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EXPORT ACTIVITY AND WAGE DISPERSION: THE CASE OF SWISS FIRMS

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Résumé

Dans ce papier, nous utilisons une base de données d'environ 3'000 entreprises (et env. 160'000 salarié-es) implantées en Suisse pour analyser l'impact de l'activité d'exportation sur la dispersion des salaires. Premièrement, nous estimons des fonctions de salaires qui tiennent compte tant des caractéristiques des entreprises que de celles des employé-es. Dans un deuxième temps, nous appliquons une méthode originale de décomposition qui permet d'identifier de manière précise l'impact de chaque caractéristique (de l'entreprise ou du salarié-e) sur la dispersion salariale observée. Les résultats montrent que l'impact de l'activité d'exportation des entreprises sur les salaires est fondamentalement une histoire de capital humain, quand bien même certaines différences entre les entreprises exportatrices et les entreprises non-exportatrices ont un impact significatif sur la distribution des salaires.

Mots-clés

Salaires, capital humain, entreprises exportatrices, décomposition d'inégalité

Summary

In this paper we use a large and detailed database to analyse the impact of export activity on wage dispersion in Swiss firms. First, earnings functions are estimated which take into account both observed and unobserved characteristics of individuals and firms. Then, an original decomposition is proposed which identifies the exact impact of each individual and firm characteristic on the wage dispersion observed, both within and between exporting and non-exporting firms. Our results suggest that the impact of export activity on wage dispersion is mainly a human capital story but also show significant differences between exporting and non-exporting firms with respect to firm characteristics and their marginal effects on wages.

Keywords

Wages, human capital, exporting firms, inequality decomposition

INTRODUCTION

According to traditional international trade theory a country's openness to trade should improve its overall welfare but would not equally affect all individuals. During the past two decades, many studies have attempted to determine the exact impact of openness to international trade on the distribution of wages[1]. Generally theoretical justification for such a link focuses on the well-known Heckscher-Ohlin theorem (and/or the Heckscher-Ohlin-Samuelson model). On the empirical side many researchers have adopted the so-called "factor content" approach[2], concluding that the change in factor content associated with increasing international trade shifts labor demand in industrialized countries in favor of skilled labor. In a competitive labor market, such a shift implies an increases in the wage differential between skilled and unskilled workers.

In this paper, however, we do not explicitly focus on the impact of openness to trade on wages, but rather on how export activity at the firm level affects wage inequality. The first question of interest concerns the eventual difference between exporting firms and non-exporting firms in their specific compensation policies. In other words, we want to test whether workers may face different "prices" (i.e. marginal effects on wages) for their characteristics according to whether or not they are employed by a firm selling its products exclusively on the domestic market. Moreover, if exporting firms are confronted with a different level of competitiveness in their product markets, the impact of firms' characteristics on wages, like the firm's size premium, may also differ between the two types of firms. Once the potential differences in "prices" of individual and firm features are identified, we investigate how wage inequality is affected by the firm's decision to partially or totally export its output. For that purpose, we do not rely on international trade theory, but rather choose the approach adopted in recent years by several labor economists, who relied on matching the data for employees and employers to understand changes in the wage structure[3]. Such studies not only confirmed wage differentials between different industries but also between firms within the same industry. Using a large and very detailed database derived from the 1996 Swiss Wage Structure Survey and the 1995 Swiss Census of Firms, we examine, at the level of the firm, the impact of export activity on wage dispersion. As the first stage we estimated earnings functions which include individual and firm characteristics and assumed that the labor market includes two sectors, one in which firms partially or totally export their output ("open" firms) and the other in which firms focus exclusively on the domestic market ("closed" firms). The selection of workers between these two sectors is endogenised via the use of a self-selection model. We are thus able to derive a breakdown of wage differences into components measuring observable and unobservable individual and firm characteristics respectively. In the second stage, using a new methodology, we succeeded in determining the exact impact of each individual and firm characteristic on the overall wage dispersion, the dispersion within and between the two types of firms and the degree of overlap between the wage distributions in both sectors.

The results of this empirical investigation show that, in Switzerland, there are significant differences between the structure of wages in open and closed firms. Even though human capital plays the central role, there are differences between open and closed firms, as far as the impact of firm characteristics and their marginal effects on wage dispersion is concerned.

[1] See, for example, Bound and Johnson (1992), Cline (1997), Johnson and Stafford (1999).

[2] See, for example, Bhagwati and Dehejias (1994) for a discussion of basic international trade models, and Wood (1994), Murphy and Welch (1991), Borjas, Freeman and Katz (1992), for empirical investigations.

[3] See, for example, Groshen (1991, 1996), Kramarz et al. (1996), Davis and Haltwinger(1996), Ramirez (2000).

The structure of the paper is as follows. Section I describes the two databases while Section II presents the methodology which is used, first to estimate wage determinants, then to decompose the overall wage dispersion into its various components. Section III defines the variables and examines their statistical characteristics while the main empirical results are presented in Section IV. Last Section offers concluding comments.

I DATA

The databases used in this paper are the 1996 Swiss Wage Structure Survey (SWSS), a large employee-employer survey, and the 1995 Swiss Census of Firms. We merged these two databases using the firms' identification numbers given by the Federal Office of Statistics.

The SWSS records individual wages in a sample of establishments belonging to all industries (including the public sector). The sampling procedure includes two stages: (1) production units are sampled; (2) individuals employed in these units are sampled. As far as the production units are concerned, the sample is drawn from the set of all the establishments with at least two employees. The sampling rate is stratified according to the 2-digit sector classification and the size of the largest plant of a given firm. The sampling design for the employees is as follows: it is exhaustive in small units (less than 20 employees), includes half of the employees in firms with 20 to 49 employees and one-sixth of the employees in firms with 50 employees or more. In 1996, 8,258 production units and 552,015 employees were included (almost 450,000 in the private sector) in the sample. These figures represent almost 7% of the private and public establishments in Switzerland and 20% of the employed workforce.

In the SWSS, the annual as well as the October remuneration, is recorded. The annual remuneration can be broken down into total wage, overtime pay (and others payments for shift-work, night-work, etc.), salaries for 13th and eventually 14th months and annual bonuses. We also know whether each worker is Swiss and, if not, the type of work permit he or she holds, the age, seniority in the firm, educational level and marital status. In addition the qualification required for the job (3 levels) and a variable defining its “activity domain” (24 levels) turn out to be useful if a distinction is made between blue- and white-collar workers. Finally, the information about the firm includes 2- and 4-digit industry codes, total employment, type of work and agreements between the employees and the employer at the level of the branch (henceforth called collective agreement) or the firm.

The 1995 Census of firms was essential for determining whether a firm exports a fraction or its total output. In the present study, this information is summarized by a dummy variable indicating whether the firm is exporting. Additional variables in this Census refer to the fraction of women, foreign workers and part-time jobs employed at the firm level. Information is also available on whether the firm consists of one or more establishments, in Switzerland or elsewhere.

Finally, the database used in this study was limited to male workers employed in the private sector of the economy and did not include agriculture. As will become clearer later, we also excluded firms employing less than 5 workers. Workers under the age of 20 or over the age of 60, who have low participation rates, were also excluded. After eliminating firms which do not have information on the variables of interest, we ended up with a final sample of 2,894 firms with 160,901 male workers.

II METHODOLOGY

We start by presenting the regressions in which we analyze the determinants of individual wages. We then discuss the econometric technique that seems appropriate for the type of data we use. We end this section by applying the methodology used to decompose wage inequality.

The regressions

One of the main assumptions of this paper is that inter-firm wage differentials are significant. The wage of a given individual is therefore assumed to be a function of his observable and unobservable productive characteristics and the features of the firm in which he is employed. Hence we may write that,

$$w_{jf} = \alpha_j + \Sigma_{k=1 \text{ to } K} b_k x_{kj} + \pi_f + u_j \quad (1)$$

where w_{jf} is the (log) wage of worker j in firm f, x_{kj} is the vector of the K observable human capital characteristics of worker j, b_k is the vector of the rate of returns associated with these characteristics and α_j is the individual fixed effect representing the role of unobservable human capital characteristics. The term π_f represents the "pure" fixed effect of firm f and u_j is the error term associated with worker j.

In this model, the fixed effect associated with firm f indicates whether workers in this firm are, *ceteris paribus*, at a given point in time, paid more or less than workers in other firms. Thus in this equation, the fixed industry effects correspond simply to the averages of the fixed firm effects within each industry. From this equation, we extract the following matching function:

$$\delta_{jf} = \alpha_j + \pi_f$$

However, to estimate this very interesting function, we need: (1) to have longitudinal information on the workers to estimate the individual fixed effects, (2) to be able to identify the firm employing worker j. The Wage Structure Survey allows us to accomplish only the last task. However, following Kramarz et al. (1996), we choose to estimate the following slightly transformed "ideal" version of equation (1):

$$w_{jf} = \Sigma_{k=1 \text{ to } K} b_k x_{kj} + \mu_f + u_j, \quad (2)$$

where the fixed effect μ_f for firm f is the sum of the "pure" firm fixed effects and the average of the individual fixed effects of the workers employed in that firm. Hereafter, fixed effects are called "the global firm fixed effects"[4]. Given the information available on the firms, the latter effect can be decomposed as follows:

$$\mu_f = \Sigma_{h=1 \text{ to } H} c_h z_{hf} + v_f, \quad (3)$$

where z_{hf} is the vector of H observable characteristics of firm f, c_h is the vector of the marginal effects associated with these characteristics on the worker's (log)wage and v_f is the error term associated with firm f.

Combining equations (2) and (3), we finally obtain the following (complete) equation:

[4] As mentioned previously, we exclude firms employing fewer than 5 workers from our sample for the following reason. Given that it is impossible to separate the individual from the global firm fixed effects, the inclusion of very small firms will undoubtedly decrease the importance of the "pure" firm effects in the estimated global fixed effects.

$$w_{jf} = \sum_{k=1 \text{ to } K} b_k x_{kj} + \sum_{h=1 \text{ to } H} c_h z_{hf} + u_j + v_f \quad (4)$$

Expression (4) distinguishes between four determinants of the wage of a given employee *j*:

i. The impact of the observed individual human capital characteristics: $\sum_{k=1 \text{ to } K} b_k x_{kj}$.
ii. The effect of unobserved characteristics of the worker: the error term u_j.
iii. The role of the observed features of the firm : $\sum_{h=1 \text{ to } H} c_h z_{hf}$.
iv. The influence of the unobserved features of the firm: the error term v_f.

The estimation procedure

The simplest way to estimate the impact of export activity at the firm level on the workers' wages would be to introduce a dummy variable in equation (4) (an additional element in the vector z_{hf}) which would indicate whether the firm is exporting or not. Such an approach however would be grounded on two restrictive hypotheses. First, this would amount to assuming that both the firms' decision to sell abroad their products and the workers' choice of firm (working in an open or closed firm) are random processes. Secondly, it would imply that the "price" structure, represented by the vectors b_k and c_h in Expression (4), is the same for both open and closed firms. The latter assumption can be easily relaxed by estimating equations (2) and (3) separately for the two types of firms:

$$w_{jo} = \sum_{k=1 \text{ to } K} b_{ko} x_{kjo} + \mu_o + u_{jo} \quad (5a)$$

$$\mu_o = \sum_{h=1 \text{ to } H} c_{ho} z_{ho} + v_o \quad (5b)$$

$$w_{jc} = \sum_{k=1 \text{ to } K} b_{kc} x_{kjc} + \mu_c + u_{jc} \quad (6a)$$

$$\mu_c = \sum_{h=1 \text{ to } H} c_{hc} z_{hc} + v_c, \quad (6b)$$

where w_{jo}, μ_o, w_{jc} and μ_c are, respectively, the (log)wage of worker *j* and the global fixed effects in open and closed firms.

Although the system of equations (5a) to (6b) no longer assumes that the rates of return on individual human capital characteristics and the marginal effects of the firms' features are the same in open and closed firms, the selection of firms and workers between these two types of firms is still considered to be a random process. To relax this assumption, we use the methodology initially proposed by Lee (1978) and extended by Lee et al. (1980).

As indicated previously the labor market is assumed to be divided into open and closed firms with two selection processes, one in which choices are made by firms and the other in which workers make the decisions. Unfortunately, we cannot distinguish the firm's choice from that of workers. We assume, therefore, that these two selection processes are generated by a single distribution. As in Lee (1978), we assume that the selection process includes two steps: (1) Open and closed firms announce the wage they offer; (2) The workers choose the type of firm in which they are willing to work. Given the characteristics of the firm and of worker, the probability of being employed in a open firm depends, therefore, on the cost to the individual of working in a open firm and his expected benefit, which is equal to the relative difference in wages between the two types of firms. As shown by Lee (1978), this criterion may be expressed as follows in a probit form:

If $I^* > 0$, a worker will be in an open firm when

$$I^* = \xi_0 + \xi_1 (w_{jo} - w_{jc}) + \Omega L - \varepsilon \ . \quad (7)$$

In (7), *L* is a vector of variables associated with the probability of being employed in an open firm (other than the wage differential) and ε is an error term reflecting unobservable random

factors. Such a structural equation, therefore, summarizes the (simplified) two-step selection process.

The variable I^*, however, is not directly observable. We only know who does and does not work in an open firm. Thus we define a dummy variable, I, which is equal to 1 if the individual is in an open firm and to 0 otherwise. Using the moments of the random truncated variables, $(u_{jc}+v_c)$ and $(u_{jo}+v_o)$, the wage equations conditional on the type of firm are:

if $I = 1$:

$$w_{jo} = \sum_{k=1 \text{ to } K} \beta_{ko} x_{kjo} + \mu_o - \sigma_{ou} \lambda_o + \varepsilon_{jo} \quad (8a)$$

$$\mu_o = \sum_{h=1 \text{ to } H} \chi_{ho} z_{ho} + \varepsilon_o \quad (8b)$$

if $I = 0$:

$$w_{jc} = \sum_{k=1 \text{ to } K} \beta_{kc} x_{kjc} + \mu_c + \sigma_{cu} \lambda_c + \varepsilon_{jc} \quad (9a)$$

$$\mu_c = \sum_{h=1 \text{ to } H} \chi_{hc} z_{hc} + \varepsilon_c \,, \quad (9b)$$

where the error terms have, by construction, a zero conditional mean. The terms λ_o and λ_c are the *inverse Mill ratios* associated to each regime[5]. The sign of the coefficients related to the selection terms will describe how the selection process affects the wages. If the truncation on wages is positive, (i.e. when $\sigma_{ou} < 0$ and $\sigma_{cu} > 0$), only the upper section of wages in the open and closed firms is observed, given fixed personal characteristics and "global" firm effects.

The estimation procedure for this system of equations, suggested by Lee et al. (1980), is as follows: we first estimate λ_o and λ_c by probit maximum likelihood, using all the exogenous variables of the system (i.e. of the vectors X, L and Z) as right-hand side variables; then, using these predicted values, we estimate the conditional wage equations, (8a) and (9a), by simple OLS. Therefore the estimated "global" firm fixed effects may be deduced and their determinants estimated (equations (8b) and (9b)), using weighted OLS[6].

The breakdown of the overall wage dispersion

The methodology applied here is borrowed from the literature on income inequality decomposition by income sources (factor components). Following Fei, Kuo and Ranis (1980), Lerman and Yitzhaki (1985) and Silber (1989), we may express the overall Gini Index of the (log of) wages as the sum of the contributions C_k of the various wage determinants previously mentioned. In other words:

$$I_G = \Sigma_{k=1 \text{ to } K} C_k \quad (10)$$

The same kind of decomposition may be used with Gini's mean difference Δ rather than Gini's Concentration Ratio I_G. Recalling that I_G may be expressed as:

$$I_G = (1/2)\,(\Delta/wb), \quad (11)$$

[5] Let us define $\lambda_o = \phi(\delta Y)/\Phi(\delta Y)$ and $\lambda_c = \phi(\delta Y)/[1-\Phi(\delta Y)]$, where ϕ and Φ are the standard normal density and the cumulative normal density evaluated at (δY), respectively, where the vector Y includes all the exogenous variables of (7) to (9b). See Heckman [1979].

[6] As mentioned by Groshen (1991) and Kramarz et al. (1995), the number of observations per firm has to be used as weights in the estimation of equations (8b) and (9b).

where *wb* is the average (log of) wage of the different workers, we conclude that:

$$\Delta = 2\ wb\ I_G \tag{12}$$

Similarly, we may define the mean difference Δ_k for the wage determinant *k* as:

$$\Delta_k = 2\ wb_k\ G_k\,, \tag{13}$$

where wb_k is the average value of the wage determinant *k* (across individuals) and G_k is the Gini index of inequality for this determinant *k*.

Finally, we may define, using the definition of the Pseudo-Gini H_k (see, Silber, 1989) of wage determinant *k*, a "Pseudo-Mean Difference" $P\Delta_k$ as:

$$P\Delta_k = 2\ wb_k\ H_k \tag{14}$$

Combining expressions (10) to (14) we conclude, after some algebraic manipulations, that:

$$\Delta = \sum_{k=1\ to\ K} P\Delta_k \tag{15}$$

Let us now call $G\Delta_k$ (Gini-Correlation Coefficient) the ratio ($P\Delta_k / \Delta_k$) between the "Pseudo-Mean Difference" and the actual Mean Difference for wage determinant *k*. We may then rewrite (15) as:

$$\Delta = \sum_{k=1\ to\ K} [(G\Delta_k) \times \Delta_k] \tag{16}$$

Let us simplify and assume, for instance, that individual wages are exclusively determined by individual characteristics, that is, let us start with the following simplified version of regression (4)

$$w_j = \sum_{k=1\ to\ K} b_k x_{kj} + u_j\,. \tag{17}$$

Combining (14) and (17), the mean difference Δ of the wage *w* may expressed as:

$$\Delta = \sum_{k=1\ to\ K} P\Delta_k + P\Delta_u\,, \tag{18}$$

where $P\Delta_k$ is the "Pseudo-Mean Difference" of the elements ($b_k\ x_{kj}$), while $P\Delta_u$ is the "Pseudo-Mean Difference" of the error terms u_j. Since it may be easily proven that the "Pseudo-Mean Difference" of the elements ($b_k\ x_{kj}$) is equal to b_k times the "Pseudo-Mean Difference" $P\Delta(x_k)$ of the elements of the vector x_{kj}, we conclude that:

$$\Delta = \sum_{k=1\ to\ K} b_k\ [P\Delta(x_k)] + P\Delta_u \tag{19}$$

Combining then (16) and (19) we finally derive the equation:

$$\Delta = \sum_{k=1\ to\ K} b_k\ [G\Delta(x_k) \times \Delta(x_k)] + [G\Delta_u \times \Delta_u] \tag{20}$$

If we apply the same decomposition to the complete wage equation (4), that is, when individual wages are determined by individual and firm characteristics, Expression (20) may be written as

$$\Delta = \sum_{k=1\ to\ K} b_k [G\Delta(x_k) \times \Delta(x_k)] + [G\Delta_u \times \Delta_u] + \sum_{h=1\ to\ H} c_h\ [G\Delta(z_h) \times \Delta(z_h)] + [G\Delta_v \times \Delta_v]. \tag{21}$$

The latter expression allows us, therefore, to decompose the overall wage inequality into four main components: observable and unobservable individual and firm characteristics.

Applying this decomposition to the open and closed firms, the difference between the dispersion of wages in these two sets of firms may then be expressed as[7]:

$$\Delta_O - \Delta_C = M_1 + M_2 + N + O + P + Q_1 + Q_2 + R + S + T, \tag{22}$$

[7] See the annex for the complete decomposition.

where the components M_1, Q_1, N, R, O, S, M_2, Q_2, P, T respectively measure the impact of differences between the two groups of firms on:

- The dispersion of the individual workers' human capital characteristics (M_1);
- The dispersion of the specific features of firms, such as their size, etc…(Q_1);
- The rates of return on the human capital characteristics of the workers (N);
- The marginal effect on individual earnings of the specific features of the firms (R);
- The dispersion of the unobserved variables in the regression analyzing the impact of individual characteristics (O);
- The dispersion of the unobserved variables in the regression analyzing the determinants of the firms' fixed effects (S);
- The Gini-correlation between the individual human capital characteristics and the logarithm of individual wages (M_2);
- The Gini-correlation between the variables affecting the firms' fixed effects and the logarithm of individual wages (Q_2);
- The Gini-correlation between the unobserved variables in the regression analysing the determinants of the individual wages and the logarithm of these wages (P);
- The Gini-correlation between the unobserved variables in the regression analysing the determinants of the firms' fixed effects and the logarithm of the individual wages (T).

III DESCRIPTION OF THE VARIABLES AND SUMMARY OF STATISTICS

Table 1 reports a summary of the statistics for the individual human capital characteristics. The latter include the interaction of skill, age and its squared value, and seniority and its squared value. We decided to use such a formulation rather the number of years of schooling, which usually appear in Mincerian earnings functions, because information on schooling is not directly available from the Wage Structure Survey[8]. For similar reasons, we preferred to use age rather than (potential) experience. The other individual characteristics are dummy variables indicating whether the worker has Swiss nationality and, if not, the type of work-permit he holds, and whether he has ever been married. The data on wages we extracted from the 1996 SWSS are the monthly "standardized" wages, according to 40 working hours per week. The wages in open firms are almost 10 percent higher than in closed firms.

To identify the system of equations (7) to (9b), we need a variable that is only included in the structural choice equation (7). We chose a dummy variable indicating whether the firm has only one, two or more establishments. The mean of this variable and of the other firms' characteristics are reported in Table 2. The information relative to the different types of workers employed in the firm (e.g., percentage of female workers) is derived from the individual data so that the number of observations per firm was weighted.

[8] In addition, using the educational level of workers to estimate the years of education would reduce the sample by almost 50,000 observations.

IV EMPIRICAL RESULTS

The results given by equations (7) to (9b) are reported in Tables 3, 4 and 5. Tables 4 and 5 report the results of the decomposition of the wage dispersion within and between open and closed firms. The statistical significance of the regressions is quite good and explains almost three quarters of the observed variance.

Determinants of the probability for an individual to be employed in an open firm

Table 3 reports the marginal effects of the determinants of the probability for a worker to be employed in an open firm. As expected, firms in manufacturing industries have, on average, a higher probability than firms in the service sector of selling some or all their output to foreign markets[9]. Similarly, *ceteris paribus*, firms with only one establishment have a higher probability of exporting. The probability of exporting is also positively correlated to the firm's size. Note however that, contrary to the implications of simple descriptive statistics, firms employing relatively more highly skilled white-collar workers have a higher probability of exporting, while those with unskilled workers have a lower probability of selling abroad their products.

As far as the impact of individual characteristics is concerned, it may be observed that, ceteris paribus, foreign workers have a higher probability of employment in exporting firms than Swiss workers. This is particularly true for workers holding special work or cross-border permits. The (relative) labor demand for Swiss workers thus seems to be lower among export firms. This might be explained by the existence of differences in unobserved characteristics between foreign and Swiss workers, for example, in the knowledge of language of the countries to which the firms export their products. In comparison with unskilled white-collar workers, blue-collar and skilled white-collar workers have lower probabilities of employment in open firms, but this is not the case for highly skilled white collar workers. Note also that in this latter category of workers, the probability of employment in an open firm decreases with the worker's age.

Wage equations

Table 4 and Table 5 report the estimated marginal effects of the individual characteristics and the determinants of the "global" firm fixed effects respectively. Table 4 shows that the standard deviation of the firm fixed effects is almost as large as that of the individual error terms. The estimated coefficient associated with the inverse Mill ratios have the expected sign, in the sense that the observed distribution of wages is positively truncated in both types of firms.

Irrespective of the type of firm, foreign workers have a negative wage premium, and it is smaller in open firms. This is specially true for foreign workers holding short-term permits (i.e., yearly or special permits). This suggests, as mentioned previously, that the (relative) labor demand for foreign workers holding short-term permits is higher among open firms.

Using the estimated age and tenure wage profiles for the six defined categories of workers, we calculated various differences in the rates of return on both age and tenure. The results are presented in Figures 1 to 6. Figures 1 to 3 refer to age profiles and 4 to 6 to tenure profiles.

The first two figures show that the difference between the rates of return on general human capital (e.g., age) obtained by highly skilled (or skilled) and unskilled blue collar workers is larger in open than in closed firms. For white-collar workers, these differentials are more

[9] The energy sector is the reference in the estimated equation.

marked, but the gap between the two types of firms is smaller, particularly for highly skilled and unskilled workers. Figures 3 shows the estimated differences in rates of return on general human capital (age) between the two types of firms, for given skills. For unskilled blue-collar workers, the rates of return on their general human capital is smaller in open firms (see Figure 3.a) while the opposite is true for highly skilled blue collar workers. For white-collar workers, the picture is less clear.

For both blue and white collar workers, the estimated earnings profiles suggest that open firms have steeper profiles than firms selling their products exclusively on the domestic market. As suggested by Akerlof and Katz (1989), this could mean that efficiency wage effects are more important among exporting firms.

As far as differences in the rates of return on tenure (specific human capital) are concerned, Figures 4 and 5 suggest a totally different picture. Unskilled white- and blue-collar workers receive a higher rate of return on tenure than either skilled or highly skilled workers. Figure 6 shows that in open firms, for white-collar workers, the rate of return on specific human capital is much lower than in closed firms. These figures indicate that for open firms general rather than specific human capital is important, particularly for highly skilled workers. This may imply that open firms need a more flexible kind of human capital, allowing workers to perform better in the face of changes in production technology and/or in the organization of work.

Estimates of the determinants of "global" firm fixed effects are reported in Table 5. The effect of the size of firms is only significant among open firms. As observed in other studies, both collective and firm-level agreements do not have a significant impact on wages in Switzerland. Interestingly, the parameters associated with the ratio of workers with different skills suggest that "spillover" effects (see Kremer and Maskin, 1996) are more important among open firms. In other words, *ceteris paribus*, an unskilled worker would earn a higher wage if he is working in an open firm employing relatively more highly skilled white-collar workers, while he would earn less if the firm employed relatively more highly skilled blue-collar workers.

Wage inequality decomposition by wage factor

Tables 6 and 7 gives the decomposition of wage dispersion within and between open and closed firms, respectively. Wage dispersion appears to be higher in closed firms. The main factor determining wage dispersion is general human capital, particularly for open firms. At a more disaggregated level, we observe that the main role is played by the general human capital of highly skilled white collar workers, particularly in open firms. Observable and unobservable firm characteristics explain almost 18% of the overall wage dispersion among open firms and around 20% of the dispersion among closed firms.

Table 7 shows that differences in the dispersion of observable firm characteristics (e.g. firm size, industry, …) lead to a decrease in the gap between the wage dispersion in open and closed firms while differences in the marginal effects of the observable firms characteristics tend to increase the gap between the wage dispersion in open and closed firms. In other words, we could say that the "quantity effect" affects more wage inequality among non-exporting firms, while among exporting firms it is the "price effect" that affects more the wage dispersion.

V CONCLUDING REMARKS

In this paper, we tested whether and how export activity at the firm level affects the wage distribution in Switzerland. Our two-step methodology allowed us to estimate the exact impact of the various determinants of the (log of) wages on the overall wage dispersion; the dispersion within and between exporting ("open") and non-exporting ("closed") firms; and the degree of overlap between the wage distributions of these two types of firms.

The main results are summarized below. The selection made by individuals between working in open and closed firms is not the result of a random process. Individuals employed in exporting firms have, on average, a comparative advantage in working there. The age and tenure earnings profiles estimated showed that open firms give relatively more importance to general (age-related) than to specific (tenure-related) human capital. Moreover, the estimated earnings profiles clearly suggest that efficiency wage effects are more important among exporting firms, even though wage dispersion appears to be higher among closed firms (where the mean difference of the log of wages is 0.4024) than among open firms (where this mean difference is 0.3680). The decomposition we applied showed that observable and unobservable firm characteristics explain almost 20 percent of the overall wage dispersion, in both open and closed firms. Differences in general human capital and in its rate of return are, however, the main factors explaining the overall wage dispersion. Finally, observable firm characteristics and their marginal effects are the main factors explaining differences in wage dispersion between open and closed firms.

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TABLES AND FIGURES

Table 1 : Means and standard deviations (in parenthesis) of individual characteristics

	Exports	
Variable	**Yes**	**No**
Monthly wage (SFr, 1996)	6'404.215 (2'823.872)	5'820.832 (2'600.543)
Swiss nationality	0.673	0.738
Seasonal permit	0.005	0.011
Yearly permit	0.040	0.041
Settled permit	0.184	0.154
Cross-border permit	0.074	0.034
Special permits	0.022	0.020
Never married	0.236	0.298
Age	41.595 (10.406)	39.201 (10.516)
Tenure	12.404 (10.075)	10.165 (8.772)
Unskilled blue collar worker	0.158	0.083
Skilled blue collar worker	0.270	0.143
Highly skilled blue collar worker	0.048	0.036
Unskilled white collar worker	0.054	0.133
Skilled white collar worker	0.205	0.343
Highly skilled white collar worker	0.263	0.259
Number of observations	80’132	80’769

Table 2: Mean Values of firms' characteristics

	Exports	
Variable	**Yes**	**no**
Firm size	222.1	170.9
Firm-level agreement	0.224	0.287
Collective agreement	0.079	0.072
No agreement	0.697	0.641
German language	0.843	0.782
French language	0.115	0.171
Italian language	0.042	0.047
Ratio of foreign workers	0.268	0.253
Ratio of female workers	0.321	0.315
Ratio of part-time jobs	0.164	0.178
Ratio of unskilled blue collar workers*	0.158	0.083
Ratio of skilled blue collar workers*	0.270	0.143
Ratio of highly skilled blue collar workers*	0.048	0.036
Ratio of unskilled white collar workers*	0.054	0.133
Ratio of skilled white collar workers*	0.205	0.343
Ratio of highly skilled white collar workers*	0.263	0.259
Firm with only one establishment	0.559	0.588
Number of observations	1,053	1,841

Note : *Weighted means using the number of observations per firm as weight.

Table 3 : Reduced form probit (marginal effects) of the probability to be in an open firm

Variable	Coefficient	z-stat
Seasonal permit	0.0888	5.24
Yearly permit	0.0882	9.87
Settled permit	0.0500	10.13
Cross-border permit	0.1613	19.77
Special permits	0.2792	29.35
Never married	0.0192	4.19
Unskilled blue collar worker	-0.3147	-3.24
Age	0.0009	0.23
Age squared/1000	-0.0040	-0.08
Tenure	0.0048	2.50
Tenure square/1000	-0.0174	-0.30
Skilled blue collar worker	-0.2858	-3.16
Age	0.0014	0.48
Age square/1000	-0.0124	-0.35
Tenure	-0.0001	-0.08
Tenure square/1000	0.0711	1.80
Highly skilled blue collar worker	-0.4761	-4.29
Age	0.0216	2.92
Age square/1000	-0.2062	-2.35
Tenure	-0.0085	-2.95
Tenure square/1000	0.1951	2.40
Unskilled white collar worker		(ref.)
Age	-0.0144	-3.43
Age square/1000	0.1732	3.34
Tenure	0.0016	0.71
Tenure square/1000	-0.0039	-0.05
Skilled white collar worker	-0.4395	-5.37
Age	0.0097	3.89
Age square/1000	-0.0892	-2.90
Tenure	0.0017	1.41
Tenure square/1000	-0.0520	-1.41
Highly skilled white collar worker	-0.1223	-1.19
Age	-0.0084	-2.46
Age square/1000	0.1101	2.74
Tenure	0.0041	3.32
Tenure square/1000	-0.0859	-2.32
Only one establishment	-0.0704	-19.24
Firm size	0.0925	66.54
Firm-level agreement	-0.0553	-11.26
Collective agreement	0.0254	4.79
German language	-0.0747	-5.81
French language	-0.1939	-14.79
Ratio of foreign workers	-0.3174	-42.50
Ratio of female workers	-0.0825	-9.65
Ratio of part-time jobs	-0.1055	-9.69
Ratio of unskilled blue collar workers*	-0.7256	-46.91
Ratio of skilled blue collar workers*	-0.2906	-20.56
Ratio of highly skilled blue collar workers*	-0.6102	-26.12
Ratio of unskilled white collar workers*	-0.8049	-41.99
Ratio of skilled white collar workers*	-0.6321	-51.00

(Table 3, continue)

Variable	Coefficient	z-stat
Energy (electricity, water, gaz)	(ref.)	
Food	0.3646	32.38
Beverages	0.1521	7.54
Tobacco	0.5080	10.24
Textiles	0.4852	22.01
Apparel	0.4643	17.40
Timber, Furniture	0.4617	38.08
Paper	0.5143	36.32
Printing, publishing	0.4428	36.26
Leather and footwear	0.5147	17.33
Chemicals	0.5286	53.53
Plastics, rubber	0.5194	18.35
Non-ferrous minerals	0.4047	31.21
Metals	0.5601	65.39
Machinery and equipment	0.4663	46.20
Electrical machinery	0.4850	49.54
Watches, jewelry	0.5013	46.21
Other manufacturing	0.4871	31.76
Construction	-0.0458	-3.18
Building installations	-0.0534	-3.66
Wholesale trade I	0.2198	16.82
Wholesale trade II	0.0836	6.49
Wholesale trade III	0.4870	5.71
Trade intermediaries	-0.4297	-20.04
Retail trade I	0.1815	11.66
Retail trade II	-0.3861	-33.47
Restaurant and hotels	-0.2087	-10.62
Repair services	0.0077	0.40
Railroads	-0.3450	-8.19
Road transport	-0.0164	-0.89
Navigation	0.3836	14.45
Air transport	-0.0986	-2.82
Transports intermediaries	-0.3661	-27.69
Communication	0.5040	23.30
Banking, finance	-0.5672	-68.94
Insurance	-0.0583	-4.25
Real estate	-0.4712	-10.62
Leasing, personal hiring	0.3785	10.55
Business services	0.2496	19.79
Personal services	-0.1459	-4.27
Teaching (private)	-0.1668	-6.44
Research and development (private)	0.2370	10.04
Health services (private)	-0.4342	-20.92
Refuse collection, draining (private)	0.1011	2.69
Social assistance (private)	-0.1554	-4.86
Religious organizations	-0.0788	-1.72
Collective services (private)	-0.2660	-11.42
Sport, culture, leisure activities (private)	-0.1714	-6.64
Log likelihood	-58'045.496	
Pseudo R-squared	0.479	
Observed mean probability	0.498	
Estimated mean probability	0.487	
Number of observations	160’901	

Table 4 : Wage equations

	"Open" firms		"Closed" firms	
Variable	**Coefficient**	**t-stat**	**Coefficient**	**t-stat**
Seasonal permit	-0.0456	-4.33	-0.1219	-16.51
Yearly permit	-0.0147	3.74	-0.0874	-21.02
Settled permit	-0.0352	-16.96	-0.0634	-27.25
Cross-border permit	-0.0354	-9.24	-0.0912	-16.18
Special permits	-0.0349	-3.62	-0.1515	-14.95
Never married	-0.0508	-26.78	-0.0643	-35.01
Unskilled blue collar worker	0.0857	1.74	0.2262	5.24
Age	0.0185	13.76	0.0159	8.55
Age squared/1000	-0.2073	-12.71	-0.1656	-7.19
Tenure	0.0085	13.19	0.0081	8.09
Tenure square/1000	-0.1353	-7.57	-0.1728	-5.56
Skilled blue collar worker	-0.0599	-1.31	0.1358	3.74
Age	0.0308	30.09	0.0257	18.14
Age square/1000	-0.3236	-26.10	-0.2676	-15.30
Tenure	0.0051	10.66	0.0063	8.79
Tenure square/1000	-0.0595	-4.63	-0.0966	-4.52
Highly skilled blue collar worker	-0.1159	-1.53	0.1961	2.74
Age	0.0403	12.91	0.0297	8.76
Age square/1000	-0.3741	-10.27	-0.2734	-6.80
Tenure	0.0021	1.87	0.0043	3.10
Tenure square/1000	-0.0416	-1.40	-0.0688	-1.73
Unskilled white collar worker		(ref.)		(ref.)
Age	0.0206	9.48	0.0245	17.91
Age square/1000	-0.2131	-8.16	-0.2662	-15.68
Tenure	0.0084	7.87	0.0106	13.45
Tenure square/1000	-0.1782	-5.95	-0.1603	-6.37
Skilled white collar worker	-0.4555	-9.55	-0.4799	-16.01
Age	0.0517	44.04	0.0568	66.07
Age square/1000	-0.5237	-37.01	-0.6260	-58.71
Tenure	-0.0005	-0.84	0.0040	8.67
Tenure square/1000	0.0465	3.01	0.0623	4.46
Highly skilled white collar worker	-0.5969	-12.16	-0.4817	-12.93
Age	0.0654	48.54	0.0677	47.85
Age square/1000	-0.5850	-37.11	-0.6572	-39.32
Tenure	0.0015	2.97	-0.0012	-2.34
Tenure square/1000	-0.0656	-4.57	0.0869	5.85
Inverse Mill ratio	-0.0637	-3.23	0.0932	3.89
Constant	7.9498	191.41	7.8240	276.86
SD of error terms	0.1806		0.1843	
SD of "global" firm fixed effects	0.1807		0.1989	
R-squared	0.7197		0.7508	
Number of observations	80'132		80'769	

Notes The F-test on "global" firm fixed effects is F(1,052, 79,043) = 36.06 for open firms and F(1,840, 78,892) = 26.46 for closed firms.

Table 5 : Determinants of estimated "global" firm fixed effects

	"Open" firms		"Closed" firms	
Variable	**Coefficient**	**t-stat**	**Coefficient**	**t-stat**
(log) Firm size	0.0214	7.72	0.0020	1.06
Firm-level agreement	-0.0152	-1.68	0.0095	1.00
Collective agreement	0.0146	1.29	-0.0063	-0.66
German language	0.1419	6.05	0.0350	1.99
French language	0.1668	6.67	0.0200	1.04
Ratio of foreign workers	-0.0314	-2.28	-0.0168	-1.49
Ratio of female workers	-0.0015	-0.09	0.0219	1.53
Ratio of part-time jobs	0.0623	3.14	0.0083	0.38
Ratio of unskilled blue collar workers	-0.0509	-1.93	0.1376	4.86
Ratio of skilled blue collar workers	-0.0477	-1.93	-0.0157	-0.75
Ratio of highly skilled blue collar workers	-0.3698	-7.74	-0.1505	-4.02
Ratio of unskilled white collar workers	-0.2316	-4.11	0.0453	1.76
Ratio of skilled white collar workers	0.0510	1.81	0.0906	4.40
Constant*	-0.1816	-4.36	0.0384	1.23
R-squared adjusted	0.4910		0.4210	
Number of observations	1'053		1'841	

Notes : These estimations are based on weighted regressions. The number of observations per firm was used as weight. The other variables included in the regressions are the industry dummy variables (2 digits).
*The constant represents the differential associated to the (reference) industry in the regression, that is the energy sector (electricity, water, gaz).

Table 6 : Decomposition of wage dispersion **within** "open" and "closed" firms

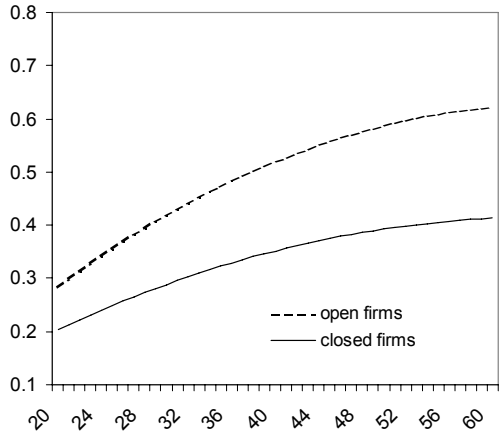
	"Open" firms	**"Closed" firms**
Ratio of different types of workers (skills) in the firm	0.00242	-0.02661
Firm size	0.00014	0.00043
Agreements	0.00245	0.00079
Languages	-0.00057	-0.00011
Ratio of foreigners, women and part-time in the firm	0.00248	0.01581
Industries	0.02886	0.05856
Sub-total firms (*observable characteristics*)	**0.03578**	**0.04887**
Error terms (*unobservable characteristics*)	**0.02994**	**0.02948**
Types of work permit	0.00572	0.01373
Never married	0.00668	0.01048
Skills	-0.18760	-0.12609
General human capital (age profiles)	0.39884	0.33458
Specific human capital (tenure profiles)	-0.01322	-0.00471
Inverse Mill ratios	0.00359	0.00932
Sub-total workers (*observable characteristics*)	**0.21401**	**0.23731**
Error workers (*unobservable characteristics*)	**0.08827**	**0.08669**
Total	**0.36800**	**0.40236**

Table 7 : Decomposition of the wage dispersion **between "**open" and "closed" firms

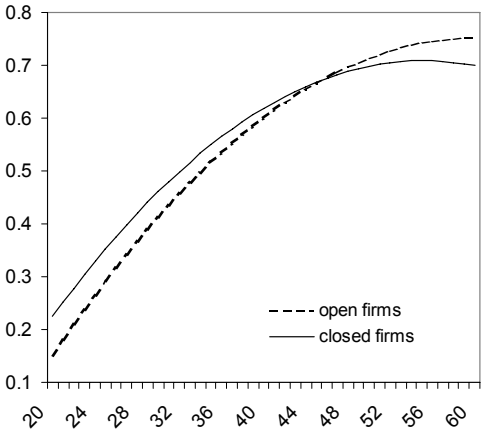
Impact of differences between the two groups of firms :	
in the dispersion of the individual human capital characteristics of the workers (M_1)	0.00088
in the Gini-correlation between the individual human capital characteristics and the logarithm of individual wages (M_2)	-0.02052
in the rates of return on the human capital characteristics of the workers (N)	-0.00366
in the dispersion of the unobserved variables in the regression analysing the impact of individual characteristics (O)	-0.00229
in the Gini-correlation between the unobserved variables in the regression analysing the determinants of the individual wages and the logarithm of these wages (P)	0.00387
in the dispersion of the specific features of the firms, such as their size, etc…(Q_1)	-0.03817
in the Gini-correlation between the variables affecting the firms' fixed effects and the logarithm of individual wages (Q_2)	0.00264
in the marginal effect on individual earnings of the specific features of the firms (R)	0.02244
in the dispersion of the unobserved variables in the regression analysing the determinants of the firms' fixed effects (S)	-0.00369
in the Gini-correlation between the unobserved variables in the regression analysing the determinants of the firms' fixed effects and the logarithm of the individual wages (T)	0.00415
Total	**-0.03436**

Age profiles : Figures 1 to 3

Figure 1: Differential in the rate of return of age between highly skilled and unskilled

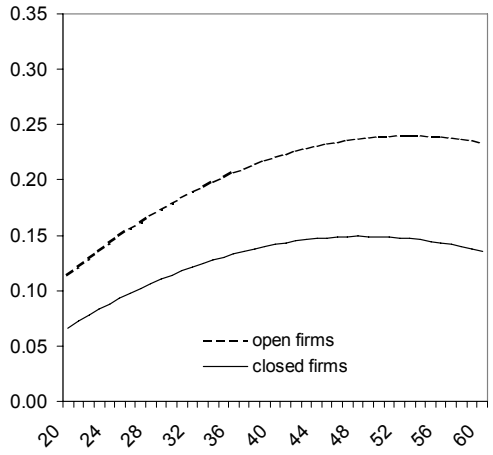


a) Blue collar workers

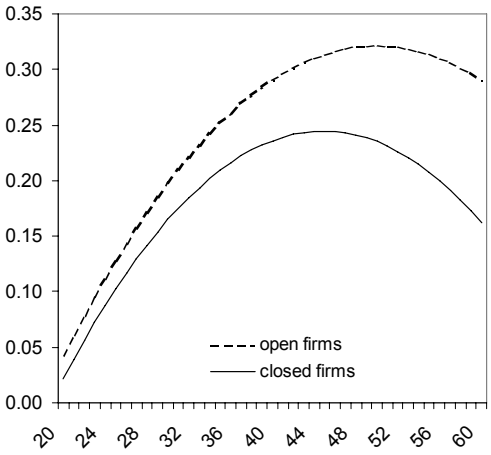


b) White collar workers

Figure 2: Differential in the rate of return of age between skilled and unskilled

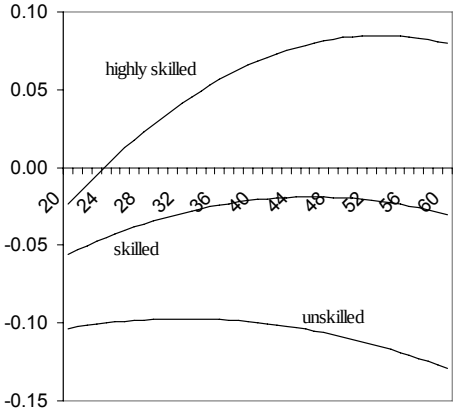


a) Blue collar workers

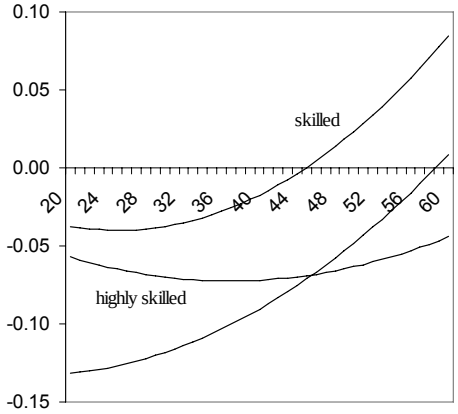


b) White collar workers

Figure 3: Differential in the rate of return of age between open and closed firms



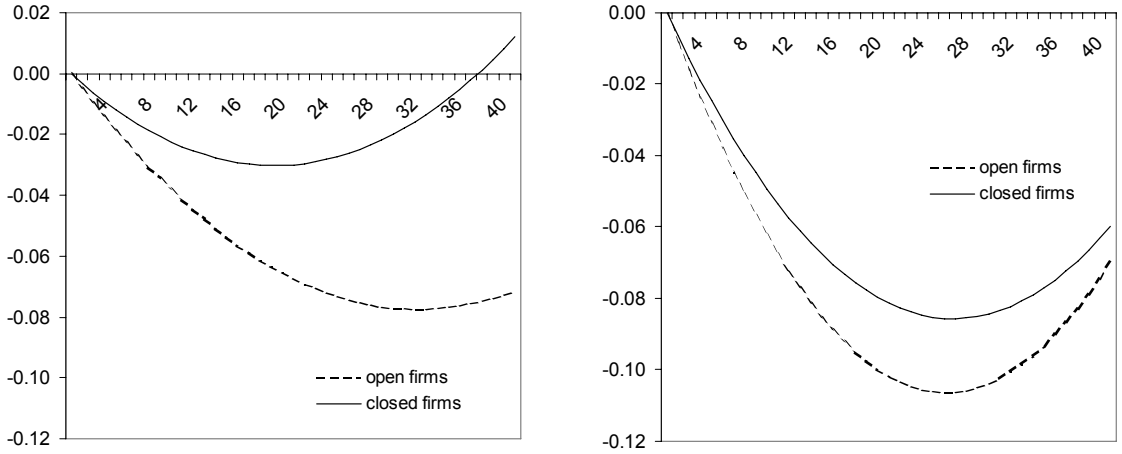
a) Blue collar workers



b) White collar workers

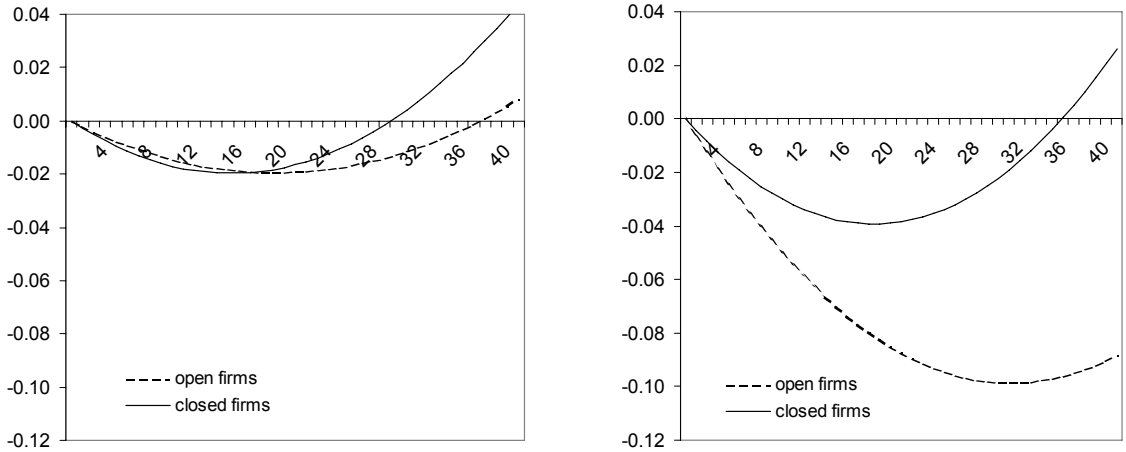
Tenure profiles : Figures 4 to 6

Figure 4: Differential in the rate of return of tenure between highly skilled and unskilled



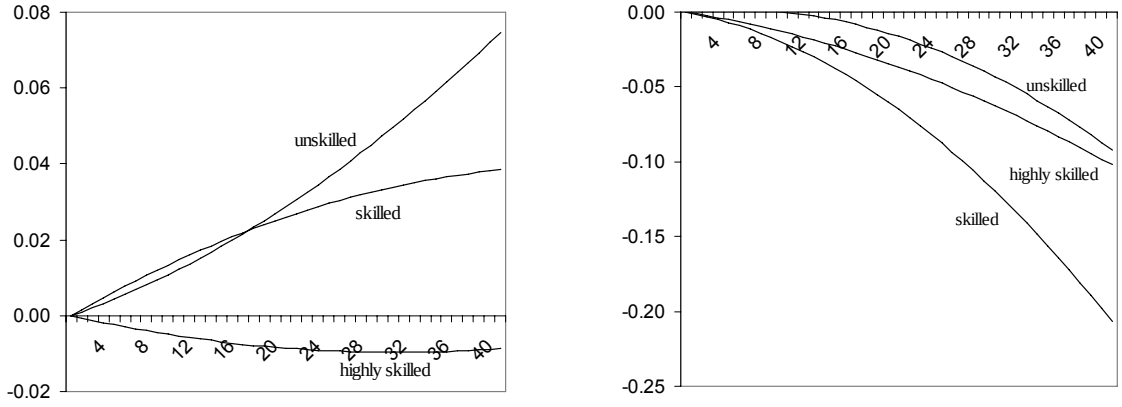
a) Blue collar workers b) White collar workers

Figure 5: Differential in the rate of return of tenure between skilled and unskilled



a) Blue collar workers b) White collar workers

Figure 6: Differential in the rate of return of tenure between open and closed firms



a) Blue collar workers b) White collar workers

ANNEX

The difference between the dispersion of wages in open and closed firms may be expressed as

(A1) $$\Delta_O-\Delta_C = \sum_{k=1 \text{ to } K} \{b_{kO}[G\Delta_O(x_{kO})\times\Delta_O(x_{kO})] - b_{kC}[G\Delta_C(x_{kC})\times\Delta_X(x_{kC})]\}$$
$$+\{[G\Delta_{uO}\times\Delta_{uO}] - [G\Delta_{uO}\times\Delta_{uO}]\}$$
$$+\sum_{h=1 \text{ to } H} \{c_{hO}[G\Delta_O(z_{hO})\times\Delta_A(z_{hO})] - c_{hC}[G\Delta_C(z_{hC})\times\Delta_C(z_{hC})]\}$$
$$+\{[G\Delta_{vO}\times\Delta_{vO}] - [G\Delta_{vC}\times\Delta_{vC}]\}$$

(A2) $$\Delta_O-\Delta_C = M + N + O + P + Q + R + S + T$$

where

(A3) $$M = \sum_{k=1 \text{ to } K} ((b_{kO} + b_{kC})/2)\{[G\Delta_O(x_{kO})\times\Delta_O(x_{kO})] - [G\Delta_C(x_{kC})\times\Delta_C(x_{kC})]\}$$

(A4) $$N = \sum_{k=1 \text{ to } K} \{([G\Delta_O(x_{kO})\times\Delta_O(x_{kO})] + [G\Delta_C(x_{kC})\times\Delta_C(x_{kC})])/2\}[b_{kO} - b_{kC}]$$

(A5) $$O = \{([G\Delta_{uO} + G\Delta_{uC}]/2)(\Delta_{uO} - \Delta_{uC})\}$$

(A6) $$P = ((\Delta_{uO} - \Delta_{uC})/2)[G\Delta_{uO} - G\Delta_{uC}]$$

(A7) $$Q = \Sigma_{h=1 \text{ to } H} ((c_{hO} + c_{hC})/2)\{[G\Delta O(z_{hO})\times\Delta_O(z_{hO})] - [G\Delta_C(z_{hC})\times\Delta_C(z_{hC})]\}$$

(A8) $$R = \Sigma_{h=1 \text{ to } H} [\{([G\Delta_O(z_{hO})\times\Delta_O(z_{hO})] + [G\Delta_C(z_{hC})\times\Delta_C(z_{hC})])/2\}[c_{hO} - c_{hC}]$$

(A9) $$S = \{([G\Delta_{vO}+G\Delta_{vC}]/2)(\Delta_{vO} - \Delta_{vC})\}$$

(A10) $$T = ((\Delta_{vO} + \Delta_{vC})/2)[G\Delta_{vO}-G\Delta_{vC}]$$

It may be observed however that

(A11) $$M = M1 + M2$$

where

(A12) $$M1 = \sum_{k=1 \text{ to } K} ((b_{kO} + b_{kC})/2)\{[G\Delta_O(x_{kO}) + G\Delta_C(x_{kC})]/2\}[\Delta_O(x_{kO}) - \Delta_C(x_{kC})]$$

(A13) $$M2 = \sum_{k=1 \text{ to } K} ((b_{kO} + b_{kC})/2)\{[\Delta_O(x_{kO}) + \Delta_C(x_{kC})]/2\}[G\Delta_O(x_{kO}) - G\Delta_C(x_{kC})]$$

and

(A14) $$Q = Q1 + Q2$$

where

(A15) $$Q1 = \sum_{h=1 \text{ to } H} ((c_{hO} + c_{hC})/2)\{[G\Delta_O(z_{hO}) + G\Delta_C(z_{hC})]/2\}[\Delta_O(z_{hO}) - \Delta_C(z_{hC})]$$

(A16) $$Q2 = \sum_{h=1 \text{ to } H} ((c_{hO} + c_{hC})/2)\{[\Delta_O(z_{hO}) + \Delta_C(z_{hC})]/2\}[G\Delta_O(z_{hO}) - G\Delta_C(z_{hC})]$$

We therefore end up with

(A17) $$\Delta_O-\Delta_C = M_1 + M_2 + N + O + P + Q1 + Q2 + R + S + T$$

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