	1.3550	1.3659	1.2433	Jun-18	1.1685	1.1645	1.1656	1.1255
Jul-14	1.3389	1.3519	1.3401	1.2409	Jul-18	1.1691	1.1730	1.1701	1.1231
Aug-14	1.3133	1.3080	1.3140	1.2384	Aug-18	1.1601	1.1611	1.1606	1.1206
Sep-14	1.2632	1.2615	1.2645	1.2360	Sep-18	1.1609	1.1561	1.1620	1.1182
Oct-14	1.2525	1.2633	1.2616	1.2335	Oct-18	1.1312	1.1419	1.1393	1.1157
Nov-14	1.2452	1.2308	1.2641	1.2311	Nov-18	1.1317	1.1192	1.1488	1.1133

Ending

1	2	3	4	5	1	2	3	4	5
Dec-14	1.2099	1.2240	1.2195	1.2286	Dec-18	1.147	1.1589	1.1561	1.1108
Jan-15	1.1288	1.1307	1.1161	1.2262	Jan-19	1.1446	1.1406	1.1316	1.1084
Feb-15	1.1196	1.1122	1.1131	1.2237	Feb-19	1.1371	1.1389	1.1305	1.1059
Mar-15	1.0731	1.0859	1.0686	1.2213	Mar-19	1.1218	1.1236	1.1171	1.1035
Apr-15	1.1224	1.1085	1.1073	1.2188	Apr-19	1.1217	1.1186	1.1066	1.1010
May-15	1.0988	1.1139	1.1060	1.2163	May-19	1.1169	1.1234	1.1242	1.0985
Jun-15	1.1138	1.1017	1.1109	1.2139	Jun-19	1.137	1.1301	1.1340	1.0961
Jul-15	1.0988	1.1086	1.0996	1.2114	Jul-19	1.1076	1.1163	1.1084	1.0936
Aug-15	1.1215	1.1166	1.1219	1.2090	Aug-19	1.0991	1.0920	1.0994	1.0912
Sep-15	1.1177	1.1207	1.1187	1.2065	Sep-19	1.09	1.0970	1.0909	1.0887
Oct-15	1.1005	1.1000	1.1083	1.2041	Oct-19	1.1152	1.1109	1.1231	1.0863
Nov-15	1.0564	1.0591	1.0723	1.2016	Nov-19	1.1017	1.1061	1.1182	1.0838
Dec-15	1.086	1.0795	1.0945	1.1992	Dec-19	1.1212	1.1165	1.1299	1.0814

S o u r c e: compiled by the authors.

The seasonal index was bounded between 0.9852 and 1.0137 (fig. 1). Thus, almost no seasonality was observed in this pair.

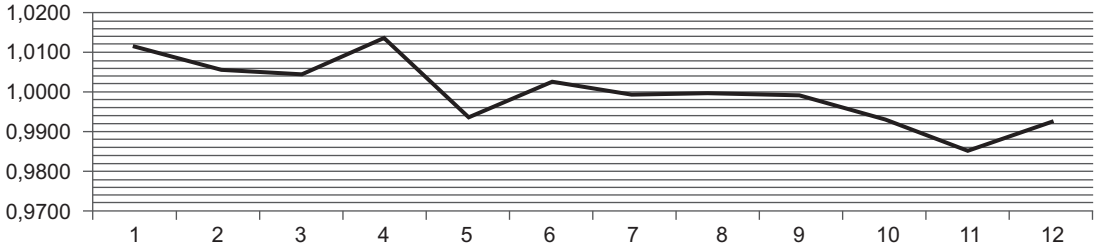

Fig. 1. Seasonal index of EUR/USD

S o u r c e: compiled by the authors.

The fluctuations of the residuals ($Y_c - Y_t$) are shown in fig. 2.

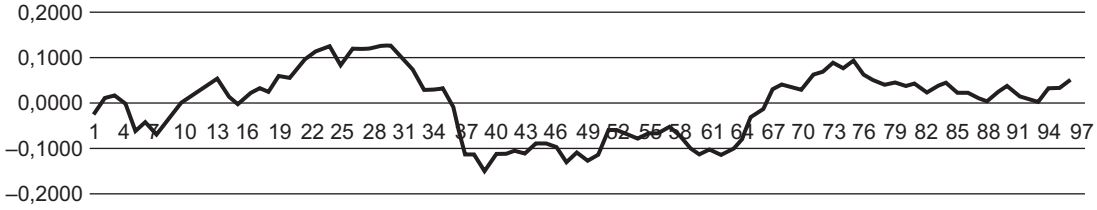

Fig. 2. Fluctuations of the residuals

S o u r c e: compiled by the authors.

There was no enough evidence to support the claim that the residuals are independent ($Z \approx 3.59$ Critical value $\tau = 1.96\, \alpha = 0.05$).

According to the fluctuations of the residuals, the EUR/USD exchange rate admitted three cycles: 1) July 2012 — March 2015; 2) April 2015 — February 2017; 3) March 2017 — December 2019. The average depth of the each short-period cycle was very small $S_1^2 = 0.027932$, $S_2^2 = 0.00203$ and $S_3^2 = 0.019118$.

In the first cycle listed above, the exchange rate varied between 1.2577 and 1.3867, this rate affected the Lebanese imports from Europe in this period. The imports value decreased from 6224 million Euro in 2012 to 5935 million Euro in 2014 so a fall around 4.64 %. The prices of European products were extremely high in Lebanon, and it was due to the maximum exchange rate of the pair. This problem was proved by the high inflation rate, because the merchants took advantages of this situation and increased their prices. While the second cycle the inflation rate in Lebanon decreased and was fallen to a negative value, and the imports of Lebanon was increased from 6176 million Euro in 2015 to 6842 million Euro in 2017, so an increase of 10.78 % in imports values, and this was due to the fall of exchange rate to a monthly close 1.0516 on December 2016. Of course, the merchants benefited from this low exchange rate to import and store more products and especially the industrial products which is the main import goods from Europe. In the third cycle the exchange rate showed a significant Euro strengthening and reached again a high 1.2421 in January 2018, and the value of the imports fall again from 6844 million Euro in 2018 to 5776 million Euro in 2019, around 15.6 % decrease In the other side, by looking to the Lebanese imports from USA (vehicles, oils pharmaceutical products etc.), in the first cycle where the exchange rate was high, we observed an increase in imports by 22 % from 1039.9 million dollars in 2012 to 1267.9 million dollars in 2014, then in the second cycle the imports fall from 1286 million dollars in 2015 to 1170.3 million dollars in 2016, when the exchange rate reaches its low during this period. Again, with the rise in the exchange rate of EUR/USD the imports from US climbed to 1328.4 million dollars [9].

When a dollar peg uses a fixed exchange rate, a country's central bank promises to give you a fixed amount of its currency in return for a U.S. dollar, the country must have lots of dollars on hand to save this peg which is not the case in Lebanon after October 2019. Lebanon's economy is in dire straits due to compounded crises. On October 2019, the economy gone into a financial crisis brought about by a sudden stop in capital inflows, which precipitated banking, debt and exchange rate crises. Lastly, on August 4, 2020, a massive explosion rocked the Port of Beirut (PoB), destroying much of the port and severely damaging the commercial areas within a 1- to 2-mile radius. Lebanon is in its third government in less than a year [10].

After October 17, 2019, were the economic crisis in Lebanon appeared and affected the banking sector. A black market was created for US dollar against Lebanese pound. The official peg of the Lebanese pound to the dollar remains at LL 1507.5, which is only being adopted for the import of wheat, fuel and medicine. In other side, the unlicensed exchangers were selling one dollar more than the official rate till reached its high in July 2020 where 1 dollar is approximately 10 000 LBP then it drops versus 7500 LL till the date of preparation of this article. The central Bank of Lebanon issued many circulars to set the position of the exchange rate in black market, it released the «Sayrafa electronic platform» for licensed exchangers and pegged the exchange rate to be 1 $ = 3900 LBP [11].

Conclusion. The presented model of time series decomposition revealed and explained the trend, seasonal and cyclical components of the Euro/US dollar exchange rate during the period 2012 till 2019.

Since the European Union and the USA were the main imports sources to Lebanon besides China, the exchange rate of the currencies of these two sources affected the Lebanese imports and the Lebanese merchants try to find the cheaper source for their trades. The Lebanon exports should benefit from the weakening in the US dollar against Euro, since the Lebanese pound was pegged to the dollar in the period fallen between 2012 and 2019, so when you exported to Europe and other countries you could to export at more competitive prices.

Finally, isn't it time to liberalize the Lebanese pound against the US dollar or to peg on another fixed number, by a decision from the Lebanese central bank? Maybe it will be a good idea if the central bank calculates the new rate based on three benchmarks: demand and supply of the Lebanese pound LBP, the movement of the currencies of the countries having the largest weights for trading and investment with Lebanon (the USD, the Euro, the Chinese Yuan) and the macroeconomics balance.

References

1. *Broda, C.* Terms of trade and exchange rate regimes in developing countries / C. Broda // J. of Intern. Economics. — 2004. — № 63(1). — P. 31–58.

2. Official dollarisation /euroisation: motives, features and policy implications of current cases [Electronic resource] / A. Winkler [et al.] // European Central Bank. — Mode of access: https://www.ecb.europa.eu/pub/pdf/scpops/ecbocp11.pdf. — Date of access: 18.10.2020.

3. *Dunis, C.* Higher Order and Recurrent Neural Architectures for Trading the EUR/USD Exchange Rate / C. Dunis, J. Laws, G. Sermpinis // Quantitative Finance. — 2008. — № 11(4). — P. 615–629.

4. *Bénassy-Quéré, A.* Dollar: un refuge pas tres sur / A. Bénassy-Quéré // La lettre du CEPII. — 2009. — № 289.

5. *Wenhao, L.* Currency competition between Euro and US Dollar [Electronic resource] / L. Wenhao // EconStor. — Mode of access: https://www.econstor.eu/bitstream/10419/74369/1/745731821.pdf. — Date of access: 18.10.2020.

6. *Genç, F.* Effect of Exchange Rate Changes on Export Performance in Turkey / F. Genç. — Gazimagosa : Eastern Mediterranean Univ., 2009.

7. *Frey, R.* Exchange Rate Volatility and International Trade — Some GARCH Estimations Stress the Importance of Trade Diversification / R. Frey // Intern. Economics. — 2005.

8. *Cromwell, J. B.* Univariate tests for time series models / J. B. Cromwell, W. C. Labys, M. Terraza. — Thousand Oaks : SAGE Publ., 1994. — 96 c.

9. European Union, Trade in goods with Lebanon [Electronic resource] // European Commission. — Mode of access: https://webgate.ec.europa.eu/isdb_results/factsheets/country/details_lebanon_en.pdf. — Date of access: 18.10.2020.

10. Lebanon's Economic Update — October 2020 [Electronic resource] // The world bank. — Mode of access: https://www.worldbank.org/en/country/lebanon/publication/economic-update-october-2020. — Date of access: 18.10.2020.

11. Crisis in Lebanon [Electronic resource] // FDD. — Mode of access: https://www.fdd.org/analysis/2020/08/04/crisis-in-lebanon. — Date of access: 18.10.2020.

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