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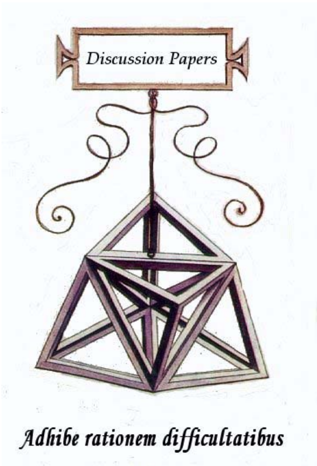

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Discussion Paper n. 43

2004

Discussion Paper n. 43, presentato: **ottobre 2004**

Indirizzi dell'Autore (corrispondente): Marco Guerrazzi, Dipartimento di Scienze Economiche, Università di Pisa, via Ridolfi 10, 56124, Pisa, Italy. Tel. +39 050 2216372. Fax +39 050 598040. E-mail: guerrazzi@Ec.Unipi.IT>

Si prega di citare così: Lorenzo Corsini and Marco Guerrazzi, Searching for Long Run Equilibrium Relationships in the Italian Labour Market: a Cointegrated VAR Approach., Discussion Papers del Dipartimento di Scienze Economiche – Università di Pisa, n. 43 (http://www-dse.ec.unipi.it/ricerca/discussion-papers.htm).

Searching for Long Run Equilibrium Relationships in the Italian Labour Market: a Cointegrated VAR Approach*

Lorenzo Corsini† and Marco Guerrazzi‡
Department of Economics
University of Pisa

Abstract

The aim of this paper is to empirically search for long run relationships in the Italian labour market, assessing the role that institutional factors played in it. In a sense, we search for the existence of a state of the economy where the labour market variables (some of which should measure the strength of institutional factors) are in a long run equilibrium. Having to deal with institutional factors, such as the presence of unions in the wage bargaining process, it came natural to use a model with New Keynesian features as theoretical background. Since we wanted to estimate equilibrium relationships, we chose the cointegrated VAR approach as estimation technique. Such approach is suited to separate long-run equilibrium relationships from short run transient dynamics, and to test the existence and the magnitude of equilibrium restoring forces. In the theoretical model we use, great emphasis is given to the variable that measures union power. Therefore, in the empirical analysis we give much attention to this variable, trying different proxies to measure it, and to assess the role it played in the Italian labour market functioning.

Keywords: New Keynesian Economics, Wage Bargaining, Union Power, Cointegrated VAR

JEL Classification: C32, J51

*We would like to thank all the participants to seminars at the conference "Research in Economics: Methodology, Coherence, and Effectiveness" held in Siena 15-16-17, May, 2003, for comments and suggestions. A particular thank goes to Annetta M. Binotti for the suggestions given at different stages of the work. The usual disclaimers apply.

†lcorsini@sssup.it

‡guerrazzi@ec.unipi.it

1 Introduction

The labour market has always been one of the key aspects in the study of the economic science. Issues such as unemployment and wages formation have been much studied, especially in theory, by several researchers.

This work aims to examine empirically the dynamics underling the Italian labour market in a period that range from the beginning of the seventies to the end of the century. Our intention, is to examine the Italian labour market from a macroeconomic point view, trying to assess relationships between some of the aggregate variables characterising this market: real wages, unemployment rate, average productivity, and union power.

Two stylised facts seem to emerge clearly in this period in Italy: the difference in the real wages growth between the seventies and the other years, and a general increase of the unemployment rate through most of the time.

We will build a theoretical framework that owes much to Layard, Nickell, and Jackman (1991) - that is - a New Keynesian model where wages are not set in a perfectly competitive market, but instead there is bargaining between unions and firms. We will then confront this model with real data to see if and how there is compatibility between theory and reality.

Our empirical analysis will be conducted mainly through cointegration. This technique is especially suited to estimate long run equilibrium relationships because it can abstract away short run dynamics. We are especially interested to shed light on two aspects of the Italian labour market. The first is the change occurred at the beginning of the eighties, not only in economic magnitudes, but also in many social aspects. The second is to find out what could be a good measure of the "union power". For this, several possibilities will be examined.

The paper is organized as follows. Section 2 presents the theoretical model. Section 3 discusses some stylised facts. Section 4 describes the main variables of interest, examining their auto-regressive properties. Section 5 introduces a discussion on how we dealt with historical and social events that deeply influenced Italian labour market. Section 6 presents the cointegration analysis on the whole sample. Section 7 does the same but on sub-samples. Section 8 deals with some methodological issues. Section 9 draws the conclusions.

2 The Theoretical Model

We base our analysis on a model in which unions and firms bargain over wages. Therefore, we use a Nash bargaining set up with unions and firms setting wages to maximise a weighted average of their utility (see Layard *et al.*, 1991). In particular, each side utility depends on the difference between utility coming from the eventual agreement and the fallback level if no bargain is achieved. We can represent this as:

$$\max_{w} \Omega = (U - \overline{U})^{\gamma} \left(\frac{\Pi}{P_c} - \frac{\overline{\Pi}}{P_c} \right)^{1-\gamma} \tag{1}$$

where U is union utility, $\overline{U}$ its fallback level, Π are the firm profits, and $\overline{\Pi}$ are fallback profits. The parameter γ measures the relative power of the union, while P_c is the consumption price index.

For sake of simplicity, we equal union utility to real gross wage:

$$U = \frac{W}{P_c} \tag{2}$$

This mean that the union, while formulating his request, is concerned only in obtaining the highest feasible real earning and it doesn't take into account any fiscal effect[1].

If a bargain is not arranged, we assume that union members will either get a job outside the firm with a nominal wage $\overline{W}$ or will be unemployed, eventually receiving a state benefit B. This leads to:

$$\overline{U} = [1 - \phi(u)] \frac{\overline{W}}{P_c} + \phi(u) B \tag{3}$$

where $\phi(u)$ is the probability of being unemployed when u is the unemployment rate[2].

The measurement of the state benefits arises several problems due to their particular normative. In Italy state benefits varies through years, not only in amount, but also in duration. An exact value is then impossible to compute. Therefore, we decided to remove B from the reservation utility.

Apart for the sake of simplicity, there are several arguments to motivate this choice. First of all, as we have observed, the value assigned to this variable is quite confusing and we can hardly think that workers are able to evaluate it correctly in formulating their claims (and maybe it is even more likely that they do not consider it at all in the bargaining).

Another motivation for this choice should be the following. Setting B to zero, is equivalent to state that the unemployed *status* provides no utility to workers. This result can be obtained assuming that the utility associated

[1]This is also justified by the fact that unions cannot influence directly fiscal policy.

[2]Obviously, $\partial\phi(u)/\partial u > 0$.

to the benefit is erased by the frustration of being unemployed. From this considerations it follows that:

$$U - \overline{U} = \frac{W}{P_c} - [1 - \phi(u)] \frac{\overline{W}}{P_c} \tag{4}$$

We imagine that firms obtain their profits from selling a homogeneous good produced through the utilisation of work and another input. The identity for the profits is

$$\Pi \equiv P_y Y - w(1 + t_e)N - P_m M \tag{5}$$

where P_c is the output price, Y is the output, $w(1 + t_e)$ is the cost for a unit of labour, N are the units of employed labour, P_m, and M are, respectively, the price and the quantity of a second input. We also set the fall back profits $\overline{\Pi}$ equal to zero.

Substituting (3) and (4) in equation (1) and solving it, we obtain

$$\frac{\left(\frac{\Pi}{P_c}\right)}{\left(U - \overline{U}\right)} \frac{\gamma}{1 - \gamma} = (1 + t_e) N \tag{6}$$

Under the hypothesis that the inside wage and the outside wage are the same we have

$$U - \overline{U} = \phi(u) \frac{W}{P_c} \tag{7}$$

and substituting (7) into (6) we have the following equation for wages

$$(1 + t_e) W = \frac{\Pi}{N} \frac{\gamma}{1 - \gamma} \frac{1}{\phi(u)} \tag{8}$$

We proceed substituting (5) into (8)

$$(1 + t_e) \frac{W}{P_y} = \left(\frac{Y}{N} - \frac{P_m}{P_y} \frac{M}{N}\right) \left[1 + \frac{\gamma}{1 + \gamma} \phi(u)\right]^{-1} \tag{9}$$

Assuming a Cobb-Douglas technology and that firms choose N and M to maximise profits (in a competitive contest), we obtain the final equation for wages:

$$(1 + t_e) \frac{W}{P_y} = \left(\frac{Y}{N}\right) \left[\frac{\alpha}{\beta} + 1 + \frac{\gamma}{1 + \gamma} \phi(u)\right]^{-1} \tag{10}$$

Equation (10) is the core of our model. We will call it *wage equation*. It shows that wages (real labour cost w) are related to productivity (Y/N), union power (γ), and unemployment (u). This equation represents also what we will call long run behaviour of wages *i.e.* the equilibrium relation holding in the long run.

3 The Theoretical Model and Some Stylised Facts

We now show how this model is related to some important stylised facts. If in equation (10) we pass to logarithms, real labour costs and labour productivity are related with an unity coefficient. Figure 1 plots quarterly data for logged real labour costs less productivity *i.e.* real unit labour costs. Figure 2 plots the logged Italian unemployment rate.

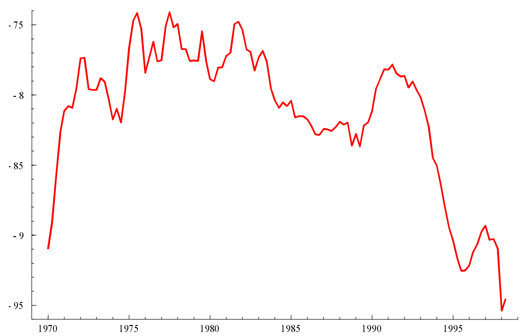

Figure 1: Italian real unit labour cost

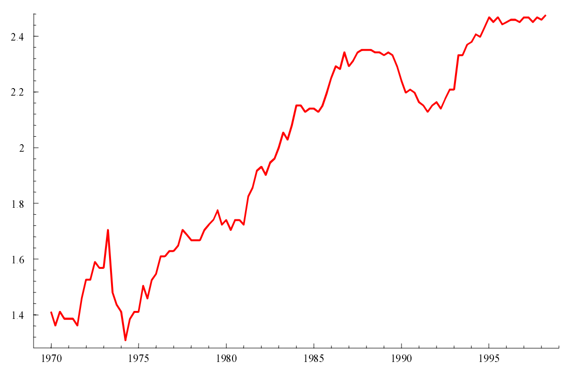

Figure 2: Italian unemployment rate

During the first part of the sample, the series appear to be uncorrelated, and the expected negative correlation is evident only at the end of the series. This can be illustrated informally using the results of a recursive regression involving real unit labour costs, a constant, and the logged unemployment rate. The recursive coefficients on the unemployment rate are plotted in figure 3.

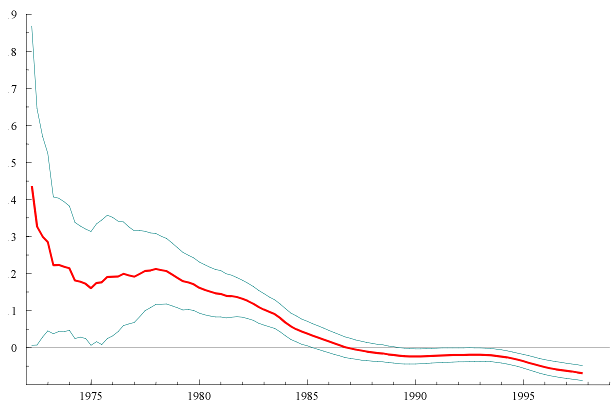

Figure 3: Recursive estimations of the regression coefficient on unemployment rate

Omitting the first part of the sample, the graph show that the relation between real unit labour costs and the unemployment rate has been stable and very weak during the observation period. As a matter of fact, the recursive estimated coefficients on the unemployment rate are always close to zero, confirming the "real wage resistance" to unemployment typical of European countries (see, for example, Lindbeck and Snower, 1988). It is clear that if unemployment has had a negligible influence on real labour cost throughout our data period, then at least one other variable must have been exerting a pressure on earnings, especially in the seventies. The variable that in our model could fulfil this role is the measure of union power.

4 Preliminary Analysis on Units Roots

Before we start in estimating our VAR model, we need to check the integration order of each series. In fact, a necessary condition for the concistency of our estimation is that all variables should share the same order of integration. A way to check this is to perform unit roots tests on each variables. In doing this, we will use the Dickey-Fuller test and the augmented Dickey-Fuller test[3].

We will describe one variable a time (showing for each of them the graphic), and we will give a full description of the tests results. Furthermore, we will propose five different proxies for union power: (*i*) unionisation rate, (*ii*) number of strikes, (*iii*) number of work conflicts per worker, (*iv*) number of strike days per worker, and (*v*) percentage of left voters.

Italian Real Wages (1970.1-1998.2)

These data (figure 4) represent the variable that in our model is called $(1+t_e)\frac{W}{P_y}$. It is calculated as the gross earning per unit of labour deflated through the GNP deflator[4]. From now on we will call w the *log* of this variable.

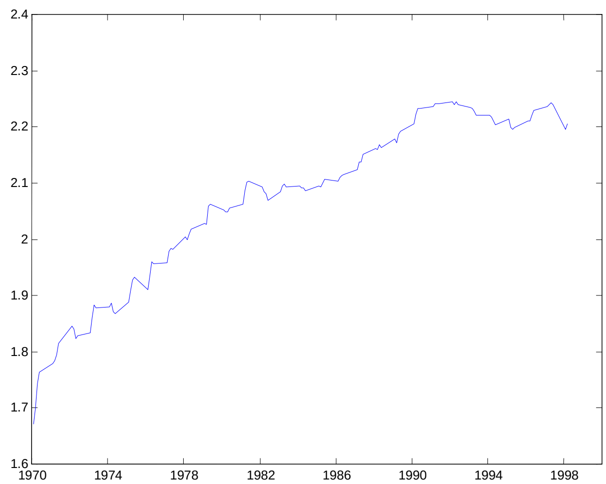

Figure 4: Italian Real Wages 1970.1-1998.2

The tests on unit roots are presented in table 1 (estimation written in bold are significant at 99%).

[3]These tests were performed with MATLAB using a specific program built by ourselves. This program is enclosed in the Appendix

[4]ISTAT source.

Italian real wages 1970.1-1998.2			
$\Delta w_t = \alpha + \rho^* w_{t-1} - \rho_2 \Delta w_{t-1}$			
	Estimated value of the parameter	Standard Error	*t*/DF/ADF value
α	**0.0595**	0.0163	3.6554 (*t*)
ρ^*	**-0.0268**	0.0078	-3.444 (ADF)
ρ_2	0.0971	0.0923	1.0519 (*t*)
$\Delta w_t = \alpha + \rho^* w_{t-1}$			
α	**0.07**	0.0148	4.7276 (*t*)
ρ^*	**-0.0315**	0.0071	-4.4191 (DF)

Table 1

The result shows that real wages follow a first order autoregressive process with a drift. The DF excludes the presence of a unit root.

From a graphical analysis of this series, one may argue that a structural break has occurred around the end of the seventies. Therefore, we tested the hypothesis that the parameters of the autoregressive model have changed during those years. However, the Chow-test we performed cannot reject the hypothesis that parameters remained the same in both sub-periods. At the end, we conclude that wages seems to be stationary around a linear trend.

We were quite surprised by these results and we still have some doubts on them. Our doubts are strengthened by fact that if we conduce this analysis on the two separate sub-samples, we cannot reject the presence of a unit root in each different sub-sample. However, the result of the Chow-test does not justify this partition of the sample.

Italian Productivity (1970.1-1998.2)

These data (figure 5) represent the Y/N of the model, and it is obtained dividing the GNP at constant price by the unit of labour[5]. From now on we will call *prod* the *log* of this variable.

[5] ISTAT source.

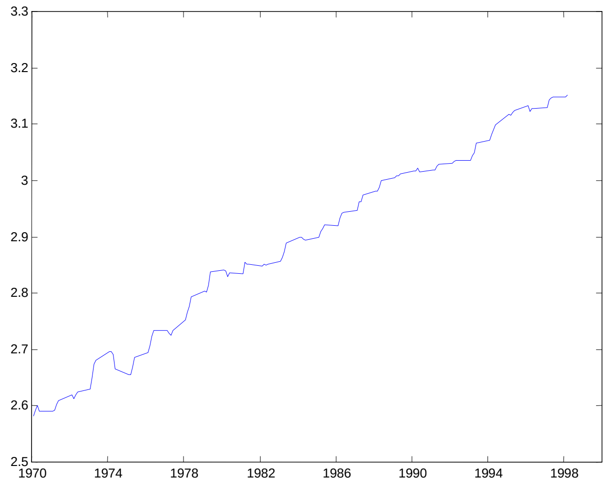

Figure 5: Italian productivity 1970.1-1998.2

The tests on unit roots are presented in table 2 (estimation written in bold are significant at 99%).

Italian productivity 1970.1-1998.2			
$\Delta prod_t = \alpha + \rho^* prod_{t-1} - \rho_2 \Delta prod_{t-1}$			
	Estimated value of the parameter	Standard Error	*t*/DF/ADF value
α	0.0119	0.0122	0.9733 (*t*)
ρ^*	-0.0315	0.0071	-0.6849 (ADF)
ρ_2	**0.2855**	0.0914	3.1235 (*t*)
$\Delta prod_t = \rho^* prod_{t-1} - \rho_2 \Delta prod_{t-1}$			
ρ^*	**0.0012**	0.00029252	4.1282 (ADF)
ρ_2	**0.2918**	0.0911	3.2019 (*t*)
$\Delta\Delta prod_t = \rho^* \Delta prod_{t-1}$			
ρ^*	**-0.5035**	0.0818	-6.1540 (DF)

Table 2

The tests cannot exclude the presence of unit roots. Since this is an AR(2) process, we do not know if there are one or two unit roots. For this reason, we check the stationary of productivity first differences ($\Delta prod_t$) and we proceed performing a DF test on them.

The DF test on $\Delta prod_t$ allows to reject the presence of a unit root in productivity first differences. Therefore, we conclude that *prod* is an I(1) variable and, surprisingly, it does not show any linear deterministic trend.

Italian Unemployment Rate (1970.1-1998.2)

These data (figure 6) represent the u of our model, and it is the unemployment rate free of seasonality[6]. From now on, we will call *dis* the *log* of this variable.

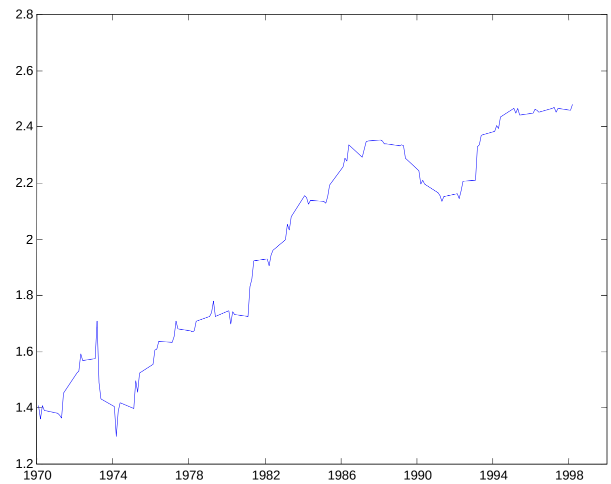

Figure 6: Italian unemployment rate 1970.1-1998.2

The tests on unit roots are presented in table 3 (estimation written in bold are significant at 99%).

[6] ISTAT source.

Italian unemployment rate 1970.1-1998.2			
$\Delta u_t = \alpha + \rho^* u_{t-1} + \rho_2 \Delta u_{t-1}$			
	Estimated value of the parameter	Standard Error	t/DF/ADF value
α	0.0337	0.0226	1.4882 (t)
ρ^*	-0.0114	0.0113	-1.0108 (ADF)
ρ_2	-0.1301	0.0938	-1.3878 (t)
$\Delta u_t = \alpha + \rho^* u_{t-1}$			
α	0.0282	0.0226	1.2502 (t)
ρ^*	0.0095	0.0112	-0.8469 (DF)
$\Delta u_t = \rho^* u_{t-1}$			
ρ^*	0.0043	0.0021	2.0689 (DF)

Table 3

From these results, we cannot reject the null hypothesis of the presence of a unit root.

This analysis seems to show that the unemployment rate is an I(1) variable, and this result is confirmed by the fact that further investigations show that unemployment rates first differences are stationary.

Italian Unionization Rate (1970.1-1998.2)

These data (figure 7) was calculated dividing the number of union members by the total number of employees. The statistics we have[7] come in annual data. Since our analysis is based on quarterly data, we had to transform the series in quarterly observations. To obtain the new series, we interpolated the original data, assuming that the value of each year coincided with the value of the respective second quarter. This procedure does not alter the structure of the original series. From now on, we will call *union* the *log* of this variable.

[7] The source was the OECD online dataset.

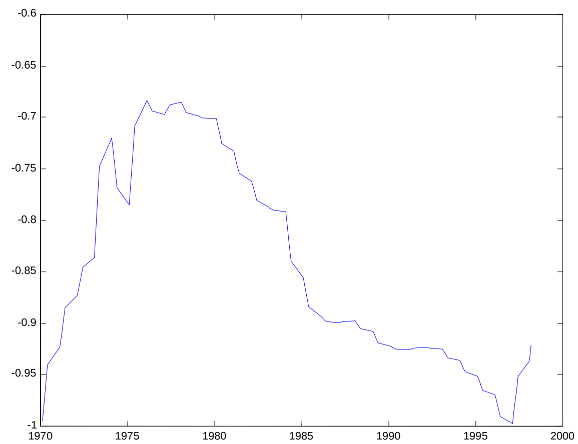

Figure 7: Italian unionization rate 1970.1-1998.2

The tests on unit roots are presented in table 4 (estimation written in bold are significant at 99%).

Italian unionisation rate 1970.1-1998.2			
$\Delta union_t = \alpha + \rho * union_{t-1} + \rho_2 \Delta union_{t-1}$			
	Estimated value of the parameter	Standard Error	t/DF/ADF value
α	-0.00899	0.005666	-1.587 (t)
$\rho *$	-0.01076	0.006666	-1.61417 (ADF)
ρ_2	**0.75698**	0.06109	12.39076 (t)
$\Delta union_t = \rho * union_{t-1} + \rho_2 \Delta union_{t-1}$			
$\rho *$	-0.00025	0.000775	-0.3250 (ADF)
ρ_2	**0.757**	0.06151	12.3066 (t)
$\Delta\Delta union_t = \rho * \Delta union_{t-1}$			
ρ_2	**-0.2420**	0.06119	-3.95499 (DF)

Table 4

From the ADF test, we find out that *union* is an AR(2) process and that we cannot exclude the presence of one or two units roots.

To discern between this two possibilities we investigated whether the first differences of this variable is stationary. The associated DF test allows to state that first differences are stationary. Therefore, we conclude that the *union* is an I(1) variable.

Number of Strikes (1970.1-1998.2)

These data (figure 8) represent the number of conflict of work that occurred in the observation period. The statistics we have come in annual data[8]. We transform the series in quarterly observation in the way we did for the unionisation rate. From now on, we will call *strike* the *log* of this variable.

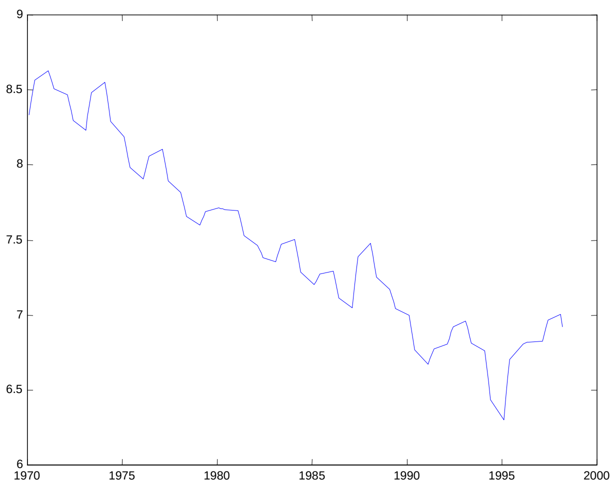

Figure 8: Italian number of strikes 1970.1-1998.2

The tests on unit roots are presented in table 5 (estimation written in bold are significant at 99%).

[8]The source was the ILO online dataset.

Italian number of strike 1970.1-1998.2			
$\Delta strike_t=\alpha+\rho^* strike_{t-1}+\rho_2\Delta strike_{t-1}$			
	Estimated value of the parameter	Standard Error	t/DF/ADF value
α	0.0898	0.0583	1.5419 (t)
ρ^*	-0.0128	0.0078	-1.6476 (ADF)
ρ_2	**0.6318**	0.0727	8.6845 (t)
$\Delta strike_t=\alpha+\rho^* strike_{t-1}+\rho_2\Delta strike_{t-1}$			
ρ^*	-0.0009	0.0006	-1.3449 (ADF)
ρ_2	**0.0732**	0.6307	8.6161 (t)
$\Delta\Delta strike_t=\rho^*\Delta strike_{t-1}$			
ρ^*	**-0.3516**	0.0723	-4.8657 (DF)

Table 5

From the ADF test we find out that this is an AR(2) process and that we cannot exclude the presence of one or two units roots.

To discern between this two possibilities, we investigated whether the first differences of this variable are stationary. The associated DF allows to state that first differences are stationary. Therefore, we conclude that the number of strikes is an I(1) variable.

Number of Work Conflicts per Worker (1970.1-1998.2)

These data (figure 9) is obtained dividing the total number of workers that participates to work conflicts by the total number of employees. The statistics we have come in annual data[9]. We transform the series in quarterly observation in the way we did for the unionisation rate. From now on, we will call *coinv* the *log* of this variable.

[9]the source was the ILO online dataset.

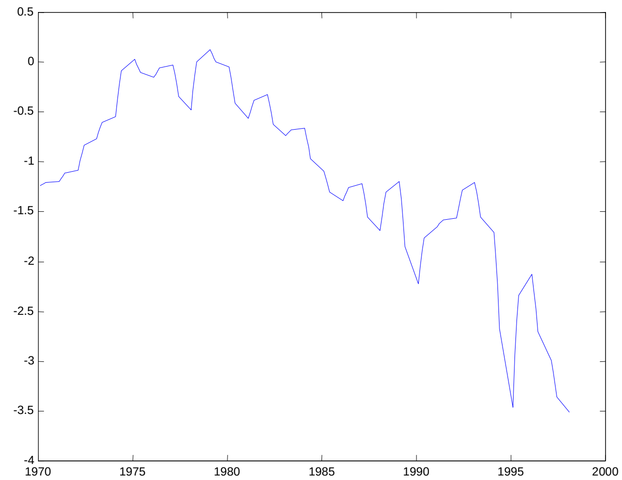

Figure 9: Number of work conflicts per worker 1970.1-1998.2

The tests on unit roots are presented in table 6 (estimation written in bold are significant at 99%).

Italian number of work conflicts per worker 1970.1-1998.2			
$\Delta coinv_t = \alpha + \rho * coinv_{t-1} + \rho_2 \Delta coinv_{t-1}$			
	Estimated value of the parameter	Standard Error	t/DF/ADF value
α	-0.0167	0.0225	-0.7411 (t)
$\rho *$	-0.0045	0.0164	-0.2714 (ADF)
ρ_2	**0.4653**	0.0889	5.2339 (t)
$\Delta coinv_t = \rho * coinv_{t-1} + \rho_2 \Delta coinv_{t-1}$			
$\rho *$	0.0052	0.0099	0.5278 (ADF)
ρ_2	**0.4562**	0.0879	5.1920 (t)
$\Delta\Delta coinv_t = \rho * \Delta coinv_{t-1}$			
$\rho *$	**-0.5320**	0.0847	-6.2798 (DF)

Table 6

From the ADF test we find out that this is an AR(2) process and that we cannot exclude the presence of one or two units roots.

To discern between this two possibilities we investigated whether the first differences of this variable are stationary. The associated DF test allows to state that first differences are stationary. Therefore, we conclude that *coinv* is an I(1) variable.

Days of Strike per Worker (1970.1-1998.2)

This data (figure 10) is obtained dividing the total number of days lost because of work conflicts by the total number of employees. The statistics we have come in annual data[10]. We transform the series in quarterly observation in the way we did for the unionisation rate. From now on, we will call *days* the *log* of this variable.

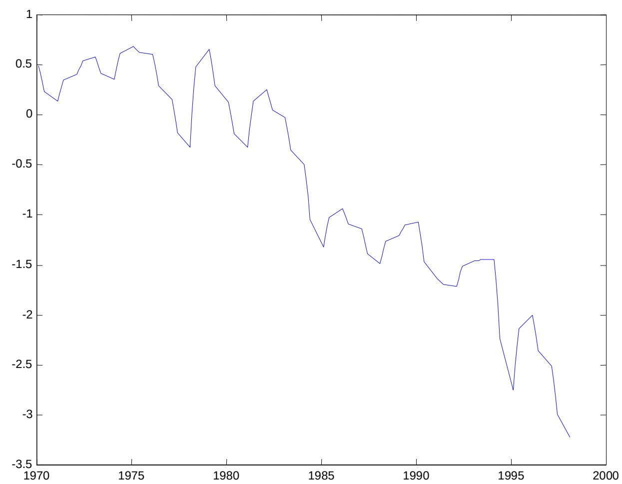

Figure 10: Days of strike per worker 1970.1-1998.2

The tests on unit roots are presented in table 7 (estimation written in bold are significant at 99%).

[10]The source was ILO online dataset.

Italian days of strike per worker 1970.1-1998.2			
$\Delta days_t = \alpha + \rho^* days_{t-1} + \rho_2 \Delta days_{t-1}$			
	Estimated value of the parameter	Standard Error	t/DF/ADF value
α	-0.0146	0.0121	-1.2041 (t)
ρ^*	-0.0001	0.0102	-0.0137 (ADF)
ρ_2	**0.5814**	0.0813	7.1468 (t)
$\Delta days_t = \rho^* days_{t-1} + \rho_2 \Delta days_{t-1}$			
ρ^*	0.0062	0.0088	0.7027 (ADF)
ρ_2	**0.5905**	0.0812	7.2754 (t)
$\Delta\Delta days_t = \rho^* \Delta days_{t-1}$			
ρ^*	**-0.3923**	0.0772	-5.0823 (DF)

Table 7

From the ADF test we find out that this is an AR(2) process and that we cannot exclude the presence of one or two units roots.

To discern between this two possibilities we investigated whether the first differences of this variable are stationary. The associated DF test allows to state that first differences are stationary. Therefore, we concluded that *days* is an I(1) variable.

Italian Left Voters (1970.1-1994.4)

This variable is obtained as the left party votes over the total votes. The data come in annual observations and for a shorter period of time[11]. We transform the series in quarterly observations in the way we did for the unionisation rate. From now on, we will call $left$ the log of this variable.

[11] The source was the International Almanac of Electoral History. See Mackie and Rose.

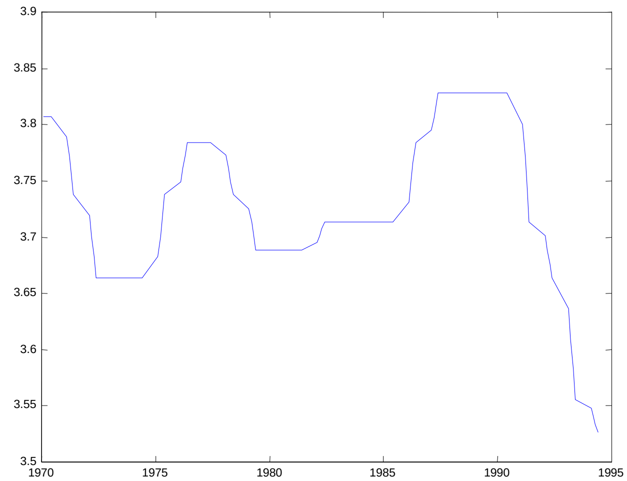

Figure 11: Italian left voters 1970.1-1994.4

The tests on unit roots are presented in table 8 (estimation written in bold are significant at 99%).

Italian left voters 1970.1-1994.4			
$\Delta left_t = \alpha + \rho^* left_{t-1} + \rho_2 \Delta left_{t-1}$			
	Estimated value of the parameter	Standard Error	t/DF/ADF value
α	**0.0882**	0.0334	2.6405 (t)
ρ^*	**-0.0237**	0.0089	-2.6544 (ADF)
ρ_2	**0.9056**	0.0518	17.4847(t)
$\Delta\Delta left_t = \rho^* \Delta left_{t-1}$			
ρ^*	**-0.1257**	0.0496	-2.5310 (DF)

Table 8

From the ADF test we find out that this is an AR(2) process and that we cannot exclude the presence of one or two units roots.

To discern between this two possibilities we investigated whether the first differences of this variable are stationary. The associated DF test allows to state that first differences are stationary. Therefore, we concluded that $left$ is an I(1) variable.

After having examined all the variables, we report the integration order of each series in table 9.

Real wages	I(0)	*Deterministic linear trend*
Productivity	I(1)	*No deterministic trend*
Unemployment rate	I(1)	*No deterministic trend*
Unionisation rate	I(1)	*No deterministic trend*
Number of strike	I(1)	*No deterministic trend*
Number of strike per worker	I(1)	*No deterministic trend*
Days of strike per worker	I(1)	*No deterministic trend*
Left voters	I(1)	*No deterministic trend*

Table 9: Integration order of the series

It clearly emerges that all the variables, apart real wages, are integrated of order one. The presence of an I(0) variable bring us some problems in building up the VAR model. In fact, as already said, all the variables should be of the same integration order. Therefore, if we want to correctly specify the VAR we should exclude the wages from it. However, we believe that Italian real wages are indeed an I(1) variable in which a structural break on the trend occurred at the beginning of the 80's. Even if the two sub-periods (in each of which, as already said, a unit root seems to emerge) are too short to statistically justify the structural break, we will conduct our analysis as if real wages are an I(1) variable.

5 Historical Events and Dummy Variables

The last thirty years, in Italy, have been a period of great changes both from a social and an economic point of view. The shocks that occurred had severe consequences on labour market. Therefore, we have to somehow take into account them in our analysis. The deterministic components, and especially dummies variables, are one of the device through which we may consider the effects of these historical events in the model specification.

While examining the real wages integration order, we have seen that a major structural break emerged at the beginning of the eighties. After the seventies, a period of great union activism, we observed a turning point in the relations among social parts. A sign of this was the so-called "cadres march" occurred in the October of 1980, during which unions suffered a severe defeat.

In general, we think that labour market dynamics changed radically around that time. Therefore, we will use a mean shift dummy starting in the first term of 1980.

Another event that deeply affected the labour market was the first oil shock. In particular, it seems to have an immediate, but temporary, effect on the unemployment rate. This brings us to use a temporary dummy variable in 1973.

Even in the second part of the period, there occurred some particular events that we have to take into consideration. The first is the recession of 1980-1981 and the rebound that followed in the second term of 1981. We have also to consider the reprise of work conflicts (after a period of social agreement promoted by the Prime Minister Ciampi) in the first term of 1995.

Apart from the use of these dummies due to historical happenings, we used some other dummies to smooth the effects of some outliers in the series. This happen for the unemployment rate of the second term of 1993 when ISTAT changed the methodology to calculate this indicator. For similar reasons, we placed a dummy in the second term of 1974 and 1975 in order to represent some discontinuities in the measurement of the unionisation rate.

Finally, we stopped our analysis at the fourth term of 1997 because in 1998 occurred a fiscal reform that was extremely relevant for the firms since it affected gross real wages. We preferred to cut our sample because it would make little sense to place a dummy on the last two observations.

6 Cointegration Analysis

The aim of this work is to search for long run equilibrium relationships in the Italian labour market. This can be achieved through an investigation of the cointegration relationships between the involved variables.

Once a VAR is specified there are several tests useful to verify the number of existing cointegrating vectors. These tests are based on the eigenvalues computation of the concentrated model, and they provide the minimum number of existing cointegrating vectors.

As soon as the number of cointegrating vectors is set, we have to give an economic interpretation to them. This should be done on the basis of the sign and the statistical significance of the cointegrating vector coefficients and their weights.

Since we are conducting an analysis on a non-competitive labour market, we expect to find the wage equation introduced above. This can be verified through the investigation of the coefficients sign of the cointegration relationships. In this case, we expect to find a relationship in which the equilibrium real wages are positively correlated to productivity and union power, and negatively correlated to unemployment rate. We should also find that the weight on wages is negative, the one on unemployment zero, the one on productivity positive or zero, and the one on union power zero.

Some problems arise when more than one cointegration relationship is found. A second relationship could be interpreted as a "price equation", that is, an equation that describes how firms set price over wages and so, indirectly, it also describes the wage that firms would be willing to pay. In the price equation, real wages depend only on productivity. Therefore, all the other coefficients in the cointegrating vector should be not statistically different from zero.

We may now proceed in estimating the cointegrating vectors and their weights through Johansen's maximum likelihood procedure[12]. We build a VAR including four variables: real labour cost (w), productivity ($prod$), unemployment rate (u), and a measure for union power. As we have already anticipated, we will try five different proxies for this variable: unionisation rate ($union$), number of work conflicts ($strike$), number of work conflicts per worker ($coinv$), days of strike per worker ($days$), and the percentage of left voters ($left$). We also add a dummies vector and a (unrestricted) constant.

A condition for the VAR to perform consistent estimations is to have Gaussian errors. Therefore, we run several tests on residuals (both on the single equations and on the system as a whole) in order to verify whether they are normally distributed and free of autocorrelation. Though the tests on the system are usually enough to choose whether to reject or not the hypothesis of Gaussian errors, the tests on the single equations are useful to find out the source of the eventual rejection.

We determine lag length on the base of these tests, adding lags until the Gaussian hypothesis on residuals cannot be rejected. The results for these tests are shown in tables 10-12[13]. The only thing that clearly emerges from these tests is that one lag is not enough to correctly specify the VAR model. Apart this, only when using the variable $strike$ we obtain what seems to be a well specified model. Furthermore, when using $strike$, two lags are enough to reach a correct specification.

Instead, while using the other four variables, the residuals normality seems to be impossible to achieve even if we keep lagging variables beyond the second lag[14]. The single equation tests clearly show that the non-normality

[12] All the following estimates were obtained with PC-FIML.

[13] In these tables, two stars mean a rejection of the hypothesis at 99%, one star at 95%.

[14] Even if we do notshow results for more then three lags, normality in not achieved even if we go beyond the third lag.

is due always to the variable that in the VAR is the proxy for union power[15].

Since using three lags never help in achieving Gaussian residuals, we proceed using a VAR model with two lags, conscious that, for most of the cases, the normality assumption does not hold.

Now that we have determined the lag-length of these VAR models, we proceed in investigating the nature of the cointegration relationships underlying the systems, each time using a different proxy for union power.

	union	*strike*	*coinv*	*days*	*left*
w AR F- test	0.8303 [0.4390]	1.3858 [0.2550]	1.4872 [0.2310]	1.4605 [0.2371]	4.1715 [0.0020] **
dis AR F- test	1.4329 [0.2436]	1.8028 [0.1703]	2.172 [0.1194]	2.2416 [0.1117]	4.8083 [0.0006] **
prod AR F- test	3.5185 [0.0334] *	5.0361 [0.0083] **	4.7197 [0.0110] *	4.6373 [0.0119] *	1.4098 [0.2291]
proxy AR F- test	93.626 [0.0000] **	63.018 [0.0000] **	34.182 [0.0000] **	45.667 [0.0000] **	38.803 [0.0000] **
w normality $\chi^2(2)$	4.0902 [0.1294]	3.5792 [0.1670]	2.7892 [0.2479]	2.6217 [0.2696]	4.2707 [0.1182]
dis normality $\chi^2(2)$	0.75368 [0.6860]	1.3576 [0.5072]	3.2795 [0.1940]	2.3307 [0.3118]	9.611 [0.0082] **
prod normality $\chi^2(2)$	8.4309 [0.0148] *	8.8608 [0.0119] *	8.1267 [0.0172] *	8.8527 [0.0120] *	1.6016 [0.4490]
proxy normality $\chi^2(2)$	16.715 [0.0002] **	2.434 [0.2961]	12.352 [0.0021] **	2.9873 [0.2246]	2.0455 [0.3596]
Vector AR F-test	5.3401 [0.0000] **	4.3086 [0.0000] **	3.2834 [0.0000] **	4.045 [0.0000] **	3.2516 [0.0000] **
Vector normality $\chi^2(8)$	24.876 [0.0016] **	13.526 [0.0950]	26.252 [0.0010] **	16.504 [0.0357] *	20.458 [0.0087] **

Table 10: Diagnostic tests for VAR models with one lag

	union	*strike*	*coinv*	*days*	*left*
w AR F- test	3.6324 [0.0303] *	2.1211 [0.1257]	3.7468 [0.0272] *	3.8407 [0.0249] *	5.1161 [0.0004] **
dis AR F- test	0.68984 [0.5042]	1.2927 [0.2794]	1.6634 [0.1950]	1.8636 [0.1608]	2.1132 [0.0724]
prod AR F- test	0.43062 [0.6514]	0.20188 [0.8175]	0.21567 [0.8064]	0.32426 [0.7239]	1.4056 [0.2314]
proxy AR F- test	0.63148 [0.5341]	0.13295 [0.8757]	1.1973 [0.3066]	0.083651 [0.9198]	0.68855 [0.6335]
w normality $\chi^2(2)$	4.013 [0.1345]	3.1541 [0.2066]	2.6409 [0.2670]	3.6224 [0.1635]	4.7283 [0.0940]
dis normality $\chi^2(2)$	2.8299 [0.2429]	0.55826 [0.7564]	3.8754 [0.1440]	2.6959 [0.2598]	3.2323 [0.1987]
prod normality $\chi^2(2)$	1.0759 [0.5839]	4.4557 [0.1078]	3.774 [0.1515]	4.1987 [0.1225]	2.4025 [0.3008]
proxy normality $\chi^2(2)$	192.36 [0.0000] **	2.3747 [0.3050]	17.916 [0.0001] **	24.636 [0.0000] **	43.758 [0.0000] **
Vector AR F-test	1.4362 [0.0648]	1.0716 [0.3682]	1.11 [0.3178]	1.1137 [0.3132]	1.7981 [0.0003] **
Vector normality $\chi^2(8)$	190.51 [0.0000] **	10.164 [0.2537]	26.027 [0.0010] **	34.597 [0.0000] **	56.949 [0.0000] **

Table 11: Diagnostic tests for VAR models with two lags

[15] Apart from the variable *strike*, as we have already noted.

	union	*strike*	*coinv*	*days*	*left*
w AR F- test	3.6468 [0.0301] *	3.3374 [0.0401] *	3.2524 [0.0433] *	3.7639 [0.0270] *	4.2927 [0.0018] **
dis AR F- test	0.085868 [0.9178]	1.3908 [0.2543]	1.6785 [0.1925]	2.029 [0.1375]	2.5336 [0.0358] *
prod AR F- test	0.20203 [0.8174]	0.71823 [0.4904]	0.78752 [0.4581]	1.0891 [0.3410]	1.5349 [0.1894]
proxy AR F- test	0.66855 [0.5150]	0.21786 [0.8047]	0.98951 [0.3758]	0.11658 [0.8901]	0.71513 [0.6140]
w normality $\chi^2(2)$	1.8332 [0.3999]	1.8926 [0.3882]	2.381 [0.3041]	2.7232 [0.2562]	4.4869 [0.1061]
dis normality $\chi^2(2)$	1.2423 [0.5373]	3.162 [0.2058]	6.5029 [0.0387] *	5.8732 [0.0530]	2.7561 [0.2521]
prod normality $\chi^2(2)$	0.21426 [0.8984]	4.1471 [0.1257]	3.2504 [0.1969]	3.7812 [0.1510]	5.4929 [0.0642]
proxy normality $\chi^2(2)$	145.77 [0.0000] **	2.1441 [0.3423]	16.997 [0.0002] **	19.587 [0.0001] **	24.838 [0.0000] **
Vector AR F-test	1.306 [0.1317]	1.1129 [0.3151]	1.2252 [0.1944]	1.0809 [0.3561]	1.7766 [0.0005] **
Vector normality $\chi^2(8)$	141.14 [0.0000] **	10.356 [0.2409]	26.83 [0.0008] **	31.836 [0.0001] **	40.646 [0.0000] **

Table 12: Diagnostic tests for VAR models with three lags

Unionisation Rate

The tests on the cointegration rank[16] are reported in Table 13[17].

Ho: rank=*p*	**Cointegration LR test on maximal eigenvalue**	**95%**	**Cointegration LR test on trace**	**95%**
***p* == 0**	38.87**	27.1	54.25**	47.2
***p* <= 1**	9.342	21.0	15.38	29.7
***p* <= 2**	*Not necessary*		*Not necessary*	
***p* <= 3**	*Not necessary*		*Not necessary*	

Table 13: Cointegration rank

This results seems to suggest the existence of at least one cointegrating vector. We report in table 14[18] the normalised β vector[19] and the relative adjustment coefficients.

[16]This table, and the ones who follow, report the value of the LR test under the null hypothesis that the cointegration rank is equal to p. This rank is equal to the number of cointegration relationships. Therefore not rejecting the null hypothesis that the rank is p, it is equivalent to state that there exist at least p long run relationships.

[17]In this table, and in the ones who follow, two stars mean significance at 99%, one star at 95%.

[18]Bold numbers in the table indicate a significance of the involved coefficient at 99%.

[19]The cointegration vector is of the form $w+\beta_2 dis+\beta_3 prod+\beta_4 power = 0$. To read the direction of the effects on the real wages we have to rearrange it as $w = -\beta_2 dis - \beta_3 prod - \beta_4 power$. Therefore, a positive (negative) value of β_j stands for a negative (positive) effect on real wage.

	Estimated β Vector	Estimated Adjustment Coefficient
w	1.0000	-0.0054720 (0.012958)
dis	**0.68405** (0.13722)	-0.088337 (0.038833)
prod	**-1.4615** (0.27080)	**0.040864** (0.0079637)
union	**0.56775** (0.20069)	0.0013805 (0.0053273)

Table 14: Estimation of normalised β vector and of the adjustment coefficients

These results are not completely consistent with what we would have expected from the model described at the beginning. Our estimates seems to negate the existence of a disequilibrium adjustment through wages or unemployment rate, leaving the role of adjustment factor only to productivity that, among the other involved variables, is the less likely to fulfil this task. Furthermore, the *union* sign in the cointegrating vector seems to be wrong, or at the best not statistically relevant.

Number of Strikes

The result of the tests on the eigenvalues are reported in table 15. They show the existence of at least two cointegrating vectors, the estimation of which is reported in table 16.

Ho: rank=*p*	**Cointegration LR test on maximal eigenvalue**	**95%**	**Cointegration LR test on trace**	**95%**
***p* == 0**	35.63**	27.1	73.68**	47.2
***p* <= 1**	30**	21.0	38.05**	29.7
***p* <= 2**	6.116	14.1	8.05	15.4
***p* <= 3**	*Not necessary*		*Not necessary*	

Table 15: Cointegration rank

	Estimated β Vector		Estimated Adjustment Coefficients	
	1st Vector	2nd Vector	1st Vector	2nd Vector
w	1.0000	1.0000	0.0025 (0.002)	-0.030193 (0.02416)
dis	**2.7265** (0.84558)	**0.30709**	-0.0002 (0.0069)	-0.15784 (0.083278)
prod	**-13.557** (2.6166)	**-0.65162**	**0.00666** (0.0012)	**0.033348** (0.0149)
strike	**-2.7142** (0.54506)	**0.17625**	**0.028113** (0.00724)	**-0.32799** (0.087569)

Table 16: Estimation of normalised β vector and of the adjustment coefficients

These results seem to be more consistent with our model but they still have some incompatibilities. The estimated coefficients of the first β vector have all the expected sign, but their value is questionable. In particular, the value of *prod* is too high to be economically sensate. Also the estimates of the adjustment coefficients are not what we would have expected. In fact, the adjustment on wages is not significant.

As for the second cointegrating vector, the sign of the coefficients may suggest that this relationship represents a price equation. Anyway, this eventuality is rejected by the exclusion restriction test on *dis* and *strike*.

Number of Work Conflicts per Worker

The results of the tests on the eigenvalues are reported in table 17.

Ho: rank=*p*	**Cointegration LR test on maximal eigenvalue**	**95%**	**Cointegration LR test on trace**	**95%**
***p* == 0**	34.07**	27.1	64.73**	47.2
***p* <= 1**	22.51*	21.0	30.67*	29.7
***p* <= 2**	6.833	14.1	8.162	8.586
***p* <= 3**	*Not necessary*		*Not necessary*	

Table 17: Cointegration rank

Even in this case there may be at least one or two cointegration relationships. Since the second relationship it is quite feeble, we focus only on the first (table 18).

	Estimated β Vector		Estimated Adjustment Coefficients	
w	1.0000		-0.037467	(0.034646)
dis	**0.15145**	(0.052109)	-0.15501	(0.11795)
prod	**-1.1751**	(0.10691)	**0.095109**	(0.022399)
coinv	**-0.045908**	(0.0095924)	0.79762	(0.31961)

Table 18: Estimation of normalised β vector and of the adjustment coefficients

These estimates are rather good. All the sign in the β vector are consistent with our model. Some problems arise when we consider the estimated adjustment coefficients. In fact, the adjustment on wages has the expected sign, but it is not statistically different from zero, while the adjustment on productivity is significant.

Days of Strike per Worker

The results of the tests on the eigenvalues are reported in table 19.

Ho: rank=*p*	**Cointegration LR test on maximal eigenvalue**	**95%**	**Cointegration LR test on trace**	**95%**
***p* == 0**	30.64*	27.1	69.31**	47.2
***p* <= 1**	29.41**	21.0	38.67**	29.7
***p* <= 2**	8.032	14.1	9.259	8.586
***p* <= 3**	*Not necessary*		*Not necessary*	

Table 19: Cointegration Rank

The tests seem to indicate the presence of at least two cointegration vectors. Their estimated values are reported in table 20.

	Estimated β Vector		Estimated Adjustment Coefficients	
	1^{st} Vector	2^{nd} Vector	1^{s} Vector	2^{nd} Vector
w	1.0000	1.0000	-0.0147 (0.0239)	-0.016227 (0.01528)
dis	**0.32680** (0.08185)	**-0.35149**	-0.09495 (0.0806)	0.033665 (0.0515)
prod	**-1.4214** (0.19000)	**-1.6410**	**0.073578** (0.01506)	**-0.010347** (0.0096)
days	-0.03486 (0.0228)	**-0.22068**	0.18422 (0.17587)	**0.58692** (0.11242)

Table 20: Estimation of normalised β vector and of the adjustment coefficients

The first cointegrating vector may represent a wage equation, even if the proxy for union power is not significant. Anyway, and quite surprisingly, the adjustment seems to take place through productivity.

As for the second vector we tried to impose the zero restriction on *dis* and *days* in the cointegration relationship but this hypothesis was rejected. Therefore, we may not even take in consideration the case of a price equation.

Left Voters

The results of the tests on the eigenvalues are reported in table 21.

Ho: rank=*p*	Cointegration LR test on maximal eigenvalue	95%	Cointegration LR test on trace	95%
p == 0	58.12**	27.1	76.7**	47.2
p <= 1	14.25	21.0	18.58	29.7
p <= 2	*Not necessary*	14.1	*Not necessary*	8.586

Table 21: Cointegration rank

This results seems to suggest the existence of at least one cointegrating vectors. We report in table 22[20] the normalised β vector and the relative adjustment coefficients.

	Estimated β Vector	Estimated Adjustment Coefficient
w	1.0000	**-0.0897** (0.0296)
dis	**0.30948** (0.045)	-0.0016 (0.10)
prod	**-1.4211** (0.106)	**0.09352** (0.019)
left	**-0.428** (0.0733)	0.017 (0.015)

Table 22: Estimation of normalised β vector and of the adjustment coefficients

Quite surprisingly, this is the proxy of union power delivering the best results. This is indeed an interesting result, but even if the percentage of the left voters could somehow depict the political and social environment, the link with the wage pressure is far from being straightforward.

[20] Bold numbers in the table indicate a coefficient significance at 99%.

The results of all these analyses are not satisfactory. First of all, when using the unionisation rate as the proxy for union power we find a cointegrating relationship among the variables, but we obtain a significant negative coefficient. This is in sharp contrast with our assumptions.

Things get better when we use variables on work conflicts. Cointegration relationships emerge and with the expected sign, but the relative estimated adjustment coefficients are usually very small and statistically not significant. The only weight that seems to be significant is the one on productivity, suggesting a very unusual kind of adjustment.

Surprisingly, we obtain the best results with the percentage of left voters, which was probably the less likely variable to fulfil the wage pressure role.

We think that these inconsistencies may be due to the structural change occurred at the beginning of the eighties. Therefore, we tried to split the sample in two parts and to estimate a distinct VAR in each sub-period.

7 Cointegration Analysis on Sub-Samples

For reason explained in section 3, we split the sample in two parts, with the first term of 1980 as first period of the second sub-sample. We have used only four of the different proxies for union power, omitting left voters since it already delivers good results on the full sample. For each different proxy we provide the estimations for both periods.

Before doing the estimations, we have run again the diagnostic test on the sub-sample. Tables 23,28, 33, and 38 show these tests. In those tables, we report only the tests for the minimum lags that allow residuals as close as possible to the Gaussian hypothesis. For brevity, we report only the vector form of these tests.

From the results of the diagnostic tests, we notice that the residuals seems to be more well-behaved in the two sub-samples (and especially in the first) then in the whole sample.

Unionisation Rate

We report in table 24 and 25 the tests on the cointegration rank and the estimation of the β vectors.

	FIRST PERIOD with 2 LAGS	SECOND PERIOD with 3 LAGS
w: AR F-test	0.62425 [0.5435]	4.1384 [0.0212]
dis: AR F- test	0.41383 [0.6654]	2.1486 [0.1263]
prod: AR F- test	1.1944 [0.3190]	0.6383 [0.5321]
union: AR *F*- test	0.19063 [0.8276]	1.5146 [0.2289]
w: Normality $\chi^2(2)$	1.6531 [0.4375]	1.0122 [0.6028]
dis: Normality $\chi^2(2)$	0.75306 [0.6862]	2.2829 [0.3193]
prod: Normality $\chi^2(2)$	5.6405 [0.0596]	2.7388 [0.2543]
union: Normality $\chi^2(2)$	6.3855 [0.0411] *	42.939 [0.0000]
Vector AR F-test	8.5091 [0.3854]	1.0648 [0.3845]
Vector normality $\chi^2(8)$	0.43247 [0.9998]	48.219 [0.0000] **

Table 23: Diagnostic tests for VAR models in the two sub-samples

Ho: rank=*p*	**Cointegration LR test on maximal eigenvalue**	**95%**	**Cointegration LR test on trace**	**95%**
***p* == 0**	29.3*	27.1	50.38*	47.2
***p* <= 1**	14.53	21.0	21.08	29.7
***p* <= 2**	*Not necessary*	14.1	*Not necessary*	8.586
***p* <= 3**	*Not necessary*		*Not necessary*	

Table 24: Cointegration rank

	Estimated β Vector	Estimated Adjustment Coefficients
w	1.0000	**-0.28745** (0.11470)
dis	-0.035530 (0.045219)	0.35047 (0.36621)
prod	**-0.91692** (0.14490)	**0.17202** (0.073338)
union	**-0.23145** (0.082497)	0.16007 (0.081989)

Table 25: Estimation of normalised β vector and of the adjustment coefficients

We found what it seems to be a wage equation in which the unemployment rate is not significant. As for the estimated adjustment coefficients of w and *dis* they are both of the expected sign even if only the coefficient on *w* is significant.

Let us turn to the second period (table 26 and 27).

Ho: rank=*p*	**Cointegration LR test on maximal eigenvalue**	**95%**	**Cointegration LR test on trace**	**95%**
***p* == 0**	19.84	27.1	47.76*	47.2
***p* <= 1**	17.46	21.0	27.92	29.7
***p* <= 2**	*Not necessary*	14.1	*Not necessary*	8.586
***p* <= 3**	4.28*	3.8	4.28*	3.8

Table 26: Cointegration rank

	Estimated β Vector	Estimated Adjustment Coefficients
w	1.0000	-0.042520 (0.044473)
dis	**0.40161** (0.070115)	**-0.41395** (0.15869)
prod	**-0.43750** (0.14399)	0.053770 (0.033237)
union	**1.1443** (0.25466)	-0.020092 (0.021660)

Table 27: Estimation of normalised β vector and of the adjustment coefficients

From the test on cointegration rank, we can hardly find any cointegration relationship. In fact, there are strong inconsistency among them. Furthermore, we are not able to identify the first relationship. The sign of *dis* and *prod* seems to suggest the existence of a wage equation, but the sign of *union* is in contrast with this interpretation. Even the estimates of the adjustment coefficients are not consistent with what we would have expected.

Number of Strikes

From the tests reported in table 29 we find that in the first period the relationship of cointegration is very feeble. The estimated coefficients of this relationship are shown in table 30.

	FIRST PERIOD with 2 LAGS	SECOND PERIOD with 2 LAGS
w: AR F-test	1.8325 [0.1801]	9.7399 [0.0002] **
dis: AR F-test	1.5799 [0.2251]	0.59812 [0.5532]
prod: AR F-test	0.12012 [0.8873]	0.41336 [0.6634]
union: AR F-test	0.20347 [0.8172]	1.2615 [0.2909]
w: Normality $\chi^2(2)$	1.0962 [0.5781]	2.1829 [0.3357]
dis: Normality $\chi^2(2)$	0.32873 [0.8484]	0.42615 [0.8081]
prod: Normality $\chi^2(2)$	0.44527 [0.8004]	2.6579 [0.2648]
strike: Normality $\chi^2(2)$	0.26614 [0.8754]	10.029 [0.0066] **
Vector AR F-test	0.91761 [0.5963]	1.3648 [0.1059]
Vector normality $\chi^2(8)$	2.5083 [0.9613]	12.387 [0.1347]

Table 28: Diagnostic tests for VAR models in the two sub-samples

Ho: rank=*p*	**Cointegration LR test on maximal eigenvalue**	**95%**	**Cointegration LR test on trace**	**95%**
***p* == 0**	22.98	27.1	48.44*	47.2
***p* <= 1**	20.56	21.0	25.45	29.7
***p* <= 2**	*Not necessary*	14.1	*Not necessary*	8.586
***p* <= 3**	*Not necessary*	3.8	*Not necessary*	3.8

Table 29: Cointegration rank

	Estimated β Vector	Estimated Adjustment Coefficients
w	1.0000	-0.26123 (0.083923)
dis	0.024033 (0.077480)	-0.46099 (0.26484)
prod	**-0.71330** (0.17589)	0.044158 (0.064197)
strike	0.12210 (0.046828)	-0.64081 (0.29001)

Table 30: Estimation of normalised β vector and of the adjustment coefficients

These results are not quite satisfactory. The only coefficient that is statistically different from zero is the one associated to productivity. There is no adjustment coefficient that is significant though the non rejection of the exclusion restriction on w is quite questionable.

We now proceed to the second period (table 31 and 32).

Ho: rank=*p*	**Cointegration LR test on maximal eigenvalue**	**95%**	**Cointegration LR test on trace**	**95%**
***p* == 0**	26.07	27.1	51.2*	47.2
***p* <= 1**	18.12	21.0	25.13	29.7
***p* <= 2**	*Not necessary*	14.1	*Not necessary*	8.586
***p* <= 3**	*Not necessary*	3.8	*Not necessary*	3.8

Table 31: Cointegration Rank

	Estimated β Vector	Estimated Adjustment Coefficients
w	1.0000	0.017188 (0.015723)
dis	**0.43483** (0.10058)	-0.076613 (0.061319)
prod	-0.56991 (0.33632)	0.023130 (0.011854)
strike	**0.23679** (0.070179)	-0.28559 (0.091886)

Table 32: Estimation of normalised β vector and of the adjustment coefficients

The cointegration rank test show once again a feeble cointegration relationship. Furthermore, the estimated coefficients are quite inconclusive. This relationship does not seem to be a wage equation, and the only thing we can be sure of is that the sign of dis is correct. Everything else (even all the adjustment coefficients) is not statistically different from zero.

Number of Work Conflicts per Worker

The results reported in table 34 show, for the first period, the existence of at least one cointegrating relationship. The estimated coefficients are showed in table 35.

	FIRST PERIOD with 2 LAGS	SECOND PERIOD with 3 LAGS
w: AR F-test	1.1198 [0.3422]	4.5661 [0.0147] *
dis: AR F-test	1.0555 [0.3630]	2.1771 [0.1232]
prod: AR F-test	0.26047 [0.7728]	0.51775 [0.5988]
coinv: AR F-test	2.5628 [0.0972]	0.025398 [0.9749]
w: Normality $\chi^2(2)$	0.060845 [0.9700]	0.43084 [0.8062]
dis: Normality $\chi^2(2)$	1.4519 [0.4839]	2.8346 [0.2424]
prod: Normality $\chi^2(2)$	3.9807 [0.1366]	0.72618 [0.6955]
coinv: Normality $\chi^2(2)$	4.0256 [0.1336]	12.189 [0.0023] **
Vector AR F-test	1.4448 [0.1089]	1.1728 [0.2564]
Vector normality $\chi^2(8)$	6.2238 [0.6222]	15.062 [0.0580]

Table 33: Diagnostic tests for VAR models in the two sub-samples

Ho:rank=*p*	**Cointegration LR test on maximal eigenvalue**	**95%**	**Cointegration LR test on trace**	**95%**
***p* == 0**	29.2*	27.1	50.43*	47.2
***p* <= 1**	17.2	21.0	21.22	29.7
***p* <= 2**	*Not necessary*	14.1	*Not necessary*	8.586
***p* <= 3**	*Not necessary*	3.8	*Not necessary*	3.8

Table 34: Cointegration rank

	Estimated β Vector	Estimated Adjustment Coefficients
w	1.0000	**-0.23832** (0.092102)
dis	0.025559 (0.061003)	0.14529 (0.31522)
prod	**-1.0187** (0.17019)	0.12655 (0.058948)
coinv	-0.020739 (0.018437)	-0.58486 (0.32388)

Table 35: Estimation of normalised β vector and of the adjustment coefficients

All the coefficient of the vector have the expected sign though only *prod* is statistically different from zero. The estimated adjustment coefficient on wages have the expected sign and is statistically different from zero.

For the second period, the results on eigenvalues diagnostics (table 36) indicate, once again, the existence of at least one cointegration relationship. The coefficients of this relationship, and the relative weights, are reported in table 37.

Ho: rank=*p*	Cointegration LR test on maximal eigenvalue	95%	Cointegration LR test on trace	95%
p == 0	35.46**	27.1	63.16**	47.2
p<= 1	20.09	21.0	27.7	29.7
p<= 2	*Not necessary*	14.1	*Not necessary*	8.586

Table 36: Cointegration Rank

	Estimated β Vector	Estimated Adjustment Coefficients
w	1.0000	-0.0096396 (0.025091)
dis	-0.064568 (0.059861)	0.030980 (0.096828)
prod	**-1.6459** (0.19131)	0.018020 (0.018607)
coinv	**-0.15376** (0.025747)	**1.8539** (0.31561)

Table 37: Estimation of normalised β vector and of the adjustment coefficients

Here we find that sign of *prod* and *coinv* in the vector is consistent with our theoretical model, but the estimated adjustment coefficients are different from our expectations.

Days of Strike per Worker

The results reported in table 39 show, for the first period, the existence of at least one cointegrating relationship. The estimated coefficients are showed in table 40.

	FIRST PERIOD with 3 LAGS	SECOND PERIOD with 2 LAGS
w: AR F-Test	1.0865 [0.3565]	7.2941 [0.0015] **
dis: AR F- Test	2.4134 [0.1151]	0.31469 [0.7313]
prod: AR F- Test	0.059809 [0.9421]	0.33917 [0.7138]
days: AR F- Test	3.2839 [0.0584]	0.16233 [0.8505]
w: Normality $\chi^2(2)$	2.707 [0.2583]	1.1461 [0.5638]
dis: Normality $\chi^2(2)$	2.7564 [0.2520]	0.48808 [0.7835]
prod: Normality $\chi^2(2)$	2.8436 [0.2413]	0.8227 [0.6628]
days: Normality $\chi^2(2)$	5.3948 [0.0674]	4.1719 [0.1242]
Vector AR F-test	1.7095 [0.0516]	1.2404 [0.1907]
Vector normality $\chi^2(8)$	12.839 [0.1175]	5.7577 [0.6744]

Table 38: Diagnostic tests for VAR models in the two sub-samples

Ho: rank=*p*	**Cointegration LR test on maximal eigenvalue**	**95%**	**Cointegration LR test on trace**	**95%**
***p* == 0**	36.01**	27.1	61.06**	47.2
***p* <= 1**	19.22	21.0	25.05	29.7
***p* <= 2**	*Not necessary*	14.1	*Not necessary*	8.586
***p* <= 3**	*Not necessary*	3.8	*Not necessary*	3.8

Table 39: Cointegration rank

	Estimated β Vector	Estimated Adjustment Coefficients
w	1.0000	-0.091361 (0.081647)
dis	**0.24890** (0.076223)	0.075840 (0.27728)
prod	**-1.3384** (0.12201)	**0.17385** (0.050713)
days	**0.066376** (0.027727)	-0.77613 (0.34237)

Table 40: Estimation of normalised β vector and of the adjustment

The sign of coefficients of the cointegration relationship are correct, but only the estimated adjustment coefficients on productivity is statistically different from zero.

For the second period, the results of the test of cointegration rank, reported in table 41, indicate the existence of at least one (feeble) cointegration relationship. The coefficients of this relationship, and the relative weights, are reported in table 42.

Ho: rank=*p*	Cointegration LR test on maximal eigenvalue	95%	Cointegration LR test on trace	95%
p == 0	21.53	27.1	48.37*	47.2
p <= 1	9.75	21.0	26.84	29.7
p <= 2	*Not necessary*	14.1	*Not necessary*	8.586
p <= 3	*Not necessary*	3.8	*Not necessary*	3.8

Table 41: Cointegration rank

	Estimated β Vector	Estimated Adjustment Coefficients
w	1.0000	0.0068375(0.010276)
dis	0.053855 (0.18055)	0.014505 (0.040507)
prod	**-3.2506** (0.59528)	0.013016 (0.0077655)
days	**-0.32877** (0.074075)	**0.43589** (0.10206)

Table 42: Estimation of normalised β vector and of the adjustment coefficients

The coefficients of the cointegration vector are compatible with a wage equation where unemployment rate have little or no effect. Anyway, the adjustment coefficients are completely unsatisfactory.

Looking at this results on the sub-samples there are some facts that clearly emerge. First of all, unionisation rate seems to perform quite well in the first sample but it completely fails in the second. This mean that if it may have measured the union power in the seventies it was not anymore so in the eighties.

As for the other three variables, they perform relatively well (in the sense of having the expected relationship with the other variables) when we estimate the β vectors, but using them we find adjustment coefficients that are hardly significant.

Looking at both the analysis on the whole sample and the one on the sub-samples, some conclusions may be reached, but some points cast shadows on them. A fact that seems relevant is that unionisation rate is a good proxy during the seventies, but it is not anymore since the eighties. The social changes occurred in Italy may well have provoked this fact.

Two of the other three variables may instead be a proxy of union power in the second part of the sample, that is, the number of strikes per worker, and the day of strike per worker.

Another important fact that emerge is that unemployment rate hardly had any effect in wages determination.

Many problems also arise when estimating the adjustment coefficients. In the first part of the sample, significant coefficients of the expected sign are found, while in the second part this hardly happened. Moreover the adjustment seems to take place through productivity rather than real wages.

In general, the weakness of the adjustment coefficients suggests that, especially in the eighties, either the short run dynamics dominated the long run dynamics, either a bad specification of the model (especially for the union power variable).

8 Some Notes on Methodology

It is quite surprising to notice how many methodological issues may arise from an empirical investigation. In effect, an empirical work covers several aspects of the research in economics. We could order the methodological issues we faced in three broad categories: (*i*) issues related to economic theory underlying the model used for the estimation, (*ii*) issues related to estimation technique and, (*iii*) issues related to the putting into practice the economic theory and the estimation technique. While the first two may seems more attractive, even much attention should be paid to the last one. We are not really saying that this is the most important issue, but it is the one were, we, metaphorically, spilt the most blood.

Inside these broad categories several issues and different methodologies exist. We want here to give a summary of the ones we encountered and how we dealt with them.

8.1 Methodology Issues in the Economic Theory

As already mentioned, we based our empirical research on a model with New Keynesian features. We do not want here to fully discuss the NKE. Instead, we will just point out some aspects of this school that were particularly important in our analysis. In any case, several journal articles gives a more accurate description of the NKE. In particular, one should look at Romer (1993) for a very clear summary, at Gordon (1990) for a more critics point of view, and at Stiglitz (1992) for a more detailed and more methodological-oriented discussion.

Since one of the aim of our work was to empirical assess the role that labour market imperfections play in the functioning of the economy, it comes really natural to use a New Keynesian model. Indeed, the New Keynesian school arose in the attempts to contrast the New Classic Macroeconomics (NCM) view of a world, where perfect competition is the rule.

The belief on which NKE is founded is that the economy behaves in a way that considerably differs from the predictions of the NCM. The fact that the latter had gained such a prominence on the base of better logical fundaments shows the need to contrast NCM on the very same field. In a word, the microfoundation of macroeconomics.

The microfundation of agents behaviour in imperfect markets is probably the very essence of the (partial) NKE revolution. Indeed, the agents behaviour was studied in a framework that was very far from the one depicted by Walras. Economic agents now operate in a world of imperfections, where firms have market power and unions bargain over wages, where agents trade in context of asymmetric information, where adjustment costs are relevant, and where, in general, the Walras assumptions do not hold. All these forms of imperfections have been deeply studied, and their consequence, first on the agents microecomic behaviour, and then on the macroeconomic performance, have been assessed.

Closing the lens to what we are really interested in, we should notice that labour market, as one of the major source for market imperfections, was at the centre of the NKE analysis. Several aspects of it were studied referring (*inter alia*) to efficiency wages, insider-outsider relationships, and theories on unions. Here, we shall focus on the former.

Standard microeconomic theory has a quite simple way to deal with the labour market. Labour marginal productivity defines the wage the firms are willing to pay (the demand curve), disutility from labour defines the wage asked by workers (the supply curve), and their encounter defines the market real wage and the equilibrium employment level. Finally, small frictions in the encountering process of supply and demand may cause small amount of (frictional) unemployment.

Obviously the real world operates in a quite different way. For example, especially in Europe, unions have a big role in the determination of wages.

The main contribution to the unions theory came from a series articles by Layard and Nickell[21]. They build up a theory were unions and firms

[21] As already stated, for a comprehensive account of their findings see Layard *et al.* (1991). It should be noted however that an earlier contribution in this field came from

bargain to obtain the best work conditions on one side and the higher profits on the other. But what is the source of such bargaining power? Looking at real world labour markets, we can well see that it came from the very institutions of labour market and from his intrinsic characteristic. Unions (and workers) can threat to go strike (depending on the strike legislation), they are somehow protected by the labour protection legislation, and they can take advantage exploiting the differences among insider (those who are already working) and the outsider (those who are not yet working)[22]. On the base of these considerations, it is possible to microfundate the bargaining between firms and unions. This is usually done through the solving of a Nash maximandum, that is, an equation that takes into consideration the claims of each parties and their relative bargaining power.

There exist two ways to formalise such a bargaining: the right to manage model and the efficient bargaining model. The main difference is that in the right to manage model unions bargain only over wages, leaving to the firms the employment decision. On the contrary, in the efficient bargaining model, unions bargain simultaneously on both the wage and the employment. It is argued that the latter deliver a more efficient (from which its name), and Pareto superior, solutions and it is therefore more logically consistent. However, we believe that the right to manage approach depicts a picture that is closer to the reality of bargaining. In fact, it is impossible (and time-inconsistent) for firms to commit themselves on employment decisions. We had therefore used this model in our analysis.

Two last issues should be treated while discussing NKE. The first one is the reason why, while describing this school, we add partial to the word revolution. In fact, even if we observe a departure from many of the assumptions characterising the neo-classical school, we also see that they detain some. In particular, NKE was developed on marginalistic fundaments and on the strong assumption of representative agents. The latter have especially attracted many criticisms. The most famous of which is probably contained in Kirman (1992). This is indeed a complicated issue, which we have not fully faced. It is true that this assumption may mine most of the results of the NKE (and of most of the economics theories), but it is also true that the systematic analysis of the working of imperfect markets is *per se* an outstanding legacy, a legacy on which the economics science can builds better, maybe with no representative agents, theories. In any case, we want to add that small relaxation of the assumptions of agents homogeneity have already been made by the NKE. The very insider-outsider theory is an example of

McDonald and Solow (1981).

[22]See Lindbeck and Snower (1988).

this. Moreover, there are recent works built up on the NKE traditions but with the adding of some features of heterogeneity. See for example Dixon, Hansen, and Kleven (2002).

We will now discuss briefly the last of the issue that we faced: the use of an economic model of equilibrium. Indeed, all the microfundations of NKE have been built around the fact that there exists equilibrium even if it is very different from the Walrasian one. In our work we do not really have to believe in this, or rather, we do not have to believe that the economy rest on such equilibrium. On the contrary we wanted to search empirically if there exist some economics forces that drive the variables of interest toward such equilibrium. An equilibrium that could be even never to be reached because of many factors, often chaotic, influencing the dynamics of the system. For this, it is not a case that to conduct our empirical research, we chose to use the cointegrated VAR technique. In fact, it is particularly suitable to separate the long run equilibrium forces that we are looking for, from the rest of the short run dynamics. Of course, this will be better discussed in the next sub section.

8.2 Methodology Issues in the Econometric Technique

Before we start a discussion on an econometrics technique, we should warn the reader that we are not econometricians and we are not willing (and able!) to discuss the many technical and statistical properties of the cointegrated VAR. On the contrary, we are interested on the economic meaning hiding behind an estimation computed with the VAR methodology. It is on this issue that we will focus our discussion.

A VAR is a system of equations all of which appear in their reduced form. As a consequence, all the variables in the system should be considered endogenous. It is clear that this approach is a rather statistical one, with almost no space for the specification of an economic model based on some kind of theory. In fact, some authors refer to this approach as "modelling without theory".

However, a connection between an economic model and a VAR exists, and it can be found in the presence of cointegration relationships in the VAR.

An economic model is often a model of equilibrium, where the variables of interests should, in principle, find an equilibrium level, and remain stable on that value. The combination of those variables should then form a stationary relationship (a cointegrated relationship, in technical terms).

The cointegrated VAR methodology consists in tracing those cointegration relationships and separating them from other, short-period and transient dynamics. We are then able to observe the long run equilibrium relationships and verify if they are consistent with the economic theory. Assessing the magnitude of such relationships has been the essence of this work.

More technically, this methodology is based on a maximum likelihood estimation applied under the assumption that the generating process follows a particular probability distribution[23].

8.3 Methodology issues in Using Economic Theory and Estimation Techniques in Real World Economies

Building up an economic model or developing an estimation technique is a difficult but exact process. In theory once the technical problems are solved everything seems to work perfectly with nothing left to approximation. However, if we confront the theoretical work with the reality everything becomes much more complicated. First of all, one have to acquire the data and to understand which of them are the most suitable for the model. This process can be long and not always successful. Sometimes, it is possible to find out that the model uses variables that simply does not exists in real life.

In our case, the simple model presented in the first part of this work encloses a particular variable - union power - that cannot be obtained form the traditional series of the national account system. The choice of a good measure for the union power is a very controversial issue in the formal study of the wage determination process.

Clearly, if a true and always reliable measure for union power existed, we would have no particular problems. But instead, we are dealing with a theoretical variable that, in reality, cannot be measured. For this reason, we have to rely on other variables that can somehow approximate the extent of the union power, conscious of the fact that we will never find out the "perfect" proxy.

In this process, we tried different possibilities: the unionisation rate, the number of strikes, the number of work conflicts per worker, the days of strikes per worker, and the percentage of left voters[24]. A graphical analysis shows that the unionisation rate reached a maximum in the middle of the seventies to decline steadily thereafter. It also shows a weak increase occurred in the last few years, probably due to the liberalisation process of the labour market

[23] The "natural" distribution for a VAR system is the Haavelmo distribution.

[24] There are some other proxies that could fulfil the wage pressure role in our model. They are the measures of employment protection and the workplace representation. These are also the measures that Layard and Nickel suggest when they present their theoretical model. However, an empirical analysis with these variables is fruitless in the Italian case. In fact, the index that measures these variables is constant for the case of workplace representation, and it is a simple mean shift dummy for the employment protection.

pursuit by the recent public administrations. The choice of this variable is due to the fact that a union with a larger membership is likely to have a stronger voice in the bargaining[25].

The number of strikes, the number of work conflicts per worker, and the days of strikes per worker are measures of work confrontation and they show a fluctuant decline over the period covered by our analysis. Clearly, a generic measure of work confrontation is not always correlated with the role of wage pressure that we need in the model. In fact, a strike may be called for different reasons than a wage claim. Moreover, it is not straightforward whether a 'strong' union will be likely to call for more strikes or if it will not need them to obtain its claims.

The percentage of left voters shows a fluctuant course without any particular trend. The choice of this variable was motivated by the fact that a larger share of left voters may be associated with a social and political environment favourable to workers requests. Moreover, we thought that an empirical text on the effectiveness of this possible measure for wage pressure could be a matter of particular interest. In fact, sometimes has been argued that a strong left political representation is one of the necessary conditions for wage moderation.

The cointegration analysis performed using these variables was not very satisfactory. Using the unionisation rate for the overall period we obtained a cointegrating relationship (a wage equation) in which the union power appears with the wrong sign. Better results are obtained considering two different sub-samples.

The measures of work confrontation do not act in a homogeneous way. The number of strikes performs the role of wage pressure only if considered in the entire period. Splitting the sample, this variable appears in the cointegrating relationship with the wrong sign. The number of work conflicts per worker appears with the expect sign in the entire sample and in the two sub-samples. Finally, the days of strike per worker act as a wage pressure in the entire sample and in the second sub-sample.

The percentage of left voters work well if considered for all the period, refusing the view according to which a large left representation is a pre-requirement to make sacrifices acceptable to workers.

The fact that each proxy plays a good role only in some periods is a clear sign of the complex dynamics underlying the labour market.

There is one last problem we faced. Our analysis covers a quite broad span of time, nearly thirty years. It is clear that when dealing with long

[25] In fact, in empirical analysis, the unionisation rate is the most used proxy for union power.

periods of time we cannot always hope to find a model that is good through all the years. Reality is often too complex and mutable to be described with a single, simple model.

Even if our model is a good[26] one, and it holds through all the periods, it is possible that the coefficients of the models change between a sub-period and another (in technical words this is called structural change). In our particular case, we observe many changes during this period that affect the Italian labour market functioning. Therefore, it would have been quite surprising that a model that werw good for the seventies were able to work also in the other decades.

It may be possible that there exists quantitative variables that are able to measure such changes, and their inclusion in the model could solve the problems. However, in this case, it is really difficult to find a variable that could "measure" the different social context.

Standard econometric technique tries to fix structural break adding dummy variables. Their use allows for a change in the values of the coefficients among different periods.

The simplest dummy variable is the one that allows a shift in the constant. Since in an econometrics model the constant usually represent the average of all the effect that we are not able to measure directly, it is possible that using such a shift we can capture the change in the social context.

It is also possible to use dummies to allow breaks in the value of the coefficient of each single dependent variable[27] (this means a change in the effect of an independent variable on the dependent variable).

As a last resort, if the break is too severe, one should try to estimate the model in the different sub-periods. This is probably the best solution, but it reduces the number of observations for each single analysis, weakening the efficiency of the estimation.

In our analysis we went through different remedies. We started searching for a variable (union power) that could take into account the difference in the society and we also used a mean shift dummy to separate the two periods. However, they did not seems to work very well, and in the end we had to split the sample, bearing the costs in term of lower efficiency.

9 Conclusions

This work tried to estimate long run equilibrium relationships in the Italian labour market since the seventies. Several problems made this task extremely

[26]With "good" we mean the model that indeed explain the functioning of a phenomenon.
[27]Unluckily, the software we used does not allow for this.

difficult. In particular, our analysis point out a radical change of regime in the labour market at the beginning of the eighties. This change also raises some problem in the model estimation. When we conducted a separate analysis of the overal period, we obtained better results and the relationship we found seems to be quite compatible with our theoretical model. However, the subsamples shortness casts a shadow on them.

Another issue we tried to set is which variable may measure union power. This issue was also altered by the change of regime, but we reached an interesting conclusion: during the seventies the unionisation rate seems to be a good proxy for union power, but since the eighties this fail to be true and we better try with the number of work conflicts per worker and with the days of strike per worker to have a measure of union power.

Two last important facts emerge from our analysis. First, we found out that the unemployment rate hardly played any role in the determination of the real wages. Second, especially in the eighties, the adjustment took place through the productivity rather then through real wages, and short run dynamics often have dominated long run dynamics.

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Appendix
MATLAB program for DF and ADF tests

```
%PROGRAMMA PER EFFETTUARE I TEST DF E ADF
clear STIMA;
clear TEST;
X=input('Inserisci la variabile di interesse');
Rit=input('Quanti ritardi inserisco');
A=input('Inserisco la costante (si=1, no=0)');
%trovo la lunghezza del campione
T=length(X);
%costruisco la variabile ritardata
LagX=X(1:T-1);
%costruisco le differenze prime
DX=diff(X);
%trovo la lunghezza del campione
T=length(LagX);
%costruisco la costante e imposto la matrice dei test
ONE=ones(T,1);
if A==0
   LagX=LagX;
   %TEST=zeros(Rit+1);
else
   LagX=[ONE LagX];
   TEST=zeros(Rit+1,Rit+2);
end
% calcolo subito il test DF
% Stimo la testing regression con OLS
coef=(LagX'*LagX)^-1*LagX'*DX;
% Calcolo la stima di sigma
DXcap=LagX*coef;
Residui=DXcap-DX;
if A==0
   s=Residui'*Residui/(T-1);
else
   s=Residui'*Residui/(T-2);
end
% Calcolo lo standard error del coefficiente
stdercoef=diag(sqrt((LagX'*LagX)^-1*s));
% Calcolo le statistiche dei test DF
if A==0
```

```
    DF=coef/stdercoef;
    TEST(1,1)=DF;
    STIMA(2,1)=coef;
    STIMA(1,1)=stdercoef;
else
    DF=coef(2)/stdercoef(2);
    tcost0=coef(1)/stdercoef(1);
    TEST(1,1:2)=[tcost0 DF ];
    STIMA(2,1:2)=[coef(1) coef(2)];
    STIMA(1,1:2)=[stdercoef(1) stdercoef(2)];
end
if Rit~=0
    for i=1:Rit
        DXRIT=zeros(T-i,i);
        for j=1:i
            DXRIT(:,j)=[DX(i-j+1:T-j)];
            DXTEMP=DX(j+1:T);
            LagXTEMP=LagX(j+1:T,:);
        end
            if A==0
            CH=[LagXTEMP DXRIT];
            % Stimo la testing regression con OLS
            stima=(CH'*CH)^-1*CH'*DXTEMP;
            % Calcolo la stima di sigma
                     DXcap=CH*stima;
                     Residui=DXcap-DXTEMP;
                     s=Residui'*Residui/(length(DXTEMP)-(i+1));
                     % Calcolo lo standard error del coefficiente
            stderstima=diag(sqrt((CH'*CH)^-1*s));
            % Calcolo le statistiche dei test DF
            TEST(i+1,1:(i+1))=[stima./stderstima]';
            STIMA(2*i+2,1:(i+1))=[stima]';
            STIMA(2*i+1,1:(i+1))=[stderstima]';
            else
            CH=[LagXTEMP DXRIT];
            % Stimo la testing regression con OLS
            stima=(CH'*CH)^-1*CH'*DXTEMP;
            % Calcolo la stima di sigma
                     DXcap=CH*stima;
                     Residui=DXcap-DXTEMP;
                     s=Residui'*Residui/(length(DXTEMP)-(i+2));
                     % Calcolo lo standard error del coefficiente
```

```
        stderstima=diag(sqrt((CH'*CH)^-1*s));
        % Calcolo le statistiche dei test DF
        TEST(i+1,1:(i+2))=[stima./stderstima]';
        STIMA(2*i+2,1:(i+2))=[stima]';
        STIMA(2*i+1,1:(i+2))=[stderstima]';
        end
    end
end
TEST=flipud(TEST)
STIMA=flipud(STIMA);
```

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