

**The NAIRU in Tunisia:
Determinants, Measurement and Policy Implications¹**

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Abstract

This paper develops a model to determine the Non-Accelerating Inflation Rate of Unemployment (NAIRU) in Tunisia, i.e, the rate of unemployment at which inflation stabilizes in the absence of any wage-price adjustments. Using data for the period 1970-2016, the NAIRU in Tunisia appears to exhibit two characteristics: (1) generally it stands above the actual unemployment rate that has been persistently high, and (2) it is sensitive to changes in average wages, the effective unemployment rate and the terms of trade, but insensitive to changes in labor productivity. Addressing the problem of relatively high unemployment in Tunisia, would therefore call for a major refocus of the country's economic policies towards measures that raise the level of factor productivity in the various economic sectors along with macroeconomic policies aimed at controlling inflationary pressures.

Introduction

The Non-Accelerating Inflation Rate of Unemployment (NAIRU) is the rate of unemployment at which inflation stabilizes in the absence of any wage-price adjustments. Thus the deviation of the actual unemployment rate from NAIRU signals a desired change in economic policy which, in turn, would depend on whether the NAIRU is lower or higher than the actual unemployment rate.

An effective unemployment rate lower than the NAIRU indicates a tightening labor market with companies facing increasingly tighter recruiting conditions of skilled workers thereby resulting in higher wages and consequently rising producer and consumer price which calls for counter inflationary measures. On the other hand, as pointed out by neo-Keynesian analysis, when the unemployment rate is higher than the NAIRU, it is possible to implement an expansionary monetary policy without risking inflationary pressures. But any attempt to bring the unemployment rate below the NAIRU threshold by fiscal and monetary "stimulus" policies would be futile in that it only increases the rate of inflation without reducing unemployment. Indeed, as the NAIRU reflects the structural level of the unemployment rate that results from the prevailing fiscal, legislative and regulatory framework, countries with a high NAIRU are urged to undertake structural economic reforms that would sustainably reduce their structural unemployment. (For a recent analysis of the of the relationship between unemployment and inflation see Gordon, 2013 and Watson, 2014).

This paper aims primarily to determine the level of NAIRU in Tunisia by developing a model based on Taheri (2000) that identifies different sources of unemployment, and considers the effects of the natural unemployment rate on the choice of economic policies, hysteresis and the weak adjustment process of the employment market. It is organized as follows: section I is a brief overview of estimation methods of the NAIRU that have been employed in the literature; section II discusses the Tunisian socio/economic and institutional context; section III presents the model for the determination of the NAIRU in Tunisia; section IV puts forward policy recommendations, followed by concluding observations.

I. Estimation methods of the NAIRU:

Being unobservable the NAIRU needs to be estimated for policy analysis. The estimation methods used in the literature can be divided into three categories: structural, statistical and reduced-form methods (Gianella et al., 2008). A brief review of each follows setting the stage for the reduced form method this paper employs to estimate the NAIRU for Tunisia.

1.1 The structural method: it consists of a system of equations that can explain wage and price setting behavior. The empirical literature distinguishes between two approaches. The first specifies wage and price equations in levels as in Layard et al. (1991), Cotis et al. (1996), L'Horty and Thibault (1998), Morrow & Roegers (2000E) Phelps, (2000) and Chagny et al. (2002). The second uses a rather ad hoc system, which represents the determination of

wages by a Phillips curve incorporating expectations and prices by a margin above unit labor costs as in Engler and Los, (1983).

Using the different specifications above, the level of equilibrium unemployment is calculated by adopting the assumptions of stable inflation, and of the compatibility of the decisions of the companies profit margins with workers real wages.

The structural approach, however, faces the problem of quantifying institutional variables such as unemployment compensation procedures, legislation, unionization, etc. As reported by Blanchard and Wolfers (1999), Broersma et al. (2000), and the omission of these variables would undermine the explanatory power of the model, particularly in the presence of interaction between institutional factors and macroeconomic shocks in determining the structural unemployment rate.

To compensate for lack of quantifiable institutional measures, increasingly studies have pooled information of national origin to estimate wage and price behavior by reduced form equations

1.2 The statistical methods: are entirely focused on the actual unemployment rate, which they split into trend (NAIRU) and cyclical (cyclical unemployment) components. The underlying assumption is that in the absence of a long-term trade-off between inflation and unemployment, the latter should, on average, fluctuate near the NAIRU. In other words, the self-balancing forces at work in the economy are strong enough to bring unemployment back to its trend level.

Statistical methods make it possible to identify these two components either on the basis of filtering techniques, the most used being the HP filter (Hodrick Prescott, 1997) and the bandpass filter (Baxter & King, 1995), or methods implying that unemployment tends to follow a random walk (Watson, 1986). But they suffer from a number of practical disadvantages:

- (1) The estimated indicators are often not sufficiently correlated with inflation and difficult to extrapolate, even in the short term.
- (2) These indicators tend to lose statistical validity at the end of the sample, which is the most interesting period for economic policy; nevertheless, it is often possible to mitigate this problem by adding at the end of the sample of data a few years of forecasts, a commonly followed practice.
- (3) Most filters behave like simple moving averages and therefore give poor results in the event of a sudden and substantial change in the unemployment rate.
- (4) It is often impossible to assess the degree of precision of the results. As a result, recent studies that estimate NAIRUs rarely use these methods, resorting instead to more efficient ones.

1.3 The reduced-form Methods: To calculate the NAIRU, recent studies have opted for the Phillips curve method incorporating inflation expectations. This method, which is part of a long-standing empirical tradition, has the main advantage of being directly related to the NAIRU definition. In addition, its simplicity and transparency make it compatible with several other models that are related to the structural method.

As in the statistical approach, some identification assumptions are necessary before estimating the NAIRU by the reduced-form method. Fortin (1989), Fuhrer (1995), Estrella and Mishkin (1998) hypothesized that the NAIRU remains stable over time. For the analysis

of periods up to thirty years, this assumption may be valid if the observed unemployment rate hovers around a stable average, as in the case of the United States since the sixties.

However, this is clearly not the case for countries in the European Union where the unemployment rate has been on an upward trend since the end of the 1970s. Under these conditions, a constant rate is unlikely to give a meaningful estimate as indicated by Setterfield et al. (1998).

One of the first attempts to estimate time-varying NAIRUs was made by Elmeskov (1993) and then taken up by the OECD. For the most part, this method deduces NAIRU movements from changes in wage inflation, based on the concept of an underlying Phillips curve.

In a related work, Bell and Blanchflower (2018)² show that the Phillips curve in Britain is flat and conclude that the British NAIRU is declining with an anticipated fall in the underemployment rate to below 3%, against 4.9% in 2017 which, as a consequence, renders the attainment full employment in the United Kingdom a difficult task.

The reduced-form method is relatively simple and gives plausible and up-to-date indicators. Nevertheless, it could be improved in different ways:

- The concept could be better defined and based in principle on a short-term notion of NAIRU, but this characteristic is weakened by a smoothing over time (which brings it closer to the notion of "unskilled" NAIRU);
- The Phillips curve relationship could be enriched by the introduction of additional explanatory variables reinforcing the link with inflation (Holden and Nymoen, 1998).

More sophisticated estimation methods further contribute to these improvements. Indeed, the Kalman filter, frequently used in the recent economic literature, allows simultaneous estimation of the NAIRU and the Phillips curve and measures the statistical uncertainty surrounding the NAIRU. In this framework, the estimated NAIRU varies over time, which confirms its ability, as has been pointed out, to explain the evolution of inflation in the United States (Gordon (1997 and 1998), King et al (1995), Staiger et al. 1997a).

In brief, the reduced form filtering techniques have several advantages. First, they give NAIRU estimates in direct relation to inflation. Second, the fully-specified Phillips curve makes it possible to distinguish between long term and short-term NAIRU³ within the same framework (Laurence and Mankiw (2002)). Third, these indicators can be easily obtained in a timely and consistent manner.

Although the reduced-form filtering methods have certain shortcomings, they bring improvements compared to the other methods, particularly as regards the real-time estimation of the NAIRU.

However, in the Tunisian context, it is not possible to apply these filtering methods because of the unavailability of quarterly or half-yearly data concerning the main variables, in particular the actual unemployment rate, the nominal wage and the labor productivity.

The alternative we have chosen is to apply the reduced method to estimate an augmented Phillips curve that is as stable as possible and that takes into account the socio-institutional context of Tunisia, particularly with regard to the wage determination process.

² David N.F. Bell, David G. Blanchflower (2018), The Lack of Wage Growth and the Falling NAIRU, NBER Working Paper No. 24502, April.

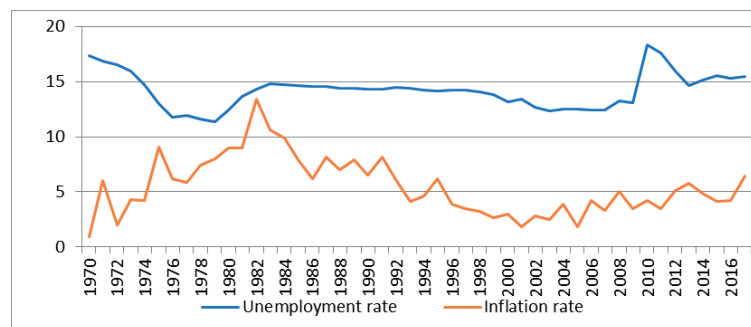
³ The short-term NAIRU is volatile, influenced by temporary factors that alter short-term inflation, such as oil and other price fluctuations. The Long-term is more stable being determined independently of such factors.

II. The Tunisian Socio-Economic and Institutional Context

Since the uprising, Tunisia has been facing consecutive vulnerabilities and an increasingly unsustainable economic situation. Indeed, the twin unemployment/inflation problem caused an increase in the public debt which reached 69.7% of GDP at the end of 2017 and 72% at the end of 2018, against 40.7% at end 2010 thus creating strong pressures on the national currency. Indicators of the labor market easing or tightening such as the unemployment and inflation rates, are important elements in assessing the Tunisian Central Bank's monetary policy in its attempt to bring about the desired national economic adjustment.

Figure I indicate the evolution of the Tunisia unemployment and inflation rates over the period 1970 and 2017. Noteworthy is that whereas in the period 1970-1983 there was an inverse relationship between unemployment and inflation as per the Phillips curve, in the subsequent period 1984-2017 this was no longer the case: inflation and unemployment rates evolved concomitantly, both showing downward trends during 1984-2007 (a result of the price stabilization policy adopted by the government since 1982⁴), followed by an upward trend since then. The jump of the unemployment rate in 2011 to over 18 percent from 13 percent the year before is due to the economic turmoil that accompanied the uprising with a consequent loss of jobs. The subsequent decline to a range of 15.8 percent in 2012-17 is partly due to a governmental policy of creating, mainly in 2011 and 2012, new jobs in the public sector⁵ to ensure political stability and not to any significant economic growth whose rate after the uprising is yet to recover to its pre 2011 levels. A contributing factor to the decreasing rate of unemployment is Tunisia's demographic transition

Figure 1
Tunisia: unemployment rate and inflation rate
(1970-2017)



Source: Author's estimates based on the database of the Institute of National Statistics

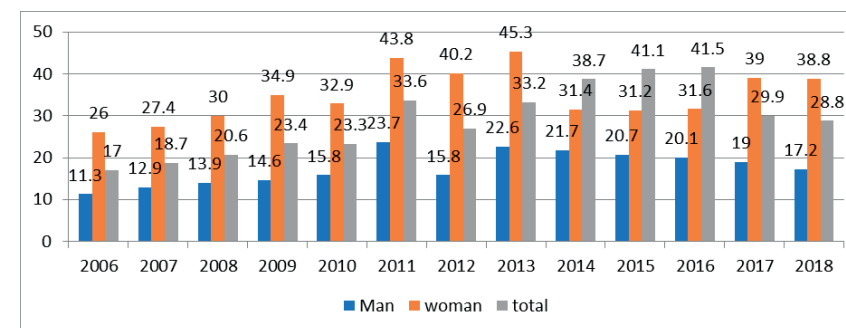
⁴ It should be noted that before 2011, unemployment rate statistics, especially of graduate student unemployment, were not necessarily complete. And with the adoption of the AMEL program, which consisted of giving unemployed graduates 200 dinars as financial aid the unemployed workers, who had been unregistered, came forward. However, were these omissions accounted for, the observed downward trend have changed significantly.

⁵ Nearly 59,000 new jobs were created. Law No. 2012-4 of 22 June 2012 provided for derogations(?) in particular for political prisoners enjoying an amnesty, the wounded of the revolution and members of family or close relatives of martyrs of the revolution

in recent years (i.e. a lower fertility rate) that has resulted in a declining rate of population growth and hence in the numbers of new jobseekers. It remains though that the government's employment policy resulted in an increased wage bill without any accompanying increases in productivity, which, in turn, has tended to sustain inflationary pressures.

Significantly, since 2006 the rate of unemployment of university graduates has been at levels higher than the national average, ranging after 2011 between 27 and 32 percent.(Fig 2). Equally, unemployment among female graduates has been much higher than male graduates ,averaging in the period 2012 -2017 34% and 20% respectively. This confirms a remaining bias in the labor market against female employment, the personal status code adopted in 1956 that gave Tunisian women equal rights with men notwithstanding.⁶

Figure 2. Unemployment rate of graduates by sex 2006-2018 (in %)



Source: Ministry of professional Training and Employment and NSI (Employment and unemployment indicators)

The inflation trend since 2000 (Fig.1), has been rising averaging in 2000-2010 about 3.1 percent compared to 10 percent in 2011-2018. The observed decline after 2012 was reversed after 2016 with inflation reaching 7.4% at the end of 2018, fueled in particular by the depreciation of the Tunisian dinar. In the pre uprising period, while monetary policy was oriented towards the support of economic activity, Tunisia managed to keep inflation within acceptable levels thanks to its policy of price administration, which countered the shocks of rising international commodity and energy prices. In the post-uprising period, however this policy began to be phased out.

The Central Bank has been attempting to counter inflationary pressures of recent years by following a tighter monetary policy through raising interest rates and controlling bank liquidity. But these measures will have a very limited impact on inflation as long as its causes

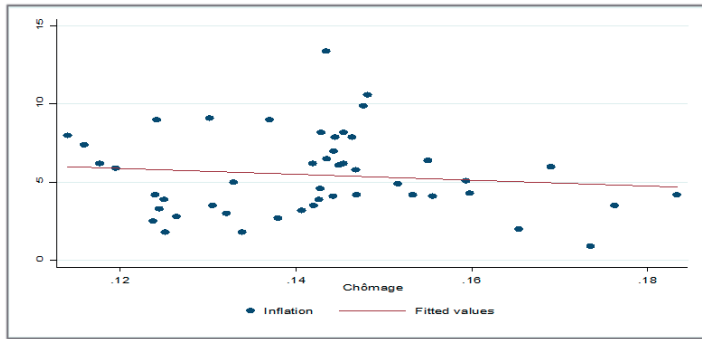
⁶ Decree of 13 August 1956 promulgating the Personal Status Code, published in JORT No. 104 of 28 December 1956.

remain beyond the control of the Central Bank: e.g. depreciation of the dinar, a flourishing informal market, and rising demand following increases in the wage bill.

The fear is that in recent years Tunisia has entered a cycle of stagflation. Inappropriate governance combined with various austerity measures taken since 2015 have led to deteriorating macroeconomic conditions. Given the expectations of economic agents in the context of the prevailing economic situation in Tunisia, as things stand, policy makers would not be able to maintain an unemployment rate lower than the natural rate⁷ without leading to a rising inflation. Hence for this policy objective to be achieved there is urgent need for institutional reform as well as structural changes in the labor and goods markets

A construction of the Phillips Curve for 1970-2017 (Fig 3) shows it is relatively flat.

Figure 3. Tunisian Phillips curve (1970-2017)



Authors estimation based on the database of the NSI

This long term flattening of the curve may be explained by three factors. Firstly, with increased foreign competition, the national companies' ability to raise prices in parallel with demand increases has diminished. Secondly, the integration of Tunisia into the WTO and the signing of free multilateral and bilateral free trade agreements with its partners have increased trade and investment flows, which has made the price of goods less sensitive to domestic demand pressure. Indeed, in recent years, and especially following the depreciation of the dinar, the relationship between inflation and domestic demand appears to have broken down. The third factor is the increasing non-compatibility of the expertise of young graduates with available work opportunities.

III. Estimating the NAIRU for Tunisia

The structural unemployment rate, reflecting persistent long-term unemployment, has been the subject of divergent explanations. In the classical tradition, the real business cycle

⁷ The natural rate is defined as the level of unemployment towards which the economy converges in the long term in the absence of fluctuations in the economic cycle and structural changes.

ascribes the persistence of a high unemployment rate to the effects of supply shocks that affect productivity and lead to a fairly stable natural rate of unemployment

Keynesian explanations of the persistence of unemployment are based on a rejection of the natural rate as a single rate of unemployment and argue for the existence of a hysteresis effect. This hypothesis, first proposed by Gregory (1986) then formalized by Blanchard and Summer (1986), predicts that long-term and prolonged unemployment, whatever its causes, could lead to a reduction in the effective supply associated with the factors production and an increase in the NAIRU.

An alternative explanation of the persistence of unemployment is that proposed by Giavazzi and Wyplosz (1985). It is based on the logic of a very slow adjustment of the economy to its stationary state rather than an adjustment in accordance with conventional assumptions of the natural rate which postulate that in the absence of economic shocks and cycles, wages tend towards a level of equilibrium that equates supply and demand in the labor market. One of the main causes of this slowness could be nominal wage rigidity.

Drawing on these varying explanations of the structural unemployment rate we construct a global Taheri based model to estimate the NAIRU for Tunisia and test its empirical results⁸.

3.1 Construction of the model

The Taheri model has the advantage of not excluding any source of unemployment. it considers the effect of the natural unemployment rate, hysteresis and the weak adjustment process. If all these scenarios are theoretically possible, by taking account of the country's political-social and institutional context, this model allows for the testing of different hypotheses of sources of unemployment. And the empirical results will then permit the determination of the most plausible alternative hypothesis

The basic equation in the model takes into account wage inflation caused by a positive gap between the NAIRU and the effective unemployment rate.

The assumption of a natural unemployment rate is represented by the following expression:

$$\Delta w_t = \alpha_1 \Delta w_{t-1} + \alpha_2 (U_t^* - U_t) \quad (1)$$

Lowercase letters indicate the logarithm of the values shown in upper case. With, Δ the difference operator, W the nominal wage, U_t^* the NAIRU, and U_t the unemployment rate actually observed.

For $\alpha_1 = 1$, we have $\Delta w_t = \Delta w_{t-1} + \alpha_2 (U_t^* - U_t)$ and therefore equation 1 confirms the natural unemployment rate assumption. However, if $0 < \alpha_1 < 1$, equation 1 captures an inflationary inertia.

⁸ It should be noted that several empirical models have been tried to determine the NAIRU in Tunisia. Indeed, in the intermediate approach of estimation of the increased Phillips curve there are no fundamental differences between all the empirical models. All relate wage inflation or price inflation the unemployment rate and / or its variations. The other variables introduced remain dependent on the country's institutional, political and social context. For example, we have tried to apply the Mc Morrow model (1996), which focuses on the famous price-wage loop, but in all its versions it led to a very high NAIRU that exceeds the effective unemployment rate over the entire period. While this possibility is not excluded by in the literature, but we preferred to adopt the results provided by the Taheri model.

In order to be able to identify the effect of hysteresis in the process of unemployment⁹, the model assumes that the NAIRU follows a self-regressive behavior:

$$U_t^* = \beta_1 U_{t-1} + \beta_2 Z_t \quad (2)$$

With, Z_t : a composite vector containing all the variables (productivity, terms of trade variations, etc.) that can influence the determination of the NAIRU.

If $\beta_1 = 0$, the stationary value of the NAIRU will be independent of the actual current unemployment rate and in this case will be equal to $\bar{U}^* = \beta_2 \bar{Z}$, with \bar{Z} the stationary value of Z . This is actually the assumption of the natural unemployment rate.

In the case of $\beta_1 = 1$ ¹⁰, there is a hysteresis effect expressed by a stationary value of the NAIRU, variable and dependent on the trajectory of Z_t in time, thus:

$$\bar{U}^* = U_0 + \beta_2 \sum z_t \quad (3)$$

For $0 < \beta_1 < 1$, the NAIRU will be equal to $\bar{U}^* = \frac{\beta_2 \bar{Z}}{(1 - \beta_1)}$.

Here, against the assumption of the natural unemployment rate, the effective unemployment rate will gradually move towards the NAIRU, with a rate of adjustment inversely proportional to β_1 .

If we substitute equation (2) in (1) and considering $\Delta U_t = U_t - U_{t-1}$, we can write:

$$\begin{aligned} \Delta w_t &= \alpha_1 \Delta w_{t-1} + \alpha_2 (\beta_1 U_{t-1} + \beta_2 Z_t - U_t) \\ &= \alpha_1 \Delta w_{t-1} + \alpha_2 \beta_1 U_{t-1} - \alpha_2 U_t + \alpha_2 \beta_2 Z_t \\ &= \alpha_1 \Delta w_{t-1} - \alpha_2 U_t + \alpha_2 U_{t-1} - \alpha_2 U_{t-1} + \alpha_2 \beta_1 U_{t-1} + \alpha_2 \beta_2 Z_t \\ \Delta w_t &= \alpha_1 \Delta w_{t-1} - \alpha_2 \Delta U_t - \alpha_2 (1 - \beta_1) U_{t-1} + \alpha_2 \beta_2 Z_t \end{aligned} \quad (4)$$

It is according to the value of β_1 in equation (4) that we can distinguish between three alternatives.

First, in the case of the natural unemployment rate, i.e. $\alpha_1 = 1$ and $\beta_1 = 0$ and equation (4) is reduced to: $\Delta w_t = \Delta w_{t-1} - \alpha_2 U_t + \alpha_2 \beta_2 Z_t$ (5)

$$\text{or } \Delta^2 w_t = -\alpha_2 U_t + \alpha_2 \beta_2 Z_t \quad (6)$$

So, for the natural rate assumption, it is the acceleration (deceleration) of inflation that is influenced by the level of the unemployment rate.

Second, for the case of hysteresis, i.e. $\beta_1 = 1$ and $\alpha_1 \neq 1$, equation (4) is reduced to:

$$\Delta w_t = \alpha_1 \Delta w_{t-1} - \alpha_2 \Delta U_t + \alpha_2 \beta_2 Z_t \quad (7)$$

⁹ The existence of a hysteresis phenomenon is based on the belief that a period of prolonged unemployment may lead to a weakening of the competitive mechanisms, in particular to a decrease in the influence of unemployment on the growth of the real wage and therefore an initially cyclical unemployment can turn into structural unemployment. Econometrically, this phenomenon means that the wage growth rate is no longer sensitive to the level of unemployment but rather to its variation, i.e. to the difference between actual unemployment and a weighted average of past unemployment.

¹⁰ We show below, following econometric estimates that this is the case for the Tunisian NAIRU

According to equation (7), in the case of hysteresis, inflation will be influenced only by changes in the rate of unemployment.

Finally, for the case of persistence of the adjustment process, equation 4 provides a simple way to test simultaneously the three hypotheses: natural unemployment rate; hysteresis and persistence of the adjustment process. i.e. $\alpha_1 \neq 1$ and, $\beta_1 \neq 0$, $\beta_1 \neq 1$, that is to say. $0 < \alpha_1 < 1$ et $0 < \beta_1 < 1$.

3.2. The explanatory variables of the NAIRU in Tunisia

The explanation of the NAIRU in Tunisia pertains to the unemployment/inflation relationship in the period 1970-2016. To analyze empirically equation (4), we integrate in the vector Z_t , which groups other than the unemployment rate and its variation, the three variables: terms of trade, labor productivity gain and its trend. Two dummy variables are introduced. It should be noted that the variables are expressed in logarithms of the export and import price indices.

a. The terms of trade

We designate this variable as *PMPC*.

Returning to the variable in the original version of the model developed by Taheri (2000), we find the presence of a delay period which is explained by the introduction of an adaptive anticipation hypothesis on prices. It is also possibly explained by the use of quarterly price indices but this is not relevant in the context of this paper as we rely on annual data.¹¹

b. The labor productivity gain

This gain is measured by $\text{Port}_t^* = (\Delta x_t - \Delta x_t^*)$ which is the difference between the growth rate of the actual labor productivity and its estimated trend over time, with x_t and x_t^* respectively being the logarithms of the apparent productivity of work and its trend.

The apparent productivity of the labor factor¹² represents a real indicator of supply shocks; its introduction into the wage equation responds to the foundation of the "increased Phillips curve" (Phan Duc Loic (1971)). The net effect of labor productivity on the volume of employment is not obvious¹³, but its effect on wages should be positive. In this model, the productivity shock on wages is introduced by taking into account the gap between the evolution of productivity and that of its trend.

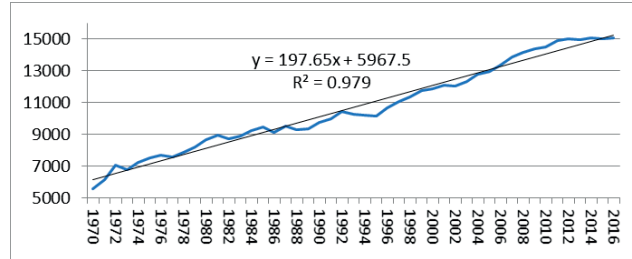
If this difference is positive it would imply a positive shock on the salary and vice versa. We try in econometric estimations to introduce a delay in the specification so that the social partners have the value of this variable and introduce it into wage negotiations.

¹¹ Data on the various annual price indexes for the period 1970 to 2016 are available in the INS statistical yearbooks.

¹² The Phillips curve literature considers that the term "augmented" is due to the introduction of certain structural variables into the Phillips curve equation, such as labor productivity, terms of trade, incomes compensation, and union negotiations.

¹³ According to Okun's law it depends on the gap between productivity and growth.

**Figure 4. Evolution of labor productivity and its trend
(1970-2016)**



The productivity trend (x^*) is calculated by determining an equation to the trend curve associated with the evolution of productivity over time. A linear trend curve is associated with $R^2 = 0.979$ and is therefore retained.

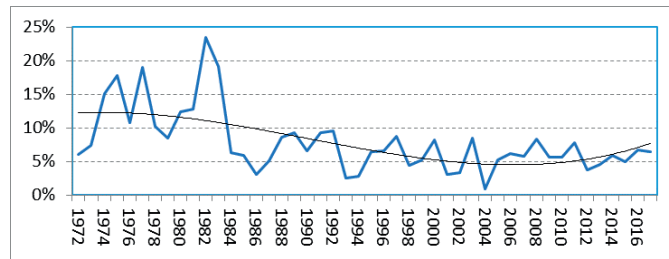
The apparent productivity of labor is calculated by relating GDP at constant prices (2005) to the number of employees. Subsequently was transformed into Log and we calculate the first differences to get Δx_t^* . We proceed in the same way for productivity and we get Δx_t .

c. Dummy variables

We introduce two dummy variables, the years 1982 and 2011. Indeed, the reading of events influencing wage bargaining in 1982 shows that there had been very high wage increases (figure3) not accompanied by improvements in real labor performance indicators. In fact, with an increase of more than 24% in the average annual wage, productivity fell by 3.4%.

The year 2011 saw the outbreak of the successful uprising. Since then major difficulties have been affecting the country's productive system and political stability. A major illustration is the question of wages which has been influenced more by social and political than by economic considerations.

**Figure 5: Average annual wage growth rate and its trend in Tunisia
(1972-2016)**



3.3. Estimation of the salary equation

By incorporating the variables predicted by the econometric model into equation (4), we obtain the following empirical equation:

$$\Delta w_t = C1 + C2\Delta w_{t-1} + C3\Delta U_t + C4U_{t-1} + C5\Delta Tech_t + C6PorT_t^* + u_t \quad (8)$$

Recall that: Δw_t is the nominal wage growth measured by the first difference of the log of the nominal wage between t and $t-1$; $\Delta Tech_t$ is the difference between the growth rates of the export price index and the import index; $PorT_t^*$ indicates the productivity shock.

In accordance with equation (4) of the theoretical model, the coefficients to be estimated will be interpreted as follows:

$$C_2 = \alpha_1, C_3 = -\alpha_2, \text{ et } C_6 = -\alpha_2(1-\beta)$$

The external terms of change are included in the Z_t vector, which is composed of variables that can influence the NAIRU. The integration of this variable into the vector Z_t depends on its determined empirical relevance.

In practical terms, the omission of this variable implies that, in Tunisia, the wage bargaining process is not influenced by the terms of trade variations. At the theoretical level, the disappearance of this variable does not prevent the determination of the NAIRU variable as long as the productivity variable remains significant.

The omission of the variable ΔU_t amounts to assuming that its coefficient will be zero in the estimated equation. Testing this hypothesis of the nullity of the estimated coefficient in the original model equation, provides a probability of rejecting $C_3 = 0$ at a 50.3% risk of being erroneous on the basis of Chi-square statistics and 51.1% on the Fisher's statistical basis. It follows that $C_3 = 0$ does not pose any empirical problem. However, $C_3 = 0$ results in $-\alpha_2 = 0$ in equation (4) of the theoretical model. Thus, not only will we eliminate ΔU_t from the empirical equation but also U_{t-1} . Under these conditions, the estimation of the wage equation does not account for the variable unemployment rate and therefore will not measure the NAIRU.

Table 1: The estimation Results of the Standard Model

. reg	dwt	1.dwt	dUt	1.Ut	dTECH	PorT	
Source							SS df MS
Model							Number of obs = 45
Residual							F(5, 39) = 3.90
Total							Prob > F = 0.0058
							R-squared = 0.3331
							Adj R-squared = 0.2476
							Root MSE = .04111
	dwt						
	L1.	.501383	.1454025	3.45	0.001	.2072787	.7954874
	dUt	-.0984147	.6600374	-0.15	0.882	-1.433466	1.236637
	Ut						
	L1.	-.3351953	.4272988	-0.78	0.438	-1.199489	.529098
	dTECH	.211421	.1402666	1.51	0.140	-.072295	.4951369
	PorT	.0323945	.2079595	0.16	0.877	-.3882434	.4530323
	_cons	.0863234	.0618231	1.40	0.171	-.0387256	.2113723

The results of equation (8)'s estimation (Table N°1), show that this model is not appropriate to the Tunisian context. Indeed, the impact of the unemployment variation and delayed unemployment, which are the key variables of the model, are not significant although the signs are negative according to the theoretical model. Similarly, the impact of productivity's fluctuations is not significant. We must underline the positive and sufficiently significant effect of exchange terms. It appears that in this version the econometric model requires improvements.

To improve the results of Table 1 in accordance with the theoretical foundations of the basic model, we proceed to drop the delayed unemployment variable U_{t-1} ($C_4=0$) and introduce the two dummy variables for 1982 and 2011. As already noted, these two years ~~that~~ were marked by two instabilities relating to wage bargaining in Tunisia.

- The year 1982, witnessed remarkable increases in wages that were not accompanied by productivity improvements. Infact simultaneously with an increase of more than 24% of the average annual salary, productivity recorded a fall of 3.4%.
- The year 2011 saw the start of wage negotiations after the revolution regardless of productivity.

Table 2 shows the results of the estimation of the new model according to the equation (9) so we will maintain the following structural form of the wage equation to be estimated:

$$\Delta w_t = C1 + C2\Delta w_{t-1} + C3\Delta U_t + C5 \Delta Tech_t + C6 PorT + C7Dummy82 + C8Dummy11$$

u_t
(9)

Table 2: Estimation result of model with dummy variables

```
. reg dwt l.dwt dUt dTECH PorT Dum82 Dum11
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Source	SS	df	MS	Number of obs = 45		
Model	.05242149	6	.008736915	F(6, 38) = 7.15		
Residual	.046416993	38	.0012215	Prob > F = 0.0000		
				R-squared = 0.5304		
				Adj R-squared = 0.4562		
Total	.098838483	44	.002246329	Root MSE = .03495		

dwt	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
dwt						
L.	.481557	.1283748	3.75	0.001	.2216759	.7414382
dUt	-1.62102	.964432	-1.68	0.101	-3.573411	.3313702
dTECH	.2518897	.1235775	2.04	0.049	.0017201	.5020592
PorT	-.0132831	.1828858	-0.07	0.942	-.383516	.3569498
Dum82	.1558118	.0382322	4.08	0.000	.0784147	.2332089
Dum11	.1081955	.0663114	1.63	0.111	-.026045	.2424359
_cons	.0345034	.0116545	2.96	0.005	.0109102	.0580967

The problem persists for the variable PorT, which turned out to be non-significant with a negative sign contrary to the model's theoretical foundations. We tried to test several models in order to improve the results while keeping the structural variables of the model (lagged nominal wage variations and unemployment)

Table 3 summarizes the different tests and indicates the adapted specification that corresponds to model 4.

Table 3. Results of the estimations for Tunisian context

	(1)	(2)	(3)	(4)
VARIABLES	modèle1	modèle2	modèle3	modèle4
L.dwt	0.501***	0.502***	0.521***	0.477***
	(0.145)	(0.145)	(0.125)	(0.108)
dUt	-0.0984	0.0881	0.105	-1.609*
	(0.660)	(0.613)	(0.602)	(0.937)
L.Ut	-0.335			
	(0.427)			
dTECH	0.211	0.225	0.232*	0.250**
	(0.140)	(0.139)	(0.134)	(0.118)
PorT	0.0324	0.0535		
	(0.208)	(0.205)		
Dum82				0.156***
				(0.0377)
Dum11				0.107*
				(0.0628)
Constant	0.0863	0.0389***	0.0377***	0.0349***
	(0.0618)	(0.0128)	(0.0118)	(0.0105)
Observations	45	45	45	45
R-squared	0.333	0.323	0.321	0.530

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

In light of these results, we can note according to the following equation:

$$\Delta w_t = \alpha_1 \Delta w_{t-1} - \alpha_2 \Delta U_t - \alpha_2 (1 - \beta_1) U_{t-1} + \alpha_2 \beta_2 Z_t$$

-First, $\alpha_1 = C2 = 0.477$, i.e. less than 1, which indicates that we do not have a fixed natural unemployment rate for the entire period of estimation. And therefore the NAIRU can change from one period to another regardless of the value of $\alpha_2 = -C4$. This change can be explained by the economic situation of the Tunisian economy and the applied economic policies.

- Second, if the value of α_2 is greater than 1 ($\alpha_2 = 1.609$) this suggests the existence of a hysteresis phenomenon. But the change in the unemployment rate is not significant in the wage equation ($\beta_1 = 1$) and therefore this hysteresis is partial and not total.

- Finally, the coefficient associated with the exchange terms $C5 = 0.25$ (which corresponds to $\alpha_2\beta_2$ of the theoretical model), which implies that $\beta_2 = 0.148$.

The conclusion that can be drawn from these results is that the Tunisian labor market is characterized by a partial hysteresis, and does not allow for a stable natural unemployment rate

3.4. Determination of the Tunisian NAIRU

As the NAIRU is an unemployment rate calculated from a salary equation based on augmented Phillips curve logic, the estimated equation must be solved by assuming that inflation is stable, i.e. the nominal wage growth rate is fixed. In this case, the unemployment rate will be equivalent to the NAIRU.

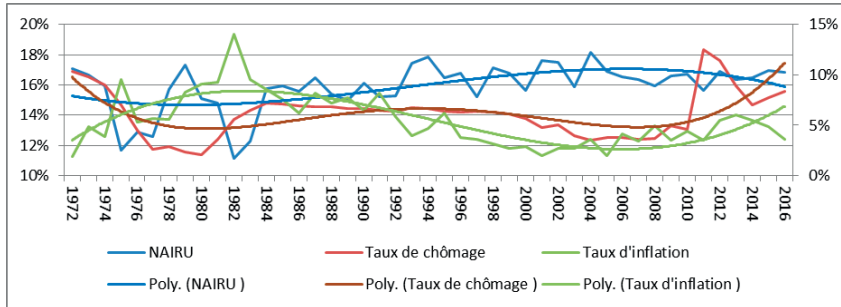
Let $dw_t = dw_{t-1} \Rightarrow U = U^*$ by replacing these two expressions in the estimated equation (9) we will have:

$$U^* = \frac{c(1) - dw_t(1 - c(2)) + c(5)\Delta Tech_t + C(6) PorT + C(7) Dummy 82 + C(8) Dummy 11}{-c(4)}$$

$$U^* = \frac{c(1) - dw_t(1 - c(2)) + c(5)\Delta Tech_t + c(6) Dum82 + c(7) Dum11}{-c(4)}$$

$$U^* = \frac{0.0349 - dw_t(1 - 0.477) + 0.25 \Delta Tech_t + 0.156 Dum82 + 0.107 Dum11}{1.609}$$

Figure 6- NAIRU, the unemployment rate and inflation and their trends (1970-2016)



This figure shows that over the entire period 1970-2016, the NAIRU was higher than the unemployment rate except for five years (1975, 1982, 1983, 2011 and 2012). Its oscillations in the period 1970-1993 had greater amplitude, with a standard deviation of 2.16, than in the subsequent period 1994-2016 with a standard deviation of only 1.18. A NAIRU averaging 15.9% against 14.0% for the actual rate meant that the scope for cyclical policy to reduce unemployment has been very limited in that the cost in terms of inflation would, in most cases, have been very high and remains so.

VI. Policy Implications

The foregoing analysis shows that the Tunisian natural unemployment rate is no longer determined by factor productivity but by the terms of trade that have contributed to the prevalence of a high NAIRU. And with it, cyclical policies have reached their limit. Henceforth, the authorities would instead need to implement structural economic policies that raise total factor productivity. Among other policies, this would call for the development of the educational system to provide the required professional and skilled manpower, developing the country's infrastructure, adopting a new industrial policy and implementing a supporting fiscal and monetary policy in brief, a major shift in the country's model of development.

With the above in mind we can draw the following policy implications:

1. Tunisia, has entered a cycle of stagflation. Governmental policies should, therefore, focus on stimulating supply rather than demand. Specifically, levels of productivity should be raised, quality of institutions improved and exports encouraged. Concomitantly it is important to develop the educational system to become better aligned with the rapid technological changes thereby enabling it to meet the evolving needs of national economic and social development. This would require a national consensus on the nature of knowledge to be transmitted to form a skilled and creative workforce and by extension the development of quality universities and training centers that, among other things, will serve this purpose.

2. Policies that encourage high-added-value industrialization which the government should have adopted but failed to do so, should be given high priority. This type of industrialization would provide expanding employment opportunities for graduates with higher education and specializations and contribute to the creation of a needed new and development model for Tunisia. Towards attaining this objective the Government should endeavor to create a business environment that would attract both domestic and foreign private investment to high value industrial ventures. If successful, such policies would lay the foundations for a sustained and balanced national development.

3. Monetary policy should play an active role in promoting the Tunisian manufacturing industry. In particular the Central Bank's interest rate policy should favour capital intensive industries over those that are not, export oriented over home industries, and healthy industries over risk prone or weak industries. On a broader level Tunisian banking regulations need to be reformed and the banking system modernized with the objective of rendering it more effective in supporting the structural transformation of the private sector.

4. The authorities should adopt a development policy aimed at reducing regional income and social inequalities; this would prepare the less advanced regions to benefit from the positive spillover effects of agglomerations and to better integrate into the world economy so that they can develop in a more dynamic and sustainable

5. In Tunisia, the partnership between the state sponsored scientific research organizations and the productive sectors could play an important role in helping map developmental goals especially in the scientific domain. However bureaucratic lags have posed obstacles to an effective partnership by causing major interruptions in obtaining timely funding for research and development programs. Specifically the Ministry of Higher Education and Scientific Research, which is in charge of

promoting research, has had to face undue delays in providing required funding linked to the prevailing public financial management system. Corrective policies that address this issue are urgently needed¹⁴.

V. Conclusion

The NAIRU in Tunisia has been and remains a little above an already relatively high actual unemployment rate, in particular of university graduating students. This calls for a major reorientation in the country's economic and social policies in order to reduce unemployment and bolster national economic and political stability. Along with macroeconomic policies aimed at controlling inflationary pressures, whatever their causes, the implementation of measures that focus on raising the level of factor productivity in the various economic sectors is urgently needed. This would help break the vicious circle of low cost labor and a low value-added productive system which has come to prevail in Tunisia and open the door for the employment of a growing skilled work force and the resurgence of national economic growth.

¹⁴ In this connection it is worth noting that lack of proper maintenance of major equipment at state laboratories had led to their being underutilized that, in turn, has affected negatively the carrying out of planned research programs.

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