October 2004

Which Human Capital Matters for Rich and Poor's Wages? Evidence from Matched Worker-Firm Data from Tunisia[†]

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Keywords: wage, returns to human capital, matched worker-firm data, quantile regressions, factor analysis, Tunisia.

JEL Classification: J24, J31, O12.

[†] This paper has been supported by the ESRC under the grant no. R000230326. Christophe Muller is also grateful for the financial support by Spanish Ministry of Sciences and Technology, Project No. BEC2002-0309, and by the Instituto Valenciano de Investigaciones Economicas. Christophe Nordman gratefully acknowledges financial support from the development research group of TEAM (Université de Paris I Panthéon-Sorbonne and CNRS) to carry out the survey in Tunisia. We have benefited from valuable comments from participants in a seminar at DIAL in Paris, in the Third Spring University of Mediterranean Economies in Ifrane, in the CLS Conference on "Labour Market Models and Matched Employer-Employee Data" in Sonderbörg (Sandbjerg), particularly from F. Kramarz, and in the Applied Econometrics Association (AEA) Conference on "Econometrics of Labour Demand" in Mons. We also thank Philippe de Vreyer for his proofreading and suggestions. Usual disclaimers apply.

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***Abstract*:**

In this paper, we study the return to human capital variables for wages of workers observed in Tunisian matched worker-firm data in 1999. This tells us how returns to human capital in a Less Developed Country like Tunisia differ from the industrial countries usually studied with matched data. We develop a new method based on multivariate analysis of firm characteristics, which allows us most of the benefits obtained by introducing firm dummies in wage equations for studying the effect of education. It also provides a human capital interpretation of the effect of these dummy variables. Moreover, in the studied data, using three firm characteristics easily collectable yields results close to those obtained by using the matched structure of the data.

The workers with low wages or low conditional wages experience greater returns to human capital than workers belonging to the middle of the wage distribution, while their return to schooling is significantly lower than that of high wage workers.

Wage regressions including the computed factors confirm that human capital is associated with positive intra-firm externality on wages. Therefore, a given worker would be more productive and better paid in an environment strongly endowed in human capital. However, the poorest workers do not take advantage of the human capital in the firm. Conversely, the poor benefit from working in the textile sector in terms of wages unlike the middle and high wage workers. Finally, the poorest and richest workers benefit from an innovative environment while the middle workers of the wage distribution do not.

Résumé :

Dans cet article, nous analysons les rendements du capital humain à partir de données liées employeurs-employés collectées en Tunisie en 1999. Cela nous indique comment ces rendements peuvent différer, dans un pays en développement comme la Tunisie, de ceux généralement obtenus dans les pays industrialisés avec données appariées. Nous développons une nouvelle méthode fondée sur une analyse factorielle des caractéristiques d'entreprise qui rapproche nos résultats, en ce qui concerne le rendement de l'éducation, de ceux que l'on obtient en utilisant des équations de salaire à effets fixes d'entreprise. Notre technique d'estimation fournit une interprétation des effets fixes d'entreprise en distinguant l'impact sur les salaires du capital humain propres aux établissements. En outre, sur ces données tunisiennes, nous montrons que l'inclusion dans l'analyse de trois caractéristiques d'entreprise facilement mobilisables procure des résultats très proches de ceux obtenus lorsque toute l'information disponible sur la structure d'appariement des données est utilisée.

Les rendements du capital humain pour les travailleurs à faible niveau conditionnel ou inconditionnel de salaire apparaissent plus élevés que ceux des travailleurs médians dans la distribution des salaires, alors que leur rendement de l'éducation est significativement plus élevé que celui des travailleurs à salaires élevés.

L'introduction de l'approche factorielle dans les équations de salaires confirme l'idée selon laquelle le capital humain peut constituer une source positive d'externalité intra entreprise. Un travailleur d'une qualification donnée serait plus productif et donc mieux rémunéré dans un environnement fortement doté en capital humain. Toutefois, les travailleurs pauvres ne semblent pas pouvoir bénéficier des qualifications de leur entreprise. En revanche, les pauvres profitent d'un emploi dans le secteur des textiles en termes de rémunération, contrairement aux travailleurs à salaires médians et élevés. Enfin, seuls les plus pauvres et les plus riches semblent profiter d'un environnement professionnel moderne et innovant.

1. Introduction

1.1 Worker or firm knowledge?

Returns to human capital and skills have always been considered dominant explanations for labour compensation. Accordingly, they have been incorporated in individual wage equations by using regressors describing schooling and the worker's experience[1]. This is particularly important for developing countries where the returns to education are expected to be higher[2]. A variety of human capital indicators have been used for this purpose, although it is fair to say years of schooling and years of work experience are the most popular regressors in similar wage equations, often accompanied by their squared values.

On the other hand, it has been recognized for a long time that some skills or human capital attributed to workers are also specific to the firm in which they work. The experience accumulated within the firm may be different from experience previously obtained outside the firm. Thus, part of the return to human capital for the worker remuneration can be viewed as if it originated from the firm.

Moreover, the endogenous growth literature emphasizes the presence of technological or social externalities that generate higher returns to traditional factors, notably labour. It is likely that some of these externalities occur in the form of general knowledge that may be diffused in the economy or the considered activity sector. It is also probable that many externalities actually take place in the firm where the worker operates since that is where the technological processes are most frequently exhibited and transmitted.

Thus, the overall return to human capital explaining the remuneration of a given worker may involve personal skill characteristics and firm knowledge characteristics. It seems

[1] Mincer (1993); Card (1999).

important to consider these two sources of returns to human capital simultaneously because education policies and policies promoting vocational training may affect the worker's and the firm's human capital environment differently. In particular, assessing policies without accounting for educational and knowledge externalities within firms may under-estimate the benefits of such policies.

Finally, distinguishing the two sources of human capital may contribute to explaining the typical over-estimation of returns to schooling in LDCs, as mentioned in Behrman (1999), which occurs while neglecting intra-firm human capital externalities. Indeed, part of the impact of knowledge on productivities may be caused by these externalities, associated or not with specific firm processes and working rules.

In this paper, we want to look at how return to human capital, and notably intra-firm human capital externalities, may arise in the developing economy of Tunisia. The case of Tunisia is interesting as a success story resulting from its relatively fast economic catching up with more developed countries. In this situation, firm and worker knowledge may have different rewards depending on the importance that is paid to human capital investments by the long run government strategies. Like its African neighbours, Tunisia cannot afford to neglect the role of human capital in the fight against poverty and in enhancing labour productivity. For instance, these issues are crucial in the light of the future creation of a free trade zone with the European Union. Henceforth, the improvement of human capital – notably by on-the-job training – constitutes a priority in any productivity progress and in raising the quality of exported products.

Studying effects of various human capital dimensions on earnings may be easier in a LDC economy because its structures may change faster and generate larger endogenous growth than a fully developed economy. Then, we shall consider as a working hypothesis that

[2] Sahn and Alderman (1988), Behrman (1999).

when the human capital density in the firm is correlated with worker wages, holding worker's characteristics constant, this mostly reflects intra-firm human capital externalities. This approach does not exclude other interpretations: selectivity or matching effects, economic rents correlated with human capital and other firm characteristics, as in Teal (1996), or unemployment shocks specific to the different human capital categories affecting specifically some industries, as in Hoddinott (1996). The tests of such interpretations are unfortunately beyond the possibilities of our data.

1.2 Crucial data

One popular way to account for firm characteristics, including for their human capital features, is to base the econometric investigation on matched worker-firm data[3]. Mostly, dummy variables for individual firms are added as independent variables in usual wage equations. We shall avail ourselves of such data, for the first time in the Tunisian case on which we focus. Then, this paper will tell us how returns to human capital in a LDC like Tunisia differ from the industrial countries usually studied with matched data.

This data is crucial to understand inter-firm wage differentials. The persistence of wage differentials for individuals with identical productive characteristics is an important stylized fact. Indeed, wage differentials that are not compensated by observed individual characteristics were found on numerous occasions in empirical studies, depending on their industry or firm[4]. Many models attempted to give a theoretical interpretation of these inter-industry or inter-firm wage differentials: some of them stress non-competitive wage

[3] Abowd, Kramarz and Margolis (1999), Goux and Maurin (1999), Abowd, Kramarz, Margolis and Troske (2000). See Abowd and Kramarz (1999) for a survey.
[4] Krueger and Summers (1988), Abowd, Kramarz and Margolis (1999) and Goux and Maurin (1999).

determination[5]. Other models, within the competitive framework, emphasize the existence of compensating wages due to, for instance, differences in jobs across industries (Murphy and Topel, 1987).

Nevertheless, data used to study inter-firm wage differentials are scarce. The Tunisian data we use provide precise information both on employees and their firms. Therefore, using these data, we examine the firm's effect on individual earnings, but also refine the fixed effect by investigating the human capital characteristics of each firm.

1.3 Policy issues

Poverty is a major subject of concern in Tunisia. The Tunisian Governments have been successful in reducing the extent of poverty since the independence[6]. Accordingly, poverty has just slightly increased from 1990 to 1995. So the global picture is that of a stabilization of poverty, although the poor are increasingly concentrated in peri-urban areas, particularly in Tunis[7]. This is where our survey took place.

Several reforms of the labour market have been recently undertaken by the Tunisian government. First, the Labour Code was revised in 1994 and again in 1996 to clarify the conditions under which workers can be laid off and to establish guidelines for financial compensation. Second, Tunisian producers will face stronger competition in their export markets after the elimination of the Multi-Fiber Arrangements (MFA) scheduled to be completed by 2005. Third, the competition will be fiercer in the local market with full implementation in 2007 of the Association Agreement signed with the EU in 1995, which allows free trade provisions. It is expected that better jobs for higher skilled workers will be

[5] See Katz (1986) for a review of efficiency wage theories and Lindbeck and Snower (1989) for a review of the insider-outsider models.
[6] The World Bank (2000); UNDP Tunis (1994).
[7] Muller (2002).

generated and less skilled workers will encounter greater difficulties in finding and retaining jobs[8] since Tunisia may find more profitable to shift towards industries with higher added values to the detriment of its traditional sectors. Then, the situation of low-wage workers is worrying in a context of increasing liberalization, economic opening and privatization. A response to policy and structural shocks may be found in the improvement of sector productivity, connected to average skill levels in Tunisia [9]. The Tunisian economy ability to restructure may thus be raised: by shedding labour and changing the skill mixes of its labour forces; by encouraging firms to invest in on-the-job training; and by consolidating Tunisia's positive record in labour relations and working conditions.

As a response to these economic transformations, Tunisia started a large modernization program of the productive sector in 1996. This program assists industrial and service firms in adjusting to a free market. Physical and non-physical firm investment is stimulated. Human capital investment will be crucial in this modernization process.

Educational policies can reduce poverty by raising labour rewards for better-educated workers. In this situation, it is natural to examine the returns to education for different wage levels. If education returns are high for the poor, fighting poverty through schooling opportunities or vocational training is adequate. On the contrary if the educational investments mostly benefit the rich, then improving the educational system may lead to higher growth but also to higher inequality and unchanged poverty.

Education reform is also instrumental in improving the education system responsiveness to emerging labour market demands. The Tunisian authorities are placing an increasing emphasis on vocational training, which fulfils the double objective of educating and preparing workers for a modern job market. Recently, the government has implemented a program to rehabilitate vocational training and employment (MANFORME, *Mise à Niveau de*

[8] Measurement of unemployment in Tunisia is a difficult and contentious issue (Rama, 1998). However, unemployment is a growing concern of the population and government.

la Formation Professionnelle et de l'Emploi). In the near future, the authorities should consider how to involve private employers in vocational training to match skills demand and supply.

What are the human capital characteristics influencing Tunisian workers' wages at different wage levels? The aim of this paper is to explore this question by first using matched worker-firm data, and second, summarizing the main characteristics of firms with a preliminary multivariate analysis. We show that, in such a case, the lack of matched worker-firm data could be compensated by some limited information on firms that is easily collected from workers. In Section 2, we present the data. We discuss estimation results for wage equations at different wage levels in Section 3. In this section, we also push the analysis one step further by incorporating firm characteristics and interpreting firm dummy effects using a factor analysis. Finally, Section 4 concludes.

2. The Tunisian matched worker-firm data

The matched worker-firm data we use are directly collected at the employee's workplace[10]. The questionnaire provides precise information about each worker: individual characteristics (matrimonial status, number of dependent children, geographic origin, father's education), wages, educational investments (number of years spent in primary, secondary, and high school, university or vocational school), post-school training (apprenticeships, preliminary internships, formal training within the current firm), total experience in the labour market and occupation in the current firm. Moreover, the data include characteristics of the firms in which workers evolve: organisational features, communication and training policies, innovation and competitive situations.

[9] Belhareth and Hergli (2000).

2.1 The workers

The 231 workers in the final sample were interviewed in February 1999. Table 1 provides some descriptive statistics about these workers, which are matched with a sample of eight firms (four firms in the textile-clothing sector and four in the Mechanics, Metallurgical, Electrical and Electronics Industries, IMMEE). 54.1 percent of the employees work in the textile sector and 45.9 percent in IMMEE. The proportion of women in the overall sample amounts to almost half, 49.8 percent.

The average educational year is 9.6 over the sample when calculated from the workers' questionnaires, using the available information on the highest level of education reached by the workers. Educational years are slightly higher for men (10.6 years) than for women (8.7 years). For men, it corresponds to the first year of high school. In contrast, calculating it from the age at the end of school (from which we deduct 6 years), the average number of schooling years is close to 13. Thus, accounting for unsuccessful years of education[11], we choose to use an education variable net from repeated classes. Consequently, the years of schooling include an important qualitative aspect[12]. 0.8 percent of the observed workers have never gone to school, 9.9 percent have only completed a primary level of education (1 to 5 years), 71.8 percent have obtained an educational level of 6 to 12 years (secondary school) and 17.3 percent have completed studies in higher education (university level). The proportion of employees having received a vocational diploma related to their current job amounts to 31.6 percent.

The average tenure in the current firm is 5.9 years. It amounts to 5 years for women, while it is higher for men (6.75 years). The total professional experience is an average of 9.1

[10] The methodology of the Tunisian survey appears in Nordman (2002a, 2002b) and Destré and Nordman (2002). The definitions and the descriptive statistics of the variables are in Tables 1 and 2 of the Appendix.

[11] For comparison, Angrist and Lavy (1997) estimate the number of repeated classes at 2 to 3 years in Morocco. Besides, UNDP (1994) shows that Tunisia in the 1980's had a higher rate of repeated classes at the primary school than Morocco.

years. On average, men cumulate more than 10 years of experience against less than 8 years for women. Besides, the previous experience apart from the current job is on average of 3.3 years. Women average 2.8 years, compared to 3.6 years for men.

The ratio of tenure to the overall work experience is 64 percent. This suggests an important percentage of young, first-time workers. Indeed, the average age in the sample is low, amounting to 29.5 years and 28 and 31 years for women and men respectively.

Some wage characteristics are worth noting. The average monthly wage declared by employees is 213 US dollars[13], while an average monthly wage for male workers is 1.7 times the female wage. Beyond differences in human capital endowments between sexes, the female proportion of the sample employed in the textiles, where wages are generally low, contributes to this wage differential: 94 percent of the observed women belong to the clothing sector, while male workers of this sector represent only 14 percent of all male workers. Indeed, the average monthly wage in the IMMEE sector is 1.6 times higher than in the textile sector. Educational differences should partially explain this: On average, the IMMEE workers have 10.6 years of education compared to 8.9 years for those working in textiles.

Statistics specific to each wage quartile show that workers' characteristics differ according to wage level. Lower wage workers are less educated, trained and experienced. They are on average younger, mainly females and have suffered longer unemployment spells. These results suggest separate modelling of the wage rates at different wage levels. To simplify the presentation, we shall call 'the poor' the observed low wage workers, and 'the rich' the highly paid workers. Naturally, these notions of living standard level are restricted in

[12] See on this point Behrman and Birdsall (1983).
[13] The average monthly wage corresponds to 1.8 times the monthly SMIG of 1997 for a regime of 48 hours per week (177.8 Tunisian Dinars, that is 125 US dollars in 2001). The declared monthly wages are those of January and February 1999.

this paper to wage workers in the formal sector and are not representative of all the poor in Tunisia[14]. We now turn to the firm characteristics.

2.2 The firms

The four firms of each sector are located in the Tunis area. They are selected based on criteria of size (not less than 50 employees), activity, vocation to export and capital ownership[15]. They all belong to the formal sector. This firm sample is interesting because these firms are typically in the range of shocks and policies we mentioned above. The average size of the establishments visited is 130 employees.

Information about the firm's characteristics have been collected directly from the employers: composition of the workforce, work organization, training and communication policies, organizational or technical innovations and competitive situation of the firm. Table 2 in the Appendix shows descriptive statistics. Figure 1 in the Appendix shows the histogram of observed wages. The two minimum wages are separately indicated by vertical lines for 40 hours a week and 48 hours a week.

Contemporary wages are concentrated around values slightly above the minimum wage, while heavy right tails account for a small number of very skilled workers. We are now ready to discuss the estimation results.

[14] Low (high) skilled workers do not systematically correspond to low (high) pay workers. Another approach could have been to oppose skill categories rather than wage levels. In this paper, we focus on wage categories to capture differential social consequences of training and education policies.
[15] The observed firms were selected among firms exporting their production and not with entirely foreign capital.

3. Estimation Results

3.1 The model and the estimation method

The matched worker-firm data enables us to estimate the returns to human capital using both workers' and their firms' information. For this purpose, the Mincer earnings function is a convenient tool for estimating the average returns to education and labour market experience. The return to education is given by the coefficient of schooling duration in the wage equation[16]. However, returns to human capital can vary across wage categories. For instance, high wage workers should not benefit from the same return to experience than low wage workers since the latter may have fewer incentives to make further on-the-job investment in human capital because they only deal with basic tasks. Alternatively, more educated individuals – generally with higher wages – may have greater incentive to invest in training because they learn more quickly. As a result, the shape of the relationship between the workers' wage level and their returns to education and work experience (former experience plus tenure in the incumbent firm) is not clear. To capture differentiated returns of education and experience between the rich and the poor, we construct four individual dummies indicating the workers' relative position in the sample in terms of hourly wage (quartile 1 to quartile 4). These dummies (QUARTILEi, i: 1…4) are allowed to interact with the main three human capital variables in the wage equation: education, tenure and previous work experience.

As alluded to in the introduction, the lack of suitable matched firm-employee data for the wage analysis has been deplored by a number of authors, such as Rosen (1986) and Willis (1986), as such data allows the structure of wages to be modelled while controlling firm-specific effects. With our matched data, we can deal with the firm heterogeneity by

introducing firm dummy variables into the wage equation. However, since we have cross-sectional data, we cannot model unobserved individual heterogeneity in the way of Abowd, Kramarz and Margolis (1999). To temper the effects of unobserved individual heterogeneity which might bias the estimated coefficients, we add control variables to our OLS regressions and perform instrumented regressions (2SLS).

Naturally, using firm dummies is a rough way of accounting for intra-firm human capital externalities. Meanwhile, it is possible that part of what could be interpreted as human capital externalities in the estimates is in fact a consequence of the worker selection by firms and vice versa. For example, very productive firms and workers may choose each other. In this paper, because of data limitations, we do not deal with this difficulty, and we assume that selectivity and sub-sampling effects can be neglected.

In the wage equations, we incorporate formal training received in the current firm (ongoing training and past training). In our sample, more educated workers generally receive more formal training: on average 12.2 years of schooling for workers having received formal training compared to 9.1 for the others.

Two other dummy variables are retained in the regressions[17]. One dummy variable controls for the worker's hierarchical position in the firm (executive or supervisor), while the other describes trade union membership. Workers who are executive or supervisor are expected to have higher earnings. The effect of union membership on wages remains unclear in the empirical literature.

We do not limit our analysis to the OLS results or 2SLS estimations. Introducing dummies for quartiles in the regressors creates endogeneity problems that may be imperfectly corrected with instrumental variable methods. A way to avoid this difficulty is by using

[16] Quadratic and more flexible polynomial specifications have been tried but cannot be accurately estimated with these data.

[17] All the other socio-economic variables such as sex, matrimonial status and geographic origin are dropped from the regressions for lack of significance and to preserve degrees of freedom.

quantile regressions. Quantile regression estimators have recently become popular estimation methods (Koenker and Bassett, 1978), which have been employed for wage analyses (Buchinsky, 1998, 2001). The popularity of these methods relies on two sets of properties. First, they provide robust estimates, particularly for misspecification errors related to non-normality and heteroscedasticity, but also for the presence of outliers, often due to data contamination. Second, they allow the researcher to concentrate her attention on specific parts of the distribution of interest. This is the case when the distribution of interest is the conditional distribution of the dependent variable.

Consequently, focusing on the quantiles of error terms in wage equations, introduces an alternative notion of wage precariousness that can be contrasted with the quantiles of the wage distribution. One can oppose the low observed level of wages in OLS and 2SLS estimates with the low conditional wage level in the quantile regression estimates. We choose to pursue these two approaches. We find that the residuals' quantiles from the regressions are correlated to those obtained when different quartiles are used to define the quantile regression. In contrast, they are not as strongly correlated to the quartiles of the wages themselves. Thus, low quantiles corresponding to the two approaches capture distinct dimensions of wage precariousness.

Finally, bootstrap confidence intervals are used for quantile regressions in order to avoid the consequences of the slow convergence of classical confidence intervals of estimates (Hahn, 1995). Let us examine the estimates.

3.2 The wage equation estimates

Our first estimates of the equations of the logarithm of individual hourly wage are reported in Table 3 of the Appendix. The first two columns correspond to OLS estimates without wage quartiles as regressors. The following two columns show the results obtained

when the returns to human capital can vary across wage quartiles through the inclusion of dummy variables for wage quartiles[18].

The wage equation which incorporates firm's fixed effect is characterized by a better goodness-of-fit than the standard Mincerian wage function[19]. As noticed by Abowd and Kramarz (1999), the return to schooling decreases after controlling for firms' heterogeneity with fixed effects. In OLS regressions, the marginal return to education in Tunisia is 6.9 percent with the firm's fixed effects instead of 8.6 percent without the firm dummies. With comparable equations and French data (1992 ECMOSS survey), we find a drop from 5.73 to 4.91 percent. The drop for Tunisia is in the scope of usual results (Abowd and Kramarz, 1999). Thus, introducing firm dummies brings to the fore a partial answer to the issue of typical over-estimation of education returns in LDCs. To our knowledge, no comparable estimates exist on Tunisia[20].

High returns to education in Tunisia in 1999 may be explained by stylized facts of the labour market. The picture that emerges from Rama's study (1998) is one of an increasingly tight labour market. His critical evaluation of the methods used to forecast unemployment rates and an econometric analysis of the data on vacancies and unemployment suggests a relatively efficient labour market. For instance, Tunisia's unemployment problem appears to have been greatly overstated. More specifically, the use of comparable labour force definitions shows that unemployment has declined quite steadily over the years, which is not surprising given the remarkable performance of the Tunisian economy. In this context, increasing opportunity costs and therefore possible high reservation wage for young educated

[18] We also test interactions of these dummies with the quadratic terms of experience variable to take into account possible differentiated decreasing returns to experience across wage quartiles. However, since the results were little significant, we choose to exclude these interactions to preserve on degrees of freedom.

[19] The Fisher test of the constrained model (without the firm's fixed effect) against the unconstrained model (fixed effects) shows that we cannot reject the unconstrained model at the 1 percent level.

[20] See Psacharopoulos (1985, 1994, 2002) for surveys reporting the returns to education in numerous countries. Some of the education effect may be caused by selection. Firm dummies may help control for the selection effects, but other individual and household characteristics are missing which does not allow us to be fully protected against a selectivity bias.

workers might lead to high returns to education in 1999. However, the following estimates will show that an alternative interpretation of these high returns is that they result from misspecifications related to differential results across wage levels.

Columns (3) and (4) elicit returns to human capital that are significantly different across wage quartiles, without and with adding the firm's fixed effect, respectively. Table 4 summarizes the main results of all these estimators by computing the coefficients of education, job tenure and previous experience for each wage quartile. Looking at OLS estimates show that the poorest workers (first quartile) have significantly higher returns to human capital than the workers belonging to the middle of the wage distribution: The returns to education amount to 4 percent, 0.3 percent and 0.2 percent for the workers belonging to the first, second and third quartiles, respectively. However, the return to schooling of the poorest workers is significantly lower than that of the richest workers (8.7 percent for the fourth quartile). More generally, except for tenure, the results emphasize a U curve that describes the returns to human capital (education and experience) as a function of the wage levels (first to fourth quartile). This is consistent with results found from quantile regression estimates in industrial countries, where returns to schooling are higher for the more skilled individuals (Martins and Pereira, 2004). As for tenure, its return is always significantly higher for the poorest employees than for the other categories, while the U curve corresponding to the estimates of coefficients is generally not significant[21].

Note that there is no mistake with the average education return dropping from 6.9% to 3.3%. This result is confirmed by running separate regressions for each quartile and suggests that unconstrained education returns may be strongly biased. Moreover, the returns at the average point of the sample vary also a lot for experience (4.26 percent without quartile

[21] One could raise an objection based on the shape of the histogram of wages: there may be only few observations between mode and extreme observations. Then, the U curve may result from too little information in the data for the second and third quartiles. Drawing the quartile lines of this histogram has shown us that this is not the case and that the low density levels occur only from the last quartile.

dummies against 2.56 percent with quartile dummies) and for tenure (respectively 4.51 percent and 2.31 percent).

We control for the possible endogeneity of the education variable by using two-stage least square regression (2SLS) whose estimates are shown in column (5). Moreover, the introduction of the dummies for wage quartiles creates an additional source of endogeneity that must be dealt with. The set of instrument for both education and the wage quartiles is reported at the bottom of Table 1[22]. An important instrument for the worker's education variable is the education level of the worker's father[23]. The main results remain unchanged (Table 4). However, the returns to human capital are refined: the average return to education decreases from 3.3 percent (OLS) to 2.4 percent (2SLS)[24]. This return falls for the poorest workers and rises for the richest. The returns to tenure and experience are also enhanced for the poorest workers.

We also investigate whether returns to human capital differ across the wage distribution by using quantile regressions for quantiles 0.25, 0.50 and 0.75. These estimates are shown in columns (6), (7) and (8) of Table 3. The results confirm a presence of gaps across the quartiles in the returns to education, tenure and previous experience (Table 4). Both returns to tenure and experience remain higher for workers belonging to the first quartile than the second and third quartiles. This is in contrast to different findings from Portugal in Machado and Mata (2001), where all aspects of human capital are relatively more valued only for high paying jobs. However, the last quartile corresponds to the highest returns to education. Meanwhile, the differences across the workers' categories are smaller than those for the OLS and 2SLS.

[22] The values of the F-statistics and R^2 in instrumental equations ensure that we are not in the weak instrument case (Abadie et al., 2002). We attempted to instrument the experience variable as well, although this did not yield any good result since we lack additional instrumental variables to perform it in good conditions.
[23] This instrument, popular when using developing country data, may capture various genetic and environment influences (Sahn and Alderman, 1988).

Let us now look at the other estimated coefficients. Completed formal training plays an important role in explaining wage differentials (its coefficient is always significant at a 5 percent level and positive). This is consistent with theories that argue that wage differentials should reflect differences in training investment. On the other hand, the negative coefficient of the ongoing formal training variable, although not always significant, is consistent with Becker's (1975) prediction that the costs of general training are shared between employers and employees (also found in Lynch, 1992; Barron et al., 1998; Parent, 1999). If this formal training is of general content, then the workers should partly compensate for it by accepting a lower wage during the training period (Leighton and Mincer, 1981; Hashimoto, 1982). Since the evidence for such effect consistent with the human capital theory is often ambiguous in US data, it is useful to obtain some evidence from Tunisian data. As shown by the estimates, they ultimately benefit from this training which provides them with a positive wage premium (from 10 percent to 30 percent increase depending on the regression) when training is completed.

Finally, the estimates of the firm dummies' coefficients are large and significant at the 1 percent level. This is in accordance with the usual wage differentials across individuals with identical productive characteristics in empirical studies[25]. Such wage differentials have been found in Tunisia in non-matched data (Abdennadher et al., 1994). The results show that workers with comparable measured characteristics earn different wages partly because they belong to different firms. In this study, wage differentials across firms will receive further consideration in the next sub-section where the firm effect on individual earnings is interpreted in terms of each company's organisational features.

[24] This is at odds with the effects of instrumental variables in some empirical works. For example, Card (1999) finds that for U.S. data, 2SLS estimates on returns to education are often 15 percent higher than OLS estimates.

3.3 Principal component analysis of the firm's characteristics

We use a principal component analysis (PCA) to summarize the information about the surveyed firms[26]. This method is based on the calculation of the inertia axes for a cloud of points that represents the data in table format. There are three possible uses of factor analysis in this context. First, and foremost, factor analyses are generally used to elicit hidden characteristics correlated with observable characteristics. Accordingly, we look for hidden characteristics which could replace the firm dummies. Second, we use the PCA results as a guide to replace these hidden firm characteristics with observable characteristics correlated with the main factors. Thus, we shall propose 'pseudo-factor' models where firm dummies are replace by a few observable firm characteristics. Third, we use the PCA as a substitute for regressions of firm dummies. Indeed, with only eight firms there is no hope for explaining firm effects with regression analysis. In contrast, the PCA allows us to investigate the determinants of the firm effects in our data.

For our purpose, the first three estimated factors concentrate most of the relevant information about the firm's characteristics. In a sense, we generalize the approach by Cardoso (1998) who regresses the firms' fixed effects on different variables.

Table 5 shows the results of the principal component analysis, with the definition of the main three inertia axes (the factors), which are linear components of the firm's characteristics used for the analysis. The other factors represent a negligible amount of statistical information and are dropped from the analysis. In our basic specification without quartile dummies, OLS estimates without the firm's dummies nor factors explain 67 percent of the log-wages variance. Adding our three factors raises this proportion by 8 percent, and

[25] See Krueger and Summers (1988), Abowd, Kramarz and Margolis (1999) and Goux and Maurin (1999).
[26] In principal component analysis, a set of variables is transformed into orthogonal components, which are linear combinations of the variables and have maximum variance subject to being uncorrelated with one another. Typically, the first few components account for a large proportion of the total variance of the original variables,

the firm's dummies instead by 9 percent only. The correlation coefficients of these characteristics with the first three factors are indicated for the interpretation. Clearly, the first factor corresponds to the activity sector (textile against IMMEE), grouping the firms most oriented towards exports[27]. The second factor describes the 'density in the firm' of the human capital characteristics. The third factor is closely associated with the firm's modern features. Naturally, as is always the case in factor analysis, these interpretations are somehow subjective. The reader may substitutes her own if wished.

Table 6 indicates the correlation coefficients of the first three factors with the firm dummies on one hand, and a few education and gender characteristics of workers in the firm on the other hand. They confirm common wisdom about how the firm is characterized by each factor. Firms in the textile sector have a higher proportion of female workers and less educated or trained workers. Firms with high human capital density exhibit higher average education levels. Modern firms invest more in formal training.

3.4 Wage equations with firm factors

The factor analysis enables us to summarize the main information on the firms' characteristics into three principal components (factors)[28]. By contrast with the firms' fixed effects introduced in the wage regressions in Table 3, the three factors suggest qualitative characteristics of the firms. In Table 7, we present the estimates of the wage equations in which the firm fixed effects are replaced by the three factors.

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and hence can be used to summarize the original data. We tried many other techniques of factor analysis. They lead to similar conclusions. We omit them in the presentation to save space.

[27] The export orientation of the firm could be more relevant than the sector to characterise the first factor. However, the impact of the sector on wages seems to make more sense given the strong sector segmentation of the market in Tunisia. Indeed, every three years collective wage bargaining at sector level are conducted for 45 sectors.

[28] Various studies tried to separate the external effects of the group or the sector in which the workers evolve from the purely individual effects on their earnings differentials. Mean variables were added in earnings functions, after a control for the individual characteristics, by Dickens and Katz (1987), Krueger and Summers

The first column reports the OLS estimates. The coefficient of the first factor, largely reflecting the textile sector, is statistically significant at 5 percent level and has a negative sign. This is consistent with the fact that in Tunisia the textile sector is the manufacturing industry with the lowest wage. Ceteris paribus, workers belonging to this sector experience a lower wage.

The second factor has a significant positive impact on wage differentials. Since this factor reflects the density of each firm's human capital, the firm's human capital may generate positive wage externality. A worker with a given skill would be more productive and thus, better paid in an environment highly endowed in human capital. The third factor, reflecting the firm's age and its capacity to promote innovations and new technology has no significant effect in this specification.

In the following two regressions (columns 2 and 3), we add the wage quartile dummies and allow them to interact with the three factors in order to identify if differentiated effects of factors and variables exist across wage groups. The factors' main results are also reported in Table 4.

First, from the OLS regression, it appears that the poorest workers (first quartile) benefit from working in the textile sector unlike medium and high-wage workers. Second, the poorest workers do not seem to take advantage of the firm's human capital since they experience a negative impact on their wages from Factor 2. This result may reflect differences in bargaining power within firms across wage groups, or be associated with differences in the human capital role in the tasks across wage groups. It could also be interpreted in terms of knowledge diffusion. The transmission of knowledge might be reserved for high wage or high skilled workers. Also, the correlation coefficient of Factor 2 with the importance of supervision is 0.98, while it is 0.96 with the managerial/staff proportion. Then, the negative

(1988), Blanchflower and Oswald (1994), Chennouf, Lévy-Garboua and Montmarquette (1997) and Kölling, Schnabel and Wagner (2002). Using factors is a further step in this direction.

effect of Factor 2 on the first quartile wage may result from the fact that excessive supervision prevents development of human capital externalities because it limits individual responsibility and improvement possibilities. The richer and more qualified social categories are the ones who benefit the most from the firm's human capital density. As for Factor 3 (modernity of the firm), its impacts on wages emphasizes the same U curve as described earlier for the returns to human capital across wage groups. The poorest and richest workers benefit from an innovating environment, while workers in the middle of the wage distribution do not.

The results with 2SLS and quantile regressions show similar features for the positive effect of the second factor. However, as expected, because of the accuracy lost in the instrumentation, the coefficient of the various equations incorporating factor dummies are often non-significant with the 2SLS, particularly when factor dummies are interacted with quartile dummies. Finally, the quantile regression estimates of factor effects are different in that they are not based on many interacted effects of factors and quartiles. In this case, the first factor corresponds to a significant negative effect, the second factor to a significant positive effect, while the third factor has no significant impact. These results illustrate the differences in the two notions of wage positions, respectively based on wage quantiles or wage conditional quantiles. These two notions are associated with the factors' different impacts.

Finally, we carry out a simple regression by replacing the three factors with three of the firm's characteristics that seem to be better reflecting each of them: a dummy for the textile sector (Factor 1), the average education level in the firm (Factor 2) and the firm's age (Factor 3)[29]. Using a questionnaire addressed to workers (e.g. during an employment survey or a labor force survey), it would be easy to collect information on these three characteristics (sector, proxy of average education in this firm, age of this firm) and use them afterwards as regressors in the wage equation. We call this regression the "pseudo factor" model (PFM,

[29] Eliminating the wage observation of the considered individual in this mean does not change qualitatively the results.

column 4 of Table 7). The coefficients of the three selected variables are statistically significant at 1 percent and have the expected sign. It is interesting to compare the estimators obtained from this regression to those drawn from a simple Mincerian model (MM) and a firm fixed effects model (FFEM) (Columns 1 and 2 in Table 3). Clearly, it appears that the PFM does very well as compared to the FFEM: the returns to human capital obtained from the PFM are closer to those of the FFEM than to the same returns drawn from the MM. More specifically, the PFM gives a return to education similar to that obtained by the FFEM (6.8 percent compared to 6.9 percent with the FFEM, while it amounts to 8.6 percent with the MM).

Let us mention a few points about the estimates with specific quartile effect of the surrogate variables that we do not show to save space. There is no significant differentiated effect of the sector variable across wage quartiles, unlike the interactions with the average education variable. Indeed, OLS estimates display the same U curve across quartiles as for the external effect of mean education on wages: this external return is significantly lower for workers belonging to the third quartile than that of the richest and poorest workers. Curiously, there is a negative impact of the establishment's age on the wages of the richest and poorest workers (-1.8%) while this effect is positive for workers in the second (3.9%) and third quartile (3.7%).

The comparison of estimation results with the firms' fixed effects with estimation results with factor effects is instructive. Indeed, the firms' fixed effects could be partly interpreted as resulting from unobserved human capital characteristics at the firm's level. Under such assumption, the estimation results show that in our data three of the firm's observable characteristics suffice to account for most of the impact of the firm's effects on wages. As a consequence, the technique proposed in this paper to take advantage of matched

worker-firm data could also be useful for other applied research when matched worker-firm data are not available.

We obtained returns to education in the equations without the firm's characteristics that are substantially different from the returns to education in equations with the firm's fixed effects. As in Chennouf et al. (1997) for Algeria, the returns to education diminish when the firm's effects are introduced. However, this only occurs when all quarters are considered together. This suggests that it is important to consider the different quartiles of the wage distribution.

Meanwhile, the returns to education obtained with the firm's fixed effects are almost indistinguishable from the returns in equations with factors, and from the returns in equations with mean education characteristics of the firms. This suggests that the firm's effects can be corrected by introducing these mean education characteristics *if the main interest is to estimate returns to education.*

Finally, the introduction of factors may be used to better interpret the firm dummies in equations with the firms' fixed effects. For example, the characteristics of firm number 1 (respectively firm number 6, respectively firm number 7) are very close to that of Factor 1, 'textile type industry with high export orientation' (respectively Factor 2, 'high qualification', respectively Factor 3, 'modern firm').

4. Conclusion

In this paper, we study the return to human capital variables for wages of workers observed in Tunisian matched worker-firm data in 1999. Thus, our results show how returns to human capital in a developing country such as Tunisia differ from industrial countries usually studied with matched data. We also develop a new method based on multivariate

analysis of firm characteristics. This method allows us many of the benefits obtained by introducing firm dummies in wage equations for studying the effect of worker's education. It also provides a human capital interpretation of the effect of these dummy variables. Moreover, in the studied data, using three firm characteristics easily collectable (average education level of workers, sector, age of the firm) yields results close to those obtained by using the matched structure of the data.

The results show wage equations incorporating the firms' fixed effects have a better fit than the standard Mincer wage functions. All the wage equations show large effects from the firm dummies.

With or without controlling for firm characteristics and for possible endogeneity of the education variable, the poorest workers (as defined in terms of wages or conditional wages) experience greater returns to human capital variables than workers belonging to the middle of the wage distribution. However, the return to schooling of the poorest workers is significantly lower than that of the richest workers.

The impact of formal job training on earnings is consistent with general predictions of human capital theory: individuals who invest in training during an initial period and receive a lower wage than what they could receive elsewhere without training. Workers may collect returns from their investment at a later period through higher marginal products and higher wages.

Using a factor analysis to summarize the information on the surveyed firm, we show the activity sector of the firm, its human capital characteristics and modern features concentrate most of the statistical information from the employer survey.

Wage regressions, including the computed factors, confirm that human capital seems to constitute a source of positive intra-firm externality on wages. However, the poorest workers do not take advantage of the firm human capital. Conversely, the poor benefit from

working in the textile sector in terms of wages unlike the medium and highly paid workers. Finally, the poorest and richest workers benefit from an innovating environment while workers in the middle of the wage distribution do not.

An alternative interpretation is that the estimated intra-firm externality on wages partially captures the role of unobserved physical capital. Indeed, it may be that high human capital and training are correlated with high capitalistic intensity across firms. If that is the case, the impacts of human and physical firm capital on wages should be analysed jointly. This calls for accurate measurement of these two types of variables, notoriously hard to observe. Another possible interpretation of the intra-firm human capital effects is that it originates from selectivity or matching effects. For example, because of specific technologies requiring high skills, some firms hire workers with high human capital and pay well this specific human capital.

What are the policy implications? In the Tunisian context, emerging tensions in the labor market – resulting from uncertainty about job tenure and deterioration in relative wages for lower-skilled workers – will need to be closely followed through comprehensive monitoring of unemployment, skill composition and location. The role of education and formal training is central in dealing efficiently with these tensions. One of the outcomes of the estimations is that human capital investment should partly proceed through the work organisation and training policy of the firm and not only stem from public education policies.

Moreover, poverty in Tunisia has been found to be more concentrated in the textile sector among manufacturing sectors. This is consistent in our data with lower wages observed in the textile sector. However, since the return to human capital is particularly high for the poorest workers in this industry, it could play a role of skill promoter for low-skilled manpower. Once these workers in this industry have raised their productivity by a work

period, they may be able to switch to another activity sector in search of better remunerations, although we cannot test this hypothesis with our data.

Finally, what can we expect from public policies using education against poverty and inequality? The U-curve of the returns to the different human capital variables in wage equations implies that human capital accumulation is likely to help alleviate poverty but may have ambiguous effects on inequality. This makes it all the more worrying that Mesnard and Ravallion (2001) found raising inequality in Tunisia depletes the aggregate number of business starts-up, and therefore may reduce future economic growth. In these conditions, welfare public programs based on reinforcement of workers' skills and knowledge should be accompanied by monitoring benefits that every society class would receive from education and training, including in the workplace itself.

APPENDIX

Figure 1. Distribution of observed monthly wages of all types of workers

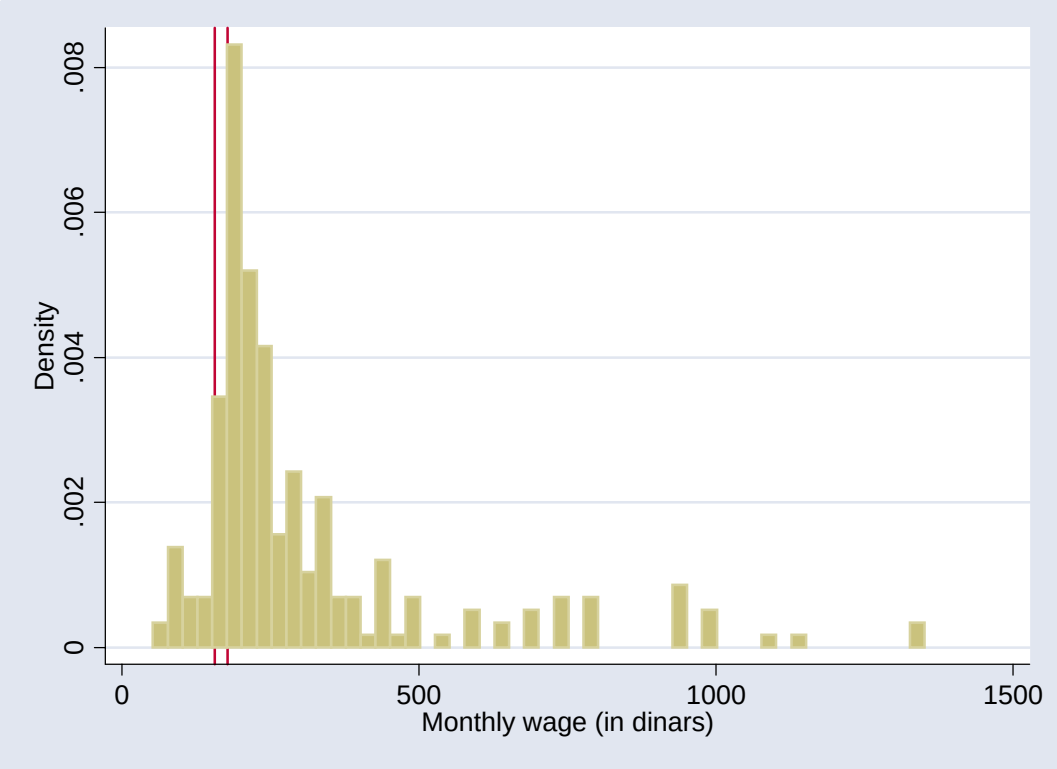

Table 1. Descriptive statistics of the workers' characteristics

Variables	*Mean*	*Standard deviation*	*min*	*max*
Age of individuals (AGE)	29.532	7.774	15	52
Sex (FEMALE, 1: woman; 0 man; conversely for MALE)	0.498	0.501	0	1
Geographical origin (PROVE, 1: rural area; 0 otherwise)	0.147	0.355	0	1
Matrimonial situation (MARI, 1: if married; 0 if divorced, widowed or single)	0.368	0.483	0	1
Single male (CELIBAH, 1: yes; 0 otherwise)	0.303	0.460	0	1
Number of dependant children (ENFT)	0.580	1.060	0	5
Father has a level of Primary school (PPRIM, 1: yes; 0 otherwise)	0.173	0.379	0	1
Father has a level of Secondary school (PSECON, 1: yes; 0 otherwise)	0.164	0.371	0	1
Father has a level of Higher education (PSUP, 1: yes; 0 otherwise)	0.125	0.332	0	1
Father is illiterate (PANAL, 1: yes; 0 otherwise)	0.194	0.396	0	1
Years of schooling (EDUCATION)	9.676	3.880	0	18
Previous apprenticeship in a firm (APPRENTI, 1: yes; 0 otherwise)	0.363	0.482	0	1
Periods of internship related to the current job (STAGA, in months)	1.468	3.617	0.00	24.0
Periods of internship not related to the current job (STAGAN, in months)	0.121	0.759	0.00	6.00
Periods of unemployment (CHOMA, in years)	1.385	2.825	0.00	18.0
Previous relevant experience (EMSIM, 1: yes; 0 otherwise)	0.554	0.498	0	1
Previous total professional experience (EXPERIENCE, in years)	3.261	4.689	0	22
Start date in the current firm (ENTREE)	1992.1	5.901	1968	1997
Tenure in the current firm (TENURE, in years)	5.898	5.902	0.17	30.08
Formal training received in the current firm (FORMAD, 1: yes; 0 otherwise)	0.182	0.387	0	1
Formal training period in the current firm in years (FORMAA)	0.091	0.323	0	3
Ongoing formal training in the current firm (FORSTIL, 1: yes; 0 otherwise)	0.017	0.130	0	1
Member of an union (SYNDIC, 1: yes; 0 otherwise)	0.203	0.403	0	1
Work in team (EQUIPE, 1: yes; 0 otherwise)	0.367	0.483	0	1
Work in chain (CHAINE, 1: yes; 0 otherwise)	0.320	0.467	0	1
Executive or supervisor (ENCADR, 1: yes; 0 otherwise)	0.190	0.394	0	1
Hourly wage (salh, in dinars)	1.893	1.347	0.29	7.57
Log of hourly wage (lnsalh)	0.197	0.251	-0.54	0.88
Monthly wage (sal, in dinars)	315.131	231.382	52	1350
Firms' fixed effects				
Firm 1	0.134	0.342	0	1
Firm 2	0.160	0.368	0	1
Firm 3	0.143	0.351	0	1
Firm 4	0.130	0.337	0	1
Firm 5	0.130	0.337	0	1
Firm 6	0.087	0.282	0	1
Firm 7	0.078	0.269	0	1
Firm 8	0.139	0.346	0	1

Table 2. Firms' descriptive statistics

Variables	*Mean*	*Standard deviation*	*min*	*max*
Average education in the firm	10.07	2.546	7.7	15.4
Average tenure in the firm	5.818	3.631	1.43	13.60
Average total experience in the firm	9.002	3.869	3.61	16.9
Average age of employees in the firm	29.717	2.880	26.19	34.55
Work independence stimulated (1: yes; 0: no)	0.250	0.463	0	1
Level of stimulated internal communication (1 to 3)	0.900	1.039	0	3
Level of competition (1 to 5)	3.125	1.642	1	5
Regular work control (1: yes; 0: no)	0.500	0.535	0	1
Age of the firm	10.438	5.766	3.5	20
Number of intermediary levels of management	5.000	0.535	4	7
Size (number of employees)	131.250	100.954	70	371
Existing system of formal training (1: yes; 0: no)	0.250	0.463	0	1
Task definition (1: globally defined; 0: precisely defined)	0.250	0.463	0	1
Organizational innovation the last four years (1: yes; 0: no)	0.5	0.534	0	1
Technological innovation the last four years (1: yes; 0: no)	0.625	0.517	0	1
% of exported production	0.603	0.462	0	1
Exportation (1: yes; 0: no)	0.75	0.462	0	1
System of versatility implemented (1: yes; 0: no)	0.625	0.518	0	1
% of employees working in chain	0.358	0.409	0.00	0.91
Sector (1: textiles; 0: IMMEE)	0.500	0.535	0	1
Rate of supervision	0.103	0.069	0.05	0.25
Rate of management	0.146	0.278	0.02	0.83

Table 3. Wage equations

Dependent variable: Log hourly wage (lnsalh)

Explanatory variables	OLS (1)		OLS Firm fixed effects model (2)		OLS (3)		OLS Firm fixed effects model (4)		IV (2SLS) Firm fixed effects model (5)		Quantile regressions (bootstrap standard error: 20 iterations) Firm fixed effects models 0.25 Quantile (6)		0.50 Quantile (7)		0.75 Quantile (8)	
Constant	-0.7324*** (0.0864)	*0.00*	0.0090 (0.1275)	*0.94*	-0.1616 (0.2186)	*0.46*	-0.0459 (0.2093)	*0.82*	-0.1034 (0.4177)	*0.81*	0.2098 (0.3110)	*0.50*	0.5531** (0.2798)	*0.04*	0.2570 (0.2652)	*0.33*
Education	0.0861*** (0.0071)	*0.00*	0.0691*** (0.0068)	*0.00*	0.0857*** (0.0103)	*0.00*	0.0870*** (0.0124)	*0.00*	0.0915*** (0.0248)	*0.00*	0.0498*** (0.0114)	*0.00*	0.0448*** (0.0156)	*0.00*	0.0686*** (0.0157)	*0.00*
QUARTILE1	–		–		-0.5933** (0.2369)	*0.01*	-0.3702 (0.2271)	*0.10*	-0.4284 (0.4424)	*0.33*	–		–		–	
QUARTILE2	–		–		0.2733 (0.2365)	*0.25*	0.5047** (0.2268)	*0.02*	1.0567* (0.5536)	*0.06*	–		–		–	
QUARTILE3	–		–		0.6223*** (0.2353)	*0.01*	0.7992*** (0.2253)	*0.00*	0.7524 (0.4845)	*0.12*	–		–		–	
Education*QUARTILE1	–		–		-0.0433*** (0.0159)	*0.01*	-0.0464*** (0.0152)	*0.00*	-0.0596* (0.0335)	*0.08*	–		–		–	
Education*QUARTILE2	–		–		-0.0809*** (0.0154)	*0.00*	-0.0839*** (0.0146)	*0.00*	-0.1286*** (0.0363)	*0.00*	–		–		–	
Education*QUARTILE3	–		–		-0.0814*** (0.0147)	*0.00*	-0.0848*** (0.0139)	*0.00*	-0.0806*** (0.0293)	*0.01*	–		–		–	
Tenure	0.0255** (0.0107)	*0.02*	0.0452*** (0.0099)	*0.00*	-0.0071 (0.0085)	*0.41*	0.0099 (0.0087)	*0.25*	0.0107 (0.0160)	*0.50*	0.0448** (0.0233)	*0.05*	0.0271** (0.0141)	*0.05*	0.0362*** (0.0122)	*0.00*
Tenure^2	-0.0004 (0.0005)	*0.43*	-0.0012*** (0.0004)	*0.01*	0.0006** (0.0003)	*0.05*	0.0002 (0.0003)	*0.54*	0.0002 (0.0005)	*0.76*	-0.0009 (0.0009)	*0.33*	-0.0006 (0.0006)	*0.34*	-0.0008* (0.0005)	*0.10*
Tenure*QUARTILE1	–		–		0.0699*** (0.0128)	*0.00*	0.0621*** (0.0130)	*0.00*	0.0755** (0.0339)	*0.03*	–		–		–	
Tenure*QUARTILE2	–		–		0.0022 (0.0091)	*0.81*	-0.0094 (0.0090)	*0.29*	-0.0362 (0.0276)	*0.19*	–		–		–	
Tenure*QUARTILE3	–		–		-0.0015 (0.0062)	*0.81*	-0.0091 (0.0062)	*0.14*	-0.0085 (0.0135)	*0.53*	–		–		–	
Experience	0.0325*** (0.0127)	*0.01*	0.0426*** (0.0117)	*0.00*	0.0373*** (0.0103)	*0.00*	0.0495*** (0.0102)	*0.00*	0.0426*** (0.0171)	*0.01*	0.0467** (0.0233)	*0.04*	0.0306** (0.0148)	*0.04*	0.0322** (0.0166)	*0.05*
Experience^2	-0.0004 (0.0007)	*0.57*	-0.0011* (0.0006)	0.10	-0.0006 (0.0004)	*0.20*	-0.0009** (0.0004)	*0.03*	-0.0005 (0.0006)	*0.40*	-0.0015 (0.0016)	*0.33*	-0.0010 (0.0008)	*0.24*	-0.0002 (0.0012)	*0.87*
Experience*QUARTILE1	–		–		0.0057 (0.0130)	*0.66*	-0.0022 (0.0127)	*0.86*	0.0274 (0.0344)	*0.43*	–		–		–	

Experience*QUARTILE2	–		–		-0.0290*** (0.0083)	*0.00*	-0.0345*** (0.0079)	*0.00*	-0.0512*** (0.0168)	*0.00*	–		–		–	
Experience*QUARTILE3	–		–		-0.0270*** (0.0082)	*0.00*	-0.0347*** (0.0079)	*0.00*	-0.0324** (0.0150)	*0.03*	–		–		–	
Ongoing formal training	-0.4972*** (0.1798)	*0.00*	-0.4159*** (0.1577)	*0.01*	-0.1542 (0.1001)	*0.13*	-0.1288 (0.0948)	*0.17*	-0.0821 (0.1211)	*0.50*	-0.3502 (0.2522)	*0.16*	-0.4649** (0.2236)	*0.04*	-0.3384 (0.2501)	*0.17*
Completed formal training	0.4885*** (0.0660)	*0.00*	0.2710*** (0.0735)	*0.00*	0.2103*** (0.0384)	*0.00*	0.1313*** (0.0445)	*0.00*	0.1107** (0.0547)	*0.04*	0.3275** (0.1433)	*0.02*	0.2270** (0.0961)	*0.02*	0.1853* (0.1007)	*0.06*
Union	-0.0835 (0.0649)	*0.19*	0.0012 (0.0619)	*0.99*	-0.0715* (0.0403)	*0.08*	-0.0573 (0.0401)	*0.15*	-0.0434 (0.0559)	*0.44*	-0.0030 (0.1023)	*0.97*	0.0884 (0.0696)	*0.20*	0.0373 (0.1113)	*0.73*
Executive or supervisor	0.2124*** (0.0698)	*0.00*	0.2655*** (0.0618)	*0.00*	0.0940** (0.0395)	*0.02*	0.1272*** (0.0384)	*0.00*	0.1264*** (0.0480)	*0.01*	0.1941** (0.0824)	*0.02*	0.3436*** (0.0764)	*0.00*	0.2889*** (0.0861)	*0.00*
Firm1	–		-0.5318*** (0.1041)	*0.00*	–		-0.2797*** (0.0679)	*0.00*	-0.2460*** (0.0890)	*0.01*	-0.7944*** (0.2545)	*0.00*	-0.8185*** (0.1240)	*0.00*	-0.6331*** (0.2587)	*0.01*
Firm2	–		-0.4824*** (0.1019)	*0.00*	–		-0.3066*** (0.0651)	*0.00*	-0.2877*** (0.0865)	*0.00*	-0.6706*** (0.2293)	*0.00*	-0.7262*** (0.1503)	*0.00*	-0.5229*** (0.1752)	*0.00*
Firm3	–		-0.7895*** (0.1033)	*0.00*	–		-0.3567*** (0.0680)	*0.00*	-0.3002*** (0.0904)	*0.00*	-0.9655*** (0.2586)	*0.00*	-1.0392*** (0.1550)	*0.00*	-0.8133*** (0.1766)	*0.00*
Firm4	–		-0.7425*** (0.1082)	*0.00*	–		-0.3745*** (0.0716)	*0.00*	-0.3208*** (0.1012)	*0.00*	-0.9637*** (0.2648)	*0.00*	-0.9987*** (0.1995)	*0.00*	-0.8391*** (0.1962)	*0.00*
Firm5	–		-0.7227*** (0.1055)	*0.00*	–		-0.4016*** (0.0682)	*0.00*	-0.3643*** (0.0953)	*0.00*	-0.9420*** (0.2426)	*0.00*	-0.9317*** (0.1855)	*0.00*	-0.7328*** (0.1602)	*0.00*
Firm7	–		-0.6098*** (0.1036)	*0.00*	–		-0.3015*** (0.0701)	*0.00*	-0.2852*** (0.0946)	*0.00*	-0.7814*** (0.2368)	*0.00*	-0.6602*** (0.1522)	*0.00*	-0.6072*** (0.1134)	*0.00*
Firm8	–		-0.7736*** (0.1007)	*0.00*	–		-0.3297*** (0.0667)	*0.00*	-0.2473*** (0.0909)	*0.01*	-0.9083*** (0.2455)	*0.00*	-0.9900*** (0.1611)	*0.00*	-0.7999*** (0.1902)	*0.00*
											Pseudo R^2		Pseudo R^2		Pseudo R^2	
R^2	0.67		0.76		0.91		0.92		0.905		0.43		0.54		0.61	
Observations	231		231		231		231		231		231		231		231	

Standard errors are given in parentheses. *P*-values appear in italic. ***, ** and * mean respectively significant at the 1%, 5% and 10% levels.

The instrumented variables in the IV regression (5) are: Education QUARTILE1 QUARTILE2 QUARTILE3 Education*QUARTILE1 Education*QUARTILE2 Education*QUARTILE3 Tenure*QUARTILE1 Tenure*QUARTILE2 Tenure*QUARTILE3 Experience*QUARTILE1 Experience*QUARTILE2 Experience*QUARTILE3

The additional instruments used in the IV regression (besides the exogenous variables of equation 5) include: age, $(age)^2$, apprenti, celibah, chaine, choma, $(choma)^2$, choma*female, emsim, enft, $(enft)^2$, log(enft), enft*age, entree, equipe, formaa, $(formaa)^2$, $(formaa)^3$, formaa*female, forstil*female, mari*female, mari*female, mari*male, panal, panal*age, panal*choma, panal*enft, panal*formaa, pprim, pprim*age, pprim*choma, pprim*enft, pprim*formaa, prove, psecon, psecon*age, psecon*choma, psecon*enft, psecon*formaa, psup, psup*age, psup*choma, psup*enft, psup*formaa, staga, $(staga)^2$, $(staga)^3$, stagan, $(stagan)^2$, $(stagan)^3$.

The definitions of the variables and instruments appear in Table 1.

Table 4. Returns to human capital and wage effects of factors on quartiles

	OLS					**2SLS**					**Quantile regressions**		
	Quartiles					Quartiles							
	1st	2nd	3rd	4th	*mean*[b]	1st	2nd	3rd	4th	*mean*[b]	*0.25 Quantile*	*0.50 Quantile*	*0.75 Quantile*
Independent variables	*Firm fixed effects models*												
Education	0.0405	0.0031	0.0022	0.0870	*0.0330*	0.0318	-0.0371	0.0108	0.0915	*0.0240*	0.0498	0.0448	0.0686
Tenure[a]	0.0621	0.0027[ns]	0.0031[ns]	0.0121[ns]	*0.0231*	0.0755	-0.0237[ns]	0.0040[ns]	0.0125[ns]	*0.0203*	0.0448	0.0271	0.0266
Experience[a]	0.0414	0.0091	0.0088	0.0435	*0.0256*	0.0700	-0.0087	0.0102	0.0426	*0.0285*	0.0467	0.0306	0.0322
	Factors effects models												
Factor 1	0.0205	-0.0131[nd]	-0.0128[nd]	-0.0175	*-0.0166*	-0.0363[ns]	0.0285[ns]	0.0001[ns]	0.0127[ns]	*-0.0049*[ns]	-0.0544	-0.0561	-0.0360
Factor 2	-0.0935	-0.0014[nd]	0.0114	0.0506	*0.0392*	0.3382[nd]	-0.3171	0.0206[nd]	0.0318	*0.0324*	0.1026	0.1020	0.0764
Factor 3	0.0112	-0.0190	-0.0134	0.0295	*-0.0014*[ns]	-0.0296[nd]	0.0179[nd]	-0.0347	0.0774	*0.0050*	-0.0121[ns]	-0.0099[ns]	-0.0113[ns]

[a]: returns calculated at the average point of the sub-sample. [b]: mean of the effects for the different quartiles. [ns]: no significantly different from zero at 10% level.
[nd]: no significantly different from the coefficient of the 4th quartile at 10% level.

Table 5. Principal component analysis

Firm characteristics	Vectors			Correlations		
	Factor 1	Factor 2	Factor 3	Factor 1	Factor 2	Factor 3
Average human capital of employees in the firm						
Average age	-0.269	-0.075	0.006	-0.75*	-0.20	0.01
Average education	-0.079	0.319	-0.196	-0.22	0.86*	-0.33
Average tenure	-0.226	-0.205	0.049	-0.63*	-0.55	0.08
Average total experience	-0.219	-0.237	0.133	-0.61	-0.64*	0.23
Variance of education	0.012	-0.268	0.091	0.03	-0.73*	0.15
Variance of tenure	-0.278	-0.196	-0.049	-0.78*	-0.53	-0.08
Variance of total experience	-0.316	-0.140	-0.110	-0.88*	-0.38	-0.19
General characteristics of the firm						
Sector (1: textiles; 0: IMMEE)	0.319	-0.107	0.112	0.89*	-0.29	0.19
Size (number of employees)	0.219	-0.054	-0.144	0.61	-0.14	-0.24
Exportation (1: yes; 0: no)	0.254	0.152	-0.156	0.71*	0.41	-0.26
Percentage of exported production	0.331	0.041	0.082	0.93*	0.11	0.14
Level of competition (1 to 5)	0.302	-0.141	-0.128	0.85*	-0.38	-0.22
Firm age	0.062	-0.074	-0.554	0.17	-0.20	-0.95*
Rate of supervision	-0.165	0.319	-0.058	-0.46	0.86*	-0.10
Rate of management	-0.051	0.355	0.061	-0.14	0.96*	0.10
Number of intermediary levels of management	-0.025	-0.303	-0.086	-0.07	-0.82*	-0.15
Existing system of formal training (1: yes; 0: no)	-0.225	0.198	0.255	-0.63*	0.54	0.44
Organisational innovation the last four years (1: yes; 0: no)	0.049	0.085	0.332	-0.08	0.39	0.71*
Technological innovation the last four years (1: yes; 0: no)	-0.029	0.143	0.415	0.14	0.23	0.57
Level of stimulated internal communication (1 to 3)	-0.128	0.267	-0.157	-0.36	0.72*	-0.27
Characteristics of employees' tasks						
Work independence stimulated (1: yes; 0: no)	0.076	0.233	-0.097	0.21	0.63*	-0.17
Frequent work control (1: yes; 0: no)	0.039	0.177	-0.194	0.11	0.48	-0.33
Versatility system implemented (1: yes; 0: no)	0.156	0.100	0.234	0.44	0.27	0.40
Percentage of employees working in chain	0.293	-0.097	0.205	0.82*	-0.26	0.35
Task definition (1: globally defined; 0: precisely defined)	-0.088	0.195	-0.010	-0.25	0.53	-0.02

*: significant at the 10% level.

Table 6. Correlations between factors, firm fixed effects and characteristics of education in the firms

	Factor 1	Factor 2	Factor 3
Firms' fixed effects			
Firm 1	-0.72*	-0.26	0.47
Firm 2	-0.21	-0.27	-0.12
Firm 3	0.38	-0.04	0.47
Firm 4	0.32	-0.07	0.03
Firm 5	0.26	-0.18	0.10
Firm 6	-0.11	0.96*	0.10
Firm 7	-0.31	0.01	-0.74*
Firm 8	0.38	-0.14	-0.32
Average education in the firm			
Average years of secondary school	-0.12	0.87*	-0.21
Proportion of university diploma	-0.24	0.94*	-0.09
Average amount of formal training	-0.78*	-0.06	0.43
Proportion of females	0.91*	-0.21	0.19

*: significant at the 10% level.

Table 7. Wage equations with factors

Dependent variable: Log hourly wage (lnsalh)

Explanatory variables	OLS Factor effects model (1)		OLS Factor effects model (2)		IV (2SLS) Factor effects model (3)		OLS Pseudo factors model (4)		Quantile regressions (bootstrap standard errors: 20 iterations) Factor effects models *0.25 Quantile* (5)		*0.50 Quantile* (6)		*0.75 Quantile* (7)	
Constant	-0.2646 (0.2080)	*0.205*	-0.4134** (0.2097)	*0.050*	-0.0103 (0.2097)	*0.976*	-0.8529*** (0.1396)	*0.000*	-0.5536*** (0.2122)	*0.010*	-0.3307*** (0.1112)	*0.003*	-0.3844** (0.1540)	*0.013*
Education	0.0843*** (0.0123)	*0.000*	0.0906*** (0.0124)	*0.000*	0.0719*** (0.0208)	*0.001*	0.0679*** (0.0069)	*0.000*	0.0552*** (0.0128)	*0.000*	0.0570*** (0.0116)	*0.000*	0.0768*** (0.0121)	*0.000*
QUARTILE1	-0.4394** (0.2247)	*0.052*	-0.4562** (0.2384)	*0.057*	-0.2405 (0.3915)	*0.540*	–		–		–		–	
QUARTILE2	0.4424** (0.2253)	*0.051*	0.5391** (0.2413)	*0.027*	-0.3072 (0.4451)	*0.491*	–		–		–		–	
QUARTILE3	0.7727*** (0.2254)	*0.001*	0.8522*** (0.2303)	*0.000*	0.4892 (0.3559)	*0.171*	–		–		–		–	
Education*QUARTILE1	-0.0416*** (0.0150)	*0.006*	-0.0487*** (0.0154)	*0.002*	-0.0302 (0.0319)	*0.345*	–		–		–		–	
Education*QUARTILE2	-0.0803*** (0.0145)	*0.000*	-0.0860*** (0.0145)	*0.000*	-0.0811*** (0.0305)	*0.008*	–		–		–		–	
Education*QUARTILE3	-0.0863*** (0.0139)	*0.000*	-0.0886*** (0.0145)	*0.000*	-0.0745*** (0.0264)	*0.005*	–		–		–		–	
Tenure	0.0066 (0.0085)	*0.438*	0.0133 (0.0087)	*0.127*	0.0133* (0.0087)	*0.062*	0.0432*** (0.0098)	*0.00*	0.0442** (0.0229)	*0.054*	0.0303** (0.0129)	*0.019*	0.0213 (0.0154)	*0.168*
Tenure^2	0.0003 (0.0003)	*0.388*	0.0002 (0.0003)	*0.579*	0.0002 (0.0003)	*0.833*	-0.0012*** (0.0005)	*0.007*	-0.0010 (0.0009)	*0.310*	-0.0007 (0.0006)	*0.243*	-0.0002 (0.0006)	*0.725*
Tenure*QUARTILE1	0.0599*** (0.0125)	*0.000*	0.0549*** (0.0133)	*0.000*	–		–		–		–		–	
Tenure*QUARTILE2	-0.0079 (0.0089)	*0.376*	-0.0144 (0.0092)	*0.120*	–		–		–		–		–	
Tenure*QUARTILE3	-0.0079 (0.0061)	*0.199*	-0.0120* (0.0065)	*0.067*	–		–		–		–		–	
Experience	0.0431*** (0.0098)	*0.000*	0.0427*** (0.0097)	*0.000*	0.0268** (0.0113)	*0.019*	0.0375*** (0.0114)	*0.001*	0.0494*** (0.0146)	*0.001*	0.0304** (0.0140)	*0.031*	0.0336** (0.0155)	*0.032*
Experience^2	-0.0007* (0.0004)	*0.083*	-0.0005 (0.0004)	*0.229*	-0.0007 (0.0006)	*0.220*	-0.0008 (0.0006)	*0.231*	-0.0026** (0.0011)	*0.020*	-0.0003 (0.0011)	*0.769*	0.0001 (0.0011)	*0.895*
Experience*QUARTILE1	0.0003 (0.0124)	*0.983*	0.0014 (0.0127)	*0.911*	–		–		–		–		–	
Experience*QUARTILE2	-0.0341*** (0.0079)	*0.000*	-0.0340*** (0.0080)	*0.000*	–		–		–		–		–	
Experience*QUARTILE3	-0.0312*** (0.0078)	*0.000*	-0.0327*** (0.0077)	*0.000*	–		–		–		–		–	
Ongoing formal training	-0.1367 (0.0949)	*0.151*	-0.0985 (0.1089)	*0.367*	-0.1364 (0.1799)	*0.449*	-0.4685*** (0.1596)	*0.004*	-0.3530 (0.2983)	*0.238*	-0.5131 (0.3611)	*0.157*	-0.4418* (0.2643)	*0.096*

Completed formal training	0.1262*** (0.0415)	*0.003*	0.1179*** (0.0417)	*0.005*	0.1594*** (0.0575)	*0.006*	0.2180*** (0.0685)	*0.002*	0.1897** (0.0884)	*0.033*	0.1413* (0.0753)	*0.062*	0.1510 (0.1146)	*0.189*				
Union	-0.0541 (0.0391)	*0.168*	-0.0420 (0.0405)	*0.301*	-0.1793*** (0.0405)	*0.003*	-0.0228 (0.0621)	*0.714*	0.0033 (0.0707)	*0.963*	0.0473 (0.0777)	*0.543*	0.0886 (0.1268)	*0.485*				
Executive or supervisor	0.1367*** (0.0381)	*0.000*	0.1239*** (0.0386)	*0.002*	0.0764 (0.0556)	*0.171*	0.2842*** (0.0621)	*0.000*	0.2013** (0.0902)	*0.027*	0.3345*** (0.0710)	*0.000*	0.3064*** (0.0845)	*0.000*				
Factor 1	-0.0166** (0.0069)	*0.017*	-0.0175* (0.0069)	*0.105*	0.0127 (0.0069)	*0.557*	–		-0.0544*** (0.0171)	*0.002*	-0.0561*** (0.0144)	*0.000*	-0.0360** (0.0185)	*0.052*				
Factor 2	0.0392*** (0.0071)	*0.000*	0.0506*** (0.0082)	*0.000*	0.0318** (0.0082)	*0.021*	–		0.1026*** (0.0343)	*0.003*	0.1020*** (0.0165)	*0.000*	0.0764*** (0.0213)	*0.000*				
Factor 3	-0.0014 (0.0088)	*0.872*	0.0295* (0.0173)	*0.090*	0.0774* (0.0173)	*0.083*	–		-0.0121 (0.0141)	*0.395*	-0.0099 (0.0214)	*0.645*	-0.0113 (0.0227)	*0.620*				
Sector (textiles: 1; IMMEE: 0)	–		–		–		-0.2470*** (0.0522)	*0.000*	–		–		–					
Average education in the firm	–		–		–		0.0621*** (0.0131)	*0.000*	–		–		–					
Age of the firm	–		–		–		-0.0162*** (0.0045)	*0.000*	–		–		–					
Factor 1*QUARTILE1	–		0.0380* (0.0223)	*0.090*	-0.0490 (0.0543)	*0.367*	–		–		–		–					
Factor 1*QUARTILE2	–		0.0045 (0.0201)	*0.825*	0.0158 (0.0443)	*0.721*	–		–		–		–					
Factor 1*QUARTILE3	–		0.0047 (0.0148)	*0.750*	-0.0127 (0.0351)	*0.718*	–		–		–		–					
Factor 2*QUARTILE1	–		-0.1442** (0.0709)	*0.043*	0.3064 (0.1965)	*0.121*	–		–		–		–					
Factor 2*QUARTILE2	–		-0.0520 (0.0612)	*0.397*	-0.3490* (0.1918)	*0.070*	–		–		–		–					
Factor 2*QUARTILE3	–		-0.0393** (0.0157)	*0.013*	-0.0113 (0.0359)	*0.753*	–		–		–		–					
Factor 3*QUARTILE1	–		-0.0183 (0.0277)	*0.510*	-0.1070 (0.0806)	*0.185*	–		–		–		–					
Factor 3*QUARTILE2	–		-0.0485* (0.0267)	*0.071*	*-0.0595 (0.0909)*	*0.514*	–		–		–		–					
Factor 3*QUARTILE3	–		-0.0429* (0.0231)	*0.065*	*-0.1121** (0.0576)*	*0.053*	–		–		–		–					
R^2	0.923		0.929		0.880		0.754		Pseudo R^2									
									0.40		0.59		0.59					
Observations	231		231		231		231		231		231		231					

Standard errors are given in parenthesis. *P*-values appear in italic. ***, ** and * mean respectively significant at the 1%, 5% and 10% levels.

The instrumented variables in the IV regression (3) are: Education QUARTILE1 QUARTILE2 QUARTILE3 Education*QUARTILE1 Education*QUARTILE2 Education*QUARTILE3 Factor1*QUARTILE1 Factor1*QUARTILE2 Factor1*QUARTILE3 Factor2*QUARTILE1 Factor2*QUARTILE2 Factor2*QUARTILE3 Factor3*QUARTILE1 Factor3*QUARTILE2 Factor3*QUARTILE3

The additional instruments used in the IV regression (besides the exogenous variables of equation 3) include: age, $(age)^2$, apprenti, celibah, chaine, choma, $(choma)^2$, choma*female, emsim, enft, $(enft)^2$, log(enft), enft*age, entree, equipe, formaa, $(formaa)^2$, $(formaa)^3$, formaa*female, forstil*female, mari*female, mari*female, mari*male, panal, panal*age, panal*choma, panal*enft, panal*formaa, pprim, pprim*age, pprim*choma, pprim*enft, pprim*formaa, prove, psecon, psecon*age, psecon*choma, psecon*enft, psecon*formaa, psup, psup*age, psup*choma, psup*enft, psup*formaa, staga, $(staga)^2$, $(staga)^3$, stagan, $(stagan)^2$, $(stagan)^3$.

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