Etimating NAIRU: the Morocco case

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Abstract:

The concept of NAIRU summarized the observed negative correlation between the unemployment rate and the inflation rate for a number of countries. This correlation persuaded some analysts of the impossibility for governments to simultaneously target both low unemployment and price stability. Therefore, it was government's role to seek a point on the trade-off between the two objectives which matched a domestic social consensus. In this paper, we intend to estimate the Moroccan's NAIRU for 1998Q1-2012Q4 period by applying the Kalman filter.

JEL numbers: C13, C22, E24, E31

Key words: NAIRU, Kalman filter, HP filter, Cointegration, Unemployment rate, Inflation rate, Phillips curve, Morocco.

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Introduction

The links between inflation and unemployment have been a major object of macroeconomic analysis and have resulted in intense academic activity during the last decades. Phillips' work in 1958 documented an empirical link between the growth rate of wages and the level of unemployment. Samuelson and Solow (1960) deduced a trade-off between inflation and unemployment that was refuted later by Phelps in 1967[1] and Friedman in 1968[2]. Lucas is the next protagonist in the story of the natural rate of unemployment, and his research in the late 1960's and early 1970's was responsible for full recognition of the concept in the economic literature[3]. Actually, the debate is still active and the development of econometrics has not yet resolved the question of the existence, the value of the equilibrium unemployment rate, its determinants, and its relationship with inflation as well as, the nature of the relationship between inflation and employment.

Most economists do not use the Phillips curve in its original form because it was shown to be too simplistic. There are two modified forms of the Phillips curve to distinguish between short-run and long- run effects on employment. In the short-run, a trade-off exists between inflation and unemployment. This relationship is called the expectations-augmented Phillips Curve since it shifts up when inflationary expectations rise. In the long- run, the unemployment rate depends essentially on structural variables, whereas inflation is a monetary phenomenon. Therefore, monetary policy cannot affect its "natural rate", also called the Non-Accelerating Inflation Rate of Employment (NAIRU) or the employment rate consistent with stable inflation. This concept is an important challenge facing policy makers because it is important to identify the rate of capacity utilization that is sustainable, in the sense that it is associated with reasonably stable inflation, over the medium to longer term.

The measurement of the NAIRU is controversial. "By its nature, it is non-observable and depends on a wide range of institutional and economic factors. It follows that even if one

[1] The author "presents a dynamic macroeconomic model from which is derived the optimal time-path of aggregate employment...an optimal utilization or employment path is one which maximizes the social utility integral subject to the adaptive expectations mechanism that governs the shifting of the Quasi-Phillips Curve." Phelps, 1967, p.254.

[2] Friedman introduced in his analysis the natural rate of unemployment which measure "the level that would be ground out by the Walrasian system of general equilibrium equations, provided there is imbedded in them the actual structural characteristics of the labor and commodity markets, including market imperfections, stochastic variability in demands and supplies, the cost of gathering information about job vacancies and labor availabilities, the costs of mobility, and so on." Friedman, 1968, p.8.

[3] For more explication, see Danilo Freitas (2011).

accepts the concept, it can only be estimated with uncertainty and it may well vary over time" (Turner and al., 2001, p.172). Although, this variable is not observable, it is important to estimate it for the case of the Moroccan economy because it can give us some possibilities for analyzing the evolution of unemployment and inflation and, generally, the economic policy. However, before estimating the NAIRU by the Kalman filter, we examine the existence or non-existence of a long run relationship between inflation and unemployment rate.

To attain this objective, this paper includes five sections. The next section discusses briefly some theoretical concepts related to the NAIRU. In the second section, we analyze the Moroccan labor market. In the third section, we estimate the long-run Phillips curve. This relationship is determined by the VECM, which is able to capture the short run dynamical relationships between variables and the long run dynamics resumed by the residuals of the cointegrating equation lagged by one period. In the fourth section, we estimate the time varying NAIRU by Kalman filter and we compare it to HP filter estimates. This model relies on the standard "triangle model" approach that includes various measures of supply and demand shocks in the specification of the Phillips curve, (Gordon, 1997). In the last section, we discuss the results and draw major conclusions.

1. Literature Reviews

The concept of NAIRU[4], dates back to Friedman (1968) and Phelps (1967). It is the result from the replacement of the traditional Phillips Curve by an Augmented Phillips Curve. While the Phillips curve leads to a dilemma inflation-unemployment, the consideration of expectations inflation in the formation of wage leads to a less favorable result: there is a unique rate of unemployment independent of the level of inflation (NAIRU), consistent with the stability of the inflation. When the agents' expectations are formed adaptively and the wage-price indexation is complete in the long-term, then the inflation increases when the unemployment rate is less than this NAIRU.

According to Turner and al. (2001), "the simplest theoretical framework incorporating the NAIRU concept in a transparent fashion is the augmented Phillips curve, which is also consistent with a variety of alternative structural models". Gordon (1997), also, specified a

[4] The first mention of this concept in the literature is allocated to Modigliani and Papademos, that define it as the measure of unemployment under which inflation has no tendency to increase or to decrease.

model called "triangle model" where inflation is determined by three factors: expectations/inertia, the pressure of demand as proxied by unemployment and supply factors[5].

The concept of NAIRU is related to inflation. However, inflation expectations are "often slow moving, which means that the effects of demand pressures or supply shocks get built into the inflation process only gradually. With regards to demand pressures, unemployment may be important not just in terms of its level, but also its recent movements", (Turner and al., 2001, p. 173). Thus, it is useful to identify three distinct concepts: the NAIRU (with no qualifying adjective), the short-term NAIRU and the long-term equilibrium rate of unemployment. Each of these three concepts relates to the same basic idea of an "unemployment rate consistent with stable inflation", but differs according to the time horizon to which they refer.

The concept of NAIRU is difficult to quantify because it is not observable. However, numerous estimation methods can be used to measure this variable. These methods may be divided into three categories: structural method, statistical method and reduced-form method.

In the structural method, the NAIRU is derived as the equilibrium of a structural model of the aggregate wage and price setting behaviors, assuming that markets are in full or some partial equilibrium. In the statistical method, the actual unemployment rate is directly divided into cyclical and trend components, where the NAIRU is simply the trend component. In the reduced-form method, the NAIRU is estimated, similarly to structural method, on the basis of a behavioral equation explaining inflation, normally the expectations-augmented Phillips curve. This method is considered as a compromise between structural and statistical methods, and the most popular technique in recent studies because it is simple to apply. Unfortunately, the reduced-form method has, also, a number of disadvantages. The main disadvantage is that "the results may be sensitive to arbitrary choices in the model" (Szeto, K.L. and Guy, M., 2004). In particular, the parameter that is chosen arbitrary is the signal to noise ratio[6]. Stock and Watson (1998) have attempted to resolve this problem while

[5] Heyer, E. et Timbeau, X. (2002) specified those three factors as: (1) past inflation, (2) demand is measured by the gap between observed unemployment rate and NAIRU (it is estimated by the Kalman filter), and (3) supply factors (importation price, trend growth of productivity...).

[6] The signal-to-noise ratio measures volatility or variance in the NAIRU relative to volatility or variance in inflation. For more explication, see the fourth section in this paper.

estimating this ratio that has been applied to an unobserved components model of trend growth of per capita Gross Domestic Product in post-war U.S. economy.

2. Evolution of unemployment and inflation in the Moroccan economy

The structure of the Moroccan economy is dominated by services. The services contribute to GDP by an average share 55% during 2009-2013 and its contribution in labor force is more than 38%. Manufacturing is the second contributing sector in GDP by an average share of 23% and its contribution in labor force is around 12%. The sector of "Agriculture, fishing and hunting" contributes to GDP by a share between 14% and 17% depending on the climatic conditions of the year. More than 40% of labor force exercises in this sector. The sector of "construction and public works" is in expansion in Morocco. This sector contributes to GDP by an average share of 7% and its contribution in labor force is more than 9%. Table 1 summarizes the distribution of employed labor force by sector and the contribution of sector To GDP during the period 2009-2013.

Table 1. Repartition of employed population 'L' by sector and contribution sector in GDP 'P_s'

	2009		2010		2011		2012		2013	
	L	Ps	L	Ps	L	Ps	L	Ps	L	Ps
Agriculture, fishing and hunting	40.5	16.4	40.2	15.3	39.8	15.5	39.2	14.4	39.4	14.7
Industry (including handcraft)	12.3	21.6	12.2	22.8	11.8	23.8	11.5	23.8	12.0	21.6
Construction and public works	9.4	7.0	9.9	6.8	10.1	6.5	9.9	6.5	9.4	9.8
Services	37.8	55.0	37.7	55.0	38.3	54.3	39.4	55.3	39.2	53.9

Source: Elaborated with HCP data

The analysis of the evolution of the unemployment rate between 1980 and 2011 reveals two trends[7] (see figure 1 in appendix). An upward trend of unemployment rate between 1980 and 1999: the rate increased from 9% in 1980 to 16.7% in 1994, decreased 12% in 1997, and increased to 13.9% in 1999[8]. A downward trend of unemployment rate between 2000 and 2011[9]: the national rate increased from 13.4% to 8.9%. This decrease was recorded

[7] The data are gotten from the HCP, Morocco.
[8] This situation has the consequence of the application of the PAS. This program has discouraged the social sectors as the education, the health and the habitat. The direct impact is the deterioration of the life's condition of the major part of Moroccan population and the indirect impact is the increase of the unemployment rate.
[9] The Moroccan economy has known, during this period, a significant expansion in spite of the drought's effect.

in the urban areas (the unemployment rate decreased from 22.4% to 13.3%) and rural areas (the unemployment rate decreased from 5.4% to 3.9%), (see figure 2 in appendix).

Moreover, this downward trend between 2000 and 2011 has not affected all categories of job-seekers (see figure 3 in appendix). The unemployment rate of the graduates[10] has registered a decline of more than ten points between 2000 and 2011 against only four points for no-graduates.

The unemployment rate of women remains higher than that of men[11] (see figure 4 in appendix). According to table, the rates of the population active of young aged 15 to 34 are lower than that of the non-young aged 35 to 45 or more in all years during 2000-2013.

Table 2. Unemployment rate in Morocco, 2000-2013

	Mean 2000-09	2010	2011	2012	2013
Total	10.9	9.1	8.9	9	9.2
Men	10.8	8.9	8.4	8.7	9.1
Women	11.1	9.6	10.2	9.9	9.6
Area					
Rural	3.9	3.9	3.9	4	3.8
Urban	17.5	13.7	13.4	13.4	14
Formation					
High Educated	24.1	18.1	19.4	18.7	19
Averagely Educated	20.9	16	15.4	15.3	15.1
Not Educated	5.3	4.5	4	4	4.5
Age					
15-24	17.5	17.6	17.9	18.6	19.3
25-34	16.2	12.8	12.9	13.2	13.2
35-44	6.3	5.4	5.2	5	5.6
45 and +	2.1	2.1	1.8	1.9	2.3

Source: HCP data

Table 2 shows that unemployment in Morocco is characterized by four features. First, women are more exposed to unemployment than men. Second, young people are more exposed to unemployment than aged. Third, the urban rate of unemployment is higher than the rural rate. Fourth, the educated population is more exposed to unemployment than

[10] This rate regroups two categories of unemployed person, the high educated and the average educated.

[11] This situation is explained, in particular, by socio-cultural factors, which have direct and indirect impacts on the access of the women to the labour market. In spite of the progress in educational attainment, the disparity between the sexes remained remarkable; so, the rate of the non-education of the women is higher than that of the men. Moreover, the rate of poverty is still higher especially in the rural areas what hinders the access the young women at the school and at the work.

uneducated especially among women. These findings are similar to those of the World Bank (World Bank 2012).

The figure 1 in appendix shows, also, that the evolution of inflation rate between 1980 and 2011records two trends: a downward trend from 1980 to 1995 and a stable trend from 1996 to 2011 (inflation varies around almost 3%). This evolution increased by peaks in 1984 (12.5%), in 1991 (8.04%), in 2006 (3.32%), and in 2008 (3.9%). This situation is explicated by the Moroccan economic policy.

The Moroccan economy has known during the seventies a protectionist system of prices. The Government has controlled the prices of all sectors (agriculture, industry, energy and service). From the beginning of 1980s, the mechanisms of prices' formation have known important changes through the policies of economic liberalization. The impact of these changes has considerably influenced on the behavior of prices and the adjustments of labor markets.

Therefore, the relationship between inflation rate and unemployment rate is not clear. The period 1980 to 1997 indicates the opposite evolution between inflation rate and unemployment rate. However, the period 1998 to 2011 indicates that the unemployment rate records a downward trend and the inflation rate records a stable trend with the exception of some peaks. Therefore, we try to explain this relationship between inflation rate and unemployment.

3. Results and Discussion

3.1. Estimation of the Long-run Phillips Curve

Before estimating the long-run relationship between the unemployment rate and inflation, it is necessary to explore the stochastic proprieties of the variables taken in this work: the inflation rate (π), the importation price (*PM*), the price of added value (*Pav*), the unemployment rate (*U*), the productivity of labor (*PrL*) and the rate of investment (*RINV*). We want to know if the variables are stationary or not and in this later case determine their order of integration. We use the ADF test for the 1998Q1-2012Q4 sample period. The following table summarizes the main results.

Table 3. Stochastic properties of variables, quarterly data

	Variables in level		Variables in first difference		
Variables	**ADF statistic**	**Critical values of the ADF statistic**	**ADF statistic**	**Critical values of the ADF statistic**	**Conclusion**
π	-0.9543	-1.9471	-8.4890	-1.9471	I(1)
PM	-0.2265	-2.9126	-7.6018	-1.9467	I(1)
Pav	0.0759	-2.9126	-9.8235	-2.9126	I(1)+C
U	-0.5631	-2.9145	-7.8504	-1.9468	I(1)
PrL	1.5874	-2.9145	-9.2671	-2.9145	I(1)+C
RINV	-1.8173	-2.9126	-13.6481	-2.9126	I(1)+C

Source: Ours estimation

Notes:
- The critical value is at 5% level. C and T indicate that the ADF test is conducted with a constant and a trend.
- Results are obtained by using E-views 5

The important result is that inflation rate and unemployment rate are *I(1)*. The presence of unit root in both theses series has important consequences for empirical exercise and the interpretations of the existence of a long-run Phillips curve. The relationship between inflation and unemployment was explored by the cointegration test. Since the Johansen test was not able to identify any cointegrating relationship, it could be concluded that there is no long-run Phillips curve, but we can have a short-term relationship. On the other hand, the relationship between inflation rate and unemployment rate was tested while introducing other explanatory variables, as *Pav*, *RINV*, *PM* and *PrL*. We concluded the presence of a relation of cointegration. To complete the investigation, we will run a VECM to capture in the same framework the short run dynamical relationships between variables and the long run dynamics resumed by the residuals of the cointegrating equation lagged by one period. It showed that the VECM is validated if the coefficient attached to this residual is negative and significant.

- The long run relationship:

$$\pi_t = -0.8958*U_t - 12.3229*Pav_t + 36.2023*RINV_t + 22.8321*PM_t - 3.3536*PrL_t$$
$$(-0.2349)^* \quad (-11.3940) \quad (-13.0490) \quad (-3.9837) \quad (-0.4748)$$
$$[-3.7999]^* \quad [-1.0815] \quad [2.7743] \quad [5.7314] \quad [-7.0635]$$

- The short run dynamical relationship:

$$D(\pi_t)^{**} = -0.2005*\zeta_{t-1} - 0.0068*D(\pi_{t-1}) - 0.0226*D(U_{t-1}) - 3.2365*D(Pav_{t-1}) - 0.989419*D(RINV_{t-1})$$
$$(0.0948) \quad (0.1417) \quad (0.1894) \quad (13.3486) \quad (7.1976)$$
$$[-2.1155] \quad [-0.0478] \quad [-0.1194] \quad [-0.2424] \quad [-0.1374]$$
$$-0.452295*D(PM_{t-1}) + 0.743013*D(PrL_{t-1}) - 0.094831$$
$$(3.1999) \quad (0.4835) \quad (0.1724)$$
$$[-0.1413] \quad [1.5368] \quad [-0.5499]$$

*Standard errors in ( ) & t-statistics in [ ]

** D(..) indicates the first difference of the variable: $D(Y)=Y-Y_{-1}$

The VECM representation is validated because the coefficient attached to the error correction term ζ_{t-1} (the lagged residual of the cointegrating vector) is negative and significant at 5%. Moreover, we used other tests to ensure that the model is identified correctly. We found the following results: The coefficients attached to independent variables are non-significant individually but jointly they are significant at 5%. The residual tests have no serial correlation test, normal distribution test and no arch test are all good signs. In addition, the long run relationship indicates that the unemployment rate, the price of added value and the productivity of labor affect negatively the inflation rate. However, the rate of investment and the price of importation affect positively the inflation rate.

3.2. Estimation of Time-Varying NAIRU

In this section, we present briefly the estimation of the time-varying NAIRU (TV-NAIRU). This estimation relies on the standard "triangle model" approach that includes various measures of supply and demand shocks in the specification of the Phillips curve (Gordon, 1997).

The generic Phillips curve has the following form:

$$\begin{aligned} ®_t &= a(L)®_{t-1} + b(L)(U_t - U_t^N) + c(L)Z_t + e_t \\ e_t &\sim N(0, \pm_£^2) \end{aligned} \qquad (8)$$

The dependant variable π indicates the rate of inflation. The variable π_{t-1} describes the level of inflation inertia in the economy. The $(U\text{-}U^N)$ is assumed to measure the degree of demand pressures, called the unemployment gap (U and U^N present the unemployment rate and the NAIRU, respectively). The variables Z measures the degree of supply pressures and e_t is the error term. In this equation, the symbol L represents the lag operator. If the sum of coefficient $a(L)$ equals to unity, then there is a steady state: the inflation rate remains constant with the unemployment rate at NAIRU ($(U_t\text{-}U_t^N)=0$) and with supply shocks absent ($Z_t=0$).

The estimation of the TV-NAIRU combines the above inflation equation (8) with a second below equation that explicitly allows the NAIRU to vary with time:

$$\begin{aligned} U_t^N &= U_{t-1}^N + £_t, \\ or \quad U_t^N &= ¨ U_{t-1}^N + £_t, 0 \prec ¨ \leq 1 \\ e_t &\sim N(0, \pm_£^2) \end{aligned} \qquad (9)$$

This equation shows that the TV-NAIRU is "assumed to follow an unobserved stochastic process, with the usual pre-specification of its path ranging from autoregressive to random walk or random walk with drift", (Botrić, 2012, p. 168). The model, equation (8) and equation (9), is "a standard "stochastic time-varying parameter regression model" that can be estimated using maximum likelihood methods described by Hamilton (1994)" (Gordon, 1997, p. 20).

The errors margins in this model are vary with a means of zero and a standard deviations of σ_ε^2 and σ_e^2. The ratio of these variances ($\sigma_\varepsilon^2/\sigma_e^2$) is the signal-to-noise ratio. This ratio is fixed arbitrary: if σ_ε^2 is zero ($\sigma_\varepsilon^2=0$) then the natural rate is constant, if σ_ε^2 is positive ($\sigma_\varepsilon^2<0$) then the natural rate moves and can explains the variance in the inflation equation.

We use the Kalman filter method to estimate this model. The results are presented as follow:

$$\pi_t = \underset{\substack{(9.3480)\\[0.0000]}}{1.510} + \underset{\substack{(2.4208)\\[0.0155]}}{0.331*(\pi_{t-1}-\pi_{t-2})} + \underset{\substack{(3.2834)\\[0.0010]}}{0.413*(\pi_{t-3}-\pi_{t-4})} - \underset{\substack{(-1.8398)\\[0.0658]}}{3.762*(PM_t-PM_{t-1})} + \underset{\substack{(2.1446)\\[0.0320]}}{5.082*(PM_{t-3}-PM_{t-4})}$$

$$+ \underset{\substack{(2.3914)\\[0.0168]}}{27.356*(Pav_t-Pav_{t-1})} + \underset{\substack{(2.2400)\\[0.0251]}}{12.457*(TINV_{t-1}-TINV_{t-4})} - \underset{\substack{(-1.8949)\\[0.0581]}}{0.329*(U_t-NAIRU_t)} \quad (10)$$

-Log Likelihood=-168.057
-Z-statistics are in ( ) & P-value are in [ ]

The estimated coefficients are the expected sign. The unemployment gap (U-NAIRU) is significant and the deviation of the importation price is also, significant. The rate of investment and the price of added value are all significant at 5% level and affect positively the inflation rate. The NAIRU values are obtained through Kalman filter estimates based on equation (9).

In the last point for this analyze, we compare the Kalman filter estimates to HP filter estimates. The chart 5 presents the Kalman filter NAIRU estimates, HP filter estimates and Unemployment rate.

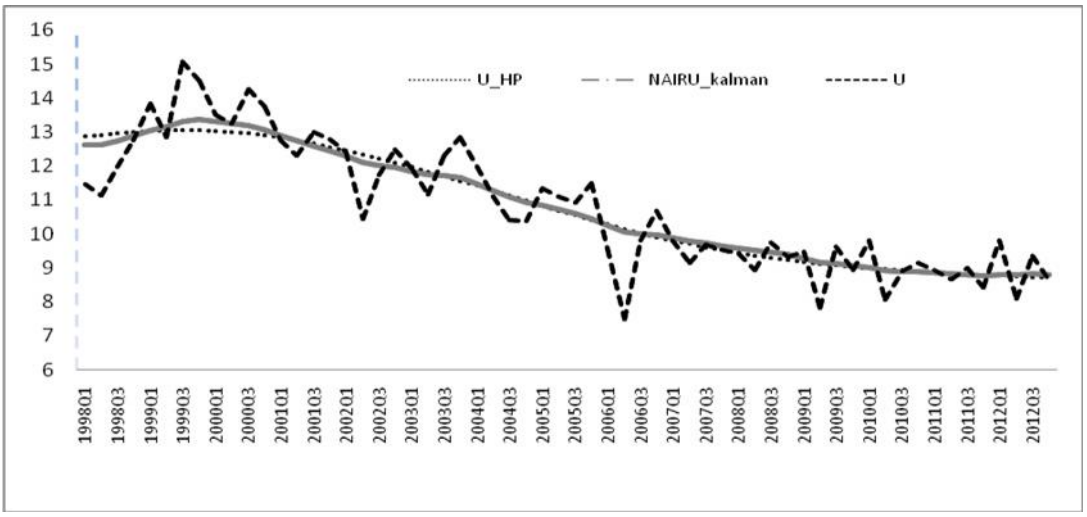

Figure 5: Kalman filter NAIRU estimates, HP filter estimates and Unemployment rate 1998Q1-2012Q4

The first thing to notice is that the estimated NAIRU is relatively smooth, which implies that the signal-to-noise ratio was relatively well specified. The average estimate of the NAIRU for the whole sample is 10.8%. Since the recorded unemployment rate has been relatively high throughout the sample period, and certainly higher than the estimated NAIRU. Moreover, the estimated NAIRU at the end of the sample period ranges between 9.02% to 8.80%. However, the NAIRU estimates using the HP filter at the end of the same period ranges between 9% to 8.7%.

To test the best filter in describing the movement of inflation, we include both filters in equation (10), than estimate by ordinary least squares (OLS). Therefore, the results in table 4 show that two models are similar with an advantage for the first model (the model with Kalman filter).

Table 4. Estimating equation (10) by OLS

	Kalman filter			HP filter		
C	1.508	(-0.133)	[0.000]	1.52	(-0.135)	[0.000]
π_{t-3}- π_{t-4}	0.324	(-0.114)	[0.007]	0.333	(-0.116)	[0.006]
π_{t-1}- π_{t-2}	0.409	(-0.110)	[0.001]	0.413	(-0.111)	[0.001]
PM_t- PM_{t-1}	-3.823	(-2.500)	[0.133]	-3.702	(-2.530)	[0.150]
PM_{t-3}-PM_{t-4}	5.101	(-2.443)	[0.042]	5.091	(-2.475)	[0.045]
Pav_t-Pav_{t-1}	28.38	(-10.090)	[0.007]	27.149	(-10.189)	[0.011]
$TINV_{t-1}$-$TINV_{t-4}$	12.648	(-5.199)	[0.019]	12.47	(-5.268)	[0.022]
U_t-U^*_t	-0.389	(-0.188)	[0.043]	-0.303	(-0.175)	[0.091]

Source: Our estimates

Notes:

- Standard error is in ( ) and P-value is in [ ].
- Results are obtained by using E-views 5

4. Conclusion

This paper has tried to determine the NAIRU for the Moroccan economy according to the structural method (traditional) and to the method of Kalman filter. For these methods, the unemployment rate is superior to the NAIRU which requires an expansionist policy of demand. This condition is the only guarantor of the creation of employment. So, it is necessary to increase the GDP and to promote domestic demand. This promotion is possible by developing the middle social class which is able to make social peace and economic growth. In addition, it is necessary to make more efforts in investment in sectors producing more value added and more attractive for investments like high technology communication and information technologies and agro-industry. The government policy must be based on the development of the human capital to improve the report quality / price especially after signature of the association agreement with the European Union.

However, we can say that this method has some limits as well. The informal sector influences the unemployment rate in Morocco. In fact, if the NAIRU is an unemployment rate which corresponds to stationary rate of inflation. It is the structural rate of unemployment that is determined by structural characteristic of the market of goods and the labor market. Or more the two markets are imperfect more the rate of structural unemployment is great. Therefore, this rate is biased. Markets of Informal work in Morocco influence this rate. The informal sector provides employment for 2.216 million people in 2007 according to the national Moroccan investigation on the informal sector (www.hcp.gov.ma).

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Appendix

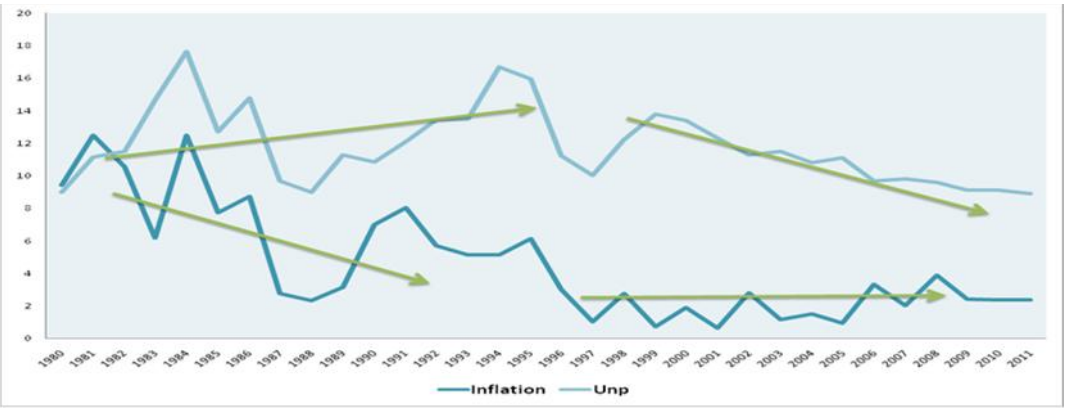


Figure 1: Annual unemployment rate and inflation 1980-2011

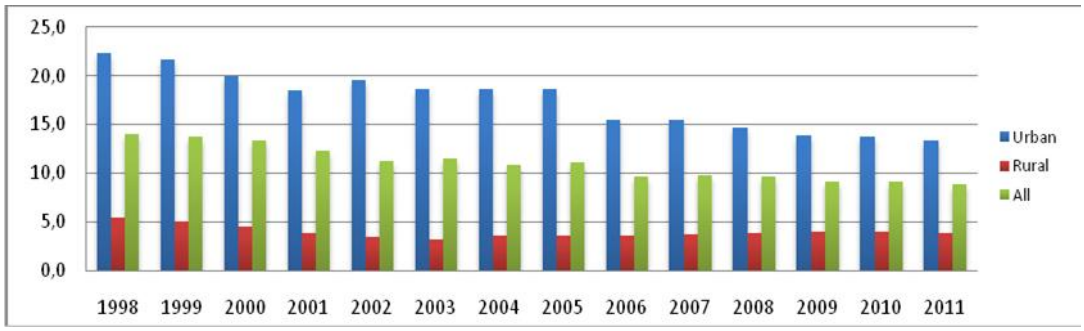
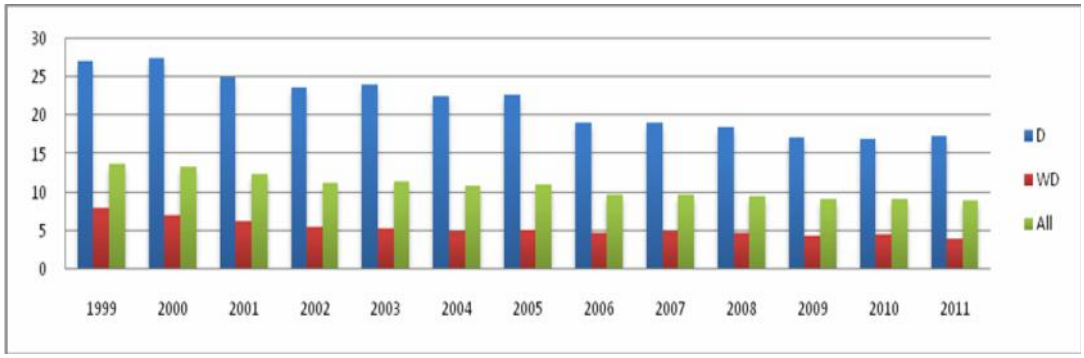


Figure 2: Annual unemployment rate according to areas 1999-2011



Notes:

D: unemployment Diploma (Graduate unemployment).

WD: unemployment No-Diploma (No-Graduate unemployment).

Figure 3: Annual unemployment rate according to diploma 1999-2011`

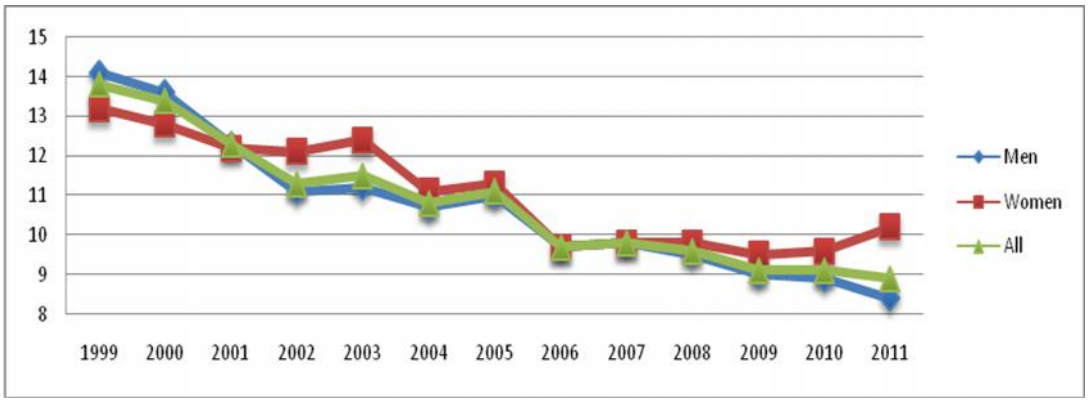


Figure 4: Annual unemployment rate according to sex 1999-2011