CeLEG Working Paper Series

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Beyond Individual Characteristics vs. Contextual Factors Explanations

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Working Paper No. 01

November 2009

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ABSTRACT

Between the late seventies and the first years of the 21st century, women started to be more and more represented among the employed population in all developed countries. Despite Italy's Regions underwent notable changes of policies and socioeconomic indicators during the last few decades, some regional specificities are historically consistent: all along the period considered regions in the South exhibit low women's employment rate coupled with low levels of civic development, weaker macroeconomic conditions and low average educational attainment.

In this paper, we exploited these sources of Regional variance in the most relevant socio-economic indicators to estimate the joint impact of individual and macro variables on women's employment.

While among individual and contextual characteristics, education played the major role to enhance women's participation in the labour market, the cultural evolution and the removal of gender-based discrimination are the sole macroeconomic variables which positively contributed to women's employment since 1970s, while a move away from the public provision of services exerted a negative impact. Contrarily to what frequently assumed, macroeconomic growth has played an ambiguous but role on women's employment over time, by worsening the probability of women's employment in the years 1977 and 1986, reversing this pattern only since the 1990s.

1. Motivation and related literature

The dramatic increase of women's employment rates explains a large part of the secular increase of labour supply in many industrial countries during the second half of the XX century. Indeed, the study of the changing determinants of women's employment stimulated a large and extending literature. Most of this literature may be divided into two parallel, though separated, strands. One dealing with individuals' characteristics and their impact on labour supply and demand; the other investigating the relevance of the institutional context, especially in terms of socio-cultural norms, public policies, industrial and macroeconomic conditions.

The present work proposes and applies an econometric methodology aimed at building a bridge joining these two strands. We simultaneously estimate the impact on women's employment of both individual and context variables, as well as the relevance of the interplay between them.

With respect to the first strand of literature, the impact of individual characteristics on women's employment has been largely investigated through the neoclassical framework of household behaviour *á la* Becker. Education is typically singled out as the major factor influencing women's employment by directly affecting potential wages and, in turn, labour market participation and fertility decisions, and the timing of these events (Gustaffsson and Kenjoh, 2007). Specifically, the theory of household's allocation of time developed after Becker (1965) states that an increase in husbands' income may induce women to consume additional non-market time, thereby reducing their participation to the formal labour market. However, historically this potential income effect may have been mitigated and possibly reversed by the increasing educational attainment of women, and the phenomenon of mating by education (Becker 1973; Mare, 1991; Schwartz and Mare, 2005; Eckstein and Lifshitz, 2009).

Next to education, housework burdens and care and family-related responsibilities are found to increase women's reservation wage and, in turn, to decrease the likelihood of low-earning women to enter into paid employment, as shown for example by Adam (1996), Colombino and De Stavola (1985), Connelly (1991), Drobnic (1997), Giannelli (1996), Grimm and Bonneuil (2001), Munasinghe *et al.* (2008). Policies alleviating the increase in financial burden related to a childbirth have indeed shown to exert a positive impact of women's labour supply. For example, Rocio Sánchez-Mangas and Virginia Sánchez-Marcos (2008) measure the potential effect of a family policy introduced in Spain providing working mothers with a monthly cash benefit of 100 euros per child aged under 3 years. They find a positive labour market participation effect for recipient mothers.

However, when considering the second mentioned strand of literature, it is found that the influence of having children on women's labour supply in fact exhibits country-specific patterns (Bardasi and Gornick, 2003; Gustafsson *et al.* 1996; Jaumotte, 2003). In general, public policies for the support of working mothers explain a significant share of national differences, e.g. in terms of parental leave schemes (e.g. Hofferth and Curtin, 2003; Ruhm, 1998; Pylkaenen and Smith, 2003), structure of social benefits and the tax system (e.g. OECD 1996, 2002, 2003, 2004) or availability and quality of public childcare facilities (e.g. Del Boca and Locatelli, 2006; Cleveland *et al.*, 1996; Connelly, 1991, 1992;

Hofferth and Wissoker, 1992; Powell, 1998). On the one hand, many works find that when childcare services are of bad quality, or expensive, or scarcely available, mothers' reservation wage increases, thereby lowering women's labour supply (e.g. Anderson and Levine, 1999; Attanasio, et al. 2008; Conelly, 1991, 1992; Hofferth and Wissoker, 1992; Kimmel, 1995; Powell, 1998); on the other hand, some works point out that women's labour supply may be more elastic to the availability of publicly provided childcare facilities rather than their price. For example, Apps and Rees (2004) add that, among the OECD countries, those supporting motherhood through childcare facilities rather than child benefits tend to exhibit both higher rates of women's labour supply and higher fertility rates. Recently, Lundin et al. (2008) find similar results for Sweden. They estimate the effect of the major childcare price reform implemented in Sweden in 2002, which introduced a cap on the price that local governments as main suppliers of childcare could charge parents. The estimated effects of childcare prices on labour supply are mostly statistically insignificant. The authors point out that this result differs from earlier studies for other countries with a less developed and subsidized childcare system, leading to the conclusion that mother's labour supply is largely dependent on the availability of publicly provided-childcare facilities more than on their price reductions. For example, Berlinski and Galiani (2007) provide a recent evidence on the positive impact of a large-scale construction of pre-primary school facilities in Argentina on mother's employment.

The role of the institutional environment has been also studied in relation to the joint decision of labour supply and fertility. For example, within a utility maximising framework under credit rationing and market imperfections, Del Boca (2002) finds that, in Italy, the availability of child care and of flexible working arrangements increases both women's participation and the probability to have a child. Del Boca, Pasqua and Pronzato (2009a) extend the analysis to an European perspective: they conclude that differences in the institutional context across European countries are able to partially explain the cross-countries variation of women's labour market participation and motherhood decisions.

Next to social policies, the role played by socio-cultural norms is gaining increasing attention. Works in this area showed that countries with more liberal attitudes toward gender roles, higher work orientation of women and higher acceptance towards young children's working mothers are also characterised by higher women's employment rates: for the relationship between women, work and culture, see for example Algan and Cahuc (2007), Antecol (2000), Fernández (2007), Fernández, Fogli and Olivetti (2004), Fortin (2005), Giavazzi et *al*. (2009), Pencavel (1998), Reimers (1985), Vella (1994).

Finally, an interesting application of the analysis of macroeconomic conditions on women's employment is the recent debate on the gender impact of the current financial and economic crisis (see, for example, Antonopoulos, 2009; ILO, 2009; Smith, 2009). Surprisingly, it is found that, in developed countries, men's employment responds more to both positive and negative macroeconomic fluctuations because, due to horizontal segregation, women are often employed in more stable industries and/or safer -though low-paid- jobs (e.g. as civil servants).

Both strands of literature suffer from a specific limitation: they ignore the possibility that factors from different levels (micro and macro factors) may relate to each other. Such a phenomenon would produce sensible biases in the estimates for two reasons. On the one hand, if the impact of individual characteristics depended on the environment, the individual estimates could at best be considered as valid only for the specific setting in which they are computed. On the other hand, the macro-level variables may exert a compound effect on women's employment, both directly and indirectly by affecting the impact of micro-level factors. In this latter case, the true impact of macro-factors would depend on the characteristics of the population under analysis. Two recent works have provided a further evidence about the existence of this interaction. Lefebvre, Merrigan and Verstaete (2009) find that the impact of a childcare policy on women's labour supply may also depend on individual or household characteristics. They measure the potential effect of a childcare policy introduced in Canada providing new childcare facilities and family-subsidies for day care spaces. The results show that childcare services have a positive long-term labour supply effects on mothers who benefited from the program when their child was less than 6 years old. These changes are more relevant for less educated women. Gutiérrez-Domènech (2005) finds that the role of education on women's labour supply is likely to depend on the institutional characteristics of the labour market. She studies women's transitions from employment to non-employment after first birth and post-birth employment dynamics in a number of European countries. The results show that mothers' employment is larger for more educated women and in countries with larger part-time employment opportunities. Moreover, a taxation scheme based on the couple's earned incomes separately increase the labour supply incentive of the partner with lower potential earnings.

 Del Boca and Sauer (2009b) offer an indirect solution to this intersectionality problem. They compare longitudinal micro-data from Italy, France and Spain to infer the role of public policies on women's employment and fertility decisions. They assume that these three countries are similar with respect to culture and gender roles. As a consequence they interpret systematic differences in the impact of individual variables between these countries as stemming from differences in social policies. The results point out that women's employment rates in the three countries would be very similar, if Italy and Spain adopted French social policies.

A more direct method to account for both micro and macro factors was proposed by Cipollone and D'Ippoliti (2009) who, merging individual-level and macro data for Italy in 2004, find that the interrelation of the two levels of analysis may be relevant. Their method allows to simultaneously deal with the impact of individual and contextual factors on the individual likelihood of being employed, controlling for the correlation between the two levels. The main advantage of this approach is the possibility to consistently and directly estimate the impact on the likelihood of being employed of several macro variables using one micro-dataset.

In this paper we extend their analysis to a longer-run perspective in order to investigate whether the resulting estimates are historically consistent. Italy provides a very convenient socio-economic framework for studying the impact of different local conditions on women's employment from a historical perspective. On the one hand, Italy's case is internationally interesting because it is jointly

characterised by the second-lowest women's employment rate in the EU-27 and the highest index of regional heterogeneity in a number of macroeconomic variables, including women's employment rate. On the other hand, the Italian case is interesting also from a historical perspective, due to its rapid socio-economic development and the pronounced regional divergence of women's employment rates.

In conclusion, this work aims at contributing to the literature in two ways. From a methodological point of view, we propose a model to overcome possible biases that arise when ignoring the interaction between micro and macro variables in determining women's employment. From a socio-economic point of view, we are able to assess the relative contribution of individual versus macro variables on the historical increase of women's employment in Italy over the last few decades.

The rest of the paper is organised as follows. In the next section, we summarize the facts we aim to explain. In section 3, we adopt a principal component analysis to synthesise Regions' heterogeneity to obtain a limited number of socio-economic indicators. In section 4, we use these indicators to carry out a multilevel analysis of women's employment. Section 5 discusses the main results and concludes.

2. Facts to explain

Italy exhibits a relevant geographical heterogeneity in the long-run evolution of the employment rates of both women and men, with Regions in the South performing much worse than the rest of the country. In this and the following sections we analyse a representative sample of Italy's population, the Bank of Italy's *Survey of Households' Income and Wealth* (SHIW), in a selected number of years: 1977, 1986, 1995 and 2004.[1]We consider only individuals of prime-age (between 25 and 54 years old), to avoid interferences with educational and early-retirement preferences and with school-to-work transitions. Our sample is composed of 4357 individuals for 1977, of which 2863 women, 7426 (2516 women) for 1986, 10350 (5274) individuals for 1995, 8716 (4476) for 2004.

Comparing these samples, it is found that between 1977 and 2004, while men's employment rate (ER) remain substantially stable, women's ER show a remarkable increase, especially in the North and in the Centre. In particular men's employment rate followed a decreasing pattern until the late 1990s (from 70,4% in 1977 to 64,1% in 1995) and then it recovered almost six percentage points reaching 69,8% in 2004. During the whole period, men's ER in the South has been significantly lower than in the North and in the Centre. Conversely women's employment exhibits a considerable increase during the same period, increasing by almost 25 percentage points in the Centre and in the North (from 28% and 30,6% respectively in 1977, to 52,6% and 55,8% respectively in 2004), though only by 7 percentage points in the South (from 20,6% in 1977 to 26,7% in 2004).

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[1] The choice of a nine-years intertemporal windows was directed by issues of data availability and the widespread evidence that changes in labour market inclusion and labour supply take some time to occur, mostly depending on variables that only slowly respond to the business cycle and policy innovations (i.e. education, taxation, culture, allocation of time and household's resources).

Figure 1: Long-run Evolution of Employment Rates by geographical area, gender and year
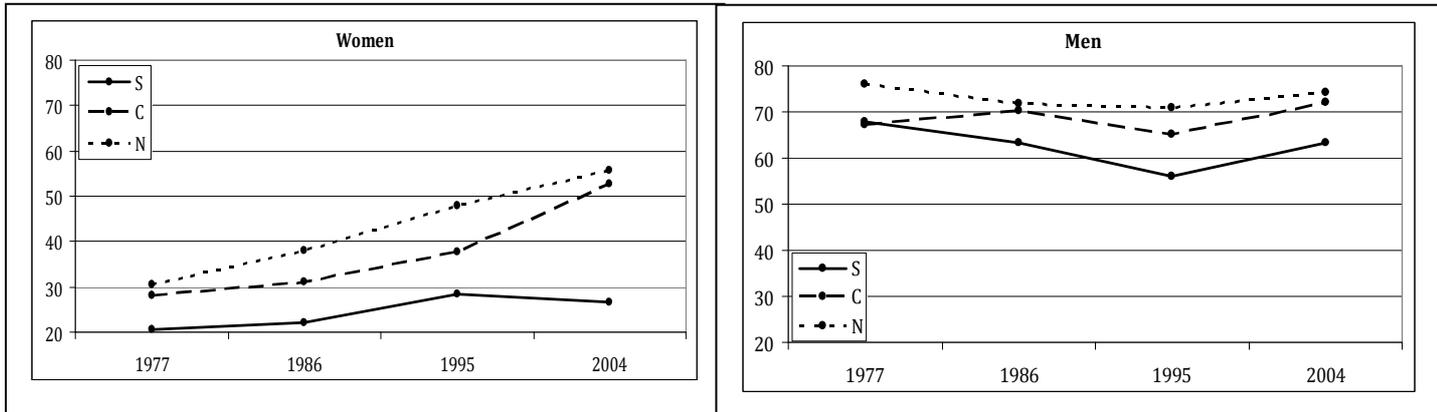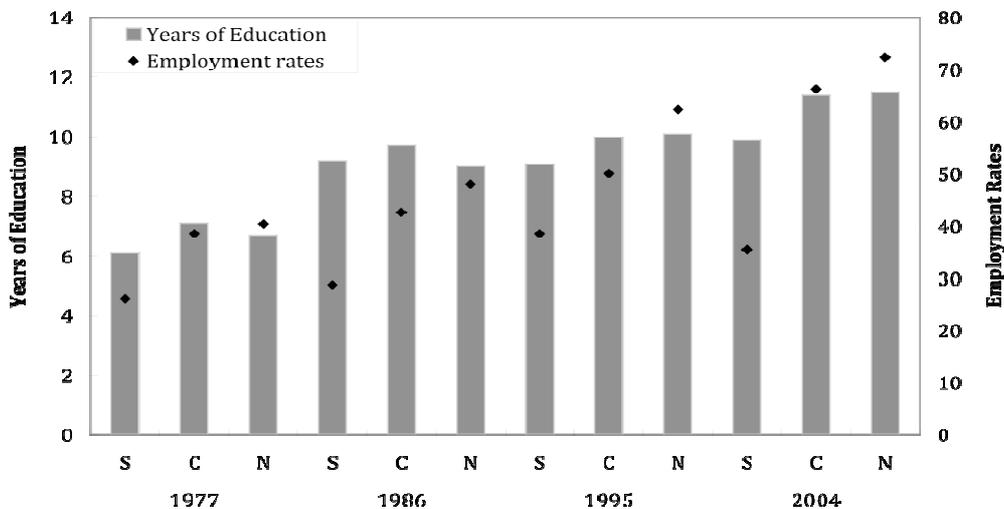
As discussed above, the bulk of the literature typically singles out the increased level of women's educational attainment as the major factor affecting the remarkable historical increase of women's employment. However, for the case of Italy, the increasing level of education, for women more than for men, tells only a part of the story.

Figure 2 shows the increased number of years spent in education by women, between 1977 and 2004. For women of prime age, the average number of years in education increased from 6.6 in 1977 to 10.9 in 2004, with a difference of almost 2 years between the South and the rest of the country (9,9 and 11,5 respectively). In the same period, employment rates grew from 35% to 58%, with again remarkable differences across Regions: the South is characterised by a women's ER equal to an half of that in the North, while Central Regions lie in between.

Figure 2: Years of education and Employment Rates, by area and year: prime-age women
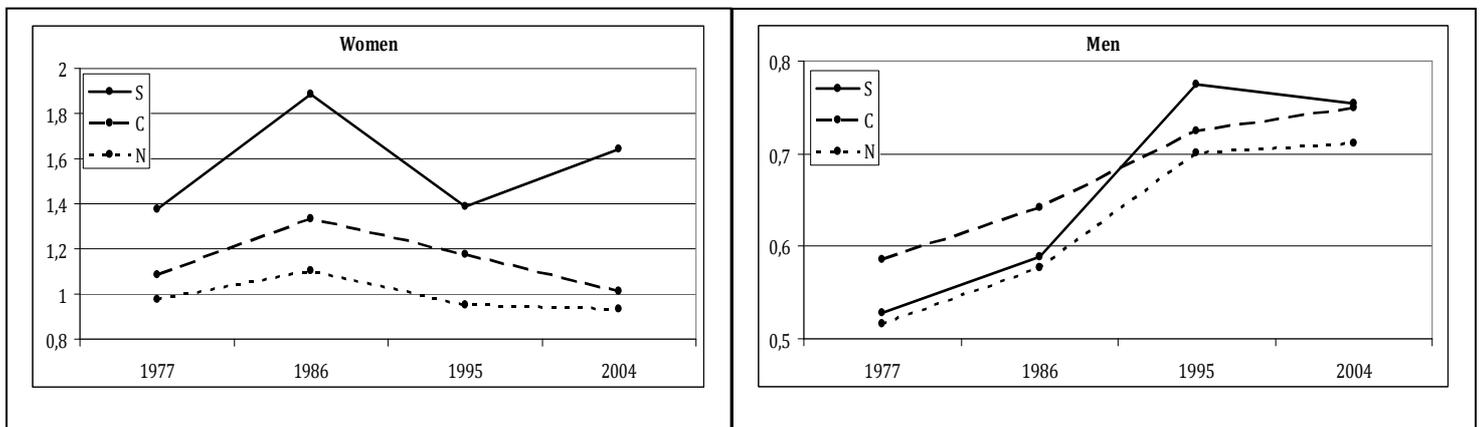
We computed rough returns to education in terms of employability, measured as the ratio between educational attainment rates (average years of education over the maximum length of education) and the employment rates. Between 1977 and 2004, they remained substantially unchanged for women, while they increased for men (Figure 3). Interestingly, for women the indicator is most of the time greater than 1, meaning that there is an unused amount of human capital especially in the South. During the 1980s, the indicator for women exhibited a remarkable increase, due to the increased enrolment rate of women. Since then it started to lower, due to the greater involvement of women in paid employment. In the most recent years, the indicator has reached the 1977 level in the North and the Centre, while it is larger than the 1977 level in the South.

For men, the indicator is typically lower than 1, but increasing over time due to the increasing number of years spent in education matched by a substantially stability in employment rates.

Figure 3: Rough returns to education in terms of employability, by area and year: prime-aged sample

Notes: *For each year, the rough measure of returns to education in terms of employability has been constructed as the ratio between the educational attainment rates (years of education over the highest possible number of years spent in education) and the employment rates. S=South; C=Centre; N=North; S=South; C=Centre; N=North.*
Source: *own elaboration on SHIW, various years, samples restricted to the [25-54] age bracket.*

In conclusion, between 1977 and 2004, a positive correlation can be drawn between the number of years women spent in education and their employment rates. This result is perfectly in line with most of empirical and theoretical literature on women's employment. However, though decreasing in recent decades, there is still an amount of unused human capital for women, when compared to men, especially in the South. These gender and regional differences may be explained by other individual and contextual factors. Thus, the next paragraph applies a factor analysis to synthesise regional heterogeneity in terms of the institutional environment.

3. Regional heterogeneity in institutional dynamics

In order to summarise the main sources of macroeconomic and institutional heterogeneity at the regional level, several variables related to the socio-economic context have been collected for the four years considered in this work (1977, 1986, 1995, 2004). The variables were chosen according to the

most relevant literature (see §1) and are summarised in Table 1, under the column "variable". We considered the following areas: industrial and macroeconomic variables, social policies, culture and gender-based discrimination, components of the Human Development Index.

Tertiarisation, the provision of services to households, and GDP growth are firstly considered: their role in promoting women's employment in Italy has most recently discussed by Boeri *et al.* (2005) and Simonazzi (2006). Next, the importance of social policy in promoting women's employment is widely acknowledged: Del Boca and Locatelli (2006) provide a comparative review of the evidence on the role of social policy in shaping women's employment across Europe. Being Social Assistance mostly managed by local administrations in Italy, it is particularly useful to capture regional specificities in terms of socio-economic factors. Finally, following Goldin (2002) and the literature on the New Household Economics and statistical discrimination, developed after Becker (1965 and 1981), we developed an index of gender-based discrimination which is able to capture the role of cultural constraints and gender roles (see for instance Fernandez, 2007).

For each year, all variables in column 1, Table 1, were normalised by their national average, and some were aggregated into homogeneous indexes through harmonic means in order to obtain 5 synthetic indexes, as listed in column 4[2]. Following this procedure, five main dimensions of heterogeneity across Regions can be distinguished: tertiarisation, GDP growth, social assistance, gender discrimination and a modified human development index.

The nature and extension of publicly-provided Social Assistance may be interpreted as a proxy of the public policy aimed at promoting the conciliation of family responsibilities and market work. It is a compound measure of: per-capita public expenditure on Social Assistance, percentage of children hosted in publicly-financed kindergartens, share of direct social expenditure and of in-kind expenditure over total public social expenditure.

The discrimination index synthesizes both horizontal[3] (occupational) and vertical gender segregation in the labour market. The latter is proxied by the number of women holding prominent self-employed occupations as a share of the total number of self-employed in the Region.

The modified index of human development (MDI) captures the regional cultural development: it differs from the HDI in two respects: on the one hand, aggregation is obtained by harmonic instead of arithmetic mean (see footnote 2), on the other hand, the underlying variables are slightly different from those of the standard HDI in order to better catch relevant differences among the Italy's Regions and to avoid the inclusion of some variables that will be measured at the individual level.

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[2] The variable Information, synthesizing the average households' expenditure for periodicals and newspapers, was not available for year 1977. We used harmonic means to prevent Regions exhibiting high unbalances in the variables to obtain extreme values of the index, while ranking higher those Regions exhibiting a more equilibrated development of all the selected variables (see Casadio and Palazzi, 2004).

[3] Bettio (2002) argues that there are pros and cons of gender horizontal occupational segregation, and that from some points of view (e.g. the gender pay gap) it should not be considered as a completely negative phenomenon. However, it is considered as such within our analysis, because -while we ignore incomes- we are here mainly concerned with its economic dimension, as a barrier to fair competition in the labour market, and with its cultural dimension, as a factor confirming gender stereotypes.

Table 1. Macro socio-economic indicators: description, aggregation and related literature.

Variable 1	Description 2	Source 3	Index 4	Sample Literature 5
Tertiarization	Share of employment in the Services Sector (men and women)	ISTAT	Tertiarisation	Fuchs, 1980 Galor, Weil 1996 Goldin, 1990 Jones *et al.* 2003
GDP growth	Regional aggregate GDP growth rate, two-years basis	ISTAT	GDP Growth	Fuchs, 1980 Galor, Weil 1996 Goldin, 1990
Social assistance expenditure	Per-capita Public Expenditure on Social Assistance	ISTAT	Social Assistance	Anderson, Levine, 1999 Apps, Rees, 2004 Attanasio, *et al.* 2008 Cleveland *et al.*, 1996 Connelly, 1991, 1992 Del Boca, Locatelli, 2006 Fortin, 2005 Hofferth, Wissoker, 1992 Kimmel, 1995 Powell, 1998
Kindergarten	Number of children hosted in public-financed kindergartens, per thousands of children 0-3 years old	CNDAIA (2006)		
Direct social expenditure	Direct public expenditure as a fraction of total public expenditure on social assistance	ISTAT		
Public services	Expenditure for in-kind services over expenditure for cash transfers	ISTAT		
Gender segregation	As defined by the European Commission and Council (2005)	ISTAT (LFS)	Gender Discrimination	Cowling, Taylor, 2001 Goldin, 2002, 2006 Rosti, Chelli, 2005 Verheul, Thurik, 2001
Prominent Employment	Share of women's self-employment as a fraction of total self-employment	ISTAT (LFS)		
Per-capita GDP		ISTAT	MDI - Modified Human Development Index	Algan, Cahuc, 2007 Antecol, 2000 Fernández, 2007 Fernández, *et al.* 2004 Fortin, 2005 Giavazzi et al., 2009 Pencavel, 1998 Reimers, 1985 Vella, 1994
Infant mortality	Raw infant mortality rate	EUROSTAT		
Culture	Average households' expenditure on cultural and entertainment activities as a fraction of average households' disposable income	ISTAT		
Information	Average households' expenditure on newspapers and periodicals as a fraction of average households' disposable income	ISTAT		

Note: ISTAT is Italy's National Statistics Office. LFS stands for Labour Force Survey.

In order to adopt more synthetic contextual indicators and to reduce the number of variables, a principal-component analysis was carried out on the five mentioned indexes, plus an index of time. Through the principal component analysis, we obtained three macro indicators which retains a straightforward interpretation, as shown Table 2. The first factor is highly correlated to MDI (+0.88)

and the public provision of services (+0.61), while being negatively correlated to the discrimination index (– 0.87). Due to the specific socio-economic differences among Italy's Regions, and being Social Assistance an important public policy for conciliation, we are inclined to interpret this factor as an index of regional *Civic Development* (henceforth CD). The second factor is negatively correlated to the public provision of Social Assistance (−0.41) and positively correlated to the extension of the Services Sector (0,72) and time (0,79): a plausible interpretation of this factor is that it measures the extent of the *Private Provision of Services* (henceforth PPS). Finally, the third factor is highly correlated to the lagged regional aggregate economic growth (+0.9), and very weakly negatively correlated with tertiarisation. As Italy's Services Sector exhibits on average a lower productivity growth than the manufacturing sector, we are inclined to interpret this factor as a measure of *Local Macroeconomic Conditions* (henceforth LMC).

Table 2. Results from the principal component analysis

| Index	Civic Development	Private Provision of Services	Local Macroeconomic Conditions
Time		+ 0,79	
Tertiarisation		+ 0,72	
GDP growth			+ 0,92
Social Assistance	+ 0.61	− 0,41	
Gender Discrimination	− 0.87		
MDI	+ 0.88		

Note: the principal-component analysis was used to extract the factors, using 80 observations for the 20 Regions in the four selected years. Rotation of factors was then adopted by means of the varimax method, which attempts to minimise the number of variables that have high correlation coefficient on a factor. In keeping with common practice (Cf. for instance Nardo et al. (2005), Nicoletti et al. (1999), Kline, P. (1994)), three factors have been selected, which satisfy the following requirements: exhibiting eigenvalues close to or larger than unity; individual contribution to the explanation of the overall variance of the data greater than 10%; cumulative contribution to the explanation of the total variance of the data greater than 60%. Within each of these factors, the single indicators are weighted according to the proportion of their cross-region variance explained by the factor. As a result, regions can be scored on each of the factors using the estimated weights.

The long-run evolution of these three factors can be briefly summarised by means of simple density estimations (Epanechnikov Kernel method), showing that cross-regional variability within each indicator is historically persistent.

Figure 4 plots the density estimation of the Civic Development index (CD) in the four relevant years. The index exhibits a relevant dispersion across Regions, though reducing over time. The index appears to undergo a mild process of convergence, from two separate clubs in 1977, to the emergence of three minor peaks in 2004, corresponding to the average values of the three geographical areas of North, Centre and South.[4]

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[4] Further data and elaboration, for this and the other indexes, are available from the authors upon request.

Figure 4: Long-Run Evolution of the Civic Development Index (CD)
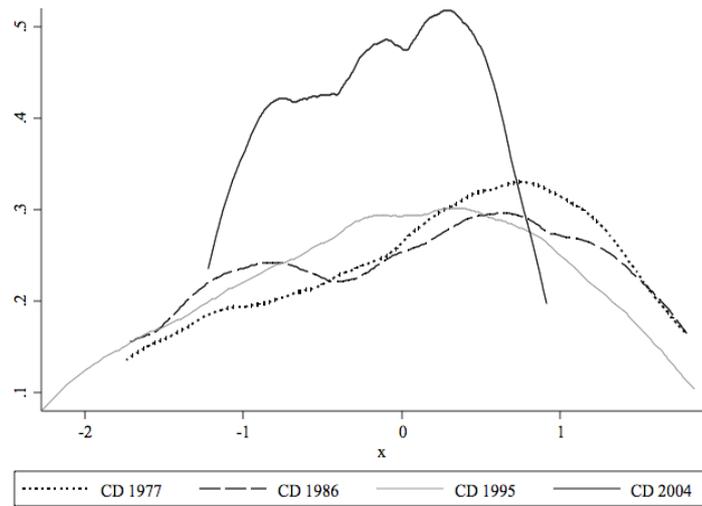
Source: own elaboration on various sources (see Table 1)

The measure of Private Provision of Services (PPS) exhibits a clear time trend, on average increasing over time (see Figure 5), and it is characterised by an inverse-U shape. It is found that Regions in the Centre exhibit the highest values of PPS on average, though the index undergoes a sustained process of convergence, with two small extreme peaks including Regions with outlier values of the index.

Finally, local macroeconomic conditions (LMC) are plotted by a more regular inverse U-shape in each year, and they exhibit a clear trend of divergence across Regions (see Figure 6). Indeed, while there is no trend on average, the distribution displays a substantial increase in its variance as time proceeds.

Figure 5: Long-Run Evolution of the Private Provision of Services Index (PPS)
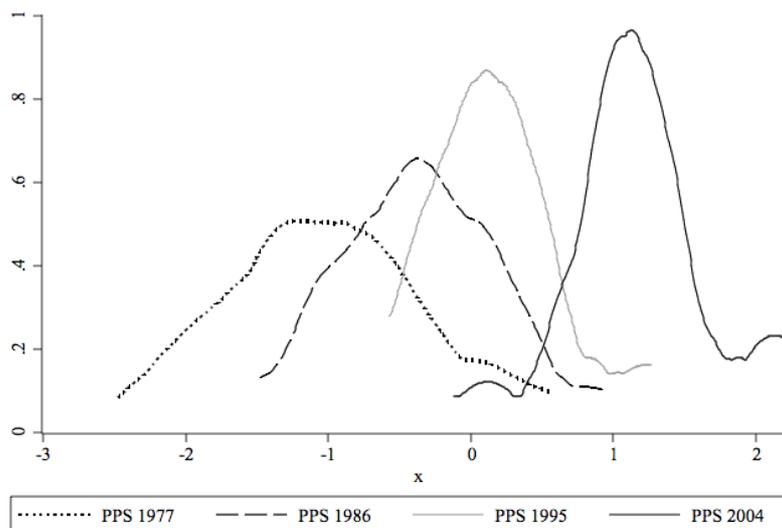
Source: own elaboration on various sources (see Table 1)

Figure 6: Long-Run Evolution of the Local Macroeconomic Conditions Index (LMC)
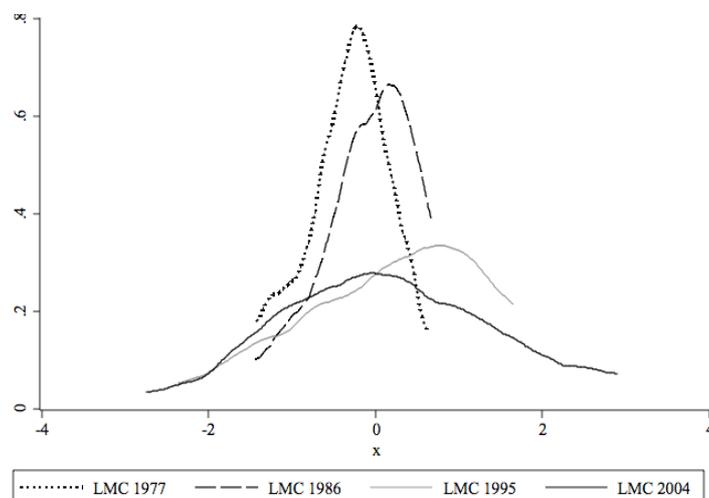
Source: own elaboration on various sources (see Table 1)

4. Merging individual characteristics and regional heterogeneity

The indexes developed within the previous analysis are used in this section for a multilevel analysis of women's employment. Such an approach allows us to cluster observations into homogenous groups defined both by micro and macro characteristics, and to use the correlation among regional dummies as an informative feature of the population structure and of the relations among the investigated variables.

In particular, the econometric specification consists of a probit model of the determinants of employment, with observed heterogeneity at the individual (first) and regional (second) levels, and unobserved heterogeneity at the regional level. Observations within groups (within a same Region) are more likely to be correlated than observations from different groups (across Regions), and failures to control for this second-level heterogeneity may lead to inconsistent estimates and misleading inferences. To account for the impact of second-level heterogeneity and its interaction with first-level heterogeneity on the likelihood of employment, we implemented a Generalized Linear Latent Model to estimate a two-level random-coefficient probit model[5] for all the sample and, then, for women and men separately, taking into account the nesting of individuals in their region of residence. The estimation packet adopted here is GLAMM,[6] a module for the software STATA version 9 (or more

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[5] An extensive discussion of GLAMM applications and estimation procedures is found in Rabe-Hesketh, S., Pickles, A., Skrondal, A. (2001), Rabe-Hesketh, S., A. Pickles, A. Skrondal, (2004b).

[6] The software requires the specification of a linear predictor, as a function of the explanatory variables, and of a link function. When convergence is reached, the output of this procedure provides parameters estimates with standard errors, and, for each parameter, a test of significance through a Wald t-statistic. GLLAMM maximizes a numeric approximation of the exact marginal likelihood of not-linear models, through the method of adaptive quadrature of Gauss-Hermite.

recent versions).

As mentioned, the first level units are prime-age individuals as recorded by the SHIW datasets.[7] In each year, the second level units are the 20 Italian Regions, whose socio-economic characteristics are summarized by the three factors developed above: CD - regional Civic Development, PPS - Private Provision of Services, LMC - Local Macroeconomic Conditions.

The next paragraphs show the results for the pooled and women estimations for each year of the analysis. Those for men are available upon request. We firstly report the results for the whole sample of men and women, in order to develop a benchmark for the estimations on women's samples. In the pooled estimations a gender identification dummy variable is used, denoted "women"; women and men are assumed to behave according to the same choice rules, apart from an unexplained residual component. The interest in applying our multilevel methods to the pooled estimation is that it provides an explanation for the systematic difference between men and women, by means of the three macro indicators. If the interaction between the dummy variable "woman" and the macro factors is significant, then ignoring regional heterogeneity may produce biased estimates of the role played by individual characteristics on women's probability of being employed. In these estimations we allow for cross-level interactions also between the three macro factors and two further individual dummy variables, "being married" and "co-living with an old-aged person". Results from these further interactions are available upon request.

From separate estimations, women-specific coefficients can be detected for all variables. Moreover, for both women and men separately, the contextual factors are allowed to interact with the Regional intercepts, the dummy variable "married" and the dummy variable "co-living with an old-aged person", which denotes the eldcare burden on the family. These gender-specific interactions allow us to verify whether and to which extent the compound effect of micro and macro variables is relevant for women's more than for men's employment.

4.1. Pooled estimation

Table 3 presents the results from the multilevel random coefficient estimation, reporting the marginal effects of micro and macro factors on the likelihood of women and men to be employed. Globally, the three regional factors exert a significant *direct* role on the likelihood of being employed of men and women together, and their specific contribution has been rather variable over the period. The local economic growth (LMC) seems to enhance employment probabilities in all years but 1977. The index of civic development (CD) is usually not statistically significant, with the exception of the year 1977. Finally, the private provision of services (PPS) seems to negatively affect the probability of being employed, though its coefficient is not always statistically significant.

Given that the regional intercepts ("regional variance") are still (statistical and quantitative) significant in each year, it might be concluded that there other sources of cross-regional heterogeneity that our contextual factors are unable to account for.

Not surprisingly, the impact of individual characteristics highly relevant. In particular, the impact of co-living with an old aged person is negative where statistically significant at the conventional thresholds, while being married appears to be mostly irrelevant. Education exerts the usual positive impact on the likelihood of being employed, with a decreasing trend in the period considered[8]. This evidence is partly explained by the larger supply of skilled labour force, which increased competition for qualified jobs. The dummy variable "woman" – which measures the unexplained residual gender difference on the probability of employment after controlling for the other variables – is confirmed significantly negative during the whole period (ranging between -50% and -70%) with a slight reduction during the decades.

Table 3: Pooled estimation: Two-Level Probit Regression, Marginal Effects

	1977	1986	1995	2004
Level 1 units	4357	9620	10350	8716
Level 2 units	19	19	19	19
Log-likelihood	-13377881	-10847353	-13634410	-12414468
Primary education	0.39	0.643	-0,22	0.009
	0.103 **	*0.111***	*0.16*	*0.172*
Lower secondary education	0.986	1.046	0.165	0.353
	0.154 **	*0.215***	*0.158*	*0.121 ***
Upper secondary education	1.233	1.312	0.525	0.722
	0.126 **	*0.227***	*0.167 ***	*0.121 ***
College education	1.591	1.439	0.824	1.084
	0.233 **	*0.221***	*0.21 ***	*0.21***
Woman	-0.706	-0.539	-0.577	-0.639
	0.07 **	*0.148***	*0.123 ***	*0.098 ***
Regional Variance	-0.665	-1.009	-0.35	-0.304
	0.06 **	*0.099***	*0.119 ***	*0.102 ***
Married	-0.041	0.319	-0.008	-0.14
	0.049	*0.111***	*0.089*	*0.085 **
Old-aged co-living	-0,11	0.424	-0.459	0.055
	0.031 **	*0.119***	*0.092 **	*0.048*
CD	0.075	-0.030	-0.014	-0.001
	0.008 **	*0.013***	*0.021*	*0.015*
PPS	-0.108	0.117	-0.017	-0.109
	0.022 **	*0.033***	*0.03*	*0.016 ***
LMC	-0.071	-0.001	0.041	0.129
	0.036 **	*0.026*	*0.01 **	*0.005 ***

* statistically significant at 5%; ** statistically significant at 1%
Other control variables: real wealth, age, age squared, urban size (4 dummy variables).
Source: own elaboration on SHIW (various years), sample restricted to age bracket [25-54], and various sources (see Table 1)

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[8] For the years 1977 and 1986, the education variable was missing for a number of working age women and men. To address this iss[88] For the years 1977 and 1986, the education variable was missing for a number of working age women and men. To address this issue, we used a module for Stata , called ICE which stands for Imputation by Chained Equations (Royston, P. 2004, 2005a, 2005b)

The details for the second level seem to fully justify the adoption of a random coefficient probit model to explore the determinants of men's and women's employment. Table 4 shows the detailed breakdown of the impact of regional variables (that is the three factors and the regional intercepts) on the cross-regional heterogeneity of the coefficient of the dummy "woman". When this impact is significant, our macro factors are able to (at least partially) explain cross-regional differences in women's employment that individual (first-level) characteristics are not able to account for. The results confirms our predictions that first-level characteristics do not suffice to explain the observed differences between men and women[9]. Indeed, the impact of being woman on the likelihood of employment is significantly related to our macro factors, as shown by the significance of CD, PPS and LMC (table 4). In particular, *coeteris paribus*, being woman is negatively related to the probability of being employed in each year, as shown by the negative coefficients of the regional intercepts (the term β_{10} in the econometric specification, see Annex 2.1.). For each year, this effect is partly mitigated in Regions with a larger index of CD, as shown by the positive coefficients for the interaction between being woman and CD on the likelihood of employment (β_{11} in the econometric specification, see Annex 2.1). It is noteworthy that this interaction effect seemed to have strengthened over time, as shown by the increasing magnitude of its coefficients (from 0.016 in 1977 to 0.260 in 2004).

Instead, the coefficients for the impacts of the interactions between being woman and PPS and LMC on the likelihood of employment are unstable over the period of analysis. They were negative in 1977 and became significantly positive in 2004, meaning that, while a marginal positive change in PPS and LMC has contributed in strengthening women's disadvantage in employment in 1977, the picture reversed in 2004, when in those Regions exhibiting a larger values of PPS and LMC , the negative impact of "being woman" on the likelihood of employment is slightly reduced.

Table 4: Details of the second level: the influence of the macro factors on the coefficient of the dummy variable "Woman"

	1977	1986	1995	2004
Woman: St.Dev.	0.255	0.295	0.257	0.296
	*0.016***	*0.032***	*0.033***	*0.022***
Regional Intercept	-0.855	-0.576	-0.541	-0.762
	*0.072***	*0.157***	*0.114***	*0.103***
CD	0.016	0.125	0.106	0.260
	-0.026	*0.028***	*0.032***	*0.035***
PPS	-0.089	-0.054	-0.133	0.096
	*0.045**	*0.041*	*0.061**	*0.026***
LMC	-0.183	-0.240	0.006	0.172
	*0.063***	*0.058***	*-0.019*	*0.013***

Source: own elaboration on SHIW (various years), sample restricted to age bracket [25-54], and various sources (see Table 1)

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[9] The joint test strongly rejects the null hypothesis that the random effects parameters are all zero.

In conclusion, coefficients in table 4 indicate how much macro factors might contribute to improve or to worsen women's disadvantage in the likelihood of employment. Given that, as previously shown (table 3), "being woman" exhibits a negative impact on the likelihood of employment, when macro-factors coefficients in table 4 are positive then we can conclude that they improve the probability of women's employment and *viceversa*.

In the light of these considerations, it can be resumed that : (i) CD improves the likelihood for women of being employed; (ii) LMC seems to have worsened the probability of women's employment in the years 1977 and 1986, reversing this pattern only in 2004; (iii) PPS provided a negative contribution to women's employment, except for the year 2004.

To confirm these prior intuitions, we performed the same analysis for women and men separately, in order to disentangle the gender effect of micro and macro indicators and their interactions.

4.2. Estimation on women

The results from the female sample are much different compared to those for men (which are available upon request and are intuitively resumed by comparing the results from the pooled and women estimations). Overall the period, education is confirmed as the strongest individual characteristic boosting women's employment: its impact is larger compared to that for men and monotonically increasing over time. With respect to family variables, and differently from what happens to men, being married significantly decreases the probability of being employed for women in all years (where it is significant), and its impact varies between -9.6% in 1986 to around -25% for the other years (in particular, from -22% in 1977 and 1995 and -27% in 2004).

While co-living with an old aged person correlates negatively with men's probability, its impact on women's significantly changed during the period of analysis. Interestingly, it exhibits a positive coefficient in1977, and negative coefficients in the following years. This gradual shift might depend on the changing family structures and, specifically, from a period of extended families – when the elderly were more actively involved in home production and unpaid labour (i.e. children care) – to a period of more individualistic families – when the elderly come back to live with their sons and daughters often only in case they cannot take care of themselves.

The results from the macro socio-economic indicators confirm the predictions from the detailed results of the pooled estimation (table 4) and are sensibly different from the results on men's sample.

While CD ambiguously affects men's probability of being employed, its impact among women's sample is unambiguously positive: it seems the sole macroeconomic indicator to exert always a positive impact on women's employment. The positive contribution of CD to women's employment is weakly significant in 1986 and 1995 (with marginal coefficients of 1.8% and 4.1%, respectively), and much more relevant (and highly significant) in 1977 and 2004, with marginal coefficients of 9.2% and 38.5%, respectively. Moreover, if PPS exhibits a marginal positive effect with men's sample, it systematically reduces the likelihood of women to be employed, though its coefficient seems to weaken over time, from -14.7% in 1977 to around -12% in 1995 and 2004.

While clearly positive for men, the impact of the economic growth (LMC) on women's probability of employment is decreasingly negative between 1977 and 1986, and becomes positive in 1995 and 2004 (around 7%).

Table 5: Women: Two-Level Probit Regression, Marginal Effects

	1977	1986	1995	2004
Level 1 units	2863	4928	5274	4476
Level 2 units	19	19	19	19
Log-likelihood	-8348920.7	-6689871.7	-7683671.9	-7786147.7
Primary education	0.528	-0.16	0.143	1.101
	0.122 **	*0.12**	*0.232*	*0.337 ***
Lower secondary education	1.283	0.705	0.595	1.437
	0.192 **	*0.170***	*0.28 **	*0.371 ***
Upper secondary education	1.542	1.011	1.109	1.857
	0.13 **	*0.160 ***	*0.29 ***	*0.372 ***
College education	2.062	1.152	1.463	2.306
	0.207 **	*0.166 ***	*0.311 ***	*0.368 ***
Regional Variance	-2.703	-0.122	-5.198	-1.443
	0.615 **	*0.142*	*0.591 ***	*0.366 ***
Married	-0.225	-0.096	-0.221	-0.063
	0.079 **	*0.070**	*0.048 ***	*0.029 ***
Old-aged co-living	0.164	-0.147	-0.16	-0.393
	0.064 *	*0.073 ***	*0.041 ***	*0.045 ***
CD	0.092	0.018	0.041	0.385
	0.016 **	*0.014*	*0.024*	*0.020 ***
PPS	-0.147	-0.095	-0.125	-0.120
	0.026 **	*0.029 ***	*0.042 ***	*0.014 ***
LMC	-0.104	-0.036	0.07	0.065
	0.041 *	*0.037 ***	*0.02 ***	*0.004***

* statistically significant at 5%; ** statistically significant at 1%
Other control variables: real wealth, age, age squared, urban size (4 dummy variables).
Source: own elaboration on SHIW (various years), sample restricted to age bracket [25-54], and various sources (see Table 1)

The details for the second level seem to fully justify the adoption of a random coefficient probit model to explore the determinants of women's employment. Tables A.1 and A.2 4 show the detailed breakdown of the impact of regional variables (that is the three factors and the regional intercepts) on the cross-regional heterogeneity of the coefficients of the dummies "being married" and "co-living with an old-aged dependant" respectively. When these impacts are significant, our macro factors are able to (at least partially) explain cross-regional differences in women's employment that individual (first-level) characteristics are not able to account for.

The results confirms our predictions that first-level characteristics do not suffice to explain the observed cross-regional variations in women's employment[10]. Indeed, the impacts of being married and co-living with an old-aged dependant on the likelihood of employment are significantly related to our macro factors, as shown by the significance of CD, PPS and LMC (see Appendix, tables A.1 and A.2). *Coeteris paribus*, being married is globally negatively related to the probability for women to be employed in each year, as shown by the coefficients of the regional intercepts (the term β_{10} in the econometric specification, see Annex 2.2.) which are overall negative (except of in 1986). Where significant, this effect is partly mitigated in Regions with a larger index of LMC, as shown by the positive coefficients for the interaction between being married and LMC on the likelihood of employment in 1977 and 1995 (β_{13} in the econometric specification, see Annex 2.1). It is noteworthy that this interaction effect seemed to have reduced over time, as shown by the decreasing magnitude of its coefficients (from 0.215 in 1977 to 0.076 in 1995, and 0.010 in 2004). Instead, the coefficients for the impacts of the interactions between being woman and PPS and CD on the likelihood of employment are unstable and less significant over the period of analysis.

If the indirect effects of CD and PPS through the micro characteristic "being married" seem poorly significant, the cross-level interactions become much more relevant in affecting women's employment with respect to the influence of macro factors on the coefficient of the dummy variable "co-living with an old-aged dependant". *Coeteris paribus*, co-living with an old-aged dependant was positively related to the probability for women to be employed in 1977, while negatively related to it since 1986 (as shown by the coefficients of the regional intercepts, the term β_{20} in the econometric specification, see Annex 2.2.). This effect has been partly mitigated in Regions with larger LMC and PPS, as shown by the positive coefficients for the interaction between co-living with an old-aged dependant and LMC and PPS on the likelihood of employment since 1986 (β_{22}, β_{23} in the econometric specification, see Annex 2.2).

5. Discussion of results and Conclusions

Between the late seventies and the first years of the 21st century, women started to be more and more represented among the employed population in all developed countries. In Italy, the increasing rate of women's employment has been accompanied by a persistent level of territorial heterogeneity both in terms of the institutional context and the economic position of women. Indeed, despite Italy's Regions underwent notable changes of policies and socioeconomic indicators during the last few decades, some regional specificities are historically consistent: all along the period considered regions in the South exhibit low women's employment rate coupled with low levels of civic development, weaker macroeconomic conditions and low average educational attainment.

In this paper, we exploited these sources of Regional variance in the most relevant socio-economic indicators to estimate the joint impact of individual and macro variables on women's employment.

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[10] The joint test strongly rejects the null hypothesis that the random effects parameters are all zero.

Confirming the results from the literature, education is proven as the most relevant individual characteristic enhancing women's employment. Our historical perspective has also shown that its importance has even increased over time: in other words, the returns to women's education in terms of employability increased their significance. Also, we found that a crucial hindrance to women's inclusion in the labour market is increasingly constituted by family and care-related work responsibilities over time. Indeed, our results show that, while co-living with an old aged person correlates negatively with men's probability, its impact on women's significantly changed during the period of analysis: while positive in 1977, it became negative in all the following years. This gradual shift might depend on the changing family structures and, specifically, from a period of extended families – when the elderly were more actively involved in home production and unpaid labour (i.e. children care) – to a period of more individualistic families – when the elderly come back to live with their sons and daughters often only in case they cannot take care of themselves. Thus, it cannot be simply concluded that the improved economic position of women has been driven by better opportunities of conciliation between market work and family life.

Moreover, the relative importance of macro factors on the historical dynamics of women's employment is non-negligible. All along the reference period, the civic development index exerted the major impact in our sample, being the sole macroeconomic indicator to exhibit always a positive influence on women's employment. Conversely, the switch towards a private provision of services seems to have accrued women's disadvantage in employment: indeed, if PPS exhibits a marginal positive effect with men's sample, it systematically reduces the likelihood of women to be employed, though its coefficient seems to weaken over time.

Finally, contrarily to what frequently assumed, macroeconomic growth is found to have exerted an ambiguous impact on women's employment over time, by worsening the probability of women's employment in the years 1977 and 1986, reversing this pattern only since the 1990s.

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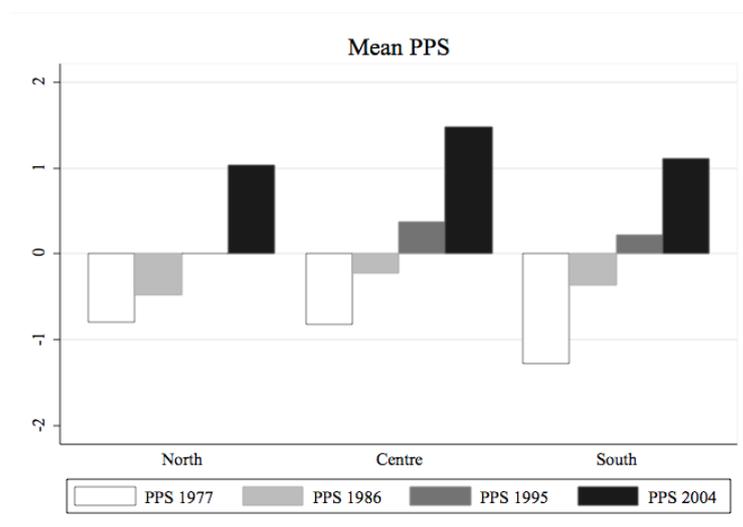
Annex

1. Historical evolution of the Macro Indicators

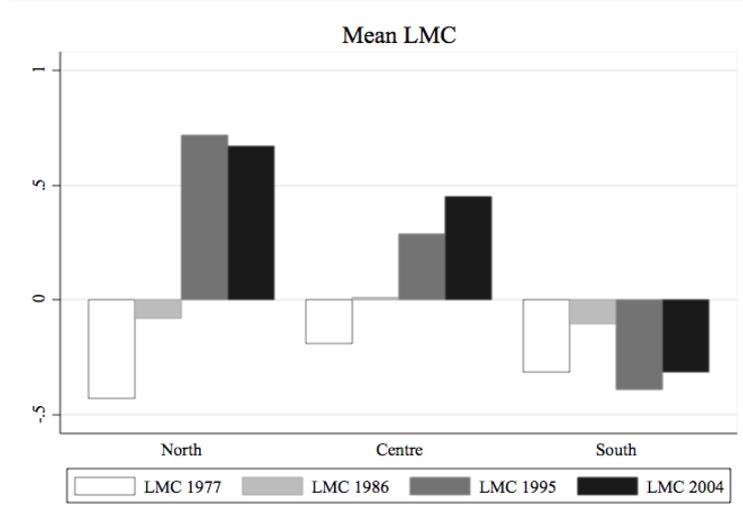Figure A: Long-Run Evolution of the Civic Development Index
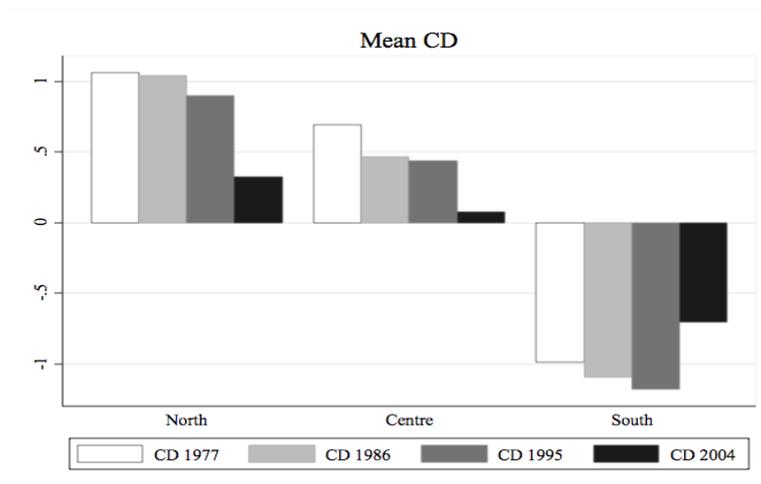
Source: own elaboration on various sources (see Table 1)

Figure B: Long-Run Evolution of the Private Provision of Services Index

Source: own elaboration on various sources (see Table 1)

Figure C: Long-Run Evolution of the Local Macroeconomic Conditions Index

Source: own elaboration on various sources (see Table 1)

2. The random-coefficient model

2.1. Pooled Estimation

Let y_{ij} be the latent variable for individual i in Region j. We observe the dichotomous response variable y_{ij}^* assuming value 1 if the individual i in Region j is employed, 0 otherwise. Let x_{1ij} be a dummy taking value 1 if the individual is woman, 0 if men; x_{2ij} be a dummy, taking value 0 when the individual i is not married and 1 otherwise; x_{3ij} be a dummy, taking value 1 when at least one old-aged dependent above 70 years old belongs to the household of individual I, 0 otherwise; x_{kij} with k from 4 to K is a set of other personal and family characteristics including: a categorical variable for education, taking value 1 for no education, 2 for primary education, 3 for upper secondary education, 4 for college education, 5 for post-graduate education; a categorical variable for the size of the municipality of residence (from 1 to 5, increasing with size); finally, a variable for household's wealth. We suppose that the impacts of $x_{1ij}, x_{2ij}, x_{3ij}$ (namely, of being woman, being married and co-residing with an old-aged dependant) on the likelihood of being employed depend on the Regional characteristics in terms of the three macroeconomic factors of section X: CD, PPS and LMC. These factors are identified by z_{1j} (which stands for factor 1, CD, in region j), z_{2j} (which stands for factor 2, PPS, in region j), and z_{3j} (which stands for factor 3, LMC, in region j).

Our random coefficient model is composed by an individual level of the following type:

$$(1) \qquad y_{ij} = \gamma_{0j} + \gamma_{1j} x_{1ij} + \gamma_{2j} x_{2ij} + \gamma_{3j} x_{3ij} + \sum_{k=3}^{K} \beta_k x_{kij} + \varepsilon_{ij}$$

25

and a second level which reads as:

(2)

$$\gamma_{1j} = \beta_{10} + \beta_{11} z_{1j} + \beta_{12} z_{2j} + \beta_{13} z_{3j} + u_{1j}$$
$$\gamma_{2j} = \beta_{20} + \beta_{21} z_{1j} + \beta_{22} z_{2j} + \beta_{23} z_{3j} + u_{2j}$$
$$\gamma_{3j} = \beta_{30} + \beta_{31} z_{1j} + \beta_{32} z_{2j} + \beta_{33} z_{3j} + u_{3j}$$

u_{1j}, u_{2j}, u_{3j} are the random effects, or the level-2 residuals for each random coefficient in Region j, distributed as a normal with mean 0 and variance σ_{ui}^2. ε_{ij} is the level-1 residual distributed as a normal with mean 0 and variance σ_ε^2. First and second level residuals are assumed to be independent. Combining (1) and (2), the random-coefficient model is given by:

(3)

$$\begin{aligned}
y_{ij} &= (\beta_{10} + \beta_{11} z_{1j} + \beta_{12} z_{2j} + \beta_{13} z_{3j} + u_{1j}) x_{1ij} + \\
&\quad + (\beta_{20} + \beta_{21} z_{1j} + \beta_{22} z_{2j} + \beta_{23} z_{3j} + u_{2j}) x_{2ij} + \\
&\quad + (\beta_{30} + \beta_{31} z_{1j} + \beta_{32} z_{2j} + \beta_{33} z_{3j} + u_{3j}) x_{3ij} + \\
&\quad + \gamma_{01} + \sum_{k=4}^{K} \beta_k x_{kij} + \varepsilon_{ij}
\end{aligned}$$

The parameters of equation (3) can be interpreted as follows:
- $\beta_{10} x_{1ij}$ represents the impact of being woman on the likelihood of employment that cannot not be explained by macro and micro factors;
- $\beta_{11} z_{1j} x_{1ij}$ represents the impact of the interaction between being woman and CD on the likelihood of employment (indirect effect of CD through "being woman");
- $\beta_{12} z_{2j} x_{1ij}$ represents the impact of the interaction between being woman and PPS on the likelihood of employment (indirect effect of PPS through "being woman");
- $\beta_{13} z_{3j} x_{1ij}$ represents the impact of the interaction between being woman and LMC on the likelihood of employment (indirect effect of LMC through "being woman");
- $\beta_{20} x_{2ij}$ represents the impact of being married on the likelihood of employment that cannot not be explained by macro and micro factors;
- $\beta_{21} z_{1j} x_{2ij}$ represents the impact of the interaction between being married and CD on the likelihood of employment (indirect effect of CD through "being married");
- $\beta_{22} z_{2j} x_{2ij}$ represents the impact of the interaction between being married and PPS on the likelihood of employment (indirect effect of PPS through "being married");
- $\beta_{23} z_{3j} x_{2ij}$ represents the impact of the interaction between being married and LMC on the likelihood of employment (indirect effect of LMC through "being married");
- $\beta_{30} x_{3ij}$ represents the impact of co-living with an old-aged dependant on the likelihood of employment that cannot not be explained by macro and micro factors;

- $\beta_{31} z_{1j} x_{3ij}$ represents the impact of the interaction between co-living with an old-aged dependant and CD on the likelihood of employment (indirect effect of CD through "co-living with an old-aged dependant");

- $\beta_{32} z_{2j} x_{3ij}$ represents the impact of the interaction between co-living with an old-aged dependant and PPS on the likelihood of employment (indirect effect of PPS through "co-living with an old-aged dependant");

- $\beta_{33} z_{3j} x_{3ij}$ represents the impact of the interaction between co-living with an old-aged dependant and LMC on the likelihood of employment (indirect effect of LMC through "co-living with an old-aged dependant");

- γ_{10} represents the first-level intercept;

- $\sum_{k=4}^{K} \beta_k x_{kij}$ represents the impact of the others micro-characteristics on the likelihood of employment ;

- ε_{ij} represents the first-level residual;

- $u_{1j} z_{1j}, u_{2j} z_{2j}, u_{3j} z_{3j}$ represents the second-level residuals.

The probability of being employed for the individual i in region j can be expressed as:

$$(4) \quad \Pr(y_{ij}=1 \mid z_{1j}, z_{2j}, z_{3j}, \sum_{k=1}^{K} x_{kij}) = \Phi \begin{pmatrix} (\beta_{10} + \beta_{11} z_{1j} + \beta_{12} z_{2j} + \beta_{13} z_{3j} + u_{1j}) x_{1ij} + \\ + (\beta_{20} + \beta_{21} z_{1j} + \beta_{22} z_{2j} + \beta_{23} z_{3j} + u_{2j}) x_{2ij} + \\ + (\beta_{30} + \beta_{31} z_{1j} + \beta_{32} z_{2j} + \beta_{33} z_{3j} + u_{3j}) x_{3ij} + \\ + \gamma_{01} + \sum_{k=3}^{K} \beta_k x_{kij} + \varepsilon_{ij} \end{pmatrix} = \Phi(\Theta)$$

where Pr is probability and Φ is the probit function, the cumulative distribution function of the standard normal distribution. The β are typically estimated by maximum likelihood.

The likelihood function for an individual i in region j, conditioned to u_{1j}, u_{2j}, u_{3j} is:

(5)

$$L_{ij}(\Theta \mid u_{1j}, u_{2j}, u_{3j}) = \left[\Phi(\Theta)\right]^{y_{ij}} \left[1 - \Phi(\Theta)\right]^{1-y_{ij}}$$

The likelihood for an individual i in region j, integrating out the random term u_{1j}, u_{2j}, u_{3j} reads:

(6)

$$L_{ij}(\Theta) = \int_{-\infty}^{+\infty} \left[\Phi(\Theta)\right]^{y_{ij}} \left[1 - \Phi(\Theta)\right]^{1-y_{ij}} \varphi_j(u_{1j}) d(u_{1j}) \varphi_j(u_{2j}) d(u_{2j}) \varphi_j(u_{3j}) d(u_{3j})$$

where $\varphi(\cdot)$ are the density functions of the corresponding random effects.

Suppose data set contains N individuals (first-level units) and R Regions (second-level units). Then, the Likelihood Function reads as:

(7)

$$\prod_{i=1}^{R}\prod_{j=1}^{T}L_{ij}(\Theta)=\prod_{i=1}^{R}\prod_{j=1}^{T}\int_{-\infty}^{+\infty}\left[\Phi(\Theta)\right]^{y_{ij}}\left[1-\Phi(\Theta)\right]^{1-y_{ij}}\varphi_j(u_{1j})d(u_{1j})\varphi_j(u_{2j})d(u_{2j})\varphi_j(u_{3j})d(u_{3j})$$

The likelihood function is approximated via a Gauss-Hermite quadrature.

2.2. Women's Estimation

Let y_{ij} be the latent variable for individual i in Region j. We observe the dichotomous response variable y_{ij}^* assuming value 1 if the individual i in Region j is employed, 0 otherwise. Let x_{1ij} be a dummy, taking value 0 when the individual i is not married and 1 otherwise; x_{2ij} be a dummy, taking value 1 when at least one old-aged dependent above 70 years old belongs to the household of individual *I*, 0 otherwise; x_{kij} with *k* from 3 to *K* is a set of other personal and family characteristics including: a categorical variable for education, taking value 1 for no education, 2 for primary education, 3 for upper secondary education, 4 for college education, 5 for post-graduate education; a categorical variable for the size of the municipality of residence (from 1 to 5, increasing with size); finally, a variable for household's wealth. We suppose that the impacts of the intercept, of being married and co-residing with an old-aged dependant on the likelihood of being employed depend on the Regional characteristics in terms of the three macroeconomic factors of section X: CD, PPS and LMC. These factors are identified by z_{1j} (which stands for factor 1, CD, in region *j*), z_{2j} (which stands for factor 2, PPS, in region *j*), and z_{3j} (which stands for factor 3, LMC, in region *j*).

Our random coefficient model is composed by an individual level of the following type:

(8) $$y_{ij}=\gamma_{0j}+\gamma_{1j}x_{1ij}+\gamma_{2j}x_{2ij}+\sum_{k=3}^{K}\beta_k x_{kij}+\varepsilon_{ij}$$

and a second level which reads as:

(9)

$$\gamma_{0j}=\beta_{00}+\beta_{01}z_{1j}+\beta_{02}z_{2j}+\beta_{03}z_{3j}+u_{0j}$$
$$\gamma_{1j}=\beta_{10}+\beta_{11}z_{1j}+\beta_{12}z_{2j}+\beta_{13}z_{3j}+u_{1j}$$
$$\gamma_{2j}=\beta_{20}+\beta_{21}z_{1j}+\beta_{22}z_{2j}+\beta_{23}z_{3j}+u_{2j}$$

u_{0j},u_{1j},u_{2j} are the random effects, or the level-2 residuals for each random coefficient in Region *j*, distributed as a normal with mean 0 and variance σ_{ui}^2. ε_{ij} is the level-1 residual distributed as a normal with mean 0 and variance σ_{ε}^2. First and second level residuals are assumed to be independent.

Combining (8) and (9), the random-coefficient model is given by:

(10)

$$y_{ij} = (\beta_{00} + \beta_{01} z_{1j} + \beta_{02} z_{2j} + \beta_{03} z_{3j} + u_{0j}) +$$
$$+ (\beta_{10} + \beta_{11} z_{1j} + \beta_{12} z_{2j} + \beta_{13} z_{3j} + u_{1j}) x_{1ij} +$$
$$+ (\beta_{20} + \beta_{21} z_{1j} + \beta_{22} z_{2j} + \beta_{23} z_{3j} + u_{2j}) x_{2ij} +$$
$$+ \sum_{k=3}^{K} \beta_k x_{kij} + \varepsilon_{ij}$$

The parameters of equation (10) can be interpreted as follows:

- $\beta_{10} x_{1ij}$ represents the impact of being married on the likelihood of employment that cannot not be explained by macro and micro factors;
- $\beta_{11} z_{1j} x_{1ij}$ represents the impact of the interaction between being married and CD on the likelihood of employment (indirect effect of CD through "being married");
- $\beta_{12} z_{2j} x_{1ij}$ represents the impact of the interaction between being married and PPS on the likelihood of employment (indirect effect of PPS through "being married");
- $\beta_{13} z_{3j} x_{1ij}$ represents the impact of the interaction between being married and LMC on the likelihood of employment (indirect effect of LMC through "being married");
- $\beta_{20} x_{2ij}$ represents the impact of co-living with an old-aged dependant on the likelihood of employment that cannot not be explained by macro and micro factors;
- $\beta_{21} z_{1j} x_{2ij}$ represents the impact of the interaction between co-living with an old-aged dependant and CD on the likelihood of employment (indirect effect of CD through "co-living with an old-aged dependant");
- $\beta_{22} z_{2j} x_{2ij}$ represents the impact of the interaction between co-living with an old-aged dependant and PPS on the likelihood of employment (indirect effect of PPS through "co-living with an old-aged dependant");
- $\beta_{23} z_{3j} x_{2ij}$ represents the impact of the interaction between co-living with an old-aged dependant and LMC on the likelihood of employment (indirect effect of LMC through "co-living with an old-aged dependant");
- β_{00} represents the model's intercept (the Regional variance in women's employment that cannot be explained by micro and macro-factors);
- $\beta_{01} z_{1j}$ represents the direct impact of CD on the likelihood of women's employment;
- $\beta_{02} z_{2j}$ represents the direct impact of PPS on the likelihood of women's employment;
- $\beta_{03} z_{3j}$ represents the direct impact of LMC on the likelihood of women's employment;
- $\sum_{k=4}^{K} \beta_k x_{kij}$ represents the impact of the others micro-characteristics on the likelihood of employment ;
- ε_{ij} represents the first-level residual;
- $u_{0j} z_{0j}, u_{1j} z_{1j}, u_{2j} z_{2j}$ represents the second-level residuals.

The probability of being employed for the individual i in region j can be expressed as:

$$(11) \quad \Pr(y_{ij} = 1 \mid z_{1j}, z_{2j}, z_{3j}, \sum_{k=1}^{K} x_{kij}) = \Phi \begin{pmatrix} (\beta_{00} + \beta_{01} z_{1j} + \beta_{02} z_{2j} + \beta_{03} z_{3j}) + \\ + (\beta_{10} + \beta_{11} z_{1j} + \beta_{12} z_{2j} + \beta_{13} z_{3j}) x_{1ij} + \\ + (\beta_{20} + \beta_{21} z_{1j} + \beta_{22} z_{2j} + \beta_{23} z_{3j}) x_{2ij} + \\ + \sum_{k=3}^{K} \beta_k x_{kij} \end{pmatrix} = \Phi(\Theta)$$

where Pr is probability and Φ is the probit function, the cumulative distribution function of the standard normal distribution. The β are typically estimated by maximum likelihood.

The likelihood function for an individual i in region j, conditioned to u_{0j}, u_{1j}, u_{2j} is:

(12)

$$L_{ij}(\Theta \mid u_{0j}, u_{1j}, u_{2j}) = \left[\Phi(\Theta)\right]^{y_{ij}} \left[1 - \Phi(\Theta)\right]^{1-y_{ij}}$$

The likelihood for an individual i in region j, integrating out the random term u_{0j}, u_{1j}, u_{2j} reads:

(13)

$$L_{ij}(\Theta) = \int_{-\infty}^{+\infty} \left[\Phi(\Theta)\right]^{y_{ij}} \left[1 - \Phi(\Theta)\right]^{1-y_{ij}} \varphi_j(u_{0j}) d(u_{0j}) \varphi_j(u_{1j}) d(u_{1j}) \varphi_j(u_{2j}) d(u_{2j})$$

where $\varphi(\cdot)$ are the density functions of the corresponding random effects.

Suppose data set contains N individuals (first-level units) and R Regions (second-level units). Then, the Likelihood Function reads as:

(14)

$$\prod_{i=1}^{R} \prod_{j=1}^{T} L_{ij}(\Theta) = \prod_{i=1}^{R} \prod_{j=1}^{T} \int_{-\infty}^{+\infty} \left[\Phi(\Theta)\right]^{y_{ij}} \left[1 - \Phi(\Theta)\right]^{1-y_{ij}} \varphi_j(u_{0j}) d(u_{0j}) \varphi_j(u_{1j}) d(u_{1j}) \varphi_j(u_{2j}) d(u_{2j})$$

The likelihood function is approximated via a Gauss-Hermite quadrature.

3. Details of the second level: estimation on women

Table A.1: Details of the second level: the influence of the macro factors on the coefficient of the dummy variable "being married"

	1977	1986	1995	2004
Married: St.Dev.	0.310	0.444	0.220	0.192
	0.036**	*0.025***	*0.024***	*0.011***
Regional Intercept	-0.190	0.156	-0.230	-0.025
	0.090**	*0.078***	*0.050***	*0.054*
CD	0.063	-0.086	-0.024	-0.142
	0.037*	*0.053*	*0.028*	*0.034***
PPS	-0.016	0.146	-0.025	-0.042
	0.068	*0.071***	*0.047*	*0.039*
LMC	0.215	-0.019	0.072	0.010
	0.101**	*0.111*	*0.022***	*0.011*

Source: own elaboration on SHIW (various years), sample restricted to age bracket [25-54], and various sources (see Table 1)

Table A.2: Details of the second level: the influence of the macro factors on the coefficient of the dummy variable "co-living with an old-aged dependant"

	1977	1986	1995	2004
Old-aged: St.Dev.	0.178	0.344	0.418	0.373
	0.016**	*0.024***	*0.034***	*0.027***
Regional Intercept	0.564	-0.300	-0.202	-0.395
	0.099**	*0.097***	*0.043***	*0.076***
CD	0.056	0.157	-0.097	0.556
	0.042	*0.036***	*0.039***	*0.032*
PPS	0.297	-0.391	0.122	0.032
	0.066**	*0.070***	*0.062***	*0.037*
LMC	0.380	-0.141	0.052	0.059
	0.068**	*0.055***	*0.026***	*0.011***

Source: own elaboration on SHIW (various years), sample restricted to age bracket [25-54], and various sources (see Table 1)