

Closing the gender gap ?

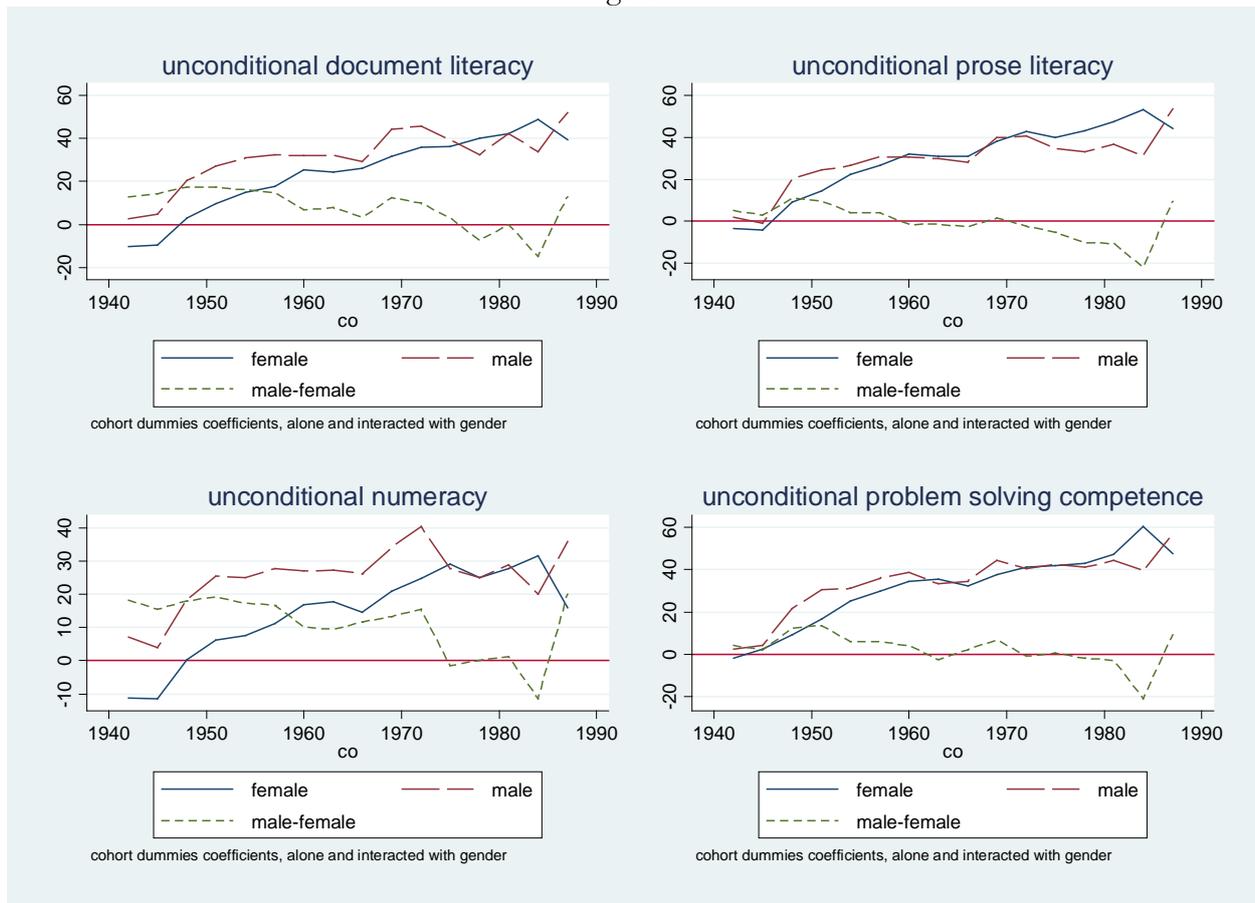
Life competences and social environment

Michela Braga e Daniele Checchi - University of Milan[♣]

1. Introduction

A recent article appeared in *Science* (Guiso et al. 2008) claims that gender based differences in proficiency are mostly explained by cultural effects. The supporting evidence exploits cross-country variation in institutions to partially account for differences in mathematical achievements among 15-year old students surveyed in the 2006 wave of PISA – *Programme for International Student Assessment*. In a similar vein, when looking at the gender differences in various dimensions of proficiency within a sample of adult population, one may be surprised by noticing that a significant gap existed for the first half of the last century, but has now disappeared or even reversed. Figure 1 depicts three-year moving averages of competences measured in a representative sample of the Italian population, collected in 2003 (Adult Literacy and Life Skills – ALL).

Figure 1



In this paper we aim exploring the driving factors of this gap. This is not an easy task, because proficiency is correlated with family background, education, labour market participation and literacy practice in the society, with causality running in unknown directions (Desjardins 2003). In addition, whenever one is interested in disentangling the (casual) effect of environment, he is confronted with the problem of self-selection of populations. Unless one can rely on random assignment to different

[♣] Paper prepared for the conference *Monitoring Italy 2009: Measuring the Progress of Italian Society* (Rome, June 3-4, 2009)

environments (as in Gould et al. 2009), it is impossible to exclude the possibility that environmental effects reflect spurious correlation among unobservable variables (like political or religious orientation). In the case of gender gaps, an important role is played by different social expectations on the role that men and women may play in the society. However social norms evolve at different speeds in different locations, according to historical tradition, level of development, exposure to alternative models, or other similar factors. One alternative way to frame the very same issue is to speak of “cultural evolution”, which may account for differences in proficiency that may characterise men and women (Fernandez 2007).

In the present paper we study the distribution of proficiency in the population, with a specific eye to the gender gap. We exploit temporal variations in cross-region indicators that may reflect social norms related to women role in society to investigate whether living in more progressive environments (namely regions where women appear to play a more independent role in the society) may account for the dynamics of the gender gap observed in figure 1. It must be stressed that ours is just a suggested interpretation, because we do not have compelling causal tests of our claims. Nevertheless, given the enormous variations that we observe in the educational attainment gap and in labour market participation over the most recent decades, we provide a consistent interpretation of these dynamics. In line with the literature, our main conclusion is that the gender gap in proficiency shrinks due to increased participation of women in education and/or in the labour market, without a (statistically significant) differential effect associated to the environment. Despite this, more progressive environments prove to be positively correlated to skill formation; as a consequence, our results support the view that social context is crucial in shaping individual behaviour, attitudes and preferences.

The remainder of the paper is organized as follows. In section 2 we provide a review of existing literature on the different dimensions of inequality with a gender dimension, while in section 3 we focus on the determinants of adult competences. Sections 4 and 5 illustrate, respectively, the data and the empirical analysis. Finally, section 6 discusses and concludes.

2. Inequality and gender differences

Gender based inequality is widespread and affects the majority of nations, cultures, religions and income groups. Gender disparities manifest and evolve over time in very different ways without any clear patterns. Historically, women life has been more home and family oriented than the men's, mostly as a result of social norms and rules. These attitudes excluded women from education in the past, and from particular types of employment and leadership positions still nowadays. Existing gender gaps are an easy inequality measure providing information about the domains where women are still receiving a different treatment from the society. There is widespread agreement among economists and policy-makers that promoting gender equality is an essential component of any effective economic and human development strategy.

Up to now, no country has yet reached the point where outcomes for women equal those for men. According to the last available global indicator for gender equality, the 2008 Global Gender Index¹, countries that have best succeeded in narrowing down the gap are the Nordic ones, characterized by highly liberal societies, protection of minority rights and comprehensive welfare systems. On the contrary, traditional patriarchal cultures perform particularly poorly on the economic participation and economic opportunity dimensions. In particular, Italy ranks 67th after countries like China and Botswana. Although Italy have shown a significant improvement in the overall performance during the last years, other European and mostly Catholic countries perform extremely better such as Poland (49th), Spain (17th) or Ireland (8th).

¹ This index quantifies inequality between men and women in economic participation, economic opportunities, political empowerment, education attainment and health and survival. It provides country rankings that allow for effective comparisons across regions and income groups, and over time.

The basic message drawn from this very simple indicator is that in many contexts women have been catching up, but they still lag behind in many dimensions, both at local and global level. In particular, women have less economic opportunities to improve their livings because they are often limited in terms of education, wealth ownership, return to education, financial opportunities, wages or career prospects, and possibilities to influence the decisions both at the family and the society level. Anecdotal observation suggests that countries where women and men have more equal economic opportunities are also the more affluent ones. The level of development seems to be associated with the role of women in the society and the strong correlation between income and gender equality indicates that gender equality is essential to achieve poverty reduction. To reach higher quality of life and to enhance progress it is crucial to consider the contribution of a variety of other factors such inequality *latu sensu*, personal satisfaction, security, environmental status and levels of trust. Inequality in school attainment has been widely explored. The positive correlation between gender equality in educational attainment and GDP levels is a well known stylized fact. Schooling level is crucial for long run growth, but even more important are competences and their evolution over individual lifespan (Hanushek and Woessmann 2007).

Despite its relevance at macro level, the literature on gender gaps has devoted little attention to gender differentials in adulthood proficiency. On the contrary, we find many papers dealing with gender differences in educational choices (in terms of years of schooling) and/or in labour market participation, often associated with differences in the expected return. From a theoretical perspective, starting from Mincer and Polachek (1974) seminal paper, human capital explanations rationalize gender differences in economic outcomes on the basis of natural differences in productivity between the sexes. Following this approach, Becker's theory (1993) argues that women have a natural comparative advantage in household production (e.g. in bearing and nurturing children) relative to men. The pre-existing "gender specific" advantages grow over time either because of the learning-by-doing process or because of social role models, and hence individuals tend to fully specialize in these tasks. Individual and households optimally decide the investment in education and training comparing their expected net benefits and balancing inputs of time, effort, resources with outputs of pay, power and prestige. Because of their role within the family, women work experience will be shorter and more discontinuous. As a result, first, family should rationally invest less in daughter's education since the expected gain is lower. Second, the relative disadvantage for women increases their marginal disutility of market work and decreases their incentive to invest in market-oriented formal education or on-the-job training. Therefore, individual ex-ante expectations will be confirmed by rational firms' behaviour that anticipates women future choices, and pay them lower wages. A similar argument extends to employment possibilities or career opportunities.

Hence, male-female differentials result from voluntary decisions in selecting individual educational attainments, careers and the intensity of labour force participation. An alternative view relates differentials to discrimination that can lead to a different behaviour towards women both *de jure* and *de facto* even if they have no observable differences with respect to men. In a recent contribution, De la Rica et al. (2008), show that a similar self-fulfilling prophecy approach can explain housework and/or labour market differences across genders despite men and women being *ex-ante* identical. Equally productive individuals are trained differently because of different expectations about the distribution of disutility shocks (i.e. unexpected need of household work) faced by each gender once skill acquisition has been completed.

From an empirical point of view, most of the wage gap can be explained by observable differences in occupational choice, educational attainment, and prior work experience. There is robust evidence that gender specific accumulation of working experience can explain a significant part of wage differentials (Mincer and Ofek 1982; Light and Ureta 1995; O'Neill 2003; Polachek 2006). However, others authors

highlight that in some contexts human capital factors explain only a small fraction of the pay gap (Kunze 2003; Blau and Kahn 2006).

A complementary strand of literature concerns the determinants of gender differentials in individual behaviour. If the existence of gender behavioural differences is widely recognised, there is no agreement on causes of such differentials. The simplest explanation relates individual behaviour to gender stereotypes (Steele 1997), leading people to conform to a specific and pre-assigned behaviour. However, in a more complex framework, individual behaviour intrinsically depends on differences that can vary significantly among genders. For example, males and female have been proved to have different attitudes towards mathematics, literacy, competition or risk. What is the mechanism behind behavioural gender differences is an open issue. Three main views can be considered here. First, gender differences may depend on nature. Second, they may be related to nurture. Third, they may be produced by the interaction of the previous two mechanisms.

On one hand, medical sciences put more emphasis on nature. Baron-Cohen (2003) finds that the two genders are intrinsically different from birth: on average males are biologically predisposed to systemise, to analyse and to be more forgetful of others, while on average females are innately designed to empathise, to communicate, and to care for others. Lawrence (2006) show that at birth there exists a difference in the level of testosterone in the developing brain around the third month of gestation, which is higher in males. The author shows how testosterone affects development and behaviour at different ages but he also points out that distinguishing between the contributions of nature and nurture to animal or human behaviour has proved to be difficult.

On the other hand, social sciences put more emphasis on nurture. Psychologists state that traits of individuals' behaviour that are peculiar of each gender emerge depending on the gender composition of the group with whom they interact (Maccoby, 1998). Similarly, social role models suggest that most sex differences result from exposure to sex role socialization, defining the appropriate ways of thinking, feeling, and behaving for men and women (Eagly, 1987; Ruble and Martin, 1998; Maccoby, 2000). Thus, the social role model approach predicts that sex differences in personality traits appear to be attenuated in more progressive and gender egalitarian cultures and they will be accentuated in more traditional cultures. If individuals identify themselves more with same-sex role models, it is possible that performance will be enhanced when individuals live in a context where gender gap is lower.

Obviously, the two mechanisms can be at work at the same time. If the two genders are not alike in all respects because of their genetics differences, brain anatomy and functioning or hormones, this should translate into gender differences in the advanced skills useful for life. However, being born in a context where women behave differently role could reduce this gap. Some recent works put emphasis on social contexts in shaping gender attitudes and behaviour. For example a natural gender gap in mathematical abilities has been contested. Using data on 15-year-old students sampled by the OECD-PISA project in 2003, Guiso et al. (2008) demonstrate that girls perform better in mathematics in more gender equal societies and in some cases they even overcome male peers. Booth and Nolen (2009a) show that gender differences in the propensity to choose risky outcomes depends on how innate preferences are modified by pressure to conform to gender – stereotypes. Similarly, Booth and Nolen (2009b) find that females behave more like boys when they are in single-sex contexts suggesting that observed differences are related to social learning rather than to inherent traits.

Whether and to which extent such differences are innate or depend on social environment have very different implications on reaching equality of opportunities. Subscribing to the “nature” approach, innate differences can translate into different behaviour and attitudes towards school and labour market, since they are differently rewarded in these activities. However, even if innate differences do exist, the environment may still be a major determinants contributing to observed differences. Thus the role of nurture, environment, culture or upbringing may therefore be central to explaining why such

differences exist and evolve over time. Following this evolutionary approach, we study how gender gap in adult proficiency evolved across age cohorts when environmental factors changed over time. In other words, we try to disentangle whether social contexts where an individual grew up had an impact in his/her adulthood level of skills. Our prior is that women who spent their childhood and adolescence in a more progressive society (namely where their older peers experienced a lower gender disadvantage), will perform relatively better in their adulthood. The underlying assumption is that individuals embedded in very traditional contexts, once exposed to more modern behaviour, tend to adapt to the new culture. As result, we expect that more egalitarian attitudes will widespread and will form more egalitarian society.

3. Background on Determinants of Adults Competences

There is a well established consensus that, for the adult population, a definition of literacy simply based upon educational qualifications is inadequate (Kirsch et al. 1993; Murray 1997). The reason is that adult literacy includes a set of skills, knowledge, and strategies that individuals build on throughout their lives. Over the last decade, adult lifelong learning has become a central issue in national policies on education, economy and welfare. The basic idea is that lifelong learning increases citizens' chances to acquire adequate skills and prevents low-paid jobs from becoming life-long traps. The underlying assumption is that literacy is not only essential for everyday life but it also enhances personal, social, and economic development. Therefore, in principle, all countries should implement policies for lifelong learning as a basic component of the social model which translate into participation in some form of organized adult education such as courses, programs or other forms of training.

Identifying the main determinants of acquisition, development and maintenance of literacy skills has been the focus of different studies. The main results suggest that educational attainment is the key determinant of cognitive skills proficiency, including adult literacy and numeracy (Kirsch et al. 1993; Raudenbush and Kasim 1998; Boudard 2001; Desjardins 2004). Each order of education is crucial in this process. In primary schools basic skills are acquired, while in secondary schools these skills are applied to learning specific contents. However, the process of acquisition, development, maintenance and depreciation of cognitive skills over the lifespan is extremely complex and involves other factors than formal education. In particular, adult proficiency depends on skills that are learned and developed in very different contexts. According to the practice engagement theory (Reder 2004), basic literacy skills start to be acquired through teaching in a specific context but they are nurtured in a cumulative way in a variety of contexts. Put differently, individual skills become reinforced and more flexible as well as they reach a higher level of functionality thanks to their practice in a number of context including, for example, home, school, work or communities.

Literacy demand changes over different stages of individual life (childhood, school years, working age, and retirement) but at the same stage, different individuals may have very different demands, according to their specific individual characteristics. For example, jobs that demand low level of literacy (by requiring people to carry out repetitive tasks) typically exert a detrimental effect on development and maintenance of adult proficiency, while work environments requiring in depth understanding of contents enhance individual proficiency. Family, communities, social relationships are crucial too and can substitute or compensate labour market experiences.

Obviously, the relative importance of different contexts changes over the lifespan. In early childhood the home and family context are crucial for skill acquisition, and this remains true also in the schooling years, though the school context begins to acquire more weight. In adulthood, family is still essential but the work context becomes more relevant together with community and social relationships that start playing a significant role. The continued learning process can complement previous education experiences and enhance individual proficiency, but it can also compensate or substitute a low level of formal education. Symmetrically, the lack of such upgrading process can potentially depreciate the stock of available individual skills.

On average older age groups tend to have lower proficiency than younger adults and reading comprehension decreases with aging (Meyer et al. 1993). It could depend on different reasons. First, it could be a pure cohort and period effect capturing longer formal education received by younger cohorts in a period of education expansion (Portrait et al. 2003). Possible differences in the quality of educational provision among age cohorts may also systematically contribute to the previous pattern. However, there is evidence that the dispersion in proficiency scores within the levels of educational attainment is higher among older cohorts leading to a diminishing predictive capacity of education over time. This means that, some older adults gain skills while many others lose them, independent of education, simply because they have accumulated very different life experiences. Although it has been found that education has a strong and persistent effect on skill over time, exclusive reliance on measures of educational attainment to predict adult skills will lead to considerable error. Results show that skill differences among age cohorts remain even after controlling for individual educational attainment. However it is worth remembering that the effect of school on adults' proficiency could be spurious, since it could simply capture the fact that more able students self select to higher level of education.

Second, it could be a recency effect suggesting that skills diminish as time elapses from the end of individual exposure to formal education because of the progressive decline in individual attention capacity, processing speed, reasoning, working memory capacity and spatial ability as age increases (Smith and Marsiske 1997). Moreover, age can be positively correlated with cognitive performance since older persons have a relative advantage compared to young people because of their experience or practice in everyday life (practice effects) (Baltes 1987). This is corroborated by studies that highlight how skill and knowledge accumulation can go over until advanced age (Schaie 1994; Marsiske and Smith 1998). The interaction between ageing and practice effects can produce different outcomes depending on the extent and nature of life experiences.

Gender differences are difficult to disentangle from differences in educational careers and/or labour market experiences. Until recently, men typically obtained more education than women, participated more to the labour market and were more frequently exposed to situations where literacy is maintained or enhanced (for example political activities). Evidence from IALS (an adult literacy survey conducted between 1994 and 1998) suggests that differences between men and women in adult skills are small but they tend to be in favour of men for the quantitative and document literacy domains, and in favour of women for the prose literacy domain. This pattern of gender differences among similar domains is consistent with findings from international assessments of school-aged children at age 14 (IEA Reading Literacy Study) and age 15 (PISA). In PISA, girls significantly outperform boys in reading literacy while by contrast boys outperform girls in mathematical literacy. Men tend to display an advantage in numeracy and document literacy skills, while women tend to display an advantage in prose literacy.

Labour force participation is a crucial element in defining individual level of skills because those in the labour force are exposed to an additional environment other than family and community. On average evidence suggests that employed people have a consistently higher level of literacy. However, these results do not consider that individual out the labour force are extremely heterogeneous since some of them are students currently enrolled and others are early retired people. The formers tend to perform relatively better, the latter relatively worse. Moreover, labour force includes unemployed people whose proficiency is quite poor.

4. The Data

The core of our analysis is the role of social environment in shaping adult proficiency with a special focus on gender differences. Since, in principle, cultural changes are driven by the circulation of new ideas, different cultural/social norms or alternative institutions, we expect that individuals brought up

in more progressive societies where women empowerment was higher, should achieve higher level of proficiency than their peers living in very traditional societies. In addition, also the gender gap should be lower for those who have been exposed to less conservative and traditional life styles. In other words, our prior is that the gender gap in adult performance would be lower in more progressive and egalitarian contexts. To test this hypothesis we combine primary data for adult proficiency with secondary data for society progressivism.

The primary data source for our analysis is the Adult Literacy and Life Skills (ALL) survey conducted by OECD in 2003, as a follow up of the International Adult Literacy Survey carried out in twenty – two countries between 1994 and 2000. The survey was designed to identify and measure a range of skills linked to individual social and economic success. In particular, it measures the functional literacy levels of adults based on the tasks encountered in contemporary developed societies. In addition, the project was aimed to shed light on the social and economic factors that determine or underlie change in the observed skill profile over time. Namely, it was focused to analyse the distribution of prose and document literacy as well as the numeracy and problem-solving in the adult population and to determine the inter-relationship of these skills. The reference population includes people aged 15 – 65 years. The ALL assessment was administered at homes by experienced interviewers. The study design combined educational testing techniques with those of household survey research. Respondents were first asked a series of questions to obtain background information on a range of variables thought to influence the formation of skill and in turn impact on a range of educational, social and health outcomes.

The ALL study defines proficiency along a continuum to establish how well adults use information to function in the society and in the economy. The measured skills include prose literacy, document literacy, numeracy, and problem solving². Additional skills assessed indirectly include familiarity with and use of information and communication technologies. Together with testing skills useful in everyday life, the survey explores individual quality of life measuring individual well-being, achievement in social life and participation in social activities in the reference community. For each domain, proficiency is denoted on a scale ranging from 0 to 500 points. Each score denotes a point at which a person has an 80 per cent chance of successfully completing tasks that are associated with a similar level of difficulty.

Secondary data sources are used to identify alternative indicators for society progressivism at different time periods and in different geographical areas. Since, we expect a society to be less conservative if women empowerment, at different level, is higher, following the Global Gender Index approach, we recover some indirect measures of women equality in Italian society along three different dimensions: labour market participation, political empowerment and sexual emancipation.

For what concerns labour market, we use as a proxy for gender equality of opportunities the gender specific employment rates obtained from the National Statistical Office (ISTAT). Unfortunately time series on labour market are available only from 1951 and have a low level of territorial disaggregation since they refer only to North, Centre and South. As a proxy for women political empowerment we use the share of elected women in politics at regional level. Data come from the database on local and regional administrators which collects socio demographic characteristics of Italian politics in charge the 31st December of each year starting from 1985. Compared with the previous indicator, in this case we have a higher level of territorial variability but the available time series are shorter.

² Prose literacy is defined as the knowledge and skills needed to understand and use information from texts including editorials, news stories, brochures and instruction manuals. Document literacy is the knowledge and skills required to locate and use information contained in various formats, including job applications, payroll forms, transportation schedules, maps, tables and charts. Numeracy is the knowledge and skills required to effectively manage the mathematical demands of diverse situations. Problem solving involves goal-directed thinking and action in situations for which no routine solution procedure is available.

To measure women sexual emancipation a good indicator should have been the birth control pill use, one of the main medical changes in the 20th century allowing women control over career choice (Goldin and Katz 2002) and occupation opportunities. Since in Italy, time series on pill diffusion are available only at national level, we prefer to exploit both time and regional variation in the voluntary abortion rate that has been shown to be inversely related to the oral contraceptive use among women (Dreyfus 1992). The second proxy for women emancipation within the society is the total fertility rate that is the number of children a hypothetical cohort of 1000 women would bear if they all experienced the same age-specific birth rates during their childbearing years. In line with abortion, as women control over her sexuality increases, the fertility rate should decrease. The data source for this indicator is the Heath for All database, containing a variety of basic health statistics at regional level starting from 1982. An alternative indicator we use for women sexual emancipation is the share of non religious marriages over the total number of marriages. Civil marriages are actually characterized by lower gender segregation and a higher equality between partners. They tend to go hand by hand with women emancipation and independence. We construct this indicator at regional level starting from 1971 using data collected by ISTAT and the municipal offices of Civil Status (Uffici comunali dello Stato Civile). Finally we use as a proxy for a progressive society the share of catholic baptisms over the newborns. This indicator is inversely related with the secularization process leading to a lower religious influence and to a more modern society. We obtain data from the Statistical Office of the Italian Catholic Church in Vatican which collects data on baptisms in each diocese. Such data are available from 1986.

Since the ALL Italian sample is representative of the adult working age population residing in all regions, the oldest individuals were born in 1938, while the youngest in 1986. In order to test whether progressivism when youth influences adult proficiency level, we match each individual with the corresponding environmental variable for the year in which she/he was 15 years old, that is when they were supposed to enter the labour market. Detailed summary statistics on the variables used in the empirical analysis are reported in the Appendix, table A1.

5. Empirical Analysis

The empirical analysis proceeds in three subsequent steps. The first step consists in analyzing the evolution of the gender gap in the average level of adult competences during the last fifty years, conditional to individual specific observables; unconditional dynamics were already reported in figure 1. The second step compares birth cohorts according to the prevailing role of women in the society in order to disentangle whether environment matters for proficiency acquisition. The last step takes into account the potential endogeneity arising in the basic model for adult proficiency and use instrumental variable techniques.

5.1 The gender dynamics

We start our analysis by considering the gender dynamics of adult competences in the last fifty years. In particular, for individual i belonging to age cohort j , we estimate the following equation:

$$competence_{ij} = \alpha_0 + \alpha_1 \cdot female + \sum_j \alpha_{2j} \cdot \delta_j + \sum_j \alpha_{3j} \cdot \delta_j \cdot female + \varepsilon_{ij} \quad (1)$$

where the dependent variable *competence* is individual performance in each tested domain (i.e. document literacy, prose literacy, numeracy and problem solving), while the explanatory variables are the gender indicator *female*, assuming value one for women, and the cohort dummies δ_j , assuming value one for those individuals born in year j . The stochastic error term ε_{ij} captures individual unobservable characteristics. The interaction of the dummies for the birth cohort and gender accounts for the

evolution of differentials between men and women over time. For all individuals born between 1938 and 1986, in figure 1 we have plotted the vector of $[\bar{\alpha}_2]$ coefficients for men, the vector of $[\alpha_1 + \bar{\alpha}_2 + \bar{\alpha}_3]$ coefficients for women and their difference. To preserve sufficient sample size by gender within each cohort we use three-year birth cohorts.³

The evolution of the average level of adult skills by gender and birth year indicates that the gender gap, measured as the difference in male–female level of competences, has closed for the cohorts born in the second half of the 1970s and, since then, the gap has reversed sign. This declining dynamic across cohorts is stable whatever measure of life competence we take. Even focusing on mathematical competences, which traditionally record a gender penalty for women, even among youngsters, one observes that female generations born in the mid 1970s tend to overcome their male counterparts. Secular evolution seems to suggest that also in those domains traditionally thought of as being dominated by males, young cohorts of females outperform.

One may observe that part of this acceleration in favour of females may be attributed to composition effects due to changes in the distribution of men and women over educational attainments, and consequently due to increasing female labour market participation over time. There is unambiguous evidence that women have already passed men in terms of acquired education, and that also their labour market attachment is catching up. Obviously, given the cross-sectional nature of the data-set, at this stage of our analysis, we are unable to distinguish between age effects and cohort effects also because we are considering quite small cohort size.⁴

However, while the competences appear to be trended either because of natural decay along the life span or because of longer stay in the educational system for younger cohorts, the gender gap closure for younger generations could potentially depend on other factors. Other than birth cohorts, the four main dimensions connected with the development of life competences that potentially account for various dimensions of gender gap, are family background, individual educational attainment, employment status, and the environment (Gallina 2006). Therefore, in order to control for individual specific characteristics accounting for the gender gap decline we estimate the following equation:

$$\begin{aligned} competence_{ij} = & \alpha_0 + \alpha_1 \cdot female + \sum_j \alpha_{2j} \cdot \delta_j + \sum_j \alpha_{3j} \cdot \delta_j \cdot female + \alpha_4 \cdot fat.education_i + \alpha_5 \cdot mot.education_i + \\ & + \alpha_6 \cdot education_i + \alpha_7 \cdot employment_i + \alpha_8 \cdot urban + \sum_k \alpha_{9k} \cdot region_k + \varepsilon_{ij} \end{aligned} \quad (2)$$

where our basic specification (3) is augmented by including individual exogenous characteristics (age cohort, gender, parental education) and by controlling for achievements (education, employment, individual place of residence - whether living in urban areas and the region of residence).

In principle, we would like control for the region where an individual was born and/or grew up, but unfortunately this information is not available in the survey. The only information reported in the survey is whether an individual was born abroad, and we exclude these observations from the sample. Thus, we are forced to use the region of residence as proxy for the region of birth, mixing two distinct phenomena: potential migration and actual environment. Given the decline of the former, the latter is an acceptable approximation for the youngest cohorts, but it may bias the estimated coefficients for the older cohorts since internal migration was likely not random.

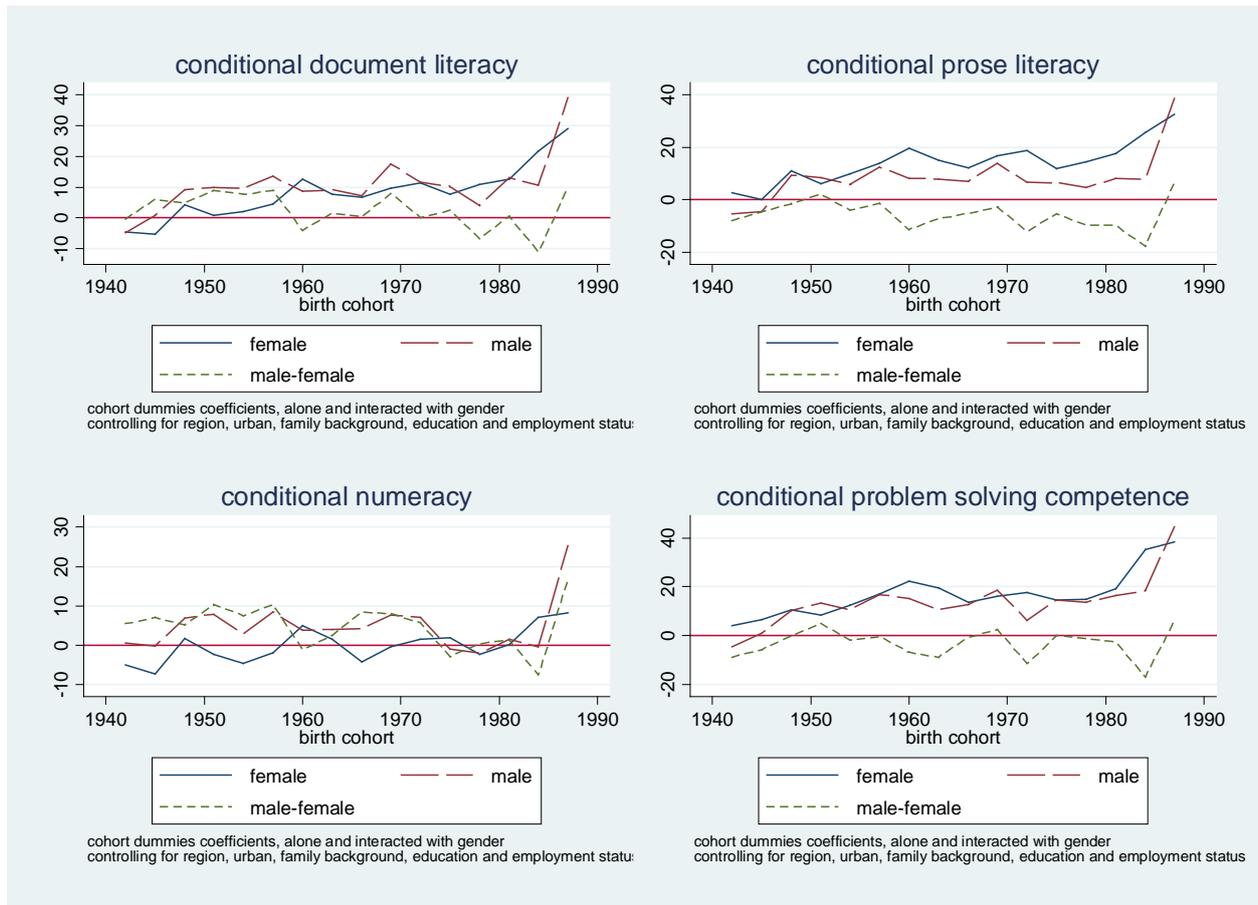
As in the previous specification, the estimates are plotted in figure 2 through the conditional vector of $[\bar{\alpha}_2]$ coefficients for men, the conditional vector of $[\alpha_1 + \bar{\alpha}_2 + \bar{\alpha}_3]$ coefficients for women and their

³ Similar (but noisier) evidence emerges when using birth years.

⁴ However, in the sequel we will be able to (partially) distinguish between the two effects by interacting the cohort with environmental variables.

difference. The inspection of our results suggests that also when controlling for individual specific observable factors the gap closure in competences among genders does not vanish and, in most cases, women perform consistently better than men. In addition, the advantage for women it emerges to be increasing after the mid 1970s (see figure 2). By comparing figure 1 with figure 2 we are induced to believe that most of the gender gap observed in the data across age cohorts may be attributed to compositional effects, since most of the cohort dummies are not statistically different from zero.

Figure 2: Conditional adult competences by gender (cohort of birth 1938 - 1986)



5.2 OLS estimates

Having documented the downward trend in gender gap, we explore whether environmental factors may have played a role in speeding up this convergence. In order to study whether and to which extent gender differences are innate or depend on social norms, we model individual proficiency as a function of individual characteristics (as outlined above) and environmental factors that potentially influence gender behaviour in educational investment. In particular, we use as an exogenous source of variation environmental features of the period in which each individual may have decided the optimal investment in education. The basic idea is that the environment in which an individual grew up constitutes one of the major determinants contributing to differences in skills observed in the adulthood. Our prior is that individuals who spent their childhood and adolescence in a more progressive society, will be more proficient in their adulthood, since they had the opportunity to observe less traditional behaviours. In addition, we expect the gender differential to be lower in more egalitarian societies that is in contexts where women have higher empowerment and where their older peers experienced a lower gender disadvantage. The underlying assumption is that individuals embedded in very traditional contexts, once exposed to more modern behaviour, tend to adapt to the new culture. Therefore, to test our

hypothesis, we estimate the following linear multivariate model of the individual proficiency of individual i belonging to age cohort j and (supposedly grown up and) residing in region k :

$$\begin{aligned}
competence_{ijk} = & \alpha_0 + \alpha_1 \cdot female + \sum_j \alpha_{2j} \cdot \delta_j + \alpha_3 \cdot environment_{kj+15} + \\
& + \alpha_4 \cdot female \cdot environment_{kj+15} + \alpha_5 \cdot education_i + \alpha_6 \cdot employment_i + \\
& + \alpha_7 \cdot fat.education_i + \alpha_8 \cdot mot.education_i + \alpha_9 \cdot urban + \sum_k \alpha_{10k} \cdot region_k + \varepsilon_{ij}
\end{aligned} \tag{4}$$

Our coefficients of interest are α_3 and α_4 , because according to their sign and significance, they provide information about which environmental features may have been correlated with a different level of adult proficiency and a differential in competence formation between genders. To fully analyse the changes in gender behaviour we should decompose the observed differences into age, cohort and time effects. The first one actually captures the standard life cycle patterns in the data, the second one is related to the evolution of participation rates across generations as a result of macro-level conditions of the society that simultaneously affect all individuals in a specific cohort, while the latter effect captures the variations in the rates as a response to business cycle fluctuations. To separate the three effects longitudinal data would be needed to track changes at the individual level for multiple cohorts. Unfortunately, all the available data on adult skills are cross sections and the best option available is the implementation of a pseudo cohort analysis to partially distinguish among the three effects. Namely, we include different environmental variables that, in principle, may have had a differential impact among the two genders over time and regions.

In each specification the crucial assumption is that the environment mostly affects competence formation when an individual is becoming adult. For this reason we match each individual residing in region k with the environmental variable observed in the same region when he/she was 15-year old.⁵ The “exposure” of an individual to the “treatment” (i.e. more progressive society) and its intensity are determined by the period in which he/she entered the labour market (cohort of birth) and by his/her region of residence, respectively. In this way we were able to find two exogenous sources of variation: over time and within regions. Thus, two individuals residing in the same region but differently aged are matched with different values of the same variable. By also retaining in our model the cohort dummies we are therefore able to control for any other effect (including aging of the sampled individuals) which may imply a separate contribution to the process of competence formation irrespective of the environment. This contributes to partially separate the age effect, captured by the cohort dummies, from the cohort effect, captured by the environmental variables. Nevertheless, two individuals with the same age residing in the same region but with a different gender are matched with the same set of variables. In such a case only the selection of the environmental variables may contribute to potentially discriminate among the two effects.

In table 1 we report the correlation between quantitative competences and environmental variables. Although the survey provides distinct measures of each tested domain, we focus on mathematical skills and we define mathematical proficiency as the average between numeracy and problem solving scores. This choice is based on three orders of reasons. First, the gender gap in mathematical performance turns out to be very robust in the youngest generations (see student performance as measured by PISA surveys). Second, there is debate over whether humans have an innate capacity for mathematics, while there is more consensus that other cognitive skills are more dependent from socio economic family background; then focusing on math allows putting more emphasis on environmental factor in explaining skill evolution over time. Third, the correlations in performance across the four domains are extremely strong and similar results obtain when we consider the average across the four areas of

⁵ As we mentioned before, we would have liked to match the individual with the environmental variables observed where she was residing when 15-year old, but unfortunately this information is not available.

competences, or even when we restrict to the literacy ones (the average between prose and documentation).

In each specification, we have computed robust standard errors and we have used probability weights to account for the survey's sample design. Although not reported in the table, controls are included for region of residence and 3-year cohort dummies; in addition, parental education, separately for mother and father, household composition and an indicator for urban/rural residence are also introduced to account for exogenous source of variation. All specifications consistently show no correlation between gender and level of competences, whereas achieved education exhibits positive and significant correlations in all cases. Depending on the specification, one more year of schooling increases the test score from 4.9 to 5.3 points. By the contrary, the positive correlation with current employment status is not robust to different specifications.⁶ As expected, family background has a positive impact on adult literacy but in all cases mother educational attainment exerts a higher effect. Living in an urban area increases adult competences, but the result is not robust to different specifications. Conversely, household size (not reported) is inversely related to proficiency, but again the result is not robust to different specifications.

When considering external environment information, in column 1 of table 1 we focus on the impact of local labour markets. The female employment rate is positively associated to competences formation, while the male employment rate does not display any statistically significant effect on individual skills. We would have expected these rates exerting a differential impact on males and females, but both interactions turn out not to be significant. However, if we exclude the level variables (rate of employment), the interaction between female and female occupation rate turns out significant (not reported), witnessing that female competence formation has been enhanced in regions and/or years where women were more actively participating to the labour market. Similarly, if we repeat the estimation by subsamples (not reported), female employment rate exerts a positive impact on female competence formation, while the same does not occur in the male subsample.

We then consider alternative proxies for the social environment: in column 2 of table 1 we use the fraction of women elected in regional government, which is often taken as a proxy for women empowerment. Estimates suggest that having grown up in contexts with higher women's political participation significantly increases competence formation, but again without a differential impact by gender. In column 3 of table 1 we consider the rate of abortion, as an (inverted) proxy for the use of contraceptives. In this case the expected negative effect, both for the variable and the interaction, is not statistically significant.⁷ In the fourth column we use fertility rates as environmental variable, and eventually in the fifth column the share of non religious marriages. This two variables exhibit the expected statistically significant correlations with competence formation (respectively negative and positive), without any differential effect by gender. Finally in column 6, we use religious practice (baptising new born), and again we find the expected sign, both for the level and the interaction but without any statistical significance.

⁶ The correlation with employment status is non significant when we restrict the sample to available data on local elections and on baptisms. In these cases we overweigh the youngest cohorts, where students are over-represented.

⁷ However we suspect that this unexpected result may depend on the regional distribution of contraception. Data collected in 2000 report that Sardinia was the region with the highest fraction of women using the pill (32%), followed by Piedmont (30%) and Veneto (28%). At the other extreme, Campania comes out lowest (9%). If we merge these data at macro-region level (North, Centre and South), the level coefficient comes out insignificant, while the interaction is negative and significant at 1% level.

⁸ In a cross country analysis, Pezzini 2005 shows that average happiness of women grew after the approval of laws rendering legal contraception and divorce.

Table 1 – Determinants of quantitative competences (numeracy and problem solving)
– OLS-ALL 2003

VARIABLES	[1]	[2]	[3]	[4]	[5]	[6]
	<i>employment rates</i>	<i>elected women</i>	<i>abortions</i>	<i>fertility</i>	<i>marriages</i>	<i>catholic</i>
Female	-13.42 [19.26]	-0.532 [6.088]	10.58 [7.670]	8.789 [9.747]	-1.633 [2.976]	8.775 [11.46]
Years of schooling	5.260*** [0.269]	4.908*** [0.580]	5.127*** [0.526]	5.042*** [0.499]	5.169*** [0.347]	5.015*** [0.580]
Currently employed	6.429*** [1.483]	2.299 [2.165]	4.332** [1.967]	2.725 [1.942]	6.082*** [1.708]	3.457 [2.143]
Regional female employment rate	1.725** [0.735]					
Regional male employment rate	-2.091 [1.294]					
Female×Regional female employment rate	0.333 [0.299]					
Female×Regional male employment rate	0.0555 [0.379]					
Fraction elected women regional government		160.9*** [60.75]				
Female×Fraction elected women regional govern.		5.613 [60.86]				
Voluntary abortion (1000 women 15-49)			-1.101 [1.047]			
Female×Voluntary abortion (1000 women 15-49)			-0.956 [0.650]			
Fertility rate (1000 women 15-49)				-0.0198*** [0.00762]		
Female×Fertility rate (1000 women 15-49)				-0.00673 [0.00727]		
Share of non religious marriages					46.12** [18.12]	
Female×Share of non religious marriages					9.964 [16.47]	
Share baptisms total born						9.772 [10.97]
Female×Share baptisms total born						-10.41 [12.64]
Mother primary education	-8.554* [4.934]	-11.47** [5.777]	-10.95** [5.568]	-10.20* [5.658]	-8.617* [5.080]	-11.48** [5.639]
Mother secondary education	-9.246** [4.601]	-11.98** [5.207]	-10.13* [5.220]	-10.32* [5.273]	-9.072* [4.760]	-10.92** [5.175]
Father primary education	-7.324* [4.407]	-12.85** [5.649]	-13.23** [5.503]	-12.59** [5.433]	-10.16** [4.689]	-13.72** [5.694]
Father secondary education	-0.941 [4.134]	-4.051 [5.084]	-4.358 [5.022]	-4.157 [5.013]	-2.753 [4.335]	-4.459 [5.119]
Urban area	3.161** [1.363]	2.616 [2.130]	1.636 [2.083]	2.114 [1.944]	0.764 [1.654]	2.463 [2.172]
Observations	6141	2519	2945	2945	4570	2514
R-squared	0.329	0.252	0.263	0.274	0.279	0.245
Log likelihood	-30827	-12670	-14799	-14776	-22970	-12659
Birth year	1942-88	1969-88	1966-88	1966-88	1954-88	1969-88

Robust standard errors in brackets - weighted by sample weights - *** p<0.01, ** p<0.05, * p<0.1 - Region, cohort and household composition controls included - for parental education the excluded category is tertiary education

Overall, we have found that competence formation across age cohort in Italy does not exhibit a gender differential. We selected the environmental variables paying attention to the role of women in the society, under the assumption that a more progressive society is a society where female employment is higher, women involvement in politics is larger, fertility rates are lower (also thanks to the use of contraception) and the religious influence of the Catholic church is limited (as proxied by the share of non religious marriages and the share of baptisms over new born). However these different dimensions do not necessarily go along together in the society, at least at regional level. Table 2 reproduces the correlation indexes for these dimensions. If we look at the second column, we find some support to our intuition: female employment goes hand in hand with civil marriages, reduction in abortion and in fertility (thanks to expanded use of contraception) and greater political participation.

Table 2 – Pairwise correlation among environmental variables (by region and birth year)

	Male empl. rate	Female empl.rate	Elected women	Voluntary abortion	Fertility rate	Non religious marriages	Share baptisms total born
Male employment rate	1						
Female employment rate	0.5935*	1					
Elected women regional government	0.4802*	0.7862*	1				
Voluntary abortion (1000 women 15-49)	0.2889*	-0.1496*	-0.1481*	1			
Fertility rate (1000 women 15-49)	-0.1968*	-0.6232*	-0.6322*	0.0656*	1		
Share of non religious marriages	0.0565*	0.5896*	0.6322*	-0.4017*	-0.4145*	1	
Share baptisms total born	-0.1942*	-0.0342	-0.0092	-0.2478*	-0.1208*	-0.025	1

Since our proxies for progressivism are constructed using different data sources, the sample size varies from one specification to the other and this does not allow full comparison of the estimates obtained through alternative specifications, in terms of both magnitude and significance. Therefore, we repeat our exercise considering the largest common sample among those considered in table 1, that regards cohorts born between 1969 and 1988. Results are reported in table 3 where all the specifications replicates those analyzed for the baseline model. The main results are very close to those previously found. In particular, also in this case, no gender penalty seems to be at work, but in addition also employment status has no effect on individual proficiency. The magnitude of the coefficient of individual school attainment is stable across specifications and it is about 4.9 score points per years of schooling. The only difference emerging in this case is that, when considering local labour market indicators by gender, despite the positive correlation among them, female employment rate enhances competences, while the male rate lower the average level of competences. As before, we found no differential impact on genders. Political participation, contraception diffusion and laity in mating appear positively associated with proficiency formation.

Table 3 – Determinants of quantitative competences (numeracy and problem solving) – same sample size – OLS-ALL 2003

VARIABLES	[1]	[2]	[3]	[4]	[5]	[6]
	<i>employment rates</i>	<i>elected women</i>	<i>abortions</i>	<i>fertility</i>	<i>marriages</i>	<i>catholic</i>
Female	26.01 [33.16]	-0.508 [6.092]	14.63 [10.06]	4.71 [12.36]	-0.0516 [6.374]	8.775 [11.46]
Years of schooling	4.907*** [0.580]	4.933*** [0.584]	4.981*** [0.611]	4.899*** [0.566]	4.956*** [0.596]	5.015*** [0.580]
Currently employed	1.439 [2.179]	2.34 [2.171]	2.942 [2.156]	1.371 [2.179]	2.777 [2.159]	3.457 [2.143]
Regional female employment rate	2.241** [0.893]					
Regional male employment rate	-2.764* [1.479]					
Female×Regional female employment rate	0.493 [0.485]					
Female×Regional male employment rate	-0.685 [0.721]					
Fraction elected women regional government		160.3*** [60.96]				
Female×Fraction elected women regional govern.		5.893 [60.91]				
Voluntary abortion (1000 women 15-49)			-1.791 [1.393]			
Female×Voluntary abortion (1000 women 15-49)			-1.367 [0.930]			
Fertility rate (1000 women 15-49)				-0.0236** [0.00984]		
Female×Fertility rate (1000 women 15-49)				-0.00365 [0.00952]		
Share of non religious marriages					43.07* [25.15]	
Female×Share of non religious marriages					-1.174 [28.43]	
Share baptisms total born						9.772 [10.97]
Female×Share baptisms total born						-10.41 [12.64]
Mother primary education	-10.94* [5.798]	-11.44** [5.779]	-11.40** [5.646]	-10.90* [5.768]	-10.89* [5.814]	-11.48** [5.639]
Mother secondary education	-11.38** [5.288]	-11.98** [5.209]	-10.47** [5.232]	-11.13** [5.281]	-10.77** [5.372]	-10.92** [5.175]
Father primary education	-13.10** [5.781]	-12.80** [5.653]	-14.20** [5.848]	-13.26** [5.702]	-13.62** [5.928]	-13.72** [5.694]
Father secondary education	-4.403 [5.232]	-4.029 [5.086]	-5.042 [5.223]	-4.47 [5.191]	-4.649 [5.325]	-4.459 [5.119]
Urban area	2.827 [2.122]	2.641 [2.136]	2.625 [2.225]	2.887 [2.124]	2.331 [2.174]	2.463 [2.172]
Observations	2514	2514	2514	2514	2514	2514
R-squared	0.256	0.253	0.247	0.257	0.248	0.245
Log likelihood	-12640	-12646	-12656	-12640	-12655	-12659
Birth year	1969-88	1969-88	1969-88	1969-88	1969-88	1969-88

Robust standard errors in brackets - weighted by sample weights - *** p<0.01, ** p<0.05, * p<0.1 - Region, cohort and household composition controls included - for parental education the excluded category is tertiary education

5.3 IV estimates

Previous findings indicate that a progressive society is associated to a more intense formation of life competences for both men and women. However, we were not convinced by the absence of a differential effect between genders especially because in our baseline model one important econometric issue is the potential endogeneity of individual school attainment and employment status. To consistently estimate equation 5 through ordinary least squares it is necessary to assume that all systematic differences among adults proficiency can be explained only by individual, household and regional observable characteristics. Instead, in our previous model, educational attainment and employment status could be correlated with the error term and therefore our estimates could be biased and inconsistent. Formally, given our basic model for adult proficiency:

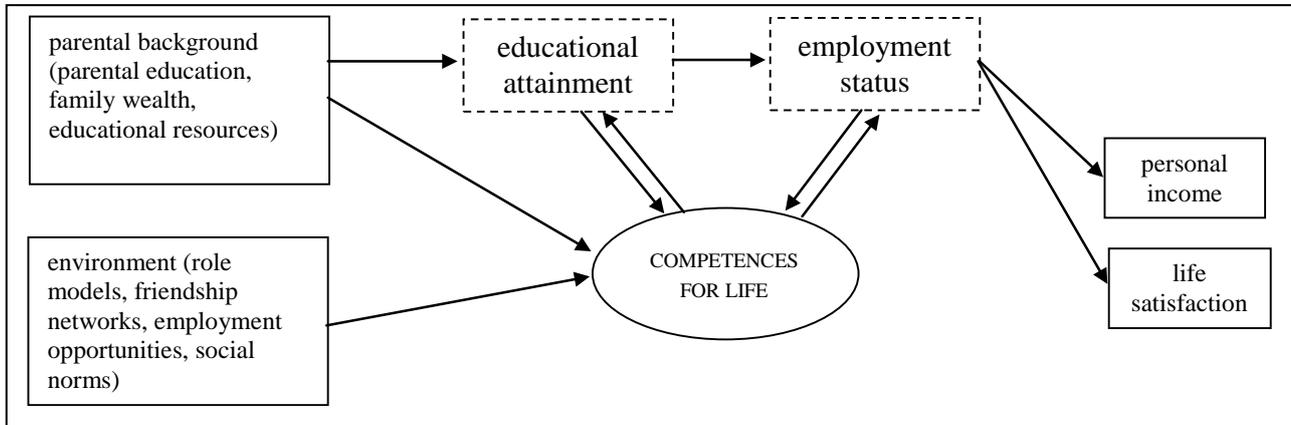
$$competence_{ij} = \alpha_0 + \alpha_1 \cdot education_i + \alpha_2 \cdot employment_i + \alpha_3 \cdot X_{ij} + \varepsilon_{ij} \quad (6)$$

where the vector X_{ij} includes all individual, household and regional relevant exogenous explanatory variables, but the educational attainment and current employment status. Endogeneity arises since:

$$\begin{aligned} corr(education_i, \varepsilon_{ij} | X_{ij}) &\neq 0 \\ corr(employment_i, \varepsilon_{ij} | X_{ij}) &\neq 0 \end{aligned} \quad (7)$$

The reasons behind the potential endogeneity of educational and employment can be illustrated simply considering the relationships that contribute to competences formation as sketched in figure 3.

Figure 3 – Sketch of the relevant relationships



The endogeneity problem in this case can depend both on simultaneity and on omitted variables. While parental background can safely be considered as an exogenous source of variation, as well as the past environment (namely measured when young), it is straightforward to consider that educational attainment includes a non negligible individual ability component. Given the cross-section nature of the data, we cannot distinguish between the contribution of pre-existing abilities to educational attainment, and the contribution of formal education to the formation of competences. The two are clearly correlated, as shown in table 4, but causality may go in both directions. Similarly, the employment status is associated to higher level of competences, but once again causality could run in both directions (see table 5).

Table 4 – Median competences by gender and educational attainment

	<i>Men</i>	<i>Women</i>
Less than compulsory education (<i>licenza elementare e media</i>)	213.0605	204.5152
	211.0975	210.1789
	223.4636	213.5242
	205.1749	201.6465
Above compulsory education (<i>diploma superiore 3-5 anni</i>)	248.0398	243.0599
	249.7704	251.8326
	256.9191	249.0705
	247.9685	246.341
Non university higher education (<i>titoli post-secondari</i>)	243.3389	250.3369
	237.2109	251.3346
	244.0225	246.9017
	239.3943	250.5606
University education (<i>diplomi universitari, laurea, dottorato</i>)	275.0602	261.8831
	268.2635	267.2925
	278.9611	262.3888
	258.6566	251.0997

Note: the first number reports document literacy, the second prose literacy, the third numeracy and the fourth problem solving

Table 5 – Median competences by gender and employment status

	<i>Men</i>	<i>Women</i>
Not employed (student, unemployed, housewife, retiree)	225.2028	214.1694
	225.7892	221.5318
	233.9442	221.8892
	219.7384	214.0245
Employed (self-employed, employee)	236.1244	235.9426
	234.2002	242.5795
	244.9904	243.2938
	231.7540	236.8351

Note: the first number reports document literacy, the second prose literacy, the third numeracy and the fourth problem solving

Hence, including individual educational attainment and employment status among the explanatory variables for life competences, likely yields biased coefficients and the bias may distort the estimates of all other coefficients, including the environmental ones. However, since we are mainly interested in the temporal evolution of the gender gap, one counter-argument for the validity of previous conclusions based on OLS estimates could be that the potential bias is likely to remain constant across age cohorts and genders; we are therefore still entitled to comment the evolution of these coefficients as describing the relative advantage/disadvantage of women in forming their life competences. To go further in our analysis, we try to deal directly with the endogeneity problem, using instrumental variable techniques and estimating the following model:

$$\begin{aligned}
 competence_{ij} &= \alpha_0 + \alpha_1 \cdot education_i + \alpha_2 \cdot employment_i + \alpha_3 \cdot X_{ij} + \varepsilon_{ij} \\
 education_{ij} &= \beta_0 + \beta_1 \cdot Z_{ij} + \beta_2 X_{ij} + \eta_{ij} \\
 employment_{ij} &= \gamma_0 + \gamma_1 \cdot W_{ij} + \gamma_2 X_{ij} + \upsilon_{ij}
 \end{aligned} \tag{8}$$

where Z_{ij} and W_{ij} represent two vectors of instrumental variables. In particular, as exogenous source of variation for individual educational attainment we use a proxy for school inputs which were available upon primary school enrolment, while as exogenous source of variation for individual employment status we use a proxy for family liquidity constraints (absence/presence of a child in the household) and one for local labour market conditions (regional dummies).

Arguably, human capital accumulation depends on the availability of schools as well as on their quality. Therefore, the first instrument we choose is a proxy for resources availability and quality of schools in the local area of residence, that is the pupil–teacher ratio (Brunello and Checchi 2005). We collected data on the pupil–teacher ratio for primary and lower secondary school, both private and private, at regional level every two years from 1946, using the Statistical Yearbooks of Education. The choice to collect data every other year is motivated by the limited short-term variability in the data. In this way we were able to construct an indicator at regional level from the oldest cohort born in 1940, which was enrolled in primary school in 1946, to the youngest cohort born in 1988 which was enrolled in primary school in 1994.⁹ A drawback of this indicator is related to the lack of information about the region in which compulsory school was attended. Since for oldest cohorts there is the possibility of endogenous migration, this instrument can be weak. For instance, some individuals might have moved to regions with a lower student – teacher ratio simply because they wanted to have a higher quality of the school system and then find a job in these regions. Instead, for younger cohort the probability of migration is lower, and therefore our instrument is less exposed to this potential critique. Conscious of this limitation, we match individuals to school quality by attributing to each individual in the sample the pupil–teacher ratio in the region of residence when she was 6 years old. The pupil–teacher ratio when 6 years old does not influence the outcome adult literacy beyond its impact through schooling investment and thus satisfies the exclusion restriction.

For what concerns individual employment status we use as instruments an indicator for family composition (having an economically dependent child) and the macro areas of residence as proxies for local labour markets. A good instrument for employment status must be highly correlated with employment decision but not with the competence level. Since, one reason why an individual enters the labour market is family financial needs, the first instrument can be considered as a proxy for liquidity constraints: the family composition is highly correlated with the employment probability but at the same time it is unlikely to impact on the individual level of acquired skilled. In addition, the dummies for the macro areas of residence actually capture the structure of the local labour market and are highly correlated with employment probability, but once we control for other specific individual characteristics, including urbanization of the current residence, they are unlikely to be correlated with adult skills. Therefore, the first-stage school attainment equation is

$$education_i = \beta_0 + \beta_1 \cdot school\ quality_{kj+6} + \beta_2 X_{ij} + \eta_{ij} \quad (9)$$

and the first-stage employment probability equation is

$$employment_i = \gamma_0 + \gamma_1 \cdot child_i + \gamma_2 \cdot macro_area_k + \gamma_3 X_{ij} + \upsilon_{ij} \quad (10)$$

where the vector X_{ij} includes all the explanatory variables of second stage but the instruments. Estimates using instrumental variables are presented in table 6. In each column we present the results of the tests for instrument validity and for model over identification. Considering the common threshold employed in the literature (Staiger and Stock 1997) for the F-statistic, a value above 10 from the test of joint significance of the instruments in the first stage regression should be necessary to conclude that the set of instruments is sufficiently strong. From our estimates, we observe that in the

⁹ The relevant school variables in explaining individual investment decision are those at the time of attending school and are those of the geographical area where an individual grew up. The proxy for school resources is the weighted average of the pupil–teacher ratio in primary and lower secondary school at the time of entry in the educational system, where the weights are represented by the relative length of the two orders in the compulsory educational Italian system (5 over 8 years for primary and 3 over 8 years for lower secondary). The basic assumption is that when entering the educational system at the age of six, parents decide the optimal investment in education considering the quality of the existing school system in the area of residence.

two samples which include the oldest age cohorts (column 1 and 4) the instruments are weaker. This could actually depend on the fact that we impute the instrument according to current place of residence. It is likely that within oldest cohorts, migration flows were more significant and therefore using a source of variation based on current place of residence for explaining educational choice may have little explanatory power. However, it is worth remembering that when estimating a model with multiple endogenous regressors, the threshold rule should not apply, while it would be preferable looking at the Shea Partial R^2 , which account for the inter-correlations among the instruments. Since, comparing the standard partial R^2 , and the Shea measure we do not find that the latter is extremely small compared to the first one, we can conclude that the instruments do not lack sufficient relevance to explain all the endogenous regressors. According to the p -values of the Hansen–Sargan test for over-identification, the proposed instruments satisfy the orthogonality condition and we do not reject the null hypothesis that all instruments are valid.

Moving to our main results, even using IV technique, we do not find statistical correlation between gender and level of competences. As in previous OLS estimates, the correlation between education attainment and adult skills is positive and highly significant. Those who are employed, on average, have a higher level of math competences. Depending on the specification and the sample considered, being employed increases the tests score from 47 to 89 points. Using instrumental variables we found that the estimated returns to schooling and employment in terms of life competences are larger than OLS estimates, suggesting a significant and negative bias in least squares estimates. We are inclined to believe that what we actually get with IV is a local average treatment effect (LATE): we are not estimating the average returns to schooling and employment for the whole population, but only for the subpopulation of all individuals who react to the instruments. The group of compliers who are influenced by the exposure to the instrument have a higher return to education and to labour market participation.

When considering the impact of local labour markets, (column 1), the female employment rate in the region of residence when 15 has a positive effect on competences formation, while the male employment rate has a negative effect. No differential impact is again found on genders. Women participation in politics (column 2) and female sexual emancipation measured through total fertility rate (column 4) are positively correlated with adult skills, while voluntary abortion has no effect (column 3). Using as a proxy of female emancipation the share of civil marriages, we found a positive effect on adult skills but inexplicably this effect is negative for females. Finally, being embedded in a more traditional context where the presence of Catholics is higher has a positive impact on the average level of skill but the effect of women is negative (column 6). The positive coefficient could be attributed to the fact that Catholic Church historically enhances education but this culture is very male oriented and this could explain the negative coefficient for females. For comparability purposes, we run our previous regressions considering the smallest sample including individuals born from 1954 to 1988. Results are presented in table 7 where all the specifications presented follow the previous ones. All results are unaffected, except those related to male employment and to fertility rate.¹⁰

¹⁰ Although not reported in tables, we also tried alternative specifications and/or alternative instruments for the endogenous variables. For example, when using together with the pupil–teacher ratio and the indicator for having a child economically dependent, the GDP per capita in the region five years before the survey, we find almost the same results of our preferred specification but we do not reject the null for the over identification test in all the specifications. Excluding from the instruments, the indicator for having a child economically dependent, we lose variability at individual level and we do not find any effect nor for environmental variables nor for education attainment and employment status. Almost the same results of those presented in tables 6 and 7 are obtained when substituting the indicator for family economic needs (child economically dependent) with the household size. Finally, when using as instruments for local labour market conditions an indicator for the region of residence (20 regional dummies), previous results hold but the model is over – identified according to Hansen – Sargan test. We also try to instrument individual educational attainment with parental education and we control for family background by including parental occupation. From a statistical point of view, the instruments are highly relevant and the F statistic is extremely high. IV estimates are very close to OLS estimates. However, some doubts arise for what concerns the exogeneity of these instruments since, in principle, parental level education is highly correlated with individual level of proficiency.

Table 6 – Determinants of quantitative competences (numeracy and problem solving)
– IV-ALL 2003

VARIABLES	[1]	[2]	[3]	[4]	[5]	[6]
	<i>employment rates</i>	<i>elected women</i>	<i>abortions</i>	<i>fertility</i>	<i>marriages</i>	<i>catholic</i>
Female	-26.21 [27.53]	18.09 [11.47]	2.226 [11.22]	-17.62 [15.88]	41.39*** [11.75]	38.24** [17.53]
Years of schooling	6.088** [3.100]	5.366** [2.105]	4.632* [2.590]	4.640* [2.403]	7.203* [4.075]	5.245** [2.425]
Currently employed	47.26** [22.94]	52.05** [20.65]	83.03*** [21.85]	74.81** [31.17]	89.04*** [20.93]	76.35*** [21.34]
Regional female employment rate	2.297** [0.915]					
Regional male employment rate	-3.312* [1.755]					
Female×Regional female employment rate	-0.749 [0.779]					
Female×Regional male employment rate	0.975 [0.827]					
Fraction elected women regional government		140.6** [71.49]				
Female×Fraction elected women regional government		-106.5 [92.16]				
Voluntary abortion (1000 women 15-49)			-2.235 [1.539]			
Female×Voluntary abortion (1000 women 15-49)			1.153 [1.117]			
Fertility rate (1000 women 15-49)				-0.0193* [0.0101]		
Female×Fertility rate (1000 women 15-49)				0.023 [0.0145]		
Share of non religious marriages					40.74* [24.43]	
Female×Share of non religious marriages					-124.0*** [43.00]	
Share baptisms total born						24.08* [14.22]
Female×Share baptisms total born						-29.42* [17.29]
Mother primary education	-13.14* [7.585]	-21.19** [9.692]	-25.58*** [9.887]	-24.48** [11.02]	-20.28** [10.27]	-25.99*** [9.851]
Mother secondary education	-13.27* [7.052]	-18.09** [7.851]	-21.92*** [8.273]	-21.06** [9.135]	-21.01*** [8.049]	-21.72*** [8.091]
Father primary education	-5.967 [11.71]	-16.22* [8.543]	-20.27* [10.43]	-19.11* [9.758]	-4.229 [13.66]	-17.86* [9.721]
Father secondary education	-1.825 [6.230]	-7.822 [6.449]	-10.91 [7.425]	-9.811 [7.162]	-1.921 [7.554]	-9.459 [7.278]
Urban area	3.006 [1.840]	2.422 [2.672]	2.863 [2.818]	3.034 [2.665]	3.131 [2.445]	2.69 [2.959]
Observations	5371	2242	2599	2599	4026	2238
R-squared	0.176	0.022	-0.302	-0.184	-0.356	-0.253
J test	4.809	0.984	1.729	0.716	2.824	0.0983
P value Sargan test	0.0903	0.612	0.421	0.699	0.244	0.952
F statistic employment probability	4.34	10.97	9.56	4.68	9.58	11.84
F statistic year of schooling	4.16	13.31	9.91	8.42	3.13	12.55
Birth year	1942-88	1969-88	1966-88	1966-88	1954-88	1969-88

Instruments: dummies macro areas, child economically dependent and student/teach, weighted average primary and lower secondary

Robust standard errors in brackets - weighted by sample weights - *** p<0.01, ** p<0.05, * p<0.1 - Region, cohort and household composition controls included - for parental education the excluded category is tertiary education

Table 7 – Determinants of quantitative competences (numeracy and problem solving) – same sample size – IV-ALL 2003

VARIABLES	[1]	[2]	[3]	[4]	[5]	[6]
	<i>employment rates</i>	<i>elected women</i>	<i>abortions</i>	<i>fertility</i>	<i>marriages</i>	<i>catholic</i>
Female	-24.18 [44.72]	18.33 [11.47]	6.186 [13.55]	-27.87 [20.77]	35.65** [15.05]	38.24** [17.53]
Years of schooling	5.516** [2.192]	5.486*** [2.118]	5.435** [2.462]	5.406** [2.345]	4.705* [2.617]	5.245** [2.425]
Currently employed	59.42** [27.62]	52.56** [20.66]	65.82*** [21.02]	69.14** [34.22]	93.34*** [27.10]	76.35*** [21.34]
Regional female employment rate	2.013* [1.157]					
Regional male employment rate	-2.879 [1.941]					
Female×Regional female employment rate	-1.056 [1.035]					
Female×Regional male employment rate	1.103 [1.229]					
Fraction elected women regional government		141.4* [72.30]				
Female×Fraction elected women regional government		-107 [92.14]				
Voluntary abortion (1000 women 15-49)			-1.975 [1.850]			
Female×Voluntary abortion (1000 women 15-49)			0.453 [1.427]			
Fertility rate (1000 women 15-49)				-0.02 [0.0142]		
Female×Fertility rate (1000 women 15-49)				0.0298 [0.0187]		
Share of non religious marriages					25.57 [34.31]	
Female×Share of non religious marriages					-104.8* [55.49]	
Share baptisms total born						24.08* [14.22]
Female×Share baptisms total born						-29.42* [17.29]
Mother primary education	-22.06** [10.56]	-21.18** [9.697]	-23.23** [9.735]	-24.95** [11.98]	-30.96*** [11.15]	-25.99*** [9.851]
Mother secondary education	-18.84** [8.460]	-18.21** [7.878]	-19.27** [8.013]	-20.78** [9.634]	-25.41*** [9.108]	-21.72*** [8.091]
Father primary education	-16.49* [8.910]	-15.86* [8.557]	-17.89* [9.799]	-16.90* [9.321]	-20.13* [10.72]	-17.86* [9.721]
Father secondary education	-8.37 [6.739]	-7.693 [6.472]	-9.539 [7.179]	-8.813 [7.141]	-10.97 [8.096]	-9.459 [7.278]
Urban area	2.52 [2.790]	2.483 [2.700]	2.412 [2.876]	2.472 [2.915]	3.274 [3.210]	2.69 [2.959]
Observations	2238	2238	2238	2238	2238	2238
R-squared	-0.05	0.018	-0.124	-0.158	-0.51	-0.253
J test	0.58	0.821	2.839	0.0451	0.211	0.0983
P value Sargan test	0.748	0.663	0.242	0.978	0.9	0.952
F statistic employment probability	7.19	10.97	10.93	3.66	7.93	11.84
F statistic year of schooling	12.14	13.19	12.73	9.35	12.38	12.55
Birth year	1969-88	1969-88	1969-88	1969-88	1969-88	1969-88

Instruments: dummies macro areas, child economically dependent and student/teach, weighted average primary and lower secondary

Robust standard errors in brackets - weighted by sample weights - *** p<0.01, ** p<0.05, * p<0.1 - Region, cohort and household composition controls included - for parental education the excluded category is tertiary education

Overall, we find robust evidence that competences are enhanced in more progressive social contexts where employment composition is less biased towards men, women are politically active, contraception use is high (and abortion/fertility is low) and religious influence is less pronounced. No differential effects by gender seem to be at work, except when considering the religious influence.

6. Conclusion and policy implications

In this paper we have reviewed adult competence formation, with special attention to gender differences. As far as the Italian case is concerned, we have found that environmental factors matter but, on average, they do not have a gender differential effect. Adult proficiency is higher in contexts inhabited by individuals who spend their childhood and adolescence in more progressive societies. In particular, factors that enhance more adults' skills are female labour market participation, women political empowerment, female sexual emancipation and laity of the society.

Taken at face value, our results suggest that the best policy for reducing competence inequality in Italy is expanding female empowerment, both in the labour market and in politics (not to speak in the marriage market). This has been favoured by achieved equality in educational attainment and by the disappearance of skill differences, even for quantitative dimensions. Obviously adult competences can also be enhanced by promoting life-long learning (Boudard and Rubenson 2003). Adult learning is not only as a means to enhance productivity and facilitate labour force participation, but it is also essential to assist individuals in their everyday actions and promote active citizenship.

From the point of view of gender differentials, we could claim that at least in the case of Italy equality has been achieved, especially in the youngest cohorts. Since schooling and labour market participation are the main determinants of skill formation, Italian women have significantly overcome their male counterpart in education, while they are still lagging in terms of labour market participation. Prolonged absence from active participation in economic life may be detrimental to their skill maintenance, and put them at risk of reopening of the gender gap. For this reason we hold that life – long learning opportunities remain the second best alternative to preserve gender equality in proficiency. Designing better strategies to promote life – long learning is an important policy issue since it may enhance social inclusion and, at the same time, it can reduce marginalisation of segments of the population and increase socio-economic cohesion.

References

- Baltes, P.B. (1987), "Theoretical Propositions of Life-span Developmental Psychology: On the dynamics between growth and decline", *Developmental Psychology*, Vol. 23(5): 611-626.
- Baron-Cohen, S. (2003), *The essential difference. Men, women and the extreme male brain*, Allen Lane, London.
- Becker, G. (1993). *Human capital*. The University of Chicago Press
- Blau, F. and Kahn, L. (2006), "The US Gender Pay Gap in the 1990s: Slowing Convergence", *Industrial and Labor Relations Review*, 60: 45-66.
- Booth, A. and Nolen, P. (2009a), "Gender Differences in Risk Behaviour: Does Nurture Matter?", IZA Discussion Paper No. 4026
- Booth, A. and Nolen, P. (2009b), "Choosing to Compete: How Different Are Girls and Boys?", IZA Discussion Paper No. 4027
- Boudard, E. (2001), *Literacy Proficiency, Earnings and Recurrent Training: A Ten Country Comparative Study*, Institute of International Education, Stockholm University, Stockholm.
- Boudard, E. and K.Rubenson (2003), "Revisiting major determinants of participation in adult education with a direct measure of literacy skills", *International Journal of Educational Research*, 39: 265–281
- Brunello, G. and D.Checchi. (2005). "School quality and family background in Italy". *Economics of Education Review*, 24(5): 563-77
- De la Rica, S., Dolado, J. and García-Peñalosa, C. (2008), "On Gender Gaps and Self-fulfilling Expectations: Theory, Policies and Some Empirical Evidence", IZA Discussion Paper No. 3553
- Desjardins, R. (2003), "Determinants of literacy proficiency: a lifelong-lifewide learning perspective" *International Journal of Educational Research*, 39: 205–245
- Desjardins, R. (2004), *Learning for Well Being: Studies Using the International Adult Literacy Survey*, Institute of International Education, Stockholm University, Stockholm.
- Dreyfus, R. (1992) "The underrated benefits of oral contraception: consequences of pregnancy and induced abortion in teenagers", *International Journal of Fertility*, 37(4) :204-10.
- Eagly, A. H. (1987). *Sex differences in social behavior: A social-role interpretation*. Hillsdale, NJ: Erlbaum.
- Fernandez, R. (2007). Culture as learning: the evolution of female labor force participation over a century. NBER wp.13373.
- Gallina, V. (ed) (2006). *Letteratismo e abilità per la vita. Indagine nazionale sulla popolazione italiana 16-65 anni*. Armando Editore
- Goldin, C. and L.Katz. (2002). "The Power of the Pill: Oral Contraceptives and Women's Career and Marriage Decisions", *Journal of Political Economy* 110 (August): 730-70
- Gould, E., V.Lavy and D.Paserman. (2009). Sixty years after the magic carpet ride: the long-run effect of the early childhood environment on social and economic outcomes. NBER wp.14884
- Guiso, L., F.Monte, P.Sapienza and L.Zingales. (2008). "Culture, gender and math." *Science*. 320(5880: 1164-1165
- Hanushek, E. and Woessmann, L. (2007), The role of education quality in economic growth. World Bank Policy Research Working Paper 4122.
- Kirsch, I. S., Jungeblut, A., Jenkins, L. and Kolstad, A. (1993), *Adult Literacy in America: A First Look at the Results of the National Adult Literacy Survey*, Educational Testing Service, Princeton, NJ.
- Kunze A. (2003), "Gender Differences in Entry Wages and Early Career Wages", *Annales d'Economie et Statistique*, 71/72: 245-266.
- Lawrence PA. (2006). "Men, women, and ghosts in science." *PLoS Biology* 4(1):e19
- Light, A. and Ureta M. (1995), "Early-Career Work Experience and Gender Wage Differentials", *Journal of Labor Economics*, 13: 121-154.
- Maccoby, E. E. (1998), *The Two Sexes: Growing up Apart, Coming Together*, Harvard University Press, Cambridge Ma.
- Maccoby, E. E. (2000). Perspectives on gender development. *International Journal of Behavioral Development*, 24, 398–406.

- Marsiske, M., and J. Smith. (1998). Development of competence: Toward a taxonomy. In: T. Husén and T.N. Postlethwaite (Eds.), *International encyclopedia of education*. Oxford: Pergamon Press.
- Meyer, B. J., Young, C. J. and Bartlett, B. J. (1993), "Reading comprehension and the use of text structure across the adult lifespan", in S. R. Yussen and M. C. Smith (Eds.), *Reading across the life span* (pp. 165–192). New York: Springer.
- Mincer, J. and H. Ofek. (1982). "Interrupted Work Careers: Depreciation and Restoration of Human Capital." *Journal of Human Resources* 17(1): 3-24
- Mincer, J. and S. Polachek (1974) "Family Investments in Human Capital: Earnings of Women", *Journal of Political Economy*, 82(2): 76-108.
- Murray, T. S. (1997). Proxy Measurement of Adult Basic Skills: Lessons from Canada. In Tuijnman. Cresskill (ed): *Adult Basic Skills: Innovations in Measurement and Policy Analysis*, NJ: Hampton Press
- O'Neill, J. (2003), "The Gender Gap in Wages, Circa 2000", *American Economic Review Papers and Proceedings*, 93: 309-314.
- Pezzini, S. 2005. The effect of women's rights on women's welfare: evidence from a natural experiment. *Economic Journal* 502(3): C208-C227.
- Polachek, S. (2006), "How the Human Capital Model Explains Why the Gender Gap Narrowed", in Blau F., Brinton M. and Grusky D. (Eds), *The Declining Significance of Gender?* Russell Sage Foundation: New York.
- Portrait, F., Alessie, R. and Deeg, D. (2003), "Disentangling the Age, Period, and Cohort Effects Using a Modeling Approach", Discussion paper, Timbergen Institute, University of Amsterdam.
- Raudenbush, S. W. and Kasim, R. M. (1998), "Cognitive skill and economic inequality: Findings from the national adult literacy survey", *Harvard Educational Review*, 68(1): 33–79.
- Reder, S. (1994), "Practice-engagement theory: A sociocultural approach to literacy across languages and cultures", in B. M. Ferdman, R. M. Weber and A. G. Ramirez (Eds.), *Literacy across languages and cultures*, State University of New York Press.
- Ruble, D. N., & Martin, C. L. (1998). Gender development. In W. Damon & N. Eisenberg (Eds.), *Handbook of child psychology* (5th ed.), pp. 933–1016. New York: Wiley.
- Schaie, K. W. (1994), "The course of adult intellectual development", *American Psychologist*, 49(4): 304–313.
- Smith, J. and Marsiske, M. (1997), "Abilities and Competencies in Adulthood: Lifespan perspectives on workplace skills", in A.C. Tuijnman, I.S. Kirsch and D.A. Wagner (eds.), *Adult Basic Skills: Innovations in Measurement and Policy Analysis*, Hampton Press, Inc., Cresskill, NJ.
- Staiger, D. and Stock, J. H. (1997), "Instrumental Variables Regression with Weak Instruments", *Econometrica*, 65 (3): 557-586.
- Steele, C. M. (1997). A threat in the air: How stereotypes shape intellectual identity and performance. *American Psychologist*, 52, 613-629.

Appendix 1 – Descriptive statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
<i>Individual</i>					
Female	6853	0.50	0.50	0.00	1.00
Literacy (average competences)	6853	228.27	47.49	85.28	375.24
Math (numeracy and problem solving)	6853	229.08	45.34	88.90	389.13
Read (prose and documents)	6853	227.46	51.55	62.99	382.67
Years of schooling	6830	10.70	4.02	1.00	26.00
Currently employed	6853	0.56	0.50	0.00	1.00
Age	6853	40.47	13.59	16.00	65.00
Education level	6853	0.64	0.84	0.00	3.00
Urban residence	6853	0.44	0.50	0.00	1.00
Household size	6853	3.35	1.20	1.00	23.00
<i>Family background</i>					
Mother education	6747	1.16	0.40	1.00	3.00
Father education	6701	1.21	0.49	1.00	3.00
<i>Environment</i>					
Male employment rate (by macro-region and year)	6112	60.48	4.56	49.80	69.70
Female employment rate (by macro-region and year)	6112	28.08	5.58	18.80	40.20
Elected women regional government (by macro-region and year)	2443	0.09	0.03	0.03	0.15
Voluntary abortion (1000 women 15-49) (by macro-region and year)	2855	11.56	4.01	5.37	28.95
Fertility rate (1000 women 15-49) (by macro-region and year)	2885	1344.68	303.30	932.20	2310.00
Share of non religious marriages (by macro-region and year)	4493	0.14	0.08	0.01	0.52
Share baptisms total new born (by macro-region and year)	2291	0.84	0.26	0.06	1.93