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Monetary policy and business cycle fluctuations of the Lebanese economy

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Abstract

The aim of this paper is to analyze how aggregate activity in Lebanon fluctuates with regard to recurrent shocks. The research starts by identifying the Lebanese economic business cycle from the first quarter of 1998 to the fourth quarter of 2015 adopting a statistical method. Furthermore, this research studies the relationship between the capacity utilization rate and the inflation rate to explore theoretically and empirically how monetary and real shocks account for the disturbances that affect the economic activity. Findings prove that, over the studied period, the Lebanese economy performs largely under its full capacity and that the capacity utilization rate is related to inflation in the short run, but not in the long run. In other terms, findings prove that monetary factors account for business cycle disturbances of the Lebanese economy in short run, but not in the long run.

Keywords: Capacity utilization rate, Inflation, Monetary disturbances, Potential output

1 Introduction

The Lebanese economy has practiced wide and irregular fluctuations of its GDP over the period 1970–2015. The GDP growth rate has reached 12.5% in 1972 to drop 58% in 1976 with the beginning of the Lebanese civil war, to increase by 83% at the end of 1990. However, starting the after-war reconstruction in 1997, the real GDP growth rate has oscillated over the period 1999–2015, from below 0% level in 1999 to 2.57% in 2009 (see Fig. 3).

On the other hand, since 1992, the Lebanese economy was characterized by a high level of dollarization as a consequence of hyperinflation. To control the inflation rate, the Lebanese monetary authorities have adopted the fixed exchange rate regime in 1997 administrating the Lebanese currency price. Thus, to maintain the Lebanese currency parity against the dollar within a very narrow limit, the Central Bank offered high interest rates on Lebanese treasury bills. The cost of fixing the Lebanese currency added to the cost of reconstruction after the civil war, and the Israeli continual attacks to south Lebanon have produced a permanent budget deficit and contributed to increase the public debts to alarming level. The public debts GDP ratio is equivalent to 185% in 2015.

What causes GDP fluctuations? The Keynesian view line theoreticians advocated the role of monetary and argued that short-run fluctuations in employment and output are largely caused by variations in aggregate demand. However, Lucas (1972, 1977) pointed

to the shortcoming of the Keynesian approach and provides a theoretical groundwork for the notion of "monetary policy ineffectiveness" by integrating the rational expectations to the economic model. Friedman and Schwartz (1963) postulated a link between monetary policy and real economic activity. Consequently, the monetarist leaders explained that monetary authorities should prevent excessive expansion of the money supply to maintain price stability.

The aim of this paper is to identify the Lebanese business cycle over the period 1998–2015 and to explore how aggregate activity in Lebanon fluctuates with recurrent shocks. In other terms, this paper investigates how the output fluctuates around the trend level that reflects the business cycles amplitude and duration. Moreover, this paper discusses whether the adopted monetary policy in Lebanon had succeeded to smooth the business cycles or not? The assessment of the causality relation between the capacity utilization rate and inflation allows to answer whether monetary disturbances matter for business cycle.

As in Cogley and Nason (1995), this paper uses Hodrick Prescott filter to identify Lebanese business cycle. However, Granger causality test is used to evaluate the relationship between the capacity utilization rate and the inflation in the short run, while OLS method is applied to assess this relation in the long run. This paper is organized as follows: Sect. 2 presents the empirical literature review. Section 3 presents the Hodrick Prescott Filter results and analysis for the Lebanese GDP followed in Sect. 4 by an analysis to the relationship between the capacity utilization rate and inflation variables to conclude in Sect. 5. All the tests are performed using EViews.

2 From cycle definition to economic models

An overview of the world history shows incessant series of recurrent cycles with either uniformities or variabilities. The history repeats itself, and it goes through cycles in almost everything: climate, economy, war, geopolitics, life and so on. Thus, the academic world of the historiography describes a cyclical view of history analyzing the cycles of episodes since the nineteenth century. However, the originators of this analysis were the Genius Ibn Khaldun (1371).

In his famous book "Al Muqaddimah" written in 1371, Ibn Khaldun recorded an early view of the history and established a coherent economic theory that explains and predicts the rise and fall of all empires, nations and civilizations, through the study of their life cycles. He explained that empires are like organisms and their life trajectories can be plotted like points in a bell curve from their beginnings to their deaths.

Mitchell (1927) presented a descriptive approach to cycle which encompasses the decomposition of a wide number of time series into sequences of cycles. Explaining the major fact about cycles is the recurrent nature of the events; he divided each cycle into four different stages, unavoidably progressing from one into another: expansion, peak, contraction and trough. However, Burns and Mitchell (1946) presented a more detailed definition of business cycle where they compared cycle to "a type of fluctuations found in the aggregate economic activity of nations that organize their work mainly in business enterprises." Nonetheless, in the conventional model of the economy, the business cycle is represented as fluctuations of actual GDP around a smooth trendline. The duration of these fluctuations can last from a few quarters to several years.

Investigating the sources of GDP fluctuations, economists are divided into two main groups supported by empirical works. Keynes (1936) as well as a group of economists attached to its school point to the monetary disturbances as source of business cycle. Consequently, using time series techniques, Christiano and Eichenbaum (1992) accumulate evidences which support the important role of monetary policy in determining aggregate output, employment and other macroeconomic factors. Alternatively, a second group, related to classical school, advocates that business cycles are generated by that non-monetary factors. In this line of view, Baxter and King (1993) present an empirical work which decomposes the GDP time series into periodic components by regressing the time series in a set of sine and cosine waves to conclude that fiscal shocks count in expressing business cycles fluctuations.

However, the rational expectation idea initiated by Muth (1961) inspired Robert Lucas to develop in 1972 the rational expectation theory which emphasizes the monetary policy ineffectiveness. Luca (1972) explained that that policymakers can guide the economy by systematically influencing the economic agents to make false expectations. Thus, in contrast with the Keynesian perspective, where policy offers relief from unemployment and market failures, Luca clarified that, in a world of rational expectations and market clearing, monetary policy is not the primary source of macroeconomic instability and that only unanticipated monetary shocks can have real effects on real variables. Furthermore, he explained that policies which try to manipulate the economy by persuading economic agents to false expectations do not improve the economy's performance, but generate "noise" making economic decisions and adjustment more complicated. Nevertheless, while accepting Keynesian economics, the monetarist theoreticians explained that excessive expansion of the money supply is fundamentally inflationary.

Otherwise, in the line of Shumpeter (1927) who has developed a theory of business cycles which puts its emphasis on industrial innovation rather than monetary sector, classical economists have developed the real business cycle model (RBC) which advocates the role of technology shocks as a cause of economic fluctuations and limits the role of monetary factors in generating these economic fluctuations. The RBC ties a theory of economic growth, behavioral model of economic agents based on the utility maximization and an explanation of the business cycle. In other terms, it integrates both the growth (Solow (1956) Model) and the business cycles theory to confirm that business cycle fluctuations are the optimal responses to unanticipated supply shocks defined by the total factor productivity.

However, Kydland and Prescott (1982) proposed a theory of business cycle fluctuations far from the Keynesian tradition. Integrating growth and business cycle theory, they characterized a general macroeconomic equilibrium model to predict the consequence of a policy rule upon the operating characteristics of the economy. This simple model, based on microeconomic foundations and where there is no role for monetary factors, generates quantitatively significant business cycles. They argued that periods of temporarily low output growth are not the results of market failure to clear, but could simply be a supply shock where slow improvements in production technologies appear.

Furthermore, Cooley and Hansen (1989) proved, in a cash-in-advance real business cycle model, that adding monetary factors made little difference to the results, which assumes a minimal role for monetary aggregates. King et al. (1988) implemented a

structural model for business cycle to conclude that business cycles are mutually determined by growth. Nelson and Plosser (1982) argued that the long-run path of macroeconomy is permanently affected by contemporary events; their empirical work demonstrates that the hypothesis that GDP growth follows a random walk cannot be rejected. In other terms, that most of the changes in GDP were permanent, and that output growth would not revert to an underlying trend following a shock. Thus, changes in aggregate demand—the heart of Keynesian macroeconomics—must be of relatively little importance.

Nevertheless, the conflict between normative implications and policy practice on one hand and between theoretical predictions and evidence on other hand is considered as an indication that some fundamentals that are essential in actual economies may be missing in classical monetary models. To overcome these deficiencies, a group of economists, while maintaining the RBC as an underlying structure, introduces Keynesian assumptions to produce economic models. Consequently, the progress in economic research combined classical and Keynesian principles to develop the New Keynesian view. Thus, Keynesian elements as imperfect competition and nominal rigidities were incorporated into a dynamic model to analyze the connection between inflation, money and the business cycle. Equilibrium conditions for aggregate variables are resulting from optimal individual behavior regarding consumers and firms as well they are consistent with the immediate markets' clearing. From that point of view, the new generation of Keynesian models has much stronger theoretical foundations than traditional ones. However, the stressing on the nominal rigidities as being a source of monetary non-neutralities provides an important differentiation between classical monetary model frameworks and new Keynesian models.

The emphasizing on the nominal rigidities as being a source of non-neutralities affords an important differentiation between classical monetary frameworks and new Keynesian models. Despite their different theoretical basics, there are important connections between the RBC models and the new Keynesian monetary model. These similarities are reflected in the assumption of an infinitely lived representative household, who seeks to maximize the utility from consumption and leisure, subject to an intertemporal budget constraint and large number of firms with access to an identical technology, subject to exogenous random shifts. Nevertheless, some key elements of RBC theory are missing in the canonical version of new Keynesian model, like the endogenous capital accumulation.

Thus, Mankiw (1989), in his famous paper "Real Business Cycles: A New Keynesian Perspective" developed a New Keynesian assumption. He considered that money has a primary role to explain the fluctuations of business cycles. Furthermore, he assumed that economic recessions are not caused by technological shocks, since economic agents are rational and response to any technological downturn causing a recession.

Though, Rotemberg and Woodford (1996) introduced imperfect competitive product markets into a standard neoclassical growth model to analyze the effects of imperfect competition upon the economy's response to many types of real shocks including the technology shock. Their findings proved that imperfect competition affects the way in which the economy responds to several shocks which may occur.

Furthermore, Goodfriend and King (1997) in line with the New Keynesian paradigm developed the new neoclassical synthesis (NNS). Merging Keynesian and classical elements, they produced the systematic application of intertemporal optimization and rational expectations as stressed by Robert Lucas proving that the evolution of inflation in the NNS models depends on current and expected future markups. Moreover, their findings specify that considering an NNS model, the near-zero inflation rate targeting is possible.

Nonetheless, a group of economists characterized business cycles by a dynamic stochastic general equilibrium (DSGE) models. These models are based on microeconomic foundations which emphasize that all agents are rational and make decisions based on intertemporal optimization under uncertainty. In other terms, economic agents' decisions today depend on their expectations on future uncertain outcomes. Thus, Smets and Wouters (2003) developed a dynamic stochastic general equilibrium (DSGE) model with sticky wages and prices for the eurozone using Bayesian estimation techniques. Their model incorporates a variable capital utilization rate, while findings prove a considerable degree of price stickiness in the eurozone. However, Christiano et al. (2005) used a DSGE model along with staggered wages and price contracts to investigate the evidence of output persistence and inflation inertia that occurs under a mix of frictions. After policy shock, the model generates persistent response in output and inertial response in inflation. Furthermore, findings prove that after the hit of a monetary policy shock, the money growth rate and the interest rate move persistently in reverse directions.

This paper applies Hodrick Prescott (HP) filter to derive the output trend and the output gap. However, a positive gap is related to the nonuse of capacity utilization, while a negative gap is related to the total use of capacity utilization implying an increase in demand and in inflation as results. This paper analyzes therefore the relation between capacity utilization rate and inflation in the short and long run to conclude empirically on the relation between Lebanese monetary policy and business cycle.

3 Lebanese business cycle from 1998 to 2015

The fluctuations of actual GDP around long-run trend which form the potential GDP constitute the business cycle. The strategy of constructing the cyclical fluctuations of the economic activity around the long-term trend suggests a general estimation of the long-term trend, by calculating the potential GDP, decomposing the trend and generating the business cycles. Consequently, Eq. (1) represents the trend-cycle decomposition of real GDP time series x_t:

$$x_t = g_t + c_t + \varepsilon_t \tag{1}$$

where g_t represents the growth (the trend component of x_t), and c_t is the cyclical component of x_t for $t=1$ to t, and ε_t represents the irregular components of x_t.

Two main groups of methodologies to perform this strategy are as follows: the statistical approach and the economic variables approach. This paper uses the statistical approach to determine business cycle. Statistical methods are based on the use of the information contained in the history of the series of GDP without reference to an economic model. Three categories of statistical methods to generate the long-term trend are

as follows: segmented trend method, linear trend method and filters method. This paper uses as in Singleton (1988) and Cogley and Nason (1995) the Hodrick–Prescott filter[1] to decompose the series into trend and cyclical components. This method allows to measure the amplitude of the business cycles and the production gap between the potential GDP and the actual GDP.

3.1 Hodrick–Prescott filter methodology

The Hodrick–Prescott (1981) filter is dedicated for business cycle and trend estimation. It is a moving average filter built using penalty-function method. Moving smoothly over time, this filter extracts optimally the unit root (stochastic trend). It is built as a response to the minimization problem of variability in the cyclical component subject to a penalty for the smoothness of the trend component or the variation in the second difference. To calculate the smoothness of cyclical component, the sum of squares of its second difference is considered. Consequently, to isolate the cycle component, the HP filter resolves the following minimization problem:

$$\text{Min}\left[\sum_{t=1}^{T}\left(xt-gt\right)^2+\lambda\sum_{t=1}^{T}\left(\left(gt+1-gt\right)-\left(gt-g-1\right)\right)^2\right], \tag{2}$$

where x_t represents the real GDP time series, g_t the growth component (potential GDP or trend) of x_t, and c_t the cyclical component of x_t, for $t=1$ to t.

The first term of Eq. (2) measures the fitness of the time series' and the second term measures its smoothness. A conflict may exist between "goodness of fit" and "smoothness." A trade-off parameter λ[2] is called to resolve this issue; if lambda is 0, the trend component becomes equivalent to the original series; while it diverges to infinity, the trend component approaches a linear trend. Therefore, the business cycles c_t is the difference between the GDP time series x_t and the growth component g_t for $t=1$ to t.

$$c_t = x_t - g_t \tag{3}$$

Although the severe discussions and heavy criticism, the HP filter stood remarkably. However, the main drawback of the HP filter is that it generates a biased trend estimation at the end of the sample. Thus, the potential GDP estimation at the end of the period may be unstable and subject to several updates and revisions when new data on the observed GDP are available.

3.2 Data sources

Yearly time series data covering the period from 1998 through 2015 for the variables GDP are collected from the database of the World Bank, more precisely, the World Development Indicators (WDI) Database (https://data.worldbank.org/indicator/

[1] Kalman Filter is an alternative filter method.

[2] The height of the value λ depends on the frequency of the data. With reference to the literature, the following values are suggested: 100 for yearly data, 1600 for quarterly data and 14400 for monthly data.

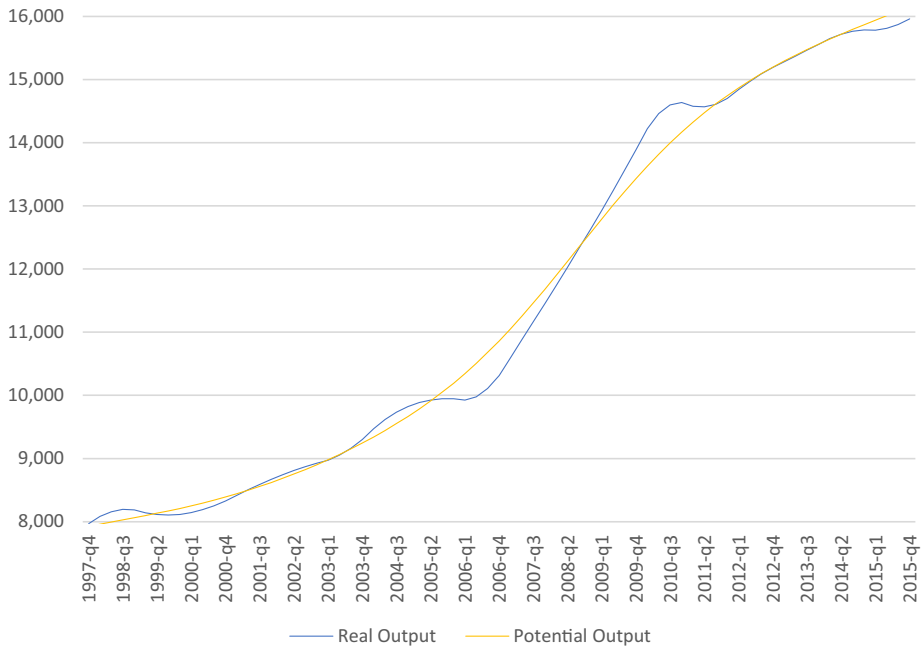

Fig. 1 Real and potential outputs of the Lebanese economy (QI-1998 to QIV-2015). *Source*: Performed by author using the Hodrick Prescott filter based on data for real GDP collected from World Bank data

NY.GDP.MKTP.KN) visited in 09/03/2018. The yearly time series are then converted into quarterly time series using the Chow and Lin solution.[3]

3.3 HP filter application results

The application of HP filter on quarterly time series of Lebanese GDP produces the potential output. The output gap is then derived using Eq. (3). Figure 1 presents the HP filter results where the Lebanese GDP series is de-trended to derive the potential output over the studied period, from the year 1998 to the year 2015. Figure 2 shows the growth rate of the Lebanese actual and potential outputs over the studied period.

3.3.1 Analyzing the real and potential Lebanese outputs

Figure 1 shows that the potential output trend is characterized by an ascendant on perpetual increase with a modest and weak growth rate since the logarithmic growth rate of this trend equals 0.975%.[4] More precisely, Fig. 2 which represents the variation of the growth rate for the Lebanese economy over the period 1998–2015 shows that since 1998 till the end of the studied period, a low average growth rate of the potential output trend is registered (0.995%). The actual output (0.973%) increases steadily with lower differences and higher amplitude relative to potential output. Actual output growth started rebounding in 2007 (average growth is 0.68% from 1998 to 2006) after a decade of

[3] The Chow and Lin solution (1971) approach to disaggregate annual time series into quarterly levels is employed for being widely used in The National Statistical Institutes. This method provides coherent and natural solution to the interpolation method, since its procedure is theoretically practical.

[4] Average logarithmic growth $= \left(\frac{1}{n} \ln\left(\frac{\text{last value}}{\text{first value}}\right)\right) \times 100$.

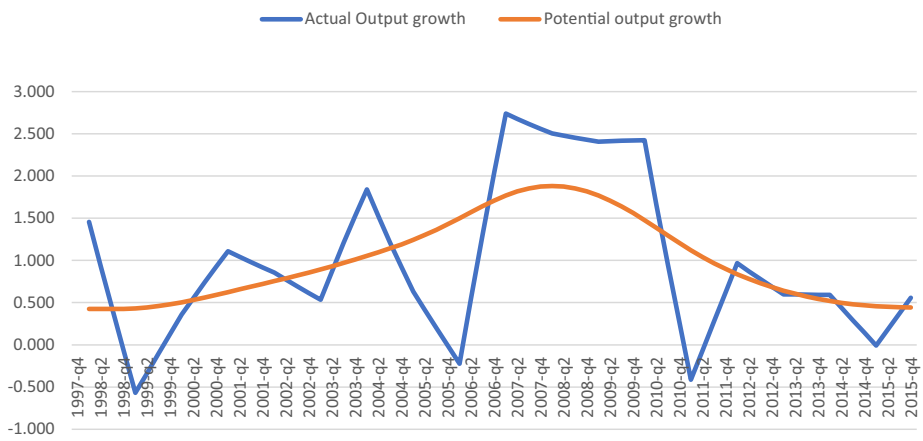

Fig. 2 Lebanese potential and actual GDP growth rate since QI-199 to QIV-2015. *Source*: Calculated by author using the Hodrick Prescott filter based on data for real GDP collected from World Bank data

slow growth starting far before December 1997. Since the Lebanese economy suffered from several economic recessions, economic crises, political assassinations and Israelite's attacks combined with a sharp depreciation of the Lebanese pound and a decline in real wages value resulting from inflation of 600%. Also, the civil war and hostilities in industrial and prosperous areas of Lebanon had a dramatic and negative impact on production and exports, triggered massive outflows of capital and people and created circumstances resulting in the "dollarization" of the economy.

Lebanon's growth performance was also remarkable in 2009 relative to the average in the MENA region, emerging and developing countries, which were feeling the effects of the global recession. The real GDP in Q4-2011 continued growing at a fast pace equal to 0.43% for a third consecutive year on the back of renewed political stability and confidence in Lebanon's economic and financial situation.

However, Mitchell (1927) states that the choice of production technology and the organizational innovation knowledge play a crucial role in productivity performance since they are the main drivers of firm level of productivity. Therefore, the increase in economy's productive potential occurs when the economy undertakes investments in new technologies, improvements in technical efficiency as adopting new methods of production, arranging for labor quality improvement, managing capital allocation and deepening and finally increasing returns to scale. Consequently, the weak progress of the potential output shown by HP results for the Lebanese economy over the studied period indicates a low level of investment in new technologies as well as a slow effort to encourage innovation, promote investment in productive capital and counteract the negative impetus from aging. Thus, the deceleration of the potential GDP is due to sluggish productivity growth or labor force demographics.

3.3.2 Lebanese business cycle identification and analysis

The deviation of output from trend, the output gap, referred to the Business cycle fluctuations. Each business cycle comprises four phases: expansion, recession, depression and recovery. The output gap measures the amount by which the actual output of an

economy falls short of its potential output. A positive gap indicates an expansion phase occurring when the economy is growing faster than its full capacity. A negative gap takes place when the economy runs a deteriorate situation. Figure 3 represents the GDP evolution over the studied period starting from QI-1998 through QIV-2015 which reveals two cycles.

The first cycle endured three years from QIV-1997 to Q1-2001 and is characterized by a slight amplitude. The expansion period continued for one year from QIV-1997 to Q3-1998 with the adoption of the fixed exchange rate regime followed by the recession period from Q2-1999 to Q1-2000. The recovery phase started bounding in QII-2000 and continued to Q1-2001.

The second cycle continued for 5 years, from QIII 2003 till QIII 2008. The expansion period was relatively smaller than the depression period which started from QI-2005 and continued till QIII-2006 The depression period was marked by an economy's confidence loss resulted from the assassination of the Prime Minister Hariri, followed by difficulties caused by the Israeli's attack to Lebanon in 2006.

However, the productive capacities such as capital stock or human skills are unable to adjust to the fluctuations in demand in the short term, but in the medium and long term. Therefore, the utilization of current production resources varies over the business cycle. Thus, a positive output gap indicates a high utilization of capacity in times of strong demand, while a negative output gap indicates that demand falls short of the production volume that can potentially be provided with existing production capacities.

On the other hand, economic theories argue that the unused production factors imply competition among producers which holds prices down. While, when the full capacity utilization rate is reached, the economy assists to an increase in the competitive pressures leading to prices increase. Furthermore, supplier's facing excess demand pressure for their goods will automatically request higher prices. Therefore, both prices and industries' cost might rise in the sectors where the capacity constraints are reached.

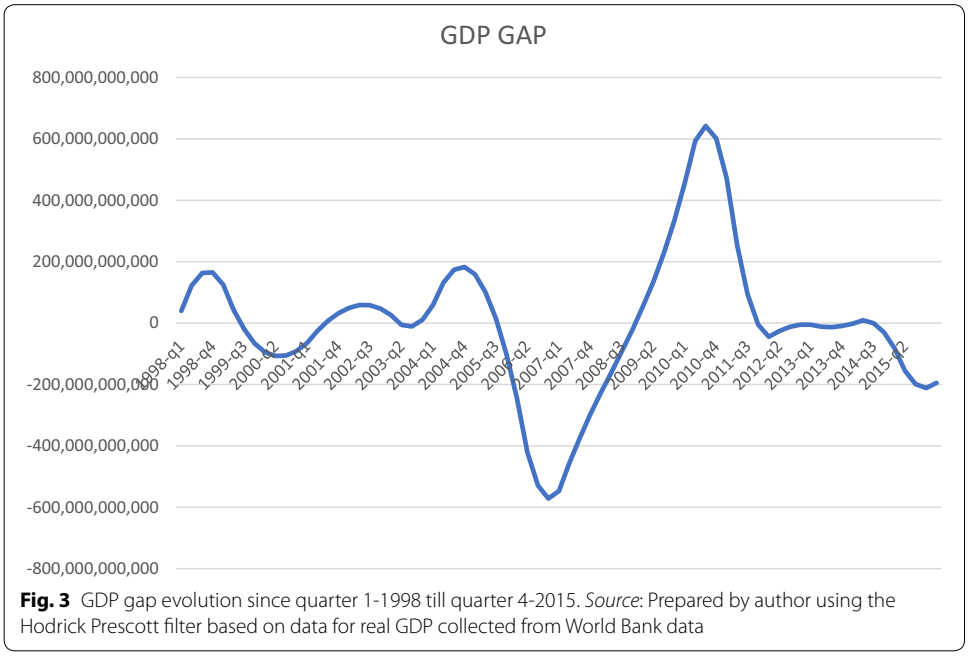

Fig. 3 GDP gap evolution since quarter 1-1998 till quarter 4-2015. *Source*: Prepared by author using the Hodrick Prescott filter based on data for real GDP collected from World Bank data

Consequently, the output gap is often seen as a key determinant of inflationary pressures in the short run. In other terms, the more increase in CUR (which means actual output exceeds its potential level), the more increase in prices. Nonetheless, the relation between CUR and inflation is not universally accepted; a contrary view is supported precisely by Finn (1996).

4 Capacity utilization rate and inflation

The capacity of utilization rate (CUR) reveals the degree of exploitation of the Lebanese economy's production capacities. It is defined as the ratio of actual GDP to potential GDP. Equation 4 states this relation:

$$\text{CUR} = \text{Actual GDP}/\text{Potential GDP} \tag{4}$$

Figure 4 compares the capacity utilization rate of the Lebanese economy and the inflation rate over the studied period from QI-1998 to QIV-2015. It reveals that the Lebanese economy, during the expansion of the both identified business cycles, was operating using more than its full capacity utilization rate, generating an inflation rate on average 5.0% for the first cycle, and 0.64% for the second cycle. Thus, the fitted procedure of Hodrick Prescott's procedure (the HP filter) to the data suggests an active role of monetary policies. The next paragraph investigates the relationship between CUR an inflation in the short run and in the long run to conclude on the impact of monetary factors on business cycle disturbances.

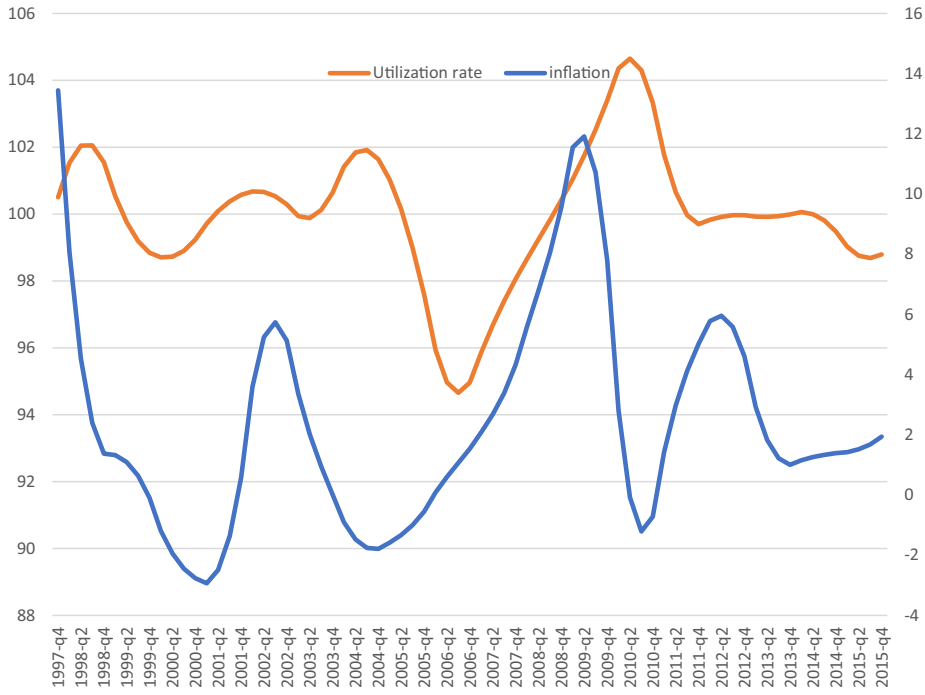

Fig. 4 Comparison between capacity utilization and inflation rates. *Source*: Author calculation based on data collected from WDI

Table 1 Unit test results for quarterly series related to inflation and from QI 1998 to QIV 2015. *Source*: Calculated by the author using EViews

ADF test	π_t	CUR
t statistic in levels	− 1.98	− 3.29*
t statistic in first differences	− 3.251*	
Phillips–Perron test		
Adj t statistic in level	− 2.90*	− 2.08
Adj t statistic in first differences		− 3.36*
KPSS test		
LM stat in level	0.20*	0.07*

*Shows the statistical significance at the 1% level of significance

4.1 The short-run relationship: Granger causality test

The bidirectional Granger causality test investigates the short-run relationship between CUR and inflation. Granger test verifies whether the past behavior of utilization rate helps to predict and forecast future rates of inflation, or inflation may be explained by utilization rate. In other terms, this part tests the validity of Eqs. 5 and 6:

$$\mathrm{CUR}_t = C_0 + \sum \alpha_i \mathrm{CUR}_{t-i} + \sum \beta_i \pi_{t-i} + \varepsilon_t \tag{5}$$

$$\pi_t = C_0 + \sum \alpha_i \pi_{t-i} + \sum \beta_i CUR_{t-i} + \varepsilon_t \tag{6}$$

where CRU is the capacity utilization rate, π is the inflation rate, and ε is the stochastic term.

However, to perform Granger test, a prior stationarity test is required. Three stationary tests are then executed to verify whether the involved time series have a random walk process or they are stationary: Augmented Dickey–Fuller (ADF) test, Philips–Peron (PP) test and Kwiatkowski–Phillips–Schmidt–Shin (KPSS) tests.

4.1.1 Stationary tests results

Table 1 shows the three unit root test results where inflation's time series (π_t) is stationary in level relatively to PP and KPSS tests. Thus, according to PP and KPSS tests, the time series (π_t) is I(0). However, the ADF test results reveal that (π_t) is stationary in the first difference which means that it is integrated of order one (I(1)). Furthermore, results shows that the CUR's time series is I(0) relative to KPSS and ADF tests and I(1) relative to PP test. This part considers therefore relatively to KPSS that the two time series, π and CUR are I(0).

4.1.2 Granger causality test results

The Granger causality test results presented in Table 2 prove that a bidirectional causality between the variables of capacity utilization rate and inflation cannot be rejected for lag one. However, utilization rate no longer explains inflation a quarter ahead (lag(2)), while inflation still explains the utilization rate considering lag(2). Therefore, the impact of

Table 2 Granger causality test results between utilization rate and inflation. *Source*: Calculated by the author

Null hypothesis	Lag	Probability
CUR does not Granger cause π	1	0.0083
π Does not Granger CUR	1	0.00004
CUR does not Granger cause π	2	0.2318
π Does not Granger CUR	2	0.0089

Table 3 First-step model 1 estimation. *Source*: Calculated by the author using EViews

Variables	Significance
CUR ($t = 0$)	Significant *P* values = 0.0107
CUR ($t = -1$)	significant *P* values = 0.0409
CUR ($t = -2$)	Nonsignificant
CUR ($t = -3$)	Nonsignificant
Constant	Nonsignificant

monetary factors on business cycle is empirically demonstrated for the Lebanese economy in the short run.

However, to investigate how far the variable utilization rate predicts and forecasts the future rate of the inflation variable, the relationship of these two variables in the long run is therefore modeled in a linear regression considering the past behavior of inflation.

4.2 Long-run relationship: OLS estimates

To confirm the causality results in the long run, this part implements two models with the current inflation rate as dependent variable. The past and current variables of CUR are the independent variables of model 1 (lag 3 as per AIC and SCI lag selection criteria). However, the model 2 includes the past quarterly inflation rates and the past quarterly capacity utilization rate in lag 2 (relatively to the PAC correlogram).

Regression estimation is performed in two steps. In the first step, the OLS method is applied to estimate the model parameters, since all variables are I(1). In the second step, the nonsignificant variables are eliminated from the model since they are not helpful to explain the dependent variable. The model including only the significant variables is then re-estimated.

4.2.1 Estimation results of model 1

The results of the first-step estimation by OLS method presented in Table 3 show that only the variables CUR at $t=0$ and $t=-1$ are significant. Therefore, the variables CUR at $t=-2$ and $t=-3$ are eliminated from the model to obtain Eq. 7:

$$\pi_{t0} = \alpha \mathrm{CUR}_{t0} + \beta \mathrm{CUR}_{t-1} + \varepsilon_t \tag{7}$$

where CUR_t is the capacity utilization rate, π_t the inflation and ε_t the error term.

Table 4 Residual diagnostic result of the first model. *Source*: Calculated by the author

Test and residual specification—null hypothesis	Results
LM test: there are no serial correlations in the residuals	We reject null hypothesis (*P* value = 0.0000)
Jarque Berra test: residuals are normally distributed	We accept null hypothesis (*P* value = 0.471246)
Breusch–Pagan–Godfrey: not Heteroskedastic	We reject null hypothesis (*P* value = 0.0004)

Table 5 First-step model 2 estimation. *Source*: Calculated by the author

Variables	Test results: significance
CUR ($t = 0$)	Nonsignificant
CUR ($t = -1$)	Nonsignificant
π_t. ($t = -1$)	Significant *P* values = 0.00
π_t ($t = -2$)	Significant *P* values = 0.00
Constant	Nonsignificant

Table 6 Residual diagnostic result of the first model. *Source*: Calculated by the author

Test and residual specification—null hypothesis	Results
LM test: there are no serial correlations in the residuals	We reject null hypothesis (*P* value = 0.0002)
Jarque Berra test: residuals are normally distributed	We reject null hypothesis (*P* value = 0.0000)
Breusch–Pagan–Godfrey: not Heteroskedastic	We accept null hypothesis (*P* value 0.0582)

Equation 7 is re-estimated in the second-step estimation to obtain Eq. 8 which shows that the utilization rate explains current inflation ($t=0$), while the inflation ($t=-1$) is negatively affected by any positive output gap.

$$\pi_{t0} = 2.06Ut_{\text{rate}\,t0} - 2.03Ut\_\text{rate}_{t-1} \tag{8}$$

4.2.2 Fitting and residual diagnostic results

The low value of the determination coefficient *R*-squared (=.1351), combined to the residual diagnostic results presented in Table 4, indicates that the first model is not helpful to predict inflation.

4.2.3 Estimation results of model 2

The results of the first-step estimation by OLS method presented in Table 5 show that only the variables π at $t=-1$ and $t=-2$ are significant. Therefore, the variables CUR at $t=-0$ and $t=-1$ are eliminated from the model to obtain Eq. 9:

$$\pi_{t0} = \beta\pi_{t-1} + \theta\pi_{t-2} + \varepsilon_t \tag{9}$$

where π_t is the inflation and ε_t the error term. Equation 9 is then re-estimated to obtain Eq. 10.

$$\pi_{t0} = 1.72\pi_{t-1} - 0.84\pi_{t-2}. \tag{10}$$

4.2.4 Fitting and residual diagnostic results

The determination coefficient R-squared is relatively high (= 96.84%). However, the residual diagnostic results presented in Table 6 indicate that the model 2 is unable to predict inflation in the long run.

Estimation results for the two models fail to prove a long-run relationship between capacity utilization rate and inflation. Therefore, results fail to prove the impact of monetary factors on business cycle in the long run.

5 Conclusion

Hodrick Prescott filter applied on the quarterly time series of the Lebanese GDP over the period 1998-2015 shows a low average growth rate of the potential output trend (0.995%). This weakness in growth is attributed to not only politic disturbances but also the choice of production technology and the organizational innovation knowledge. Thus, monetary disturbances are not the source of Lebanese cycle but real shocks. To enhance economic growth, the Lebanese economy should undertake investments in new technologies, improvements in technical efficiency as adopting new methods of production, arranging for labor quality improvement, managing capital allocation and deepening and finally increasing returns to scale.

However, since the low level of the Lebanese utalization rate capacity, findings fail to prove a long-run relationship between utilization rate and inflation for the Lebanese economy over the studied period.

Thus, the role of monetary factors on business cycle disturbance is empirically proved for the Lebanese economy in the short run, but the applied tests results fail to prove a long-run relationship between monetary factors and business cycle fluctuations.

Authors' contributions
LG realized the design of the study, the collection, the analysis, the interpretation of data and writing the manuscript. The author read and approved the final manuscript.

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Competing interests
The author declares no competing interests.

Availability of data and materials
The datasets generated and/or analyzed during the current study are available in the [World Development Indicators (WDI) Database] repository, [https://data.worldbank.org/indicator/NY.GDP.MKTP.KN visited in 09/03/2018].

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