The Female Labour Market in Italy: Evidence from Regional and Sectorial Data

Carlo Carraro*, Enrico Rettore** and Marina Schenkel***

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*University of Venezia
** University of Padova
***University of Udine

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Address for correspondence:

Prof. Carlo Carraro
Department of Economics
University of Venice
Ca' Foscari
30123 Venice, Italy
Phone: +39+41+2578285
Fax: +39+41+2578365
E-mail: ccarraro@unive.it

SUMMARY

This paper presents a micro-econometric model of the female labour market in Italy. The model is derived from a theoretical framework in which the labour market is assumed to be segmented, i.e. firms offer different labour contracts to different types of workers. In this context, female workers decide whether or not to participate in the labour market according to the contract offered, to their individual characteristics, to the regional features of the labour market, and to the economic performance of the sector in which they want to be employed. This is why the econometric model is estimated using a pseudo panel of data in which the sectional dimension is defined by the number of sectors, regions and types of female workers (age classes). The time dimension goes from 1970 to 1990. The econometric model is composed by four equations which endogenize female workers' participation decision, firms' labour demand and the features of the optimal contracts, i.e. wages and numbers of hours. The estimation results, obtained by explicitly accounting for the aggregation of individual equations, confirm the main implications of the theoretical model. In particular, hours and participation decisions crucially depend on the worker's characteristics, rather than on labour market conditions, thus leaving a minor role to the "discouraged" and "added" worker hypotheses. Moreover, the results stress the importance of quantity adjustment costs in the Italian labour market.

NON TECHNICAL SUMMARY

This work explores the recent developments in the female labour market in Italy with a general approach, integrating demand and supply decisions in a regionally and industry segmented model.
In order to achieve this, labour demand is defined both in terms of hours and employed workers, while only the participation decision is modelled on the supply side.
Solving both the worker and the firm maximisation problem, four equations have been specified for each type of female labour: hours, wages (which together define the contract which is offered by the firm), participation and demand for workers.
Each type of worker differs from the others with respect both to productivity and aversion to work. The latter variable, which can be thought mainly as disutility of work as long as working hours increase, is known to the firm. The firm therefore presents an optimal contract to the worker, i.e. a contract with the minimum wage that will induce the worker to work a given number of hours.
The profit maximisation level of labour demand and of hours for each type of worker, and hence the wages, are determined for a given product demand.
If one type of worker is more efficient than all the others, he/she will be fully employed. Demand for all the other types will depend on the former employment level.
Without adjustment costs, the number of hours and the total wages will not depend on the production level: otherwise, the econometrically estimated equation of hours will contain it.
Parameter estimation has been achieved using a completely new data base on women participation, hours and wages, disaggregated by age, region and sector. The four equations have been properly aggregated in order to match the available data. Consistent estimates of the model parameters have been subsequently obtained applying a pseudo-panel technique.
The results are broadly consistent with our expectations, as far as the variables which enter the various equations are concerned. Adjustment costs appear to be relevant, since value added is significant both in the hours and wage equations; moreover, single degree holders in the region, the variable that proxies the most efficient group of workers, does not seem to have a statistically significant impact on labour demand.

Hours, wages, and also participation seem to depend on the worker's characteristics, while in the labour demand equation, the only significant variables are wages and value added.
From the theoretical premises, and from the empirical results, the existence of some involuntary unemployment is to be expected. Firms follow an efficiency wage mechanism in wage determination, and have no incentive to lower it, because it would induce an efficiency loss.
Demographic variables seem to have a declining influence on wages and participation decisions. Educational attainments influence participation directly, with no effect on hours and wages.
In addition to wages, also labour market conditions do not have a significant effect on participation, either proxied by value added or by the employment/active ratio.
The negative trend in the hours equation, as well as the positive one in the wage equation, are consistent with the historical experience of all industrialized countries.
Coefficients have proven to be stable through time and across groups. Fixed effects are significant in the first and third equations. Differences among them are not large and assume the expected sign. Therefore we can conclude that workers' heterogeneity is captured by the model variables, and its effect is largely consistent with theoretical predictions.

CONTENTS

THE FEMALE LABOUR MARKET IN ITALY: EVIDENCE FROM REGIONAL AND SECTORIAL DATA

1. Introduction

One of the most remarkable events in the recent history of the Italian labour market was the progressive reduction of the female participation in the sixties. This trend, which seemed to contradict the experience of all other industrialised countries, was reversed in the seventies. After 1972, both female participation and unemployment grew steadily. However, regional differences in the dynamics of labour supply proved to persist, and sometimes to worsen, in the eighties (Bodo and Sestito,1991; Altieri, 1992), showing a divergence between participation rates in the North and in the South. Moreover, the pattern of labour market variables became increasingly industry specific.

The complex phenomena characterising the Italian female labour market received little attention in the theoretical and applied literature. In recent years, some studies have been carried out on female participation, both at the aggregate (Leoni, 1987; Colombino and De Stavola, 1985) and micro (Colombino, 1986; Rettore, 1989) level. However, no comprehensive analysis which integrates demand and supply decisions in a regionally and industry segmented model of the Italian female labour market has so far been proposed.

The present work aims at filling this gap by studying the recent (1970-1990) developments in the female labour market in Italy using a new, more general approach. First, both the demand and supply side are jointly modelled. Second, labour demand is defined both in terms of hours and employed workers. Third, a pseudo panel technique is proposed to account for regional and sectoral differences in the pattern of employment levels, wages and participation rates.

In order to understand the mechanisms which lye behind the empirical results, a theoretical model has been developed and specified, solving both the firm's and the worker's maximisation problem. Then the individual equations have been explicitly aggregated, taking into account industry-specific and regional effects. Parameter estimation has been achieved using a completely new data base on women participation rates, hours and wages, disaggregated by age, region and sector (Cf. Abbate, 1993).

The structure of the paper is the following: in section 2, the theoretical framework is presented. Section 3 describes the aggregation procedure and the econometric technique which has been implemented in order to obtain the results presented in section 4. Finally, section 5 summarises the main achievements of our work.

2. A Theoretical Framework for a Segmented Female Labour Market

This section describes the theoretical framework that has been used to define the estimated equations of the Italian female labour market. This framework will help us determining both the variables to be introduced into the model, and the expected sign of the equation coefficients. Moreover, it will clarify the relationship between the model variables, and the interdependence between the main phenomena characterising the female labour market.

2.1 Basic Assumptions

The basic assumption of this theoretical framework is that the female labour market is a segmented market in which different types of female workers offer their labour services. A supply function is therefore to be determined for each type of female labour. At the same time, a demand function for each type of female labour will be derived from the firm's optimisation problem.

The second important characteristic of the theoretical framework is that firms' labour demand is decomposed into a demand for hours and a demand for heads. This is particularly important in the female labour market in which seasonal and part-time labour demand and supply are quite relevant. Accordingly, firms demand both the number of female workers they want to hire, their type, and the number of hours that each worker belonging to a given type is asked to work.

On the supply side, a given type i worker decides whether or not to accept the contract offered by the firm. The contract is defined by the wage (per period of time) and the number of hours (to be worked in the same period of time). Hence, the labour supply function is defined by the participation decision of all available female workers.

Finally, it is important to emphasize that each type i worker differs from type j workers both because her productivity may be different and because her aversion to a large number of working hours (per unit of time) may also be different. This aims at capturing two stylised facts: (i) female workers with family responsibilities are strongly adverse to contracts specifying an excessive number of daily working hours; (ii) female workers, particularly in Southern Italy, are demanded for seasonal jobs. At the same time, we want to account for differences in education and skill that affect labour productivity.

2.2 Theoretical Model and Equilibrium Conditions

Let us provide a more formal description of the above assumptions. Let $u_i(c_i,e_i)$ be type i worker's utility function, where c_i denotes consumption and e_i represents the worker's disutility to effort. In order to simplify the presentation, let us consider a separable utility function: $u_i(c_i,e_i) = c_i - e_i(x_i) \geq 0$, where x_i is the number of hours that the worker accept to work and $e_i(x_i)$ denotes the effort aversion function. Let us assume $e_i(x_i)$ to be continuous, twice differentiable, and with positive first and second derivatives.

Notice that each type of worker is defined by a specific effort aversion function. This is therefore the first characteristic that differentiates female workers.[1]

The budget constraint is $w_i = c_i$ (the price of the consumption good is normalized to one), where w_i denotes the total wage (income) earned by the worker per period of time. Hence, the utility function can be written as: $u_i(c_i, e_i) = w_i - e_i(x_i)$. Let u_i^o be type i worker's expected reservation utility. If a given firm offers a contract (w_i, x_i) to each type of worker, this worker accepts the contract (i.e. she decides to work), if and only if:

$$(1a) \qquad w_i \geq e_i(x_i) + u_i^o \geq 0 \qquad i=1,2, \ldots, n$$

where n is the number of different types of female workers existing on the market. Hence, type i worker's labour supply decision is defined by inequality (1a). Notice that, under complete information, firms' cost minimization process leads them to offer the minimum wage that can induce a worker to accept the contract. This implies:

$$(1b) \qquad w_i = e_i(x_i) + u_i^o \qquad i=1,2, \ldots, n.$$

Let us now specify the other characteristic of each type of workers. As previously said, different levels of education and skill imply that productivity differs across workers. In particular, let y_i be type i worker's production per unit of time. This production level is related to the number of hours x_i through the productivity function $f_i(x_i)$, i=1,2,...n, i.e.:

$$(2) \qquad y_i = f_i(x_i) \geq 0 \qquad i=1, \ldots, n$$

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[1] A similar model with heterogeneous preferences has been used in Killingsworth (1987).

For a given number of hours x, the inequality $f_i(x) > f_j(x)$ implies that a type i worker is more productive than a type j worker, $i \neq j$.

Let us assume $f_i(x_i)$ to be continuous and twice differentiable. Moreover, marginal productivity (assumed to be positive) is first increasing and then decreasing. In words, we assume that there exists a threshold number of hours above which marginal productivity begins to decrease. This threshold is specific of each type of workers and, jointly with the worker-specific production function $f_i(x_i)$, contributes to define the second characteristic which differentiates each type of female worker.

Let us now determine the optimal number of hours which defines the contract offered by firms. Let the production level of a representative firm be:

$$(3) \qquad Y = \sum_{i=1}^{n} y_i L_i$$

where Y is total production, y_i is type i worker's production, and L_i is the total number of type i workers employed by the firm. In order to define the structure of the contracts offered by firms, and their labour demand, let us define the profit function of a representative firm:

$$(4) \qquad \Pi = R(Y) - \sum_{i=1}^{n} [w_i L_i + C_i(x_i, L_i)] =$$

$$= R(\sum_{i=1}^{n} y_i L_i) - \sum_{i=1}^{n} \{[e_i(x_i) + u_i^o] L_i + C_i(x_i, L_i)\}$$

where R(Y) is the firm's revenue function, L_i denotes the employment level of type i workers, and $C_i(x_i, L_i)$ is the cost of adjusting the number of hours and the employment levels of each type of workers. The firm's decision variables are w_i, x_i and L_i, $i=1,2, \ldots ,n$.

In order to determine the profit-maximizing levels of these variables, let us differentiate the function Π with respect to x_i and

L_i. This yields:

(5) $$\partial\Pi/\partial x_i = [\mu f_i'(x_i) - e_i'(x_i)]L_i - \partial C_i/\partial x_i = 0$$

$$\Rightarrow \quad [\mu - e_i'(x_i)/f_i'(x_i)]f_i'(x_i)L_i = C_{xi}(x_i,L_i)$$

where $\mu = \mu(Y)$ denotes the firm's marginal revenue and $C_{xi}(x_i,L_i) = \partial C_i/\partial x_i$. Moreover:

(6) $$\partial\Pi/\partial L_i = [\mu f_i(x_i) - e_i(x_i)] - \partial C_i/\partial L_i = 0$$

$$\Rightarrow \quad [\mu - e_i(x_i)/f_i(x_i)]f_i(x_i) = C_{Li}(x_i,L_i)$$

where $C_{Li}(x_i,L_i) = \partial C_i/\partial L_i$.

Finally, the firm's optimal production level is determined by the condition:

(7) $$\mu(Y) = MC(x,L)$$

(i.e. marginal revenue equal marginal cost), where MC(.) is the marginal cost function of the representative firm, and $x = (x_1 \dots x_n)$, $L = (L_1 \dots L_n)$. Notice that the specification of the marginal revenue function depends on market structure.

Assuming an interior solution, equations (5)(6)(7) determines labour demand for each type of workers L_i, $i=1,\dots,n$, and the firm's desired number of hours x_i, $i=1,\dots,n$. Then, the wage w_i, $i=1,\dots,n$, is determined by (1b).

The objective of the estimation procedure is to quantify the economic relationships defined by the first-order conditions (5)(6) and by the participation constraint $w_i = e_i(x_i) + u_i^o$. Therefore, for a given Y, these equations can be written as follows:

(8a) $$L_i = L_i(w_i, Y, \theta)$$

(8b) $$x_i = x_i(w_i, Y, \theta)$$

(8c) $$w_i = w_i(x_i, Y, \theta)$$

where θ is a vector containing proxies for type i workers' effort aversion, productivity, and expected reservation utility (or reservation wage).[2] Notice that two proxies of type i worker's reservation wage can be her non labour income and her probability of being employed. The lower this probability, the lower the expected reservation wage.[3]

It is however possible that an interior solution does not exist. This is the case if either a type of workers is not employed or if it is fully employed (the demand for that type of workers exceeds supply). This latter situation arises when, for example, one type of workers is more efficient than all the other ones, because its productivity is larger and its effort aversion is lower than those of all other types of workers. In this case, labour demand for types whose demand does not exceed supply depends on the employment level of the fully employed type of worker.[4] Suppose type n is fully employed. Then labour demand would be:

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[2] As the utility function is defined in wage units, the reservation utility coincides with the reservation wage.

[3] Re-call that, given the structure of the model, the reservation wage affects the participation decision rather than the decision on the number of hours to supply. This latter variable, as well as the number of workers to employ, belongs to the set of firm's decision variables.

[4] This result is shown in Carraro-Soubeyran (1996) for a model in which the firm optimally chooses the number and type of production plants and their utilization rate. In order to transpose their result to the model of the labour market discussed in this paper, it is sufficient to replace different types of plants with different types of workers, and the utilization rate with the number of hours.

(9a) $$L_i = L_i(w_i, Y, \theta, N_n) \qquad i=1, \ldots, n-1$$

(9b) $$L_n = N_n$$

where N_n denotes the total availability of type n workers. The presence of fully employed types of workers in the female labour market is therefore a testable proposition because it introduces the quantity of type n workers in the other labour demand equations.

It is also important to notice that, were the adjustment cost $C_i(x_i, L_i)$ equal to zero, the number of hours x_i and the wage w_i would not depend on the production level Y. In this case, we would have (see eqs. (6) and (7)):

(10) $$e_i(x_i)/f_i(x_i) = e'_i(x_i)/f'_i(x_i)$$

which determines x_i independently of Y and w_i. Then, w_i is determined by (1b) as a function of x_i. In words, w_i and x_i depend on the technology and on workers' tastes thus becoming independent of market conditions. Inverting the production function $f_i(x_i)$ and defining $d_i(y_i) = e_i[f_i^{-1}(y_i)]$, the equilibrium condition (10) can be re-written as:

(11) $$d_i(y_i)/y_i = d'_i(y_i)$$

where $d_i(y_i)$ is type i worker's disutility to produce y_i, and $d'_i(y_i)$ is its first derivative. Hence (11) states that the average and marginal disutility to produce are equal at the equilibrium. This determines an interior solution for y_i and x_i only if the function $d'_i(y_i)$ is first increasing and then decreasing. This condition is guaranteed by the assumption that marginal productivity is first increasing and then decreasing.

Therefore, if the econometrically estimated equation which captures the dynamics of the number of working hours does not depend on the aggregate production level (another testable proposition), then adjustment costs are likely to be statistically not significant.

2.3 Model Predictions

Let us provide a more detailed description of the model predictions. In practice, the econometric estimation has been performed using a linearised form of equations (8).[5] The structure of the econometric equations, the aggregation procedure and the estimation method are described in section 3. Here, using the model structure previously described, we would like to discuss the expected sign of the econometric model coefficients.

In all equations, the dependent variables (employment, hours, wage) are affected by the level of worker specific variables, such as productivity, effort aversion, and the reservation wage. These variables enter into the model through the optimal wage contract that firms offer to each worker. On the one hand, the contract, in order to be accepted, has to meet a worker's requirements in terms of hours and minimum (reservation) wage. On the other hand, firms want to offer a contract which corresponds to the worker efficiency (in terms of production per unit of time).

For these reasons, the hourly wage offered to a given worker is expected to be an increasing function of the worker's productivity and reservation wage, whereas it is a decreasing function of her effort aversion. The contract, however, is defined by two variables, wages and hours. As previously seen, the convexity of the effort aversion function implies that the hourly wage is an increasing

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[5] As shown below, in section 4, we have also tested for the possibility that N_n enters the labour demand equation as in (9).

function of the number of hours.

This latter variable, which is set by the firm alongside with employment levels, decreases with the wage necessary to induce the worker to accept the contract. Moreover, the number of hours demanded by the firm increases with workers' productivity, whereas it decreases when her effort aversion and minimum expected wage increase.

Besides worker specific variables, the contract may also depend on economy specific variables. In particular, we expect the behaviour of hours and wages to be procyclical, even if the efficiency-wage features of the model imply that firms adjust more easily employment levels than hours when market demand changes. This conclusion, however, crucially depends on the function $C_i(.)$ which defines the cost of adjusting hours and employment levels for each type of workers. Hence, the relative impact of market demand on hours and employment levels is an empirical matter, rather than a theoretical one. As stated at the end of the previous section, if demand affects only employment, then adjustment costs may be considered as negligible.

The last variable which belongs to the firm's set of decision variables is the level of employment (number of employed workers). Here the model is quite standard, and worker specific variables are unlikely to play a crucial role. As it is obvious, labour demand for a specific type of worker is inversely related to the hourly wage and positively related to total production (market demand, at the equilibrium). The only original features is the constraint on the demand for the most efficient type of workers. If the firm is rationed on its demand for most efficient workers, the level of this latter variable affects the demand for all other types of workers, as the rationed demand spills over the other ones. This is also a testable proposition.

The last equation to be estimated is the one describing female workers' participation decision. Using condition (1a), the decision to participate to the labour market (a binary variable) depends again on worker specific variables (productivity, effort aversion, reservation wage) and on the characteristics of the contract offered by the firm (the number of hours and the wage). The participation rate is expected to increase with the wage and to decrease with the number of hours, whereas workers with lower effort aversion and reservation wage are ready to accept contracts which are less favourable (i.e. their participation rate is higher). Finally, an increase of productivity should reduce a worker's participation rate as it implies higher wages (the supply curve is backward bending).

The equations just described pertain to the single worker and firm. Given the nature of the data set described in the Introduction, they need to be aggregated in order to match the information contained into the available data. The next section will describe the aggregation procedure and the pseudo-panel estimation method that have been used to provide a quantitative assessment of the equations describing the behaviour of the Italian female labour market.

3. Aggregation and econometric estimation method

3.1. Definitions

Let the equation describing the variable y_{it}, representing the outcome of the i-th agent behaviour at time t, be:

(12) $$y_{it} = x'_{it}\,\alpha_1 + z'_t\,\alpha_2 + \varepsilon_{it},$$

$i=1,\dots,n_t$, $t=1,\dots,T$; x_{it} are k_x time-varying observable characteristics of the agent, whereas z_t are k_z time-varying observable characteristics of the economic environment; it is assumed that ε_{it} is an innovation for each i, its mean being individual specific and time invariant, $E\{\varepsilon_{it}\} = u_i$.

Let information on individuals be unavailable to the analyst so that standard inference for fixed effect panel data models, as in Hsiao (1986), cannot be used. Instead, values of y_{it} and x_{it} aggregated by groups are available. Let G_{jt} be the set made up by all sample units exhibiting the j-th of J possible outcomes from a discrete random variable, at time t. Let $n_{(j)t}$ be the number of sample units belonging to G_{jt}. We assume that $y_{(j)t}=\sum_{i\in G_{jt}} y_{it}$, $x_{(j)t}=\sum_{i\in G_{jt}} x_{it}$ and $n_{(j)t}$, $t=1,T$, $j=1,J$, are observable (here and in the sequel a bracketed index is used to denote groups).[6]

Deaton (1985) shows how to solve the inference problem if cross-sections of agents in different time periods are available, with no overlapping among cross-sections from different time periods. In his set-up, aggregation is needed to control for the possible correlation between the unobservable and observable individual heterogeneity, but clearly the level of aggregation out of the researcher control is the mildest one (see also Verbeek, 1992 and Moffit, 1993). By contrast, for the set of data on the female labour market in Italy that we are going to use the aggregation procedure with which the data have been obtained is out of the researcher control. Therefore, the estimation procedure has to be slightly modified as follows.

Equation (12) written for the j-th group sample mean becomes:

$$\bar{y}_{(j)t} = \bar{x}'_{(j)t}\,\alpha_1 + z'_t\,\alpha_2 + \bar{\varepsilon}_{(j)t} \qquad (13)$$

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[6] For instance, such situation arises if, to preserve confidentiality, information is delivered by the data producer only after having aggregated, possibly mildly, individual data. Clearly, the researcher is not free to choose the aggregation criterion: he can only choose among the grouping criteria allowed by the available aggregation.

with $E\{\bar{\varepsilon}_{(j)t}\} = u_{(j)t}$ and $var\{\bar{\varepsilon}_{(j)t}\}=\sigma^2_\varepsilon/n_{(j)t}$; z_t in equations (12) and (13) is exactly the same because the economic environment is assumed to be the same for all individuals.

$E\{\bar{\varepsilon}_{(j)t}\} = u_{(j)t}$ is the mean of the innovation for those units belonging to the j-th group at time t. If groups are defined to be cohorts (invariant over time at least in the sample period as in Deaton, 1985), then $u_{(j)t} = u_{(j)}$, which is time invariant because the T sub-samples made up by the units belonging to the j-th group in the T periods are drawn by definition from the same sub-population.[7]

Given the above assumptions, let us describe how consistent estimates of the model parameters can be obtained.

3.2. Consistent estimation via aggregated data.

Let g_{it} be a J-dimensional column vector whose j-th element is equal to one if and only if the i-th agent at time t belongs to the j-th group, zero otherwise; let $\gamma_{(j)} = E\{u_{(j)t}\}$ be the mean over the T time periods of the time-varying, j-th group specific effect. Then, consider the following decomposition of ε_{it}:

(14) $$\varepsilon_{it} = \gamma' g_{it} + \eta_{it},$$

γ is a J-dimensional vector whose j-th element is $\gamma_{(j)}$; η_{it} is an individual-specific, time-specific deviation from the group mean $\gamma' g_{it}$.

As for the mean value of η_{it} conditional on belonging to the j-th

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[7] If groups are not defined to be cohorts, $u_{(j)t}$ varies over time because sample units in the j-th group at time t and sample units in the same group at time s, in general, are drawn from different sub-populations.

group at time t, it is obtained as the difference between the j-th group, time t specific effect $u_{(j)t}$ and the j-th group mean specific effect $\gamma_{(j)}$:

$$(15) \qquad E\{\eta_{it}|g_{it}\} = (u_{(.)t}-\gamma)'g_{it}$$

($u_{(.)t}$ is a column vector obtained by stacking the $u_{(j)}$'s). In general, it is different from zero and time-varying, because even conditioning on observables, individuals belonging to a given group in different time periods need not be equal on the average.

A convenient identifiability restriction arises if $E\{\eta_{it}|g_{it}\}$ can be maintained to be zero, that is if $u_{(j)t}$ can be maintained to be time invariant, j=1,...,J. This assumption implies:

$$(16) \qquad E\{\eta_{it}g_{it}\} = E\{E\{\eta_{it}|g_{it}\}g_{it}\} = 0$$

for all i and t. The sample counterpart of condition (16) is:

$$(17) \qquad \sum_{i=1}^{n_t}(y_{it}- x'_{it}\ \alpha_1 - z'_t\ \alpha_2 - \gamma' g_{it})g_{it}/n_t= 0, \qquad t=1,...,T$$

which defines JT estimating equations linear in the k_x+k_z+J unknown parameters.[8] The implied estimator is feasible because the involved sample moments depend on micro-data only through $y_{(j)t}$, $x_{(j)t}$, and $n_{(j)t}$, that is values of y_{it} and x_{it} aggregated by groups, group dimensions, and the economic environment characteristics z_t. Asymptotic theory for this estimator requires that sample sizes for each group in each time period goes to infinity, but does not require T to go to infinity.

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[8] An detailed discussion of the properties of the so called analog estimation method is in Manski (1988).

Equation (17) stresses the Instrumental Variables nature of the estimation procedure, with group dummies at each time acting as instruments. Among other things, equation (17) allows to state that $JT \geq k_x+k_z+J$ is necessary for identifiability.[9] Note that the identifying restrictions do <u>not involve any exogeneity assumption about x_{it} and z_t</u> with respect to ε_{it}.

An explicit form for the estimator implied by (17) is easily obtained. Let $Y_t = [y_{it}]$, $X_t = [x_{it}']$, $G_t = [g_{it}']$ and $Z_t = [z_t']$ be n_t-rows matrices whose i-th rows are y_{it}, x_{it}', g_{it}' and z_t', respectively. Equation (17) in matrix notation becomes:

$$(18) \qquad G_t' \; E_t(\alpha_1,\alpha_2,\gamma) = G_t' \; (Y_t - X_t\alpha_1 - Z_t\alpha_2 - G_t\gamma) = 0, \qquad t=1,\ldots,T.$$

It is a well known result in the Instrumental Variable literature that when the number of instruments exceeds the number of parameters to be estimated, the optimal estimator is obtained from the following minimization problem:

$$(19) \qquad \min_{\alpha_1,\alpha_2,\gamma} \sum_{t=1}^{T} E_t(\alpha_1,\alpha_2,\gamma)' \; G_t(G_t' \; G_t)^{-1} \; G_t' \; E_t(\alpha_1,\alpha_2,\gamma).$$

By further defining G°, X°, Z°, and Y° as the matrices obtained by stacking G_t, X_t, Z_t, and Y_t respectively, $t=1,\ldots,T$, W° as $[X^\circ \vdots Z^\circ \vdots G^\circ]$ and A° as the block diagonal matrix whose t-th element on the diagonal is G_t, the estimator is defined as:

$$(20) \qquad \begin{bmatrix} \hat{\alpha}_1 \\ \hat{\alpha}_2 \\ \hat{\gamma} \end{bmatrix} = (W^{\circ\prime} A^\circ (A^{\circ\prime} A^\circ)^{-1} A^{\circ\prime} W^\circ)^{-1} W^{\circ\prime} A^\circ (A^{\circ\prime} A^\circ)^{-1} A^{\circ\prime} Y^\circ.$$

Following the preceding discussion, if membership in a certain cohort

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[9] However, see Moffitt (1993) for a more parsimonious parametrization of the model.

at time t implies membership in the same cohort at all time periods, then the mean value of η_{it} conditional on belonging to group j at time t does not depend on t, i.e. $E(u_{(.)t}-\gamma) = 0$, $t=1,\ldots,T$. As a consequence, condition (16) is automatically satisfied. Clearly, a major advantage of grouping by cohorts is that consistency follows by construction, rather than relying on questionable identifying restrictions.

3.3. Endogenous explanatory variables

Let some of the explanatory variables x_{it} be correlated with ε_{it}, for instance as a consequence of equation (12) being a member of a system of simultaneous equations defining (some of) the variables x_{it} as endogenous. A major implication of the discussion in section 3.2 is that the estimator defined by the system of equations (17) is still consistent. This result is a direct consequence of assumption (16), qualifying the grouping criterion as exogenous with respect to ε_{it}.

It is worth noting, however, that a likely source of endogeneity bias is ignored in model (12), and is not accounted for by grouping individuals, namely the presence of an unobservable time-specific individual-invariant effect. To illustrate this point suppose a time specific, individual invariant component is added to the mean of ε_{it}, $E\{\varepsilon_{it}\} = u_i + \omega_t$. To simplify the analysis, let the researcher be able to aggregate by cohorts. Conditioning on cohort membership at time t, the mean value of ε_{it} becomes:

(21) $$E\{\varepsilon_{it}|g_{it}\} = u_{(.)}'g_{it} + \omega_t,$$

and the mean value of η_{it} becomes:

(22) $$E\{\eta_{it}|g_{it}\} = \omega_t,$$

instead of being zero as in section 3.2. As a consequence, the mean of η_{it} conditional on cohorts membership no longer supplies an identifiability restriction from which to recover an estimating equation analogous to (17).

In our model we do allow for macro shocks. Therefore, to recover an estimate, we exploit orthogonality conditions between ω_t and the predetermined explanatory variables. Note however that, as compared to the estimator defined in (17), the asymptotic theory for this new estimator requires also T to go to infinity.

3.4. Specification of dynamics and diagnostics.

Each equation in the model after aggregation looks like (13), with $E(\bar{\varepsilon}_{(j)t}) = u_{(j)t} + \omega_t$, and $u_{(j)t}$ time-invariant as a consequence of our identifying restrictions.

However, two further problems had to be solved. The first one concerns the seasonality of all time series, which led us to transform the variables through the usual $(1-\rho L^4)$ filter, where L is the lag operator. The second problem arises because time series are cointegrated.

In the case of cointegration, the standard estimation approach is the Engle-Granger two-step method proposed by Engle-Granger (1987). However, there is a good deal of Montecarlo evidence that it often does not work very well in finite samples (see Banerjee-Dolado-Hendry-Smith, 1986; Banerjee-Dolado-Galbraith-Hendry, 1993). As suggested in Davidson-Mackinnon (1993), the simplest alternative to the Engle Granger two-step procedure is to estimate a model in which the first difference of the dependent variable is regressed against the lagged dependent variable, the lagged explanatory variables, their first differences and the variables which are not cointegrated (including a constant). This regression enables us to perform a correct inference on the key parameters of the model (see Sims-Stock-Watson, 1990).[10]

Estimating the regression just described by OLS is equivalent to estimating the single equation ECM, in which the unknown long-run coefficients appear, by nonlinear least squares. The fits of both equations would be the same, as well be the estimates of the parameters which appear in both, but the results of Banerjee-Dolado-Hendry-Smith (1986) suggest that the procedure that we are going to use provides better estimates of the long-run relationship between the dependent and explanatory variables.

The possibility to apply cointegration methods to panel data has been studied by Pesaran-Smith (1995) that emphasises the possibility of aggregation biases. Here we solve the problem using the suggestion provided in Hall-Urga (1996) which shows that no bias arises if a common trend characterises the explanatory variables. This is a condition that we assume in order to perform correct inference on the model parameters.

As for checking the adequacy of the specification, we tested for the across groups invariance of the regression coefficients. To test the invariance hypothesis, we considered the regression of the residuals from the estimation of the model under the maintained hypothesis on each of the included explanatory variables, in each of the J groups: estimates significantly different from zero in such auxiliary regressions detect which explanatory variables have different effects on the dependent variable according to group membership.

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[10] Although one can make inferences about the individual coefficients of this equation in the usual way, one must be careful if one tries to do anything else (Davidson-Mc Kinnon, 1993). For example, the long run relationship between the dependent variable and the explanatory variables can well be derived from the coefficients of the equations just described, but standard asymptotic theory would not apply to the parameters thus computed.

Most empirical evidence support our maintained hypothesis. We recorded few rejections of the null for the wage equation. Since estimating such equation under the alternative did not yield any qualitatively appreciable difference, to ease exposition we only present results obtained under the null.

4. Econometric Specification and Results

4.1 Model Specification

The empirical specification of the model follows from the theoretical framework presented in section 2. Let us briefly describe here which variables have actually been used in the empirical model. A precise definition of all variables is provided in the Appendix.

In the equation which define the number of hours worked by each type of female worker, the dependent variable is total hours worked by employed women in the Region, also disaggregated by sector and age, i. e. the groups of sample units are formed crossing geographical areas (North, Center, South), economic sectors (Agriculture, Manufacturing, Services, Public Administration) and age classes (14-29; 30-39; 40-49; 50-59; above 60). The explanatory variables in the hours equation are as follows: women who have completed primary school, secondary school and university degree holders, share of married women in the group, average non-labour income, value added and a linear trend. With the exception of the last two, these variables identify the workers average characteristics in the group (the $x_{(j)t}$ variables). The first two variables are proxies for group-specific productivity, married woman identifies a characteristic which is assumed to increase the worker's aversion for a large number of working hours, whereas non-labour income proxies the level of the reservation utility.

Value added has been introduced to capture sectorial economic performances (the variable z_t), whereas a linear trend captures long term dynamic effects (e.g the long term reduction of working hours induced by technical progress).

The average number of children was not included in the final specification, because this variable was not statistically significant, in addition of being a poor proxy of mothers' (and other relatives') family burden. The reason is that we could not observe the average number of children of employed women disaggregated by region, sector and age, but rather the average number of children in the region, thus loosing the sectorial and age class variability.[11]

In the wage equation, the dependent variable is the average hourly wage of employed women in the region, disaggregated by age and sector. Groups are therefore formed as in the hours equation. The $x_{(j)t}$ variables in the wage equation are the share of women who attended at most the primary school, those with a secondary and university degree, and the average non-labour income. The share of married women has been replaced by the number of hours. Children have gain been excluded. The z_t variables are the value added (disaggregated again per sector and region) and the probability of being employed. A linear trend was included to account for long term productivity growth.

A variable which was excluded after having proved not to be significant is the ratio between employed and active women, which was thought to reflect the probability of receiving a job offer.[12]

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[11] Due to the aggregation procedure, also the number of employed women in each group, multiplied by the trend and the fixed effect, appears in the estimated equation.

[12] As in the hours equation, and for the same reason, the employed women in each group enter the specification multiplied by the trend and the fixed effect.

In the equation which models women's decision to participate in the labour market, the dependent variable is active women disaggregated by age and region. In the final specification, the following variables have been retained: hours, wage, probability of being employed, non-labour income, primary school leavers, degree holders and married women in each group. Value added and trend were excluded after having proved not to be significant.[13]

The final equation describes labour demand. The dependent variable is employed women in the region. Unmarried university degree holders, aged between 30 and 49, have been chosen as the most efficient group of workers, because they exhibit the highest and most stable employed/population ratio (similar to the male population one). This variable has been used to test for the presence of rationing in the demand side of the model.

The other variables which have been included in the final specification are value added and wage. Value added in this equation also proxies the number of firms which, according to the aggregation procedure, multiplies the number of efficient workers and the fixed effect.

In all equations, wage and non-labour income have been considered gross of taxes because no group-specific tax rate was available and applying a single rate to the average income in each group would have result in a growing bias, the more progressive the rate of taxation is. All money variables have been deflated by the consumers' price index (base: 1985.III=100).

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[13] Again, aggregation leads to introduce two additional variables in the estimated model. The sub aggregate which multiplies the probability of being employed and the fixed effect is women who reside in the region.

4.2. Results

Let us present our estimation results. In Table 1, the long term effects of a unit variation of any explanatory variable, all the other variables being constant, are presented. These coefficients are the parameters of the long-run relationship between dependent and explanatory variables in each equation. They are obtained from the dynamic regression described in section 3.4. Notice that standard errors are not reported. As claimed in Davidson-McKinnon (1993), it is possible to perform correct inference on the parameters of our estimated regression, but not on their linear or nonlinear transformations. In our case, every long-run elasticity is the ratio between the coefficient of a given explanatory variable at lag zero and the coefficient of the lagged dependent variable. Hence, standard errors are not correct, even if the parameters are consistently estimated (Davidson-McKinnon, 1993). This is why standard errors are not reported in Table 1. However, in the discussion we will account for the fact that some long-run elasticities are likely to be statistically non significant because the coefficients related to the respective explanatory variable in the dynamic regression are all statistically non significant.

Since the macro model has been obtained from the micro one by aggregation, the results can be interpreted from a micro point of view. For instance, in the hours equation, the effect of a unit variation of the variable "university degree holders", is the differential variation of the hours worked in a week between a secondary school and a University degree holder. According to our results, in the long run University degree holders would be expected to work 12.43 hours per week less than secondary degree holders (see Table 1, first column). Notice, however, that the variables related to education are unlikely to be significant in this equation. Indeed, the coefficients in the dynamic equation are as follows:

Variable	Coefficient	P-value
Obb	-9.051	0.226
Obb(-1)	7.163	0.068
Obb(-4)	-0.820	0.803
Obb(-5)	1.490	0.208
Lau	-7.122	0.346
Lau(-1)	-4.171	0.245
Lau(-4)	4.025	0.198
Lau(-5)	6.540	0.094

where Obb denotes the dummy for workers with a single degree only, whereas Lau denotes the dummy for University degree holders. The F test also leads us to accept the hypothesis that the coefficients for these two variables are jointly non significant. The education variables are also non significant in the wage equation, whereas they are significant and with the right sign in the participation equation. In this latter equation, women with a single degree have a participation probability which is 26.3% lower than secondary degree holders in the long run. By contrast, University degree holders have a participation probability which is 46.11% higher (see Table 1, third column). As previously explained, education variables were not introduced in the labour demand equation.

All other variables in the hours equation have the right sign and are likely to be statistically significant. In particular, the fact of being married, or an increase of the reservation wage induced by a rise in non-labour income, reduce the number of hours in the contract that firms and workers agree upon (with respect to the contract signed by unmarried, secondary degree holders). Married workers work 6.42 hours per week less than the unmarried ones, whereas an additional million liras of non labour income is likely to reduce by 0.479 hours per week the number of hours in the labour contract.

Finally, the number of hours is shown to be procyclical, as in most aggregate models of the labour market.

As far as the wage equation is concerned, results are less satisfactory. The negative sign of the coefficient associated to the number of hours is inconsistent with the model predictions. The explanation that can be offered refers to a peculiar feature of our sample which contains mainly public school teachers in the upper segment of female workers. As public school teachers work a lower number of hours and receive a higher hourly wage than other workers, this could explain the negative sign of the number of hours. A second explanation is that the data set does not provide us with a satisfactory proxy for workers' productivity. As previously discussed, the education variables are unlikely to be significant in the hours equation. Hence, the effect of a proxy for productivity is missing. This implies that the number of hours in the wage equation may also capture a productivity effect (low productivity workers work more hours than the other ones). Moreover, the theoretical model suggests that a lower productivity implies a lower wage. As a consequence, the number of hours may be negatively related to the wage.

Also non-labour income does not show the expected sign. Indeed, in the theoretical model there are two effects that may be captured by the presence of non labour income in the wage equation. The first effect is that a lower non labour income proxies a lower reservation wage and therefore reduces the (equilibrium) wage. The second effect associates non labour income with effort aversion. The lower the first, the lower the latter and therefore, according to the theoretical model, the lower the equilibrium wage (other things being equal). However, the long-run elasticity of non labour income in the wage equation is unlikely to be significant. The coefficients in the estimated dynamic equations are:

Variable	Coefficient	P-value
Redn	-0.000036	0.038
Redn(-1)	0.000021	0.238
Redn(-4)	0.000031	0.044
Redn(-5)	-0.000028	0.063

where Redn denoes non labour income.

As far as the other variables are concerned, our results show that wages are also procyclical, as they increase with value added, our proxy for business cycles. It is important to stress that the presence of this variable in the wage equation, as well as in the hours equation, enables us not to reject the hypothesis that adjustment costs are quite relevant in the Italian labour market. As previously explained, the theoretical model predicts that the features of the equilibrium contracts, i.e. wages and hours, only depend on the worker's characteristics (productivity and effort aversion) unless adjustment costs are relevant. The empirical evidence seems to confirm that adjustment costs are indeed a relevant feature of the Italian female labour market.

Finally, the last explanatory variable is the employment likelihood. Its negative sign is in contrast with the theoretical expectation, but is consistent with the negative sign found for non-labour income (both variables proxy the reservation wage).

In the equation which captures workers' participation decision there are several variables which are likely to be statistically significant. Beside the two education variables discussed above, there is the dummy for married women, who have a participation probability 9.5% lower than other workers (see the third column of Table 1).

An increase of one million liras in non labour income reduces the participation probability by 1.72%, whereas a contract with 10 additional working hour per week reduces the participation probability by 0.22%. Therefore, the number of hours does not seem to have a major impact on workers' participation decision. A reduction of the employment probability reduces the participation probability thus providing support to the "discouraged worker" hypothesis. However, the effect is quite small (0.02%). Finally, as expected, a higher wage increases the participation probability.

The last equation is the labour demand equation. Notice that a wage reduction increases labour demand, which is also higher during cyclical booms of economic activity (as measured by value added). The most relevant information is provided by the last coefficient which relates the number of University degree holders in the region, the variable that proxies the most efficient group of workers, to labour demand. This coefficient provides a test of one proposition of the model, i.e. that when the solution is interior, labour demand cannot depend on the employment level of the efficient types of workers. This coefficient (0.1981 in Table 1) does not seem to be statistically significant. The estimated parameters in the dynamic equation are:

Variable	Coefficient	P-value
Eff	-0.0010	0.989
Eff(-1)	0.073	0.259
Eff(-4)	-0.121	0.078
Eff(-5)	0.0022	0.975

Therefore, the labour market dynamics is not described by the interior equilibrium of the model, but the reason is the presence of adjustment costs, as previously shown, rather than the existence of a "mismatch" problem (i.e. some types of workers are fully employed, whereas others are unemployed). Our empirical evidence seem to support the conclusion that unemployment exists in all groups of female workers analysed in this study.

5. Conclusions

The empirical model we have estimated enabled us to analyse various features of the Italian female labour market between 1970 and 1989. The theoretical model upon which it is based assumes that workers decide whether or not to participate to the labour market according to the characteristics of the labour contract offered by firms. This contract is defined by two variables, number of hours and wage, which are set by the firm is such a way to induce the required labour supply. Therefore, wages and hours crucially depend on the worker's characteristics, as well as on the cyclical dynamics of the labour market.

From these theoretical premises, it is to be expected that some unvoluntary unemployment exists. Firms follow an efficiency wage mechanism in wage determination, and have no incentive in lowering it because this would induce an efficiency loss.

Our results are not at odds with theory, and with other empirical studies. Demographic variables seem to have a declining influence on wages and participation decisions. Even if the children variable was not well measured, it seems that husbands rather than children have a greater impact on the participation decision and on the worker's efficiency.

Educational attainments influence participation directly, without any effect on hours and wages. This is quite understandable since women have had on average poor career developments, more related to experience than to their degrees. However, the investment made in education induces them to enter and to remain in the labour market, quite independently of wage conditions, but rather focusing on the number of hours specified by the contract.

In addition to the wage, also labour market conditions do not have a significant effect on participation, either proxied by value added or by the employment probability. In other words, neither "discouraged" (which is more connected with the latter variable), nor "added" (which is captured by the former) worker effects seem to explain workers' participation decisions.[14] This is confirmed by other pieces of recent empirical evidence (Cf. Rettore, 1989), and is perhaps the most important change in women labour supply. This tendency to the homogenization of male and female behaviour has far reaching consequences, also because it implies a stable rise in female and total unemployment rates.

Fixed effects are significant in the first and third equations. Differences among them are not large and assume the expected sign (e.g. hours and participation are larger in northern regions).

We can therefore conclude that the proposed model provides a convincing framework to explain the regional and industry-specific dynamics of the Italian female labour market. Workers' heterogeneity is captured by the model variables and their effects are largely consistent with theoretical predictions. To explain these satisfactory achievements, we would like to stress the importance of having used a new, very detailed set of data, and a micro-founded, specifically designed aggregation and estimation procedure.

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[14] The value added variable does not appear in the participation equation, whereas employment probability has a minor impact on female workers' participation.

Appendix: Description of variables

In this Appendix some details are given on how variables used in the model estimation have been constructed. In the following the first index refers to the group, the second to the period. Unless otherwise stated, all variables refer to women. Variables measured in italian lira have been deflated by a price index, with 1985.III=100. The data set is described in Abbate (1993). The sample goes from 1970.1 to 1990.4.

Hours equation.

$ORE_{gt} = \sum_i Q_{igt}\ ORE_{igt}$: weekly hours of work.

OBB_{gt}: number of workers with education not higher than compulsory level.

LAU_{gt}: number of workers with a degree.

CON_{gt}: number of married workers.

$REDN_{gt}$: unearned income of workers (thousands of italian liras).

TREND, TREND^2: time and time squared.

$VAG_{gt} = \sum_i Q_{igt}\ VAG_{igt}$: value added (ten millions of Italian liras).

Wage equation

$SAL_{gt} = \sum_i Q_{igt}\ SAL_{igt}$: average hourly wage (thousands of italian liras).

OBB, LAU, CON, REDN, ORE, OCC, VAG: as in the hours equation.

$POCC_{gt}$: ratio of the number of workers to the number of people participating in the labour force in the region. $POCC_{gt}$ assumes the same value for all groups of units living in the same region.

$MINC_{gt}$: minimum wage by region and industry according to current regulations. It assumes the same value for all groups of units in the same age group.

Participation equation

TOT_{gt} : number of units belonging to the g-th group at time t.

ATT_{gt} : number of people in the labour force.

OBB, LAU, CON, REDN: as in hours equation, but with respect to the full group, not just to the workers sub-group.

$MINC_{t}$: minimum wages in the textile industry.

ORE_{gt}, SAL_{gt} : as in the hours equation.

Demand equation

Q_{igt} : share of total value added by industry and region at time t.

OCC_{gt} : number of workers employed in group g at time t.

VAG_{igt} : value added by industry and region at time t (ten millions of Italian liras).

SAL_{igt} : average hourly wages by industry and area at time t (thousands of Italian liras).

ORE_{igt} : weekly hours by industry and area at time t.

EFF_{gt} : number of unmarried women, older than 29 and younger than 50, with education at least at high school level. They are assumed to be the most efficient group of workers.

Tab. 1: Long-run Elasticities

	hours	wage	part.	labour demand
primary school (max)	-2.078	-.0384	-.2630	
university degree	-12.432	-.1662	.4611	
married woman	-6.421		-.0957	
non labour income	-.00047	$-.17*10^{-4}$	-.01729	
actual wage			.00022	-823.109
hours		-.0132	-.000225	
employment likelihood		-.0564	.02627	
value added	.000107	$.47*10^{-5}$		.04765
efficient workers employment levels				.1981

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(xx) This paper was presented at the Conference on "Technology, Employment and Labour Markets" organized by the Athens University of Economics and Business and Fondazione Eni Enrico Mattei, Athens, May 16-18, 1996

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