Management Studies and Economic Systems (MSES), 6 (1/2), 59-79, Winter & Spring 2021

Lebanese Potential Output Calculation and Business Cycles Identification

* ***Jennifer Challita***

Department of economics, Faculty of Economics and Business Administration, Lebanese University, Branch 1, El Hadath Beirut, Lebanon

Received 6 March 2021, Accepted 8 June 2021

ABSTRACT:
The article measures the amplitude of the business cycles and the output gap in Lebanon by determining the trend path of the GDP around which the actual output fluctuates. Business cycles facilitate the understanding of the economic dynamic' fundamentals, they provide also a kind of support for the implementation of any monetary or economic policy. In this context, monetary policies are evaluated to assess their effect on business cycles, the extent to which a shift in a monetary policy affects the dynamics of business cycles.
The Lebanese output gap is estimated through a structural method using the economic variables production function, which relies on economic theory and tries to make explicit the nature of constraints that limit output.
Results show that the unemployment rates in Lebanon were always much higher than the unemployment rates in Lebanon during the period of study were always much higher than the NAIRU, which means an important part of the human capital was unexploited. Moreover, the monetary policy in Lebanon impacted the business cycles and generated as a result expansion period characterized by positive output growth. Worth mentioning that expansion periods were short-lived, while stagnation and recession periods long-lasted for many quarters. However, a lack of intervention made all policies framework unable to support certain macroeconomic stability, hence there was no major influence on the Lebanese economy, and their impact was barely felt which cannot be translated to substantial and extensive outcomes on different Lebanese economic aggregate variables.

Keywords: *Business cycles, Potential output, Real GDP, Monetary policies, Output growth, Recession, Expansions, Stagnation, Inflation, Unemployment rate, NAIRU*

INTRODUCTION

Lebanon is a country that has experienced a chaotic evolution of its GDP where economic fluctuations were strong and irregular since 1970-till present. In 1972 the GDP growth rate reaches 12.5%, then it drops by -58% in 1976 with the beginning of the Lebanese civil war. Such irregularities in the magnitudes of the growth rate continued as well, after 1990 the end of the civil war. Thus, Lebanon is no exception to the principle that there is a typical economic cycle, where output is not always at its long-term trend level[1], rather it fluctuates around the trend path of GDP. The latter is a similar concept to the potential output developed by OKUN (1962), Okun has showed an inverse linear relationship between the gap in the unemployment rate to its natural rate and the gap in the output to its potential level in the United States over the period

***Corresponding Author, Email:** *jenniferchallita@hotmail.com*

1- That is the level corresponding to full employment of the factors of production

1920- 1940[2]. Therefore, the potential output is a useful tool to determine the trend path of GDP on the long term, which is the path the GDP would take if factors of production were fully employed.

The main objective of this article is to determine how capital and labor in Lebanon did influence the pattern of business cycles. However, did the implemented monetary policy impacted the business cycles and stimulated growth? Or it was mostly engaged in the financing of accumulated public debt?

To answer these questions, the output GAP will be determined through an economic method, which allows us to identify the business cyclical variations and the output gap of the Lebanese economy, by calculating the potential inputs and output. Accordingly, to estimate Lebanon's potential growth, and derive the output GAP, a production function methodology is adopted. Since the production function is one of the key concepts of mainstream neoclassical theories, it is mainly required that the Lebanese potential output be consistent with the notion of "full employment".

Business Cycles Determinants and Methods for Identification

In order to decompose and extract business cycles, Singleton (1988), Cogley and Nason (1995) and King and Rebelo (1998) define the business cycles using an alternative approach characterized by a statistical filtering method, the Hodrick-Prescott filter, a decomposition technique between trend and cycles for the output.

However, Authors like King, Plosser and Stock (1991) concluded that business cycles are mutually determined with growth by implementing a specific structural model for real business cycle. More precisely Plosser used a model that consists of a utility function for a single representative agent who faces a tradeoff between consumption and leisure (a model initiated by Charles Cobb and Paul Douglas 1927–1947) . The model and the parameters used by Plosser are based on King, Plosser, and Rebelo paper.

Moreover, Baxter and King in 1999 used a spectral analysis of time series as a different approach that decompose the GDP time series into periodic components, by regressing the time series in a set of sine and cosine waves. Authors concluded that fiscal shocks certainly matter in defining business cycles fluctuations.

And lately, the NBER research department, made several recommendations regarding the subject. However, referring to this research department two major parts can define the business cycles: cyclical peaks and bottoms.

In 1982 Kydland and Prescott argued that changes and advancements in technology that lead to shifts in supply accounted "Not only long term increases in living standards but also to many of the short-term fluctuations in business cycles." Norrbin (1988) distrusted that the total factor productivity is an effective measure of real shocks in technology, hence he used instead the Military spending time series measurement in order to forecast the TFP. As well Evans (1992), Mankiw (1989) and Hall (1988) measured the total factor productivity as exogenous technology shock parameter, though they used indicators of monetary policy as money, interest rates and government spending. Nelson and Plosser (1982), King and Rebelo (1999), marked different specifications. In addition to the technological shocks in triggering business cycles, authors developed a real business cycle model and studied the capacity utilization rate and revenue diversity and tested their effects on technological shocks.

On the other hand, Christiano and Eichenbaum (1992), Baxter and King (1999), Braun (1994) and McGrattan (1994) studied the effect of fiscal shocks as tax rates and government spending on business cycles models. For Bernanke, Gertler and Gilchrist (1996) they highlighted on the credit friction role in response to technological monetary shocks, thus they implemented a real business cycle model, with multiple equilibria. These structural equations aimed to determine real causes of business cycles.

Productivity shocks account for a part of disturbances that affect the economic activity for being a fundamental feature of a market

2- The "gap version" states that for every 1% increase in the unemployment rate, a country's GDP will be roughly an additional 2% lower than its potential GDP

economy, knowing that, a real business model reacts primarily to a total factor productivity shock (Dotsey Michael 2004). By increasing the productivity, the economy is intuitively capable to produce more goods which leads to an increase in both output and level of capacity.

Business Cycles Calculation: Production Function

The Economic variables approach includes two phases: the first one is the Output elasticities Calculation, using Inputs as Labor Supply and Capital stock. Regarding the Total factor productivity, it is computed as the residual of the production function equation.

The second phase is dedicated for Potential Output Calculation, thus potential inputs are highly required. The capital stock is considered as fully utilized, the potential total factor productivity is derived by the Hodrick-Prescott statistical technique and finally in order to calculate the potential Labor supply, the NAIRU component is extracted from the Phillips curve equation.

Perpetual Inventory Method and Capital stock Calculation

The basic approach of the Perpetual Inventory Method is to intercept the capital stock of a given economy as an inventory. As long as the Capital formation (Investments) increases, the stock of Inventory will also increase. Once a new investment flow entered an economy's inventory, it remains there forever. Directly after the investment has been made, it will provide its maximum quantity of services, and decreases in the course of time. The depreciation rate is the amount by which the capital stock falls per period.

The net capital stock at the beginning of period $\boldsymbol{t}, \boldsymbol{K_t}$, can be written as a function of the net capital stock at the beginning of the previous period $\boldsymbol{t-1}, \boldsymbol{K_{t-1}}$, and gross new investment flow, I_t. Assuming geometric depreciation at a constant rate δ, we can rewrite the capital stock equation as:

$$\boldsymbol{K_t = (1-\delta)K_{t-1} + I_t} \qquad \textbf{(1)}$$

Where capital stock of each period measured by the previous period stock (net of depreciation) augmented with new investment flows.

The application of the production function approach assumes a physical capital depreciation rate of 0.05 which is 5% annual, this assumption is consistent with past research on MENA made by the IMF[3], and additional furnished data from Knoema (Penn World Table 9.0) regarding the average depreciation rate of the capital stock in Lebanon[4]

In order to apply the perpetual inventory method, we need information about the Initial capital stock, thus it is measured as:

$$\boldsymbol{K_0 = \frac{I_0}{(\delta+i)}} \qquad \textbf{(2)}$$

Where I_0 is the initial investment expenditure, $\boldsymbol{\delta}$ is the physical capital depreciation rate and i being the average logarithmic growth rate of investment in the sample period 1998q1-2015q4, when calculated we obtain the number 0.77%

Cobb Douglas Production Function: Output Elasticities Estimation

The goal of this part is to estimate the production function of the Lebanese economy. Thus, and in order to avoid an estimation of a spurious regression, the properties of the time series related to the variables used in this study are reported.

STATIONARY TEST RESULTS

The GDP variable appears to be stationary in 1st difference when the KPSS test is submitted (we fail to reject the null hypothesis stating that the GDP is stationary for 1% level as confidence interval). Regarding the Capital variable, it proves to be stationary in 1st difference for ADF test (5% level as confidence interval) and KPSS test (1% level as confidence interval). And finally, the Labor variable also showed to be

3- (IMF 2012, IMF 2013b, IMF 2013d, and the Total Economy Database (TED) from Chen and others 2010) as well as on oil importers (IMF 2014, TED from Chen and others 2010, and Gollin 2002) which assume physical capital's share of output to range from 0.4 to 0.67 for oil exporters and from 0.25 to 0.4 for oil importers and the physical capital depreciation rate from 0.05 to 0.15.

4- https://knoema.com/PWT2015/penn-world-table-9-0?tsId=1027870/
https://knoema.com/search?query=capital%20depreciation

stationary in 1st difference for only KPSS test (for 1% level as confidence interval).[5]

Provided that all-time series variables GDP, Capital and Labor are stationary in first difference, they are integrating of order 1.

Two main problems are not well handled by the OLS estimates, a possible endogeneity of regressors and non-stationarity of the economic variables involved in the analysis of the Lebanese production function, where the classical assumptions of standard regression models are violated.

The Dynamic OLS estimator will be implemented in order to evaluate the co-integrating vectors that describes the long-run relationships among the variables in the Lebanese Production function[6].

Although in literature, results from the ADF and PP tests are frequently confirmed by the KPSS test, Maddala and Kim (1998) emphasized in their survey that KPSS test is also overwhelmed by the same size properties and poor power as the traditional PP and ADF tests. Leybourne and McCabe (1994) modified KPSS test is reported to have better size adjusted power properties than its predecessor since it considers the possible moving average terms in the original data generating process.

Johansen Co-Integration Test Results

The prior test for a Co-integrating equation estimator is the standard Johanson Co-integration. This test suggests the existence of 1 long run relationship among the 3 variables Labor, Capital, real GDP, for Maximum Eigenvalue.[7]

Estimation of Long-Run Equilibria: Stock Watson Co-Integrating Regression – DOLS

The developed model of Stock and Watson, known as Dynamic Ordinary Least square, is considered as practically convenient, yet much powerful tool to implement. However, based on Monte Carlo simulations, Stock and Watson proved that this estimator, compared to several alternative estimators, is superior and more efficient in generating results when working with small samples.

Hereafter, the latest advances in dynamic time series modelling are employed in this study. The framework of these series authorizes the co-existence of both long and short-run forces that control the cyclical influences and deviation. These latter are fundamentally interactive with our chosen aggregate variables in the production function. In order to facilitate our inferences concerning the short-run dynamics, beside the application of the Dynamic OLS, a standard VECM formulation will be implemented after the DOLS estimation.

Stock-Watson (1993) Dynamic OLS (DOLS) equation modelling is as follow:

With $B = [c, \alpha, \beta]', X = [1, K, L]$

$$\boldsymbol{Y_t} = \boldsymbol{B'X_t} + \sum_{j=-k}^{j=L} \vec{\boldsymbol{d}}_1 \Delta \boldsymbol{K_{t-j}} + \sum_{j=-k}^{j=L} \vec{\boldsymbol{d}}_2 \Delta \boldsymbol{L_{t-j}} + \sum_{j=-k}^{j=L} \vec{\boldsymbol{d}}_3 \Delta \boldsymbol{Y_{t-j}} + \boldsymbol{\varepsilon_t}$$

Y_t is the dependent variable, Real GDP

X_t matrix of explanatory variables, Capital and Labor

B' co-integrating vectors, it characterizes the long-run effect of a change between the two dependent and independent variables.

L *and* k are the lag and lead length.

Lag and lead terms included in DOLS regression have the purpose of making its stochastic error term independent of all past innovations in stochastic regressors.

ESTIMATION RESULTS

Regarding the multivariate Co-integration test, the three aforementioned variables proved to be co-integrated, where they exhibit long –run equilibrium relationships. The results made by E-views are generated by using a Dynamic Ordinary Least square method, Co-integrating equations (Stock and Watson 1993). As for the OLS estimator, we employed the HAC covariance

5- Results generated by Eviews

6- Although in literature, results from the ADF and PP tests are frequently confirmed by the KPSS test, Maddala and Kim (1998) emphasized in their survey that KPSS test is also overwhelmed by the same size properties and poor power as the traditional PP and ADF tests. Leybourne and McCabe (1994) modified KPSS test is reported to have better size adjusted power properties than its predecessor since it considers the possible moving average terms in the original data generating process.

7- Results generated by Eviews

matrix estimator, the Newey Test. This specification is used to overcome serial correlations (autocorrelation), and Heteroscedasticity in the error terms of the model.

The model used in the analysis of the DOLS estimator is dictated by the typical formulation postulated by economic theory for the Production function analysis. However, given that the three tested time series are unit-root nonstationary, the co-integrating regression model to be evaluated is as follow:

$$\boldsymbol{Y_t = B'X_t + \sum_{j=-k}^{j=L} \vec{d}_1 \Delta K_{t-j} + \sum_{j=-k}^{j=L} \vec{d}_2 \Delta L_{t-j} + \sum_{j=-k}^{j=L} \vec{d}_3 \Delta Y_{t-j} + \epsilon_t}$$

$$\boldsymbol{lnY_t = lnA_t + \alpha\, ln\, K_t + \beta\, ln\, L_t + \sum_{j=-k}^{j=L} \vec{d}_1 \Delta ln\, K_{t-j} + \sum_{j=-k}^{j=L} \vec{d}_2 \Delta ln\, L_{t-j} + \sum_{j=-k}^{j=L} \vec{d}_3 \Delta ln\, Y_{t-j} + \epsilon_t} \quad \textbf{(3)}$$

The number of the Leads and lags of the model is equal to 3 (j is equal to 6 so ---3, 2, 1,0) based on Akaike and Shwarze criterion without altering results to any significant degree.

The estimation results of the approximate long-run relationship between the dependent and the independent variables of the production function related to the Lebanese economy can be written as follow:

$$\boldsymbol{lnY_t = 10.62 + 0.40\, lnCapital + 0.43\, lnLabor}$$

Variables Significance

Long-run relationships are only reported. Regarding the probability values, the Constant, the Labor and the Capital Factors are all statistically significant with respective probability values: Constant (0.0000), Capital (0.0000) and Labor (0.0000). Thus, the dependent variable Real GDP is well defined and explained by these independent variables.

However, the production function equation can be written as follow:

$$\boldsymbol{Y = 41,349.K^{0.40}.L^{0.43}}$$

The generated results by Eviews show that the sum of α and β is statistically less than one (0.83) for the Lebanese economy, hence a constant return to scale proposition is to be rejected at a standard significance level, where the resulting coefficients can largely describe the Lebanese economy response to any changes in inputs, as being decreasing return to scale on the long run. This situation happens when output increases by less than proportional change in inputs due to decreasing marginal returns on capital and Labor.

The diminishing return to scale in the Lebanese production function is mainly caused by a low share of labor comparing to the international standard (in the US production function, it is 0.75), it is equal to 0.44 while it should be improved to reach at least 0.6, this way the Lebanese production function will achieve a constant return to scale, which will improves the real output and generates positive output GAP, as a result expansion and recovery phases for business cycles will take place.

However, the constant return to scale refers to a technical feature of the Cobb-Douglas production function, it is a long run concept where all factors of production are available. In order to apply the theory in a proper way, the Lebanese Production function will be assumed as having a constant return to scale where both capital and labor share will sum up to one. Supposing the capital share will remain the same, i.e. 0.40, hence the labor share will be amended to become 0.6. As a result, the production function equation will take the following form:

$$\boldsymbol{Y = 5,370.K^{0.4}.L^{0.6}}$$

Worth mentioning that the above equation will be used in the calculation of the Lebanese Potential output since the calculated Cobb-Douglas production function that represents the real situation in Lebanon holds a decreasing return to scale results.

Potential Production Function Estimation: Potential Input Estimation for Business Cycles Generation

To estimate business cycles through the output gap, the calculation of separate gaps for the production factors and productivity are required. Regarding the capital stock, it is assumed that the

capital is always at its structural level, since adjustments to the capital stock at the aggregated level are usually slow[8]. Hence, the output gap calculation is based on gaps in productivity (the Total Factor productivity gap) and labor (the labor market gap by extracting the NAIRU).

Estimating the Potential Total Factor Productivity

A more efficient use of Capital and Labor resulting in higher output is associated to an improvement in total factor productivity. In our estimation, the series related to the total factor productivity is not observable, so we begin by deriving standard measures for the trend total factor productivity and we calculate it by taking out the generated results. Consequently, the total factor productivity term, which is the contribution of capital and Labor to actual real GDP, is obtained as a Solow Residual from equation (4):

$$A_t = Y_t \,/\, L_t^{\alpha} K_t^{\beta} \qquad (4)$$

Formerly, following Gradzewicz and Kolasa (2005), an approximation for the Lebanese economy's trend Total Factor productivity is found by smoothing the original calculated series with an HP filter (λ=1600, for quarterly basis). The HP filter exploits the link between the total factor productivity cycle and the degree of capacity utilization in the economy.

Estimating the Potential Utilization of the Capital Stock

Concerning the capital stock and its potential utilization, a capacity utilization series is not presented, there is no justification to smooth this series in the production function approach. Consistent with the literature, we assume that the existing stock of capital is fully utilized. Therefore, defining the potential factor use of the capital is straightforward since the full utilization of the existing capital stock in an economy provides us the maximum potential output contribution of this capital. This simplification mostly depends on the assumption that, given the perpetual inventories rule, the capital stock can be regarded as an indicator for the overall capacity of the economy (Denis et al., 2000), Although standard, such an approach is not without criticism. A proxy for the full utilization of the optimal capital stock should rely on I_t^* (i.e. the level of investment the economy can produce in the long run). Since it is not clear how the latter can be properly estimated, we follow the standard approach.

Estimating the Potential Employment

In order to calculate the potential Employment, the Natural rate of unemployment (NAIRU) is required. Consequently, this NAIRU will be calculated through two different methods: first method is a purely statistical method, the Hodrick Prescott filter where the extracting trend will be the NAIRU. The second method is an economic variable method where the Phillips curve is employed. However, in this economic variable method the NAIRU is calculated as time Invariant NAIRU and Time varying NAIRU. Regarding the Time varying NAIRU, there is also two techniques to calculate this NAIRU, the first one is long-term and short-term shocks estimation, the second one is unemployment GAP estimation.

8- Andersen and Rasmussen (2011)

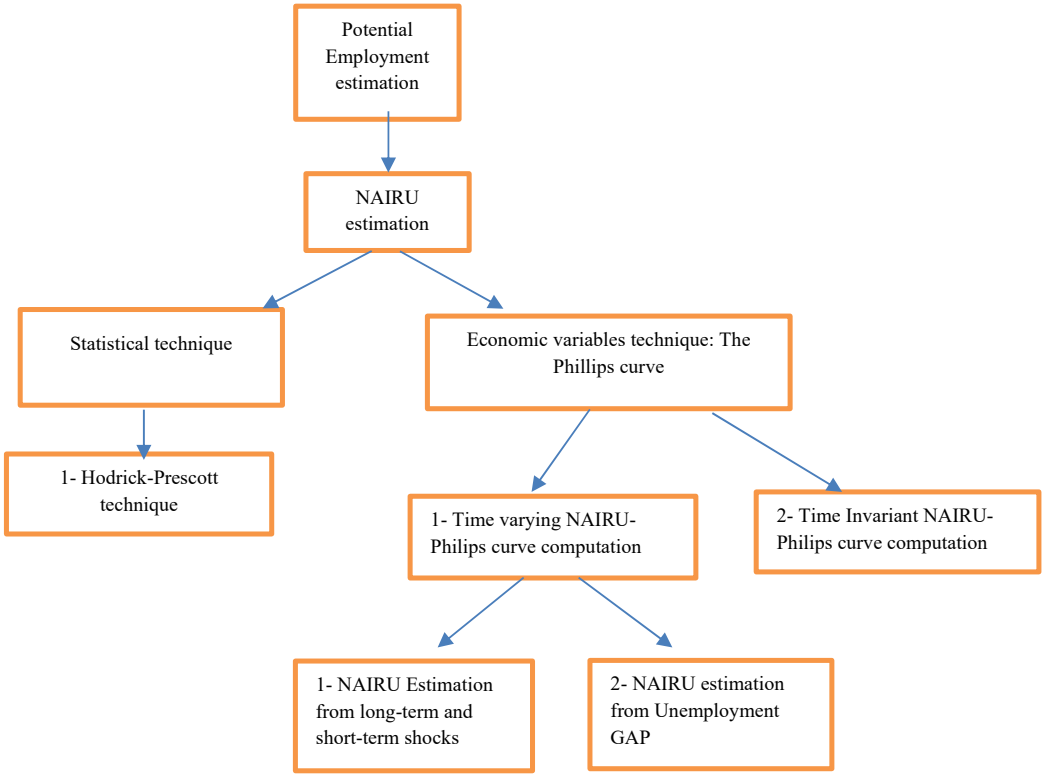


Figure 1: Different implemented steps for NAIRU estimation

NAIRU Definition and Literature Review

The non-accelerating inflation rate of unemployment (NAIRU) is developed by New Keynesian economists, advocate of the imperfect competition model, while the natural rate of unemployment is a concept formulated by the Monetarist (Friedman) and the Neo-Classical economists. The two concepts, natural rate of unemployment and the NAIRU are supposed identical, whenever the economy is assumed at its full employment, the rate of unemployment when the labor market is in equilibrium.

Accordingly, the natural rate of unemployment or often called the NAIRU (non-accelerating inflation rate of unemployment) is the rate of unemployment at the long run equilibrium. The estimation of the NAIRU is frequently employed in monetary and fiscal policy deliberations. Some economists argue that NAIRU changes over time, rising problems for policy formation (Gordon 1997, 1998; Cohen, Dickens and Posens, 2001; Ball and Mankiw, 2002), this notion goes back at least initially to Perry (1970), who proposed that the demographic changes of the labor force composition would leads to changes in the NAIRU. But new methods were developed to track its changes where structural break models and time-varying coefficients model were applied. The results showed that the NAIRU estimations and time variations are far from robust and remarkably imprecise (Staiger, Stock and Watson, 1997, 2001; Stock 2001).

The estimations of the non-accelerating inflation rate of unemployment are obtained from estimates of the Philips curve. The Philips curve is an inverse relationship between the unemployment rate and the money wages increase rate. The lower the rate of unemployment, the rate of wage inflation will be higher. In other terms it exists a tradeoff between unemployment and wage inflation. But the

permanent unemployment-inflation tradeoff is quite mistaken, where the Philipps curve is rather flat in the short run and quite vertical in the long run, which means that there is a tradeoff but only on the short run. However, the simple Philips curve (stating a permanent unemployment-inflation tradeoff) fell apart after 1960, where the data for 1970 and 1980, in both Britain and the US do not fit the simple Philipps curve story. Thus, expected or anticipated inflation shows up to complete the missing piece of the puzzle in the Philipps curve model. When introducing the natural rate hypothesis in his research paper, Friedman (1968) defined the above situation as per the following: ***"There is always a temporary tradeoff between inflation and unemployment; there is no permanent tradeoff. The temporary tradeoff comes not from inflation per se, but from unanticipated inflation, which generally means, from a rising rate of inflation."***

The non-accelerating inflation rate of unemployment (NAIRU), is firstly derived in order to obtain the potential employment. The non-accelerating inflation is expected to be generated from the equilibrium unemployment rate (Staiger, Stock and Watson, 1996; Gordon, 1966; Ball, 1996; Stock and Watson, 1999).

The analysis of a times series history will help us to make current decisions and to fix plans based on long-term forecasting. Consequently, the NAIRU will be estimated in three different steps.

First, the NAIRU will be estimated as invariant NAIRU.

Second, the NAIRU will be estimated as time varying NAIRU, after the estimation of two kind of shocks, long-term and short-term shocks.

Third, we will use the Hodrick Prescott filter decomposition technique in order to model the unemployment rate as the sum of a trend and a cyclical component, where the cyclical component is regarded as the unemployment GAP and the trend component as a reference for the equilibrium unemployment rate (natural rate of unemployment, also called the NAIRU).

Then, a reduced form equation for the Philipps curve is estimated.

The Phillips curve equation is estimated as New Keynesian Philips Curve: the inflation rate is a function of anticipated inflation, the unemployment rate relative to the NAIRU, and the supply shock by including changes in money supply, in other words the money growth.

NAIRU Estimation: Theory and Model Setting

The short run tradeoff between inflation and unemployment can be written as follow:

$$\boldsymbol{\pi = k - \rho U}$$

Where π is the inflation, U is the unemployment, k and $\boldsymbol{\rho} \rangle 0$ are parameters.

This equation reflects the negative relation that exists between unemployment and inflation. Since the short-run link between unemployment and inflation would likely shift over time (Samuelson and Solow's 1960) there must be fundamental factors causing the shift in this tradeoff.

The seminal contributions of Phelps's (1967, 1968) and Friedman (1968), revealed the importance of expected inflation in explaining the shifts in the inflation-unemployment tradeoff. The short-run non-neutrality theory explains the key role of expected inflation, hence any increase in expected inflation will be allied to an equal increase in actual inflation.

Thus, the inflation unemployment tradeoff is rewritten as follow:

$$\boldsymbol{\pi = \pi^{e} - \rho(U - U^{*})}$$

Where, π^{e} is the expected inflation, regarding the $\boldsymbol{GAP(U - U^{*})}$ **,** $\boldsymbol{U^{*}}$ denotes the natural rate of unemployment.

The natural rate of unemployment integrates both shifts resulting from expected inflation and the one of the tradeoffs presented by the parameter k in the previous equation, it is viewed as the unemployment rate that in the long run an economy should reach. Thus, the rationality of expectations assumes that on the long run, the actual inflation should be equal to the average of expected inflation, consecutively over the same long interval unemployment cannot deviate from the average natural rate.

However, the natural rate can be changeable over time and its variations can be the main source of the unemployment-inflation tradeoff shift. Whereof, an amended version of the previous equation is proposed by the literature,

where changes in inflation is modeled as per the following Phillips curve equation:

$$\Delta\boldsymbol{\pi} = \boldsymbol{\pi}^{e} - \boldsymbol{\rho}\,(\boldsymbol{U} - \boldsymbol{U}^{*}) + \boldsymbol{Z_t}$$

Where Z_t represents an external shock, in our study regarding the Lebanese economy, 2 supply shocks will be tested, the Money supply shocks and changes in import price inflation (crude oil WTI price).

To some extent, both variations in the natural rate of unemployment and the Money supply shocks exhibit shifts in the unemployment-inflation tradeoff.

To implement this equation, it is crucial to clarify how inflation expectations are formed. The traditional approach in measuring the inflation expectations augmented Phillips's curve has assumed that it can be modeled within a backward univariate autoregressive model, in other words expected inflation is a weighted average of past inflation.

Accordingly, the revised equation becomes:

$$\Delta\boldsymbol{\pi_t} = \boldsymbol{\gamma} + \boldsymbol{\alpha(L)}\Delta\boldsymbol{\pi_{t-1}} + \boldsymbol{\delta(L)}\Delta\boldsymbol{\pi_{t-2}} + \boldsymbol{\rho(L)}(\boldsymbol{U_t} - \boldsymbol{U}^{*}) + \boldsymbol{\beta(L)}\boldsymbol{Z_t} + \boldsymbol{\varepsilon_t} \qquad (5)$$

Where $\boldsymbol{\alpha(L)}, \boldsymbol{\delta(L)}, \boldsymbol{\rho(L)}$ and $\boldsymbol{\beta(L)}$ are polynomials in the lag operator of order 0, 0, 0 and 0, respectively.

$\Delta\boldsymbol{\pi_t}$ and $\Delta\boldsymbol{\pi_{t-1}}$, $\Delta\boldsymbol{\pi_{t-2}}$ represent current and lagged changes in the inflation rate, $\boldsymbol{Z_t}$ is an exogenous regressor including the Money supply growth shocks, and finally ε_t is a serially uncorrelated error term.

The NAIRU Triangle model of Gordon's (1997) is well described in the equation (5). The demand side influence through the $(\boldsymbol{U_t} - \boldsymbol{U}^{*})$, the supply side through the $\boldsymbol{Z_t}$, and price rigidities via past changes of inflation rates $\Delta\boldsymbol{\pi_{t-1}}, \Delta\boldsymbol{\pi_{t-2}}$.

Several studies have attempted to estimate the inflation equation as per the previously mentioned form. Lags of inflation and unemployment are included differently in each study. Also, different control variables are chosen to represent the supply shocks[9], knowing that some economists can leave it entirely in a residual.

Two econometric difficulties were faced by the NAIRU literature. The first one is related to an identification problem. Though, the equation can be estimated in a consistent way through ordinary least square method provided that the natural rate $(\boldsymbol{U}^{*})$ is assumed constant over the period of the study and that the supply shocks are contemporaneously uncorrelated with the unemployment $(\boldsymbol{U_t})$. As a result, the value of the NAIRU, $(\boldsymbol{U}^{*})$ is easily subtracted after a parameter estimation. Both assumptions are, theoretically speaking, acceptable.

However, if any correlations were found, the problem can be solved by setting some instrumental variables that are correlated with unemployment but uncorrelated with supply shocks. In practice, this technique is rarely undertaken.

Lucas in his work in 1973, used the nominal GDP as the independent variable, he assumed that the supply shocks in the residual were not correlated with the nominal GDP. As for Barro (1977), he used the money growth for anticipation study, he also proved that the supply shocks do not influence the money growth.

In our estimation, the traditional identification assumption is followed, where the supply shocks are considered as simultaneously uncorrelated with the unemployment $(\boldsymbol{U_t})$.

The second econometric issue is related to the standard errors' computation. The estimations of NAIRU standard errors are rarely provided by empirical literature treating the Phillips curve equation. Nonetheless, a published paper by Staiger, Stock and Watson (1997) treated this issue, accordingly they estimated a NAIRU that is equal to 6.2% with a confidence interval of 95%.

Empirically the NAIRU is used for forecasting purpose. In other words, economists expect a rise in inflation when the unemployment is below the NAIRU, and vice versa. As a result, monitoring the unemployment rate and the NAIRU regularly is a must whenever the policy regime adopts an inflation targeting regime as a monetary policy tool. By late 1990, evidence for forecasting tools were very different. However, Staiger, Stock and Watson (1997) declared that the estimation of the NAIRU is rough, but, in a later report on 1999, Stock and Watson confirmed

9- See Gordon (1998) and Staiger, Stock and Watson (1997)

the following: "Inflation forecasts produced by the Phillips curve generally have been more accurate than forecasts based on other macroeconomic variables, including interest rates, money, and commodity prices."

Time Invariant NAIRU: Assuming the NAIRU Is Constant

In order to estimate the NAIRU for the Lebanese economy, we would rewrite the Phillips curve equation as below:

$$\Delta\boldsymbol{\pi} = \boldsymbol{\rho U^*} - \boldsymbol{\rho U} + \boldsymbol{Z_t} + \boldsymbol{\varepsilon_t} \quad (6)$$

After including the expectations in inflation changes, the equation becomes:

$$\Delta\boldsymbol{\pi} = \boldsymbol{\alpha}\Delta\boldsymbol{\pi_{t-1}} + \boldsymbol{\delta}\Delta\boldsymbol{\pi_{t-2}} + \boldsymbol{\rho U^*} - \boldsymbol{\rho U} + \boldsymbol{Z_t} + \boldsymbol{\varepsilon_t} \quad (7)$$

Assuming that the natural rate of unemployment is constant and that the external supply shocks are not correlated with the unemployment rate. Then by regressing the changes of inflation on unemployment and on a constant, the value of the NAIRU U^* can be estimated. In other words, the NAIRU (U^*) is presented by the ratio of the constant term (ρU^*) to the absolute value of the unemployment coefficient (ρ).

STATIONARY TESTS AND RESULTS

With reference to the K PSS test as generate by Eviews, all variables are taken as stationary in levels, they do not need any differentiation.

Long-Run Estimation: Ordinary Least Square Method

The Estimation of equations (6 and 7) is initialized with an OLS regression since all variables are stationary in Level and does not need any differentiation. Inflation changes, M2 growth and oil price changes are stationary in Level for all tests (ADF, Phillips-Perron and KPSS), Unemployment rate is stationary in Level for KPSS only.

- **1st Method: Without Including the Inflation Expectations**

The two types of shocks will be tested in two different equations in order to determine which external shocks affect the most the inflation rate in the Lebanese economy.

1st Equation: M2 Growth as External Shock

$$\Delta\pi = \underset{(0.0003)}{18.70} - \underset{(0.0008)}{8.45}\, U_t + \underset{(0.0008)}{18.50}\, Z_t$$

The results of the linear regression indicate that both coefficients the unemployment rate and the M2 growth are significant with a P-value respectively equal to (0.0008) and (0.0008). Also, the constant is significant with a P-value equal to (0.0003) The R-squared ratio is equal to 0.2768, meaning that the chosen variables can explain 27.68% of inflation changes.

After performing this exercise for quarterly data in Lebanon q1-1998 till q4-2015 we obtained a constant equal to 18.70208, thus ($\rho U^* = 18.70208$), the unemployment coefficient ρ is equal to (-8.455822). Whereof, ($-8.455822U^* = 18.70208$), which generates a NAIRU equal to 2.211 as a Constant NAIRU.

2nd Equation: Oil Price Changes as External Shocks

$$\Delta\pi = \underset{(0.0002)}{20.77} - \underset{(0.0008)}{9.26}\, U_t + \underset{(0.6685)}{0.009}\, Z_t$$

The generated results by Eviews are quite similar as before (when including the M2 growth as external shock), unemployment rate and constant are both significant. But what draws our attention now 2 elements: first, the taken external shock, oil price changes, appeared to be insignificant to explain changes in inflation. Second a lower R-square is registered equal to 15.09%.

However, when we calculate the NAIRU from the constant term, we get a slightly higher NAIRU equal to 2.242.

- **2nd Method: Including Inflation Expectations**

Relationship between the real and monetary sides of the economy is inseparably linked to estimations about inflation expectations. Thus, we will introduce the inflation expectations in our two equations.

1st Equation: M2 Growth as External Shock

$$\Delta\pi = \underset{(0.0675)}{1.90} + \underset{(0.0000)}{1.69}\Delta\pi_{t-1} - \underset{(0.0000)}{0.82}\Delta\pi_{t-2} - \underset{(0.1667)}{0.79}U + \underset{(0.6992)}{0.50}Z_t$$

After including the inflation expectations, all variables except the inflation autoregressive terms became insignificant to explain the inflation changes in the Lebanese economy.

2nd Equation: OIL Price as External Supply Shock

$$\Delta\pi = 1.82 + 1.69\Delta\pi_{t-1} - 0.82\Delta\pi_{t-2} - 0.75U - 0.0001Z_t$$
(0.0785) (0.0000) (0.0000) (0.1911) (0.9688)

Same results are generated when including the oil price as external supply shock. Variables as unemployment, and the external shock turn to be insignificant, while the inflation expectations t-1 and t-2, are significant with same P-value for both equal to 0.0000.

Hence, the NAIRU cannot be calculated from equations including inflation expectations.

Time Varying NAIRU: Computing Long-Term and Short-Term Shifts in Inflation-Unemployment Tradeoff

The question regarding the assumption of a constant NAIRU had arisen between many economists, mainly in the late of 1990. Consequently, a large literature grows in order to estimate the path of time-varying NAIRU. The idea of this literature is based on two features: first, movements in the natural rate of unemployment are characterized as long-term shifts in the Phillips curve relation, inflation-unemployment. Second, the short–run fluctuations are captured by the external supply side shocks.

The NAIRU is estimated by many economists as Staiger, Stock and Watson (1997) and Gordon (1998). However, stochastic processes were given for the NAIRU as random walk and for the external shocks as white noise, after that, economists used a statistical procedure in order to separates any shifts of the Phillips curve into the NAIRU and the external shocks.

The following approach helps us to model the Phillips curve tradeoff, taking into consideration the long-term and the short-term of two kinds of shocks:

$$\Delta\boldsymbol{\pi} = \Delta\boldsymbol{\pi^e}_{-1} - \Delta\boldsymbol{\pi^e}_{-2} + \boldsymbol{\rho U^*} - \boldsymbol{\rho U} + \boldsymbol{Z_t} + \boldsymbol{\varepsilon_t} \quad \textbf{(8)}$$

$$\boldsymbol{U^* + Z_t/\rho = U + \Delta\pi/\rho - \Delta\pi^e}_{-1}\boldsymbol{/\rho + \Delta\pi^e}_{-2}\boldsymbol{/\rho} \quad \textbf{(9)}$$

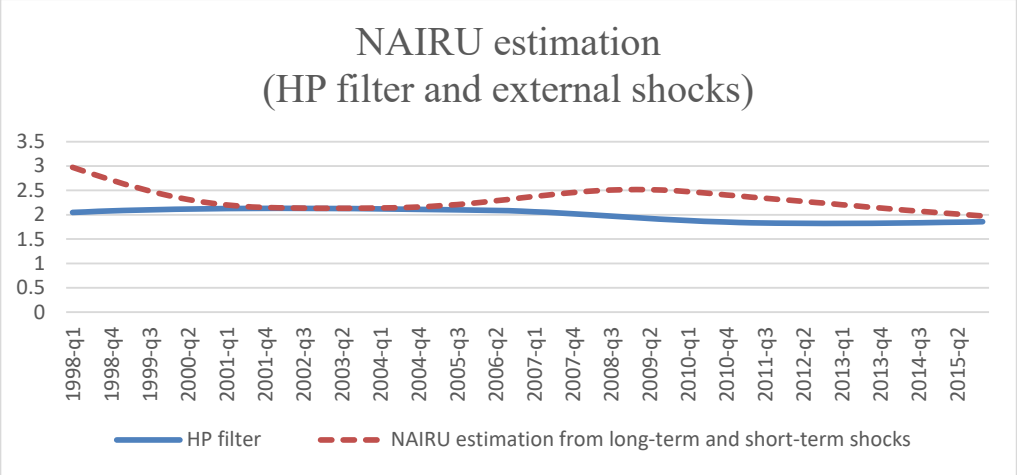
The data obtained before helps to compute the right-hand side of the equation $\boldsymbol{U + \Delta\pi/\rho - \Delta\pi^e}_{-1}\boldsymbol{/\rho + \Delta\pi^e}_{-2}\boldsymbol{/\rho}$, which leads to estimate the two kinds of shocks $\boldsymbol{U^* + Z_t/\rho}$. Again, the sum of these two kinds of shocks contains the long-term trend which is represented by the NAIRU U^*, and the short-term shocks which represent the external supply side shocks. Hereafter, this process will enable the extraction of the NAIRU $\boldsymbol{U^*}$ from $\boldsymbol{U^* + Z_t/\rho}$, in order to do that, the standard technique will be used, the Hodrick-Prescott filter, a generalization of a linear time trend which allows the estimation of a trend in a series.

Before implementing this procedure, two parameters must be chosen. The first one is the slope of the Phillips curve, i.e. $(\boldsymbol{\rho})$. In our previously results we got $\boldsymbol{\rho = 8.455822}$. The obtained value greatly corresponds to the disinflation cost conventional wisdom, it can be interpreted as follow: whenever the inflation rate is reduced by one percentage point, it will produce an extra $\frac{\mathbf{1}}{\boldsymbol{\rho}} = \frac{\mathbf{1}}{\mathbf{8.455822}} = \mathbf{0.1182}$ point-quarterly of unemployment, which is 0.4728% annual.

The second parameter is the HP smoothing parameter, to choose the appropriate value it must depends upon the periodicity of the data. Since the data is quarterly, the smoothing parameter is 1600.

Figure 2 presents the estimation of the Lebanese economy over the last 68 quarters (from 1998 till 2015), the dashed line gives the values of $\boldsymbol{U + \Delta\pi/\rho - \Delta\pi^e}_{-1}\boldsymbol{/\rho + \Delta\pi^e}_{-2}\boldsymbol{/\rho}$, which corresponds to the sum of two kinds of shocks the long term one and the shorter term, these shifts represents the inflation-unemployment tradeoff. Hence, this dashed line describes the smoothed version of the NAIRU series we want to estimate.

The path of the NAIRU can be described as hump-shaped curve. It trended down from q4-1998 till q1-2004 (the higher NAIRU is registered on q1-1998, for the value of 2.97 and the lowest NAIRU value is 2.13 for the period q3-2003), then it trended up again to reach its highest level in q2-2009 (2.51)



Source: Author calculation

Figure 2: NAIRU estimation using the Hodrick-Prescott filter method and through long-term and transitory shifts since 1998 till 2015 in Lebanon

Time varying NAIRU: NAIRU Estimation from the Unemployment GAP

Hodrick-Prescott Filter Decomposition Technique of Unemployment

Any filter's idea is to separate noise from data and make it clearer. The Kalman filtering also known as quadratic linear estimation is a computational algorithm, it provides efficient means to estimate the state space approach of a process under a Gaussian environment. The filter supports estimation in several aspects for past, present and future events (G. Welch and G. Bishop, 2004)[10]. After the publishing paper of Rudolph Kalman (1960) in the Journal of Basic Engineering, the usage of the filter has spread into tremendously broad range of areas, such as chemistry, nuclear medicine, finance, econometrics, statistics…

The Kalman filter was widely used in economics literature: Burmeister and Wall (1982) used the filter to model rational expectations and hyperinflation in Germany. Hodrick and Prescott (1997) in modeling the US business cycles used the Kalman filter to develop their own HP filter. Chen (2001) computed the inflation and the term structure of real interest rates under the expectations hypothesis. Harvey and Timbur (2003), estimated trends and cycles for the US GDP and investment. Koopman and Bos (2004), using US monthly inflation rate they produced a stochastic volatility model.

However, and since the Kalman filter is used to develop the HP filter which is more suitable for economic data series, the decomposition technique used in this part will also apply the HP filter.

Below represents the model used to decompose the unemployment rate between a stochastic trend component U^* and the cycle component G_t (which represents the GAP between the unemployment rate and the Trend Component of unemployment rate, mainly called the natural rate of unemployment):

$$\boldsymbol{U_t = U^* + G_t}$$

As per Denis et al. and Fabiani and Mestre (2002, 2004), the cyclical component regarded as the unemployment GAP[11] is modeled as a

10- Named after Rudolf Emil Kalman (1930, Budapest/Hungary).

11- It reflects by how much the deviation of the unemployment from its natural rate can influence or helps to predict the inflation rate.

stationary (second order autoregressive model):

$$G_t = \emptyset_1 G_{t-1} + \emptyset_2 G_{t-2} + \varepsilon_t \quad (10)$$

- **Test For Stationarity**

When applying the ADF test to check whether the unemployment GAP series is stationary or not we found that it is stationary in level, it doesn't need any differentiation for ADF test (5% interval of confidence) and KPSS test (1% interval of confidence).[12]

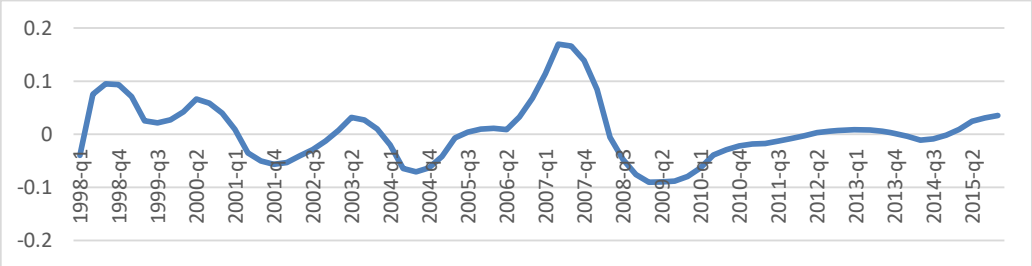
- **Long-Run Relationship: OLS Estimates of the Equation**

The estimation results of the linear regression equation (10) indicates that both coefficient of the unemployment GAP ($t = -1\ and\ t = -2$) are significant with a P-value respectively equal to (0.0000) and (0.0000). The R-squared ratio is equal to 0.9754, meaning that the past values of the unemployment GAP can explain 98.31% of the present unemployment GAP changes (Figure 3). The equation results are described as follow:

$$G_t = 1.70\, G_{t-1} - 0.83\, G_{t-2}$$

Following the obtained results of the OLS regression, we re-estimated the GAP of the unemployment taking into consideration an autoregressive term equal to 2. The above figure reports our estimation and reflects real characteristics of the Labor market in Lebanon. The trend hits a trough in q1-1998 at the outset of the economy reform conducted by the BDL, in other terms, the adoption of the fixed exchange rate regime, after long period of high inflation in the country. The trend rises steadily till q1-2001. A slight decrease is scored until 2005-q1, then, it increases again to hit a bottom in q1-2008, the two years 2007 and 2008 marked a significant growth with better performance, yet this economic growth was severely hampered by subsequent political disruptions like assassinations of General Francois El Hajj and Captain Wissam El hajj, and vacancy in the office of the president, during that period low rates of inflation marked (on average 3.11%)

Another trough is marked between 2009-q4 and 2010-q1, the economic growth recovery gained momentum in 2009 and 2010 (imports registered a small growth and a considerable surplus is registered in the balance of payment[13]), but this economic activity remains sluggish especially starting 2010-q3 where inflation resumed its upward trend given the rise in import prices.



Source: Author calculation GDP data from WDI

Figure 2: Unemployment GAP evolution in Lebanon since 1998 till 2015

12- Results generated by Eviews

13- National Economic Accounts of Lebanon, 2010 – Ministry of Economy and Trade – October 2010

Phillips Curve Computation Using the Unemployment GAP Re-Estimation

As mentioned before, the short run tradeoff between unemployment and inflation is admitted, therefore the concept of the NAIRU is considered a useful piece for business cycle theory, where a stable inflation can be associated to some level of unemployment. However, the NAIRU level does change over time, and it fells remarkably lately 1990s in the US. Various factors were identified in order to explain the NAIRU changes including government policies and demographic factors, but the more promising hypothesis is the one that attributes the NAIRU fluctuations to the productivity fluctuations.

The cyclical component $G_t = U_t - U^*$ is identified according to the Philips curve relationship, the equation 7) that we have set before.

$$\Delta\boldsymbol{\pi_t} = \boldsymbol{\gamma} + \boldsymbol{\alpha(L)}\Delta\boldsymbol{\pi_{t-1}} + \boldsymbol{\delta(L)}\Delta\boldsymbol{\pi_{t-2}} + \boldsymbol{\rho(L)G_t} + \boldsymbol{\beta(L)Z_t} + \varepsilon_t$$

One more specification, the parameter $(U_t - U^*)$, which is the unemployment GAP between the unemployment rate and the natural rate denotes the cyclical component G_t already obtained in the first step and ρ measures the responsiveness of inflation to unemployment.

The equation (7) will be estimated using an OLS regression since all variables are need any differentiation. Again, the variable unemployment GAP represents the results of the cyclical component obtained in the Hodrick-Prescott filter. In order to calculate the NAIRU, the unemployment GAP will be treated as unobserved and hence re-estimated in the equation

- 1st Method: without including inflation expectations:

1st equation: M2 growth as External shock

$$\Delta\pi_t = 1.72 - 14.01G_t + 20.40Z_t$$
(0.0000) (0.0090) (0.0004)

2nd equation: Oil price as External shock

$$\Delta\pi_t = 2.24 - 13.43G_t + 0.003Z_t$$
(0.0000) (0.0226) (0.8669)

When including the M2 growth as external supply side shock, variables as the unemployment GAP and the M2 growth appear to be significant with respective P-Values (0.0090) and (0.0004). In addition, an R-squared value for 0.2293 is registered.

Regarding the oil price, when included as External shock, the unemployment GAP appears to be significant to explain the inflation changes with an interval of confidence equal to 5% (P-value 0.0226). While the oil price shock, it is insignificant for having a P-value within an interval of confidence more than 5% (P-value = 0.8669).

Worth mentioning that, when including both variables, M2 growth and oil price shock, as external shocks in the same equation, the unemployment GAP and the M2 growth remain significant, and also, the oil price shock variable remain insignificant.

In order to estimate the NAIRU:

$$\Delta\pi_t = 1.725188 - 14.01702G_t + 20.40120Z_t$$
$$\Delta\pi_t = 1.725188 - 14.01702(U_t - U^*) + 20.40120Z_t$$
$$\Delta\pi_t = 1.725188 - 14.01702U_t + 14.01702U^* + 20.40120Z_t$$
$$\Delta\pi_t - 1.725188 + 14.01702U_t - 20.40120Z_t = 14.01702U^*$$
$$U^* = \frac{\Delta\pi_t - 1.725188 + 14.01702U_t - 20.40120Z_t}{14.01702}$$

- 2nd method: Including the inflation expectations:

1st equation: M2 growth as external shocks

$$\Delta\pi_t = 0.27 + 1.70\Delta\pi_{t-1} - 0.81\Delta\pi_{t-2} + 1.52G_t + 0.13Z_t$$
(0.0044) (0.0000) (0.0000) (0.2691) (0.9179)

2nd equation: Oil price shocks as external supply shocks:

$$\Delta\pi_t = 0.27 + 1.70\Delta\pi_{t-1} - 0.81\Delta\pi_{t-2} + 1.58G_t - 0.001Z_t$$
(0.0039) (0.0000) (0.0000) (0.2526) (0.6946)

The estimation of both equations, after including the inflation expectations, reveals to us that all variables become insignificant to explain the inflation changes in Lebanon

Estimation Results and Summary of the Non-Accelerating Inflation Rate of Unemployment: NAIRU

The NAIRU results are obtained through four steps, in the first step we opted a standard Hodrick-Prescott filter for the unemployment rate, where we derived GAP that measures the inflation pressure generated from the difference between the unemployment rate and the natural rate of unemployment was calculated. In the second step, the NAIRU was calculated as constant all over the period.

However, the third step results, we attempt to derive the equilibrium unemployment which is approximated by the predicted unemployment rate consistent with a time varying NAIRU, also the technique of Hodrick Prescott were used in order to separate the long-term shocks (NAIRU) from the shorter-term shifts (exogenous external shock)

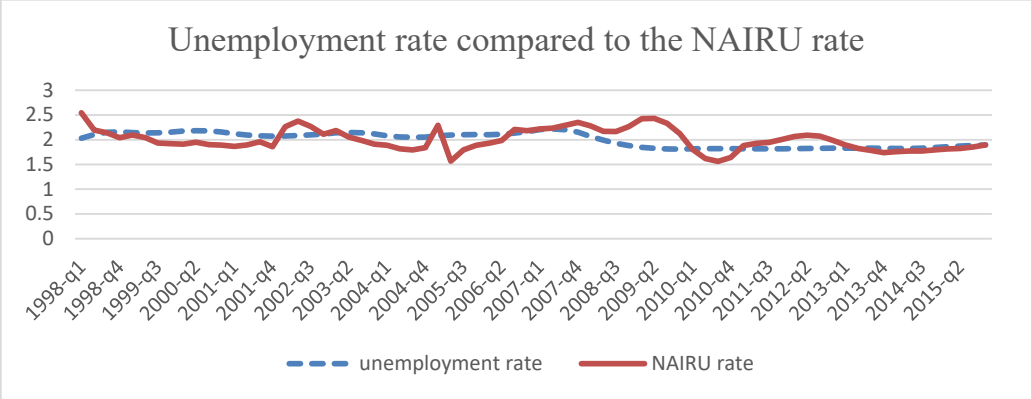
And in the last method, we also estimated a Phillips equation where the Unemployment GAP derived in the first step is employed and re-estimated.

Figure 4 represents a comparison between the NAIRU rate and the unemployment rate, followed by Table 1 that summarizes all NAIRU results using statistical and econometric tools.

Regarding the empirical relationship between the inflation rate and the estimated equilibrium unemployment rate, it is well documented, which makes Lebanon a no exception to this rule. Lebanon did encounter an increase in its NAIRU, when it has experienced large disinflation periods, knowing that the correlation for the whole period between the unemployment rate and the inflation changes is -0.3855. Regarding the period between 2001 q4 till 2002 q4, the correlation appeared to be very high and positive (0.82), same results for the period between 2005q3 till 2007q3 (correlation very high equal to 0.94), a positive relationship existed between the NAIRU and the inflation rate, a phenomenon that is called the stagflation. Thus, the Phillips Curve proposition cannot be verified during these periods.

The Keynesian economic literature has offered two major causes for the stagflation. First it can occur when a negative supply shock hit the economy, which reduces the productive capacity of an economy caused by an increase in import price inflation (ex. Oil prices). As a result, cost of production rises which makes in turn production less profitable and slows the economy.

Second, when monetary authorities implement inappropriate macroeconomic policies, especially the usage of stimulative monetary policy by allowing an excessive growth of the money supply in order to counteract the resulting recession of an unfavorable supply shocks.



Source: Author calculation for the NAIRU, unemployment rate as extracted from WDI

Figure 3: Unemployment rate compared to the NAIRU rate as estimated from the Unemployment GAP from 1998q1 till 2015q4

Table 1: NAIRU estimation results using both statistical and econometric tools

Date	Statistical tool	Econometric tool		
	Hodrick Prescott technique	constant NAIRU	Time Varying NAIRU	
	HP filter		NAIRU estimation from long-term and short-term shocks	NAIRU estimation from the unemployment GAP
1998-q1	2.0473424	2.211	2.973399683	2.545146379
1999-q1	2.08900264	2.211	2.633468382	2.094064211
2000-q1	2.115866927	2.211	2.364054211	1.91256807
2001-q1	2.126711794	2.211	2.201549364	1.867072816
2002-q1	2.127705786	2.211	2.140882979	2.265335755
2003-q1	2.125170594	2.211	2.132180079	2.18482029
2004-q1	2.119806389	2.211	2.136930436	1.888021392
2005-q1	2.111302937	2.211	2.172134744	2.291523141
2006-q1	2.095035214	2.211	2.257379132	1.930233154
2007-q1	2.061578137	2.211	2.374771293	2.218392956
2008-q1	2.005454486	2.211	2.477296147	2.280218207
2009-q1	1.938251167	2.211	2.517291948	2.426223465
2010-q1	1.880399913	2.211	2.474010997	1.803886377
2011-q1	1.842180567	2.211	2.38417991	1.880722844
2012-q1	1.82371361	2.211	2.295149193	2.067346087
2013-q1	1.82083364	2.211	2.206369448	1.89384094
2014-q1	1.828629382	2.211	2.116123013	1.758146637
2015-q1	1.842907648	2.211	2.033911193	1.814417736
2015-q2	1.846982831	2.211	2.01454822	1.824034148
2015-q3	1.851127399	2.211	1.995392669	1.854057706
2015-q4	1.855296205	2.211	1.976316828	1.892153694

Source: Eviews software test results for statistical and econometric tool

The recent oil price boom between the years 2002-2008, when the price of crude oil hardly increased, was caused by two main factors, the Venezuelan crises of 2002, and the Iraq War of 2003). However, a supply oil shock has undesirable economic consequences on oil-importing countries. Back to our country Lebanon, he has not lived a fall in economic activity during that period where no short-run increase in real GDP has been witnessed along with a slight long-run inflationary pressures (average inflation rate 3.53%, while average inflation rate for the whole period is 2.87%). Thus, it seems that the supply oil shock is not the direct cause of stagflation in Lebanon.

A different look of Friedman to the history generalizes and confirm that the stagflation is the result of years of Keynesian economic policies, also called a Keynesian phenomenon. It is so because any deficit spending is associated to a flexible money supply, which crowds out private capital and causes negative long-term consequences for the economy.

The change of the lag assumption is an immediate objective in order to get a way that loops counterclockwise. Though, the lag

structure, is not just a mechanical matter, important behavioral assumptions are greatly revealed regarding "who knows what when". Any deviations of real output and employment from their initial equilibrium levels, reveal information differentials between the two groups of agents in the model, workers, and entrepreneurs. In the standard, Friedman[14] loop, exercise: the truth about the inflation is perceived by the Entrepreneurs before workers do, noticing that their output demand prices are going up in relation to money wages, firms find that hiring labor at a reduced real wage is interesting for them. On the other hand, the perceptions of workers regarding the inflation rate are lagging, therefore, they believe that they are being employed at somewhat improved real wages. Consequently, the produced disequilibrium is the results of this inconsistency in beliefs. The equilibrium volume of employment will be attained if the same beliefs regarding the inflation rate are shared by both sets of agents, even if both beliefs were erroneous vis-a-vis the rate of inflation in prospect.

For the clockwise loop, firms' owners recognize before workers do, what is going to be the rate of inflation. To develop the counterclockwise loop, one should assume that labor catches on before firms do[15] (inflation anticipation). When the inflation is intensified and workers, anticipating it correctly, demand unchanged real wages, firms incorrectly see a rise in the real supply price of labor and, consequently, offer less employment. So, Friedman in his Nobel-lecture, argued that high rates of inflation render the economy increasingly inefficient, and this inefficiency will leads to a decrease in the demand for Labor.

As a result, we can conclude that the period of stagflation witnessed in Lebanon is characterized by a Friedman inflation anticipation perception.

Potential Employment Calculation

After the estimation of the Long-run unemployment rate using the OLS regression, the Lebanese employment Level is computed now as below:

$$L_t^* = active_t(PR_t^*(1 - NAIRU_t)) \quad (11)$$

Before we proceed with our calculation, it is crucial to start with clear definitions for the Labor force participation rate (*PR)*, knowing that PR_t^* represents the trend or equilibrium participation rate.

As per the Federal Agency, the "Bureau of Labor Statistics (BLS)" The Labor force participation rate (*PR)* is calculated as below:

LFPR= Labor force / Civilian Non-Institutionalized Population **(12)**

In Lebanon, the Labor force includes ages 15 and plus, for being defined as active population as described by the International Labor Organization. In order to calculate the potential participation, rate a proxy is obtained by regressing the actual activity rate on a constant, the unemployment rate and a time trend.

The equation used above has many benefits, since any changes in working age population, participation rate and structural unemployment rate are taken into consideration.

Below, a comparison between the actual and the potential employment level of the Lebanese economy, Figure 5 clearly shows that the actual employment in Lebanon is always below the potential employment which indicates the presence of a waste in the human capital resources.

Potential Output Estimates and Business Cycle calculations

The potential output equation is sat and estimated as follow:

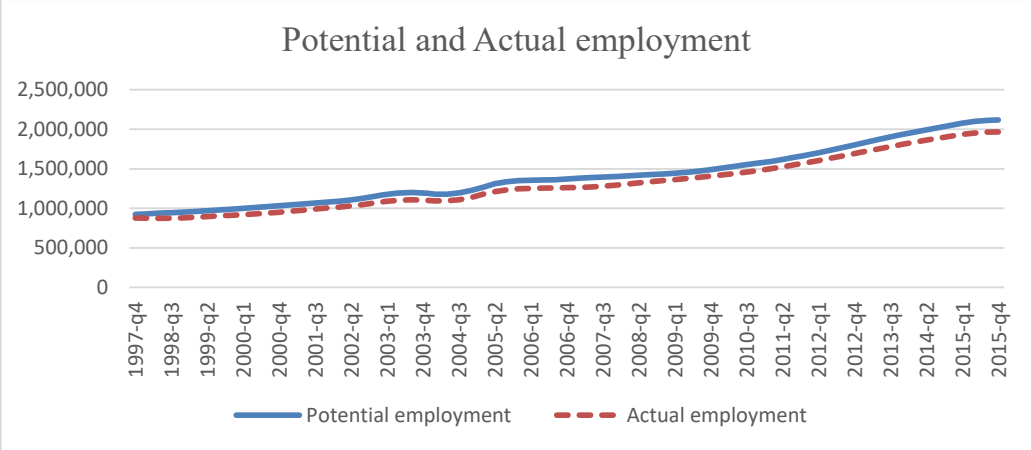
$$Y_t^* = A_t^* K_t^{*\alpha} L_t^{*\beta} \quad (13)$$

Where α=0.4 and β=0.6 in order to preserve the Constant return to scale proposition.

When calculating the potential output, the generated results are depicted in Figure 6.

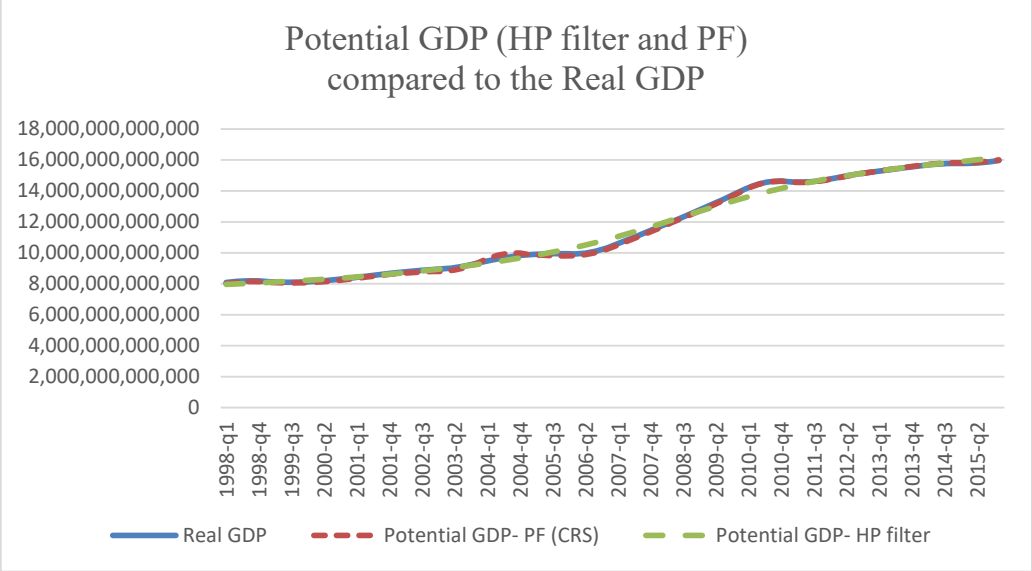
14- M. Friedman, "Inflation and Unemployment" Journal of Political economy, June 1977

15- Assuming that, when firms know what is going on, Labor has gotten an exaggerated notion of the inflation rate which will produce the same consequences.



Source: Author Calculation

Figure 5: comparison between potential employment and actual employment in Lebanon (1998-2015)



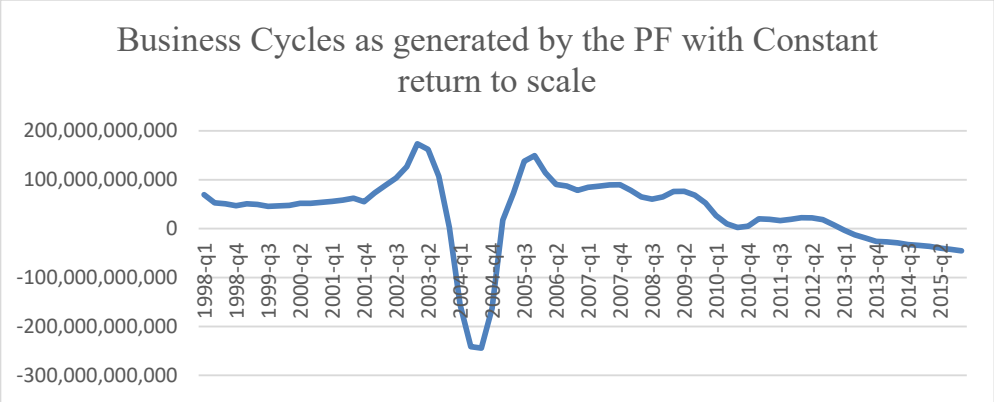
Source: Author Calculation

Figure 6: Potential GDP (calculated through hp-filter and production function) compared to real gdp (1998 -2015)

The Potential GDP generated by the economic variables' method (the production function PF) appears to be more consistent with the real GDP than the Potential GDP extracted by the purely statistical method. However, the generated output GAPs (Real GDP – Potential GDP) for the production function will represent the business cycles of the Lebanese economy.

The output GAP is measured by subtracting the estimated potential GDP level from its actual level. The generated business cycles in Figure 7 shows that the equilibrium level of the GDP (national income) is variable regarding the long run potential output, hence positive and negative output GAPs are generated. During the period of 1998 till 2015, the Lebanese economy is characterized by one major business cycle. However, negative output GAPs are mainly caused by an under-utilization of some factor resources, also called a demand-deficient unemployment. The demand-deficient unemployment appears when the unemployment become a long-term phenomenon caused by a persistent fall in aggregate demand. As per the generated results of the NAIRU, the Unemployment rate in Lebanon always marked a higher rate than the NAIRU rate, especially during the recession period. While positive output GAPs are mainly caused by an over-utilization of a nation' resources. Both positive and output GAPs can shape different business cycles.

The main business cycle as generated by the economic variable method (Production Function) started before 1998 and it ends in quarter 1-2005. It is characterized by a long stagnation phase prolonged by a period of slow growth, which lasted for 16 quarters, till q4-2001. Hereafter, a short expansion period persisted for 5 quarters only, while the recession and the depression period were bit longer and deeper (it took 6 quarters as a total). However, after the recovery period, a steadier growth resumed around the q1-2005, but the Lebanese economy appears to dive once again in a sharp recession period which started in 2006-q1, this phase is mostly characterized by a general slowdown in the economic activity measured by negative economic growth. Yet, the depression period effectively took place and it started in 2013 q1 and continued



Source: Author Calculation (Real GDP –Potential GDP)

Figure 7: Business cycles as generated by the production function 1998-2015

RESULTS AND DISCUSSION

The potential production level represents the economy supply indicator, while the output GAP is conceived as the excess or insufficiency of a demand. As a result, negative number for the gap indicates excess capacity and positive number indicates excess demand. The analysis of the output GAP in this article is considered as a starting point for business cycles studying, since the diagnosis of the Lebanese economy in the cycle consists primarily of the evaluation of sustainable production potential level without inflationary pressures, this production level is then compared to the observed level of production.

Nevertheless, the Lebanese output gap is estimated through a structural method using the economic variables production function, a function which relies on economic theory and tries to make explicit the nature of constraints that limit output.

In order to extract the Output GAP, the calculation of a production function, a Cobb-Douglas type, took place. Shortly, both share of Labor and Capital that reflects the reality of the Lebanese economy didn't sum up to one and the main reason behind this diminishing return to scale in the production function is mainly due to the low share of labor comparing to the international standard (in the US production function, it is 0.75), it is equal to 0.44, however it is recalculated to reach 0.6, this way the Lebanese production function achieved a constant return to scale. Moreover, the unemployment rates in Lebanon during the period of study were always much higher than the NAIRU (figure 3), which means an important part of the labor force was unemployed. Referring to Okun's law, a theory that explains how much a gross domestic product of a country can lose when the unemployment rate is higher than it natural rate (NAIRU), the Lebanese production function that measure the output, highly depends on the labor amount used in the production process, hence a positive relationship exists indeed between employment and output, any increase in the unemployment rate will have an adverse effect on the real output.

One business cycle was calculated for the production function approach. Indeed, the monetary policy in Lebanon impacted the business cycles and generated as a result expansion periods characterized by positive output growth. Though, following the production function method which is calculated within a constant return to scale context using different economic variables as Labor and Capital factors, expansion periods are shortly lived, while stagnation and recession periods long-lasted for many quarters. However, these two phases occur when there is a widespread drop in spending, which can be triggered by various events such as adverse supply shocks, financial crisis and external trade shocks. The Lebanese government was mostly required to respond to recessions by adopting expansionary macroeconomic policies in order to avoid a depression phase. However, the lack of intervention made all policies framework unable to support a certain macroeconomic stability, hence there was no major influence on the Lebanese economy, and their impact was barely felt which cannot be translated to substantial and extensive outcomes on different Lebanese economic aggregate variables.

CONCLUSION

In other terms, Lebanon lived under these long periods of stagnation and recession, 1998 till q4-2001 and 2005-q4 till after 2015 respectively, a fragile economic situation due to slow GDP growth, rapidly rising public debt and persistent deficit in the current account, along with high rates of dollarization. Also, many political turmoil occurred as political assassinations, Israel war, the repercussions of the Syrian civil war and the MENA regional political tensions.

Instead of promoting growth, the monetary policy in Lebanon primarily dealt with public debt financing. However, in order to shore up the economy, promote sustainable growth, improve equity and competitiveness, many dossiers need to be tackled by the Lebanese government. Fiscal policies and public investments need to be anchored in a consolidation plan in order to stabilize the public debt and lower its share from the GDP. Anti-corruption regulatory framework should be made effective, and it needs to be significantly enhanced and made operational.

REFERENCES

Andolfatto, D. (1996). Business Cycles and Labor-Market Search, American Economic Review, *American Economic Association*, 86 (1), 112-32.

Arrow, K. J., Chenery, H. B., Minhas, B. S., and Solow, R. M. (1961). Capital-Labor Substitution, and Economic Efficiency. *Review of Economics and Statistics*, 43, 225-50.

Burns, A. F. and Wesley, C. M. (1946). Measuring Business Cycles. New York, New York: National Bureau of Economic Research.

Cohen, J., William, T. D., and Adam, P. (2001). Have the New Human Resource Management Practices Lowered the Sustainable Unemployment Rate? In The Roaring Nineties: Can Full Employment be Sustained? Ed. Alan B. Krueger and Robert M. Solow, 219–259. New York: The Russell Sage Foundation and the Century Foundation Press.

Davis, J. S. and Haltiwanger, J. (1991). Gross Job Creation, Gross Job Destruction and Employment Reallocation, Working Paper Series, Macroeconomic Issues, 91-5, Federal Reserve Bank of Chicago.

Hallebone, E. and Priest, J. (2009). Business and Management Research: Paradigms and Practices. Palgrave Macmillan.

Hansen, G. D. (1985). Indivisible Labor and the Business Cycle. *Journal of Monetary Economics, Elsevier*, 16 (3), 309-327.

Keynes J. M. (1936). The General Theory of Employment, Interest and Money (New York and London: Harcourt, Brace and Co.,1936), 96-97.

King, R., Plosser, C. and Rebelo, S. (1988). Production, Growth and Business Cycles: I. the Basic Neoclasical Model. *Journal of Monetary Economics*, 21, 195-232.

Lucas, R E. (1977). Understanding Business Cycles. Carnegie-Rochester Conference Series on Public Policy, *Elsevier*, 5 (1), 7-29, January

Mankiw, N. G. (1989). Real Business Cycles: A New Keynesian Perspective. *Journal of Economic Perspectives*, American Economic Association, 3 (3), 79-90.

Merz, M. (1995). Search in the Labor Market and the Real Business Cycle. Journal of Monetary Economics, Elsevier, 36 (2), 269-300.

Mortensen, D. T. and Pissarides, C. A. (1994). Job Creation and Job Destruction in the Theory of Unemployment. *Review of Economic Studies*, Wiley Blackwell, 61 (3), 397-415.

Mortensen, D. T. and Nagypal, E. (2007). More on Unemployment and Vacancy Fluctuations. *Journal of Economic Dynamics and Control*, 10 (July 2007), 327-347.

Plosser, C. I. (1989). Understanding Real Business Cycles. *Journal of Economic Perspectives*, 3, 51-77.

Robert, S. (2005). The Cyclical Behavior of Equilibrium Unemployment and Vacancies. American Economic Review, *American Economic Association*, 95 (1), 25-49.

Rogerson, R. (1988). Indivisible Labor, Lotteries and Equilibrium. *Journal of Monetary Economics, Elsevier*, 21 (1), 3-16.

Staiger, D. S., Stock, H. J. and Watson, M. W. (1997). How Precise are Estimates of the Natural Rate of Unemployment? In Reducing Inflation: Motivation and Strategy. C.D. Romer and D. H. Romer, eds. Chicago: University of Chicago Press, pp. 195–246.