The Determinants of Foreign Reserves in Lebanon: An Applied Approach

July 28, 2026

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Introduction

Foreign Reserves at Lebanese Central Bank were significantly depleted starting late 2019 due to several inappropriate decisions taken by the Government and the Central Bank. This has led to a systemic and structural shift in the trust of the country's citizens in the government and the banking system, effectively changing the underlying behavioral and economic mechanisms of the foreign reserve dynamics. For the purpose of assessing the determinants of foreign reserves in the Lebanese Central Bank, we ran a few regression models to figure out the determinants of foreign reserves, along with diagnostic tests to validate the results. We eventually found that the change in Net Other Investments, the 1-month lagged percentage change in the flow of the trade balance, and the change in FDI had significant effects on the percentage (natural log) change in reserves. On the other hand, the changes in portfolio investment and remittances were initially significant but the results were later shown to be completely false and distorted. In this paper, we will discuss the regression models and the tests we performed and interpret the results from both a statistical and economic framework.

Theoretical Background

The theory behind the balance of payments (BOP) is straightforward but profound. The BOP identity can be identified as follows:

(1) $KA + CA - \Delta R = 0$

Equation (1) simply states that the sum of the capital CA and the capital account KA plus the negative change in Central Bank reserves ΔR should be equal to zero, so as for BOP to be in balance. To elaborate, if the CA and the KA are in surplus, the resulting increase in AR has to be recorded as negative to maintain BOP balance or equilibrium. And the opposite is true in case CA and KA are in deficit. That is why ΔR is always recorded opposite in sign in BOP accounts: negative when it increases and positive when it decreases.

Note that equation (1) can rewritten as:

(2) $\Delta R = KA + CA$

(3) $\Delta R = f(KA, CA)$

Where equation (3) translates the BOP identity into a functional form, making the change of reserves depend on the state of the current and capital accounts. More specifically, in the context of Lebanon, it makes ΔR depend on the trade balance (in goods and services) and remittances under CA; and on FDI, portfolio investments, and other investments (deposits, loans, and trade finance) under KA.

As such, the equation that we will estimate to start with (original model) will have the following form:

(4) $\Delta R = f(Remittances, PI, Other\ Investments,$ TB, $and\ FDI)$

Where:

PI: Portfolio Investment

TB: Trade Balance

FDI: Foreign Direct Investments

Note that all explanatory variables on the right side are measured in net terms and are expected to have a positive relation with ΔR. Lastly, data run from March 2006 to December 2025.

The Original Model

Regression Statistics	
Multiple R	0.4543
R Square	0.2064
Adjusted R Square	0.1893
Standard Error	0.0315
Observations	238

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	5	0.059931099	0.01198622	12.0690781	2.11844E-10
Residual	232	0.23040724	0.000993135		
Total	237	0.290338339			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0.0046819	0.0071301	0.6566439	0.5120607	-0.0093660	0.0187298
Remittences	-0.0000628	0.0000211	-2.9820347	0.0031688	-0.0001042	-0.0000213
Portfolio Investment	0.0000099	0.0000044	2.2641661	0.0244880	0.0000013	0.0000185
Net Other	0.0000143	0.0000028	5.1819834	0.0000005	0.0000089	0.0000197
TB t-1	0.0051014	0.0025258	2.0196944	0.0445650	0.0001249	0.0100778
FDI	0.0000302	0.0000163	1.8529547	0.0651587	-0.0000019	0.0000624

The original model estimation results are shown above. We can observe that all of the variables are significant at the 5% level except FDI, which is borderline insignificant at the 5% level. We will omit it for now and the results are shown below.

Regression Statistics	
Multiple R	0.4412
R Square	0.1947
Adjusted R Square	0.1808
Standard Error	0.0317
Observations	238

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	0.056521229	0.014130307	14.08092683	2.63086E-10
Residual	233	0.23381711	0.001003507		
Total	237	0.290338339			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0.01211643	0.005924716	2.045065181	0.041972154	0.000443569	0.023789292
Remittences	-7.2809E-05	2.04478E-05	-3.560704737	0.000448288	-0.000113095	-3.25224E-05
Portfolio Investment	1.0419E-05	4.39146E-06	2.372667602	0.018473098	1.76743E-06	1.90715E-05
Net Other	1.386E-05	2.76152E-06	5.018841351	1.03215E-06	8.4189E-06	1.93004E-05
TB t-1	0.00463749	0.002526458	1.835570468	0.067695701	-0.00034013	0.009615111

Now we observe that trade balance at t−1 is borderline insignificant with a p-value of 6.76%. This thus shows that FDI acted as a suppressor variable for the lagged trade balance, so we will keep it as a control variable. Therefore, we will maintain the original model; we follow now with the analysis.

Net Remittances are significant, but with a **negative** coefficient. Results in the literature are mixed; some of the previous literature shows positive coefficients while others reveal negative coefficients. The negative coefficient result we got is regularly justified by Dutch-disease[1] and/or Import-absorption theory[2]. In the case of Lebanon, remittances increase consumption, thus resulting in a decrease in Central Bank foreign reserves accumulation[3].

1-Month Lagged Trade Balance is significant as export and import transactions influence reserve accumulation. A one-month lag is economically accepted as trade invoicing, customs clearance, and settlement lags of a given month's trade flows are often reflected in reserves with a delay. This is a common finding in reserve models based on monthly Balance of Payments (BOP).

Net Other Investments also appeared to be significant, i.e. it impacts foreign reserves accumulation at the Central Bank. Since Lebanon was highly dollarized (and still is) and highly banked, net other investments (including deposits), are expected to be significant and contribute to the development of Central Bank's foreign reserves accumulation. One main reason is the fact the deposits at banks represented the largest portion of central bank and commercial banks' balance sheets.

Net Portfolio Investment is also significant and can be explained in the sense that portfolio investments usually pass through financial markets and prompt Central Bank intervention and reserve accumulation, thus this economic mechanism could prompt such results.

[1]*Dutch disease is an economic phenomenon where a massive surge in wealth (typically from natural resource discoveries, foreign aid, or large investments) causes a nation's currency to appreciate.*

[2]*Import-absorption theory (known as Absorption Theory) suggests that an economy's capability to "absorb" or spend new wealth on domestic and foreign goods boost inflation and adjusts the real exchange rate.*

[3]*In some studies, remittances appear insignificant. That is because in Lebanon remittances don't vary much, which will render them insignificant because low variance leads to a large standard error.*

However, **Net Foreign Direct Investment** appears to be insignificant. This is odd, but perhaps could be explained by the fact that most of FDI is rent-like, since it is concentrated in the real estate sector, and doesn't contribute greatly to productive capacity. But this is not the whole story, as we will see later.

Regardless, we will proceed with further testing and see if these economic mechanisms align with adjusted versions of the original model.

The Structural Break

Considering the 2019 banking crisis, we have to be wary of a structural break in our data. Therefore, we ran a Chow test with the first subsample (pre-crisis) being from March 2006 to September 2019 and the second subsample (post-crisis) from October 2019 to December 2025. Their sample sizes are 163 and 75 respectively, hence around a 70/30 split in the data.
Here are the results:

Pre-2019 Results:

Variable	Coefficient	p-value
Remittences	-2.168E-05	45.535%
Portfolio Investment	8.056E-06	11.665%
Net Other	1.342E-05	0.002%
TB t-1	5.389E-03	2.072%
FDI	3.580E-05	2.026%

R-Squared: 18.84%

Post-2019 Results:

Variable	Coefficient	p-value
Remittences	-3.665E-05	69.674%
Portfolio Investment	1.368E-05	17.508%
Net Other	1.141E-05	10.609%
TB t-1	8.109E-03	62.927%
FDI	-5.565E-05	44.292%

R-Squared: 6.11%

When we compute the squared sum of residuals for the pooled sample and both subsamples, we are able to compute the Chow test f-statistic. The formula is as follows:

$$F = \frac{\frac{RSS_C - (RSS_1 + RSS_2)}{k}}{\frac{RSS_1 + RSS_2}{N_1 + N_2 - 2k}}$$

$$F = 42.78$$

An f-statistic of 42.78 implies a p-value of approximately 1.09×10^{-34}. This value is near 0, indicating practically irrefutable evidence of a structural break, which is not surprising. This is also evident in the regression results, considering how the p-values changed immensely. In the

pre-2019 subsample, the lagged trade balance, FDI, and net other investments are all significant at the 5% level. However, portfolio investment and remittances are now insignificant. On the other hand, we can see in the post-2019 model that none of the variables remain significant, as correlation broke down due to the regime switch as evident by the change in R-Squared. Furthermore, it is interesting to see that FDI is now significant in the pre-2019 subsample, thus suggesting that the post-crisis period slightly distorted its metrics.

Let's now tackle the switch in portfolio investment and remittances in some details. When it comes to portfolio investment, we could perhaps attribute the change in the p-values to the change in the sample size as the p-value did not change drastically. Then this begs the question, how did TB t−1 and FDI stay significant in the pre-2019 sample despite the loss in sample size? We can simply attribute it to the fact that their explanatory power is generally stronger than that of portfolio investment and it was able to persist even under a smaller sample size. However, the case of remittances is far more interesting. In the original model, it was highly significant with a p-value of 0.31%. However, after splitting the pooled sample into pre-2019 and post-2019 subsamples, the p-values became 45.53% and 69.67% respectively. Such a large change in the p-values could not be just attributed to the change in the sample size but rather to omitted variable bias in our original model. We tried by adding a dummy variable to account for the regime switch and we noticed that remittances became highly insignificant while the dummy variable was significant. This essentially indicates that remittances ***accidentally*** acted as a proxy variable for the regime switch, hence artificially inflating its t-statistic. Considering this and the lack of sufficient explanatory power of portfolio investment, we omitted both of them and stuck with the pre-2019 subsample, thus reaching this final model:

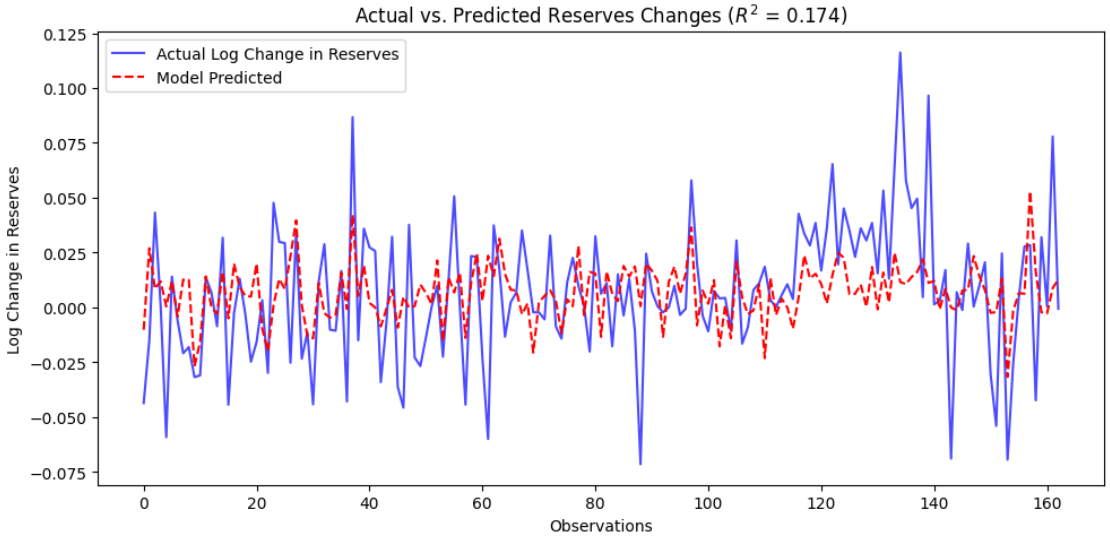
Regression Statistics	
Multiple R	0.4171
R Square	0.1740
Adjusted R	0.1584
Standard E	0.0282
Observatio	163

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0.026722397	0.008907466	11.16191665	1.0929E-06
Residual	159	0.126885648	0.000798023		
Total	162	0.153608045			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-0.00693181	0.003779461	-1.834073393	0.068512493	-0.014396228	0.000532612
Net Other	1.4245E-05	3.00042E-06	4.747767697	4.55796E-06	8.31948E-06	2.01711E-05
TB t-1	0.00586868	0.002290426	2.562265779	0.011327802	0.001345098	0.010392263
FDI	3.654E-05	1.5155E-05	2.411112488	0.017044032	6.60936E-06	6.64716E-05

We can observe that all coefficients are now significant and our R-Squred is an acceptable 17.4% and thus we will be proceeding with this model for the rest of this study.



Variable	Full Sample	Pre-Crisis Sample	Post-Crisis Sample
Remittances	Significant	Insignificant	Insignificant
Portfolio Investment	Significant	Insignificant	Insignificant
Net Other Investments	Significant	Significant	Insignificant
Trade Balance t−1	Significant	Significant	Insignificant
FDI	Insignificant	Significant	Insignificant

The 3 variables that remained significant in the pre-crisis sample remained significant in our final regression output. The interesting significance switch observed in the table above is that of FDI. It was the only (borderline) insignificant variable in the full sample but then became significant in the pre-crisis sample. Essentially, the structural break overall distorted the t-statistics and FDI happpened to get caught in the crossfire, hence its initial insignificance in the full sample. The significance in the pre-crisis period is thus validated by our initial economic explanation, whereby the FDI transactions are realized as foreign reserves.

The practical interpretation (whereby ***holding all else equal***) for each coefficient are as follows: As **FDI** increases by 1 million USD, foreign reserves are expected to increase by an average of 0.00365%. As **last month's flow of the Trade Balance** increases by 1 percentage point, foreign reserves are expected to increase by an average of 0.00586%. As **Net Other Investments** increase by 1 million USD, foreign reserves are expected to increase by an average of 0.00142%.

Let's now run a few diagnostic tests to ensure that our metrics are valid.

Diagnostic Tests (Technical Section: Optional)

We first ran a variance inflation factor (VIF) test to check if multi-collinearity exists between our explanatory variables. The formula for the VIF test is given by:

$$VIF_i = \frac{1}{1 - R_i^2}$$

The highest R-Squared observed was when we regressed FDI on TB t−1 and Net Other, giving a value of 1.23%. Inputting this number, we get a VIF result of 1.012. For reference, a VIF over 5 is considered high multicollinearity, so our value near 1 is practically perfect. Therefore, no multicollinearity persists in our model.

We then ran a White Test for heteroskedasticity and got the following results:

R^2	3.737%
n	163
LM Statistic:	6.091
p-value:	80.75%

We got a p-value of 80.75%, meaning that we were unable to reject the null hypothesis of the error variance being constant, hence suggesting homoskedasticity. This is a splendid result as it suggests that our model's metrics are not distorted by heteroskedasticity thus making our p-values more reliable.

We then ran a Breusch-Godfrey test to check for serial correlation using 12 lags in our residuals. Here are the results:

R^2	16.95%
n	151
LM statistic:	25.60
p-value:	1.22%

We observe a p-value of 1.22%, meaning that we reject the null hypothesis of no serial correlation. This confirms that serial correlation does exist in our model, and that the effect of previous data points spilling over into the current one is observed. This unfortunately overestimates the t-statistics and thus we should account for it.

Therefore, we opted for Newey-West[4] (HAC) Standard Errors across 12 lags to verify our p-values. Here are the results:

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-0.0069	0.004	-1.802	7.20%	-0.014	0.001
Net Other	1.43E-05	3.22E-06	4.43	0.00%	7.94E-06	2.05E-05
TB t-1	0.0059	0.001	3.936	0.00%	0.003	0.009
FDI	3.65E-05	1.59E-05	2.295	2.20%	5.33E-06	6.77E-05

All of the now adjusted p-values are less than 5% (besides the intercept). This proves that our original p-values were valid despite the autocorrelation, thus making our results much more robust.

Another assumption remains, which is the model's residuals being normally distributed. To check for it, we use a Jarque-Bera test. We got a Jarque-Bera test statistic of 11.029, which implies a p-value of 0.4%. This indicates that our model's residuals are ***not*** normally distributed. However, this is not much of a problem; such Jarque-Bera results are common in time series data and considering our sample size is large[5] enough (n = 163) the results remain robust under asymptotic assumptions via Newey-West.

Finally, we need to tackle endogeneity. We have already observed how the lagged trade balance and FDI aided one another in achieving significance and capturing the full effect, which rules out omitted variable bias from that angle. On the other hand, risk of simultaneous causality can still persist since all the variables except trade balance are not lagged. However, the reasoning behind this happening can be systemic risk – such as the crisis – which we have already removed from our sample data. Therefore, we can now generally rule out endogeneity as a concern.

All in all, these diagnostic tests helped us in validating our p-values and thus the inferences we are trying to make out of the results. Looks like both the economic mechanisms/literature and the empirical evidence are valid and well aligned!

[4] *Newey-West (HAC) Standard Errors modifies the variance-covariance matrix using a Bartlett kernel to weights autocovariances up to lag 12, leaving coefficients unchanged.*

[5] *Due to the central limit theorem, the non-normality of the residuals is generally harmless for the coefficients and standard errors.*

Conclusion

The outcome of the study conveys a coherent and economically trustworthy story. In pre 2019 period, Lebanon's foreign reserve accumulation reacted to predictable balance-of-payments dynamics. Trade flows, FDI, and "other investment" were consistent with macro open-economy theory, and the reserve variation was fairly explained well explained (R^2 19%). As important, we found that remittances don't contribute to **changes** in BDL foreign reserves as they are fairly stable, but as we saw changes in trade, FDI, and other investments very well do. For the post 2019 crisis, the model collapsed as R^2 dropped to 6.11%. All variables that were significant in the period prior to 2019 became insignificant with FDI coefficient changing sign. Lebanon's reserve depletion since late 2019 is attributed to administrative and policy-driven forces rather than market-based flows that this model was able to capture. These forces were mainly multiple exchange rates, informal capital control, wasteful subsidies, not to mention war and political instability.

As such, specific reforms should be implemented to restore the typical determinants of foreign reserve – FDI, trade balance, and other investments. These imply reforms in three major areas that aim to: increase domestic production and competitiveness, helped by a reasonable exchange rate policy; restore confidence to a restructured banking sector, made possible by a fair deposit recovery plan; and enhance the business and investment climate, aided by better governance and rule of law.

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