Research Article

The Links between Energy Consumption, Financial Development, and Economic Growth in Lebanon: Evidence from Cointegration with Unknown Structural Breaks

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We investigate the relation between financial development, energy consumption, and economic growth in the economy of Lebanon over the period 2000M2–2010M12. Our findings confirm the existence of cointegration among the variables. The results indicate that financial development and energy consumption contribute to economic growth in Lebanon. The impact of energy consumption on economic growth is positive showing the significance of energy as a main stimulant of economic growth. Financial development is also found to play a vital role in enhancing economic growth. Financial development and economic growth also result in further increase in energy consumption. We offer some policy implications specific to Lebanon considering the recent discovery of large oil and gas reserves in the country and the historical importance of its banking sector which remains a center of Lebanon’s service-oriented economy.

1. Introduction

Energy economics has drawn substantial attention from academicians in recent times. A number of studies have investigated the causal relationship between energy consumption and economic growth. This issue is important because energy drives the wheels of economic growth since it is a key factor of production, along with capital, and labor. In addition, the higher the GDP per capita, the more the energy demand, which is a relation that is intuitively appealing. The pioneering study by J. Kraft and A. Kraft [1] confirms this by providing evidence of unidirectional causality from GNP to energy use for the US over the period 1947–1974.

Much of the research aimed at exploring the long run relationship and the direction of causality between economic growth and energy use has included several other variables, for example, population, urbanization, financial development, and so forth, to better understand the underlying dynamics of the relation. Lee et al. [2] included capital stock and labor to explain energy use for some Asian nations. They found that the positive link between economic growth and energy demand gets stronger as relevant variables are included. Ang [3] explored the dynamic causal relationships between GDP and energy consumption in France. He found that economic growth influences energy consumption (and pollution) in the long run, but the relation reverses in the short run in case of France. Apergis and Payne [4–6] and Wolde-Rufael [7] argued that rise in energy demand in African countries is closely linked to income. Population growth creates pressure on rural resources, forces people to move to urban areas, and thus increases energy demand. For sustained economic growth, the increased energy demand over a long period must be met from new sources, or by developing cost-effective alternative energy. Using both bi- and multivariate models for New Zealand, Bartleet and Gounder [8] found causality running from real GDP to energy use. They also found that
real GDP and employment exert significant impact on capital formation, where capital stock plays an important role in determining the direction of causality. The objective of this paper is to examine the existence of long run relationship among energy consumption (\(ln E_t\)), financial development (\(ln F_t\)), and economic growth (\(ln Y_t\)) for Lebanon using monthly data over the period of 2000\(M_1\)–2010\(M_{12}\). The ARDL bounds testing approach to cointegration is used to examine a long run relation among the series. The innovative accounting technique (variance decomposition approach and impulse response function) (the methodological framework is based on the studies by Shan [9] and Shahbaz et al. [10]) shows the response of dependent variable to shocks arising in independent variables. We use this method to examine the short run dynamics and the direction of causality. This method is helpful in determining the relative strength of causal relation beyond the chosen time frame [9, 11] and the magnitude of the feedback among the series.

The rest of the paper is organized as follows. Section 2 reviews the relevant literature with focus on the link between economic growth and energy consumption, economic growth and financial development, and financial development and energy consumption. Section 3 discusses the motivation of this study. Section 4 describes the data and estimation strategy. Results of the study are reported in Section 5. Conclusion and policy implications are reported in Section 6.

2. Literature Review

The question of whether energy consumption and/or financial development sway the rate of economic growth of a country or a region has shaped an important query among economists in the literature for some time. This interest is driven primarily from the important policy implications that can be obtained from such studies in relation to the desired action(s) that can accelerate the rate of economic growth and prosperity of a country. Empirical studies in this regard, however, provided conflicting results so economists’ views on this issue have not been unanimous. Below, we will provide a brief review of the studies that addressed the impacts of these variables on economic growth.

2.1. Economic Growth and Energy Consumption. Energy forms the lifeblood of the world economy as it is an essential input to producing almost all of the goods and services of the modern global economy. It contributes to economic growth directly as it creates jobs and value associated with extracting, transforming, and distributing of energy. Furthermore and more importantly, this sector’s activities relate to and strengthen the rest of the economy as energy forms an input for almost all production processes of goods and services. Supply interruptions of many sources of energy are known to have a great impact as they can harshly impact the economies of almost all countries. In addition, stable and lower energy prices are known to help stimulate the growth rate of any economy. This is because lower energy prices result in increasing disposable income for consumers and lowering costs for firms. The resulting improved profit margins for firms and higher disposable income for consumers provide incentives for accelerated rates of growth.

One can distinguish between four different hypotheses explaining relationship between the energy consumption and economic growth based on the type of the relationship between both variables [12].

(i) Neutrality hypothesis implies no causality between energy consumption and economic growth. This means that energy conservation may not adversely affect economic growth.

(ii) Conservation hypothesis advocates for an implementation of conservative energy policy, as economic growth would not be slowed down by conservation. Economically, this means that causality is unidirectional running from economic growth to energy consumption.

(iii) Growth hypothesis is supported when unidirectional causality is running from energy consumption to economic growth. The latter indicates that energy conservation may reduce investment and negatively influence economic growth.

(iv) Feedback hypothesis confirms the interdependence between energy consumption and economic growth since both variables affect each other. This encourages the implementation of energy expansionary policies for long run sustainable economic growth.

The energy growth nexus has been extensively investigated since the pioneer work of J. Kraft and A. Kraft [1]. The authors examined the relationship between energy consumption and economic growth in case of the United States. The empirical results revealed that economic growth Granger causes energy consumption. Later on, a large number of empirical studies using different approaches, time periods, and proxy variables have tested this causal relationship in a number of countries. Abosedra and Baghestani [13], Cheng and Lai [14], Soytas and Sari [15], Oh and Lee [16], Jimbe, [12], Fatai et al. [17], Lee et al. [2, 18–20], Chontanawat et al. [21], Narayan and Smyth [22], Apergis and Payne [4], and Bowden and Payne [23] among others have examined this issue for different countries and over various sample periods. Lines of evidence from these empirical studies are still mixed at best and controversial results in terms of the direction of causality and the strength of impact of energy use on economic growth are reported. Some papers documented unidirectional causality from economic growth to energy consumption (growth hypothesis). Narayan and Smyth [22], Apergis and Payne [4], Odhiambo [24], Bowden and Payne [23], Tsani [25], Wang et al. [26], and Yazdan and Hossein [27] found evidence supporting this view.

Other researchers have documented unidirectional causality running from economic growth to energy consumption (conservation hypothesis). This hypothesis is supported by Lise and van Montfort [28], Erdal et al. [29], Huang et al. [30], Mallick [31], Saad [32], Binh [33], Qazi et al. [34], and Soile [35]. Next, the feedback hypothesis is supported if bidirectional causality between energy consumption and
growth is found. This is supported by Glasure [36], Lee and Chang [20], Belke et al. [37], Eggoh et al. [38], Marques et al. [39], Kaplan et al. [40], Shahbaz et al. [41], Fuihhas and Marques [42], Zeshan [43], and Shahbaz et al. [10].

The final hypothesis is that of neutrality, where no causality between energy consumption and growth is found, and it is supported by Sotoys et al. [44] and Gross [45]. In the case of Lebanon, Dagher and Yacoubian [46] applied the cointegration developed by Johansen [47] and Granger causality by Toda and Yamamoto [48] as well as the VECM Granger causality to examine cointegration and causality relationship between energy consumption and economic growth. Their results indicated that long run relationship exists between the variables and energy consumption and economic growth are bidirectional Granger cause.

2.2. Financial Development and Economic Growth. Since pioneering works of Schumpeter [49], of Goldsmith [50], and recently of McKinnon [51] and Shaw [52], the relation between financial development and economic growth has attracted interest of both theorists and practitioners. Demirguc-Kunt and Levine [53] and Levine [54] provided an extensive literature survey on this topic. Gürşay et al. [55], Wolde-Rufael [7, 56], and Shahbaz [57], among others, have used both cross-country and time series data to investigate the relationship between financial development and economic growth.

Financial development has a positive effect on economic growth as it may increase the efficiency of capital accumulation [50] and/or augment the level of saving and consequently investment [51, 52]. By increasing the size of savings and improving the efficiency of investment, financial development leads to higher economic growth [54, 58, 59]. Furthermore, financial development would support financial innovation and promote the adoption of advanced technology [37, 60]. In the related literature, this is known as "supply-leading." In other words, financial development causes economic growth in the sense of Granger. Ibrahim [61] observed that financial development stimulates economic growth in Malaysia. Jalil and Ma [62] found that financial development contributes to economic growth by increasing capital formation in Pakistan and China. Shahbaz [57] showed the same results in case of Pakistan. Coccorese [63] reported that economic growth is Granger cause of financial development. Masih et al. [64] applied long run structural modeling (LRSM) to examine the causality between financial development and economic growth in Saudi Arabia. They validated the existence of supply-side hypothesis. Kar and Mandal [65] also noted that financial development promotes economic growth by enhancing capitalization in India.

"Demand-following" hypothesis suggests that financial development follows economic growth. Patrick [66] pointed out that "demand-following" relationship indicates that real economic activity Granger causes financial development by generating demand for financial services as an economy develops. Liang and Teng [67] investigated the relationship between financial development and economic growth in China using VAR approach. They noted cointegration between the variables and economic growth Granger causes financial development. Fung [68] finds that positive impact of economic growth on financial development is due to productivity boost. Chukwu and Agu [69] also supported demand-side hypothesis in case of Nigeria. Amarathunga [70] also confirmed the presence of demand-side hypothesis in case of Sri Lanka. In case of South Africa, Odhiambo [71] investigated the relationship between financial development and economic growth by applying the ARDL bounds testing and the VECM Granger causality approaches. The results indicated that the variables are cointegration and financial development is Granger cause of economic growth. Odhiambo [72, 73] investigated the causality between financial development, foreign capital inflows, and economic growth for Tunisia. The empirical results revealed that financial development follows economic growth and that financial development and foreign capital inflows are interdependent. Hassan et al. [74] also reported unidirectional causality running from economic growth to financial development in developing economies. Odhiambo [72, 73] used trivariate model to examine causality between financial development and economic growth by incorporating foreign capital inflows. The empirical evidence validated the existence of demand-side hypothesis in Tanzania.

The feedback effect between financial development and economic growth is also found in the existing literature. For example, Ilhan [75] applied cointegration and error correction method for the relationship between financial development and economic growth. He noted that cointegration exists and that the feedback effect is validated in case of South Africa. Zheng et al. [76] used bivariate framework model and reported that financial development and economic growth are complementary in case of China. The same exercise was conducted by Al-Malkawi et al. [77] in case of UAE and results found a feedback effect between financial development and economic growth. Eslamloueyan and Sakhaei [78] applied generalized least square (GLS) method with cross-section seemingly unrelated regression (SUR) to probe the relationship between financial development and economic growth and confirmed the findings of Husam-Aldin et al. [79]. On the contrary, Bakhouch [80] reported that financial development does not promote economic growth and that economic growth does not contribute to financial development, that is, neutral hypothesis. Gantman and Dabós [81] also supported the view by Bakhouch [80] that financial development and economic growth are independent.

2.3. Financial Development and Energy Consumption. Love and Zicchino [82] reported that financial development impacts on real interest can possibly result in an increase in investment. This in turn can promote economic growth and generate employment opportunities which further increase income. Such impact will increase purchases by consumers especially of durable items [83, 84] which add further to energy use. This shows that the linkages between energy use and economic growth are better understood when we go beyond a simple bivariate framework. Karanfil [85] suggested using stock market capitalization, liquid liabilities, and domestic credit to the private sector, each as share of GDP among the financial variables. Yandan and Lijun [86]
examined the impact of financial development on primary energy consumption in Guangdong (China). Their study finds Granger causality running from energy consumption to financial development, while the reverse is insignificant. Sadorsky [83] examined 22 emerging economies (1990–2006) using different indicators of financial development. This included FDI, bank deposits as share of GDP, stock market capitalization as share of GDP, stock market turnover ratio, and total stock market value traded as a share of GDP. His results confirmed that energy consumption is positively linked to economic growth but the impact is small.

Sadorsky [87] investigated the impact of financial development on energy consumption using data of 9 Central and Eastern European frontier economies. He reported that financial development increases energy demand once deposit money and bank assets to GDP, financial system deposits to GDP, liquid liabilities to GDP, and stock market capitalization are used as measures of financial development. Similarly, Shahbaz and Lean [88] examined energy demand for Tunisia and reported results showing that financial development increases energy demand resulting from economic growth. In the case of Malaysia, Tang and Tan [89] examined the relationship between financial development and energy consumption by incorporating relative prices and foreign direct investment (FDI) in energy demand function. They report bidirectional causality between financial development and energy consumption both in the short and the long runs. Islam et al. [90] reported that financial development, economic growth, and population are driving forces to increase energy demand in Malaysia. The feedback effect is also reported between financial development and energy consumption in the long run but financial development Granger causes energy demand in short run.

3. Motivation of the Study

This paper provides an investigation of the relationship between economic growth, financial development, and energy consumption using monthly data over the period of 1993–2010 in case of Lebanon. This is a country with a sectarian-based parliamentary republic located in the Middle East, with a population of approximately 4.2 million. The Lebanese economy is service oriented, with tourism and banking sectors being the main driving force, contributing over 70% of GDP and therefore considered the primary sectors for growth. The banking sector is one of the main pillars of Lebanese economy with a size equivalent to 350% of GDP as of 2009. Lebanese banks benefit from a strong net inflow from both expats and the Gulf States; domestic private sector credit growth has been 19% until October 2011 and the banking system’s foreign assets have also grown rapidly, supporting the fact that the banking industry is not affected by the political unrest. About 18% of GDP is contributed by the industrial sector and about 5% by the agriculture. Net remittances from the Lebanese Diaspora living abroad, mainly in the Gulf region, also contribute 5% to the GDP. Tourism industry development in Lebanon dates back to the 1960s when Lebanon’s capital, Beirut, was known as “the Paris of the Middle East.” This sector contributes notably to the employment in the economy. Employment in that sector as a share of total employment stood at 31.2% in 2005 and is estimated at 38% in 2010. This is not surprising given that the percentage of tourism and travel in GDP stood at 31.2% in 2005 and is estimated at 37.6% in 2010 [91]. This is not unexpected in a country that is known for its diverse atmosphere, earliest history, ancient Roman ruins, preserved castles, and notable mosques and churches, as well as its stunning beaches in the Mediterranean Sea and rugged ski resorts.

The country’s economy has faced much challenge owing to its continuous political unrest. The civil war (1975–1990) had a heavy unconstructive impact on the nation, causing the country to have a high budget deficit. Even more recent, the assassination of ex-Prime Minister Rafik Hariri in February 2005, the July 2006 war between Lebanon and Israel, the sit-ins, protests and clashes between the opposing government alliances in 2006 till 2008, and the constant instability and corruption within Lebanon contributed to the huge deficit and the increase in sectarianism. In 2010, growth in Lebanon was stimulated by rising nonresident deposits, an elevated number of tourist arrivals, and a vigorous real estate market. However, due to the regional political chaos, both tourist arrivals and expat’s housing demand in the real estate sector have slowed down in 2011. Furthermore, the continued unrest in Syria seems to challenge Lebanon’s economic prospects in 2012, especially when 25% of Lebanon’s exports are to Syria and 11% of its imports are from Syria.

We think that examining the possible linkages between economic growth, financial development, and energy consumption in Lebanon is justified and needed for three reasons. First, the above features of Lebanese economy justify the need for this study as it will assist the policy makers in the country in assessing their priorities for resource allocations for the country’s development. Second, the clear interface of tourism and energy use, in Lebanon, is another important factor for policy makers to consider given the outages of electricity and shortages of some fuels in the country. Third, the authors are not aware of any study of this issue for Lebanon with the exception of that of Dagher and Yacoubian [46]. Our study improves upon theirs, however, since we do not employ a bivariate framework as they did and since our sample is larger than theirs (1980–2009) and excludes the years of the civil war in Lebanon (1975–1990).

The findings should help better understand this relationship that underlies energy use, financial development, and economic growth nexus for Lebanon which will help identify an appropriate policy mix for these sectors in future economic planning for economic growth of that country.

4. The Data and Estimation Strategy

In this study our primary interest lies in the energy consumption-economic growth nexus, financial development-economic growth nexus, and energy consumption-financial development nexus.

The prime hypothesis of energy consumption-economic growth causality postulates that economic growth is impeded by energy conservation policies if causality runs from energy
consumption to economic growth. Energy conservation policies do not have adverse impact on economic growth if causality is running from economic growth to energy consumption or no causality is found between both of the variables.

The second hypothesis deals with financial development and economic growth. Financial development boosts investment activities by directing financial resources to new and existing potential ventures which not only enhances domestic production but also raises the rate of economic growth. This implies that financial development drives economic growth. This unidirectional causality running from financial development to economic growth is called supply-side hypothesis. The rise in per capita income or economic growth will increase the demand of financial services for both customers (consumption purpose) and producers (investment purpose) which as a result raises financial development. This shows that economic growth leading to financial development is called demand-side hypothesis.

The third hypothesis deals with energy consumption and financial development nexus. Financial development results in an increase in funds availability to investors for new and existing investment and to consumers to purchase ticket items which directly can increase energy demand. In turn, a rise in demand for financial services associated with financial development can lead to increased demand for energy. On the other hand, an increase in energy consumption as a result of an increase in the level of income may also lead to further financial development as a larger percentage of the population is exposed to the need to use financial services. Finally financial development and energy use may be complementary in nature as a feedback effect may exist.

4.1. The Data. We have monthly frequency data over the period of 2000M2–2010M12. We use $M_2$ as a measure of financial development (see Adu et al. [92] for more details). Economic growth is measured by the index of coincident indicator as a measure for real economic activity in Lebanon. The coincident indicator is a broad measure for real economic activity in Lebanon. It is based upon a linear combination of a set of indirect indicators. These consist of imports of petroleum products (18.2 per cent), electricity production (18.6 per cent), cement deliveries (16.5 per cent), number of foreign passengers (11 per cent), total international trade (11.8 per cent), value of checks clearance (12 per cent), and $M_3$ money supply (12 per cent). Finally, we use energy use in millions of KWH as proxy energy consumption. We convert all series into natural logarithm to avoid sharpness and variations in the data. The log-linear specification provides efficient results as compared to simple linear specification. $E_t$ denotes financial development, energy consumption is indicated by $E_{t-1}$, and $Y_t$ is for economic growth in time period $t$. The data of $M_2$ and index of coincident indicator are obtained from The Central Bank of Lebanon while energy consumption data is obtained from the Central Administration of Statistics-Lebanon.

4.2. The ARDL Bounds Testing Approach. We employ the autoregressive distributed lag (ARDL) bounds testing approach to cointegration developed by Pesaran et al. [93] to explore the existence of long run relationship between economic growth, financial development, and energy consumption in the presence of structural break. This approach has multiple econometric advantages. The bounds testing approach is applicable irrespective of whether the variables are $I(0)$ or $I(1)$. The results of the ARDL approach are insensitive small sample data test. Moreover, a dynamic unrestricted error correction model (UECM) can be derived from the ARDL bounds testing through a simple linear transformation. The UECM integrates the short run dynamics with the long run equilibrium without losing any long run information. The UECM is expressed as follows:

\[
\Delta \ln E_t = \alpha_1 + \alpha_T T + \alpha_E \ln E_{t-1} + \alpha_Y \ln Y_{t-1} + \alpha_F \ln F_{t-1} + \sum_{i=1}^p \alpha_i \Delta \ln E_{t-i} + \sum_{j=0}^q \alpha_j \Delta \ln Y_{t-j} + \sum_{k=0}^r \alpha_k \Delta \ln F_{t-k} + \mu_t,
\]

\[
\Delta \ln F_t = \alpha_1 + \alpha_T T + \alpha_E \ln E_{t-1} + \alpha_Y \ln Y_{t-1} + \alpha_F \ln F_{t-1} + \sum_{i=1}^p \gamma_i \Delta \ln F_{t-i} + \sum_{j=0}^q \gamma_j \Delta \ln E_{t-j} + \sum_{k=0}^r \gamma_k \Delta \ln Y_{t-k} + \sum_{k=0}^r \gamma_k \Delta \ln F_{t-k} + \mu_t,
\]

\[
\Delta \ln Y_t = \alpha_1 + \alpha_T T + \alpha_E \ln E_{t-1} + \alpha_Y \ln Y_{t-1} + \alpha_F \ln F_{t-1} + \sum_{i=1}^p \beta_i \Delta \ln E_{t-i} + \sum_{j=0}^q \beta_j \Delta \ln Y_{t-j} + \sum_{k=0}^r \beta_k \Delta \ln F_{t-k} + \beta_F \Delta F_{t-k} \mu_t,
\]

where $\Delta$ is the first difference operator, $\ln Y_t$ is natural log of index of coincident indicator (economic growth), $\ln F_t$ is natural log of $M_2$ (financial development), and $\ln E_t$ is natural log of energy consumption. $D$ is a dummy for structural break point and $\mu_t$ is error term assumed to be independently and identically distributed. The optimal lag structure of the first differenced regression is selected by the Akaike information criteria (AIC). Pesaran et al. [93] suggest $F$-test for joint significance of the coefficients of the lagged level of variables. For example, the null hypothesis of no long run relationship between the variables is $H_0: \alpha_E = \alpha_Y = 0$ against the alternative hypothesis of cointegration $H_1: \alpha_E \neq \alpha_F \neq 0$. Accordingly, Pesaran et al. [93] compute two sets of critical values (lower and upper critical bounds) for a given significance level. Lower critical bound is applied if the regressors are $I(0)$ and the upper critical bound is used for $I(1)$. If the $F$-statistic exceeds the upper critical value, we conclude in favor of a long run relationship. If the $F$-statistic
falls below the lower critical bound, we cannot reject the null hypothesis of no cointegration. However, if the $F$-statistic lies between the lower and upper critical bounds, inference would be inconclusive. When the order of integration of all the series is known to be $I(1)$, then decision is made based on the upper critical bound. Similarly, if all the series are $I(0)$, then the decision is made based on the lower critical bound. To check the robustness of the ARDL model, we apply diagnostic tests. These tests are used to check for normality of error term, serial correlation, autoregressive conditional heteroskedasticity, white heteroskedasticity, and the functional form of the empirical model.

4.3. The VECM Granger Causality Test. After examining the long run relationship between the variables, we use the Granger causality test to determine the causality between the variables. If there is cointegration between the series, then the vector error correction method (VECM) can be developed as follows:

$$\begin{align*}
\Delta \ln E_t & = b_1 + b_{21,1} \Delta \ln F_t + b_{22,1} \Delta \ln F_{t-1} + \ldots + b_{23,1} \Delta \ln F_{t-2} + \varepsilon_t \\
\Delta \ln F_t & = b_3 + b_{31,1} \Delta \ln E_t + b_{32,1} \Delta \ln E_{t-1} + \ldots + b_{33,1} \Delta \ln E_{t-2} + \xi_t
\end{align*}$$

where difference operator is $\Delta$ and ECM$_{t-1}$ is the lagged error correction term, generated from the long run association. The long run causality is found by examining the significance of coefficient of lagged error correction term using $t$-test statistic. The existence of a significant relationship in first differences of the variables provides evidence on the direction of short run causality. The joint $\chi^2$ statistic for the first differenced lagged independent variables is used to test the direction of short run causality between the variables. For example, $\alpha_{12,j} \neq 0 \forall j$ shows that economic growth Granger causes energy consumption and economic growth is Granger of cause of energy consumption if $\alpha_{11,j} \neq 0 \forall j$.

5. Results of the Study

The results of descriptive statistics and correlation matrix are reported in Table 1. The Jarque-Bera test statistics reveal that the series of economic growth, energy consumption, and financial development have normal distributions. Our empirical evidence finds that correlations between the variables are positive and strong. For instance, a positive correlation is found between energy consumption and economic growth. Financial development and economic growth are positively correlated and financial development and energy consumption also have positive correlation. The normal distribution of the series leads us to proceed for further analysis.

The next step is to test the unit root properties of the variables. The stationarity level of the variables is very important for policy implications. For example, if energy consumption series is stationary at level, it shows that innovations in energy use have transitory effects and series returns to its trend path; otherwise, innovations show permanent effect on energy consumption if energy consumption series is nonstationary. Similarly, the impact of financial policies adopted to improve financial sector efficiency has temporary effect on financial development if financial development series is stationary at level. Financial policies will have permanent impact on financial development if series is found to be integrated at $I(1)$. The shocks to economy by economic policies have permanent effects if economic growth series is nonstationary which implies that fiscal and/or monetary or any other stabilization policies would only have permanent effects on the real output levels. If economic growth series is stationary, then shocks to economy have transitory effect. Therefore, it is necessary to check the order of integration of the variables before applying the ARDL bounds testing to investigate the long run relationship among the series of interest. ADF and Ng-Perron unit root tests were therefore applied and results are disclosed in Table 2. The results reveal that energy consumption, economic growth, and financial development are nonstationary at level. All the variables are stationary at 1st difference with intercept and trend. This indicates that the series have unique order of integration, that is, $I(1)$.

However, the results of these traditional tests may be biased. These unit root tests do not have information about unknown structural break occurring in the series. The appropriate information about unknown structural breaks would help policy makers in designing a comprehensive energy, financial, and economic policy to enhance economic growth for the long run by considering these structural breaks. This issue is resolved by applying Clemente-Montanes-Reyes unit root test with single and two unknown structural breaks arising in the variables. Our empirical exercise indicated that all the series are nonstationary at level with single structural break in energy consumption, financial development, and economic growth in 2008M1, 2009M1, and 2006M6, respectively. (In this regard, we note that the 2006 Lebanon War started on July 12, 2006, and continued until a United Nations-brokered cease fire on August 14, 2006. Furthermore, Lebanon witnessed a series of protests and sit-ins that began on December 1, 2006. This was led by groups in Lebanon that opposed the US and Saudi-backed government of Prime Minister Fouad Siniora. This ended on May 21, 2008, following the Doha Agreement. On January 25, 2008, a bombing in the Lebanese capital, Beirut, killed a senior intelligence officer, who was involved in the investigation of assassination of former Prime Minister Rafiq Hariri who was killed in 2005. This was followed by a series of bombings and assassinations which have struck Lebanon, most of them occurring in and around the capital, Beirut, during the last few years. Finally, we note that 27 January 2009 marked a historical event in which Syria accepted Lebanon's first ambassador ever to Damascus.) We conclude that all the variables are stationary at first difference accommodating
Table 1: Descriptive statistic and correlation matrix.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Median</th>
<th>Maxi.</th>
<th>Mini.</th>
<th>Skewness</th>
<th>Kurtosis</th>
<th>Jarq.Bera</th>
<th>ln $E_t$</th>
<th>ln $Y_t$</th>
<th>ln $M_t$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$ln E_t$</td>
<td>6.7773</td>
<td>6.7719</td>
<td>7.0707</td>
<td>6.5132</td>
<td>0.2122</td>
<td>2.7366</td>
<td>1.3722</td>
<td>1.0000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$ln Y_t$</td>
<td>5.1574</td>
<td>5.1439</td>
<td>5.5861</td>
<td>4.7858</td>
<td>0.4778</td>
<td>2.3847</td>
<td>0.7105</td>
<td>0.7197</td>
<td>1.0000</td>
<td></td>
</tr>
<tr>
<td>$ln M_t$</td>
<td>10.1706</td>
<td>10.1084</td>
<td>10.9920</td>
<td>9.6700</td>
<td>0.9432</td>
<td>3.0181</td>
<td>1.9575</td>
<td>0.7017</td>
<td>0.9118</td>
<td>1.0000</td>
</tr>
</tbody>
</table>

Table 2: Unit root analysis.

<table>
<thead>
<tr>
<th>Variable</th>
<th>ADF unit root at level T-statistic</th>
<th>Prob. value</th>
<th>ADF unit root at 1st difference T-statistic</th>
<th>Prob. value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$ln E_t$</td>
<td>-2.9832 (3)</td>
<td>0.1394</td>
<td>-11.3974 (2)*</td>
<td>0.0000</td>
</tr>
<tr>
<td>$ln F_t$</td>
<td>-2.2992 (4)</td>
<td>0.4321</td>
<td>8.8743 (4)*</td>
<td>0.0000</td>
</tr>
<tr>
<td>$ln Y_t$</td>
<td>-1.9300 (4)</td>
<td>0.2547</td>
<td>-17.4153 (3)*</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

Note: * represents significance at 1% levels. Lag order is shown in parentheses.

The next step is to examine the long run relationship between the variables of which results are shown in Table 6. In energy consumption demand function, we find that financial development adds in energy consumption. A 1 per cent increase in financial development is linked with 0.1272 per cent increase in energy demand. The impact of economic growth on energy consumption is positive as expected and statistically significant at 5 per cent level of significance. We find that 0.2003 per cent energy consumption is increased due to 1 per cent increase in economic growth. Energy consumption has positive effect on financial development and it is statistically significant at 10 per cent level. A 1 per cent increase in energy demand raises financial development by 0.30 per cent. Economic growth has positive and statistically significant impact on financial development. A 1 per cent increase in economic growth is positively linked with financial development by 1.6 per cent. In economic growth empirical model, we find that energy consumption stimulates economic growth and it is statistically significant at 1 per cent level of significance. We note that a 1 per cent increase in energy consumption boosts economic growth by 0.2620 per cent. The positive relationship exists from financial development to economic growth at 1 per cent significance level. A 0.4239 increase in financial development leads to economic growth by 1 per cent. We find that energy consumption and financial development are complementary but energy consumption has stronger impact on financial development and the same inference is for economic growth to financial development. Energy consumption and economic growth are interdependent but economic growth depends on energy consumption. The assumptions of classical linear regression model (CLRM) are fulfilled by energy consumption, financial development, and economic growth models successfully. There is no evidence of nonnormality of error terms or serial correlation and no evidence of ARCH or white heteroskedasticity. The functional form of all the models is well specified.

In the short run (Table 7), we find that financial development and economic growth have positive impact on energy consumption at 5 per cent significance level. The impact of energy consumption and economic growth is also positive and it is statistically significant at 5 per cent level of significance. Finally, energy consumption stimulates economic growth at 1 per cent level of significance. Financial development also adds in economic growth at 5 per cent level. The negative and statistically significant estimates for each of the $ECM_{t-1}$, 0.6450, 0.0419, and -0.2693 (energy consumption, financial development, and economic growth), lend support to a long run relationship among the series. The short run deviations from the long run equilibrium are corrected by 66.50%, 4.19%, and 26.93% towards long run equilibrium path each month. The diagnostic tests show that error terms...
Table 3: Clemente-Montanes-Reyes structural break unit root analysis.

<table>
<thead>
<tr>
<th>Variable</th>
<th>( T_{B1} )</th>
<th>( T_{B2} )</th>
<th>Test statistics</th>
<th>( K )</th>
<th>( T_{B1} )</th>
<th>( T_{B2} )</th>
<th>Test statistics</th>
<th>( K )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \ln E_t )</td>
<td>2008M₄</td>
<td>—</td>
<td>−2.053</td>
<td>3</td>
<td>2006M₆</td>
<td>—</td>
<td>−8.346*</td>
<td>2</td>
</tr>
<tr>
<td>2004M₄</td>
<td>2008M₄</td>
<td>−2.909</td>
<td>1</td>
<td>2006M₆</td>
<td>2009M₆</td>
<td>−7.510*</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>( \ln F_t )</td>
<td>2009M₁</td>
<td>—</td>
<td>−2.372</td>
<td>3</td>
<td>2005M₁</td>
<td>—</td>
<td>−4.224**</td>
<td>5</td>
</tr>
<tr>
<td>( \ln Y_t )</td>
<td>2006M₆</td>
<td>—</td>
<td>−2.450</td>
<td>3</td>
<td>2006M₆</td>
<td>—</td>
<td>−6.465*</td>
<td>5</td>
</tr>
<tr>
<td>2003M₉</td>
<td>2008M₁</td>
<td>−5.270</td>
<td>4</td>
<td>2006M₉</td>
<td>2006M₉</td>
<td>−5.711**</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

Note: \( T_{B1} \) and \( T_{B2} \) are the dates of the structural breaks; \( K \) is the lag length; * and ** show significance at 1% and 5% levels, respectively.

Table 4: VAR lag order selection criteria.

<table>
<thead>
<tr>
<th>Lag</th>
<th>( \log L )</th>
<th>LR</th>
<th>FPE</th>
<th>AIC</th>
<th>SC</th>
<th>HQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>245.5326</td>
<td>NA</td>
<td>4.02e−06</td>
<td>−3.91816</td>
<td>−3.843584</td>
<td>−3.884099</td>
</tr>
<tr>
<td>1</td>
<td>585.0314</td>
<td>657.0944</td>
<td>1.94e−08</td>
<td>−9.242442</td>
<td>−8.969512</td>
<td>−9.131571</td>
</tr>
<tr>
<td>2</td>
<td>600.3055</td>
<td>28.82361</td>
<td>1.76e−08</td>
<td>−9.343637</td>
<td>−8.866008</td>
<td>−9.149613</td>
</tr>
<tr>
<td>3</td>
<td>615.0278</td>
<td>27.07002*</td>
<td>1.60e−08</td>
<td>−9.435932</td>
<td>−8.753605</td>
<td>−9.158755*</td>
</tr>
<tr>
<td>4</td>
<td>624.1486</td>
<td>16.32916</td>
<td>1.60e−08</td>
<td>−9.437880*</td>
<td>−8.550856</td>
<td>−9.077550</td>
</tr>
<tr>
<td>5</td>
<td>627.3032</td>
<td>5.495216</td>
<td>1.76e−08</td>
<td>−9.343600</td>
<td>−8.251878</td>
<td>−8.900117</td>
</tr>
<tr>
<td>6</td>
<td>633.6844</td>
<td>10.80681</td>
<td>1.85e−08</td>
<td>−9.301361</td>
<td>−8.004941</td>
<td>−8.774725</td>
</tr>
<tr>
<td>7</td>
<td>635.0608</td>
<td>2.264400</td>
<td>2.10e−08</td>
<td>−9.178400</td>
<td>−7.677282</td>
<td>−8.568610</td>
</tr>
<tr>
<td>8</td>
<td>642.5061</td>
<td>11.88850</td>
<td>2.16e−08</td>
<td>−9.153324</td>
<td>−7.447509</td>
<td>−8.460382</td>
</tr>
</tbody>
</table>

* indicates lag order selected by the criterion; LR: sequential modified LR test statistic (each test at 5% level); FPE: final prediction error; AIC: Akaike information criterion; SC: Schwarz information criterion; HQ: Hannan-Quinn information criterion.

5.1. The VECM Granger Causality. If cointegration is confirmed, there must be uni- or bidirectional causality among the series. We examine this relation within the VECM framework. Knowledge about causality can help craft appropriate energy and financial policies for sustainable economic growth. Table 8 reports results on the direction of long and short run causality. We find feedback relation between energy consumption and economic growth. This implies that economic growth depends upon energy consumption and rise in income per capita further increases energy demand. Therefore, adoption of energy conservation policies will have detrimental impact on economic growth. Our findings suggest the importance of encouraging energy exploring policies. In this regard, we praise the government of Lebanon in concluding its first offshore oil and gas rights auction which has drawn interest from about 100 companies. They have bought geophysical data in preparation for an upcoming bid round for Lebanese offshore energy production rights, which should
### Table 5: The results of ARDL cointegration test.

<table>
<thead>
<tr>
<th>Estimated models</th>
<th>Bounds testing to cointegration</th>
<th>Diagnostic tests</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Optimal lag length</td>
<td>$F$-statistics</td>
</tr>
<tr>
<td>$F_E (E/E, Y)$</td>
<td>4, 4, 4</td>
<td>6.577**</td>
</tr>
<tr>
<td>$F_E (F/E, Y)$</td>
<td>4, 4, 4</td>
<td>4.730**</td>
</tr>
<tr>
<td>$F_E (Y/E, F)$</td>
<td>4, 4, 4</td>
<td>8.719*</td>
</tr>
</tbody>
</table>

#### Bound testing to cointegration

- Diagnostictests
  - $F_E (E/E, Y)$
  - $F_E (F/E, Y)$
  - $F_E (Y/E, F)$
  - Structural break
  - $\chi^2_{\text{NORMAL}}$
  - $\chi^2_{\text{ARCH}}$
  - $\chi^2_{\text{RESET}}$

#### Diagnostic tests

- Critical values ($T = 132$)
  - Lower bounds $I(0)$
  - Upper bounds $I(1)$

### Table 6: Long run results.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Dependent variable = ln $E_t$</th>
<th>Dependent variable = ln $M_t$</th>
<th>Dependent variable = ln $Y_t$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>$T$-statistic</td>
<td>Coefficient</td>
</tr>
<tr>
<td>Constant</td>
<td>4.4502**</td>
<td>22.1637</td>
<td>$-0.0714$</td>
</tr>
<tr>
<td>ln $E_t$</td>
<td>...</td>
<td>...</td>
<td>$0.2968^{**}$</td>
</tr>
<tr>
<td>ln $M_t$</td>
<td>0.1272*</td>
<td>2.6974</td>
<td>...</td>
</tr>
<tr>
<td>ln $Y_t$</td>
<td>0.2003**</td>
<td>2.2226</td>
<td>1.5958*</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.5111</td>
<td>0.8358</td>
<td>0.8440</td>
</tr>
<tr>
<td>Adj-$R^2$</td>
<td>0.5035</td>
<td>0.8332</td>
<td>0.8416</td>
</tr>
<tr>
<td>$F$-statistic</td>
<td>67.4413*</td>
<td>32.8348*</td>
<td>34.9205*</td>
</tr>
</tbody>
</table>

#### Diagnostic test

- $\chi^2_{\text{NORMAL}}$
- $\chi^2_{\text{SERIAL}}$
- $\chi^2_{\text{ARCH}}$
- $\chi^2_{\text{WHITE}}$
- $\chi^2_{\text{REMSAY}}$

### Table 7: Short run results.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Dependent variable = $\Delta$ ln $E_t$</th>
<th>Dependent variable = $\Delta$ ln $M_t$</th>
<th>Dependent variable = $\Delta$ ln $Y_t$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>$T$-statistic</td>
<td>Coefficient</td>
</tr>
<tr>
<td>Constant</td>
<td>$-0.0037$</td>
<td>$-0.5813$</td>
<td>0.0073*</td>
</tr>
<tr>
<td>$\Delta$ ln $E_t$</td>
<td>...</td>
<td>...</td>
<td>$0.0639^{**}$</td>
</tr>
<tr>
<td>$\Delta$ ln $M_t$</td>
<td>0.4539**</td>
<td>2.5264</td>
<td>$-0.0419^*$</td>
</tr>
<tr>
<td>$\Delta$ ln $Y_t$</td>
<td>0.2735**</td>
<td>2.3395</td>
<td>$0.1442^{**}$</td>
</tr>
<tr>
<td>ECM $t-1$</td>
<td>$-0.6450^*$</td>
<td>$-0.7953$</td>
<td>$-0.0419^*$</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.3756</td>
<td>0.0904</td>
<td>0.2002</td>
</tr>
<tr>
<td>Adj-$R^2$</td>
<td>0.3608</td>
<td>0.0689</td>
<td>0.1813</td>
</tr>
</tbody>
</table>

#### Diagnostic test

- $\chi^2_{\text{NORMAL}}$
- $\chi^2_{\text{SERIAL}}$
- $\chi^2_{\text{ARCH}}$
- $\chi^2_{\text{WHITE}}$
- $\chi^2_{\text{REMSAY}}$
occur soon (Lebanon Explores Offshore Energy, By April Yee, 2/25/2013, http://www.moneyshow.com/investing/article/1/ TheNational-30654/Lebanon-Explores-Offshore-Energy/). Furthermore, given that Lebanon is very close to some of the major producers of LNG in the world (Qatar, Nigeria, and Egypt), Lebanon should explore this option to meet its energy needs via this source in the short term given the close geographical location of these sources and the low cost of shipment as well as the good relations with these countries.

Financial development and energy consumption Granger cause each other, that is, supporting bidirectional causal relationship. Financial development results in lowering the cost of borrowing to consumers and producers for big durable items and for setting up new businesses. This raises energy demand which leads to further economic expansions. These further attract consumers and raise the demand for financial services and hence financial development. The bidirectional causality between financial development and economic growth also could show the importance of directing monetary policy in Lebanon to enhance capitalization, especially in the energy sector which is highly capital intensive. This is important given our earlier observation of the importance of encouraging energy exploring policies.

In the short run, bidirectional relationship between financial development and energy consumption is found. The feedback effect exists between energy consumption and economic growth and economic growth Granger causes financial development.

5.2. Variance Decomposition Method (VDM). We have used the generalized forecast error variance decomposition method (GFEVDM) using vector autoregressive (VAR) system to test the strength of causal relationship between energy consumption, financial development, and economic growth in case of Lebanon. This is due to the limitations associated with VECM Granger causality test which cannot capture the relative strength of causal relation between the variables beyond the selected time period. The GFEVDM indicates the magnitude of the predicted error variance for a series accounted for by innovations from each of the independent variables over different time-horizons beyond the selected time period. The main advantage of this approach is that it is insensitive with ordering of the variables because such ordering is uniquely determined by VAR system. Further, the GFEVDM estimates the simultaneous shock effects. Engle and Granger [96] and Ibrahim [97] argued that, with VAR framework, variance decomposition approach produces better results as compared to other traditional approaches.

The results of variance decomposition approach are reported in Table 9. The results indicate that a 67.16 per cent portion of energy consumption is explained by its own innovative shocks while innovative shocks of financial development and economic growth contribute to energy consumption by 21.44 per cent and 11.39 per cent, respectively. The innovative shocks stemming in energy consumption contribute to financial development by 23.37 per cent. The contribution of economic growth to financial development is 15.68 per cent and the rest is explained by innovative shocks on financial development. Economic growth is 23.35 per cent and 39.78 per cent explained by innovative shocks in energy consumption and financial development.

Overall our results show that the feedback effect is found between financial development and energy consumption but it is stronger from energy consumption to financial development. The unidirectional causality is found running from energy consumption and financial development to economic growth, that is, energy-led growth and finance-led growth hypothesis.

The results of IRF are shown in Figure 3 which reveals that the response of energy consumption is positive but minimal after 10th and 6th time horizon due to one standard deviation shock stemming from financial development and economic growth. The response in financial development is positive and strong due to one standard deviation shock in energy consumption and economic growth. Energy consumption and financial development seem to contribute to economic growth. Overall our results are consistent with findings of variance decomposition approach.

6. Conclusion and Policy Implications

This paper explored the relationship between economic growth, financial development, and energy consumption in Lebanon. Using data for 2000M₁–2010M₁₂, we have applied unit root test accommodating single unknown structural break stemming in the series. The ARDL bounds testing is applied to find out cointegration among the variables in the presence of structural breaks. The directions of causal
Response to generalized one S.D. innovations ± 2 S.E.

Table 9: Variance decomposition method (VDM).

<table>
<thead>
<tr>
<th>Horizon</th>
<th>Variance decomposition of $\ln E_t$</th>
<th>Variance decomposition of $\ln F_t$</th>
<th>Variance decomposition of $\ln Y_t$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\ln E_t$</td>
<td>$\ln F_t$</td>
<td>$\ln Y_t$</td>
</tr>
<tr>
<td>1</td>
<td>100.0000</td>
<td>0.0000</td>
<td>0.0000</td>
</tr>
<tr>
<td>5</td>
<td>83.1278</td>
<td>14.6550</td>
<td>2.2170</td>
</tr>
<tr>
<td>20</td>
<td>71.7926</td>
<td>18.1021</td>
<td>10.1052</td>
</tr>
</tbody>
</table>
relationships between economic growth, financial development, and energy consumption were examined by applying the VECM Granger causality and robustness of causality results was tested by using innovative accounting approach.

Our results found cointegration between the series in the presence of structural breaks arising in the variables. We found that economic growth and financial development raise energy demand. Energy consumption boosts economic growth and financial development also contributes to economic growth by capitalization enhancing effect. Furthermore, energy consumption and economic growth increase the rate of financial development. The VECM Granger causality analysis revealed that bidirectional causality is found between energy consumption and economic growth. The feedback effect also exists between financial development and energy consumption. Economic growth and financial development are Granger causes of each other. The results by innovative accounting approach are different from the VECM Granger causality test. This may be due to difference in the methodological backgrounds of both techniques. The empirical analysis by innovation accounting approach shows the bidirectional causal relationship between financial development and energy consumption. Economic growth is Granger cause of energy consumption and financial development.

The study, therefore, recommends that, in the short run, policy makers should put more emphasis on developing strategies that would result in achieving higher mobilization of savings in order to boost Lebanese investors’ confidence and to also attract more foreign investment in Lebanon. Furthermore, desired financial policy to encounter the rising demand for energy by enhancing the process of capitalization of the energy sector is also very desirable. Our results further caution of the use of policy tools geared towards restricting energy consumption in short run that is a part of national energy policy, as these may result in lower economic growth. Such conservation policies should be taken gradually and carefully as to not negatively impact the growth of the economy. Furthermore, given that Lebanon is very close to some of the major producers of LNG in the world (Qatar, Nigeria, and Egypt), it should explore this option to meet its energy needs via this source in the short term given the close geographical location of these sources and the low cost of shipment as well as the good relations with these countries. However, in the long run, the Lebanese government should shift its focus towards achieving higher economic growth, in order to boost its financial development and to sustain a steady flow of needed energy. In this regard, policy makers should put emphasis on the development of domestic energy resources to protect the country from any undesirable external energy shock given its extensive dependence on energy imports.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

References


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