NOTES D'ÉTUDES

ET DE RECHERCHE

ESTIMATION OF A TIME VARYING NAIRU FOR FRANCE

Delphine Irac

July 2000

NER # 75

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Estimation of a time varying NAIRU for France[1]

Delphine Irac[2]

july 2000

Résumé

Dans la multitude de concepts que recouvre l'idée de chômage d'équilibre (chômage d'inadéquation, chômage non inflationniste, chômage tendanciel, chômage structurel), la notion qui présente le plus d'intérêt pour une banque centrale apparaît être celle de NAIRU puisqu'elle met directement l'accent sur l'inflation. Cette étude considère ainsi la relation de Phillips en forme réduite, supposant une relation stable entre inflation et déséquilibre de la demande, comme le point de départ le plus prometteur pour dériver une estimation du chômage d'équilibre. Nous adoptons une méthode semi-structurelle fondée sur la combinaison d'une approche économique et statistique. La relation de Phillips retenue s'inspire du « triangle model » suggéré par Gordon où l'inflation est déterminée par l'inertie des anticipations, l'excès de demande et des chocs d'offre défavorables. L'idée centrale de la méthode est de considérer le NAIRU comme un paramètre variant dans le temps, en imposant certains a priori sur sa volatilité : il est réestimé de période en période sur la base d'un modèle espace-état composé de la relation de Phillips retenue à laquelle a été associée une marche aléatoire décrivant l'évolution du NAIRU.

Moyennant des hypothèses raisonnables sur la variance des innovations affectant le NAIRU, l'estimation par la technique du filtre de Kalman d'un modèle espace-état composé de ces deux équations aboutit à des résultats empiriques sur la France qui apparaissent assez réalistes : le time varying NAIRU estimé rend compte de la montée graduelle du taux de chômage observé dans les années 1970 et 1980 tout en présentant un degré de variabilité acceptable (variations infra-annuelles faibles). En travaillant sur la période 1986-1999, le NAIRU obtenu s'élève à 10 % au deuxième trimestre 1999 (entre 9% et 11% compte tenu de la marge d'incertitude). L'estimation du modèle depuis le début des années 1970 donne le profil du time varying NAIRU sur les dernières décennies. Alors que le NAIRU a augmenté de 2,7 points entre 1977 et 1988, sa montée graduelle semble s'être ralentie depuis la deuxième partie des années 1980, avec deux périodes principales de décélération : la première durant la deuxième partie des années 1980 et la deuxième au milieu des années 1990.

Bien que cette méthode exploite l'ensemble d'information contenu dans la courbe de Phillips, elle ne permet pas d'identifier l'ensemble des paramètres structurels à l'œuvre dans la formation du NAIRU. Elle semble dès lors peu à même de fournir un programme de mesures détaillé pour réduire le NAIRU et doit donc être complétée, hors modèle, par le suivi d'indicateurs statistiques sur l'emploi (démographie, taux de remplacement...). Dans la deuxième partie de ce document, une mise en parallèle est ainsi faite entre le time varying NAIRU estimé et les informations dont on dispose sur le marché du travail. Selon nos évaluations, les facteurs démographiques ainsi que l'amélioration du coin fiscalo-social ont joué un rôle important dans la

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[1] The starting point of this document is a note that was begun at the EU1 Division of the IMF following a suggestion by A. Zanello and A. Ubide. This note was jointly written with F. Lenseigne. I wish to thank all of them for helpful comments. Of course I accept sole responsibility for any remaining errors.
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stabilisation du NAIRU ces dernières années. Par ailleurs, d'autres facteurs (niveau d'employabilité de la main d'œuvre, effet de seuil dans l'indemnisation du chômage…) ont probablement un impact significatif sur la formation du chômage d'équilibre.

Abstract

Among the several concepts encompassed by the idea of an equilibrium rate of unemployment (labour mismatch, unemployment trend, non inflationary unemployment, structural unemployment), the NAIRU appears as the more interesting one for a central bank since it focuses directly on inflation. Thus, the paper considers the reduced Phillips equation, assuming a stable relationship between inflation and some kind of demand desequilibrium index, as the most promising starting point to estimate an equilibrium rate of unemployment. We adopt a semi-structural method based on a combination of an economic and a statistical approach. The Phillips equation we consider is very close to the so-called "triangle model" suggested by Gordon, where inflation rate is determined by three factors (hence the "triangle") : adaptive expectations and inertia, excess demand or shortage – estimated by the gap between the actual unemployment rate and the NAIRU – and supply shock variables. We regard the NAIRU as a time-varying parameter and estimate a state space model composed of a random walk process that describes its variations over time and of a Phillips equation

Under reasonable assumptions on the innovations to the NAIRU equation, the estimation of the state-space model (using Kalman filter techniques) yields empirical results for France that appear quite convincing: the time varying NAIRU we obtain accounts for the steady increase in the actual unemployment rate during the 1970s and the 1980s and offers the appropriate degree of smoothness. Working on the sample 1986-1999 the time varying NAIRU amounts to 10% in the second quarter of 1999 (with an interval confidence between 9% and 11%). The estimation of the model since 1970 gives information on the path followed by the NAIRU during the last decades. Whereas the NAIRU increased by 2.7 points between 1977 and 1988, its steady rise seems to slow down somewhat since the second part of the 1980s, exhibiting two main deceleration periods: first during the second part of the 1980s and second in the mid-1990s.

Though this method exploits the set of information contained in the Phillips curve and provides fairly robust measures of the NAIRU, it gives little insight regarding its underlying determinants. It must therefore be completed by the analysis of the recent developments in French labour market. In the second part of this paper, we provide strong evidence that the changes in the NAIRU in France during these two episodes may be linked to significant shifts in the demographic composition of the workforce together with a break in the evolution of the fiscal-social wedge. Several other factors (such as threshold effects in unemployment benefits or individual abilities) play probably a major role in unemployment variation.

I) Introduction.

The NAIRU has acquired a very prominent and popular status in designing macro economic policy in developed countries. Nevertheless both policy making and academic circles contend that any concept of structural/equilibrium unemployment rate is far from being without problems as can be evidenced by endless debates and studies about its properties, its relevance for macroeconomic policy, its consistency, its stability and its determinants. Most economists seem however to agree that any model linking the inflationary process to demand desequilibrium - evaluated as the gap between unemployment rate and the NAIRU - should deliver at least two empirical results. First, the model must be consistent with past history of inflation and, more particularly, account for the desinflationary process in the 1980s, a decade when major structural changes were at play in the price formation process: shifting bargaining power between labor and capital, prices liberalization, peg of the FF to the DM, increasing competition stemming from emerging markets as well as within the EU, etc...Secondly, the cyclical component of unemployment must be stationary, which implies that the NAIRU must keep pace with the upward trend recorded in the unemployment rate in France. In this context, the NAIRU is likely to be non-stationary.

Most of the debate has focused on the traditional Phillips/Friedman curve assuming a **stable** relation between inflation, expected inflation and some kind of demand desequilibrium index (usually the difference between unemployment and the "structural" rate of unemployment) of the following form:

$$\pi = \pi^e + G(U)$$

Where π represents actual inflation, π^e expected inflation and U unemployment. In the long run, the price formation process is stable (actual inflation happens to be its expected value which in turn is steady at π^*) $\pi = \pi^e = \pi^*$, and U should be such that G(U) = 0. This restriction implies the disappearance of any trade off between inflation and unemployment in the long run. The equation thus delivers a Non Acceleration Inflation Rate of Unemployment (NAIRU).

This note is organized as follows. Section 2 provides some general considerations about the main drawbacks of the structural approach to determine the equilibrium rate of unemployment. In section 3, we consider several state space models based on a Phillips curve that yield different estimates of time varying NAIRUs for France (section 4 and 5). In section 6, we compare the time varying NAIRUs we have obtained to some structural variables reflecting labour market situation.

II) Failure of structural models to provide robust estimation of the equilibrium rate of unemployment.

The estimation of a traditional Phillips curve for France ordinary leads to two major problems: the instability of the estimated NAIRU and/or the inability to display the upward trend recorded in the unemployment rate since 1974. Estimating a standard Phillips curve for France, in which labor market variables (discretionary component of the increase in the minimum wage and employers social contribution) and terms of trade have been introduced as well as productivity growth, Cotis et alii (1996) obtain an inflation equation that fits the data quite well. But the NAIRU computed by this method shows a very high variability, even after smoothing with a Hodrick-Prescott filter. The smoothed NAIRU is still economically not acceptable: it fluctuates between 5% and 13% since 1974, peaking at 13% in 1981 to dive to 5% in 1988 to rise again to about 11% in 1993 to plunge again afterwards to **8.5% in 1995**. These large swings are probably due to the introduction of structural terms, especially the terms of trade, which fluctuate considerably in 1974 and 1979.

More generally, all methods aiming at identifying the influence of supply side variables, particularly of the labor market structure, on the NAIRU seem incapable of giving robust information about the determinants of the NAIRU. This failure is not only due to the lack of theoretical underpinnings that characterizes the Phillips curve. Indeed it has often been argued that the main drawback of the Phillips curve approach is the lack of firm theoretical and/or microeconomic foundations, being a “measurement without theory”. Its interpretation remains difficult since it does not embody explicitly microeconomic foundations guiding wage formation. Some models have explicitly aimed at overcoming this major drawback of the Phillips curve. The general framework of so called “WS-PS” (wage setting-price setting) class of models is that of imperfect competition on the labor market where workers are prone to ask for wages higher than their labor market clearing values. Several avenues have been explored to justify such settings: reservation wages (mostly due to unemployment and other benefits) prevent workers from working with a wage below a given threshold; efficiency wage models where firms pay higher wages than the clearing market wage in order to prompt workers to work more efficiently in a set up where they cannot get control over individual workers productivity; the “right to manage” models exhibit wages where workers set their own wage given the probability to be unemployed and unemployment benefits leaving firms to set the number of hiring in order to stay on their production curve; insiders/outsiders models which lead to hysteresis outcome with fired workers becoming permanent unemployed. All these four models share a common feature, namely unemployment is part of the wage formation process. They lead to the construction of the wage setting schedule, in which the level of wages depends on unemployment. This can be rewritten as a Phillips curve only in the case suggested by Manning (1993).

However, the standard (WS)-(PS) framework does not seem to provide a good representation of the labor market that can be conclusively exploited. First, the different terms that appear in this model are very difficult to quantify (like the bargaining power of unions) or display common trends and are therefore correlated with each other (fiscal/social wedge, minimum wages, and replacement rate…). Secondly, wages determination cannot be fully described by a bargaining process. For instance, firms may want to offer higher wages in order to keep the most efficient workers, to motivate their workforce or to save on turnover costs. Thirdly, it seems difficult to well identify the different trends that appear in the (WS)-(PS) model. According to Blanchard (1997), the (WS) curve moves with the reservation wages that keep pace with real wages and thus with the productivity trend (the main reason why productivity should not have influence on the NAIRU in the long run). (WS) is also influenced by many other factors that seem very difficult to identify such as the demographic structure of the labor force, the legal and administrative restrictions on layoffs etc... Adopting a (WS)-(PS) framework, Cotis et alii (1996) find a **10% equilibrium rate of unemployment at the end of 1995** and identify two main culprits that could be responsible for the 6.9 points increase of this rate since 1974: the fiscal wedge, that could explain 2.6 points and the real interest rate, that could explain 4.3 point. The latter can be understood as a transitory productivity shock: if the cost of capital increases, then the accumulation of capital slows down and so does productivity. As a consequence, in the short run, the equilibrium unemployment rate increases as long as workers have not adjusted their demands to the new regime of productivity trend. Again, the whole discussion here focuses on the speed of adjustment of wage demands to new trend in productivity. But as they underline, their conclusion does not seem really convincing since they neglect many variables likely to explain the lack of adjustment of real wages to the slowdown of productivity growth. More recently, using this framework, L'Horty & Rault (1999) have established a relation between the NAIRU and several structural variables[3] that yields a structural unemployment rate so close to the actual rate that we can wonder whether it really has an explanatory power in terms of long term diagnosis.

III) The case for a time varying NAIRU.

In order to depart from the failures of structural models and to provide a robust estimation of the NAIRU, we adopt a semi-structural method based on a combination of both an economic and a statistical approaches. The methodology we adopt hereafter is based on a state space model composed of a Phillips equation and a random walk process that describes the variation of the NAIRU. This methodology occupies a middle ground between a univariate statistical approach such as the HP filter and a complete structural model like a WS-PS model. Even though it gives rise to some statistical problems (especially the arbitrary calibration of the variance of the random walk innovations), it has the advantage of considering the NAIRU as a fundamentally time varying variable.

[3] Productivity per hour, terms of trade, mismatch, fiscal and social wedge, job destruction rate …

It is true that the state space model we adopt does not provide a structural explanation of the NAIRU. Nevertheless, compared to a pure statistical approach, it exploits the set of information contained in the Phillips curve without requiring to identify all the supply shocks (productivity, labor market variables, terms of trade etc) that have an influence on the NAIRU. In this perspective, this method can be related to the multivariate filter for the measurement of the potential output suggested by Laxton and Tetlow (1992). This kind of "semi structural" models have advantage over quasi structural models because they can exploit information drawn from economic theory without relying on perfect representations of the true structure.

The model we adopt is very close to the so-called "triangle model" suggested by Gordon (1997,1998):

$$\text{(M)}\begin{cases}\pi = c_1\pi_{-1} + c_2\pi_{-2} + (1-c_1-c_2)\pi_{-3} + c_3(U-\overline{U}) + \sum a_i z_i + \varepsilon^{\pi} \\ \overline{U} = \overline{U}_{-1} + \varepsilon^{U}\end{cases}$$

Where U represents the unemployment rate, π inflation, z supply-shock variables and $\overline{U}$ the NAIRU. The determination of the inflation rate is determined by three factors (hence the "triangle") : adaptive expectations and inertia, excess demand or shortage – estimated by the gap between the actual unemployment rate and the NAIRU – and supply shock variables. This kind of state space approach is also used by Boone *et alii* (2000) and by Jaeger and Parkinson (1994) to evaluate the degree of hystereris in unemployment rate. The inflation equation actually corresponds to a reduced form of a wage-price spiral.

$$\begin{cases}\dot{w}_t = \pi_t^e + F(U_t) + z_t^w + s_t^w \\ \pi_t = \dot{w}_t - \dot{\Pi}_t^* + z_t^{\pi} + s_t^{\pi}\end{cases}$$

Where π^e represents inflation expectations, $\dot{\Pi}^*$ the productivity growth trend, $\dot{w}$ the wage growth, $F(U)$ the excess demand or shortage – represented by a certain function F of unemployment. z^{π} and z^w capture short-lived supply-shock effects such as increase in import prices, temporary deviation of productivity from its trend, change in the labor share...

s^{π} and s^{w} embody all the supply side variables that have a long run effect on prices and wages. The goal of a structural approach based on the Phillips curve is precisely to identify these variables s^{π} and s^{w}, whereas the time varying NAIRU approach provides a way to circumvent this difficulty.

Assuming backward looking inflation-expectations, namely that: $\pi_t^e = \alpha(L)\pi_t$

We get: $\pi_t = \alpha(L)\pi_t + F(U_t) - \dot{\Pi}_t^* + z_t^{\pi} + z_t^{w} + s_t^{\pi} + s_t^{w}$

Along the steady state path, $\pi = \pi^e$ and $z^w = z^{\pi} = 0$. The no-supply-shocks NAIRU is therefore determined as :

$$F(\overline{U}_t) = \dot{\Pi}_t^* - s_t^w - s_t^{\pi}.$$

If we make the assumption that F is linear (namely $F(U) = b(L)U$), the wage-price spiral can be expressed with the following reduced form:

$$\pi_t = a(L)\pi_{t-1} + b(L)(U_t - \overline{U}_t) + z_t^w + z_t^{\pi}$$

The inflation equation should be combined with a second equation that represents the variation of the NAIRU over time. As a short cut, the NAIRU is assumed to follow a random walk whose variance has to be calibrated[4] and plays the role of a smoothing parameter. Along the steady state path, inflation terms must disappear and the actual rate of unemployment must be equal to the NAIRU. We must therefore impose two restrictions on the model: first, there must be no constant term in the inflation equation and secondly the sum of the coefficients describing the expectations of inflation must be set equal to 1 in order to get a long term vertical Phillips curve.

This method has some obvious drawbacks. First, modeling inflationary expectations with a backward polynomial seems a bit too simplistic. Actually, expectation probably do not follow a constant pattern over the period 1970q1-1999q2 where inflation dropped from rates between 10 and 15 per in cent in the late seventies and early eighties to rates below 2 per cent in the late nineties. To circumvent this difficulty we have essentially worked on the sub-

[4] This calibration is in fact an identifying restriction.

sample 1986q1-1999q2 since the inflation process in France appears to exhibit a structural break in the mid 1980s. Secondly, computing a long term variable – the structural unemployment – from an equation that is supposed to deal only with short term behavior – the Phillips curve – may be criticized. As some economists do, we may claim that the Phillips curve is just the short-term part of an ECM version of a more structural model. Most of econometric tests show that the unemployment rate and the real wage are I(1) in France over the last twenty years (cf Bonnet and Mahfouz (1996)). Blanchard and Katz (1997) suggest an error-correction specification in which the real wage ($w_t - p_t$) is a function of the unemployment rate and of the reservation wage that keeps pace with productivity (x_t) with a steady share of wages in value added[5].

$$\Delta w_t = \Delta p_{t-1} - \lambda\left(w_{t-1} - p_{t-1} - x_{t-1}\right) - b\left(U_t - \overline{U}_t\right) + \varepsilon_t^w$$

Where x is the log of the productivity level. The standard Phillips curve corresponds to the possibly incorrect restriction that λ is equal to zero.

In spite of these drawbacks, the time varying NAIRU method represents an innovation with respect to the traditional deterministic approach by considering the NAIRU as a fundamentally stochastic variable and by providing confidence intervals. The importance of the measures of the precision of the estimates of the NAIRU has been stressed by Staiger, Stock and Watson (1996). A time varying approach has the advantage to deal with all the sources of uncertainty. Indeed in the spline model or the break model (such that they are decribed in Staiger, Stock and Watson (1996) for instance), uncertainty arises only from unknown parameters, whereas in the time varying model, breaks are treated as occurring randomly. However, the variance of the breaks is calibrated, which gives rise to another source of uncertainty.

[5] Although, the share of wages in value added is not I(0) in most European countries in limited samples running over the 1980s.

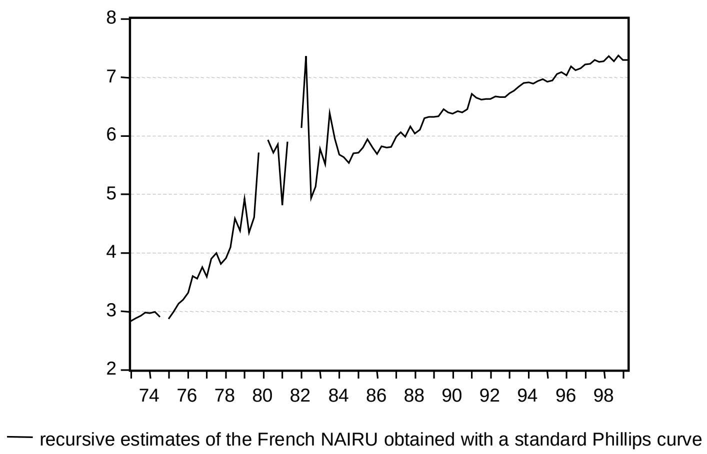
IV) Estimation results for France.

The issue of the variability of the NAIRU appears quite clearly when estimating a standard Phillips curve on different samples.

$$\Delta\pi = c_1\Delta\pi_{-1} + c_2\Delta\pi_{-2} + c_3U + c_4 d(\dot{p}_{ME}) + c_5$$

This equation yields a NAIRU equal to : $\overline{U} = -\frac{c_5}{c_3}$. On the sample 1970-1999, $\overline{U}$ would then amount to 7.3%, whereas on the reduced sample 1986-1999, $\overline{U}$ is negative. Nevertheless a recursive estimation of this equation by recursive least squares provides a first idea of the shape of a time-varying NAIRU. As the following graph shows, the NAIRU obtained by applying recursive least squares on a standard Phillips curve has increased steadily since the beginning of the 1970s.

figure 1



A state-space model seems specifically designed to estimate more accurately this time-varying NAIRU. We therefore estimate the following model using the Kalman filter algorithm :

$$\begin{cases} \pi = c_1\pi_{-1} + c_2\pi_{-2} + (1 - c_1 - c_2)\pi_{-3} + c_3(U - \overline{U}) + \sum a_i z_i + \varepsilon^{\pi} \\ \overline{U} = \overline{U}_{-1} + \varepsilon^{U} \end{cases}$$

Estimation results are displayed in table 2 and 3 with for different short term supply shocks. As expected, the coefficient of the unemployment gap term is negative whatever the calibration of the variance for the state equation and even if supply side variables are added. The assumption made about the size of the standard deviation of the error term in the equation for the NAIRU equation determines the smoothness of the NAIRU evolution. As a comparison between the different figures below shows, setting the standard error equal to 0.1 leads to a NAIRU that seems to offer the appropriate degree of smoothness: with higher standard deviations, the variability of the NAIRU seems too high to be acceptable: With a standard deviation of 0.4 (figure 29), the NAIRU changes from quarter to quarter and with a standard deviation of 0.2, the NAIRU is still very correlated to the cycle. On the other hand, if the standard deviation is too low, the NAIRU appears to be almost constant (figure 30).

Setting the standard error equal to 0.1, the estimation of the basic model (with no supply side terms) with the quarterly growth rate of consumption prices as endogenous variable between 1986q1 and 1999q2 yields a NAIRU of **10% at the beginning of 1999** (table 2 eq 1 and figure 23). By extending the estimation sample to 1970q1-1999q2, the NAIRU we obtain is a bit higher (10.4%) (figure 27, eq 11). Whereas the NAIRU increased by 2.7 points between 1977 and 1988 (from 6.6% in 1977 to 9.3 % in 1988), its steady rise seems to slow down somewhat since the second part of the 1980s, exhibiting two main deceleration periods: first during the second part of the 1980s (+1.1 points between 1988 and 1995) and second in the mid-1990s (+0.3 point only for the last four years). The computation of a sacrifice ratio appears very useful to analyze the trade off between unemployment and inflation: a permanent reduction in inflation by one point requires a 3.4 point increase in the unemployment gap for two years[6]. This sacrifice ratio is in line with the results obtained by Turner and Seghezza (1999) for France.

The filter is initialized by the ols estimates of the Phillips equation. In order to assess the robustness of our results, we use the output of the smoothing filter as new initial values for

[6] This result has been obtained by simulating the observation equation of the SSM 1 with the coefficients estimated by the likelihood method and by calculating the difference between the simulation and the base line.

the forecasting Kalman filter. On the sample 1970-1999, the estimate converge towards a NAIRU very close to our first result: 6% in 1970 and 10.14% at the beginning of 1999. On the reduced sample, the robustness is not so clear-cut: indeed whereas the NAIRU is still around 10% in 1999, it also amounts to 10% in 1986. This result is worth noting since it implies that despite our time varying approach the NAIRU would be amount constant since 1986 around 10%.

In order to assess the degree of uncertainty surrounding the estimation of the NAIRU, two kinds of error have to be taken into account. First, estimating the parameters of the model implies a standard error surrounding the values of the coefficients. On the other hand, the Kalman filter yields a mean squared error that only results from the filtering procedure itself. Whereas this latter is directly given by the algorithm, the uncertainty due to coefficients estimation has to be computed by Monte Carlo simulations, following Hamilton (1994). The interval confidences we obtain (for one standard error) are quite large: around +/-0.7point for the whole sample and around +/- 1.2 points for the sample 1986-1999.

Supply side terms do not have very significant effects when estimating the model on the whole sample. By contrast, on the reduced sample, inflation appears to have been influenced by deviation of global factors productivity from its trend and by import prices (energy and manufactured goods). Estimating this model with supply terms (table 2, eq2 to 9) leads automatically to a NAIRU that is superior to the one obtained with the basic model, since a part of inflation pressures is now attributed to supply effects and not only to excess demand. The figures obtained with this model should therefore be treated with caution, since the NAIRU would amount to 11% in 1999q2 (eq9).

It is interesting to assess the extent to which these results are dependant on the measure of inflation. So far inflation has been measured as the quarterly growth rate of the consumption price. The year-on-year growth rate of consumption price is much smoother (see figure 2) : the unemployment gap calculated by taking this latest rate has to be smooth as well and therefore the NAIRU has to exhibit a higher variability[7] (see figure 32). Consumption prices have increased faster than value added prices on average since the 1980s, as figure 3 shows. The NAIRU we obtain with the year-on-year growth rate of value added prices is therefore lower since the unemployment gap has to be higher to account for this more significant deceleration (figure 33).

figure 2

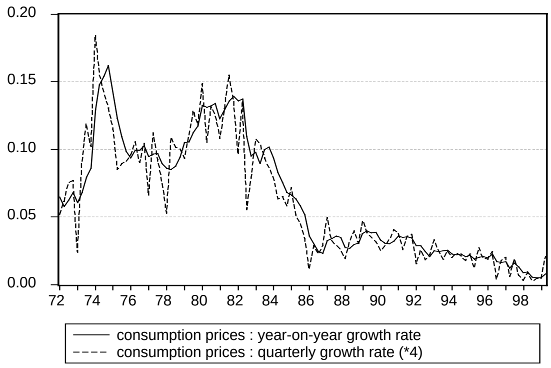
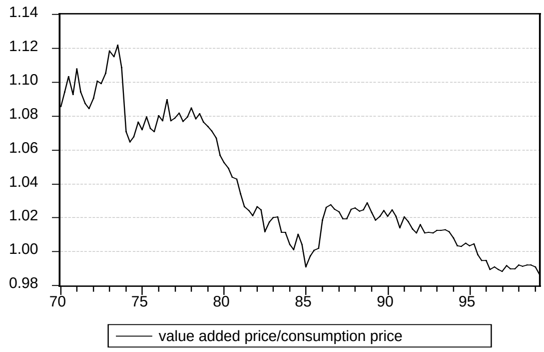


figure 3



It may seem strange to obtain estimates of the NAIRU that exhibit upward trends whereas the model we estimate implies that the NAIRU follows a random walk. In all likelihood, the disturbance term ε^U actually follows an autoregressive process and our model is therefore misspecified. That is the reason why we consider the following model :

$$\begin{cases} \pi = c_1\pi_{-1} + c_2\pi_{-2} + (1 - c_1 - c_2)\pi_{-3} + c_3(U - \overline{U}) + \sum a_i z_i + \varepsilon^\pi \\ \overline{U} = \overline{U}_{-1} + \varepsilon^U \\ \varepsilon^U = \rho\varepsilon^U_{-1} + \eta \end{cases}$$

In order to cope with estimation problems, we adopt a two-step procedure : we calibrate the coefficient of the Phillips curve equation by using the estimates of the basic model (with ε^U following a white noise) and we estimate by contrast the standard error of η (0.12) and the autoregressive coefficient ρ (0.701). The unemployment gap is more narrow with this model

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[7] obtained by positing a higher standard error (0.7).

than with the basic model (figure 34) and the NAIRU appears therefore higher (11.2% in 1999).

V) Convexity of the Phillips curve.

The assumption of a convex Phillips curve has been investigated in several studies (Isard and Laxton (1996), Faruqee, Laxton and Rose (1998), Laxton et alii (1998)), and focus on the effects of stabilization policies on the NAIRU. The underlying intuition is that inflation increases faster when unemployment is below the equilibrium rate of unemployment than it decreases in the opposite case. One consequence is that the average unemployment, consistent with a constant average inflation rate, should thus be superior to the deterministic NAIRU, e.g. the theoretical NAIRU. In such a model, policy errors – namely letting the inflation rate reach too high levels – must later on be offset by very restrictive monetary policies. Let us suppose for instance a stabilization policy that aims at keeping the actual inflation rate between π^{min} and π^{max} and let us drop the time varying assumption for the moment. According to the following, graph such a policy leads to an actual rate of unemployment fluctuating between U^{min} and U^{max}.

Convexity in the Phillips curve implies that the average rate of unemployment U^m, consistent with a constant average inflation rate, is superior to the deterministic NAIRU $\overline{U}$, that is the theoretical NAIRU drawn from a Phillips curve (represented in the following graph by the intersection between the Phillips curve and the horizontal axe). The spread between $\overline{U}_t$ and U_t^m depends on the degree of convexity of the Phillips curve and reflects the welfare cost generated by errors in the stabilization policy. By contrast, in the linear model, the particular sequence of inflation rates that follow a price stability policy has no implications in terms of unemployment costs.

For instance, if the Phillips curve has this linear specification:

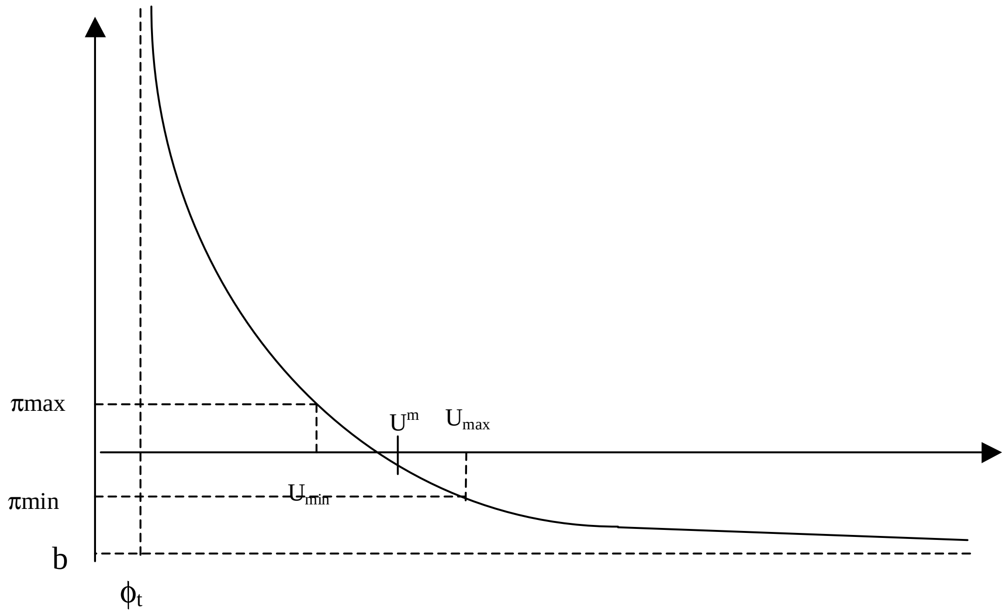
$$\pi_t = \pi_{t-1} + b\left(\overline{U}_t - U_t\right)$$

Summing this equation for $t = 1,\dots,T$, we obtain immediately:

$$\pi_T = \pi_1 + b\sum_{t=2}^{T}\left(\overline{U}_t - U_t\right) \approx \pi_1 + bT\left(\overline{U} - U^m\right)$$

The unemployment cost just depends on the initial and last values of inflation and not on its particular path. More precisely, if the stabilization policy succeeds in restoring price stability: π_T is then equal to π_1 and the overall unemployment cost $\left(\overline{U} - U^m\right)$ is zero.

Figure 4



These considerations underpin the Phillips curve specification that we now investigate:

$$\pi_t = a(L)\pi_{t-1} + b\frac{\overline{U}_t - U_t}{U_t - \phi_t} + \varepsilon_t^{\pi}$$

Where ϕ_t and b represent the two asymptotes of the Phillips curve. ϕ_t can be analyzed as the "minimum unemployment level", that is impossible to reach no matter the degree of excess demand. The parameter b represents the point above which increases in unemployment have no additional downward effects on the inflation process. Following

Laxton (1998), we can assume that the parameter ϕ_t keeps pace with the actual unemployment rate. We have first estimated the state space model.

$$\phi_t = Max(0, U_t^s - 4)$$

Where U_t^s=actual rate of unemployment smoothed with an Hodrick-Prescott filter. But it seems also reasonable to set ϕ_t equal to a constant. That is what we have also carried our estimations with $\phi_t = 4$.

The state space model we test can be written as follows:

$$\begin{cases} \pi_t = a(L)\pi_{t-1} + b\dfrac{\overline{U}_t - U_t}{U_t - \phi_t} + \varepsilon_t^{\pi} \\ \overline{U}_t = \overline{U}_{t-1} + \varepsilon_t^{U} \end{cases}$$

The results we obtain are very close to the estimation obtained by Laxton and alii (1998) for Multimod. This specification leads to a NAIRU that is substantially superior to the NAIRU obtained with a linear Phillips curve. This is quite logical since the unemployment cost resulting from a stabilization policy is non zero with the convex Phillips curve. The assumption of convexity in the Phillips curve improves slightly the fit in the inflation equation. The likelihood increases from 224 to 232 from the linear equation (equation 1) to the convex equation with ϕ_t that follows U_t (equation 17) (230 with a convex specification with ϕ_t=4). Similarly, the sum of square residuals is slightly diminished when adopting the convex specification.

This semi-structural approach provides estimates of the NAIRU that can be updated from quarter to quarter and thus enables to rapidly assess inflationary pressures. Up to now, little attention has been devoted to identifying the determinants of the evolution of the NAIRU. In the remainder of this document, our prime concern is just to list the main changes in the French labour market since the end of the seventies to identify the possible culprits of the rise in the time varying NAIRU we have estimated in the last section.

VI) The time varying NAIRU as a leading indicator of inflation.

Stock and Watson (1999) show for the United States that Phillips curves that use housing starts, capacity utilization or the rate of growth of manufacturing and trade sales produce inflation forecasts that are generally more accurate than forecasts constructed from Phillips curves using the unemployment rate. To assess whether the time-varying NAIRU model provides good indicators of future inflation, it is necessary to compare its performance (in terms of mean squared errors) to the performance of a Phillips curve based on alternative measures of real economic activity. We therefore consider a standard Phillips equation based on a capacity utilization rate (*cur)* :

$$\Delta(\pi) = c_1 + c_2\Delta(\pi_{-1}) + c_3 cur_{-5} + c_4 d$$

Where π is measured by the year-on-year growth rate of value added prices and d represents a dummy variable equal to 1 since 1995 and 0 before). We compute the one-step ahead forecast of inflation using this Phillips equation with the capacity utilisation rate and using the time-varying model[8]. The root mean squared error is slightly inferior with the state-space model compared to the capacity utilization model (0.0021 vs 0.0027). Moreover, the turning points are generally better captured with the capacity utilization equation.

[8] We proceed as follows: to calculate the forecast for the period t we estimate the state space model (17) up to (t-1) and then calculate : $\pi_t = c_1\pi_{t-1} + c_2\pi_{t-2} + (1 - c_1 - c_2)\pi_{t-3} + c_3(U_t - \overline{U}_{t-1})$

figure 5

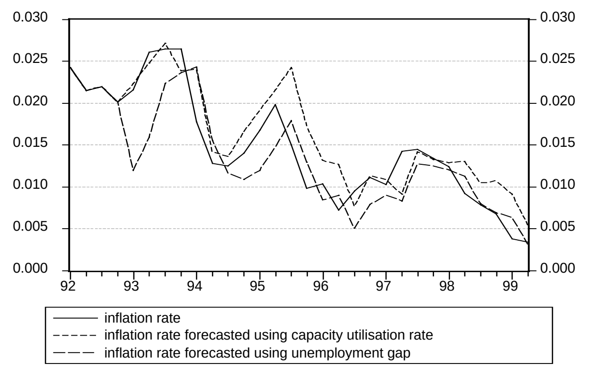
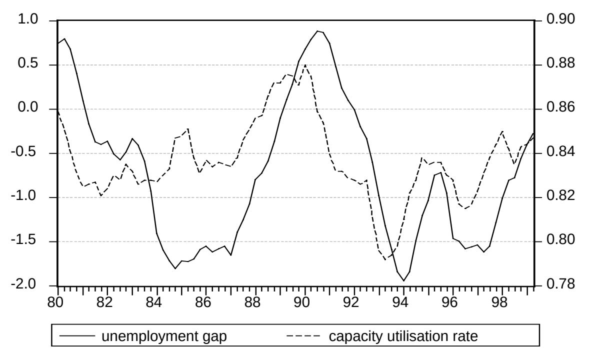


figure 6

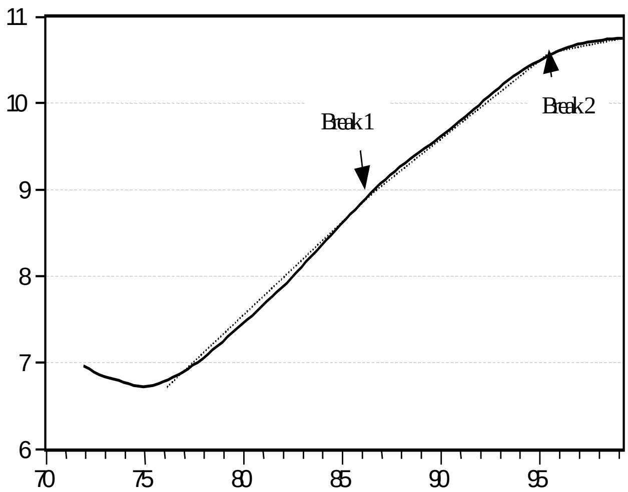


The time varying NAIRU model does not clearly outperform a standard Phillips curve equation using capacity utilization. It nevertheless provides a useful tool to estimate the efficiency of labour market reform.

VII) Time Varying NAIRU and labor market variables.

The best way to interpret the evolution of the time varying NAIRUs we obtain is to split the whole estimation sample into several phases corresponding to the different paths followed by the NAIRU. Indeed, we have *a priori* considered the shocks experienced by the NAIRU as fundamentally stochastic but the empirical analysis reveals the existence of two significant breaks: first during the second part of the 1980s, second in the mid-1990s. After a strong rise from the mid 1970s to the end of 1980s, the NAIRU growth rate has gradually slowed down as shown in figure 7.

Figure 7: Breaks in the TV NAIRU obtained by equation 10.



In this section, we endeavor to link up these breaks with what we know about changes in the French labor market. As we will see, during these two episodes, France has witnessed significant transformation in the demographic composition of its workforce and breaks in the evolution of its fiscal-social wedge. These two factors have probably played a positive role in the deceleration of unemployment.

a) Studying French unemployment at the nationwide level appears relevant.

The computation of a nationwide unemployment can mask considerable variations at the regional level as a recent occasional paper by the IMF[9] underlines. North European regions have witnessed a decline in their unemployment rates over the last two decades, whereas in the southern regions the unemployment rate has steadily increased to reach 23% in certain countries. The interest in studying unemployment differences across regions is in fact twofold. First, it would be a little dubious to search for national factors to explain the phenomenon if its roots are essentially regional. Secondly, large discrepancies at the regional level may themselves be a cause of the rise in the NAIRU. For instance, if the leading region

[9] cf IMF (1999).

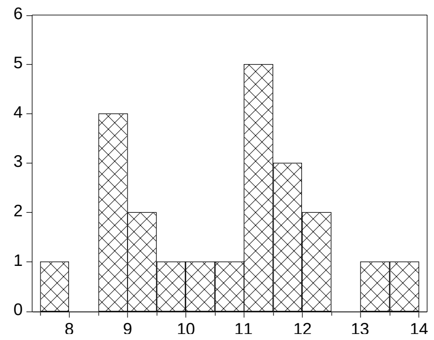
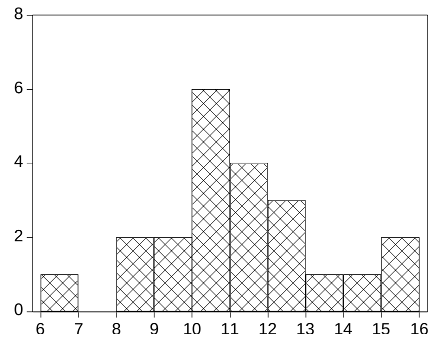
in wage bargaining exhibits a relatively low unemployment the wages growth, which is set at the national level, will be too high to reduce unemployment in high unemployment areas. Besides, large regional differences mean that labor mobility does not play its correction role. In this context, temporary region-specific shocks are not promptly offset by relative wage changes (if the wage-bargaining is too centralized) or by labor migration. They will therefore result in long lasting unemployment.

Though France is to a large extent on the borderline between the North and the South of Europe, its unemployment rates does not show a too high dispersion as we can notice from the following table displaying the coefficient of variation of the French regional unemployment rates. Moreover, whereas it is well known that unemployment dispersion is one of the features of the Italian and the Spanish labor markets (the coefficient of variation amounts to 0.62 for Italy according to the IMF (1999)), it seems difficult to establish a clear connection between the rise in the NAIRU and regional dispersion in France.

Table 1

	National unemployment rate	Standard deviation	Coefficient of variation
1981q4	7.9	1.3	0.17
1985q1	10.2	1.5	0.15
1987q1	10.7	1.7	0.16
1990q1	8.9	1.8	0.15
1992q1	10.0	1.9	0.19
1995q1	11.7	2.0	0.17
1999q2	11.3	2.16	0.19

Figure 8 and 9: Histogram of regional unemployment rates

Figure 8: in 1985q1	Figure 9: in 1999q2
	

b) Changes in the age and gender composition of the work force.

Demographic factors have play an important role in the stabilization of the NAIRU over this decade. Between, roughly, 1972 and 1983, different measures[10] aiming at promoting retirement for senior workers below the legal age were carried out but most of these measures have been cancelled or at least moderated since the beginning of the 1980s[11]. Thus, examining the share of senior workers in the work force does not appear a fruitful avenue. By contrast, two kinds of changes in the age and gender composition of the workforce can be seen as important factors of the stabilization of the NAIRU since the beginning of the decade: the decrease in the labor force share of young workers and of the decrease in the activity rate of the 24-49 year old women. Differences in unemployment rates across age groups are quite significant in France, as the following figures show. Since the beginning of the 1980s, the young workers (16-24 year old) unemployment rate fluctuate between 15% and 25% and is particularly high concerning young female workers (between 20% and 30%). If the labor force share of young workers has exhibited a downward trend since the beginning of the 1970s, an acceleration of this decrease is particularly noticeable during the second part of the 1980 (cf figure 10). This break concurs with the educational policy that has been

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[10] GRL (Garantie de ressources licenciement, 1972) et GRD (Garantie de ressources démission, 1978)

[11] cf Blanchet et Marioni (1996).

carried out at that time, aiming at raising significantly the average study duration: the proportion of an age group that pass the “baccalaureat” has for instance increased from around 30% in 1985 to more than 60% in 1996[12]. This acceleration of the lowering in the weight of young workers in the labor force has probably resulted in a slowdown of the NAIRU increase. Secondly, the gap between the unemployment rate of males and females has not been closed over the last three decades and the rising share of female workers could be a cause of the rise in the NAIRU throughout the three latest decades. However, as figure 9 display, the share of the 25-49 year old female workers in the labor force has sharply declined with the extension of the so-called APE to women with two children in 1994 (APE: “allocation parentale d’éducation”, that is a special allowance for women that reduce their working time or quit their job to raise their children). The activity rate of women with two children (with the youngest being less than 3 year old) has dropped by about 15 points between 1994 and 1997. According to Afsa (1998), between 200,000 and 250,000 women would have withdrawn from the labor market after having their second children.

The effects of these movements on the unemployment rate are tough to assess (flexion effect...). They are probably very important all the more as female workers who withdraw from the labor market to benefit from these allowances come mostly from categories facing high level of unemployment (up to now, a third of them has experienced unemployment during the latest year). To evaluate the impact of demographic changes on unemployment the method we implement is close to the methodology of Katz and Krueger (1999). The purpose is to answer the following question: What would have happened to unemployment if the age and gender structure of the labor force had remained constant since the mid 1980s ?

We can decompose the global rate of unemployment in the following way:

$$U_t = \sum_i U_{i,t} prop_{i,t}$$

[12] cf Estrade et Minni (1996).

Where i represents a particular demographic group and $prop_i$ the share of this group in the work force. The unemployment rate France would have witnessed if the proportion of these different demographic categories in the work force had remained constant since t_0 is thus:

$$U_t^{t_0} = \sum_i U_{i,t} \, prop_{i,t_0}$$

As figure 17 shows, demographic changes have probably had an impact of around 0.4 point since the beginning of the 1990s: While the actual rate of unemployment was 11.8 % on average in 1998, the unemployment rate that is calculated assuming that demographic structure has remained constant since 1990 amounts to 12.2%. It is worth noting that demographic changes have always play a positive role on unemployment over the last three decades as figure 15 shows (the actual rate is always below the rate assuming a constant demographic structure). Let us underline however that this method has some obvious drawbacks since we neglect the effects of the age and gender composition of the workforce on age group-specific or gender-specific unemployment rates.

Figure 10: Labor force share of Young Workers

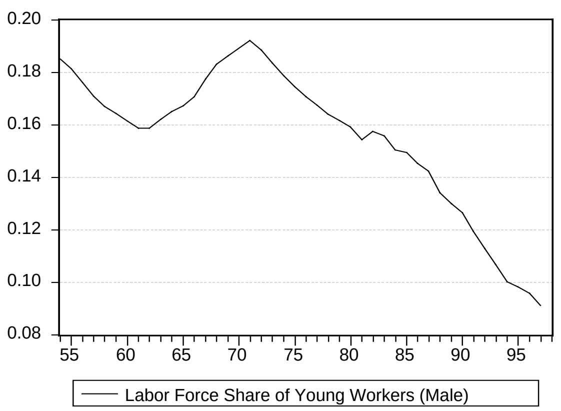


Figure 11: Share of Female Workers

Figure12: Unemployment rate of Young Workers

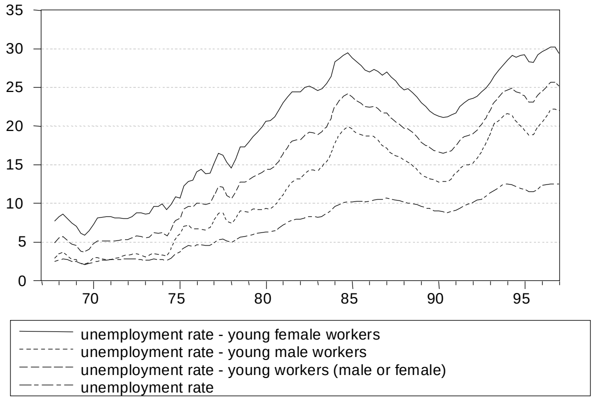


Figure 13: Unemployment rate of Female Workers

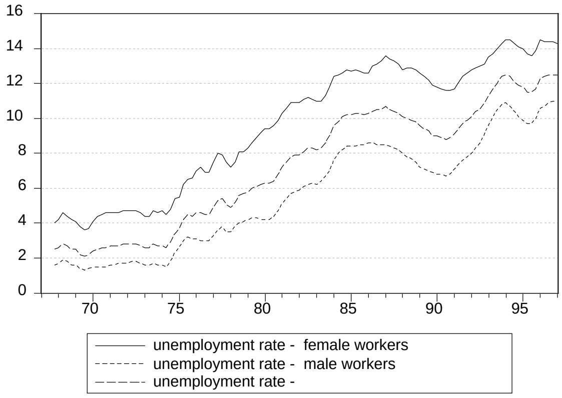


Figure 14:

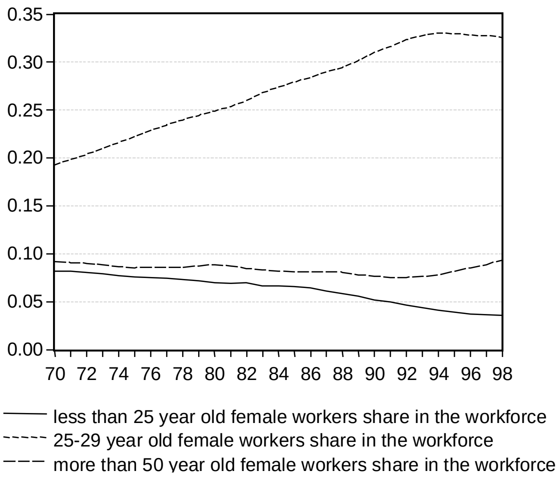
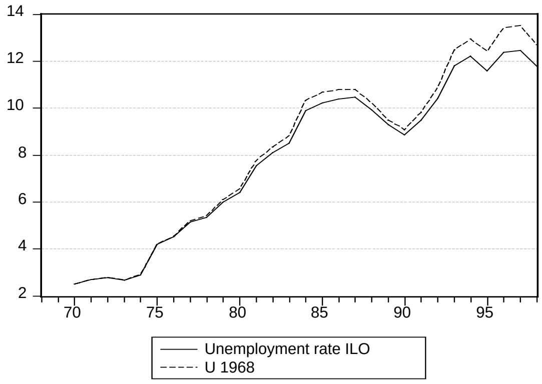
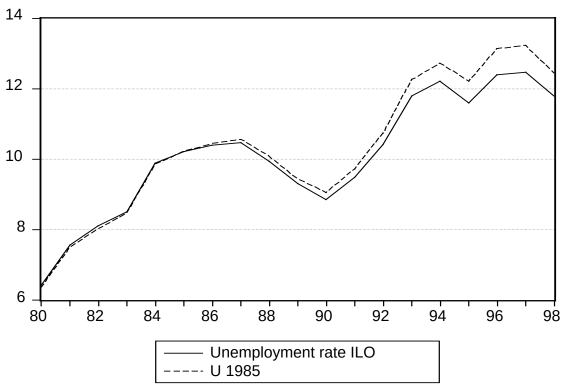


Figure 15:



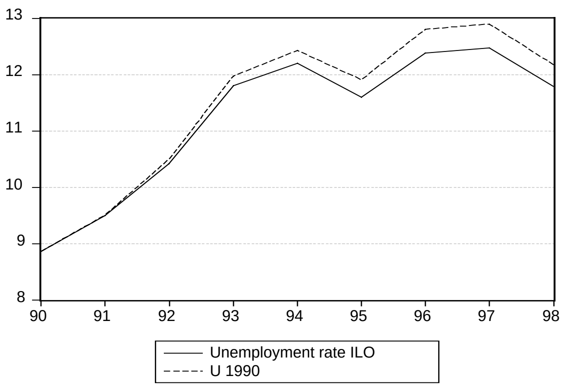
U 1968: unemployment rate rebuilt assuming that sex and gender composition of the labor force has not changed since 1968.

Figure 16



U 1985: unemployment rate rebuilt assuming that age and gender composition of the labor force has not changed since 1985.

Figure 17



U 1990: unemployment rate rebuilt assuming that age and gender composition of the labor force has not changed since 1990.

c) Long lasting unemployment.

Figure 18: Long-lasting unemployment

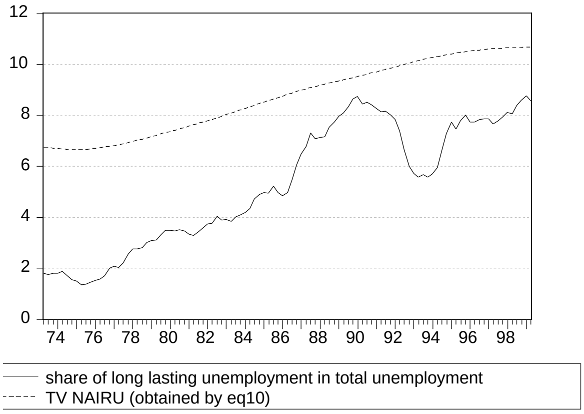
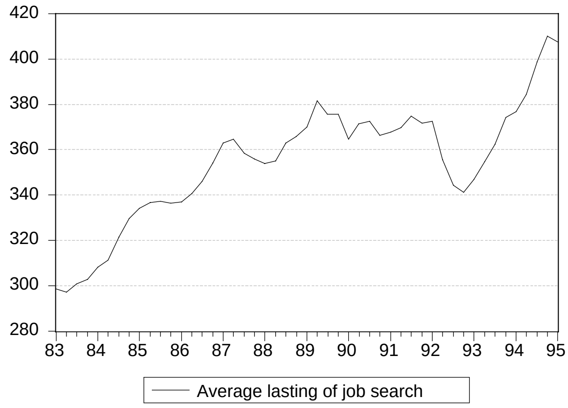
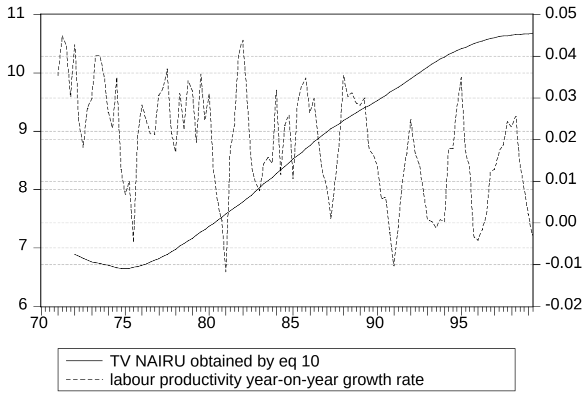


Figure 19: Average lasting of job search



d) Productivity.

Figure 20: Time varying NAIRU and labor productivity

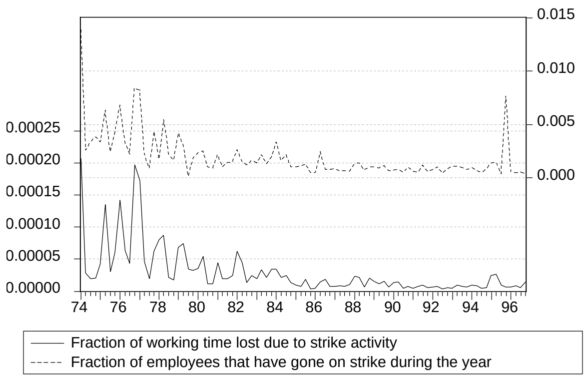


Much attention has been devoted to identifying the role of productivity in the determination of the NAIRU. The standard price formation equation is in fact based on the implicit assumption of a monopolistic price formation with the price of value added being determined by a fixed (or at least stationary) mark up over unit labor cost. The large swings recorded in the mark up over the last 30 years makes this assumption dubious and leads us to question the impact of the growth rate of productivity on the NAIRU. According to Bonnet and Mahfouz (1996), who estimated a minimalist traditional Phillips curve, the increase of the NAIRU over time is only due to a slowdown in productivity. But this conclusion is not widely shared. Actually as emphasized by Blanchard and Katz (1997), productivity seems to have no long-run effects on unemployment as can be seen from decades of massive increases in productivity and no evidence of long term changes in unemployment in the United-States for instance or in France before the seventies. As long as any increase in productivity is passed onto real wages, as it should be the case in the long run, productivity is not a parameter explaining the NAIRU. In the (WS)-(PS) framework, an argument laid out by Blanchard and Katz (1997) is that “wage demand” (real wage consistent with employment demanded by firms) and “wage supply” (real wage demanded by workers and consistent with the reservation wage and the unemployment rate) curves move along in the same direction in case of a productivity shock. However, if the relationship between NAIRU and productivity does not hold in the long term, it may be worth considering in the short term. An unexpected positive productivity shock makes unit labor costs fall, then increases profitability and is passed in the short term into a lower NAIRU as long as wage demands by workers have not fully adjusted the shock. Once wage demands have been geared to the new pattern of productivity, the NAIRU should return to its pre-shock level.

e) Bargaining power of employees.

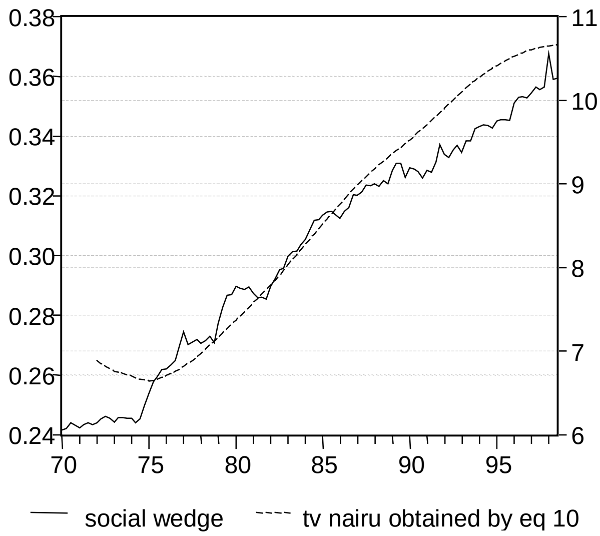
The bargaining power of employees seems to have weakened since the beginning of the seventies as the following graph illustrates. The fact that workers demand for wages gain is more timid than before because they are anxious about their job prospects and because unions are weak can have caused a shift (to the left) in the Phillips curve and therefore have decreased the NAIRU. However, the main impact of this rising worker insecurity is probably an increase in wage inequalities as Card (1998) has shown for the US.

Figure 21: Strikes



f) Social system.

Figure 22: Social system[13].



After a steady deterioration over the last two decades, the increase in social wedge has slightly decelerated since the late 1980s. The effects of this slowdown in the social wedge growth on the NAIRU could be all the more significant as a great part of the recent rebates of social charges have targeted unskilled workers, who are faced with a high unemployment rate (see Duchêne et alii (1996)). Nevertheless, the debate about the effects of the social benefits system on the NAIRU has been rekindled by a recent study by Laroque and Salanié (1999). According to this paper, the French system of social assistance do undermine incentives to work and generate a significant amount of voluntary unemployed people[14].

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[13] See appendix for the method of computation of this social wedge.

[14] The difference of income between a couple where both members earn the minimum insertion wage (RMI) and a couple where only one member work and earn the minimum wage (SMIC) amounts only to 500 francs.

VII) Conclusion.

The methodology we adopt in this paper is based on a state space model including a Phillips equation and a random walk process that describe the process followed by the NAIRU. This methodology occupies a middle ground between a univariate statistical approach such as the HP filter and a complete structural model like the WS-PS model. Even though this time varying NAIRU approach gives rise to some statistical problems (especially the arbitrary calibration of the variance of the random walk innovations), its interest is twofold. First the random walk assumption conveniently describes the NAIRU as driven by persistent shocks without imposing any restriction on the structural breaks affecting unemployment. Moreover, in a second step, the estimated time varying NAIRU can be related to some key variables that characterize the French labor market. This analysis conveys useful information about the structural determinants of the equilibrium rate of unemployment. If the time-varying NAIRU model that is investigated in this paper does not clearly outperform standard Phillips curve equations based for instance on capacity utilization to forecast inflation, it provides a very useful tool, easy to implement to estimate the efficiency of labor market reforms in France.

APPENDIX 1. Estimation Results.

Linear Phillips curve model.

$$\begin{cases}\pi = c_1\pi_{-1} + c_2\pi_{-2} + (1 - c_1 - c_2)\pi_{-3} + c_4(U - \overline{U}) + a_1 z_1 + \cdots + a_n z_n + \varepsilon^{\pi} \\ \overline{U} = \overline{U}_{-1} + \varepsilon^{U}\end{cases}$$

Where z_i represents supply side variables.

π =price consumption deflator.

Table 2: Estimation sample 1986q1-1999q2

	Eq 1	Eq 2	Eq 3	Eq 4	Eq 5	Eq 6	Eq 7	Eq 8	Eq 9
endog.	π_1	π_1	π_1	π_1	π_1	π_1	π_1	π_1	π_1
state eq se	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
π_{-1}	0.35 (1.89)	0.172 (1.17)	0.161 (2.96)	0.207 (1.59)	0.171 (1.62)	0.266 (1.95)	0.186 (1.47)	0.152 (1.66)	0.238 (2.02)
π_{-2}	0.43 (2.96)	0.43 (4.05)	0.43 (11.02)	0.374 (3.90)	0.38 (4.76)	0.449 (3.85)	0.462 (4.23)	0.433 (5.47)	0.475 (5.54)
$U - \overline{U}$	-0.0007 (-12.43)	-0.0005 (-13.13)	-0.0005 (-34)	-0.0005 (-12.8)	-0.0005 (-15.70)	-0.0005 (-12.47)	-0.0005 (-14.5)	-0.0005 (-20)	-0.0005 (-13)
$d(\dot{p}_{MM})$							0.048 (1.56)	0.060 (2.8)	0.039 (1.4)
$d(\dot{p}_{ME})$						0.011 (2.31)	0.0097 (2.45)		0.011 (3.38)
brent								0.0037 (1.91)	
devgfp			-0.048 (-4.2)						-0.054 (-2.1)
devKprod		-0.03 (-1.41)							
Δ(*devgfp*)					-0.103 (-1.76)				
Δ(*devKprod*)				-0.077 (-1.15)					
Log likelihood	224	229	209	229	228	234	230	225	234
adjusted R^2	0.16	0.291	0.350	0.291	0.303	0.400	0.39	0.31	0.57
SSR	0.0003	0.00023	0.00023	0.00023	0.00023	0.00019	0.00018	0.00020	0.00012
Final TVNAIRU	10.0	10.7	10.9	10.8	10.8	10.8	10.6	10.6	11.0

Note: The Kalman filter algorithm has been initialised by the ols method. One should not pay too much attention to the estimates of the TV NAIRU at the beginning of the sample since they are very dependant on the initialisation.

Table 3: Estimation sample 1970q1 – 1999q2

	Eq 10	Eq 11	Eq 12	Eq 13	Eq 14	Eq 15	Eq 16	Eq 17	Eq 18
endog.	π_1	π_1	π_1	π_1	π_1	π_1	π_1	π_2	π_3
state eq se	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.7	0.7
π_{-1}	0.471 (5.12)	0.476 (4.61)	0.465 (16.92)	0.629 (7.16)	0.600 (16.5)	0.454 (4.76)	0.518 (4.47)	1.24 (16.9)	0.98 (22)
π_{-2}	0.259 (2.6)	0.228 (2.11)	0.225 (7.26)	-0.060 (-0.6)	-0.011 (-0.26))	0.244 (2.35)	0.185 (1.43)	-0.1 (-0.8)	-0.13 (-2.0)
$U - \overline{U}$	-0.002 (-16.25)	-0.0017 (-13.4)	-0.0025 (-32.73)	-0.0017 (-14.9)	-0.0024 (-28.04)	-0.0017 (-14)	-0.0016 (-12.02)	-0.00045 (-2.46)	-0.00078 (-4.49)
$d(\dot{p}_{MM})$							-0.066 (-2.55)		
$d(\dot{p}_{ME})$						0.005 (1.15)	0.012 (2.28)		
devgfp			-0.0092 (-0.55)						
devKprod		0.0077 (0.178)							
Δ(*devgfp*)					-0.060 (-2.07)				
Δ(*devKprod*)				-0.049 (-0.73)					
Log likelihood	397	397	337	396	361	397	395	369.5	332
adjusted R^2	0.712	0.713	0.769	0.694	0.74	0.71	0.705	0.97	0.94
SSR	0.003	0.004	0.002	0.004	0.003	0.0036	0.0037	0.0056	0.009
Final TVNAIRU	10.6	10.4	11.6	10.5	11.5	10.4	10.4	10.5	10.3

Where :

π_1 = consumption prices, quarterly growth rate

π_2 = consumption prices, year-on-year growth rate

π_3 = value added prices, year-on-year growth rate

$\dot{p}_{MM}$ = import price, manufactured goods.

$\dot{p}_{ME}$ = import price, energy.

$\dot{p}_{Comp}$ = competitors price on the domestic market.

devgfp= deviation of global factors produtivity from its trend (obtained by an HP filter).

devKprod= deviation of capital produtivity from its trend (obtained by an HP filter).

$\dot{gfp}$ = growth rate of global factors productivity.

$\dot{Kprod}$ = growth rate of capital productivity.

Convex Phillips curve model.

$$\begin{cases} \pi_t = a(L)\pi_{t-1} + b\dfrac{U_t - \overline{U}_t}{U_t - \phi_t} + \varepsilon_t^{\pi} \\ \overline{U}_t = \overline{U}_{t-1} + \varepsilon_t^{U} \end{cases}$$

Table 4: Convex Phillips curve.

	sample : 1986:1-1999:2	
	$\phi_t = U_t^s - 4$ (eq 19)	$\phi_t = 4$ (eq 20)
π_{-1}	0.196 (1.16)	0.222 (2.06)
π_{-2}	0.411 (3.3)	0.390 (4.87)
$U - \overline{U}$	-0.0022 (-12)	-0.0038 (-19.9)
Log likelihood	232	230
Adjusted R^2	0.285	0.293
SSR	0.000257	0.000254
Final TVNAIRU	10.29	10.30

figure 23: equation 1

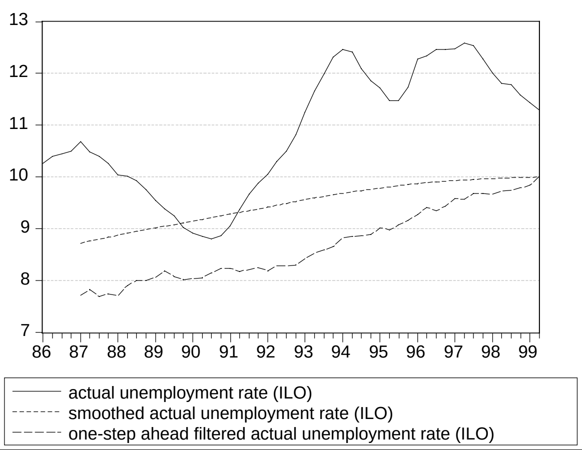


figure 24: equation 19

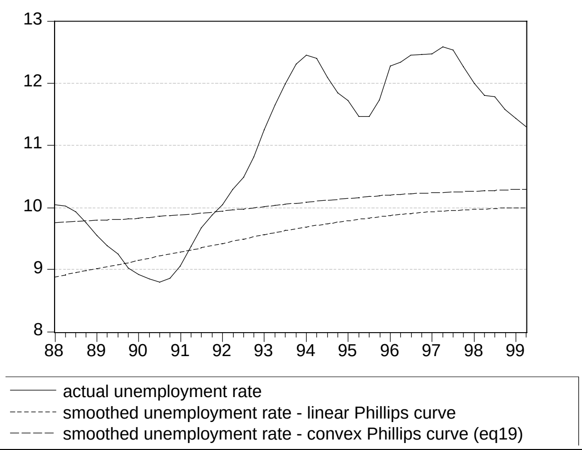


figure 25: equation 9

figure 26: equation 10

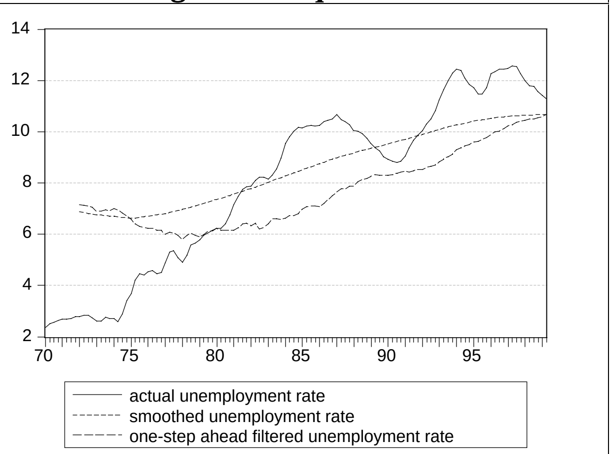


figure 27: equation 11

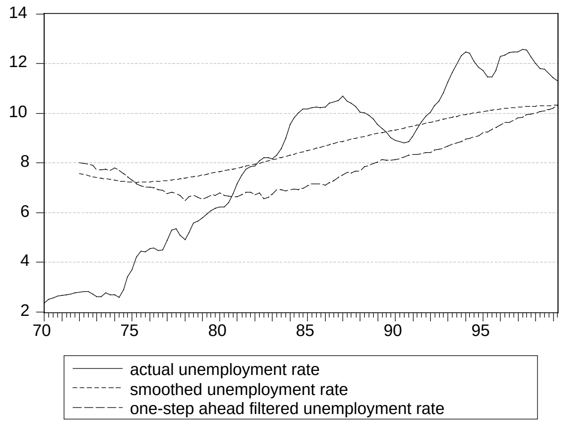


figure 28: unemployment gap and inflation

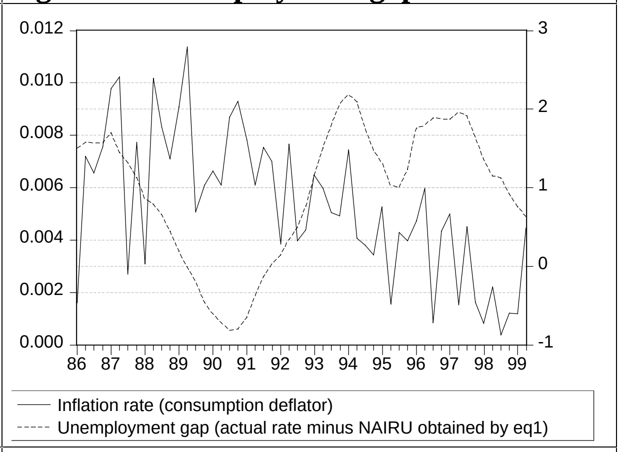


figure 29: equation 1 with $\sigma_U^2 = 0.4$

figure 30: equation 1 with $\sigma_U^2 = 0.001$

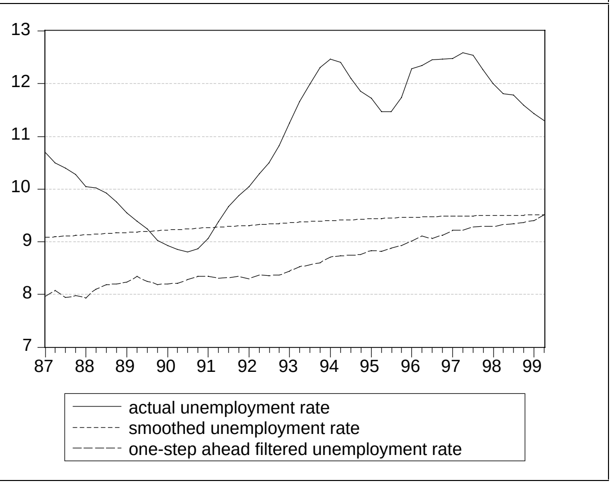


figure 31: eq 10: confidence interval (1970:1-1999:2)

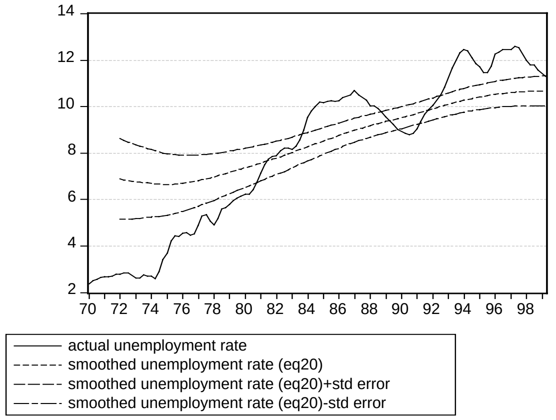


figure 32: equation 17

figure 33: equation 18

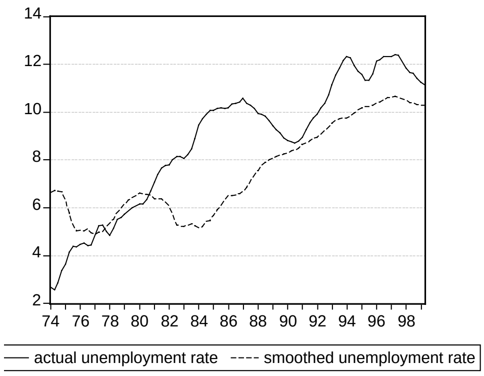


figure 34: NAIRU modelled as a second order autoregressive process

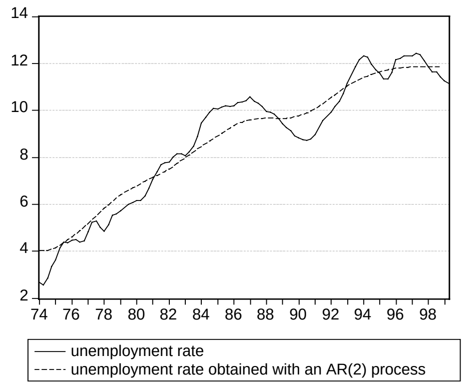


figure 35: acceleration of import prices (manufactured goods)

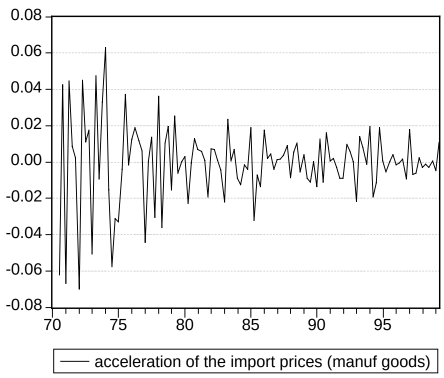
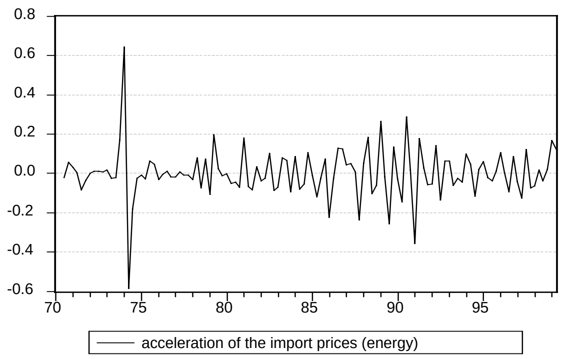


figure 36: acceleration of import prices (energy)



APPENDIX 2. Data.

Age and gender composition of the labor force:
1988-1998: Enquête sur l'emploi, INSEE (table number PA01)
1968-1998: Annuaire rétrospectif de la France.

Social wedge:
(social contribution (employers) + social contribution (employees) + CSG)/remuneration

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