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Policy matters. The long run effects of aggregate demand and mark-up shocks on the Italian unemployment rate

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Abstract. This paper estimates a VAR including labor productivity, real wage and unemployment rate, to identify the dynamic effects of technology, demand, and mark-up shocks, respectively, on the Italian labor market. Identification is achieved by imposing recursive restrictions on the matrix of long run multipliers. Our results show that both mark up and aggregate demand shocks permanently reduce the unemployment rate. Finally, technology shocks do not significantly affect the unemployment rate in the long run. These findings convey important policy implications: expansionary aggregate demand and deregulation policies reducing the mark up permanently decrease the Italian unemployment rate.

Key words: Structural VAR, Unemployment hysteresis, Aggregate demand and deregulation policies

JEL classification: C32, E32, J29

1. Introduction

Several studies on the European labor market, though using different theoretical frameworks and empirical techniques, have tried to take into account the high persistence in the unemployment rate, which in its extreme form is modeled as a variable affected by full hysteresis (Ball 1999; Bean 1994; Layard et al. 1991). The latter expression has been used to describe that the past experience of high (low) unemployment permanently raises (reduces) the

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equilibrium unemployment. In statistical terms, full hysteresis implies that all the shocks to the unemployment rate have a permanent effect and, hence, that the unemployment series is an I(1) process. In this case, the unemployment problem may be mitigated by expansionary aggregate demand policy.

The high persistence of unemployment is related to those factors that have a permanent or long-lasting effect on the natural rate, for example skill-biased technology shocks or national wage rigidity (Blanchard and Katz 1996). Moreover, a history of unemployment may itself generate sluggishness in unemployment: for example, skills gained during employment may erode during a period of unemployment, reducing the probability to become re-employed. Based on this argument, the shock accounting and propagation literature adopts an aggregate perspective to analyze the labor market dynamics and the hysteresis in unemployment. This approach is known as Structural Vector Autoregression (SVAR) analysis. A partial list of papers that study labor markets using SVAR analysis includes Balmaseda et al. (2000), Castillo et al. (1998), Gamber and Joutz (1993), Dolado and Jimeno (1995, 1997), Dolado and Lopez-Salido (1996).

In our paper, we present a modified version of the AD-AS model proposed by Castillo et al. (1988) and Balmaseda et al. (2000). The model considers a wage setting rule and includes technology, aggregate demand, and mark up disturbances (structural shocks). As in the insider-outsider model proposed by Blanchard and Summers (1986), the wage setting rule we use states that nominal wages are chosen one period in advance and set to equate expected employment to a weighted combination of lagged labor supply and employment. Wage-setters take care of the insiders via lagged employment and the outsiders via lagged labor supply. Moreover, the model is augmented by a "discouragement effect" on labor force participation: The labor force reduces as unemployment increases. Both, the wage setting behavior described above and the discouragement effect contribute to the explanation of sluggishness in unemployment. Full hysteresis is a particular solution of the model in the case where exclusively lagged employment (insiders) is considered in the wage bargaining process. In the full hysteresis solution, all three structural shocks may have permanent effects on the unemployment rate.

In order to discuss the empirical relevance of the model, we estimate a VAR system including labor productivity, real wage and unemployment. We apply impulse response analysis to study the dynamic effects of the structural shocks on the Italian labor market. Identification is achieved by imposing recursive restrictions on the matrix of long run multipliers along the lines of Blanchard and Quah (1989) and, more recently, of Clarida and Gali (1994).

Integration analysis suggests that the Italian unemployment rate is not mean-reverting over time, in other words, it is characterized by full hysteresis. The SVAR analysis shows that both (negative) mark up and (positive) demand shocks permanently reduce unemployment, while technological progress reduces unemployment (though not significantly). Finally, there is no evidence of technological bias. This outcome conveys important policy implications: aggregate demand and deregulation policies (reducing the mark up) may permanently affect the Italian unemployment rate.

In conclusion, this paper offers new evidence on the strong long-run relationship between macroeconomic policies and unemployment, as recently emphasized by several authors, e.g., Ball (1999), and Blanchard and Giavazzi (2001) for the OECD economies; Castillo et al. (1998) and Dolado and

Lopez-Salido (1996) for Spain; Fortin (1996) and Posen (1998) for Canada and Japan, respectively; Rodseth (1997) for Norway.

The paper is organized as follows: Section 2 presents the theoretical model and the solutions related to the full hysteresis case. Section 3 describes the VAR representation for productivity, real wage, and unemployment rate as well as the long-run identifying assumptions that allow us to recover the structural shocks (technology, demand and mark-up shocks). Section 4 discusses the statistical properties of integration and cointegration of the variables showing that the VAR representation implied by our economic model is supported by the data. Finally, it shows the results. Section 5 concludes.

2. Theoretical framework

2.1. The basic model

In order to analyze the Italian labor market dynamics, we set up a modified version of the models proposed by Castillo et al. (1998) and Balmaseda et al. (2000). The focus is on quantifying the role played by technology, demand, and mark-up shocks in explaining the dynamic behavior of labor productivity, real wages, and the unemployment rate.

Let us consider the following structural equations

$$y_t = d_t - p_t \tag{1}$$

$$y_t = n_t + \theta_t \tag{2}$$

$$p_t = w_t - \theta_t + \mu_t, \tag{3}$$

where y_t denotes the (natural) log of output, d_t log of nominal expenditure, p_t log of prices, n_t log of employment, w_t log of wage. Parameters θ_t and μ_t represent productivity and mark up shift factors, respectively. Equation (1) gives function for the aggregate demand function, Eq. (2) for the production function under a CRS technology. Finally, Eq. (3) describes a simple price setting rule, i.e., a mark up on the unit labor cost. The function of the labor supply and wage setting rule are given by the following equations

$$l_t = \alpha(w_t - p_t) - bu_t \tag{4}$$

$$w_t = w^* + \gamma_1 \varepsilon_{dt} + \gamma_2 \varepsilon_{\mu t} \tag{5}$$

$$w^* : n_t^e = (1 - \lambda)n_{t-1} + \lambda l_{t-1}, \tag{6}$$

where l_t denotes log of labor force, n_t^e the expected employment, $u_t = l_t - n_t$ the unemployment rate; ε_{dt} and $\varepsilon_{\mu t}$ represent shocks to demand and mark up, respectively. Equation (4) is the labor supply function: it depends on the real wage, i.e., $w_t - p_t$, and the unemployment rate, i.e., u_t. Parameter α expresses the elasticity of labor supply, while b captures the effects of unemployment on the labor supply decisions. $b > 0$ implies that long term workers unemployed become demoralized and exit from the labor force, i.e., a *discouragement effect*. Viceversa, $b < 0$ may be interpreted as the case in which the head of household loses her job and induces other household members to participate more in the labor force, i.e., a *participation effect*. Hence, for $b > 0$, the *discouragement effect* dominates, and the labor force tends to reduce as unemployment increases. Equations (5) and (6) describe a wage setting rule, where wages show both a backward looking component and a forward looking one. As in the insider-outsider model proposed by Blanchard and Summers (1986), nominal wages are chosen one period in advance and set to equate n_t^e to a weighted combination of lagged labor supply and employment. In this framework, wage setters care both about insiders, i.e., the employed workers (n_{t-1}), and the outsiders, i.e., the unemployed through l_t. The key parameter characterizing the unemployment persistence is given by λ. In particular, $\lambda = 0$ implies *full hysteresis*, while $0 < \lambda < 1$ characterizes *partial hysteresis* in the unemployment rate. In Eq. (5) wage fluctuations depend both on w^* and on mark up as well as demand shocks.

To close the model, we specify the evolution of the shift factors: d, θ and μ. For the sake of simplicity, let us assume that these stochastic processes are pure random walks. Hence, under the random walk hypothesis we have

$$\Delta d_t = \varepsilon_{dt} \tag{7}$$

$$\Delta \theta_t = \varepsilon_{st} \tag{8}$$

$$\Delta \mu_t = \varepsilon_{\mu t}, \tag{9}$$

where $\varepsilon_{dt}, \varepsilon_{st}, \varepsilon_{\mu t}$ denote *i.i.d* uncorrelated aggregate demand, technology and mark-up shocks, respectively. As noted by Balmaseda et al. (2000), the random walk hypothesis merely simplifies the algebra. The only necessary assumption is that these stochastic processes are I(1). In our empirical investigations we relax this assumption by assuming the shift factors in Eqs. (7), (8), and (9) to follow I(1) processes in order to allow for a richer dynamics.

2.2. *Full hysteresis*

As discussed in Castillo (1998) and Balmaseda et al. (2000), in the case of wage setters caring only about insiders in the wage bargaining, the parameter λ in Eq. (6) is equal to zero (full hysteresis) and unemployment can be characterized by a unit root process. In particular, the persistence of unemployment is an increasing function of the discouragement effect on the labor force and the impact of lagged employment on the wage determination process (λ). The Italian unemployment rate can be empirically characterized by a stochastic process with a unit root as we will see in Sect. 4.2. For this reason, we derive the solution of the theoretical model only for the case of full hysteresis. Imposing $\lambda = 0$ and expressing Eqs. (1) to (9) in terms of shocks, we obtain the following representation:

$$\Delta y_t = (1 - \gamma_1)\varepsilon_{dt} - (1 + \gamma_2)\varepsilon_{\mu t} + \varepsilon_{st} \tag{10}$$

$$\Delta n_t = (1 - \gamma_1)\varepsilon_{dt} - (1 + \gamma_2)\varepsilon_{\mu t} \tag{11}$$

$$\Delta w_t = \gamma_1 \varepsilon_{dt} + \gamma_2 \varepsilon_{\mu t} \tag{12}$$

$$\Delta p_t = \gamma_1 \varepsilon_{dt} - \varepsilon_{st} + (1 + \gamma_2)\varepsilon_{\mu t}. \tag{13}$$

Linear combinations of the above variables yield

$$\Delta(y_t - n_t) = \varepsilon_{st} \tag{14}$$

$$\Delta(w_t - p_t) = \varepsilon_{st} - \varepsilon_{\mu t}. \tag{15}$$

Obviously, changes in labor productivity are driven exclusively by technology shocks, see Eq. (14), while changes in real wage are driven by technology and mark-up shocks, see Eq. (15). Finally, changes in unemployment rate are determined by technology, mark up, and demand shocks as follows:

$$\Delta u_t = (1+b)^{-1}\left[-(1-\gamma_1)\varepsilon_{dt} + (1+\gamma_2-\alpha)\varepsilon_{\mu t} + \alpha\varepsilon_{st}\right]. \tag{16}$$

Positive technology shocks increase labor productivity, real wages and unemployment rate (unless the elasticity of labor supply, α, is zero). This latter effect describes the so-called "technological bias explanation of unemployment". In other words, skill biased technological progress increases the unemployment rate because the demand of new (skilled) workers does not compensate the number of unskilled workers that are unemployed due to the innovation process. Negative mark-up shocks, i.e., a reduction of the mark up, increase real wages and decrease the unemployment rate. Finally, positive aggregate demand shocks reduce unemployment if indexation of the wage setting rule is not complete, i.e., $\gamma_1 < 1$. In general, all these shocks may have permanent effects on the unemployment rate.

3. The empirical model

We apply VAR analysis in order to analyze the dynamic effects of technology, demand, and mark-up shocks on variables characterizing the labor market. The identification is achieved by imposing long run restrictions, as given by Eqs. (14)–(16). Additionally, variance decomposition and impulse response analysis are employed to assess the importance of these shocks on the variables included in the model[1]. The VAR representation used and presented in the following section is thus guided by our economic model solved for the full-hysteresis case. This implies that all the variables included are in first differences. In Sect. 4.2 we will discuss the statistical properties of the variables (integration analysis) and of the system (cointegration) that support our theoretical model and the associated VAR representation.

3.1. VAR representation

Let $X_t = [\Delta(y_t - n_t), \Delta(w_t - p_t), \Delta u_t]'$ be a covariance stationary vectorial stochastic process. X_t admits the following Wold representation, where the deterministic components of the variables have been omitted for the sake of simplicity:

$$X_t = A(L)v_t. \tag{17}$$

The following conditions hold: (i) $A(L) = I + A_1L + A_2L^2 + \ldots$, (ii) $v_t \sim (0, \Sigma_v)$, (iii) $\det \Sigma_v \neq 0$ and (iv) $A(0) = I$. Representation (17) is the VAR reduced form. Suppose that X_t has the following structural moving average representation

[1] Notice that despite its wide use, impulse response analysis may be subject to several critical appraisals, see Hendry and Mizon (1998) for an exhaustive discussion.

$$X_t = B(L)\varepsilon_t, \tag{18}$$

where $\varepsilon_t \sim (0, \Sigma_\varepsilon)$. The innovations v_t are assumed to represent linear combinations of the structural disturbances ε_t, i.e., $v_t = S\varepsilon_t$ for some (3×3) full rank matrix S. Hence the following relation holds:

$$S\Sigma_\varepsilon S' = \Sigma_v.$$

Since Σ_v may be estimated from the reduced form, the identification problem relates to the conditions under which the structural parameters in $S\Sigma_\varepsilon S'$ can be recovered from Σ_v. The structural model, i.e., the coefficients of $B(L)$, will be identified introducing enough restrictions to determine S univocally. The orthonormality of the variance-covariance matrix $\Sigma_\varepsilon = I$ provides six non linear restrictions on S. In order to just-identify the model, we need three additional restrictions that we will be outlined in the following section.

A cavet in the specification of our representation is worth noting. Like any small structural model, Eq. (17) may be affected by a problem of omitted variables. As pointed out by Carruth et al. (1998), some prices or the real interest rate may be important determinants of the unemployment rate. In particular, these authors find that the oil price is the relevant variable in accounting for U.S unemployment fluctuations.

3.2. Identification

From Eqs. (14) to (16) we choose the following *long run identifying restrictions*: demand shocks, ε_d, have no permanent effects on labor productivity $(y - n)$ and real wage $(w - p)$; mark-up shocks, ε_μ, have no permanent effects on labor productivity. In fact, a CRS production function implies that only technology shocks affect productivity in the long run, while the long-run component of real wage is only driven by productivity and mark-up shocks.

These restrictions imply that the matrix of the long run multipliers $B(1)$ is lower triangular, i.e.:

$$B(1) = \begin{pmatrix} b_{11}(1) & 0 & 0 \\ b_{21}(1) & b_{22}(1) & 0 \\ b_{31}(1) & b_{32}(1) & b_{33}(1) \end{pmatrix} \tag{19}$$

where, given Eqs. (14)–(16), the relationships with the structural parameters are given by

$$B(1) = \begin{pmatrix} 1 & 0 & 0 \\ 1 & -1 & 0 \\ \frac{\alpha}{1+b} & \frac{1+\gamma_2-\alpha}{1+b} & \frac{\gamma_1-1}{1+b} \end{pmatrix} \tag{20}$$

Following Clarida and Gali (1994), S is obtained by $S = A(1)^{-1}C$, where $CC' = A(1)\Sigma_v A(1)'$.

3.3. Variance decomposition

Consider the structural representation (18) and let $j = 1, 2, 3$ be the number of shocks, $i = 1, 2, 3$ the number of variables, $t = 1, \ldots, T$ the number of quarters and $var(\varepsilon_{itj}) = 1$, respectively. We can express the variance of X_i as follows

$$V_{iT} = \mathrm{var}(X_i) = \sum_{j=1}^{3}\sum_{t=1}^{T} b_{ijt}^2. \tag{21}$$

Our interest mainly focuses on the proportion of the variance of each variable explained by technology, mark up and demand shocks which we define as

$$V_{iT}^{\varepsilon_s} = \frac{\sum_{t=1}^{T} b_{i1t}^2}{\sum_{j=1}^{3}\sum_{t=1}^{T} b_{ijt}^2}, \quad V_{iT}^{\varepsilon_\mu} = \frac{\sum_{t=1}^{T} b_{i2t}^2}{\sum_{j=1}^{3}\sum_{t=1}^{T} b_{ijt}^2}, \quad V_{iT}^{\varepsilon_d} = \frac{\sum_{t=1}^{T} b_{i3t}^2}{\sum_{j=1}^{3}\sum_{t=1}^{T} b_{ijt}^2} \tag{22}$$

where the numerator in (21) represents the variance of the i-th variable explained by shocks ε_s, ε_μ, ε_d and, the denominator the total variance of the i-th variable. In Subsect. 4.3 we report results for the ratios (21) for $T = 1, 4, 16, 60$.

4. Results

4.1. Data

The data stem from OECD *Business Sector Data Base*. We use Italian quarterly data for the period 1960:1 to 1999:4 on the following series:

d: GDP – gross domestic product (market prices);
n: total employment (number of workers);
p: GDP deflator (market prices);
w: compensation for employees;
u: unemployment rate;
$y - n$: labor productivity (real GDP per workers) in (natural)logs;
$w - p$: real wage in (natural)logs;
u: unemployment rate.

4.2. Statistical properties of the data

The theoretical model, outlined in Sect. 2, has been closed under the assumption that the unemployment rate is characterized by full hysteresis. This assumption captures the stylized fact that in the past two decades the behavior of Italian unemployment has changed with respect to the post-war period showing higher persistence, in particular, after 1974. Figure 1 shows the evolution of the Italian unemployment rate since 1960. The unemployment rate increases from a value of 5%, stable throughout the 60's, to about 12% in the 1999, and it looks like a non-stationary series. In this section, we study the non-stationary nature of the Italian unemployment rate to check for the presence of full hysteresis.

As stated above, full hysteresis in unemployment describes a situation in which all shocks, both transitory (e.g. aggregate demand shocks) and permanent shocks (e.g. technology shocks), may have permanent effects on the series. Within the framework of a linear dynamic model, full hysteresis requires a unit root in the unemployment series. Hence, the persistence of a series in the sense of a unit root can be modeled as the sum of an autoregressive

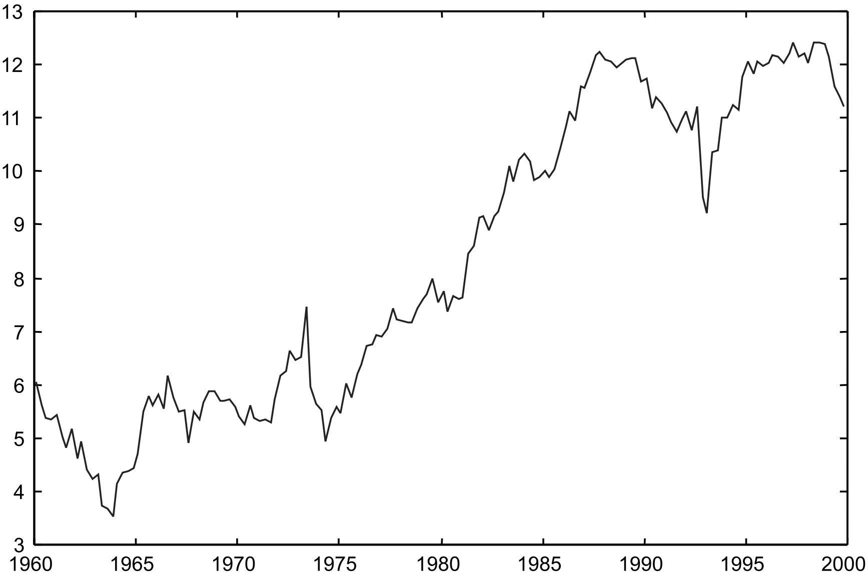

Fig. 1. The Italian unemployment rate 1960:1–1999:4

process of a higher order with a constant mean value parameter and verified by using tests on the order of integration of the series. We call it the unit root approach to the study of unemployment persistence (e.g., Layard et al. 1991 and Roed 1996).

A second approach has pointed to the possibility that the degree of persistence may be caused by abrupt changes in the mean rate of unemployment (e.g., Phelps 1994) and that between these shifts unemployment may be stationary. Recently, Bianchi and Zoega (1994) have calculated the sum of the coefficients in the autoregressive process as a measure of persistence with time invariant mean and compare it to the same measure of persistence obtained when the mean shifts are taken into account. By means of this strategy, this study tried to asses the significance of mean shifts of unemployment for the OECD countries. The findings of these authors suggest that the Italian unemployment rate is an I(1) process rather than a stationary I(0) process with shifting mean.

Following the unit root approach, we discriminate between an I(1) process with drift and trend stationary series, by relying on a battery of unit root and stationary tests. As stated by the solutions in Sect. 2.2, not only the unemployment rate is a variable characterized by high persistence, but also real wage and labor productivity are I(1) processes. Hence, we test the presence of unit root in all the series considered in the basic model.

Table 1 reports the results of the following tests on integration: the Augmented Dickey Fuller test (ADF), the Phillips and Perron test (PP) and the stationary KPSS test. The number of lags used in the specification of these tests is also reported. While the ADF and PP tests are unit root tests, i.e., the null hypothesis is I(1) process, the KPSS is a stationarity test, i.e., the null is an I(0) process.

Table 1. Integration and cointegration analysis

Series	Test*	Statistics	5%cv	10%cv	Conclusion
u	ADF(4)	−2.49	< −3.45	< 3.15	I(1) + drift
u	PP(4)	−14.58	< −21.5	< −18.1	I(1) + drift
u	KPSS(4)	0.26	> 0.146	> 0.119	I(1) + drift
Δu	ADF(3)	−6.55	< −2.9	< −2.59	I(0)
Δu	PP(3)	−189.77	< −14	< −11.2	I(0)
Δu	KPSS(3)	0.11	> 0.46	> 0.34	I(0)
$(w-p)$	ADF(1)	−1.92	< −3.45	< −3.15	I(1) + drift
$(w-p)$	PP(1)	−1.73	< −21.5	< −18.1	I(1) + drift
$(w-p)$	KPSS(1)	1.88	> 0.146	> 0.119	I(1) + drift
$\Delta(w-p)$	ADF(0)	−7.95	< −2.9	< −2.59	I(0)
$\Delta(w-p)$	PP(0)	−91.14	< −14	< −11.2	I(0)
$\Delta(w-p)$	KPSS(0)	4.54	> 0.46	> 0.34	I(0)
$y-n$	ADF(4)	−2.22	< −3.45	< −3.15	I(1) + drift
$y-n$	PP(4)	−5.07	< −21.5	< −18.1	I(1) + drift
$y-n$	KPSS(4)	0.66	> 0.146	> 0.119	I(1) + drift
$\Delta(y-n)$	ADF(3)	−6.24	< −2.9	< −2.59	I(0)
$\Delta(y-n)$	PP(3)	−98.83	< −14	< −11.2	I(0)
$\Delta(y-n)$	KPSS(3)	0.96	> 0.46	> 0.34	I(0)
e	ADF(0)	−1.63	< −1.95	< −1.61	I(1)
e	PP(0)	−6.57	< −8	< −5.7	I(1)
e	KPSS(0)	2.26	> 0.463	> 0.347	I(1)
e	CRDW	0.102	$R_L = 0.25$	$R_U = 0.64$	I(1)

Notes: ADF Augmented Dickey Fuller test (Fuller 1996); PP: Phillips – Perron test (Phillips and Perron 1988); KPSS: KPSS stationary test (Kwiatkowsky et al. 1992); CRDW: cointegration test by Sargan and Bhargava (1983).
* Indicates the number of lags. The lag width was chosen by the Wald test; e: residuals of the Engle and Granger first stage regression (Engle and Granger 1987).

More precisely, when the *levels of* the variables are considered, $[u, (w-p), (y-n),]$ the null hypothesis for the ADF and PP tests is a unit root with drift (I(1) process with drift), while the alternative is a linear trend stationary series. Instead, the null hypothesis of the KPSS test is linear trend stationary series versus the unit root with drift case. When the first difference of the variables is considered, $[\Delta u, \Delta(w-p), \Delta(y-n),]$ the null hypothesis of the ADF and PP test is unit root (I(1) process), while the alternative is stationary series. For the KPSS test the null is stationary series while the alternative is unit root.

For all the variables in levels, the null hypothesis of unit root with drift cannot be rejected and in the case of the KPSS test the null of stationarity is rejected. These results allow us to conclude that all the series contain at least one unit root. Performing the unit root tests on the first differences of the variables, it is possible to reject the null of a unit root (ADF and PP test) or not to reject the null of a stationary series (KPSS). This outcome suggests that the first differences of the series are I(0) process. To conclude, unemployment rate u, real wage $(w-p)$, and $(y-n)$ are I(1) processes with drift. These univariate properties of the data are consistent with the full hysteresis hypothesis.

Moreover, notice that (14)–(16) imply that $B(1)$ is triangular. Since $\det(B(1)) = \frac{1-\gamma_1}{1+b} \neq 0$, our economic model implies no cointegration among the variables. Therefore, we test for the existence of cointegration to check if structural representation (18) suggested by the theoretical model is consistent with the long run properties of the data. Both univariate tests (ADF, Phillips-Perron, KPSS and the CRDW by Sargan and Bhargava, 1983) performed on the Engle-Granger first stage regression (Engle and Granger 1987) and the multivariate test by Johansen (1991) suggest no cointegration, see Tables 1 and 2. To conclude, our theoretical prior is supported by these outcomes and hence we proceed in the analysis by specifying the VAR in first differences.

4.3. Impulse response and variance decomposition analysis

Figures 2–4 display the impulse response functions (IRF) with 90% confidence bands for technology, mark up, and demand shocks. Confidence band are derived by using the bootstrapping method with 1000 repetitions (see, Runkle 1987). IRF are derived by a four-lag VAR in all the following variables: $\Delta(y_t - n_t), \Delta(w_t - p_t), \Delta u_t$.

A four-lag VAR is suggested by tests for model reduction: the reduction for eliminating the lag length 5 is accepted while the reduction for the lag length 4 is rejected on overall- F tests presented in Table 3. Moreover, a four-lag VAR reduces the "costs" as measured by the Schwarz and Hannan-Quinn information criteria that have a minimum for this model (see Table 3). Diagnostic tests in Table 4 provide evidence in favor of white noise residuals and parameter constancy.

Figure 2 shows the IRF for a *positive* technology shock. Productivity immediately increases in consequence of the shock: in the first quarter it remains steadily around the impact level then begins to increase after the 5th quarter, reaching the new long-run level after about 20 quarters. As implied by the theoretical model (CRS hypothesis), a technology shock permanently affects labor productivity in a significant way. The variance decomposition (Table 5) suggests that the technology shock is the main source of variation in labor productivity, explaining about 90% of its variance in the short and medium run and 100% in the long run. Real wages show an impulse response similar to that of productivity. They immediately react to the shock and reach the new long run path after about 20 quarters. However, contrary to labor productivity, the response of real wages is not significant at the 90% level for each quarter. A technology shock has little weight in the variance of the real wage (Table 5): about 2% of the total variance in the first quarter, about 25–30% in the medium and long run. Unemployment drops after the shock. Such a reduction, although permanent (i.e., the new unemployment equilibrium level is below the initial one) is not significant. Technology shocks do

Table 2. Johansen maximum likelihood procedure

H_0	λ_{max}	95%cv	Trace	95%cv
$r = 0$	19.94	23.8	30.58	34.6
$r \leq 1$	9.85	16.9	10.64	18.2
$r \leq 2$	0.78	3.7	0.78	3.7

Notes: cv = critical values from Osterwald-Lenum (1992), Table 2.
For these tests we use a VECM(4), for the four-lags specification, see Table 3 and Table 4 of the present paper.

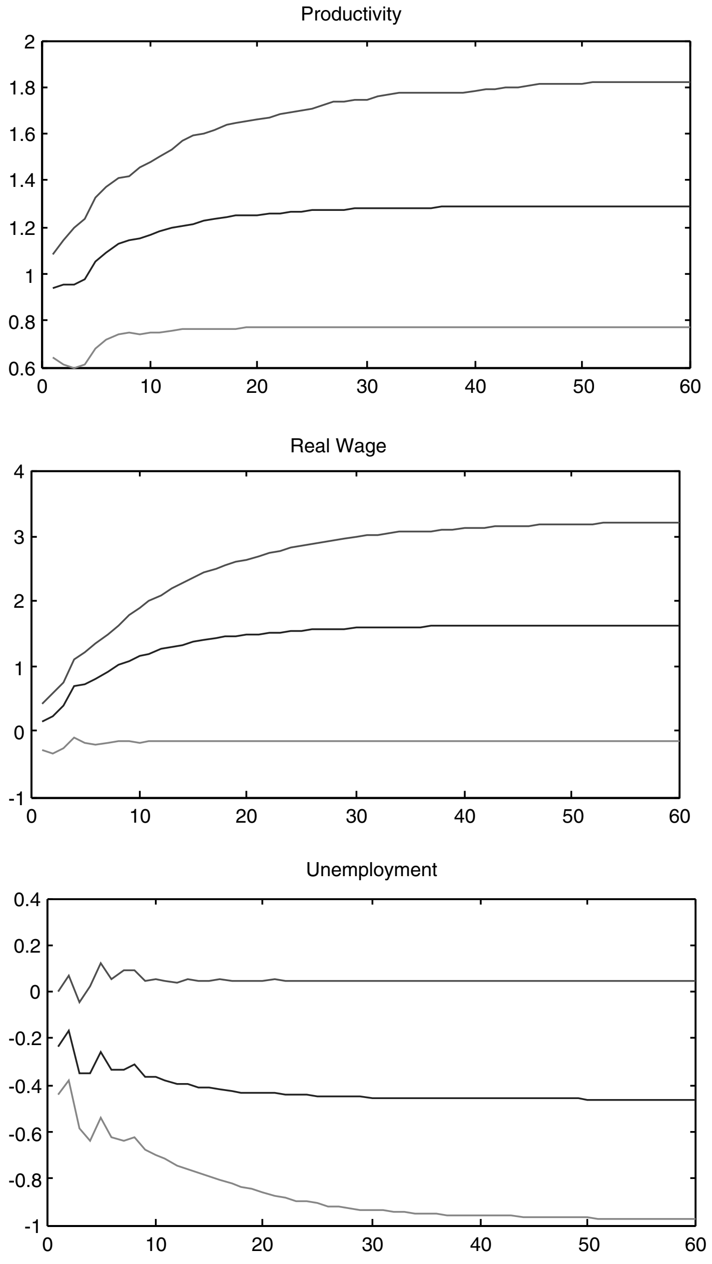

Fig. 2. The effects of a positive technology shock

not play a major role in the unemployment variation since they are responsible for less than 10% (i.e., 6%) in the first quarter, about 11–18% in the medium run and only 21% in the long run (Table 5).

Figure 3 displays the IRF due to a *negative* mark up shock. A mark-up shock immediately reduces labor productivity. After the initial negative effect

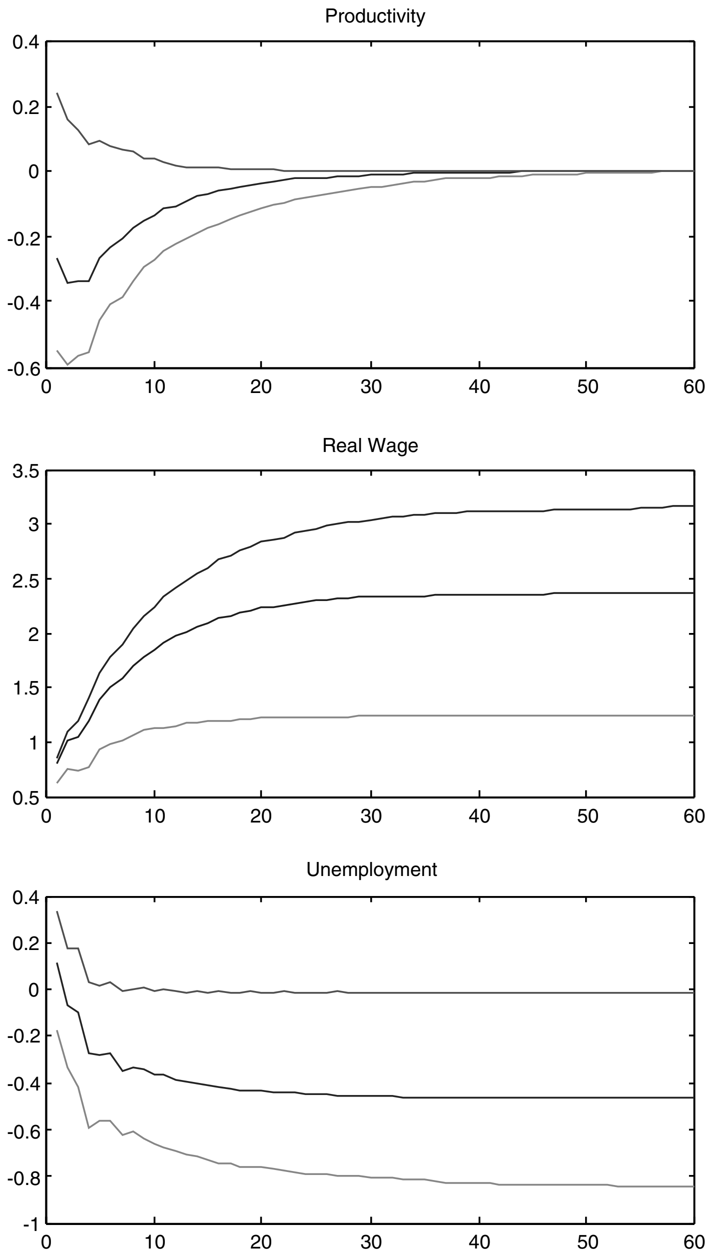

Fig. 3. The effects of a negative mark up shock

productivity remains for some quarters at its minimum level before returning to its starting level. The effect of the shock vanishes after about 30 quarters. The effect of the shock is very modest and not significant at 90% level of confidence for every quarter following the shock. mark-up shocks explain only a small fraction of the overall variance in productivity: 7% in the first

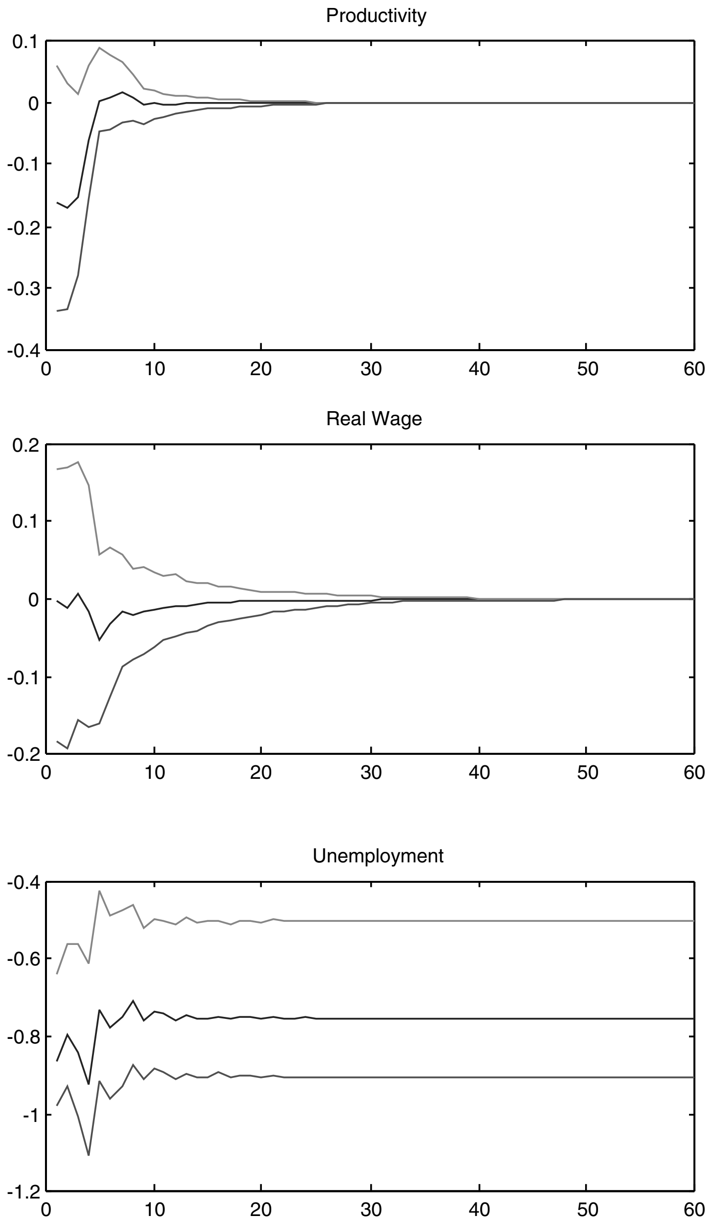

Fig. 4. The effects of a positive aggregate demand shock

quarter, 10% after 4 quarters and zero for longer horizons. Real wages immediately increase in consequence of the mark-up shock raising steadily for the first 20 quarters. After about 30 quarters real wages reach their new long run level. The mark-up shock permanently affects real wages in a significant way. It represents the main source of variation to wages. The explained variance is about 97% in the first quarter, 74% after one year and about 68%

Table 3. Information criteria and tests of model reduction

VAR	log|Ω|	Schwarz	Hannan-Quinn
VAR(5)	−20.875	−19.283	−19.850
VAR(4)	−20.791	−19.508	−19.967
VAR(3)	−20.599	−19.317	−19.776
VAR(2)	−20.435	−19.152	−19.611

Model Reduction	F-overall	(p-value)
VAR(5) to VAR(4)	F(9, 328) = 1.314	(0.2281)
VAR(4) to VAR(3)	F(9, 336) = 3.118	(0.0013)
VAR(4) to VAR(2)	F(18, 390) = 2.980	(0.0000)
VAR(4) to VAR(1)	F(27, 403) = 2.7361	(0.0008)

Notes: For a discussion of these tests, see Hendry (1995).

Table 4. Diagnostic tests

Statistics	$\Delta(y-n)$	$\Delta(w-p)$	Δu	System (vector) tests
F-autoc	1.527 (0.18)	2.239 (0.06)	1.008 (0.42)	1.177 (0.21)
F-arch	0.667 (0.99)	0.026 (0.99)	1.988 (0.09)	0.867 (0.85)
F-het	1.118 (0.33)	0.188 (1.00)	0.486 (0.97)	0.634 (1.00)
χ^2-nor	6.617 (0.05)	9.334 (0.01)	44.180 (0.00)	63.270 (0.00)
F-const(4q)				0.883 (0.56)
F-const(16q)				0.785 (0.82)
F-const(32q)				1.322 (0.07)
F-const(64q)				1.041 (0.43)

Notes: F-autoc: test for no serial correlation; F-arch: test for no autoregressive conditional heteroskedasticity; F-het: test for no heteroskedasticity; χ^2-nor: test for normality; F-const: 1-step (ex post) forecast test for parameter constancy; (.) = p-value; (.q) = number of quarters; for a discussion of these tests, see Hendry and Doornick (1993).

Table 5. Variance decomposition

	Lags	V^{ε_s}	V^{ε_μ}	V^{ε_d}
Unemployment	1	0.0692	0.0171	0.9137
	4	0.1126	0.0721	0.8153
	16	0.1897	0.1913	0.6190
	24	0.2044	0.2076	0.5880
	60	0.2118	0.2165	0.5717
Real wage	1	0.0289	0.9711	0.0001
	4	0.2543	0.7456	0
	16	0.3031	0.6969	0
	24	0.3130	0.6870	0.0004
	60	0.3177	0.6823	0
Productivity	1	0.9018	0.0712	0.0270
	4	0.8925	0.1040	0.0035
	16	0.9976	0.0024	0
	24	0.9997	0.0003	0
	60	1	0	0

in the long run. Unemployment shows a positive impact effect: after the second quarter unemployment falls below its initial value, reaching the new long run level after about 20 quarters. The effect of the shock is modest in the short run: mark-up shocks are responsible only for 1% in the first quarter and 7% after 4 quarters. Moreover, it is not significant. In the long run, a mark up shock is more important: after 60 quarters it explains 21% of the total variation of the unemployment rate. Moreover, this effect is statistically significant.

Figure 4 displays the IRF due to a *positive* demand shock. Productivity immediately reduces but after 5 quarters returns to its initial value again. Moreover, the effect is not significant. Demand shocks have no influence on the variance of productivity. Real wage is acyclical: the effect is close to zero at each quarter. Demand shocks are not responsible for real wage variation since the portion of explained variance is almost zero at each horizon. Unemployment immediately drops and after 10 quarters reaches the new long-run level. Demand shocks permanently affect the unemployment rate and their effects are statistically significant. Furthermore, they are the main source of fluctuations in unemployment accounting for 91% of the total variance in unemployment after 1 year, 81% after 4 years, 57% in the long run.

These outcomes are in line with the main implications of the theoretical model. In detail, (i) positive technology shocks increase labor productivity and real wage, while they do not significantly affect the unemployment rate. This latter result stands in contrast both with the technological bias hypothesis – we find no evidence that technological improvements increase the Italian unemployment rate, contrary to Marchetti and Nucci (2001)- and with the common view of favorable employment effects of technological innovation. This also suggests an indication for the amount of the elasticity of labor supply α. The absence of a statistically significant effect of technology shocks on the unemployment rate is consistent with a labor supply function that is relatively inelastic with respect to changes in the real wage. In terms of our model, this implies a value of α close to zero. (ii) Negative mark-up shocks increase real wage and decrease unemployment. (iii) Positive aggregate demand shocks reduce unemployment. This finding mainly depends on the sluggish adjustment of wages ($\gamma_1 < 1$) and prices. This interpretation is also consistent with the argument of acyclical behavior of the real wage (aggregate demand shocks do not affect real wages significantly), suggesting the importance of sticky wage and sticky price theories of the business cycle (e.g., Kempf 1992 and OECD 1994).

4.4. Policy implications

Our empirical findings convey important policy implications. First, expansionary demand policies can permanently reduce the unemployment rate. This result is in line with other recent empirical evidence: Balmaseda et al. (2000) find that unemployment fluctuations in the OECD countries are dominated by demand shocks in the short run and by technology shocks in the long run, while in Italy and Spain demand shocks are also important in the medium and long run. Other works provide evidence that aggregate demand affects long-run movements in unemployment, see Ball (1999) for the

OECD economies, Castillo et al. (1998) and Dolado and Lopez-Salido (1996) for Spain, Fortin (1996) for Canada and Posen (1998) for Japan, and Rodseth (1997) for Norway. This empirical evidence is important in the light of the recent debate on potential strategies for tackling high unemployment in Europe. The discussion may be summarized as consisting of two central opposite views: structural reform, including for example wage bargaining decentralization, reduction of hiring and firing costs and of the barriers to labor mobility (see e.g., OECD 1994, and Bean 1994) versus economic policies that act through monetary policy and/or determinants of aggregate demand. Our evidence suggests that such positions should not be seen that polar but rather as concomitant. Indeed, within a theoretical framework, where the labor market is rigid and structural reform can play a role, several policies are very powerful. The reason why monetary and fiscal policies are important instruments for the reduction of unemployment is exactly the same as the one that justifies structural reforms, namely the rigidity. Hysteresis in the unemployment rate makes economic policies effective, both in the short and the long run. For this reason, we should consider aggregate demand policies as useful instruments for managing unemployment as well as concomitant rather than contrasting with regard to structural labor market reforms. A further aspect is worth noting: by symmetry of the shocks, contractionary demand policies have permanent and sharply negative effects on unemployment. On the one hand, this can be an explanation for high unemployment rate by itself: contractionary monetary policy (which occurred in Italy during the 1980s) possibly caused the high Italian unemployment rate. On the other hand, the extreme effectiveness must enhance attention for future restrictive policies because of this potential strong permanent contractionary effect.

Second, policies which lower the mark up permanently reduce the unemployment rate. We refer to this kind of policies as deregulation policies, since they operate essentially through the regulation of the product market, in order to increase the degree of competition among firms (for example increasing the differentiation among products and/or reducing the entry cost). In the context of European integration, such a policy may reflect for example the reduction of tariff barriers or standardization measures, making it easier to sell domestic products in other European countries. Deregulation policies that are intended to reduce entry costs may come from the elimination of state monopolies or the reduction of red tape, associated with the creation of new firms. The mechanism through which deregulation policies affect unemployment in the long run has recently been stressed by Blanchard and Giavazzi (2001). When the number of firms is not fixed in the long run, a reduction in entry costs leads to an entry of new firms and thus to a higher elasticity of demand (a lower mark up) and, hence, lowers unemployment and induces a higher real wage. This mechanism is captured by our analysis, in so far as a reduction in the mark up causes a sharp reduction in the Italian unemployment rate at a higher real wage level.

5. Conclusion

In this paper we quantitatively assessed the dynamic responses of labor productivity, real wage, and unemployment rate to technology, aggregate demand, and mark-up shocks for the Italian economy during the period 1960–1999.

These structural shocks were identified by imposing recursive restrictions on the matrix of long run multipliers in a VAR system. These long-run identifying assumptions were derived by an AD-AS model in which wage setters care only for the insiders (employed workers). This wage-setting behavior generates full hysteresis in unemployment. The presence of a unit root in the Italian unemployment rate is confirmed by various integration tests. This finding implies full hysteresis and, as a consequence, both demand and supply shocks permanently affect the unemployment rate. Our main results can be summarized as follows: (i) positive technology shocks increase labor productivity and real wage; (ii) negative mark-up shocks increase real wage and decrease unemployment; (iii) positive aggregate demand shocks reduce unemployment. With respect to unemployment, there is no evidence for technological bias. Instead, positive aggregate demand and negative mark-up shocks permanently reduce unemployment. This outcome suggests that in economies which suffer from strong unemployment state dependence, both aggressive disinflationary policies and/or passive macroeconomic policies during recessions are highly cost bearing, since they lead to a permanently higher unemployment. Finally, deregulation polices also permanently reduce unemployment.

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