Abstract

This paper presents a model in which wages throughout the economy depend only on the labour market conditions in some low-unemployment sector. In equilibrium, a labour demand shift towards the primary sector tends to raise the unemployment rate everywhere else in the economy and leaves wages unchanged. Overall this implies an increase in aggregate unemployment. Based on SHIW micro data for the period 1977-1991 we find that wages in Italy depend only on the tightness of the labour market in the North. We estimate that around 15% of the increase in aggregate unemployment in Italy can be explained by a shift in labour demand in favour of the North not matched by an equal shift in labour supply.

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Regional Imbalances and Aggregate Performance in a Leading Sector Model of the Labour Market: An Analysis on Italian Data 1977-1991

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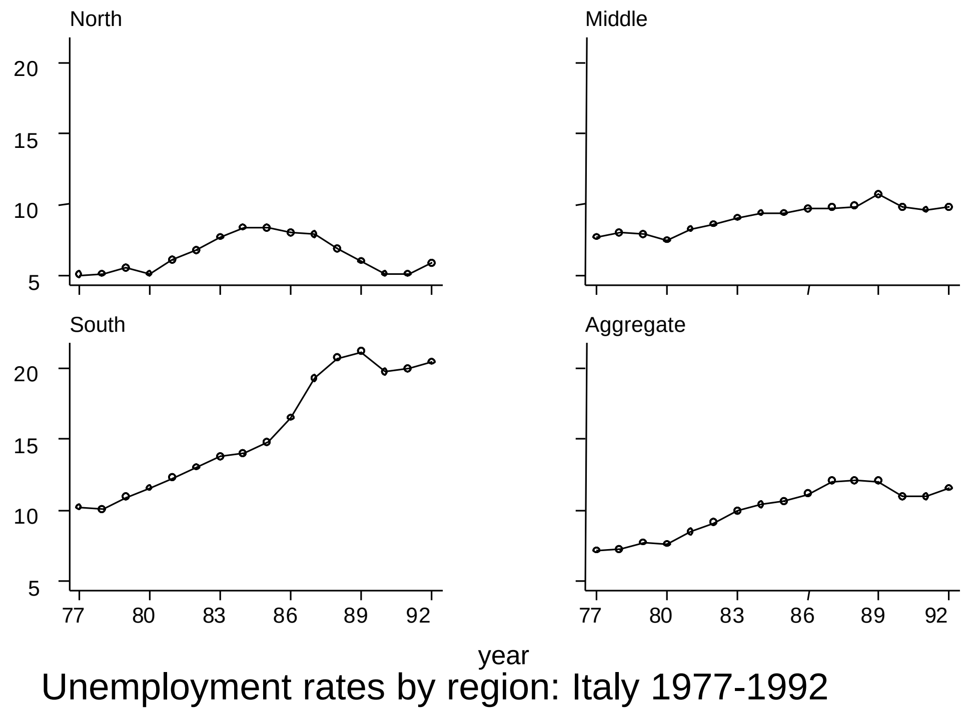
1. Introduction

The unemployment rate in Italy grew roughly monotonically between the 70s and the early 90s, increasing from about 7% in 1977 to 12% in 1992. In this respect, Italy does not differ from many other continental European countries. What is peculiar to the Italian experience is that the increase in the rate of unemployment was mainly concentrated in the less industrialized regions of the South.[1] While the typically low unemployment rate in the North stayed basically untrended, going from 5% in 1977 to less than 6% in 1992, the unemployment rate in the South doubled in this 15-year span, increasing from 10% in 1977 to 20% in 1992. The regions in the middle of Italy, situated halfway between the *Mezzogiorno* and the North, started off with a level of unemployment of 8% and ended with an increase of 2 percentage points. This is illustrated in Figure 1.

Figure 1



Notes. Source: *Annuario Statistico Italiano,* ISTAT, various issues.

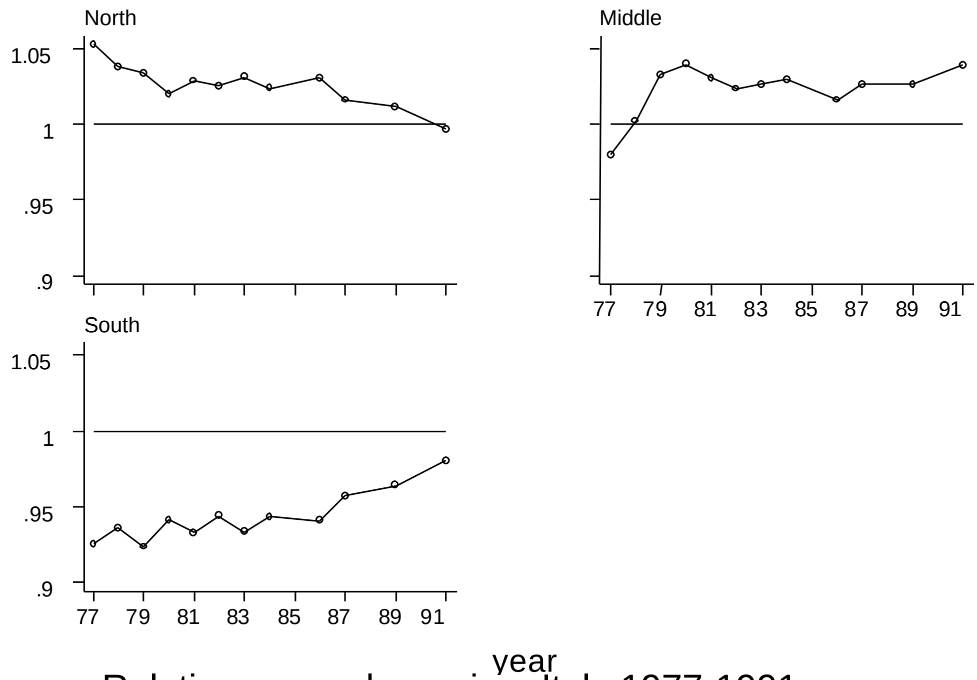
1. Throughout the paper the term 'South' refers to the Southern regions and the Islands (Sicily and Sardinia).

The aim of this paper is to evaluate whether the unbalanced evolution of labour demand and supply across different geographical areas — for brevity labelled as 'mismatch' in what follows — is partly responsible for the increase in aggregate unemployment.

In theory, a shift in labour demand towards the low-unemployment Northern regions and away from the high-unemployment Southern region might explain part of the increase in the aggregate rate of joblessness. The mechanism we describe, despite having mainly a second order effect, is theoretically and empirically fairly sound. Based on the original work by Lipsey (1960) on the microfoundation of the Phillips curve, it is now widely accepted that wages set by firms and workers are negatively affected by the rate of unemployment, whose moderating influence, however, declines with its level. If wages respond to changes in the *local* unemployment rate, the more local unemployment rates are disperse, the higher the average wage claim in the economy and, everything else being equal, aggregate unemployment. Assuming fixed wage pressure, one would observe diverging local unemployment rates and diverging relative wages.

When we turn to the Italian data, we observe that while regional unemployment rates display increasing dispersion over the period, regional wages in Italy show instead a tendency to converge, as it can be seen from Figure 2. In 1977 workers in the North received 4% more than the national average and those in the Middle and the South respectively 3% and 6% less. By the end of the period, while those at the North received approximately the average wage, the wage at the South and the Middle was respectively 3% less and 3% more than the national average.

Figure 2



Relative wages by region: Italy 1977-1991

Note: Three year moving averages plotted. See notes to Table 1.

At first glance, changes in relative wages across geographical areas correlate positively with changes in relative unemployment, casting some doubts on whether a shift in net relative demand across regions can be held responsible for the increase in aggregate unemployment in Italy. We will show anyway that, when the wage setting process is dominated by the tightness of the labour market at the North, labour demand shifts across regions may well imply stable unemployment in the North, rising unemployment in the rest of the country, and stable regional wage differentials.

The intuition is straightforward: any rise in the demand for labour in the North will tend to reduce the unemployment rate there and, via this, increase wage claims everywhere in the economy. In equilibrium, this implies a rise in the unemployment rate in the secondary sector and stable wage differentials.

If, on top of this, there is an exogenous increase in wage pressure, pushing wage claims in the secondary sector above those of the leading sector, the model can encompass both rising unemployment differentials and increasing wage differentials, without exogenous wage pressure being the main culprit of the rise in aggregate unemployment.

The question of whether a shift in labour demand carries the responsibility for the rise in the aggregate rate of unemployment has relevant policy implications and lies at the core of the present Italian debate on the performance of its labour market and increased disparities between the North and the South. Indirectly, the above hypothesis will be contrasted with the widespread view that exogenous changes in wage pressure across regions bear the main responsibility for the rise in Southern unemployment. Although it is indisputable that some rise in relative wage pressure occurred in the South, the point we want to address is whether this can be blamed for all of the rise in unemployment.

The contribution of this paper is two-fold. Section 2 provides a model for the analysis of regional mismatch, based on a 'leading-sector' wage setting process. Section 3 estimates a regional wage function for Italy over the period 1977-1991 using micro data from the Bank of Italy Survey of Households' Income and Wealth. This section provides evidence in favour of an asymmetric wage setting model. Section 4 resumes the arguments made in Section 2 and the empirical results presented in Sections 3 to assess the role played by the regional imbalance between demand and supply of labour in shaping the evolution of aggregate unemployment in Italy. Section 5 concludes and states the main findings.

2. The Theoretical Framework

In this section we develop a simple two-sector model of the labour market, that illustrates how sectoral demand and supply shocks can affect the aggregate unemployment rate when the wage-setting mechanism is asymmetric across sectors, *ie* when the unemployment conditions prevailing in one of the two sectors (the so called 'leading sector', which is generally the low-unemployment one) determine wage claims throughout the economy. Section 3 will provide some evidence in favour of this model which is depicted in Figure 3. The symmetric model, where sectoral wage claims only depend on the own-sector unemployment rate, is discussed in Manacorda and Petrongolo (1998).

We consider an economy in which the labour force is split into two sectors or — equivalently — two categories of workers, identified with N_1 and N_2, that jointly produce some output *Y*. Equilibrium in this economy is determined by the interaction of a labour demand for each input and a corresponding wage-setting schedule.

On the labour demand side, we assume that technology is represented by a Cobb-Douglas production function, combining the two types of labour under constant returns to scale

$$Y = AN_1^{a_1} N_2^{a_2}, \qquad a_1 + a_2 = 1 \tag{1}$$

in which *A* represents the aggregate state of technology. Under perfect competition in the goods market, the labour demand schedule for each type of labour is $w_i = a_i (Y / N_i)$, $i = 1,2$, with w_i denoting the real wage paid to input i and α_i representing the share of total output accruing to it. Expressing labour demand schedules in logarithms, we have

$$\begin{aligned} \ln w_1 &= \ln a_1 + \ln A - (1 - a_1) \ln N_1 + a_2 \ln N_2 = \\ &= \ln A + \ln a_1 - (1 - a_1) \ln(1 - u_1) + (1 - a_1) \ln(1 - u_2) - (1 - a_1) \ln \frac{l_1}{l_2} \end{aligned} \tag{2}$$

for type 1, and similarly for type 2, where u_i denotes the unemployment rate of each type of workers, and l_i its labour force share. Sector-specific demand and supply variables are represented by α_i and l_i respectively. They are in fact relative indicators ($a_1 + a_2 = l_1 + l_2 = 1$) and therefore are meant to isolate purely sectoral shocks from aggregate changes. In the following we assume that labour force changes are purely exogenous, *ie* we do not allow for endogenous migration. This does not seem an unrealistic assumption for Italy where, even in face of diverging local unemployment rates but still converging wages, internal migration has declined steadily (see, among others, Faini *et al*, 1997).

When the 'sectors' considered are regions — as it is the case in the present analysis — we can introduce an equivalent Cobb-Douglas aggregate welfare function where a_i represents the taste parameter associated to the output of the generic region i.[2] This case is discussed in Appendix A, where we show that both our model and its empirical implementation remain unchanged.

Turning to wage setting, there is consensus on the recognition of a negative convex relationship between wages set by workers and firms and the unemployment rate. As pointed out by Manning (1993), a wage equation of this kind can be obtained as a first order condition for wages deriving from a bargaining problem between firms and workers. The literature on the subject has identified two relevant models of sectoral wage behaviour (see Jackman and Savouri, 1991), namely the 'own-sector' model and the 'leading-sector' model. The 'own-sector' model, which is the one most often used to describe sectoral wage-setting, assumes that wages set for each category of workers depend on their specific unemployment rate, generating a symmetric mechanism of wage determination throughout the economy. The 'leading-sector' model assumes instead that the unemployment conditions prevailing in some leading sector of the economy shape wage determination across all sectors. Supposing that sector 1 is the leading or, equivalently, primary sector in the economy described, we will consider a sectoral wage function such as

$$ln\, w_i = z_i - \gamma\, ln\, u_1, \quad i = 1,2 \tag{3}$$

where wages set for each type of labour are a negative convex function of the unemployment rate of type 1 workers. The parameter γ represents the absolute value of real wage elasticity with respect to the unemployment rate of the primary sector. Although there is not constraint for this to be the case, in order to keep things simple we have assumed the wage elasticity parameter to be constant across sectors. Wage pressure factors, that affect sectoral wages at

2. We are grateful to Richard Jackman for having pointed this out.

given unemployment, are represented by the vector z_i, which is allowed to vary across sectors.

Wage-setting and labour demand can be then be combined for each group of workers in order to eliminate w_i. Total differentiation gives

$$du_1 = \frac{u_1(1-u_1)}{a_2u_1 + g(1-u_1)} \begin{pmatrix} dz_1 - d\ln A - \ln\frac{N_1}{N_2}da_1 + \\ -a_2\left(d\ln\frac{a_1}{a_2} - d\ln\frac{l_1}{l_2}\right) + \frac{a_2}{1-u_2}du_2 \end{pmatrix} \quad (4)$$

and

$$du_2 = \frac{1-u_2}{a_1} \begin{pmatrix} dz_2 - d\ln A - \ln\frac{N_1}{N_2}da_1 + \\ -a_1\left(d\ln\frac{a_2}{a_1} - d\ln\frac{l_2}{l_1}\right) + \left(\frac{a_1}{1-u_1} - \frac{g}{u_1}\right)du_1 \end{pmatrix} \quad (5)$$

using the property that $d\ln a_1 = (1-a_1)d\ln[a_1/(1-a_1)]$.

A few things are worth mentioning. First, unemployment in the primary sector positively depends, other things being equal, on the unemployment rate of the secondary sector. This derives from the fact that inputs are co-operant in the production function: higher unemployment and therefore lower employment in one sector decreases marginal productivity of labour in the other sector, therefore depressing demand and increasing unemployment. The same effect can be found in the determination of unemployment in the secondary sector, and it is represented by the term $[a_1/(1-u_1)]du_1$. However, u_2 also depends on u_1 because of a feed-back effect deriving from the asymmetric wage-setting mechanism considered. A rise in unemployment in the primary sector generates lower wage claims in the secondary sector and therefore tends to reduce the secondary sector unemployment. This latter effect is represented by $-(g/u_1)du_1$ and it dominates the former when $u_1 < g/(g+a_1)$.

A measure of the shift in relative labour demand across sectors net of shifts in relative labour supply is given by the index

$$dmm_{12} = d\ln(a_1/a_2) - d\ln(l_1/l_2) = -dmm_{21} \quad (6)$$

where *mm* stands for 'mismatch'. This has the desirable property of having the same absolute magnitude and opposite signs for the two groups.

A convenient approximation to our index is

$$dmm_{12} \approx d(u_2 - u_1) + d\ln(w_1/w_2) \quad (7)$$

deriving from the first order Taylor approximation $d\ln(1-x) \approx x$, valid for x close to zero. In partial equilibrium, any shift in the relative net demand will either imply an increase in the difference between the local unemployment rates or a rise in relative wages.

Finally, let us define z as the aggregate level of wage pressure, obtained as a weighted average of group-specific wage pressure forces, in which the weights are given by shares of output accruing to each input: $z = a_1 z_1 + a_2 z_2$. Along these lines we define $dz = a_1 dz_1 + a_2 dz_2$, the change in aggregate wage pressure at constant factor shares.

The closed-form solution for du_1 and du_2 is finally given by

$$du_1 = \frac{u_1}{g}\left(dz - d\ln A - \ln\frac{N_1}{N_2} da_1 \right) \tag{8}$$

and

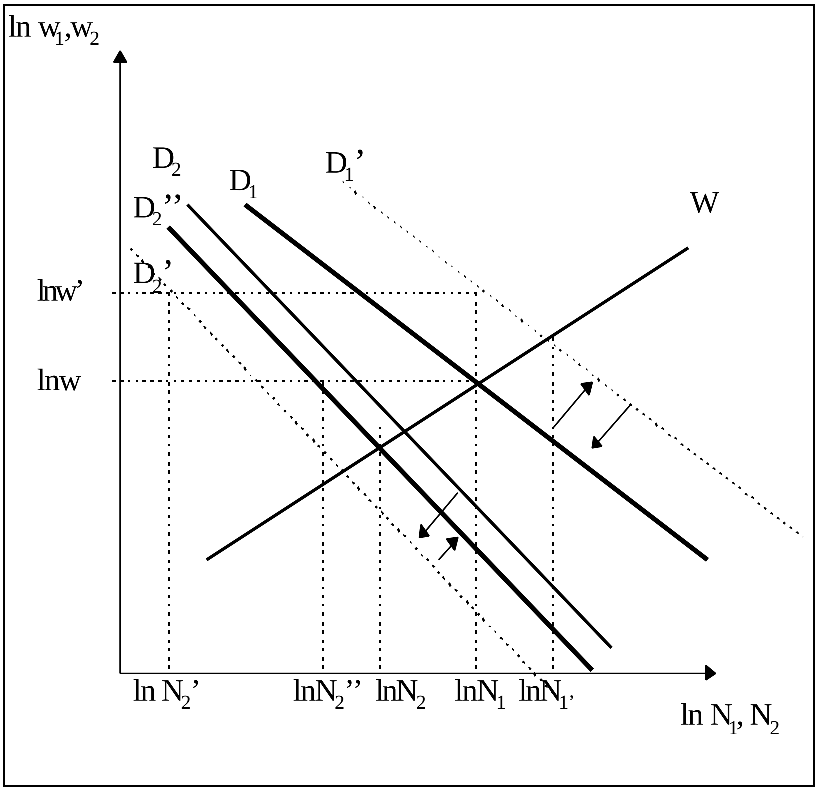
$$du_2 = \frac{u_1(1-u_2)}{g(1-u_1)}\left(dz - d\ln A - \ln\frac{N_1}{N_2} da_1 \right) + \\ + (1-u_2)(dz_2 - dz_1) + (1-u_2) dmm_{12} \tag{9}$$

Equations (8) and (9) illustrate the effect of any exogenous shock on the unemployment rate of the primary and the secondary sectors. One first observation concerns the fact that the unemployment rate in the primary sector is solely affected by aggregate factors. In particular, it is independent of sectoral demand and supply shocks. On the other hand, the unemployment rate in the secondary sector is an increasing function of the net demand shift favouring the primary sector.

To get a grasp of the model, observe that the negative effect on u_1 (du_1<0) of a relative net demand shift towards sector 1 (dmm_{12}>0) is perfectly offset by the resulting increase brought about by the a rise in wage claims everywhere in the economy. This tends to make both input prices relatively more costly and increase their unemployment. In equilibrium, the unemployment rate in the leading sector comes back to its original level while the unemployment rate in the secondary sector increases. As it can be seen from equation (3), constant unemployment in sector 1 also implies constant relative wages across sectors. Constant relative wages and increasing unemployment in one sector could only be rationalized within a symmetric wage setting model in terms of an asymmetric demand shock coupled with some change in wage pressure. Here we have shown that, if wage setting is asymmetric, this can also happen at fixed wage pressure.

Figure 3

The occurrence of a shift in net demand in an asymmetric wage-setting model



Notes. The figure depicts the occurrence of a relative net demand shift in favour of the leading sector of the economy (sector 1). We assume that wage pressure is equal across the two sectors and that labour supply is given. Equilibrium in sector 1 is given by the intersection of a common wage curve (W) and a downward sloping labour demand schedule (D_1), which jointly determine sector 1 employment (N_1). This determines the level of wages in both the leading and the secondary sector (w) and the level of employment in the secondary sector (N_2). The occurrence of a demand shift against the unskilled shifts D_1 up and D_2 down. As a first round effect, this raises skilled employment and reduces unskilled employment. Wages grow. Because of the two factors being co-operant in the production function, a reduction (increase) in the equilibrium value of N_2 (N_1) tends to shift the demand curve back down (up). While this second round effect is such to bring D_1 back to its original level and leave employment in the leading sector as well as wages all over the economy unchanged, D_2 shifts back only partially and employment in the secondary sector is reduced.

Both unemployment rates are positively affected by an excess aggregate wage pressure dz over the feasible average wage growth. The feasible growth in the average wage is measured by the increase in total factor productivity, $d\ln A$, plus the growth in output that a given sectoral productivity shock would produce at given relative employment: $\ln\left(N_1/N_2\right)da_1$. This last term, although depending on da_1, cannot be interpreted as a pure imbalance factor and therefore it is not included into the net relative demand shock. It represents in fact the output gain (loss) that both types of labour enjoy (suffer) when sectoral productivities change.

Finally, the unemployment rate in sector 2 depends positively on the wage pressure differential $dz_2 - dz_1$. For the same reason described before, a change in wage pressure in the leading sector will only affect the unemployment rate of the secondary sector. A rise in $dz_2 - dz_1$ first generates higher relative wages in sector 2, and therefore an increase in u_2 and a fall in u_1. The second round effect involves a rise in wage claims throughout the economy, via the fall in u_1, raising both unemployment rates. The net effect is no change in u_1 and an increase in u_2.

The aggregate unemployment rate u is given by a weighted average of sectoral unemployment rates: $u = l_1u_1 + l_2u_2$. The change in u is therefore computed as

$$du = u_1dl_1 + u_2dl_2 + l_1du_1 + l_2du_2 = \frac{u_1(1-u)}{g\left(1-u_1\right)}\left(dz - d\ln A - \ln\frac{N_1}{N_2}da_1\right) \qquad (10)$$
$$+ l_2\left(1-u_2\right)\left(dz_2 - dz_1\right) + l_2\left(1-u_2\right)dmm_{12} + \left(u_2 - u_1\right)dl_1$$

The term in dl_1 in equation (10) is a compositional effect, due to migration of the labour force from one unemployment group to the other. It tends to have a negative impact on aggregate unemployment if there are net migration flows towards the primary sector, which is plausibly the low-unemployment one.

Aggregate unemployment increases when aggregate wage pressure rises over the feasible real wage, and when the change in wage pressure in the primary sector is lower than the one in the secondary sector, this last effect being induced by the behaviour of unemployment in sector 2.

Finally, aggregate unemployment is an increasing function of the net relative demand shift favouring the leading sector. This happens because this kind of shock does not have positive effects on the unemployment rate of the primary sector, while increasing unemployment in the rest of the economy. The effect on aggregate unemployment is therefore unambiguous.

Unlike in the symmetric wage-setting model, where the aggregate effects of sectoral imbalances crucially depend on the fact that mismatch generates higher dispersion along a convex wage-setting function, the curvature of the wage function does not play a crucial role in this asymmetric wage setting model. Here mismatch simply works through the sensitivity of wages in the economy to the unemployment in the primary sector.

Extending this framework to an n-sector economy, it can be shown (see Appendix B) that the effect of sectoral mismatch on group specific unemployment is perfectly analogous to the one in the two-sector case. Suppose that sector 1 is the leading sector, the relative imbalance between demand and supply for the generic sector i can be written as

$$dmm_{i1} = d\ln\left(a_i / a_1\right) - d\ln\left(l_i / l_1\right), \qquad i = 1,\ldots,n, \qquad (11)$$

which is clearly zero for $i = 1$. Equations (8) and (9) rewrite then as

$$du_1 = \frac{u_1}{g}\left(dz - d\ln A - \sum_{i=1}^{n} \ln\frac{N_i}{N_1} da_i \right) \qquad (12)$$

and

$$du_i = \frac{u_1(1-u_i)}{g\,(1-u_1)}\left(dz - d\ln A - \sum_{j=1}^{n} \ln\frac{N_j}{N_1} da_j \right) + \\ + (1-u_i)(dz_i - dz_1) - (1-u_i)dmm_{i1} \qquad (13)$$

Again, the unemployment in the leading sector will only be affected by aggregate shocks. On top of this, sector specific unemployment rates will instead depend on the excess wage pressure and shifts in net demand both measured relative to the leading sector.

Equations (12) and (13) are the basis of the empirical analysis of Section 4, where they will be applied to a three-fold geographical classification for Italy.

3. The Wage Setting Process in Italy

There is plenty of evidence (see Blanchflower and Oswald, 1994) that wages respond negatively to local unemployment and that the relationship is convex in the wage-unemployment space. The higher the local unemployment rate, the more workers are willing to moderate their wage claims but as long as unemployment increases, this bites gradually less on wage claims.

In order to estimate a wage equation for Italy, we use individual data from the Bank of Italy Survey of Households' Income and Wealth (SHIW) (for a description see Brandolini, 1993, and Cannari and Gavosto, 1994). The survey has been run continuously from 1977 to 1984, then in 1986, 1987 and in every other year thereafter. Our estimates refer to the period 1977-1991, the longest time span in which we can have a consistent series for both wages and unemployment. We restrict the analysis to full-year employees, aged 18-65. The sample consists of 53,072 individuals.

One of the main advantages of the data set we use is that it includes individual-specific variables, and in particular information on human capital characteristics of the individuals (such as gender, age and education), alongside information on occupation and sector of activity, although at some coarse degree of disaggregation.

Table 1 provides some descriptive statistics on the data. Compared to the other two areas, the employed labour force at the North is relatively younger, on average less educated, and composed by a higher proportion of blue collars and female workers. This is probably due to the different industrial structure as well as to the non-random selection of the unemployed at the Middle and especially at the South. Differences between the Middle and the South are of similar qualitative nature but smaller in magnitude.

Table 1
Descriptive statistics
Means/proportions

Variables		North	Middle	South
ln real wage		3.890	3.898	3.830
sex	females	0.367	0.340	0.285
education	no schooling	0.080	0.122	0.120
	primary school	0.330	0.369	0.339
	junior school	0.366	0.297	0.287
	high school	0.210	0.193	0.219
	university	0.014	0.019	0.035
age category	18-20	0.038	0.025	0.026
	21-30	0.280	0.242	0.208
	31-40	0.282	0.276	0.302
	41-50	0.255	0.265	0.268
	51-65	0.145	0.191	0.195
occupation	blue collars	0.522	0.455	0.433
	white collars	0.453	0.516	0.548
	managers	0.024	0.029	0.019
	number of observations	25,649	12,290	15,133

Notes. Source: SHIW individual records, 1977-1984, 1986, 1987, 1989, 1991. Data are weighted by post-stratification individual weights. Wages defined as take home annual pay net of taxes, social security contributions and inclusive of bonuses, thirteenth wage and overtime payments. Wages are deflated using the national consumer price index with base 1977. Selection criteria: full year employees, aged 18-65, with a reported wage.

In what follows we try to determine whether regional wages are affected by regional labour market conditions or whether it is the aggregate unemployment rate that matters. Also, these hypotheses will be contrasted with the alternative hypothesis that wages are set according to the labour market conditions prevailing in some leading sector of the economy.

The features of the Italian system of industrial relations suggest that wages in Italy might be determined on the basis of the labour market conditions prevailing in the North. This system implies two different levels of wage setting: a national one and a local one. National bargaining between the unions and the association of entrepreneurs determines minimum binding wages for each industry. Within each industry, minima vary according to two main parameters: occupation (*inquadramento*) and seniority. These minima extend automatically to all workers whether unionized or not. On top of this, individual or collective superminima can be bargained at the firm level or conceded unilaterally by the employer. If, as many commentators have argued, unions pursue an explicit egalitarian aim and value positively *equal* proportional *increases* in wages everywhere in the economy, it would be rational for unions to ask for wages to be linked to the tightness of the labour market in the low unemployment-rate area of the North. Suppose for a moment that wage increases were linked to the labour market conditions at the South. This would imply a discontent on the part of the workers at the North, who would see wages set at a level below the one implied by the labour market conditions prevailing in their local labour market. Clearly, the question remains as to why unions pursue an explicit egalitarian aim. One reason might be that, as the wage distribution is skewed to the right, any policy aimed at those with wages below the average will have the support of the median voter.

The existing evidence seems to give credit to this hypothesis. Bodo and Sestito (1994), based on average contractual wage rates for blue collars in manufacturing for the period 1960-1991, find that the evolution of the unemployment rate in the North explains changes in wages both in the North and in the South. They obtain the same result using firm-level data on average earnings for blue collars for the period 1985-1990. Casavola, Gavosto and Sestito (1995) estimate various specifications of a wage equation for Italy on a sample of small firms over the period 1986-1993 and find that firm-level wages in the South are not affected by the local unemployment rate, and only mildly affected by the local male unemployment rate. The drawback of these studies is that they are not able to control for individual specific characteristics.

To our knowledge, the only published study which controls for individual characteristics is the one by Blanchflower and Oswald (1994), who use data from the International Social Survey Programme for the years 1986 and 1989. The authors find that wages are responsive to labour market conditions but the result disappears when they control for regional fixed effects. We argue below that this is a predictable result and — more importantly — that any sensible specification of a wage equation should explicitly control for these fixed effects.

The estimated equation has the form

$$\ln w_{it} = c_i + q q_{it} + b_i trend - g \ln u_{*t} + e_{it} \tag{14}$$

where *i* refers to regions and *t* to years (t=1977-84, 1986, 1987, 1989, 1991).

The dependent variable is the logarithm of cell-mean yearly labour income. Labour income is defined as yearly earnings net of taxes and social contributions and inclusive of overtime payments and bonuses. Wages are deflated using the national consumer price index with base 1977.

The unemployment rate is labelled by the symbol *u* which in turn can be thought as the local unemployment rate u_{rt}, the aggregate unemployment rate u_t, or the leading-sector unemployment rate u_{Lt}. The leading sector is identified with the Northern low-unemployment area. Data on unemployment used throughout the analysis are the official ones published by the Central Statistics Bureau (ISTAT).

All specifications include region-specific fixed effects c_i and control for a number of observable characteristics of the individuals, namely sex, age, education, and occupation, all included in the vector q_{it}. We decided not to introduce industry controls in the equation, on the grounds that any relative shift in the industrial structure between regions should be embodied in our mismatch indicator. Nonetheless, the exclusion of these variables does not bear any substantial difference in terms of our estimates. Estimation on cell-means implies using proportions of individuals into each category (by sex, age, education, occupation) as relevant conditioning variables. Given that these proportions are not constant over time, the vector of controls q_{it} is also time-varying. One should be careful in interpreting coefficients on proportions: not only do these pick up the marginal effect of the variable on the level of individual wages, *ie* according to the standard interpretation, the price of individuals' marketable characteristics, but also any indirect effect due to the varying proportions of employees with different skills through demand and supply mechanism. To understand this, suppose there is a male-female wage gap purely due to discrimination. At fixed prices, a rise in the proportion of women in the labour force reduces the average wage in two ways. On the one hand there is a direct effect due to increased proportion of relatively lower paid workers. On top of this, if they compete with equally productive male workers and are preferred by employees because of their lower wage, firms will tend to substitute away from male workers towards female ones. This further pushes the average wage down. Lastly, if one is prone to assume that increased supply of female workers reduces their wages, this is a third potential source of variation in an aggregate wage function.

Changes in sector-specific wage pressure are picked up by linear trends, which are allowed to have a different coefficient for each region. In these regressions we also tried to allow for different coefficients on unemployment across different regions. Unfortunately, insufficient variation made our coefficients poorly identified.

As noted in the study by Jackman and Savouri (1991), one would also like to include macroeconomic variables affecting wages at given unemployment. The general procedure is to include year dummies. This allows one to remove a common mean which is bound to pick up the secular and cyclical changes that are common to all regions. Unfortunately, when other cross-section invariant variables are included in the regression, year dummies need to be excluded in order to identify the model. This is clearly the case when a common rate of unemployment — whether aggregate or the leading sector's — enters equation (14).

The wage equation is first estimated on ten regional aggregates, the finest possible regional disaggregation with our data, and the results are then replicated on three regional aggregates (North, South and Middle). While we wish to estimate the components of wage determination at the three-fold classification level, little variation is left to identify precisely the regression coefficient. Our hope is to show that the results are robust to the level of aggregation used, and that some lack of identification when individual observations are collapsed into three regional aggregates simply stems from the absence of sufficient time series variation.

In Table 2a we report the estimation results for the wage equation on ten regional aggregates. Ten regional dummies are present in all our specifications, so to exploit time variation to identify our coefficient on log unemployment. Omission of regional dummies constantly reinforces our results, providing negative and highly significant estimates of the coefficient on the $\ln u_{rt}$ term. When regional dummies are omitted this coefficient mainly picks up the negative cross-sectional correlation between local unemployment rates and real wages, namely the circumstance that where unemployment is higher (in the South), wages are on average lower. An F-test of equality of the regional effects, both across the whole of Italy and within the three macro regions, leads systematically to rejection of the null.

All specifications include linear trends for the three macro regions. Estimation was initially performed with ten regional specific trends but an F-test on the equality of the coefficients on linear trend *within* the three macro-regions (North, South and Middle) leads to acceptance of the null hypothesis. We are instead unable to reject equality of the coefficients on the three linear trends between the three macro-areas. Although wage pressure terms are not significantly different from zero, the differences among them are in fact significant and in particular there is some evidence of a higher specific wage pressure growth in the South.

Columns I, II and III estimate each wage-setting model in turn, excluding aggregate controls. Column I estimates a simple regional equation, where (log) wages only depend on the (log) local unemployment rate. In column II we estimate a leading sector model with the unemployment rate at the North as an explicative variable, while in column III we report a specification with the aggregate unemployment rate as a regressor. In all of the three case, the unemployment variable enters the equation with a *positive* sign. The results suggest, if any, some form of endogeneity at work. Any increase in wage pressure would push both the unemployment rate and wages up. In columns V and VI we control for aggregate disturbances.

In column IV we include the three unemployment rates in the regression, in order to check whether potential correlation among these might have affected our previous estimates. The coefficient on Northern unemployment becomes negative and significant, while local unemployment has no effect on regional wages. Aggregate unemployment comes in with a positive sign. This kind of perverse effect of aggregate unemployment when different unemployment measures are included simultaneously is also found in Jackman, Layard and Savouri (1991). As they note, aggregate unemployment may stand as a proxy for unobserved aggregate supply shocks, that tend to raise aggregate unemployment as well as wages all over the country. This mechanism is likely to be responsible for the positive coefficient on $ln\, u_t$ in any of our regressions.

In columns V-VII we include possible proxies for aggregate performance with either the local or the leading-sector unemployment rate in turn. In columns V and VI the own-sector wage setting model is tested. As argued above, one control for aggregate factors is naturally represented by the aggregate unemployment rate. Column V shows that, when $ln\, u_t$ is included, both unemployment variables are non significant. Alternatively, when all possible aggregate factors are controlled for using time dummies (column VI), the effect of local unemployment is insignificantly differently from zero.

In column VII a similar exercise is replicated using the leading-sector unemployment rate. The only available control for aggregate disturbances to wages is represented by the aggregate unemployment rate, given that the insertion of time dummies would make the model unidentifiable. Using this aggregate control gives a negative and significant elasticity of regional wages with respect to the unemployment rate in the North. Overall, the elasticity of wages with respect to the unemployment rate in the North is estimated to be in the order of 14%.

Table 2a
Regional wage equation for Italy: 1977-1991 - Ten regional aggregates
(dependent variable: logarithm real regional wages)

		Specification						
Variables		I	II	III	IV	V	VI	VII
ln unemployment	local	.012			-0.030	-.045	-.033	

rate		(029)			(.037)	(.038)	(.037)	
	aggregate			0.123	0.449	0.189		0.423
				(.062)	(.136)	(.082)		(.132)
	North		0.017		-0.130			-0.138
			(.026)		(.055)			(.054)
sex	female=1	-0.476	-0.468	-0.454	-0.415	-0.423	-0.380	-0.434
		(.141)	(.140)	(.138)	(.136)	(.140)	(.139)	(.134)
age category	21-30	0.860	0.882	0.924	1.068	1.019	1.425	1.011
		(.396)	(.393)	(.385)	(.382)	(.392)	(.405)	(.375)
	31-40	0.621	0.616	0.610	0.880	0.714	1.308	0.824
		(.383)	(.378)	(.367)	(.372)	(.376)	(.413)	(.365)
	41-50	0.824	0.851	0.890	1.066	1.012	1.481	0.991
		(.402)	(.396)	(.388)	(.391)	(.401)	(.423)	(.378)
	51-65	0.726	0.731	0.738	1.023	0.869	1.409	0.949
		(.399)	(.391)	(.380)	(.389)	(.394)	(.417)	(.377)
education	primary school	0.090	0.107	0.086	0.189	0.188	0.192	0.124
		(.357)	(.348)	(.341)	(.342)	(.351)	(.346)	(.331)
	junior school	-0.064	-0.076	-0.145	0.063	-0.049	0.042	0.008
		(.321)	(.315)	(.303)	(.308)	(.313)	(.311)	(.300)
	high school	0.369	0.348	0.288	0.479	0.347	0.480	0.449
		(.329)	(.330)	(.318)	(.317)	(.321)	(.323)	(.314)
	university	0.095	0.074	-0.010	0.135	0.044	0.184	0.105
		(.359)	(.360)	(.349)	(.344)	(.351)	(.360)	(.342)
occupation	white collars	0.109	0.127	0.149	0.103	0.166	-0.033	0.089
		(.121)	(.124)	(.120)	(.120)	(.120)	(.161)	(.118)
	managers	1.592	1.661	1.813	1.807	1.908	1.477	1.740
		(.468)	(.482)	(.472)	(.467)	(.477)	(.499)	(.458)
linear trend	aggregate	0.006	0.006	0.002	-0.010	0.000	0.006	-0.009
		(.002)	(.002)	(.003)	(.005)	(.003)	(.002)	(.005)
	Middle	0.006	0.006	0.006	0.005	0.006	0.005	0.005
		(.002)	(.002)	(.002)	(.002)	(.002)	(.002)	(.002)
	South	0.006	0.006	0.007	0.007	0.008	0.007	0.006
		(.002)	(.002)	(.002)	(.003)	(.003)	(.003)	(.002)
constant		3.034	3.010	2.807	2.807	2.555	2.406	2.218
		(.456)	(.445)	(.445)	(.518)	(.491)	(.454)	(.489)
year dummies							✓	
regional effects		✓	✓	✓	✓	✓	✓	✓
Adj. R2		0.8262	0.8267	0.8337	0.8431	0.8345	0.8484	0.8438

Notes. Regressions are run on regional observation (ten-fold classification: (1) Piemonte - Val d'Aosta - Liguria, (2) Lombardia, (3) Trentino Alto Adige - Veneto - Friuli Venezia Giulia, (4) Emilia Romagna, (5) Toscana - Umbria - Marche, (6) Lazio, (7) Campania, (8) Abruzzi - Molise - Puglia, (9) Basilicata - Calabria, (10) Sicilia -Sardegna. Control group: region 1, no education, blue collar, male, aged 18-20. Number of observations: 110. 1987 excluded because 10-fold disaggregation not available. Estimation method: generalised least squares, with observations weighted by cell size. Standard errors in brackets. See notes to Table 1.

To check whether the unemployment rate at the North is simply picking up the effect of the economic cycle, we have inserted in specification VII the rate of growth of real GDP as an additional regressor. The test (not reported in the table for brevity) confirms our previous findings: the coefficients on the two unemployment rates remain substantially unchanged in magnitude and significance, while the business cycle variable does not enter the equation significantly.

Concerns for a possible simultaneity bias in equation (14) would lead to the use of instrumental variables for the unemployment rate. Equations estimated using lagged unemployment (both the Northern and the aggregate one) as instruments for current unemployment do not produce any remarkable difference in the results. In particular, when estimating specification VII, we obtain a coefficient of -.191 (s.e. .068) on Northern unemployment and a coefficient of .498 (s.e. .167) on aggregate unemployment.

As wage pressure is concerned, Table 2a shows that the aggregate unemployment rate enters almost all our equations significantly and with a positive sign, which we interpreted in terms of the unemployment rate acting as a proxy for aggregate wage pressure, above the one represented by the linear trend. Regional trends allow instead to pick up any change in region-specific wage pressure. Aggregate wage pressure, as captured by the aggregate unemployment, which rises by 4% a year between 1977 and 1991, implies in turn an average annual rise in wages across all regions of 1.7%. In other words, most of the wage pressure in Italy in the period 1977-1991 had an aggregate nature. Still, there is evidence of a faster growth of wages at the Middle and the South as compared to the North.

As the other controls are concerned, sex, age and occupation variables enter the different specifications with the expected sign. The different modalities of each of these variables turn out to be jointly significant at standard acceptance levels. While no smooth age profile can be detected, it must be emphasised that the age variable picks up both pure age (or seniority) effects as well as cohort effects, in turn due to varying demographics as well as to macroeconomic shocks affecting entrants in the labour markets at a same point in time. As the education variable is concerned, it must be noted that the coefficients turn out to be unstable across specifications and individually not significant. If any, these regressions show that there is no clear sign of returns to education in Italy.

In Table 2b we replicate the results so far presented on three regional macro-aggregates only. The general pattern is that our results on the effect of unemployment on wage determination are fairly robust to the degree of aggregation. Since 19 coefficients are estimated on 36 data points, it should not come as a surprise that the estimates are not particularly precise. In our preferred specification VII, the coefficients on the unemployment rates both at the North and nation-wide remain remarkably similar to those in Table 2a, albeit their standard errors increase.

Table 2b
Regional wage equation for Italy: 1977-1991-Three regional aggregates
(dependent variable: logarithm real regional wages)

	Specification

Variables		I	II	III	IV	V	VI	VII	VIII
ln unemployment rate	local	0.117 (.042)			0.055 (.057)	0.044 (.061)	0.069 (.086)		
	aggregate			0.223 (.068)	0.406 (.156)	0.166 (.104)		0.464 (.144)	.514 (.126)
	North		0.071 (.038)		-0.137 (.070)			-0.130 (.070)	-.153 (.049)
sex	female=1	-0.932 (.467)	-0.830 (.509)	-0.799 (.439)	-0.784 (.420)	-0.852 (.452)	-0.772 (.731)	-0.722 (.414)	.077 (.341)
age category	21-30	0.944 (.738)	1.444 (.784)	1.391 (.678)	1.109 (.677)	1.218 (.729)	1.383 (1.335)	1.328 (.637)	
	31-40	0.177 (.690)	0.650 (.712)	0.653 (.608)	0.607 (.639)	0.441 (.683)	0.816 (1.444)	0.860 (.581)	
	41-50	0.476 (.753)	1.123 (.774)	1.123 (.669)	0.874 (.708)	0.871 (.764)	1.117 (1.475)	1.185 (.627)	
	51-65	0.733 (.748)	1.204 (.774)	1.092 (.661)	1.045 (.676)	0.893 (.725)	1.342 (1.512)	1.283 (.627)	
education	primary school	-1.924 (.764)	-1.462 (.819)	-1.263 (.712v	-1.332 (.730)	-1.483 (.784)	-1.510 (.990)	-1.068 (.675)	
	junior school	-1.677 (.663)	-1.333 (.699)	-1.198 (.587)	-1.032 (.640)	-1.402 (.659)	-0.949 (.919)	-0.797 (.590)	
	high school	-1.257 (.665)	-1.137 (.726)	-0.882 (.618)	-0.578 (.649)	-1.021 (.656)	-0.361 (.968)	-0.428 (.628)	
	university	-1.034 (.623)	-0.993 (.684)	-0.919 (.586)	-0.754 (.567)	-0.977 (.599)	-0.478 (.783)	-0.694 (.562)	
occupation	white collars	0.089 (.172)	0.212 (.204)	0.212 (.169)	0.059 (.175)	0.184 (.175)	-0.330 (.487)	0.099 (.169)	.272 (.115)
	managers	0.574 (.869)	1.450 (1.035)	1.952 (.909)	1.473 (.975)	1.590 (1.050)	0.534 (1.450)	1.925 (.852)	2.45 (.661)
linear trend	aggregate	0.007 (.003)	0.008 (.004)	-0.001 (.004)	-0.009 (.007)	0.001 (.005)	0.002 (.007)	-0.011 (.007)	-.012 (.005)
	Middle	0.009 (.003)	0.008 (.003)	0.008 (.003)	0.007 (.003)	0.009 (.003)	0.007 (.004)	0.006 (.003)	.006 (.002)
	South	0.005 (.003)	0.008 (.003)	0.009 (.003)	0.006 (.003)	0.007 (.003)	0.007 (.004)	0.008 (.003)	.007 (.002)
regional effects	Middle	-0.199 (.047)	-0.143 (.043)	-0.141 (.036)	-0.154 (.046)	-0.165 (.050)	-0.151 (.060)	-0.125 (.035)	-.069 (.018)
	South	-0.339 (.062)	-0.247 (.054)	-0.236 (.046)	-0.260 (.067)	-0.275 (.072)	-0.257 (.096)	-0.212 (.045)	-.126 (.030)
constant		4.876 (.920)	4.060 (.935)	3.577 (.811)	3.456 (1.000)	4.025 (1.032)	3.874 (1.458)	2.931 (.835)	2.864 (.219)
year dummies							✓		
Adj. R2		.9087	.8905	.9181	.9278	.9159	.8968	.9281	.9173

Notes. Regressions are run on regional observation (three-fold classification: North, Middle and South). Control group: North, no education, blue collar, male, aged 18-20. Number of observations: 36. Estimation method: generalised least squares, with observations weighted by cell size. Standard errors in brackets. See notes to Table 1.

An F test on the occupation dummies in column VII leads to a rejection of the null with a p-value of 3.5%. The same cannot be said for the education and age dummies. In column VIII we re-estimate a wage function simply with controls for occupation. The coefficients stay basically unchanged but are much more precisely estimated. Overall, a point estimate of .13-.15 seems a good picture of the data.

As a last check for the robustness of our results, we have substituted in turn the unemployment rate at the Middle and at the South for the unemployment rate at the North, both in specifications VII and VIII. In neither case, these unemployment rates turn out to be significant.

If we now look at the extremely parsimonious specification VIII, we can gauge some information on wage pressure. There is clear evidence of a lower level of wage pressure at the South. Conditional on the occupational structure, wages in the South in 1977 were 12% lower than the national average. Gradually, the gap has been reducing, with wage pressure growing faster in the Middle and the South. Overall, these trends are able to explain an average annual rise in wages relative to the North in the order of .7% and .6% respectively. Blunt regressions of the wage differentials on a linear trend without further controls bear a coefficient respectively of .5% and .7% , both statistically indistinguishable from the point estimates in column VIII. This suggests that all of the changes in wage differentials are to be blamed on increased wage pressure, but this does not imply, by any means, that the latter is the only responsible for the rise in unemployment differentials.

4. The Effect of Regional Mismatch on Aggregate Unemployment

We started by observing the remarkable difference in the evolution of the unemployment rates in the three broad geographical areas of the country. While in the period 1977-1991 the dispersion of regional unemployment rates increased, along with a generalised increase in the aggregate unemployment rate, wages showed a tendency to converge. In Section 3 we provided evidence for a leading-sector model of wage determination, in which wages are set nation-wide on the basis of the unemployment rate prevailing in the North.

The next step is to evaluate the impact of the evolution of net relative labour demand shifts across areas on aggregate unemployment. As we discussed in Section 2, in a leading sector model shifts in net demand in favour of the leading sector imply, everything else being equal, an increase in aggregate unemployment. We can now measure the shifts in labour demand and labour supply in each of the areas and estimate the effect of these changes on aggregate unemployment.

Table 3 reports the average share over time of the employed population, the labour force and the wage bill in the three regional aggregates. Workers at the North account for about half of the employed population while those at the South for about one-third.

Table 3
Average shares of employment, labour force and wage bill

	Employment	Labour force	Wage bill

	n/N	l/L	α
North	.502	.484	.513
Middle	.194	.194	.200
South	.304	.322	.287

Notes. Source for employment, unemployment and labour force: *Annuario Statistico Italiano*, ISTAT, various issues. Data on wages are obtained from SHIW (see notes to table 1).

In Table 4 we report the evolution of the demand and the supply of labour in the three geographical areas, measured in terms of annual growth rates, obtained as coefficients on a linear trend of the series of logarithms between comparable points along the cycle, *ie* the two peaks of 1979 and 1988. We simply fit a linear regression estimated on the observations in 1978, 1979, 1980 1987 and 1989.

In column I we report the rate of growth of the employment share of each type of workers: relative employment decreases at the North and, to a lesser extent at the South, but increases in the Middle. When data are weighted by relative wages, this gives the growth rate in the wage bill accruing to each input ($d\ ln(a)$), reported in column II. As we discussed in Section 2, under the assumptions of constant returns to scale Cobb-Douglas technology and perfect competition in the product market, this measure is proportional to the marginal productivity of each input and represents an adequate demand index. Column III contains the rate of growth in the labour force share of each group ($d\ ln(l)$). This is our supply indicator. Finally, column IV reports the indicator of imbalance between demand and supply, defined as the difference between the rate of growth in demand and the rate of growth in supply ($d\ ln(a) - d\ ln(l)$).

Table 4
Annual growth rates in demand and supply (x 100)

	Employment (I)	Demand (II)	Supply (III)	Demand-Supply (IV)=(II)-(III)
	dln(n)	d ln(α)	d ln(l)	d ln(α) -d ln(l)
North	-.105	-.357	-.470	.113
Middle	.388	.430	.142	.288
South	-.077	.347	.614	-.267

Notes. Growth rates evaluated as coefficients of a regression of the relevant variable in logarithm on a linear trend between comparable points along the business cycle. See main text for details.

The relative wage share falls in the North with a total reduction of almost 5% over the 14-year period. Relative demand grows instead in the Middle and — to a lesser extent in the South — with an overall increase respectively of 6% and 5% from 1977 to 1991.

Differences in labour supply across regions are also noteworthy. The labour force share grows by almost 9% in the *Mezzogiorno* while it decreases by almost 7% in the North. The growth in the Middle is in the order of 2%. Although both demand and supply decrease in the North, the net outcome is a growth in net demand of about 1.5% in 14 years. Both labour demand and labour supply increase in the Middle but the former outpaces the latter and the net result in an overall increase of 4%. Net demand decreases instead the South, with an overall decrease of about 4%.

We can now assess the effect of regional imbalances between labour demand and supply on total unemployment. Table 5 reports the results of this exercise. Column I reports the actual changes in the unemployment rate in the three geographical areas and in the aggregate economy, using the same procedure for peak-to-peak changes described above. The unemployment rate in the South increases as much as almost 7 times the unemployment rate in the North, with an increase of around 1 percentage point a year.

Columns II to IV report the estimation of the effect of regional mismatch on each local unemployment rate and finally on aggregate unemployment, according to equation (13) evaluated at the starting value for the aggregate unemployment rate. Column II displays the coefficient on the mismatch term, which is simply the time average of $u_i - 1$. The mismatch indicator is obtained from Table 4 subtracting the imbalance indicator in the North (the leading sector) from the regional imbalance in the generic region i. This corresponds to our mismatch indicator reported in equation (11). Shifts in demand and supply imply an increase in unemployment at the South but a reduction at the Middle. The implied aggregate variation in unemployment is obtained by weighting the estimated changes in local unemployment by average labour force shares in each area, reported in column V. In the aggregate, regional mismatch explains an annual average rise in unemployment of about 0.7 percentage points, approximately 15 per cent of the total increase in aggregate unemployment.

Table 5
The impact of regional imbalance between demand and supply on unemployment

	Annual changes in unemployment rate du (∗100)				Labour force shares
	Actual (I)	Coefficient (u_i-1) (II)	Estimated Mismatch $d\ln(\alpha_i/\alpha_1) - d\ln(l_i/l_1)$ (III)	Coefficient ∗ mismatch (IV) =(II) ∗ (III)	(V)
North	.159	-.936	0	0	.484
Middle	.262	-.911	.175	-.159	.194
South	1.0341	-.856	-.381	.326	.322
TOTAL	.483			.074	

Notes. See notes to table 4. Numbers obtained by evaluating equations (12) and (13) on data

5. Conclusions

Starting from the observation that the secular growth in unemployment in Italy in the last two decades was mainly concentrated in the *Mezzogiorno*, we have evaluated the impact of regional imbalances between demand and supply of labour across geographical areas on aggregate unemployment.

In Section 2 we have presented a simple non-competitive model of the labour market, where wages are set on the basis of the unemployment conditions prevailing in some leading sector of the economy. Assuming, for simplicity, that the demand equation comes from a Cobb-Douglas specification of the production function and that the market for final goods is perfectly competitive, it turns out that in equilibrium sectoral imbalances only affect the unemployment rate in the secondary sector. Any demand shift in favour of the primary sector implies, *coeteris paribus*, an increase in the *aggregate* unemployment rate via an increase in the unemployment rate in the secondary sector.

In Section 3 we have estimated a regional wage equation for Italy over the period 1977-1991 using the SHIW. We reject a model of 'own-sector' wage determination and find that nation-wide wages are affected by labour market conditions prevailing in the low-unemployment area of the North. We have estimated that an increase of 10% in the unemployment rate in the North implies a decrease of about 1.3% in nation-wide real wages. We have also found evidence of increasing region-specific wage pressure at the South. This helps to rationalize the converging trends in relative wages across areas and the increasing unemployment at the South.

Building on these premises, in Section 4 we have estimated the impact of regional labour demand and supply imbalances on aggregate unemployment. It emerges that while both demand and supply decline in the North, the opposite happens in the South and the Middle. However, labour supply falls more rapidly than demand in the North and, to a larger extent, in the Middle. In the South supply grows more rapidly than the demand and on balance net demand decreases. We estimate the effect of the increasing regional imbalance being responsible for approximately 15 per cent of the total increase in aggregate unemployment in Italy over the period of observation.

Appendix A:
The case of regional mismatch

In Section 2 we discuss a two-sector model of the labour market where the technology is represented by a Cobb-Douglas production function in the two inputs. This case applies to the analysis of mismatch, say, by skill or industry. When the 'sectors' considered are regions we could introduce an equivalent constant returns to scale Cobb-Douglas aggregate utility function

$$V = \Phi Y_1^{a_1} Y_2^{a_2}, \qquad a_1 + a_2 = 1 \qquad \text{(A1)}$$

where a_{i} represents the taste parameter associated to output Y_{i} of the generic region i and Φ is a shift parameter. Under the assumption that regional labour markets are perfectly competitive, in equilibrium the marginal utility of each regional product Y, must equal its price

$$\frac{\P V}{\P Y_i} = p_i \,. \qquad \text{(A2)}$$

It follows that the parameters a_{i} bear the straightforward interpretation of aggregate expenditure shares devoted to the consumption of the good Y_{I}

$$a_i = \frac{p_i Y_i}{p_1 Y_1 + p_2 Y_2} \,. \qquad \text{(A3)}$$

Let us assume that production in each region is represented by a linear technology, with capital in the background,

$$Y_i = A_i N_i \qquad \text{(A4)}$$

where A_{i} is a technology parameter and N_{i} is employment. Under the assumption of perfectly competitive labour markets, the real wage in region i is given by

$$\frac{w_i}{p_i} = A_i \qquad \text{(A5)}$$

Substituting (A4) and (A5) into (A3), it follows

$$a_i = \frac{w_i N_i}{w_1 N_1 + w_2 N_2} \qquad \text{(A6)}$$

In equilibrium, the taste parameters in the aggregate utility function equal the share of the wage bill wage accruing to each regional labour input. Equation (A6) justifies therefore the use of a_{i} as a relative indicator of the demand for region i even in the case of regional mismatch.

Appendix B:
Three input case

Consider a Cobb-Douglas production function in three labour inputs

$$Y = AN_1^{a_1} N_2^{a_2} N_2^{a_3}, \quad a_1 + a_2 + a_3 = 1 \tag{B1}$$

where we have assumed constant returns to scale. On the wage determination side, assume that wages only respond to the labour market conditions in the leading sector 1

$$\ln w_i = z_i - g \ln u_1, \quad i = 1,2,3 \tag{B2}$$

Under perfect competition, wages equal marginal productivity

$$\begin{aligned} \ln w_1 &= \ln A + \ln a_1 + a_2 \ln \frac{N_2}{N_1} + a_3 \ln \frac{N_3}{N_1} = \\ &= \ln A + \ln a_1 - (1 - a_1)\ln(1 - u_1) + \\ &+ a_2 \ln(1 - u_2) + a_3 \ln(1 - u_3) + a_2 \ln \frac{l_2}{l_1} + a_3 \ln \frac{l_3}{l_1} \end{aligned} \tag{B3}$$

and

$$\begin{aligned} \ln w_2 &= \ln A + \ln a_2 + a_1 \ln \frac{N_1}{N_2} + a_3 \ln \frac{N_3}{N_2} = \\ &= \ln A + \ln a_2 - (1 - a_2)\ln(1 - u_2) + \\ &+ a_1 \ln(1 - u_1) + a_3 \ln(1 - u_3) + a_1 \ln \frac{l_1}{l_2} + a_3 \ln \frac{l_3}{l_2} \end{aligned} \tag{B4}$$

and similarly for input 3.

It is convenient to rewrite the labour demand for secondary sectors (2 and 3) as follows

$$\begin{aligned} \ln w_2 &= \ln A + \ln a_2 - (1 - a_2)\ln \frac{N_2}{N_1} + a_3 \ln \frac{N_3}{N_1} = \\ &= \ln A + \ln a_2 - (1 - a_2)\ln(1 - u_2) + \\ &+ a_1 \ln(1 - u_1) + a_3 \ln(1 - u_3) - (1 - a_2)\ln \frac{l_2}{l_1} + a_3 \ln \frac{l_3}{l_1} \end{aligned} \tag{B5}$$

and analogously for the third sector.

By eliminating *w* from (B2) and (B3), and differentiating, it turns out that for input 1

$$\begin{aligned} & dz_1 - \frac{g}{u_1} du_1 = d\ln A + d\ln\alpha_1 + \alpha_2 d\ln\frac{l_2}{l_1} + \alpha_3 d\ln\frac{l_3}{l_1} + \\ & + \left(\frac{1-\alpha_1}{1-u_1}\right)du_1 - \left(\frac{\alpha_2}{1-u_2}\right)du_2 - \left(\frac{\alpha_3}{1-u_3}\right)du_3 + \ln\frac{N_2}{N_1}d\alpha_2 + \ln\frac{N_3}{N_1}d\alpha_3 = \\ & = d\ln A + \ln\frac{N_2}{N_1}d\alpha_2 + \ln\frac{N_3}{N_1}d\alpha_3 - \alpha_2\left(d\ln\frac{\alpha_2}{\alpha_1} - d\ln\frac{l_2}{l_1}\right) + \\ & - \alpha_3\left(d\ln\frac{\alpha_3}{\alpha_1} - d\ln\frac{l_3}{l_1}\right) + \left(\frac{1-\alpha_1}{1-u_1}\right)du_1 - \left(\frac{\alpha_2}{1-u_2}\right)du_2 - \left(\frac{\alpha_3}{1-u_3}\right)du_3 \end{aligned} \tag{B6}$$

using the property

$$-d\ln\alpha_1 = \alpha_2 d\ln\frac{\alpha_2}{\alpha_1} + \alpha_3 d\ln\frac{\alpha_3}{\alpha_1}. \tag{B7}$$

For input 2 (but an analogous expression can be obtained for input 3)

$$\begin{aligned} & dz_2 - \frac{g}{u_1} du_1 = d\ln A + d\ln\alpha_2 - (1-\alpha_2) d\ln\frac{l_2}{l_1} + \alpha_3 d\ln\frac{l_3}{l_1} + \\ & + \left(\frac{1-\alpha_2}{1-u_2}\right)du_2 - \left(\frac{\alpha_1}{1-u_1}\right)du_1 - \left(\frac{\alpha_3}{1-u_3}\right)du_3 + \ln\frac{N_2}{N_1}d\alpha_2 + \ln\frac{N_3}{N_1}d\alpha_3 = \\ & = d\ln A + \ln\frac{N_2}{N_1}d\alpha_2 + \ln\frac{N_3}{N_1}d\alpha_3 + (1-\alpha_2)\left(d\ln\frac{\alpha_2}{\alpha_1} - d\ln\frac{l_2}{l_1}\right) + \\ & - \alpha_3\left(d\ln\frac{\alpha_3}{\alpha_1} - d\ln\frac{l_3}{l_1}\right) + \left(\frac{1-\alpha_2}{1-u_2}\right)du_2 - \left(\frac{\alpha_1}{1-u_1}\right)du_1 - \left(\frac{\alpha_3}{1-u_3}\right)du_3 \end{aligned} \tag{B8}$$

using the property

$$d\ln\alpha_2 = (1-\alpha_2) d\ln\frac{\alpha_2}{\alpha_1} - \alpha_3 d\ln\frac{\alpha_3}{\alpha_1}. \tag{B9}$$

Collecting terms, we have

$$du_1 = \left(\frac{g_1}{u_1} + \frac{1-\alpha_1}{1-u_1}\right)^{-1} \begin{pmatrix} dz_1 - d\ln A - \ln\frac{N_2}{N_1}d\alpha_2 - \ln\frac{N_3}{N_1}d\alpha_3 \\ + \alpha_2\left(d\ln\frac{\alpha_2}{\alpha_1} - d\ln\frac{l_2}{l_1}\right) + \alpha_3\left(d\ln\frac{\alpha_3}{\alpha_1} - d\ln\frac{l_3}{l_1}\right) + \\ + \frac{\alpha_2}{1-u_2}du_2 + \frac{\alpha_3}{1-u_3}du_3 \end{pmatrix} \tag{B10}$$

$$du_2 = \left(\frac{1-u_2}{1-a_2}\right)\begin{pmatrix} dz_2 - d\ln A - \ln\frac{N_2}{N_1}da_2 - \ln\frac{N_3}{N_1}da_3 + \\ -(1-a_2)\left(d\ln\frac{a_2}{a_1} - d\ln\frac{l_2}{l_1}\right) + a_3\left(d\ln\frac{a_3}{a_1} - d\ln\frac{l_3}{l_1}\right) \\ + \left(\frac{a_1}{1-u_1} - \frac{g}{u_1}\right)du_1 + \frac{a_3}{1-u_3}du_3 \end{pmatrix} \qquad \text{(B11)}$$

From which

$$H\begin{bmatrix} du_1 \\ du_2 \\ du_3 \end{bmatrix} = \begin{bmatrix} dz_1 \\ dz_2 \\ dz_3 \end{bmatrix} - \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix}p + \begin{bmatrix} a_2 \\ a_2 - 1 \\ a_2 \end{bmatrix}dmm_{21} + \begin{bmatrix} a_3 \\ a_3 \\ a_3 - 1 \end{bmatrix}dmm_{31} \qquad \text{(B12)}$$

where

$$H = \begin{bmatrix} \frac{g}{u_1} + \frac{1-a_1}{1-u_1} & \frac{-a_2}{1-u_2} & \frac{-a_3}{1-u_3} \\ \frac{g}{u_1} - \frac{a_1}{1-u_1} & \frac{1-a_2}{1-u_2} & \frac{-a_3}{1-u_3} \\ \frac{g}{u_1} - \frac{a_1}{1-u_1} & \frac{-a_2}{1-u_2} & \frac{1-a_3}{1-u_3} \end{bmatrix} \qquad \text{(B13)}$$

and

$$\begin{aligned} p &= d\ln A + \ln\frac{N_2}{N_1}da_2 + \ln\frac{N_3}{N_1}da_3 \\ dmm_{j1} &= d\ln\frac{a_j}{a_1} - d\ln\frac{l_j}{l_1} \end{aligned} \qquad \text{(B14)}$$

By inverting the matrix H

$$H^{-1} = \begin{bmatrix} \frac{a_1 u_1}{g} & \frac{a_2 u_1}{g} & \frac{a_3 u_1}{g} \\ (1-u_2)\left[\frac{a_1 u_1}{g(1-u_1)} - 1\right] & (1-u_2)\left[\frac{a_2 u_1}{g(1-u_1)} + 1\right] & \frac{a_3 u_1 (1-u_2)}{g(1-u_1)} \\ (1-u_3)\left[\frac{a_1 u_1}{g(1-u_1)} - 1\right] & \frac{a_2 u_1 (1-u_2)}{g(1-u_1)} & (1-u_3)\left[\frac{a_3 u_1}{g(1-u_1)} + 1\right] \end{bmatrix} \quad \text{(B15)}$$

and letting

$$dz = a_1 dz_1 + a_2 dz_{21} + a_3 dz_3 \quad \text{(B16)}$$

it is straightforward to derive equation (10) and (11).

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