# FINANCE-GROWTH VOLATILITY NEXUS: EVIDENCE FROM LEBANON

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## ABSTRACT

A generalized autoregressive conditional heteroskedasticity (GARCH) model incorporating shocks of financial deepening and growth variables in the variance equation of the other variable respectably is used to investigate whether there is a significant bi-directional spillover of shocks between the two variables in Lebanon. We find that even though there is a bidirectional Granger-causality between financial deepening and economic growth after 7 months, financial deepening Granger-causes economic growth after one month and exhibit stronger feedbacks in both shocks and conditional variance. We offer some policy suggestions specific to the desired strategy intervention in the Lebanese economy that are consistent with our empirical results.

## 1. INTRODUCTION AND INSIGHTS FROM THE LITERATURE

The financial development role in boosting growth has received considerable attention in the literature for many years since the influential works of McKinnon (1973) and Shaw (1973). Theoretically, financial development enhances growth as it reduces the volatility of investment by allowing for better diversification of risk, and by mitigating shocks to credit supply. This leads to promoting growth by providing active liquidity and risk managements and avoiding unprofitable investments (e.g., (King and Levine, 1993; Levine, 1997)). Such theoretical conjectures received considerable empirical support from numerous studies, and for a large group of countries [e.g., Levine and Zervos (1998); Darrat (1999) and Khan and Senhadji (2000)].

The second strand of the literature which forms the basis for our analysis concerns the relationship between financial deepening and economic growth volatility. It has been hypothesized that financial market development may reduce macroeconomic volatility by diminishing information asymmetry (Greenwald and Stiglitz, 1993) by enhancing the diversification & reducing various risks (Acemoglu and Fabrizio, 1997) and by absorbing external shocks in the real economy (Aghion et al., 1999).

In contrast to the flood of research on the relationship between financial market development and economic growth, empirical work on the relation of macroeconomic volatility to financial development to has been relatively limited. For instance, Hwang and Lee (2013) found that financial deepening as measured by the ratio of M2 to the gross domestic product (GDP) is positively related to growth volatility, whereas Kose et al. (2003) found that the ratio of M2 to GDP reduces output volatility. Beck et al. (2006) found a weak evidence that financial intermediaries dampen the effect of terms of trade volatility, while Neaime (2005) found that financial openness increases

consumption volatility. In contrast, Bekaert *et al.* (2006) found that financial liberalization reduces consumption growth volatility, Abdullahi and Suardi (2009) found that financial market depth reduces output volatility, and Larrain (2006) found that with more credit extended to the private sector idiosyncratic volatility is reduced by far more than systematic risk.

Considering the above, financial development seems to be a contributing sector to growth and its volatility in many economies. Nonetheless, empirical assessment of this issue in Lebanon seems absent. To the best of our knowledge, only few articles examined the issue empirically for Lebanon although not explicitly. For example, Abosedra and Fakih (2017) investigated the role of remittances and financial deepening in growth in Lebanon using quarterly data from 1993 to 2011. Their results provided support that remittances and financial development share a robust long-run relationship with growth in Lebanon. Abosedra and Fakih (2014) also empirically investigated the impact of financial deepening and the use of information and communication technology (ICT) on Lebanon's economy by estimating a Vector Error Correction Model (VECM) using data from 1993 to 2009. Their results reported unidirectional causality running from economic growth to financial deepening. Awdeh (2012) studied the causality between banking sector development and growth in Lebanon (1992-2011). Utilizing Granger Causality tests, he reported a one-way causality running from economic growth to banking sector measures. Abosedra *et al.* (2015) investigated the causal relationship between financial development, energy consumption and economic growth in Lebanon using data from 1993M1 to 2010M12. Their findings confirmed the existence of cointegration among the variables. It indicated that financial development and energy consumption contributed positively to economic growth in Lebanon.

Based on the above information, this study attempts to fill the gap by assessing the linkage between financial development and growth volatility in the case of Lebanon. Accordingly, we think that it is imperative to examine this issue for Lebanon as no other empirical work on the relation of macroeconomic volatility to financial development was conducted for Lebanon.

Furthermore, this study differs from previous ones in that a bivariate generalized autoregressive conditional heteroscedasticity (GARCH) model with shock spillovers is used to examine whether there is a bi-directional transmission of volatility between financial deepening and economic growth. The ARCH model of Engle (1982) and the GARCH model of Bollerslev (1986) are known to capture feedbacks in both past shocks and volatility, respectively. While unconditional estimates of volatility may establish linkages between economic growth volatility and the level of financial development, they are unable to uncover the process by which linkages come about and persist over time. We use a bivariate GARCH model, which we extend by incorporating shocks from financial deepening in the conditional variance equation of economic growth and shocks from economic growth in the conditional variance equation of financial deepening. Such process, we think, should have more value to the policy makers. We use monthly data, and found that shocks in financial deepening have direct impacts on growth in Lebanon. The positive conditional correlation between financial deepening and growth speaks for a stronger relationship rather than a reduction or an augmentation of macroeconomic volatility.

The rest of the study is organized as follows. Section 2 presents the data set, describes the variables, and gives some empirical arguments on the use of proxies for financial deepening and economic growth. Section 3 describes the empirical models and includes the main findings of the paper. Second 4 concludes and includes some policy recommendations.

## 2. DATA AND VARIABLES

### 2.1. Measures of Economic Growth

We use monthly data obtained from the Central Bank of Lebanon (BdL, Banque du Liban) at http://www.bdl.gov.lb. since monthly data for GDP are unavailable, we follow Tang and Abosedra (2016) among others, in our use of the index of coincident indicator (CI) as a measure of economic growth in Lebanon. This is an

index constructed on relevant cyclical macroeconomic aggregates and is based upon a linear combination of a set of indirect indicators. It consists of electricity production (18.6%), imports of petroleum products (18.2%), cement deliveries (16.5%), number of foreign passengers (11%), total international trade (11.8%), value of cheques clearance (12%), and M3 money supply (12%).

## 2.2. Measures of Financial Deepening

We follow Darrat et al. (2005) and measure financial deepening (FD) in Lebanon as follows,

$$fd_{1,t} = ln(M2_t)/ln(GDP_t/12), \tag{2a}$$

$$fd_{2,t} = ln(DD_t)/ln(M1_t), \tag{2b}$$

$$fd_{3,t} = ln(BA_t)/ln(BL_t), \tag{2c}$$

where $M1_t$ is currency in circulation, $M2_t$ is $M1_t$ plus time deposits, $DD_t$ is demand deposit, $BA_t$ and $BL_t$ are respectively bank and financial corporation medium and long-term claims on and liabilities to the private sector, and GDP is the gross domestic product.

For the case of this study, we use monthly data on the Lebanese economy. As a proxy to financial deepening, we use FD1 as the ratio of M2 to GDP, FD2 as the ratio of demand deposits to M1, and FD3 as the ratio of bank long-term claims on the private sector to bank long-term liabilities to the private sector. $fd_{1,t}$ represents according to King and Levine (1993) the size of the financial market relative to the overall economy. $fd_{2,t}$ represents according to Vogel and Buser (1976) the sophistication of banks in providing financial services. $fd_{3,t}$ represents according to Denizer et al. (2002) the degree to which funds are transferred from savers to borrowers. Noting that $M1_t, M2_t, DD_t, BA_t$, and $BL_t$ were in Lebanese Pound (LBP), they are expressed in dollar terms using the exchange rate between LBP and USD at $t$. Figure 3 shows that the three measures of financial deepening in Lebanon are positively trending with the positive trend stronger in $fd_{1,t}$ and $fd_{2,t}$ than in $fd_{3,t}$.

Equations (2a-2c) give three measures of financial deepening capturing one or more aspects of financial development in Lebanon. The two first measures are used in a number of papers. The third differs in that it is an attempt to measure financial institution confidence in the fate of entrepreneurial activities with uncertain future cash flows. Figure 1 portrays the monthly patterns of $ln(CI_t) = ci_t, \ fd_{1,t}, fd_{2,t}$, and $fd_{3,t}$, respectively.
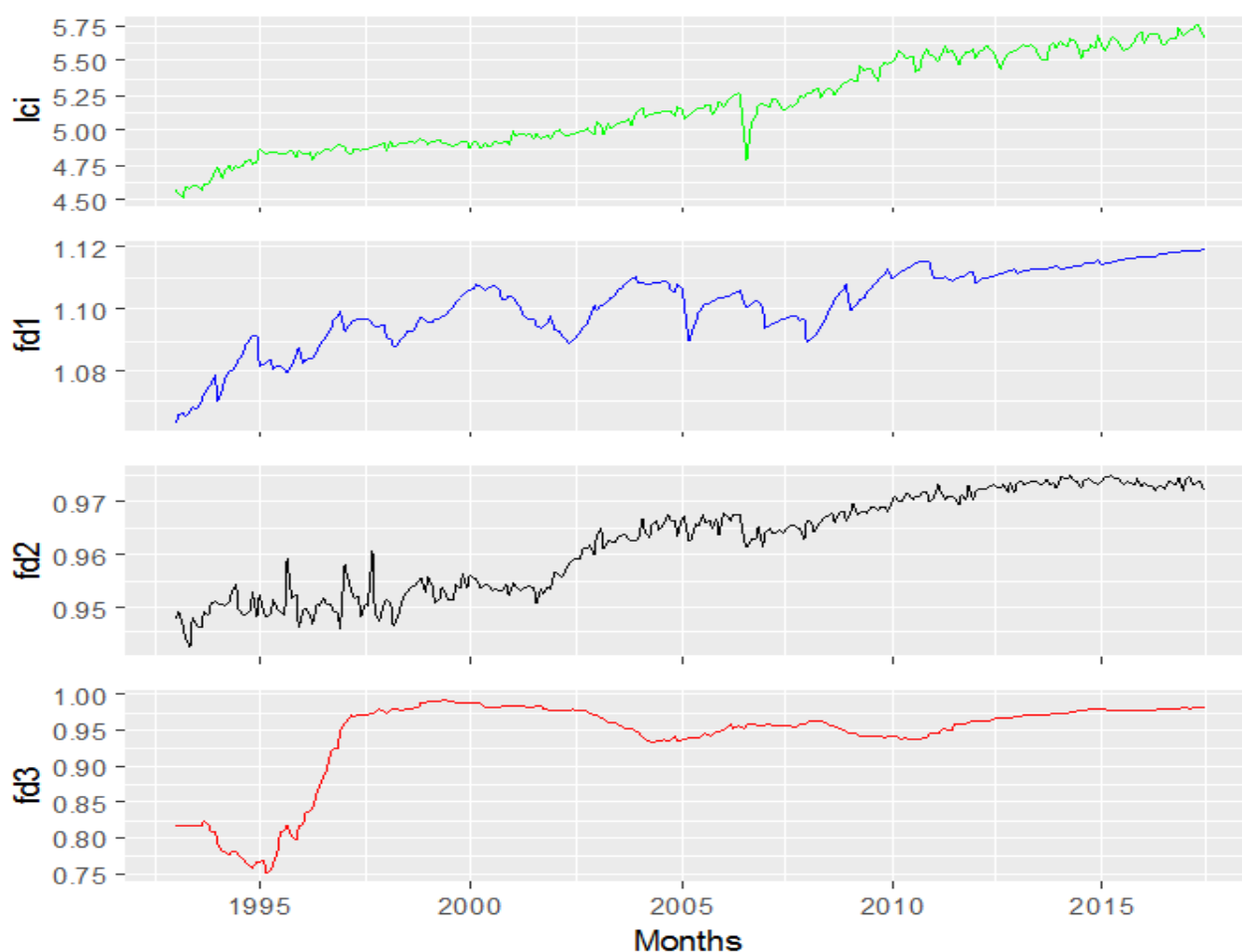
**Figure-1.** Monthly pattens of log (CI), log(FDI), log(FD2) and log(FD3)

Figures 1 shows that $ci_t$, $fd_{1,t}$, $fd_{2,t}$, and $fd_{3,t}$ increase over time. A clear positive deterministic trend seems to govern the four-time series. We know from previous studies that a positive trend is often an indication that the time series may be carrying a unit root. We will test the four series under the null hypothesis of a unit root.

**Table-1.** Unit root tests on the augmented Dickey-Fuller augmented model

|  | Optimal number of lags | H0: Unit root | H0: Unit Root without Trend | H0: Unit Root without Trend and without Drift |
|---|---|---|---|---|
| $ci_t$ | 12 | -1.83>-3.42 at 5%: Accept H0 | 6.07>4.71 at 5%: Reject H0 | 1.70<6.30 at 5%: Accept H0 |
| $fd_{1,t}$ | 14 | -3.65<-3.42 at 5%: Reject H0 | 4.75<4.71 at 5%: Accept H0 | 6.65>6.30 at 5%: Reject H0 |
| $fd_{2,t}$ | 17 | -1.66>-3.42 at 5%: Accept H0 | 2.80<4.71 at 5%: Accept H0 | 1.55<6.30 at 5%: Accept H0 |
| $fd_{3,t}$ | 12 | -4.74<-3.42 at 5%: Reject H0 | 8.71>4.71 at 5%: Reject H0 | 12.48>6.30 at 5%: Reject H0 |

$fd_{1,t} = ln(M2_t)/ln(GDP_t)$,     $fd_{2,t} = ln(DD_t)/ln(M1_t)$,     $fd_{3,t} = ln(BA_t)/ln(BL_t)$,

$ln(CI_t) = ci_t$, $M1_t$=currency in circulation at t, $M2_t$=$M1_t$ plus time deposits at t, $BA_t$=bank claims on the private sector at t, $BL_t$ = bank short-term liabilities at t, and $CI_t$ = the coincident indicator at t. Unit root test on the augmented Dickey-Fuller approach, which is

$\Delta Y_{t-1} = \theta_0 + \theta_1 tt_t + \gamma Y_{t-1} + \sum_{i=1}^{p} \Delta Y_{t-i} + u_t$, where $Y_{t-i}$ is any of the four variables, $tt_t$ is a time trend, and $p$ is the number of optimal lag.

## 3. SHORT AND LONG-RUN ANALYSIS

### 3.1. Long-Run Analysis

Several approaches are proposed in the financial economic literature to test under the null hypothesis that a particular time series is non-stationary at its levels and changes of some order. Table 1 reports unit root tests based on the augmented Dickey-Fuller (ADF) model on the levels of $ci_t, fd_{1,t}, fd_{2,t}$, and $fd_{3,t}$, respectively.

Table 1 reports unit root tests on ADF models including a drift and a time-trend. As Figure 2A shows, $ci_t$ is a non-stationary process with a significant time trend but without a significant drift. Among the measures of financial deepening only $fd_{2,t}$ is a non-stationary process with a drift but without a significant trend. While $fd_{3,t}$ is a stationary process, it carries a significant trend and drift. Since $fd_{3,t}$ is trending, removing such a significant trend must help in multivariate analysis where it is involved.

We do not report ADF models without drift and without trend because these models give statistic values that are inconsistent with respect to the sign of the critical values (see, Gujarati (2003)). Against the critical value that is -1.95, the test statistic values are 3.88, 1.66, 2.29 and 0.814 for $ci_t, fd_{1,t}, fd_{2,t}$, and $fd_{3,t}$, respectively.

The next step in analyzing how the four variables are related to each other in the short- and long-run, we rely on the ADF model including a drift, a time trend and quarterly dummies. As we find that both $fd_{1,t}$ and $fd_{3,t}$ are stationary processes, our co-integration test only involves $ci_t$ and $fd_{2,t}$.

Testing whether $ci_t$ and $fd_{2,t}$ are co-integrated, we cannot accept the null hypothesis of no long-run relationship. However, the two series are unconditionally co-integrated when the number of lags is 2. Since the Akaike Information Criterion (AIC) sets the optimal number of lags at 17, we use quarterly dummies as exogenous variables to control for possible shifts in the drift of the two time series. In fact, we find that when more lags are included in testing the co-integration relationship, both the Trace and the Max-Eigen statistics obtained under the Johansen procedure weaken.

### 3.2. Short-Run Analysis

Since we are left with only two variables, let $ci_t$ and $fd_{2,t}$ be $y_t$ and $x_t$, respectively. A bivariate vector error correction model (VECM) is given by the following:

$$\begin{bmatrix} \Delta y_t = \gamma_{10} + \pi_{12}\varepsilon_{t-1} + \sum_{i=1}^{p} \gamma_{11,i} \Delta y_{t-i} + \sum_{i=1}^{p} \gamma_{12,i} \Delta x_{t-i} + v_{y,t} \\ \Delta x_t = \gamma_{20} + \pi_{21}\varepsilon_{t-1} + \sum_{i=1}^{p} \gamma_{21,i} \Delta y_{t-i} + \sum_{i=1}^{p} \gamma_{22,i} \Delta x_{t-i} + v_{x,t} \end{bmatrix}, \tag{3}$$

where $\Delta y_t$ is change in $y_t$, $\Delta x_t$ is change in $x_t$, $\varepsilon_{t-1} = (y_{t-1} - \beta x_{t-1})$, $\varepsilon_{t-1}$ is the error correction term (ECT), $\beta$ is the co-integrating coefficient, $\gamma_{10}$ and $\gamma_{20}$ are constant terms, $\gamma_{11}$ and $\gamma_{21}$ are autoregressive coefficients of the first-order, $\pi_{12}$ is a coefficient measuring the adjustment speed of economic growth to deviation

from the long-run equilibrium, $\pi_{21}$ is a coefficient measuring the adjustment speed of financial deepening to deviation from the long-run equilibrium, $\gamma_{11,i}$ are autoregressive coefficients measuring the lagged effect of economic growth on current growth, $\gamma_{22,i}$ are autoregressive coefficients measuring the lagged effects of financial deepening on the ongoing sophistication of the financial system, $\gamma_{12,i}$ are coefficient measuring the lagged effects of financial deepening on economic growth, $\gamma_{21,i}$ are coefficients measuring the lagged effects of economic growth on the deepening of financial services and products, $v_{y,t}$ is an error in forecasting changes in growth, and $v_{x,t}$ in an error in forecasting changes in financial deepening.

**Table-2.** Short-run impacts under VECM and Granger-causality under VAR

| | $\Delta y_t$ | $\Delta x_t$ |
|---|---|---|
| D1, $\gamma_{101,201}$ | 0.0105 | **-0.0007\*** |
| D2, $\gamma_{102,202}$ | 0.0039 | **0.0011\*** |
| D3, $\gamma_{103,203}$ | **-0.0209\*** | **0.0012\*** |
| D4, $\gamma_{104,204}$ | 0.0114 | **0.0016\*** |
| $\pi_{12,21}$ | 0.0251 | **0.0023\*** |
| $\Delta y_{t-1}, \gamma_{111,211}$ | **-0.4586\*** | 0.0014 |
| $\Delta y_{t-2}, \gamma_{112,212}$ | **-0.4894\*** | **-0.0049\*** |
| $\Delta y_{t-3}, \gamma_{113,213}$ | **-0.3225\*** | 0.0001 |
| $\Delta y_{t-4}, \gamma_{114,214}$ | **-0.3120\*** | -0.0004 |
| $\Delta y_{t-5}, \gamma_{115,215}$ | **-0.1948\*** | 0.0013 |
| $\Delta y_{t-6}, \gamma_{116,216}$ | **-0.1722\*** | 0.0003 |
| $\Delta y_{t-7}, \gamma_{117,217}$ | **-0.2270\*** | -0.0047 |
| $\Delta y_{t-8}, \gamma_{118,218}$ | -0.1200 | -0.0043 |
| $\Delta y_{t-12}, \gamma_{1112,2112}$ | 0.1399 | **-0.0074\*** |
| $\Delta y_{t-13}, \gamma_{1113,2113}$ | 0.0442 | **-0.0068\*** |
| $\Delta y_{t-14}, \gamma_{1114,2114}$ | 0.0367 | **-0.0068\*** |
| $\Delta x_{t-1}, \gamma_{121,221}$ | 5.5291 | **0.2647\*** |
| $\Delta x_{t-5}, \gamma_{125,225}$ | **-4.3432\*** | 0.1116 |
| $\Delta x_{t-10}, \gamma_{1210,2210}$ | **2.9944\*** | -0.0249 |
| $\Delta x_{t-12}, \gamma_{1212,2212}$ | -1.6846 | **0.3724\*** |
| $\Delta x_{t-13}, \gamma_{1213,2213}$ | **-2.9162\*** | -0.2743 |
| $\Delta x_{t-15}, \gamma_{1215,2215}$ | **-3.0339\*** | 0.0133 |
| $\Delta x_{t-16}, \gamma_{1216,2216}$ | **3.5160\*** | -0.0083 |
| $\Delta x_{t-17}, \gamma_{1217,2217}$ | **7.6115\*** | -0.0905 |

| Adjusted R-squared | 0.3494 | 0.4060 |
|---|---|---|

(1) $\Delta y_t \leftrightarrow \Delta x_t$ means that $\Delta y_t$ and $\Delta x_t$ Granger-cause each other at lags 7-11.

(2) $\Delta y_t \rightarrow \Delta x_t$ means that $\Delta y_t$ Granger-causes $\Delta x_t$ at lag 6.

(3) $\Delta x_t \rightarrow \Delta y_t$ means that $\Delta x_t$ Granger causes $\Delta y_t$ at lags 1-3, 15-17.

$$\Delta y_t = \gamma_{10} + \pi_{12}\varepsilon_{t-1} + \sum_{i=1}^{p} \gamma_{11,i}\Delta y_{t-i} + \sum_{i=1}^{p} \gamma_{12,i}\Delta x_{t-i} + v_{y,t},$$

$$\Delta x_t = \gamma_{20} + \pi_{21}\varepsilon_{t-1} + \sum_{i=1}^{p} \gamma_{21,i}\Delta y_{t-i} + \sum_{i=1}^{p} \gamma_{22,i}\Delta x_{t-i} + v_{x,t},$$ where $\varepsilon_{t-1}$ is

the error correction term, $y_t$ = the log of economic growth, $x_t$ = the log of financial deepening, and

$(y_{t-1} - \beta x_{t-1})$ = the error correction term. One asterisk (*) means that the coefficient or the statistic is significant at 5%.

Table 2 reports the estimated vector error correction model (VECM) including quarterly dummies. In equation (3) $\gamma_{10}$ and $\gamma_{20}$ are constant in $\Delta y_t$ and $\Delta x_t$, respectively. They appear in Table 2 as D1, D2, D3 and D4 for the first, the second, the third and the fourth quarter of the year. In the absence of significant structural breaks, these dummies may partially account for shift in drift since our sample spans 23 years of monthly data. Looking at the sign and the significance of coefficients associated with D1, D2, D3 and D4, the quarterly economic growth average is significantly negative in the 3rd quarter, whereas a quarter being the second quarter gives a mean average of financing deepening that is different from the mean average of finance deepening in the third quarter.

The VECM differs from the vector autoregressive (VAR) model in that the VECM include deviations from long-run equilibrium. These deviations stem from $(y_{t-1} - \beta x_{t-1})$ and are associated with coefficients $\pi_{12}$ and $\pi_{21}$ in equation (3). Table 2 does not give the co-integrating estimate, which is -35.89. Since $y_t$ is an index and $x_t$ a ratio, we cannot interpret -35.89 as long-run sensitivity of $y_t$ to 1% change in $x_t$. Rather than giving an economic interpretation to the co-integrating estimate at -35.89, we attempt an economic interpretation on the adjustment speed coefficients. Both $\pi_{12}$ and $\pi_{21}$ are positive, which means that holding $y_t$ constant $x_t$ must either increase or decrease to get back to equilibrium. In fact, the adjustment is significant in $\Delta x_t$, not in $\Delta y_t$.

If the adjustment to long-run equilibrium occurs via financial deepening, the short-run impacts of financial deepening on economic growth are first noticeable at lag 5, while short-run impacts of economic growth on financial deepening are first noticeable at lag 1. Using the traditional Granger-causality test, we find that economic growth and financial deepening Granger-cause each other at lags 7-11 respectively, but not earlier. The earlier unidirectional Granger-causality at lag 1 runs from financial deepening to economic growth. In line with the much-lagged economic growth effect of financial deepening, the unidirectional Granger-causality of financial deepening on economic growth is even stronger (looking at the significance level) at lags 15-17.

### 3.3. Volatility Dynamics

According to a number of studies, financial development reduces macroeconomic volatility through efficient intermediation, asset risk profile transformation, efficient allocation of resources, and risk sharing mechanisms (Bernanke and Gertler, 1990). However, the reduction of macroeconomic volatility is a non-linear proposition as the reduction ceases at higher level of financial development (Dabla-Norris and Srivisal, 2013).

Since the relationship is non-linear in its second moment, re-expressing logarithmic changes in terms of point-estimate variances is not satisfactory. Squaring either $\Delta y_t$ or $\Delta x_t$ and relating to either $\Delta x_t$ or $\Delta y_t$ gives estimates that are difficult to interpret as the dimensionality of the variables has changed. An alternative is to square either $\Delta y_t$ or $\Delta x_t$ and relate to either the square of $\Delta x_t$ or the square of $\Delta y_t$. Dabla-Norris and Srivisal (2013) relate the square of a measure of financial deepening to the square of a measure of economic growth. In the context of yearly data, where clustering features are not longer present in the data, the implicit assumption that past volatility is independently related to current volatility makes sense.

However, it is possible that unconditional variance is not sufficient to squeeze feedbacks in past shocks and variances. Therefore, under the assumption that $\Delta y_t$ and $\Delta x_t$ exhibit significant autoregressive conditional heteroscedasticity (ARCH) effects, their co-variance processes can take the following forms,

$$h_{y,\tau} = \omega_y + \alpha_y v_{y,\tau-1}^2 + \beta_y h_{y,\tau-1} + \delta_{12} \rho_{xy,\tau} \frac{v_{x,\tau}^2}{h_{x,\tau}}, \tag{4}$$

$$h_{x,\tau} = \omega_x + \alpha_x v_{x,\tau-1}^2 + \beta_x h_{x,\tau-1} + \delta_{21} \rho_{xy,\tau} \frac{v_{y,\tau}^2}{h_{y,\tau}}, \tag{5}$$

$$h_{xy,\tau} = \omega_x \omega_y + \alpha_x \alpha_y v_{x,\tau-1} v_{y,\tau-1} + \beta_y \beta_x h_{xy,\tau-1}, \tag{6}$$

where $v_{x,\tau}$ and $v_{y,\tau}$ are error terms at $\tau$ from equation (3) for $\tau$ less than $t$ because of loss of degree freedom in estimating a robust VECM, $h_{y,\tau}$ and $h_{x,\tau}$ are conditional variances given past shocks and conditional variances, $h_{xy,\tau}$ is the conditional co-variance given past cross-sectional shocks and variances, $\omega_x$ and $\omega_y$ are unconditional variances given no memories in shocks and variances, $\alpha_x$ and $\alpha_y$ are coefficients measuring feedback (ARCH) effects in shocks of either sign, $\beta_x$ and $\beta_y$ are coefficients measuring feedback effects in conditional (GARCH) variance, $\rho_{xy,\tau} = h_{xy,\tau}/\sqrt{h_{y,\tau}}\sqrt{h_{x,\tau}}$, and $\delta_{12}$ and $\delta_{21}$ are spillover coefficients.

In line with Ben Sita and Abosedra (2012) the ratio of $v_{x,\tau}^2$ to $h_{x,\tau}$ measures possible spillover from financing deepening to economic growth. Similarly, the ratio of of $v_{y,\tau}^2$ to $h_{y,\tau}$ measures possible spillover from economic growth to financial deepening. Weighting in terms of $\rho_{xy,\tau}$ reduces the magnitude of the ratios, which has the advantage of forcing the standardized square shares to evolve around zero whenever the correlation between economic growth and financial deepening is closer to zero. The weighting scheme is in line with previous studies (see for instance, Ben Sita and Abdallah (2014)).

In line with Engle and Kroner (1995) Equations (4), (5) and (6) constitute a system of equations relating current variance to past shocks, past variances, and past interaction between financial deepening and economic growth. Since the parameters of these equations must be positive, they are restricted when we estimate equations (5) and (6). We will still use a flexible model, such as the dynamic conditional correlation (DCC) model of Engle (2002) for a robust check of the linkages in volatility between financial deepening and economic growth. Table reports the estimates of equations (4), (5), and (6), and also the estimates from a bivariate DCC model.

**Table-3.** Estimates on univariate and bivariate GARCH models with shock spillovers

| | Model 1 | Model 2 | Model 3 | Model 4 |
|---|---|---|---|---|
| $\omega_y$ | 0.0009* | | 0.0299* | 0.0013* |
| $\omega_x$ | | 0.0000 | 0.0001 | 0.0000 |
| $\omega_x \omega_y$ | | | 0.0000 | |
| $\alpha_y$ | 0.0927* | | 0.2267 | 0.1302* |
| $\alpha_x$ | | 0.1232* | 0.3346* | 0.0894* |
| $\delta_{12}$ | | | 0.0359* | |
| $\delta_{21}$ | | | -0.0004 | |
| $\beta_y$ | 0.1151 | | 0.3273 | 0.2029* |
| $\beta_x$ | | 0.8790* | 0.9426* | 0.9078* |
| $\alpha_{xy}$ | | | | 0.1901* |
| $\beta_{xy}$ | | | | 0.0408 |
| Log-likelihood | 541.65 | 1466.75 | 1999.92 | 1035.69 |
| AIC | -3.91 | -10.64 | -14.52 | -6.995 |

Models 1, 2 and 3 are based on $h_{y,\tau} = \omega_y + \alpha_y v_{y,\tau-1}^2 + \beta_y h_{y,\tau-1} + \delta_{12}\rho_{xy,\tau}\frac{v_{x,\tau}^2}{h_{x,\tau}}$,

$h_{x,\tau} = \omega_x + \alpha_x v_{x,\tau-1}^2 + \beta_x h_{x,\tau-1} + \delta_{21}\rho_{xy,\tau}\frac{v_{y,\tau}^2}{h_{y,\tau}}$;

$h_{xy,\tau} = \omega_x \omega_y + \alpha_x \alpha_y v_{x,\tau-1} v_{y,\tau-1} + \beta_y \beta_x h_{xy,\tau-1}$. $v_{y,\tau}$ is the economic growth residual from the VECM, and $v_{x,\tau}$ is the financial deepening residual from the VECM. Model 4 is estimated on the entire sample with univariate GARCH models as in Models 1, 2 and 3 but with a conditional correlation following the structure of the dynamic conditional correlation (DCC) of Engle (2002). One asterisk (*) means that the coefficients is significant at 5%.

Table 3 includes Models 1, 2, 3 and 4. Model 4 follows the multivariate GARCH structure of Engle (2002) where univariate GARCH models are partially used to obtain standardized residuals, which are the main ingredients in defining the dynamic correlation process. Unlike Models 1, 2 and 3, which we estimate on residuals from the VECM, Model 4 is estimated using the entire sample including 293 observations. Both Models 1 and 3 show that economic growth is not persistent in variance as opposed to Models 2 and 3 showing that changes in financial deepening are persistent in shocks and variances.

Model 3 shows that shocks of either sign spill over from financial deepening to economic growth, but not the other way around. The unidirectional transmission of shocks is positive and persistent since financial deepening is a persistent volatility process. Without indicating the original source of shock spillovers, Model 4 shows looking at $\alpha_{xy}$ that both processes are linked to same news event. However, while $\alpha_{xy}$ at 0.1901 gives the intensity of the relationship, $\delta_{12}$ at 0.0359 gives the impact of the transmission from an identifiable source. However, both Models

3 and 4 give estimates that do not show how the two processes are linked to the same news over time. Figure 2 shows the conditional correlation patterns between financial deepening and economic growth.
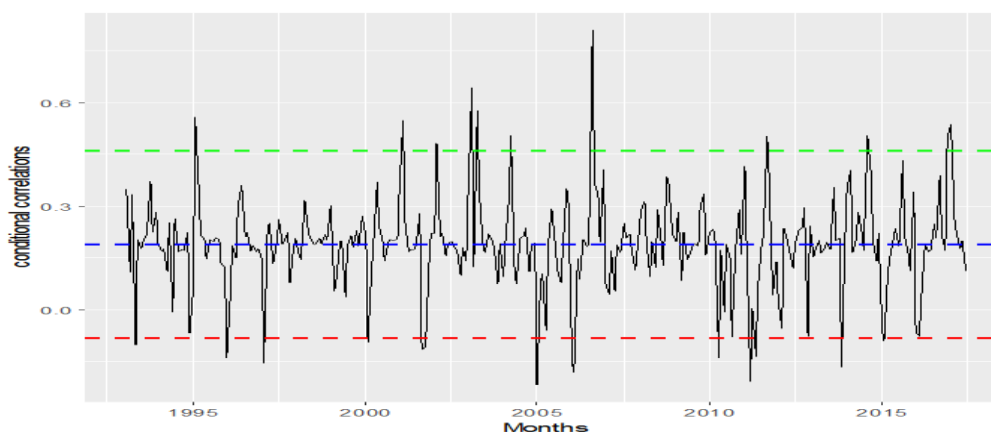


**Figure-2.** Change in log (CI) and change in log (FD2)

Figure 2 shows that the correlation between financial deepening and economic growth is time-varying and mean-reverting. The correlation was highest in 2006 that coincides with the war with Israel. The jump in correlation that results from such a dramatic event confirms the strong linkages between financial deepening and economic growth. Figure 2 also shows that the correlation between the two process is on average positive. This can be seen by looking at the dashed line in blue. Considering two standard deviations away from the mean average, the dashed line in green gives the upper bound, whereas the dashed line in red gives the lower bound. We can count 10 months with excessive positive correlation coefficients, and 10 months with excessive negative correlation. However, excessive positive correlations are followed by negative excessive correlations, which result into a mean-reverting conditional correlation process.

## 4. CONCLUSION

The relationship between financial development and economic growth and its volatility is one of the well-known and confrontational topic in the economic literature. This paper contributes to the literature by examining this subject for Lebanon where empirical assessment of this issue seems absent. Therefore, this paper explores empirically whether such relationship exist in Lebanon and whether there is a significant spillover of shocks between the financial deepening and growth volatility in Lebanon. The goal is to check the validity of the hypothesis that the degree of financial deepening may have an impact on the severity of growth volatility in Lebanon. The empirical results showed that there is a bidirectional Granger causality between financial deepening and growth but at later lags. Economic growth Granger-causes financial deepening after 7 months while financial deepening Granger-causes economic growth after one month. Furthermore, and in relation to volatility, shocks from financial deepening are transmitted to growth, but not the other way, and it exhibits stronger feedbacks in both shocks and conditional variance. We argue that continuously enhancing financial deepening in Lebanon might constitute a venue to evade the vulnerability of the Lebanese economy to sever downturn of the business cycle, and as mean to enhance output smoothing opportunities, as well as achieving further integration of the real and the financial sectors in Lebanon. The inherently unstable political environment in Lebanon with its implications on the reliability of monetary and fiscal policies in Lebanon will add more complications to the policy makers' desired action as they try to enhance the financial deepening process in the country. However, given that financial deepening causes economic growth after one month and shows stronger reactions in both shocks and conditional variance, it is essential that the policy makers rank the continuous development of the country's financial sector as

critical given the high degree of association between the financial sector development and lesser macroeconomic volatility. However, in long run, the Lebanese government should pay more attention towards achieving higher economic growth, as doing so will further enhance its financial development and generate a steady flow of needed funding for future growth. In this regard, policymaker's efforts in developing and implementing structural reforms for the development of the economy are surely needed. Steps and policies to lessen the domination of unproductive public sector on economic activity of the country would help in getting rid of economic inefficiencies. For example, the government by continuously covering the losses of the public-sector enterprises, Electricité du Liban (EdL) is an example, and by hiring of public sector employees because of political affiliation, plus the spillovers from the war in Syria and its economic costs and challenges have led to fiscally-unjustified and unsustainable situation. All of this reported here simply means some difficulty for policy-makers in Lebanon in their pursuit for economic growth and stability in Lebanon. Policies to lessen the negative impacts of the subsidizing public sector enterprises, and of public sector employees are needed to get the country's economy back on track.

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