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Estimates of Structural Changes in the Wage Equation: Some Evidence for Italy

by

Mauro Costantini
ISAE, Piazza dell'Indipendenza, 4, 00185 - Roma - Italy

Sergio de Nardis
ISAE, Piazza dell'Indipendenza, 4, 00185 - Roma - Italy

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ABSTRACT

This paper focuses on the influence of labour market reforms on the wage equation for Italy over the period 1981-2006. Using Gregory and Hansen (1996) residuals based tests for cointegration in model with regime shifts, we try to detect endogenously a possible structural break in the long run relationship between real wage, unemployment rate and labour productivity. Evidence of a structural shift is found and parameter elasticities of the equation before and after the break are estimated.

Keywords: wage equation, cointegration, structural break.

JEL Classification: C22, E24.

NON-TECHNICAL SUMMARY

Italy registered notable improvements in the functioning of labour market, since the period (the eighties) in which it was considered one of the most prominent examples of Eurosclerosis. Better results in terms of both unemployment and job creation were achieved without jeopardizing wage moderation and, above all, despite dismal economic growth. During this period, several reforms were adopted to modify labour market institutions from a condition of marked rigidity. It is tempting to connect better employment performance to institutional innovations.

In this paper, we investigate this link. We do it by specifying a parsimonious form of a wage setting model, leaving out of specification variables related to institutional factors whose possible change would determine the permanent modifications in the macro-behaviour of labour-market actors we are searching for. In doing so we can get a reliable indication about the time of the break due to reforms and then estimate direction and magnitude of the consequent shifts.

Three-steps estimation procedure is used to detect shifts between real wage, unemployment rate and labour productivity in the wage equation. First, we apply unit root tests to establish the nonstationarity of the these variables. Second, we use Gregory and Hansen approach for cointegration to detect endogenously the time of the break. Finally, we estimate the elasticities of the parameters of the wage equation before and after the regime shifts.

Findings show that in the considered period (1981:1-2006:4) a regime shift emerged in 1994:2. This may be related to the wave of institutional modifications that took place in the early nineties, when the system of wage formation was radically transformed in Italy and resort to temporary work experienced an acceleration. Notably, parameters estimation, before and after the break, shows a marked increase in the responsiveness of real wage to unemployment rate following the shift: a doubling of the elasticity according to the point estimates. A move indicating that the Italian economy experienced, in the middle nineties, a structural passage from a regime of high to one of low equilibrium unemployment.

STIME DI CAMBIAMENTI STRUTTURALI NELL'EQUAZIONE DEL SALARIO: EVIDENZE PER L'ITALIA

SINTESI

Questo studio analizza l'influenza delle riforme del mercato del lavoro italiano sull'equazione del salario nel corso del periodo 1981-2006. Utilizzando la metodologia di Gregory-Hansen (1996) per testare l'esistenza di cointegrazione in modelli con *shift* di regime, si cerca di identificare in modo endogeno un possibile *break* strutturale nella relazione di lungo periodo che lega il salario reale a disoccupazione e produttività del lavoro. Viene trovata in effetti evidenza di un mutamento strutturale; si stima, quindi, il cambiamento sperimentato dalle elasticità prima e dopo il *break*.

Parole chiave: equazione del salario, cointegrazione, *break* strutturali.

Classificazione JEL: C22, E24.

CONTENTS

1 INTRODUCTION[1]

Labour markets in continental Europe have been long deemed rigid, in stark contrast to Anglo-Saxon countries considered as the realm of flexibility. The term Eurosclerosis was originally coined in the early eighties to depict the pattern of high observed (and equilibrium) unemployment and of slow job creation, despite a growth performance that in Germany, France, Italy or Spain was, in those days, not lower than in the UK and the US. To address labour market problems, continental European economies have adopted different reforms since. Contents of interventions varied according to nations, as well as their time of implementation (the very late being Germany). In spite of heterogeneity, common features can be detected in these reforms: the bulk of national labour markets was mainly affected by changes in wage formation (resulting in more moderation), while the structure of employment protection legislation was maintained basically unchanged; flexibility was, instead, introduced at the margin, mainly through the liberalization of temporary contracts for new hiring (a route epitomized by the Spanish experience). Besides potential inequality inherent in these changes (the burden of flexibility weighs only on a segment of active population), a relevant question, from a macroeconomic perspective, is whether such institutional modifications delivered a better functioning of labour markets and, after all, an abatement of structural unemployment. In this work we deal with this issue, focusing on the Italian economy. The case of this country is quite indicative for this discussion. Considered an example of rigidity, Italy showed, within the lapse of a decade, appreciable improvements in labour market aggregate indicators: unemployment rate almost halved since 1995, going back to levels of thirty years before; employment and participation rates, although remaining below European averages, got better. These achievements didn't jeopardize a general condition of wage moderation and, peculiarly, they were realized despite disappointing economic growth. Interestingly, these results were reached in a

[1]The authors would like to thank Massimo Mancini and Claudio Lupi for useful comments and suggestions

period of intense labour market reforms. After variations in the early eighties in the mechanism of wage formation and the adoption of norms on some forms of temporary work, a major wave of changes in industrial relations took place at the beginning of the nineties, marking a discontinuity with former regulation (on the relevance of these modifications see Brandolini et. al. 2006). Main novelties were the complete abolition, in 1992-93, of the long-lasting indexation mechanism and the adoption, in 1993, of a two-tiers system for wage negotiation (nation-level linked to government target inflation, firm-level aimed at barganing variable pay rises related to productivity improvements). Moreover, the early nineties saw a significant boost to temporary work, thanks to an enlargement of the possibility to resort to fixed-term contracts at contractual level; a form of hiring which was further reinforced in the following years.

To our best knowledge, only two papers have investigated the effect of italian labour market reforms on wage behaviour in a macroeconomic perspective. They both focus on changes occurred in the early nineties. Fabiani et al. (1997) used the parameter instability test developed by Hansen (1992) to check the stability of wage and price behaviour in the Bank of Italy Quarterly Model (BIQM). On the grounds of a Lagrange Multiplier test of the null hypothesis of constant parameters against the alternative of structural changes, they find no empirical support to the view that the income policy episode and the 1993 reform represent fundamental innovation in the wage formation mechanism. Using the same approach, Destefanis et al. (2005) study the influence of the 1993 agreements on the disinflation experienced in Italy through the 1990s, providing econometric estimates both for reaction function of the Central Bank of Italy and for 2-digit industry wage equation. Their findings show that the relationship between wages and the other labour market variables seems not much affected by the 1993 agreements. Both these works are however not interested in detecting structural breaks in the cointegration relationship between variables included in the wage equation, which is, instead, at the center of our analysis. This paper attempts to contribute to the empirical literature in two ways. First, adopting a simple wage setting model we try to detect endogenously structural breaks in the long-run relationship between real wage, unemployment and labour productivity using a different methodology (Gregory and Hansen, 1996). Second, we estimate the elasticities between these variables before and after the breaks over the period 1981:1-2006:4. This paper is organized as follows. In section 2, the wage setting model is presented. In section 3, we describe data and implement empirical analysis. Section 4 concludes.

2. THE WAGE SETTING EQUATION

The wage setting equation is derived from models of wage bargaining between insider workers and non-competitive firms (Layard et.al., 1991; Blanchflower and Oswald, 1994; Bårdsen et.al., 2005). In its most general form, the equation is defined as

$$W/P = g(U, Z), \tag{1}$$

where the real consumption wage, W/P, depends on the unemployment rate, U, and of a set of other variables summarised in Z. The vector Z includes both factors affecting the bargaining power of workers (e.g., wage setting systems, degree of unionization, employment protection rules, unemployment benefits, search effectiveness from outsiders, and so on) and factors entering the process of profit maximization of monopolistically competitive firms (basically labour productivity, assuming that mark up on marginal cost is independent of activity). We are interested in detecting structural breaks in this relationship. Particularly, we want to have indications on whether (and if so, when) institutional changes in the functioning of the Italian labour market have produced permanent modifications in the way the rate of unemployment impacts on bargained wage. The kind of change we search for is hence a proper regime shift. To this end, we leave out of Z the subset of all variables that are strictly related to labour market institutions: it is their change that would possibly reflect in shifts (both in level and in elasticity) in the parameters. Given this strategy, our specification of the wage equation will retain only the productivity factor of the vector of variables Z, becoming

$$W/P = g(U, PR) \tag{2}$$

where consumption real wage varies negatively with unemployment (as unemployment increases, the market power of wage setters declines) and positively with labour productivity, PR (rising productivity, workers can bargain a higher real wage).
A log-linearization of (2) is the following

$$lwp_t = \mu + \alpha_1 lu_t + \alpha_2 lpr_t + \epsilon_t, \tag{3}$$

where t denotes the time period, lwp_t indicates the log of real wage, lu_t denotes the log of the unemployment rate, lpr_t is the log of labour productivity and ϵ_t is an error term. In next section, equation (3) is estimated.

3. DATA AND EMPIRICAL RESULTS

In this section we present our empirical analysis. It consists of three steps. First we investigate the properties of the variables with unit root tests. As a second step, we apply single equation methods for cointegration with and without regime shift to wage setting equation. Finally, we estimate the elasticities of parameters of the long run relationship for wage equation over the period 1981:1-2006:4. Quarterly data are taken from ISTAT and OECD. Data are not seasonally adjusted, since the use of filtered series by some filters associated with the X-11 seasonal adjustment program would cause a tendency to disguise the structural instability (Ghysels and Perron, 1996). Real wage and labour productivity variables are a transformation of ISTAT data. Real per capita wage is a ratio between wage and salaries per employees (full time equivalent) and labour productivity is a ratio between GDP at constant 2000 prices and total employment (full time equivalent). Unemployment rate data are taken from OECD. All variables are in logarithms.

3.1 UNIT ROOT TESTS

We first test for the unit roots of the wage equation variables using four different tests, namely the ADF test (Dickey and Fuller, 1979, 1981), the PP test (Phillips and Perron, 1988), the DF-GLS test (Elliot, Rothenberg, and Stock, 1996), and the Zivot and Andrews (1992, hereafter ZA) test. The ADF and PP tests of the null hypothesis of a unit root have been widely used in empirical work. The DF-GLS test has the advantage of having more power than the former two. Using these three different unit root tests allows us to verify the robustness of the unit root results. The ZA test is considered since several events occurred in Italy during the period of 1981:1-2006:4 that may have caused a structural break in the data. This test allows for an estimated break in the trend function under the alternative hypothesis and is consistent with the alternative hypothesis of cointegration tests in the presence of a possible regime shift (see section 3.2). ZA present three models:

Model A (a shift in the mean of the process):

$$y_t = \hat{\mu}^A + \hat{\theta}^A DU_t(\hat{\lambda}) + \hat{\beta}^A t + \hat{\alpha}^A y_{t-1} + \sum_{j=1}^{k} \hat{c}_j^A \Delta y_{t-j} + \hat{e}_t \tag{4}$$

Model B (a shift in the rate of growth of the process):

$$y_t = \hat{\mu}^B + \hat{\beta}^B t + \hat{\gamma}^A DT_t^*(\hat{\lambda}) + \hat{\alpha}^B y_{t-1} + \sum_{j=1}^{k} \hat{c}_j^B \Delta y_{t-j} + \hat{e}_t \tag{5}$$

Model C (a shift in both the mean and the rate of growth of the process):

$$y_t = \hat{\mu}^C + \hat{\theta}^C DU_t(\hat{\lambda}) + \hat{\beta}^C t + \hat{\gamma}^A DT_t^*(\hat{\lambda}) + \hat{\alpha}^C y_{t-1} + \sum_{j=1}^{k} \hat{c}_j^C \Delta y_{t-j} + \hat{e}_t \tag{6}$$

where $DU_t(\lambda) = 1$ if $t > t\lambda$, 0 otherwise; $DT_t^*(\lambda) = t - T\lambda$ if $t > T\lambda$, 0 otherwise. The symbol ˆ on the parameters λ in the previous equations denotes the estimated values of the break fraction $\lambda = T_B/T$, where $1 < T_B < T$.

To implement the sequential trend break model, some regions must be chosen such that the end points of the sample are not included. The reason is that in the

Table 1: Unit root test. Variables in Level

variables	ADF	PP	DF-GLS	ZA
lwp	-0.708(4)	-1.537	-1.192(4)	-4.888(1989:3)
lu	-1.524(3)	-1928	-0.627(3)	-3.172(1992:4)
lpr	-1.851(4)	-1.620	0.919(4)	-4.225(1992:3)

Notes : *i)* ADF test is computed with the number of lags chosen using the Schwarz Bayesian criterion. Lags are reported in parenthesis; *ii)* PP is computed using the Bartlett Kernel with automatic Newey-West bandwidth selection (Newey and West, 1994); *iii)* DF-GLS test is computed with the number of lags chosen using the Schwarz Bayesian criterion. Lags are reported in parenthesis; *iv)* ZA indicates Zivot and Andrews test. Breaks date are in parenthesis

presence of the end points, the asymptotic distribution of the statistics diverges to infinity. ZA suggest that the 'trimming region' be specified as (0.15T, 0.85T). The break points are selected recursively by choosing the value of T_B for which the ADF t-statistic (the absolute value of the t-statistic for α) is maximized. The testing procedure is not conditional on prior selection of breakpoint, that is the break point is estimated rather then fixed. The null hypothesis in equations 4-6 is that $\alpha = 1$ which implies that there is a unit root in y_t. The alternative hypothesis is that $\alpha < 0$, which implies that there is a trend stationary process with a only one breakpoint occurring at an unknown time. Unit root test results for variables in level are reported in Table 1. For the ADF, PP and DF-GLS tests, models with constant are used. For ZA test, model (c) is considered. Results show that for all series, the null hypothesis of unit root cannot be rejected. In table 2, unit root results for variables in first difference are reported. The null hypothesis can be rejected in all cases.

Table 2: Unit root test. Variables in first difference

variables	ADF	PP	DF-GLS	ZA
lwp	$-3.958^{*}(3)$	-4.906^{*}	$-3.611{*}(3)$	$-5.2120^{**}(1996{:}3)$
lu	$-4.242^{*}(3)$	-5.254^{*}	$-3.675^{*}(3)$	$-5.376^{**}(1997{:}2)$
lpr	$-3.905293^{*}(3)$	-6.354^{*}	$-3.572^{*}(3)$	$-5.583^{*}(1991{:}3)$

Notes : *i)* ADF test is computed with the number of lags chosen using the Schwarz Bayesian criterion. Lags are reported in parenthesis; *ii)* PP is computed using the Bartlett Kernel with automatic Newey-West bandwidth selection (Newey and West, 1994); *iii)* DF-GLS test is computed with the number of lags chosen using the Schwarz Bayesian criterion. Lags are reported in parenthesis; *iv)* ZA indicates Zivot and Andrews test. Breaks date are in parenthesis; *v)* $*$, $**$ and $***$ indicate significance at 1%, 5% and 10% levels respectively.

3.2 TESTING FOR COINTEGRATION IN PRESENCE OF REGIME SHIFTS

In our second estimation step, we investigate the presence of a long-run relationship between real wages, unemployment and labour productivity using single equation methods for cointegration in the presence of structural breaks. To this end, we adopt the procedure recently proposed by Gregory and Hansen (1996, hereafter GH) developed in the field of the Engle and Granger (1987, hereafter EG) cointegration analysis. The GH tests can be viewed as a multivariate extension of the endogenous break univariate approach used in the previous section. Specifically, GH propose ADF statistics to test the null hypothesis of no cointegration against the alternative of cointegration in the presence of a possible regime shift. In particular, GH consider cases where the intercept and/or the slope coefficient have a single break of unknown timing.[2]

To model structural change, it's useful to define the dummy variable:

[2] Multivariate tests are also proposed in the literature. They, however, only consider a level shift (for a recent survey see Perron, 2006).

$$DU_t = \begin{cases} 0 & \text{se } t \leq [n\tau], \\ 1 & \text{se } t > [n\tau], \end{cases}$$

where the unknown parameter $\tau \in (0,1)$ denotes the (relative) "timing" of the change point, and [ ] denotes integer part. Structural change can take several forms. GH discuss three kinds of changes: a) a level shift in the cointegrating relationship, which can be modeled as a change in the intercept, while the slope coefficients are held constant; b) a level shift with time trend in model; c) shift in the level and slope (regime shift). In this paper, we consider the case a) and c).[3] For equation (3), we have:

$$lwp_t = \mu_1 + \mu_2 DU_t + \alpha_1 lu_t + \alpha_2 lpr_t + \epsilon_t, \tag{7}$$

$$lwp_t = \mu_1 + \mu_2 DU_t + \alpha_1 lu_t + \gamma_1 lu_t DU_t + \alpha_2 lpr_t + \gamma_2 lpr_t + \epsilon_t, \tag{8}$$

where μ_1 indicates the intercept before the shift, and μ_2 denotes the change in the intercept; α_1 and α_2 represent the cointegrating slope coefficient before the regime shift, γ_1 and γ_2 denote the change in the slope coefficients. The solution adopted by GH to model regime shifts is similar to that of Banerjee, Lumsdaine and Stock (1992) and Zivot and Andrews (1992). GH compute the cointegration test statistics for each possible regime shift $\tau \in T$ and take the smallest value (the largest negative values) across all possible break points. In principle the set T can be any compact subset of (0,1). However, in practice T $= (0.15, 0.85)$ seems a reasonable suggestion, following the earlier literature.

In table 3 cointegration results are reported. First, the EG testing procedure for cointegration is considered. The null hypothesis of no cointegration cannot be rejected with ADF and test. However, as structural breaks are considered, a

[3] Hall (1986) points out that time trend should not be included in the wages: the increase in the real wage is always linked with a long-run increase in the productivity.

Table 3: Cointegration tests. Wage equation

Model	ADF	k	T_b
EG	-1.923	4	
GH(C)	-5.452^{**}	4	1995:3
GH (C/S)	-5.650^{**}	4	1994:2

Notes : *i)* EG indicates Engle and Granger procedure. Constant is included in the cointegration regression. Engle and Yoo (1987) critical values at 1%, 5% and 10% significance level for ADF test are -4.45, -3.93 and -3.59; *ii)* GH(c) and GH(c/s) denote Gregory and Hansen model with level and regime shifts respectively.** denotes significance level at 5%; *iii)* K indicates the lags selected; *iv)* T_b indicates the break date.

cointegration relationship for the wage equation is found. The ADF test shows evidence in favour of cointegration under structural changes. This implies that it is very important to allow for a structural change in the cointegrating vector. Breaks date are shown in figure 1, where each point corresponds to a specific ADF statistics of each of the two breaking models (C and C/S) is shown.

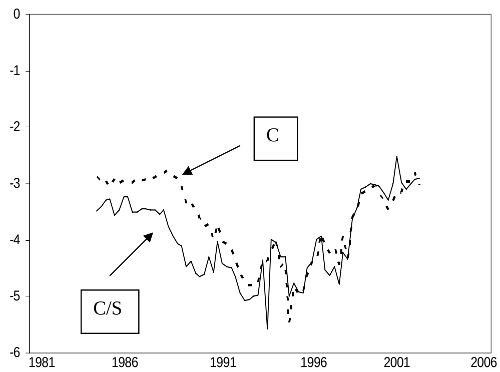

Fig. 1. Regime shifts ADF plots for wage equation.

Break dates identified with the G-H test are economically significant. They indicate that in the time period 1981:1-2006:4, during which numerous interventions were successively adopted in the Italian economy to alter labour market institutions, changes that produced permanent modifications in the wage setting relationship were those concentrated in the early nineties: a regime shift is singled out in 1994:2. Actually, in that period fundamental changes took place in Italian industrial relations. They may be summarised in three main points: 1) abolition of the wage indexation in July 1992, then formalized in the so called Protocol of July 1993; 2) setting up (in the same Protocol) of a two-level system of wage bargaining, with a national level dedicated to safeguard real compensation in a forward-looking mechanism anchored to government's target inflation rate, and a firm-level directed to allow wage rises according to local productivity performance; 3) greater diffusion of fixed-term contracts through the possibility to negotiate agreements at the firm-level. All this suggests to investigate more in depth the consequences of the breaks on the wage formation mechanism: magnitude and direction of the shifts are called into questions. Estimates are performed in the next section.

3.3 ESTIMATION OF THE LONG RUN RELATIONSHIP

Once found that the cointegration relationship is not distorted with structural breaks, we proceed to estimate the cointegrating wage vector taking into account break date. The equation regression is estimated with OLS estimator and results are summarized in table 4. The estimated regression coefficients of all variables are statistically significant and consistent with theoretical prediction. Of major interest are, obviously, estimates of parameters before and after the shifts detected in the relationship. Responsiveness of real wage to unemployment rate substantially increases (by a factor of two, according to the point estimates) between the period that precedes and the one that follows the second quarter of 1994, date of the identified regime shift: elasticity changes from -0.136[4] to -0.262. As for the elasticity of real wage to labour productivity, the break makes it closer to the one-to-one relationship holding in the long run; a slight change that could reflect innovations in bargaining mechanism (with flexible wage rises determined at firm-level). Summing up, estimates indicate that the regime break singled out in cointegration analysis produced, in middle nineties, an appreciable rise in the elasticity of real wage to unemployment rate.

[4]The pre-break estimate of the elasticity of real wage to unemployment rate is not too distant from the value of -0.1 proposed by Blanchflower and Oswald (1994) for a set of industrial countries.

Table 4: Wage equation. Dependent variable: lwp.

Variabile	coefficients	Std. Error	t − Statistic
constant	0.355	0.142	2.49^{**}
DU	0.741	0.314	2.36^{**}
lu	−0.136	0.062	2.18^{**}
luDU	−0.262	0.116	2.26^{**}
lpr	0.871	0.190	4.56^{**}
lprDU	0.942	0.426	2.21^{**}

Notes: *i)* DU=0 up to 1994:2, and 1 thereafter; *ii)* ** indicates 5% significance level.

A change that goes in the direction of an abatement of labour market structural imbalances, with a move of the Italian economy from a "higher" to a "lower" equilibrium unemployment regime. Considered the policy changes described in section 3.2, such a passage of regime is connectable to the profound reforms adopted in those years in the mechanism of wage formation and to the larger impulse, given in the same period, to temporary work.

4. CONCLUSIONS

Italy experienced appreciable improvements in the labour market macro-performance since the years (the eighties) in which it was one of the prominent examples of Eurosclerosis. Better results in terms of both unemployment and job creation were achieved without jeopardizing wage moderation and, above all, despite dismal economic growth. During this period, several reforms were adopted to modify labour market institutions from a condition of marked rigidity. It is tempting to connect better employment performance to institutional innovations. In this paper, we investigate this link. We do it indirectly by specifying a parsimonious form of a wage setting model, leaving out of specification variables related to institutional factors whose possible change would determine the permanent modifications in the macro-behaviour of labour-market actors we are searching for. In doing so, we are obviously unable to correlate exactly shifts to specific measures, but we can get a reliable indication about the time of the break due to reforms and then estimate direction and magnitude of the induced shifts. Three-steps estimation procedure is used to detect shifts between real wage, unemployment rate and labour productivity in the wage equation. First, we apply unit root tests to establish the nonstationarity of the these variables. Second, we use Gregory and Hansen approach for cointegration to detect endogenously the time of the break. Finally, we estimate the elasticities of the parameters of the wage equation before and after the regime shifts. Findings show that in the considered period (1981:1-2006:4) a regime shift emerged in 1994:2. This may be related to the wave of institutional modifications that took place in the early nineties, when the system of wage formation was radically transformed in Italy and resort to temporary work experienced an acceleration. Notably, parameters estimation, before and after the break, shows a marked increase in the responsiveness of real wage to unemployment rate following the shift: a doubling of the elasticity according to the point estimates. A move indicating that the Italian economy experienced, in the middle nineties, a structural passage from a regime of high to one of low equilibrium unemployment.

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