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Faculdade de Economia

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Working Paper nº 74

UNIVERSIDADE NOVA DE LISBOA
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Outubro, 1987

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(Revised, OCTOBER 1987)

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ABSTRACT

The object of this paper is the econometric testing of the Gray-Fischer result that the optimal (macro) degree of real wage rigidity depends of the stochastic structure of the economy, increasing with the importance of the demand shocks and decreasing with the importance of the supply shocks.

In the paper is presented, and applied to Portuguese data, a simple methodology to construct a series of the degree of real wage rigidity that is consistent with the received theory of wage indexation. To do this it is used a non parametric method dealing with the innovations in the relevant variables. Another series, of the importance of the demand shocks relative to the supply shocks, is also constructed for the same economy.

These two series are used, together with an assumption on the agents' learning mechanism, to perform the empirical test of the mentioned result for which it is found clear support.

1. INTRODUCTION

Wage rigidity and especially real wage rigidity is at the center of many economic debates as a possible cause of unemployment. Basically the idea is that as a consequence of that real wage rigidity, in the sequence of an adverse supply shock, the real wage does not fall enough to prevent the emergence of unemployment. More generally, what happens is that, because of those rigidities, the wages do not change -instantly- in order to prevent the deviation of the rate of unemployment from its equilibrium value [1]. Of course, if one starts from a disequilibrium situation, the shock-cum-rigidity will make the actual and the equilibrium rates of unemployment converge or diverge further depending on the nature and sign of the shock.

The meaning of this is that the price signal does not convey enough information to induce a sufficiently fast and acurate adjustment. It will be necessary, then, to supplement that price signal with a quantity signal, the unemployment. Why should this deviation of the actual and

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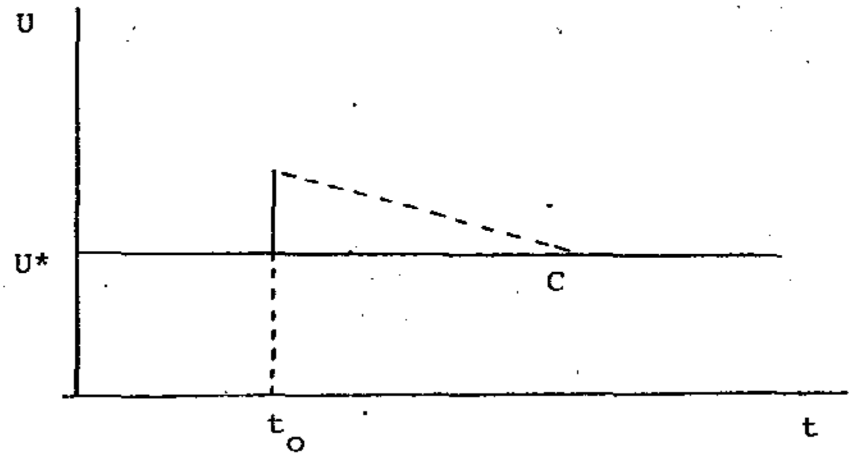
[1] This is a short-run analysis. If the shock is permanent or there is hysteresis in the rate of unemployment, see e.g. Blanchard and Summers (1985), the equilibrium rate of unemployment will itself change.

equilibrrium rates of unemployment persist is a different problem with possibly different causes. While the emergence of this deviation is one of "within the period" or instantaneous response (a sort of impact effect) the persistence of the deviation is a "medium-run" sort of question. There is also a kind of "long-run" question, connected with the determination of the equilibrium rate of unemployment itself. If the shocks are partly permanent or if there is hysteresis in the rate of unemployment (see the footnote [1] above) that equilibrium rate of unemployment would be changing too, as a consequence of the shock.

To see this, consider the Figure 1 where the actual and equilibrium rates of unemployment are plotted against time. Suppose there is real wage rigidity and an adverse supply shock happens at t = t0 :

Figure 1



Note: t is time, U is the rate of unemployment and U* its natural or equilibrium level.

If the shock is purely temporary, lasting for one period, the degree of real wage rigidity determines an instantaneous or "within the period" deviation between the actual and equilibrium rates of unemployment. If there was no persistence effects, those rates would again be equal in the next period but, otherwise, this convergence takes time and equality happens only at C, sometime in the future. It is straightforward to change the figure in order to accomodate possible changes in the U*.

In this paper, attention is concentrated on the "rigidity" effect that is the "within the period" effect. Perhaps the more intuitive way of thinking on this issue is in terms of "indexation" where the wage setting mechanism makes those wages "immediately" and automatically responsive to price developments. Fischer(1977) puts it in such terms that:

"wages with escalator clauses are flexible nominal wages; wages without escalator clauses are flexible real wages".

In a way, this perspective is, however, too limited for our purposes because indexation is not the only source of real wage rigidity at least at the macro level. Indeed one can find examples, see the following, where wages show some real wage rigidity and there is no indexation of contractual wages either explicitly or implicitly (under the guise of wage drift).

Another possible source of real wage rigidity, if one thinks in aggregate terms, is contract staggering. The effects of contract staggering were analysed in the literature, see Taylor(1980), as a source of unemployment persistence, a problem out of the scope of this paper. However, another possible motivation for contract staggering is that workers, acting as a group [2], use this method to incorporate some new information in the aggregate wage, faster than the normal interval for contract renegotiation. In this way and because some of that information is conveyed by price developments this phenomenon can be thought of as an instance of institutional choice where the workers, acting as a group with a coherent objective, choose the nature and extent of staggering the contract negotiations to achieve a target degree of aggregate real wage rigidity [3].

Contractual wage indexation and contract staggering are, in this sense, substitutes and the extent of the use of each mechanism will be determined by their relative costs and benefits.

From what was said before what matters for our purposes is the extent of the actual "instantaneous" association or

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[2] The more so, the more important the union confederations.

[3] The workers may wish to introduce a measure of real wage rigidity in order to impose costs on policymakers' generating demand shocks.

correlation between real wages and prices, independently of its source. To study the adjustment of the real wage rigidity to the stochastic structure of the economy we can appeal to the theoretical literature on optimal (macro) wage indexation, see e.g. Gray(1976) and Fischer(1977).

The fundamental result of this literature is that optimal wage indexation and, therefore, optimal wage rigidity is an increasing function of the intensity of the demand shocks and a decreasing function of the supply shocks to which the economy is subjected. Of course, for welfare analysis, the precise extent to which it will be desirable that real wages are rigid depends not only on the stochastic structure of the shocks but also on the underlying structural parameters of the economy (agents' preferences and technologies) and the assumed social welfare function.

Here we will take a more limited perspective. We will construct a measure of the degree of real wage rigidity for our sample period and we will use that measure to test the fundamental result of the Gray-Fischer theory of optimal wage indexation. To do this we will use the three variate autorregressive models including detrended output, output price inflation and real product average labour costs estimated elsewhere, see Barosa(1986), and make a few other assumptions.

The measure of the degree of real wage rigidity is the coefficient of correlation between the contemporaneous innovations in real wages and price inflation plus one. It should be clear from the considerations above that one cannot obtain a proper measure of real wage rigidity from untransformed variables like wages and prices or their rates of growth because the necessary correlations are defined as "instantaneous" and the untransformed variables will, in general, involve persistence like phenomena. To analyse within the period effects one really needs to work with innovations in the relevant variables and those three variate autorregressive models are the simplest models capable of providing the necessary information.

Also based in those models we will suggest a simple way of identifying the necessary information about the stochastic structure of the shocks. A simpler way of restating that fundamental result on optimal wage rigidity is to say that real wage rigidity should be an increasing function of the importance of the demand shocks relative to the supply shocks. Therefore, we will not need to presume having identifyed both the demand and supply shocks and we will show in the following that the covariance of the contemporaneous innovations in output and price inflation will provide a simple measure of the relative importance of the demand shocks.

A previous attempt to test this prediction of the

Gray-Fischer model, see Grubb et al.(1983), using untransformed variables and assuming to have identifyed the demand shocks as the residuals of an autorregression of the nominal output and the residuals of an autorregression of the "underlying feasible real wage" as the supply shocks didn't support the mentioned theoretical result while our tests do support it. Our interpretation of the failure in Grubb et al. (op.cit) to find evidence that the stochastic structure of the economy influences the degree of real wage rigidity in the theoretically predicted way is that their methodology was not correct because, firstly, their varibles mix rigidity with persistence and, secondly, their demand shocks are a combination of demand and supply shocks that is not properly accounted for. Another aspect that may be important is that their tests rested in a cross section regression of variables for a sample of countries while our tests, for a single country, are based in time series regressions under the explicit assumption of a learning mechanism.

The plan of the paper is to reproduce, for convenience, the essentials of the Gray(1976) model in section 2, to present the measure of the degree of real wage rigidity in section 3, to present and comment on our proposed measure of the relative importance of the demand shocks in section 4 and to test the adjustment of the degree of real wage rigidity to changes in the composition of the shocks as predicted in section 5. Finally in section 6 a brief set of conclusions will be presented.

2. THE GRAY'S MODEL

The Gray's model consists of six equations written in log linear form:

(1) $\log Y = \partial \log L + \mu$

(2) $\log M^S = \log \bar{M} + \varepsilon$

(3) $\log M^D = \log k + \log P + \log Y$

(4) $\log M^S = \log M^D$

(5) $\log L^D = - \eta(\log w - \mu) + \eta \log \partial$ with $\eta = 1/(1-\partial)$; $\partial < 1$.

(6) $\log L^S = \Omega \log w + \eta \log \partial$

Equation (1) is the production function relating output to employment through the corresponding elasticity ∂ and a stochastic term μ, the supply shock, symmetrically distributed with zero mean. Equation (2), the money supply equation defines the demand shock ε, again simmetrically distributed with zero mean and uncorrelated with the supply shock μ. Equation (3) is a velocity equation. Equation (5), the labour demand function is derived from profit maximisation on the basis of the production function above and η is the elasticity of demand for labour. In the labour supply function Ω is the elasticity of labour supply and the constant term ($\eta \log \partial$) is defined so that the certainty equivalent of the logarithm of the real wage w is equal to zero.

For welfare analysis and consequently for the derivation of an expression for the optimal degree of indexation it is necessary to postulate a social loss function. This is assumed to be the expected value of the squared deviations of output from a target level Y_O:

$$(7) \qquad Z = E[(\log Y - \log Y_O)^2]$$

It is also assumed that the welfare maximising agents are rational risk neutral decision makers who correctly assess the stochastic structure of the economy. The target output Y_O is defined to be the outcome of the perfectly competitive, frictionless, version of the economy described by the model (1) - (6).

From the model above are derived expressions for the logarithms of actual (ignoring the labour supply) and target output as:

$$(8) \qquad \log Y = \partial\eta \left[\frac{(1-\gamma)\varepsilon+\gamma\mu}{1+\partial\eta(1-\gamma)}\right] + \mu + \partial\eta \log \partial$$

$$(9) \qquad \log Y_O = \partial\eta\mu \left[\frac{\Omega}{\Omega+\eta}\right] + \mu + \partial\eta \log \partial$$

Note in (8) that γ is the indexation parameter. This is obtained from

$$\log w = \log W - \log P$$

$$= \log W^* + \gamma(\log P - \log P^*) - \log P$$

so that $\gamma = \frac{\log W-\log W^*}{\log P-\log P^*}$. Starred variables are the the certainty equivalents of the non-starred ones and correspond to $\mu = \varepsilon = 0$.

Substituting (8) and (9) into (7) yields:

$$(10) \qquad Z = \partial^2\eta^2\{V_\mu\left[\frac{\gamma}{1+\partial\eta(1-\gamma)} - \frac{\Omega}{\Omega+\eta}\right]^2 + V_\varepsilon\left[\frac{(1-\gamma)}{1+\partial\eta(1-\gamma)}\right]^2\}$$

Here V_μ and V_ε are the variances of the supply and demand shocks respectively.

Upon minimisation of (10) with respect to γ one obtains from the first order condition

(11) $\gamma_O = \theta + (1-\theta)\ (\frac{\Omega}{1+\Omega})$ where

$$\theta = \frac{V_\varepsilon}{[\frac{\eta^2(1+\Omega)}{\Omega+\eta}]V_\mu + V_\varepsilon}$$

From this last expression it is apparent that the optimal degree of indexation increases with the importance of the demand shocks, measured by V_ε, relatively to the supply shocks, measured by V_μ. To be more precise rewrite (11) as

(11a) $\gamma_O = (\frac{\Omega}{1-\Omega}) + (1 - \frac{\Omega}{1+\Omega})\ \theta$

and differentiate γ_O with respect to $\frac{V_\varepsilon}{V_\mu}$ which is a possible measure of the relative importance of the demand shocks. This derivative is:

$$\frac{\partial \gamma O}{\partial\left(\frac{V_\varepsilon}{V_\mu}\right)} = (1 - \frac{\Omega}{1+\Omega})\ \frac{\frac{\eta^2(1+\Omega)}{\Omega+\eta}}{[\frac{\eta^2(1+\Omega)}{\Omega+\eta} + \frac{V_\varepsilon}{V_\mu}]^2} > 0$$

Now this derivate is unambiguously positive because Ω, the elasticity of labour supply is positive and η was defined in equation (5) to be positive also.

This last step is what we take to be the crucial result from Gray's analysis that we propose to test empirically.

One further aspect deserving being mentioned because it could limit the generality of the Gray-Fischer result on optimal wage rigidity is that, so far, the analysis was done for a closed economy. In the following we will consider some of the work that extended the analysis of the macroeconomic effects of wage indexation to the open economy.

Intuitively one is not expecting any essential modification of the result above because the external shocks affect the domestic economy through the aggregate demand and supply and so the problem can be stated as before, even if the optimal degree of indexation or rigidity will, now, depend also of other structural parameters of the economy that are specifically related to the fact that it is an open economy.

Two types of questions need, however, to be considered. One is the fact that some of the external shocks will affect both the supply and demand curves of the economy through the terms of trade and, another, that the extent of isolation of the domestic economy from external shocks depend on the exchange rate regime. Various authors, e.g. Flood and Marion (1982), Marston (1982), Marston and Turnovsky (1983), Aizenman (1983) and Turnovsky (1983), addressed these questions although not always whith the same purposes as Gray-Fischer.

3. THE DEGREE OF REAL WAGE RIGIDITY

By real wage rigidity one understands the inability of the real wage to accomodate a supply shock in such a way that no unemployment (or overemployment) is generated by that shock besides what is implicit in the objective level of this variable. This rigidity is a consequence of the price signal not conveying enough information for a sufficiently fast and accurate adjustment of the real wage to a stochastic impulse to the economy. Basically, an economy can be subjected to two types of shocks the demand and the supply shocks that require different kinds of adjustment in the real wage in order to keep employment and, given the work force, unemployment at its social optimum. While a demand shock calls for no changes in the real wage in order to keep output and, therefore, employment constant, the only way to prevent the emergence of unemployment when the economy is subjected to a supply shock is precisely through the adjustment of the real wage.

By the very nature of the concept and under the assumption that new information during the relevant time period can be obtained through the observation of the prices, what is relevant to describe the degree of real wage rigidity is a measure of how aggregate wages change "instantaneously" in response to unexpected inflation.

For the purposes at hand it is irrelevant to know if this element of wage change is built in contracts under the guise of escalator clauses or if it results from other institutions like the staggering of contract negotiations during the period of analysis. In this last possibility one is assuming, again, that during the relevant period new information becomes available, perhaps as repports on the rate of price inflation, so that each contract will incorporate more information than the previous ones.

To measure real wage rigidity as the contemporaneous correlation of price and wage innovations does not take into account that part of the wage innovation that may be due to a specific, autonomous, wage shock and yet found its way to prices within the same period. We may have a problem of errors in variables here. To make this question clear consider the following structural model in innovations:

$$y = -w + u$$

$$p = w - y$$

$$w = \beta . p + z$$

The first equation is an aggregate supply, the second is an aggregate demand written as a velocity equation from which the money term has been dropped and the third one is a postulated real wage adjustment mechanism stating that real wage innovations can result from price innovations and from autonomous wage pushing. y, p, w are, respectively, the output, price inflation and real wage growth innovations and u is a supply shock, v is a demand shock and z is a wage push shock. All these structural shocks are assumed uncorrelated so that their covariances are zero.

The solution of the model above, in matrix form, is:

$$\begin{bmatrix} y \\ p \\ w \end{bmatrix} = \frac{1}{1-\beta} \begin{bmatrix} 1 & -\beta & -1 \\ -1 & 1 & 1 \\ -\beta & \beta & 1 \end{bmatrix} \begin{bmatrix} u \\ v \\ z \end{bmatrix}$$

Note, firstly, that the reduced form equations for the output and price innovations can be written in terms of the v and (z-u), that is the demand and the "net" supply shocks.

Secondly, $\beta+1$ can be interpreted as a sort of ex-post elasticity of wage rigidity similar to the elasticity of aggregate wage indexation.

To make it clear that there is a feedback of the wage push shocks to real wages through inflationary developments one may write the reduced form equation for real wages as:

$$w = \frac{\beta}{1-\beta} (-u + v + z) + z$$

The coefficient on z is the sum of two effects, a direct one plus another which is a feedback term as wage shocks affect price inflation during the period.

A parametric approach to the evaluation of β is tricky. Estimation of the real wage innovations equation is subjected to simultaneous equation byas whose sense is not constant and estimation of the full model is not possible without recourse to exogenous information. Also, the algebraic solution of the model for the variance covariance matrix of the endogenous variables is made difficult by the resulting non linearities even for such a simple model. Moreover this very simple model was used for illustrative purposes only and its "correctness" is doubtful to say the least.

Recognizing all these difficulties our prefered approach is to make a minimum of structural assumptions and simply proxy the real wage rigidity parameter by the calculated coefficient of contemporaneous correlation between real wage and price inflation innovations plus one. The coefficient of correlation is a measure of the linear association between two variables and, therefore, can be interpreted in our case as an approximation to the true value of the parameter. Note in this connection that making real wage innovations a linear function of the inflation innovations results from the simplifying assumptions made in the model above and that more complex or non linear functions could have been postulated.

The importance of the error implyed by the approximation through coefficients of correlation (maintaining the assumption that the true functional relation is linear) depends of the importance of the shocks z, a variable which is not observable, in the innovations of the real wage growth.

To look further into this question it is useful to remember that those shocks are the exogenous component of the real wage innovations and that one should not expect them to be part of any sistematic wage policy because they would, then, be anticipated. Only a random wage policy would be captured in the guise of shocks but in that case the only result would be the introduction of more noise in the economic system. This should not mean that in a non systematic way the real wage innovations could not be or were not subjected to exogeous shocks, as defined, but only that the possible error in the calculation of the β's is not relevant for the purposes at hand. Note, also, that if these shocks where identically nil the appriximation would be exact. It is in this sense that our tests of the adjustment of the real wage rigidity may have a problem of errors in the variables. However, since the degree of rigidity is always used as the left hand side variable in the estimations its only effect, see Pindyck and Rubinfeld (1976), is an increase in the standard errors of the coefficients.

The innovations from the three variate autorregressive models are in Table 1. These series were constructed with the residuals from the 1954-73 model as the innovations for 1955-73 and the residuals from the model 1954-83 as the innovations for 1974-83.

In the following we will make a few comments on those innovations. Firstly, the late sixties and early seventies are characterised by negative innovations in deviations of output from trend resulting possibly from attempts to control the inflationary pressures that were building up at the time. In Barosa(op. cit.) we also found some evidence supporting the idea that the pre revolutionary years could be generally characterized as a regime of repressed inflation, see e.g. Malinvaud(1980). Secondly, 1974/75 were the years of the revolution characterized by negative output innovations resulting from the energy and raw materials price shocks and also from the internally generated productivity shocks. This view is consistent with the positive price inflation innovations ocurring at the same time. Also a very strong, positive, innovation in real wage growth happened in 1974 due to the marked increase in the bargaining power of the unions.

Generally accomodative policies and the introduction of price controls can explain the positive innovation in excess demand and the negative innovation in price inflation of 1976 while in 1977 this pattern was reversed possibly as a consequence of the combination of deflationary policy with a strong devaluation of the currency. For wages we had the introduction of administrative controls. The pattern of the innovations for 1978 clearly suggest the deflationary policies. This was somewhat reversed in 1979 and more clearly so in 1980 to generate a political business cycle for the elections to take place late in that year. The negative innovation in price inflation in this period can be attributed to a discrete revaluation of the currency that also may have had a negative impact on the expectation of future inflation. The later years assisted to another reversal of policies particularly in 1983/84. The positive innovations in inflation in the last two years can be attributed to the fact that fiscal contraction was brought about mainly through the reduction in subsidies.

The essential conclusion of these last few paragraphs is that the innovations from our models look in broad accordance with what one would expect, ex-post. In this sense they are a good summary of the main macroeconomic events for the Portuguese economy in this period.

We will use, now, these innovations to calculate the degrees of real wage rigidity as indicated before. Firstly we calculated the coefficients of correlation between the real wage and price inflation innovations for the periods before and after 1974 to find the following degrees of real wage rigidity:

$\beta+1$ (1955-73) = 0.700

$\beta+1$ (1974-83) = 0.500

The more interesting aspect of this finding is that it runs against the "conventional wisdom" on this point. A central tenet of this conventional wisdom, as we see it, is that after the revolution there was an increase the labour market rigidities. Of course, on our interpretation, to this decrease in the real wage rigidity corresponds an increase in the nominal wage rigidity but this seems to be beside the point. And there is also the case of the quantity rigidity that prevented the adjustment of the number of employees made necessary by the real wage rigidity.

It is important to note that no optimal properties can be ascribed, in this context, to this decrease in the degree of real wage rigidity. The observed decrease in the degree of real wage rigidity can leave it above the optimum level while before that was not the case.

For many reasons we do not expect the degree of wage rigidity to be constant for periods as long as the ones we considered. Because the wage rigidity seems to be an instance of institutional choice we may expect it to show some sluggishness. For this reason we next calculate the degree of real wage rigidity considering non overlapping periods of three years[4]. This choice was done quite arbitrarily and was determined only in order to produce a maximum of meaningful non overlapping observations.

The calculated measures of real wage rigidity are in Table 2.

Finally, since we expect the measure of real wage rigidity to show autocorrelation but also want to allow the possibility of more frequent changes we next calculate a yearly series of degrees of real wage rigidity considering overlapping periods of four years in the following manner (where DR stands for our measure of the degree of real wage rigidity, IRW and IP for the innovations in real wages and price inflation):

$$DR(t)=@\{[IRW(t),...,IRW(t-3)],[IP(t),...,IP(t-3)]\}+1.$$

$$DR(t+1)=@\{[IRW(t+1),...,IRW(t-2)],[IP(t+1),...,IP(t-2)]\}+1.$$

This method of a "rolling" period has two shortcomings in that the choice of a basic four year period is, again, ad-hoc and that in this way we risk introducing spurious autocorrelation in the series even if we can think of good reasons why the true series should show some autocorrelation. Its strong point is that in this way we obtain a yearly and, therefore, much larger, series. The

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[4] Except for the last two periods in order to use all the available information.

calculated values are in Table 3.

These values show some interesting features. We found very high degrees of real wage rigidity from 1955 up to 1965 with a peak of 1.16 in 1958-61 [5] followed by relatively low values up to the revolution when these increased sharply to 1.15 for the period 1973-76, that is when the consequences of the revolution in the labour market where more pronounced. After that period the degree of real wage rigidity decreased to very low values for 1979-82 and 1980-83. The fact that there was a marked increase in the degree of real wage rigidity from the years before the revolution to its aftermath may be the reason why one notes a general feeling that the revolution brought an increase in the labour market rigidities even if condidering the whole of the post revolutionary period against the whole period before that has a lower degree of real wage rigidity. Another possible reason will be indicated later.

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[5] In general we expect the true coefficient, in a macro calculation, to be restricted to the interval [0,1].

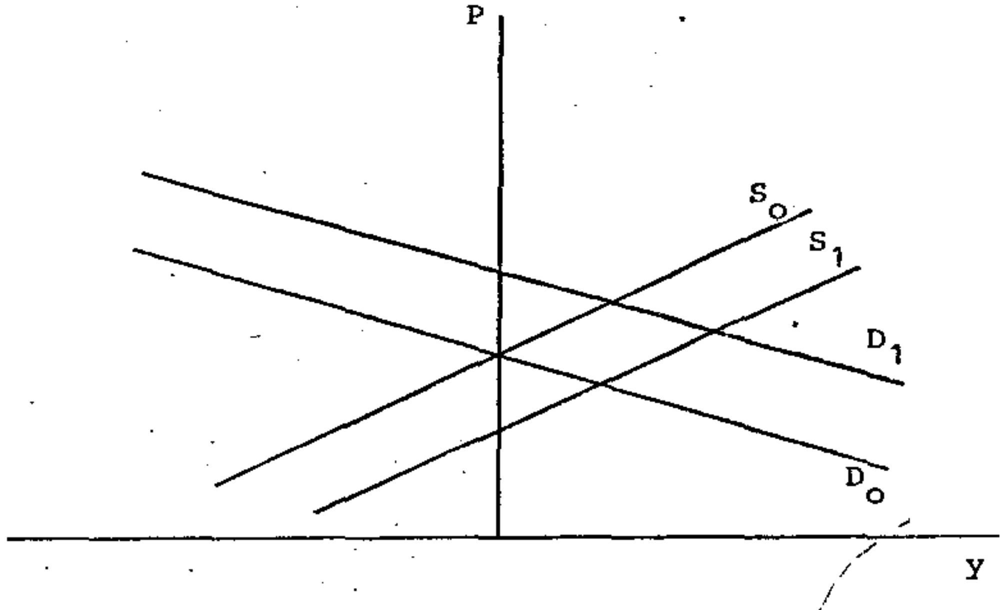
4. THE RELATIVE IMPORTANCE OF THE DEMAND SHOCKS

Except under the most extreme assumptions simple models do not convey the necessary information to identify the demand and the supply shocks. However all that is necessary to test the adjustment of wage rigidity to its optimal level made necessary by changes in the stochastic structure of the economy is the importance of the demand shocks relative to the supply shocks, a piece of information than can be provided by very simple macroeconomic models.

Our contention is that the structural shocks can not be identifyed from the residuals of simple models like the ones we have been using or indeed like that used in Grubb, et al.(op. cit.) for this purpose because the innovations in nominal output or the innovations in real output and price inflation do reflect the mixture of the demand and supply shocks to which the economy was subjected during the period of analysis (one year in the case). Indeed the same observed innovations can result from innumerable combinations of demand and supply shocks of different signs and magnitudes.

To get a simple intuition of this consider the Figure 2 where dynamic aggregate demand and supply schedules are represented in the space of the output gap and inflation. By definition, if the economy is not subjected to shocks these two curves intersect over the inflation (P) axis.

Figure 2



From an initial situation (D0,S0) consider now the effects of a single demand shock. This will determine a shift of the curve D0 to D1 and the observed outcome will be positive innovations in both excess demand (y) and inflation. From the same original situation a single supply shock would determine a shift of the supply curve from S0 to S1 and the observed outcome will be a positive innovation in y accompanyed, now, by a negative innovation in P.

It is only likely that during any period of one year the economy will be subjected to both demand and supply shocks of different signs and magnitudes and consequently these shocks will not be properly identifyed from the two sets of innovations. However the types of shocks we are considering induce covariances of different signs between the output and inflation innovations. A positive covariance can be interpreted as meaning that the demand shocks were relatively more important and a negative covariance that the supply shocks were relatively so. Moreover, as we shall see, the larger (algebraically) that covariance the relatively more important the demand shocks. This covariance is, therefore, our proposed measure of the relative importance of the demand shocks.

This relationship can also be seen more formally using the simple model of the previous section. We can rewrite the solutions for y and P in terms of the demand shock v and the "net" supply shock (u-z) as:

$$y = a1\ (u-z) + a2\ v$$

$$P = b1\ (u-z) + b2\ v$$

were a1, a2, b2 > 0 and b1 < 0, because we defined $0 > \beta > -1$.

Now Cov (Iy,IP) = E (Iy.IP) because we assumed the innovations to have zero means. Substituting the expressions above for Iy and IP and taking expectations:

$$\text{Cov}\ (Iy,IP) = a1b1\ \text{Var}\ (u-z) + a2b2\ \text{Var}\ (v)$$

because the Cov [(u-z),v] is zero under the assumption that the structural shocks are uncorrelated. Note also that a1b1 < 0 and a2b2 > 0 so that the covariance between the innovations increases with the variance of the demand shocks and decreases with the variance of the supply shocks. It certainly increases with the ratio Var (v) / Var (u-z) that is with the importance of the demand shocks relative to the supply shocks, under the maintained hypothesis that the importance of those shocks can be adequately measured by the corresponding variances.

The calculated measures of the relative importance of the demand shocks are presented in Tables 2 and 3. These numbers were calculated with Portuguese data as previously described and using the same periods and methods as for the measure of real wage rigidity. From the figures in Table 2 one may note the finding that during the period 1973-75 the demand shocks were relatively the more important ones. This could be seen as going against the intuition when one remembers the very important suppy shocks occurring during this period that resulted from the increases in the prices of energy and raw materials. In the case of the Portuguese economy there were also very important productivity and wage shocks resulting from the shift in the bargaining powers of firms and unions consequent to the 1974-75 period. Our interpretation of the observed outcome is that at the same time the policy authorities concerned with the social and political process of the revolution choosed to accomodate, to a large extent, the supply shocks that were negative and to do that they generated very strong demand shocks. Also, one should note the effects in the Portuguese economy of the recession in the O.E.C.D. countries and the loss of the colonial markets as important demand shocks.

5. REAL WAGE RIGIDITY AND THE STOCHASTIC STRUCTURE OF THE ECONOMY

From the theories of optimal wage rigidity one expects to find a positive association between the measures of real wage rigidity and relative importance of the demand shocks. This positive association is already apparent in the numbers in Tables 2 and 3 but becomes even clearer if one plots the measure of wage rigidiy against the Cov(Iy,IP) as is done in Figures 3 and 4. From these scatter diagrams one also notes that the possible functional relationship between the variables looks like an exponential[6]. This means that the degree of real wage rigidity is more than proportionally increased in response to an increase in the relative importance of the demand shocks.

To perform the econometric test of the adjustment of the real wage rigidity to changes in the stochastic structure of the economy one needs to make assumptions about the agents' learning mechanism of those changes. A possible extreme assumption would be that those agents know the true distribution of the shocks as summarized by our measure. An

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[6] This was econometrically confirmed when the regressions made with a transfomed explanatory variable RDS = exp[Cov(Iy,IP)] showed improved measures of global fit.

alternative assumption could be that the agents do not know that true distribution and when observing a new value of the measure of the relative importance of the demand shocks are uncertain if the eventual change means some shift in the true distribution or if it is simply a different draw from the same distribution.

A consequence of this last assumption is that agents may behave as if they had a sort of Bayesian learning mechanism updating their information set with each new observation but without, necessarily, forgetting their previous observations. The simplest formalization encompassing these two assumptions consists of using a geometric lag structure of the form:

$$DR(t) = c + a1 \sum_{i=0}^{\infty} a2^{i}\, RDS(t-i) + \sum_{i=0}^{\infty} a2^{i} e(t-i)$$

that can be estimated as

$$DR(t) = c + a1\, RDS(t) + a2\, DR(t-1) + e(t)$$

and the eventual statistical significance of the coefficient a2 will discriminate between the two assumptions about the information set of the agents and their learning mechanism.

The model above was estimated using our anual series of DR and RDS and produced the following results (standard errors within brackets):

$$DR(t) = \underset{(0.28)}{-0.583} + \underset{(0.34)}{0.905}\, RDS(t) + \underset{(0.16)}{0.439}\, DR(t-1) + e(t)$$

$\bar{R}2 = 0.556$ SE = 0.241 LM(1) = 0.264

These results do show that the relative importance of the demand shocks has a role in explaining the degree of real wage rigidity. In fact the estimated coefficient is positive, as theoretically predicted, and significantly different from zero. The coefficient on the once lagged degree of rigidity is also significantly different from zero. This supports our "looser" informational assumption and can be interpreted as the existence of some "sluggishness" in the adjustment of the degree of wage rigidity to the stochastic structure of the economy above that already included in the calculation of DR. This sluggishness may, then, be important for the unemployment creation properties of the macroeconomy in the sense that the real wage rigidity may take too long to be adapted to the evolution of the stochastic structure of the economy.

Globally the results above are satisfactory because all the coefficients are well defined and with the expected signs. The fit of the model is also satisfactory and the residuals show no significant first order autocorrelation according to the LM test.

The Portuguese labour contracts never incorporated, to a significant extent, escalator clauses and, therefore, the observed wage rigidity is largely the result of other forms of institutional choice. The labour market institutions were importantly shaken in the aftermath of the revolution in 1974-75 with the increase in the bargaining power of the unions and other forms of workers' organization; see Barosa (1985) for an account of some of those changes.

An interesting aspect to look at in this connection is how much did those institutional changes affected the way in which the degree of real wage rigidity is set and, specifically, the relationship between the degree of wage rigidity and the relative importance of the demand shocks. To see this we reestimated the model above but now restricting the sample to the period before 1974. The obtained results were (standard errors within brackets):

$$DR(t) = \underset{(0.39)}{-0.308} + \underset{(0.50)}{0.624}\ RDS(t) + \underset{(0.26)}{0.415}\ DR(t-1) + e(t)$$

$\bar{R}2 = 0.416$ S.E. $= 0.266$

Note that in this model none of the estimated coefficients is signifficantly different from zero. One possibility is that there is no significant sluggishness in the adjustment of the degree of wage rigidity in the sense that the term in DR(t-1) should not be included in the regression. We, therefore, estimated the model excluding the lagged endogenous variable:

$$DR(t) = \underset{(0.34)}{-0.622} + \underset{(0.35)}{1.216}\ RDS(t) + e(t)$$

$\bar{R}2 = 0.419$ SE $= 0.274$ DW $= 1.341$

This other version of the model looks like an adequate description of the mechanism of adjustment of the degree of real wage rigidity to the structure of the shocks. Note that, now, the coefficient on RDS is positive and well defined.

In order to make a comparison across the pre and post revolution periods one would only like to have two sets of results corresponding to each of those periods. However the sample corresponding to the later years is too short to give meaningful results. Our strategy is to compare the results from our two models under the assumption that the differences in these models understate the true differences across periods.

If this is the case the major difference was that before the revolution the adjustment of the degree of rigidity to changes in the stochastic structure of the economy was much faster and stronger. There was no further sluggishness in the setting of that degree of wage rigidity. Note that the model for the whole sample imply the following coefficients on RDS(t-i):

i = 0: 0.91; i = 1: 0.40; i = 2: 0.18; i = 3: 0.08

while the model for the restricted sample imply that, except for i=0, all those coefficients were zero.

This is another possible explanation for the conventional wisdom's idea that the labour market rigidities increased after the revolution when we found that taking the whole periods the real wage rigidity seems to have decreased in the later period.

Statted differently this result means that before the revolution the newly arrived information was more heavily weighted than in the later years and a possible reason for this difference in behaviour is an increase in the "noise" associated with that new information. Some support for this interpretation is given by the variances (multiplyed by 1000) of the output and inflation innovations. These were, for Iy, 0.13 for 1955-73 and 0.47 for 1974-83 and, for IP, 0.40 for 1955-73 and 0.75 for 1974-83. The increased uncertainty may call, even in terms of an optimal adjustment, for longer periods of observation that show themselves in this model as sluggishness in the adjustment of the real wage rigidity.

Whatever the reasons, the fact is that a slower adjustment of the wage rigidity makes the economy more prone to generate new unemployment in case of an adverse supply shock.

6. CONCLUSIONS

The primary objective of this paper was the development and usage of a new methodology to construct an annual series of the degree of real wage rigidity, using non parametric methods, that is consistent whith the received theoretical concepts on this issue, both at the aggregate level and in terms of its micro foundations.

To do this, a perspective where the phenomena of wage rigidity and persistence are clearly distinguished, was adopted. For the study of the first of those phenomena it is necessary to work whith the innovations in the relevant variables because the problem consists of the study of the properties of the economy to induce incremental variations in unemployment as a consequence of temporary stochastic shocks.

Using those innovations and recognizing that the choice of the aggregate degree of wage rigidity is likely to be an instance of institutional choice that involves a measure of sluggishness, the method of the "rolling period" was adopted for the construction of that annual series of the degree of real wage rigidity for the Portuguese economy in 1959-83.

It was this series that was used to test econometrically the fundamental result of the theoretical literature on optimal wage rigidity at the macroeconomic level. Even if a complete test of the results of this theoretic body was not performed it was found clear empirical support for the assotiation of the degree of of wage rigidity and the stochastic structure of the economy as theoretically predicted.

The application to the Portuguese economy produced other interesting results. The first of these was that the degree of real wage rigidity was lower in the period before 1974 than in the latter period but that the speed of the adjustment of that degree of rigidity to the changes in the combination of demand and supply shocks was higher, then. A possible explanation for this finding is that it is a consequence of the increase in economic uncertainty which means, for the aggents, a greater "confusion" between observations from a single distribution and changes in the distribution of the shocks itself.

Without estimating a full structural model one can not say whether the wage rigidity was above or below its optimal level in any of the periods. What the results suggest is that in terms of wage adjustment the possibly lower flexibility of this variable in the latter period should be seen in terms of an increase in the persistence of the wages, documented in Barosa (1985). If this is the case the problem lies more in the persistence in time of the deviations of unemployment from its optimal level than in the size of the incremental variations in unemployment induced by the stochastic shocks. Of course, a succession of adverse shocks can generate, by cumulative effect, an important deviation of unemployment from its target level.

TABLE 1

INNOVATIONS

	I.Y	I.RW	I.P
1955	0.02086	0.00690	0.00900
1956	0.00040	-0.02150	0.01750
1957	-0.01352	-0.01200	-0.01910
1958	-0.02459	-0.00970	-0.00680
1959	0.00500	0.01590	-0.00410
1960	0.01011	-0.09100	-0.00130
1961	0.00363	0.01930	0.00630
1962	0.00742	0.02340	-0.02240
1963	-0.00397	0.02020	-0.01410
1964	0.00705	0.04700	-0.00810
1965	0.00799	0.00330	-0.00370
1966	-0.00692	-0.02180	0.01300
1967	-0.00377	-0.00250	-0.00750
1968	0.01456	0.01410	-0.04400
1969	-0.02079	-0.01550	0.04830
1970	-0.00230	0.00540	-0.00450
1971	-0.01023	0.02850	-0.00410
1972	-0.00252	0.01130	0.01930
1973	0.01156	-0.02060	0.02630
1974	-0.01060	0.05860	0.02310
1975	-0.05259	0.01230	0.00380
1976	0.01339	0.00320	-0.01320
1977	-0.00659	-0.05310	0.03340
1978	-0.00470	-0.03760	-0.00310
1979	0.00741	0.00940	0.01260
1980	0.01585	0.08710	-0.04520
1981	0.01173	-0.00490	0.02150
1982	0.00391	-0.05090	0.05600
1983	-0.02994	-0.03200	0.01070

Source: BAROSA (1986)

Notes: I.Y are the innovations in output.

I.RW are the innovations in the rate of growth of average labour incomes, deflated by the implicit GDP deflator.

I.P are the innovations in price inflation.

TABLE 2

Degree of Rigidity (DR) and Relative Demand Shocks (RDS)

Period	DR = ρ(I.RW,I.P) + 1	RDS = Cov.(I.yD,I.P) x 10^3
1955-1957	0.965	0.22
1958-1960	0.265	0.05
1961-1963	0.150	0.00
1964-1966	0.113	-0.09
1967-1969	0.018	-0.81
1970-1972	0.742	0.03
1973-1975	0.966	0.39
1976-1978	0.158	-0.20
1979-1981	0.000	-0.12
1981-1983	0.345	0.29

TABLE 3

Degree of Rigidity (DR) and Relative Demand Shocks (RDS)

Period	DR = ρ(I.RW,I.P) + 1	RDS = Cov.(I.y,I.P) x 10^3
1955-1958	0.98	0.21
1956-1959	0.68	0.10
1957-1960	0.62	0.07
1958-1961	1.16	0.05
1959-1962	0.74	-0.01
1960-1963	0.63	0.01
1961-1964	0.97	0.00
1962-1965	0.84	0.00
1963-1966	0.20	-0.04
1964-1967	0.29	-0.05
1965-1968	0.11	-0.20
1966-1969	0.15	-0.55
1967-1970	0.04	-0.54
1968-1971	0.29	-0.54
1969-1972	0.18	-0.16
1970-1973	0.29	0.11
1971-1974	0.75	0.08
1972-1975	0.96	0.26
1973-1976	1.15	0.02
1974-1977	0.77	-0.06
1975-1978	0.34	-0.11
1976-1979	0.46	-0.12
1977-1980	0.13	-0.27
1978-1981	0.23	-0.08
1979-1982	0.00	-0.20
1980-1983	0.60	-0.19

FIGURE 3

Scatter Diagram of the Degree of Rigidity (DR) and Importance of the Relative Demand Shocks (RDS)

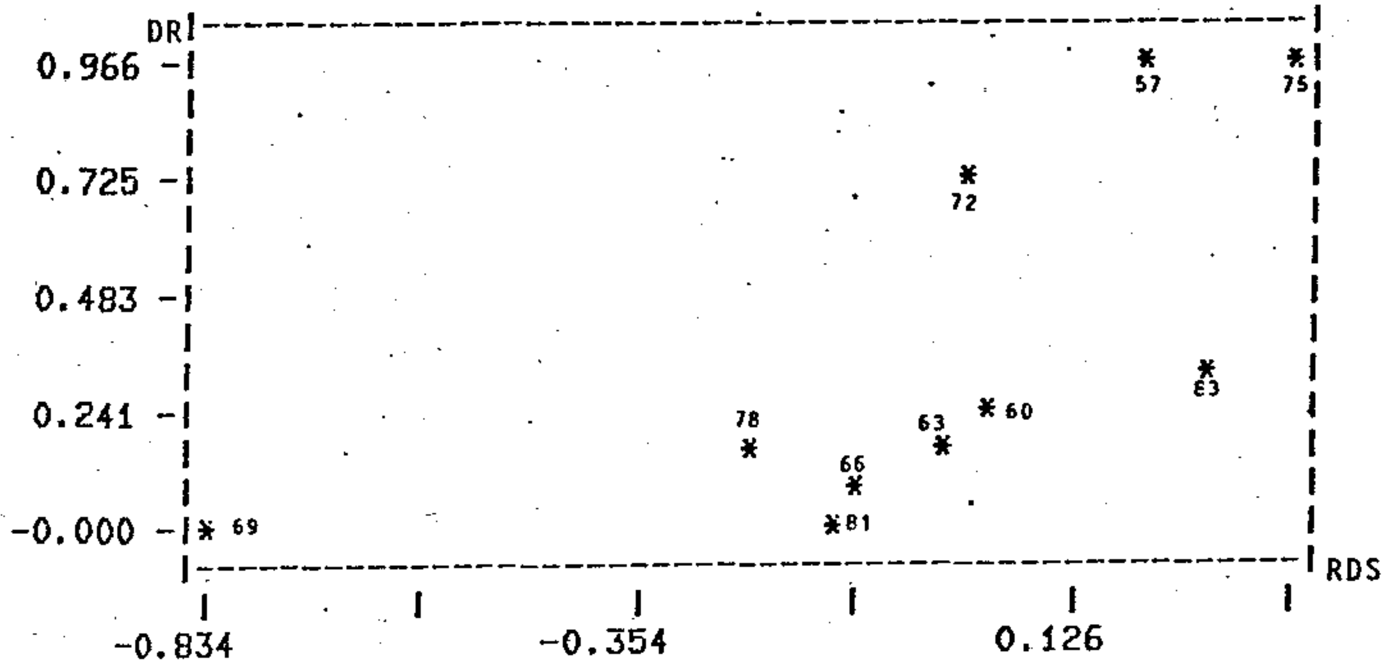
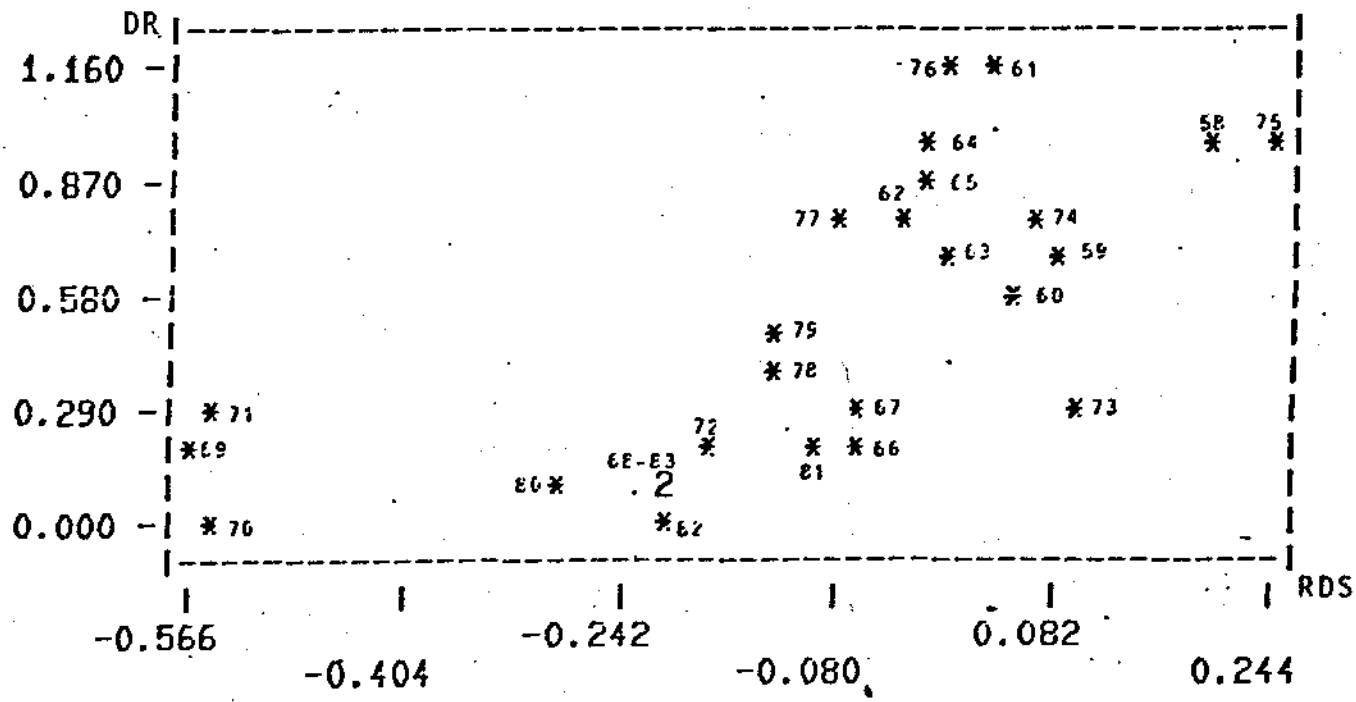


FIGURE 4

Scatter Diagram of the Degree of Rigidity (DR) and Importance of the Relative Demand Shocks (RDS)



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