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ABSTRACT

We estimate separate earnings equations for blue collar, white collar and managerial/professional workers using analytical job characteristics by detailed occupation from the Canadian Classification and Dictionary of Occupations. We find that, while blue collar workers are rewarded for the ability to use physical equipment and professionals and managers for their skills in "symbolic analysis", white collar workers appear to be rewarded for unobserved individual characteristics. We interpret the commonly found negative coefficients that still remain after correction for multicollinearity in terms of the technological obsolescence of the occupations requiring these characteristics.

Key words: job classification; job cluster; job evaluation; job requirements; occupation; occupational family; occupational classification; skills; skill obsolescence; technological change; wage determination; wage structure; working conditions;

RÉSUMÉ

Cet article s'adresse à l'étude de la contribution des caractéristiques analytiques des emplois à l'explication des disparités interindividuelles et interoccupationnelles des salaires. La distinction est faite entre les emplois de cols bleus, les emplois de cols blancs, les cadres et les professionnels. Il ressort de l'analyse que les professions de cols bleus sont principalement rémunérées en fonction de leurs habiletés reliées à l'usage des équipements, que les professionnels et les cadres à leurs habiletés reliées à la "manipulation" des symboles et que les cols blancs sont davantage rémunérés en fonction de leurs habiletés personnelles. Les signes négatifs obtenus pour certaines caractéristiques sont interprétés en terme de désuétude ou d'obsolescence technologique.

Mots clés: rémunération; évaluation des emplois; technologie; familles occupationnelles; salaires; conditions du travail.

INTRODUCTION

One of the key propositions in classical economic analysis is to the effect that individuals who have a more demanding occupation should in return receive higher earnings. One of the major applications of this theory, the theory of wage compensating differentials, is applied in company job evaluation programmes. These programmes apply in 70% of companies in Canada (Thériault, 1991), defining and quantifying job requirements so as to rank them, first in terms of requirements and thence in terms of earnings.

Because each of these plans is based on a series of key evaluation factors, namely skill, effort, responsibility, and working conditions, which are measured by a series of analytical job characteristics (AJC's), one can expect to find indications of the effect of these characteristics in the inter-individual variation in earnings. While true in theory, much remains to be resolved in practice.

In academic practice, the method that is generally used to estimate the effects of these characteristics consists essentially of inserting them individually (Brown 1980; Meng 1989) or in factor-analytical form (Dauffenbach and Greer; 1986; Howell and Wolff, 1992) into a human capital type earnings equation. These studies, for the most part, confirm the hypothesis of compensating earnings differentials in spite of the presence of results that are ambiguous and at times contrary to expectations, for instance characteristics that produce a negative return (Vahey, 1995). This article proposes to reexamine these ambiguities, first by dividing the sample into the major occupational categories and then by interpreting the remaining counter-intuitive results in light of the general technological environment of each major occupational group.

It seems most appropriate to sub-divide the sample by major category because it is usually observed that companies use as many evaluation schemes as there are job categories (job families) and that these job categories correspond, essentially, to

the major occupational categories: blue collar; white collar; and managers and professionals (Milkovich and Newman, 1985)[1]. We thus propose this enhancement, not only to conform better with job evaluation practice in the field of compensation, but also because one may conceptualize the activities of these three categories very differently. Blue collar workers use technologies specific to the production of physical goods; white collar workers use technologies specific to current administration; and managers and professionals (M&P) use technologies appropriate for "symbolic analysis" and decision making.

Secondly, it seems more and more apparent that technological change affects the nature of jobs, work organization, compensation plans and required job skills. This suggests, among other things, that technological change may have altered the relationship traditionally observed between AJC's and earnings. While this study does not attempt to measure the incidence of the change in technology or in the returns to AJC's, it attempts to provide a new interpretation of the estimated returns to AJC's in light of the different technologies that characterize each major occupational group.

The first section briefly recalls the standard theoretical background, its corresponding regression model and empirical expectations. The second introduces the sub-division of the sample according to occupational category and presents the data and variables used for estimation purposes. The third section presents and comments on the estimation results, incorporating the technological dimension. The concluding section summarizes our major findings suggesting some implications for individuals, governments and organizations.

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[1] They also divide managers into executives and middle managers.

THE MODEL

Nowadays the hypothesis of wage compensating differentials is based on hedonic wage theory (Thaler and Rosen, 1975) which assumes: that jobs are differentiated from each other in terms of working conditions; that these working conditions reflect the demands of production; and that they cause discomfort to workers. From the company's viewpoint, the same theory stipulates that they will be prepared to compensate their workers for these requirements in so far as the cost of the premium paid does not exceed the cost of eliminating them. In equilibrium, when worker tastes and preferences meet the profit constraints of the companies, a contract curve is traced out between all employers and all workers which engenders higher earnings for the more demanding jobs and lower earnings for the less demanding jobs.

In an equation that relates hourly wage rates of individuals on the one hand, with, the AJC's of the jobs they occupy on the other, one would expect to obtain regression coefficients on each of the AJC's that are strictly positive and significant because it is assumed: that these variables reflect productive abilities which are typically found within a tayloristic framework of work organization; and that all other factors that influence earnings have been controlled for. Under these circumstances, the earnings equation for estimation becomes:

$$(1) \qquad \ln w_k = a_0 + \sum_i a_{1i} C_{ik} + \sum_j a_{2j} AJC_{jk} + u_k$$

where $\ln w_k$ represents the natural log of the *hourly wage rate* of the kth individual; C_i a block of control variables related to the determination of individual earnings (there are i of them); AJC_j, the group of analytical job characteristic variables (there are j of them), corresponding to individual k's occupation; a_0, a_{1i}, and a_{2j} the estimation

parameters; and u_k the residual term. As discussed above, all a_{2j} are expected to be strictly greater than zero for each and every one of the characteristics. Further, in order to conform to employment evaluation practice as described earlier, equation (1) is to be estimated separately for the three distinct labour force categories: blue collar jobs, except for construction which is a special case; white collar; and managers and professionals.

THE DATA

The data used for the estimation are drawn from two sources: the 1989 *Labour Market Activity Survey* (LMAS) and the *Canadian Classification and Dictionary of Occupations* (Canada, 1971 and occasional updates)[2] (CCDO). The LMAS provided the dependent variable (lnw_k) and the control variables (C_{ik}). The dependent variable is the *ln* of an *hourly wage rate* calculated by Statistics Canada using information obtained on annual earnings, other forms of income (commissions, tips and bonuses) and hours worked.

Insert TABLE 1 about here

The control variables were coded according to responses to questions asked on *education, age, male, union status, firm size, job tenure, disabled* or not and whether or not a member of a *visible minority*. *Job tenure* is measured in years; the variables of *education, age* and *firm size* are measured categorically; and *male, union status, disabled* and *visible minority* are dichotomous (for example unionized = 1 if unionized and 0 otherwise). Table 1 gives an idea of the form, frequency (for

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[2] At the time of compilation of our data set the recently published National Occupational Classification (Canada, 1996) was not available.

dichotomous and categorical variables) and the mean of these variables for the whole of our sample of the work force[3]. In all we used a stratified sample of 2,656 blue collar workers, 3,870 white collar workers and 2,811 managers and professionals.

Insert TABLE 2 about here

The AJC's could be matched with data on salaries because the LMAS provides information on the detailed occupation of the respondent[4]. Once the detailed occupation is known, the job characteristics are taken straight from the CCDO. This document gives a brief description of the occupations in the survey sample in addition to a numerical or letter code that identifies their technical profile and thus their AJC's. Table 2 shows the list of 23 characteristics that we were able to consider[5]. The list is accompanied by a brief description of each characteristic and descriptive statistics[6].

Insert TABLE 3 about here

Table 3, in turn, provides information on the distribution of AJC's by occupational category. We note, for example, that the characteristics most in demand among managers and professionals are *verbal* and *numerical aptitude* as well as *talking, hearing, seeing* and *direction*. White collar occupations tend to be assigned

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3 Values for major occupation, major industry and province of residence have been excluded so as not to unduly lengthen the text. They may be obtained from the authors on request.

4 Generally at the 3-digit level of the Standard Occupational Classification (SOC).

5 The characteristics that were not considered were those that did not occur in any occupation at our level of aggregation, that were too highly correlated with similar characteristics or were too infrequent, for example colour discrimination.

6 See Appendix B for the manner of resolution of various coding problems.

tasks that, in essence, necessitate the *manipulation* of office equipment (telephones, computer keyboards, photocopy machines, and the like). In the case of blue collar workers, we note for the first time the appearance of ambient working conditions (*dust and smoke*, *humidity* and the like), and a greater need for *strength* and *body dexterity*. Two points should be noted. First, the required job characteristics differ among categories. Second, when a characteristic is required by more than one category it does not necessarily have the same meaning for both; for example, *manipulation* will be different for blue collar and for white collar workers. The consequence of the first comment is that an estimation at the aggregate level (all occupational categories together), which may contain characteristics that are unique to particular occupational categories, runs the risk of measuring the effect of the category rather than of the characteristic. The consequence of the second comment is that the estimation of the effect of a characteristic common to the three categories may suffer from a large variance. Dividing the overall sample into three occupational categories reduces the effects of these types of problem.

ESTIMATION RESULTS

In light of potential heteroskedasticity problems related to *firm size* and the use of dichotomous variables, the estimator used to estimate equation (1) is Ordinary Least Squares, corrected for heteroskedasticity. Otherwise, and although the effects of the control variables and AJC's have been estimated jointly, we will deal separately with each of these categories of variable.

Insert TABLE 4A about here

The Control Variables

In Table 4A, which shows the estimation results for the control variables, we find first, that their effects on earnings are comparable with those found in similar studies. The coefficients on *age* and *education* have a tendency to increase progressively from one level to the next, irrespective of occupational category. Furthermore, we observe differences in weighting among categories. For instance, *age* (experience) carries a higher return for blue collar workers while *job tenure* is more highly rewarded in the case of white collar workers and managers and professionals. The other control variables, *firm size, male, union status, visible minority* and *disabled* also conform with the usual expectations but with different incidence by occupational category. Overall, this sub-set of results constitutes a further test of the standard human capital theory, confirming its robustness and providing new information about its applicability to the main occupational categories.

Analytical Job Characteristics

Insert TABLE 4B about here

The estimations results for equation (1) of AJC's are shown in Table 4B which we refer to as the "all-inclusive" regression models.

Blue Collar Workers

First, for the blue collar equation, we find that half of the coefficients on the AJC's are negative and statistically significant. In effect, of the 14 analytical characteristics included in the equation, it appears that 10 have a negative coefficient and that 7 of these are significant. Of the four variables with positive coefficients, *noise* and *specific*

vocational preparation (SVP) are the only ones that are significant[7].

A first, classical interpretation of these results would be that there exists an omitted variable bias due to fixed individual characteristics such as ability, aversion to dust, etc. However, the assumed inverse correlation between the omitted and the observed characteristics is not well suited to blue collar occupational technologies where individual characteristics should not significantly affect individual worker productivity on automated production lines. One must thus look for an alternative omitted variable.

Accordingly, our second interpretation is that the AJC's available in the CCDO essentially reflect out-dated production technologies for this group of workers. In effect, were we to draw up the technical profile of occupations characterized by such technologies, we would not have to look much further for their characteristics than *noise, dust and smoke, humidity, strength, body dexterity* and *seeing* and *hearing*, exactly as identified in the CCDO. Today, modern production environments are healthier, require less *strength* and *body dexterity* and employ machinery and equipment which are far superior to human beings in detecting variations in sounds, shapes, distance, movement, light or colour. Moreover and in contrast, the relatively high return to the minority (2.2%) of blue collar workers with *university education* tends to substantiate this interpretation in that it may reflect a return to the capacity to learn, in particular to learn the use of complex technological hardware. Similarly, *SVP* carries a relatively high return, reflecting the importance of practical experience in the use of these technologies.

Analysis of simple correlations suggests that a third explanation of these results is that there may be considerable multicollinearity among the AJC variables. Because

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[7] For analytical purposes *SVP* should be considered a human capital factor. However, for practical reasons, because it is measured in the CCDO it was classified and discussed here as an AJC. Further, it is unusual to find such a variable in standard human capital estimates.

there was no *a priori* theoretical reason for choosing which variables to exclude to correct for the multicollinearity problem, it was decided to use the forward stepwise method of regression in a second step, letting the software select the variable(s) that lead to the model with the highest explanatory power. The results of stepwise regressions are shown in Tables 5A and 5B.

Insert TABLES 5A and 5B about here

The control variables remain relatively stable but many of the negative coefficients on AJC's are eliminated. The effects of *noise, outside/inside, strength, spatial perception* and *body dexterity* in the all-inclusive regression are confirmed. The effects of *talking, hearing, seeing, controls* and *direction* disappear, suggesting that the insignificant negative coefficients obtained in the all-inclusive regression are, in part, the result of multicollinearity.

However, those variables retained by the stepwise procedure still tend to support a technological change interpretation. The characteristics on which the return is negative all seem to be required of workers in occupations which, in comparison with say the new manufacturing technologies (CAD, CAM), are "old" technology. *Outside/inside* is required by workers in the occupations: farmers and farm managers (SOC 711); other farming and horticultural (SOC 718 and 719); mining and quarrying (SOC 771); and materials handling (SOC 931). *Spatial perception* is required only by workers in the "other machining" category (SOC 831, 835, 837 and 839) where such perception may be more efficiently performed by machines. *Body dexterity* is required by workers in: other farming and horticultural (SOC 718 and 719); fishing, hunting and trapping (SOC 731); and forestry and logging (SOC 751).

In summary, after using the stepwise approach to eliminate some of the effects

of multicollinearity in the sub-sample of blue collar workers, those coefficients which remain negative and significant can be interpreted as reflecting characteristics of occupations using older technologies.

White Collar Workers

In the white collar equation we find that none of the AJC's has a significant effect on compensation except for the extent of *SVP*. Four of them are positive in sign and the other four are negative, but no coefficient has a sufficiently small standard deviation for the t-statistic to reach the critical threshold for rejection of the zero null hypothesis at the 5% probability level.

Second, we believe that the compensation administration for white collar workers differs from that of blue collar workers and this explains why we find no significant AJC's. In effect, and as is generally accepted, there is not one single, universal, traditional model of compensation management but two: the traditional, industrial compensation model which applies mainly to blue collar workers; and another, no less traditional, which applies more to white collar workers. The industrial model is tayloristic in nature and closely links earnings with the job itself. In the "salaried worker" model, employers generally have more latitude as regards compensation and it is not unusual to find that a certain component of compensation is based on "merit" (Betcherman et al. 1994), which is hard to measure for survey purposes. In these circumstances, two individuals in the same occupation may well be paid very differently and an omitted variable bias due to fixed individual characteristics then appears much more plausible.

The administration technology used by white collar workers is different from both the production technologies used by blue collar workers and the "symbolic analysis" technologies used by managers and professionals. This may also be

reflected in the relatively low returns to *SVP* (0.03 for white collar workers *versus* 0.12 for blue collar)[8] and to most of the categories of formal *education* (Table 4A).

This first interpretation of the estimation results is open to challenge from alternative hypotheses, for example, that the different returns to compensation factors reflect discrimination towards female-dominated occupations or, again, problems of multicollinearity. As with blue collar workers, there was considerable inter-correlation among the variables. When the regression is repeated using the stepwise method the control variables again remain stable. The results of the all-inclusive regression are substantially confirmed for the AJC's (Table 5B), except that *hazards, strength, clerical perception, manipulation* and *seeing*, all of which were insignificant in Table 4B, now disappear. *Body dexterity* is required by workers in personal and apparel service occupations but with a negative return[9].

Although the stepwise procedure retained both *talking* and *hearing*, these two variables are highly correlated. On removal of *talking* (regression not reported), the explanatory power remained virtually unchanged, the control variables remained stable, *SVP* decreased to 0.04 and remained significant, *body dexterity* declined to 0.06 and became insignificant while *hearing* declined to -0.04 but remained significant. When the regression was rerun with *talking*, instead of *hearing*, the coefficient on *talking* became negative with an insignificant value of -0.01. These results suggest that, taken together, *hearing* and *talking* skills have a negative return for white collar workers.

In summary, after as far as possible correcting for multicollinearity in the sub-sample, we conclude that the remuneration of white collar workers is far more

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[8] The results for managers and professionals will be discussed below.

[9] SOC 613 and 614: funeral directors and embalmers; housekeepers and servants; barbers and hairdressers; guides; travel attendants; child-care workers; apparel and furnishings; laundry and dry cleaning; and pressing.

discretionary than that of blue collar workers; they are evaluated on relatively few measurable AJC's. The technologies they use afford them a relatively small return to *education* and *SVP* and their traditional skills such as clerical perception do not appear to distinguish among them for compensation purposes.

Managers and Professionals (M&P)

Taken Together

For the equation for managers and professionals, we find three AJC's that turn out positive and significant: *manipulation*, *talking* (verbal aptitude) and *numerical aptitude*. These results seem particularly interesting because they underscore, for the first time to our knowledge, the importance of *numerical aptitude*, without in the process neglecting the capacity for analysis of written content which is captured by *verbal aptitude*. In effect, whereas the characteristic *manipulation* deals more specifically with the skills and dexterity required by certain professional occupations[10], *verbal aptitude* and *numerical aptitude* may capture the abstract reasoning and data analysis that characterize the jobs of M&P working in the field of or making use of the new information technologies (Zuboff, 1988).

Further, and given the numerous negative signs associated with the CCDO variables of perception (*perception of forms* and *clerical perception*), visual acuity (*seeing)* and dexterity (*finger dexterity* and *body dexterity*) for this category of the work force, these results reinforce the hypothesis of a structural shift away from attaching value to physical abilities toward the payment of premiums for reasoning, judgement and analysis.

Without putting too much emphasis on the interpretation of the constant term,

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[10] Professionals requiring *manipulation* are: physical and life scientists; engineers and engineering technicians ; teachers other than at universities; all health care professionals; and artistic and recreational professionals.

it was noticed that, on removing the variable for *SVP* (regression not reported), which is the hardest of the negative results obtained for M&P to explain, the constant term fell from the equivalent of an inordinately high $90.92 to a more reasonable value equivalent to $6.66. This and further examination of the correlations for M&P job characteristics tend to confirm the usefulness of the stepwise procedure.

Except for the change in the constant term, the control variables remain relatively stable when the stepwise method is applied. There are, however, some notable changes in the coefficients on the AJC's. Three variables emerge as significant and positive in sign: on the one hand *numerical aptitude*, which may capture the element of 'symbolic analysis'; and, on the other hand, *eye-hand-foot coordination* and *seeing* which appear somewhat unusual.

Treated Separately

Examination of the unusual results for M&P led us to further question the assumption that they should be treated as one labour market category. The means (not reported) of the AJC's for M&P separately show major differences. All managers have *SVP* of 7.0, and require *talking* and *direction*; it would be expected that these three elements will be captured by the constant term in a regression consisting of managers only. All other AJC's are zero except for *seeing* and *numerical aptitude* which are perfectly correlated and are required by 94% of managers. The situation is somewhat more diverse for professionals who must have a variety of characteristics including both *talking* and *hearing* which are perfectly correlated and required by 89% of the category.

Insert TABLES 6A and 6B about here

There are also notable differences between coefficients on the control variables in the all-inclusive regressions for the two categories (Tables 6A and 6B). The return on formal *education* is generally higher for professionals while for managers *age/experience* is more highly rewarded. *Male* managers have a 21% advantage over females while the difference is only 9% for professionals. A major difference emerges for *union status*; those managers who are unionized suffer a 4% discount while unionized professionals receive a return of 10%. Membership in a *visible minority* appears to be a significant disadvantage for managers (-26%) while there is no significant difference for professionals.

For these reasons and also because the literature on professionals suggests that there are major differences in orientation between managers and professionals (Guérin *et al*, 1996; Raelin, 1986), we decided to pursue separate analyses of professionals and managers.

(a) Managers separately

The two regressions (all-inclusive *versus* stepwise) are effectively the same for managers because there are only two (perfectly correlated) AJC's that vary, *seeing* and *numerical aptitude*. Either variable is affected by a negative and non-significant coefficient at the 5% level.

Two hypotheses emerge: (1) the required aptitudes are for the most part contained and developed in, and selected directly from their educational curricula, that is that they are highly correlated with formal education, and/or (2) compensated aptitudes for this category of worker are mainly personal and unobservable by the survey. The strong effect of education tends to confirm the former while the low adjusted R^2 tends to confirm the latter.

(b) Professionals separately

The all-inclusive regression shows a significant positive coefficient on *numerical aptitude* (5% level). A somewhat less significant coefficient (10% level) is obtained on *talking* which represents "expressing or exchanging ideas by means of the spoken word" (Canada, 1971). Significant (at the 5% level) negative coefficients appear for *outside/inside* and for *hazards*, suggesting the obsolescence of professional occupations with a lower element of symbolic analysis. This is reinforced by the appearance of less significant (10% level) negative coefficients on *strength* and *clerical perception*.

However, the constant term is again unrealistic ($67.39) while the coefficient on *SVP* is large and significantly negative (Table 6B). Once again, when the regression is rerun without *SVP* (not reported) the control variables remain stable, all of the AJC's become insignificant, and the constant term falls to the equivalent of $5.06. In the stepwise regression (without *SVP*) the control variables remain stable but the AJC's change substantially with two being retained in the stepwise regression, *spatial perception* and *manipulation*, both of which are positive in sign.

Much of the work of professionals involves 'symbolic analysis' which was captured by *numerical aptitude* in the combined M&P regression although it was not retained in the stepwise regression. However, when the regression is rerun with *numerical aptitude* instead of *spatial perception* (not reported) it becomes significant at the 10% level. *Spatial perception* thus seems to best capture those aspects of symbolic analysis that are not captured by formal *education* while *manipulation* appears to capture certain physical aspects of professional practice.

The fact that *SVP* produces either a significant negative return (the all-inclusive regression) or has no effect (the stepwise regression) merits further comment. First, the sample of professionals is heterogeneous not only among but also within

professional occupations[11]. For instance the category containing nurses also contained nursing assistants and certain categories of therapist. Thus some professions are such that formal education is of primary importance in the performance of the customary duties (university professors) while others require practical training experience as captured by *SVP* (physiotherapists). The interpretation and relevance of *SVP* thus differs widely within the sub-category of professionals. Second, there may be a measurement problem with SVP for professionals. In the CCDO a four year bachelor's degree is treated as equivalent to two years of *SVP* while each year of graduate study is treated as one year of *SVP*. There are two problems with this: the interpretation of *SVP* in a knowledge-oriented occupation; and an overlap between the *SVP* and formal education variables. *SVP* for professionals tends to imply practical experience training required to supplement formal education, for example articling by law students or the period of work experience required before a graduate engineer can obtain the P.Eng designation. Cross-tabulations (not reported) show that in general it is the more highly educated professionals who have the highest level of *SVP*. This may simply be the result of double counting rather than a measure of actual years of essential, supplementary practical experience required for qualification. These reasons, and also because it reflects training for symbolic analysis, may explain why formal education at the post-secondary and university levels rather than *SVP* emerge as significant in the regression.

In summary, managers and professionals should be treated as two separate groups for job evaluation purposes. After separating them and applying the stepwise

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[11] It contains diverse professions: physical and life scientists (SOC 211 and 213); mathematicians, statisticians, systems analysts and programmers (SOC 218); architects and engineers (SOC 214 and 215); technicians in architecture and engineering (SOC 216); social scientists, lawyers and judges, librarians and archivists (SOC 213, 233, 234, 235, and 239); religious occupations (SOC 251); teachers in primary, secondary and post-secondary education (SOC 271, 273 and 279); all categories of medical worker (SOC 311, 313, 315 and 316) ; and artists, writers, and athletes (SOC 331, 333, 335, 336 and 337).

regression method, we conclude that both these sub-groups are rewarded for characteristics that may be perceived as representing analytical capability. While managers all require a high level of *SVP*, this characteristic does not carry a reward for professionals for whom *education*, *spatial perception* and *numerical aptitude* appear to be better measures of such analytical capability.

CONCLUSION

To summarize the procedure, we started with the separation of the work force into three major job categories, and found that each of these yielded regression results for AJC's that were negative and significant whereas theory would predict values that are strictly positive. Some of these were the result of multicollinearity and many were eliminated using the forward stepwise regression method. Those that remained may reflect occupations that use older technology. We further concluded that it was necessary to separate managers from professionals. The stepwise method made little difference to the results for managers, who are evaluated on relatively few AJC's, but had a substantial effect on that for professionals, eliminating all of the significant negative coefficients previously obtained.

The results of estimating the contribution of analytical job characteristics to the explanation of earnings differences among individuals are, at first glance, somewhat surprising given the large number of coefficients that are negative and often significant and an even larger number of coefficients that are not significant. Use of stepwise regression to resolve the multicollinearity problem serves to eliminate many of the counter-intuitive coefficients but the negative coefficients that remain may reflect the type of technology in which they operate as well as the major transformations that are currently affecting labour markets and, in this respect, carry several implications.

First, the results that suggest that blue collar workers in older technologies

suffer a discount or negative return show not only the importance for the individual of his choice of company or industry but also the importance to firms of adopting new technologies.

Second, the results obtained for white collar workers, and equally for managers, tend to suggest that the variation in their earnings is more a matter of individual performance, combined with a non-tayloristic model of compensation, than of job descriptions.

Third, although it was found that managers and professionals should be treated as belonging to two separate labour market sub-categories, both experience a strong return on formal education, the characteristic which is most likely to equip them for symbolic analysis.

As mentioned in our introduction, there remains a lot more to be learned about the kind of vocational preparation and skill development needed in the future. To this end it is of primary importance that we expand our knowledge and understanding of the most sought-after characteristics.

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APPENDIX A - TABLES

Table 1: Descriptive Statistics for the Dependent and Control Variables (C_i)

Variable	Blue- collar without construction		White collar		Managers and professionals	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Dependent variable: ln W_k	2.332 ($10.30)	0.559	2.113 ($ 8.27)	0.488	2.596 ($13.41)	0.529
Independent Variables						
Schooling:						
0-8 years (1)	-		-		-	
some secondary education	0.290	0.454	0.225	0.418	0.062	0.240
graduated from high school	0.226	0.418	0.301	0.459	0.145	0.352
some post-secondary	0.105	0.307	0.148	0.355	0.090	0.287
trades certificate or diploma	0.096	0.295	0.069	0.254	0.058	0.233
post-secondary cert. or diploma	0.100	0.300	0.144	0.351	0.256	0.436
university degree	0.022	0.146	0.055	0.228	0.375	0.484
Age: 16-19 years (1)	-		-		-	
20-24 years	0.139	0.346	0.150	0.358	0.085	0.279
25-34 years	0.308	0.462	0.282	0.450	0.301	0.459
35-44 years	0.228	0.419	0.215	0.411	0.325	0.469
45-54 years	0.141	0.348	0.136	0.343	0.187	0.390
55-64 years	0.082	0.275	0.074	0.263	0.069	0.253
65-69 years	0.005	0.070	0.008	0.089	0.089	0.094
Tenure	5.96	7.87	4.67	6.35	7.60	7.84
$Tenure^2$	97.40	217.7	62.13	162.1	119.2	210.6
Male	0.797	0.403	0.300	0.458	0.474	0.499
Union status	0.380	0.485	0.233	0.423	0.407	0.491
Firm size: ≤ 19 employees (1)	-		-		-	
20-99 employees	0.200	0.400	0.172	0.377	0.159	0.366
100-499 employees	0.150	0.357	0.118	0.323	0.201	0.401
500+ employees	0.352	0.478	0.347	0.476	0.435	0.496
Disabled	0.127	0.332	0.104	0.306	0.074	0.262
Member of a visible minority	0.045	0.207	0.039	0.193	0.031	0.174
Total number of observations	2,656		3,870		2,811	

(1) Reference category

Table 2: Descriptive statistics of analytical job characteristics - work force

Characteristic	Abbreviated description	Mean	Std. devn.	Min.	Max.
1. Specific vocational preparation	training period: 0 = short demonstration; 1 = one month or less, etc.	4.103	1.635	1	7
Working conditions					
2. Noise	constant or intermittent noise sufficient to cause marked distraction or possible injury to hearing	0.142	0.35	0	1
3. Dust and smoke	fumes, odours, toxic conditions, dust and poor ventilation	0.056	0.23	0	1
4. Humidity	water or other moisture content sufficient to cause marked bodily discomfort	0.008	0.09	0	1
5. Outside	75% or more of time is spent outside	0.031	0.17	0	1
6. Outside-inside	50% of work is inside and 50% outside	0.201	0.40	0	1
7. Hazards	exposure to risk of bodily injury	0.196	0.40	0	1
Effort					
8. Strength	0 = sedentary work; 1 = lifting a maximum of 10 lbs 2 = maximum weight of 10 to 20 lbs; 3 = maximum of 20 to 50 lbs, etc.	1.199	0.81	0	3
Aptitudes					
9. Aptitudes · verbal	ability to understand the language and to present ideas clearly	0.265	0.44	0	1
10. · numerical	ability to calculate quickly and accurately	0.184	0.39	0	1
Skills					
11. Perception · spatial	ability to visualize shapes and to read blueprints	0.036	0.19	0	1
12. · of forms	ability to perceive pertinent detail in objects	0.021	0.14	0	1
13. · clerical	ability to perceive pertinent detail in text or tables	0.045	0.21	0	1
14. Finger dexterity	ability to rapidly manipulate small objects with the fingers	0.002	0.04	0	1
15. Eye-hand-foot coordination (EHFC)	coordination necessary for rapid and precise movement	0.015	0.12	0	1
16. Body dexterity	need to stoop, kneel, crouch or crawl	0.166	0.037	0	1
Other characteristics					
17. Climbing	climbing ladders, poles or scaffolding; maintaining body equilibrium	0.064	0.25	0	1
18. Manipulation	extend the arms, manipulate, work with the hands, fingering or feeling	0.837	0.37	0	1
19. Talking	expression by the spoken word	0.418	0.49	0	1
20. Hearing	ability to discriminate sounds	0.509	0.50	0	1
21. Seeing	visual acuity, above average perception of shape, size, distance, movement, colour etc.	0.618	0.49	0	1
22. Controls	operation of machinery	0.041	0.20	0	1
23. Direction	Direction, control & planning of the activities of others	0.188	0.39	0	1

Source : Canadian Classification and Dictionary of Occupations (1971) and calculations by the authors

Table 3: Analytical job characteristics by occupational category

Characteristic	Blue collar without construction	White collar	Managers and professionals
SVP	3.099 (3 - 6 months)	3.340 (3 - 6 months)	6.131 (1 - 2 years)
Working conditions			
Noise	0.489	0	0
Dust and smoke	0.165	0	0
Humidity	0.030	0	0
Outside	0.72	0	0
Outside-inside	0.343	0.045	0.131
Hazards	0.385	0.045	0.028
Effort			
Strength	1.967	0.845	0.763
Aptitudes			
Aptitude			
· verbal	0	0	0.945
· numerical	0	0	0.657
Skills			
Perception			
· spatial	0.031	0	0.099
· of forms	0.031	0	0.047
· clerical	0	0.098	0.025
Dexterity			
· finger	0	0	0.053
· EHFC	0	0	0.054
· body	0.320	0.065	0
Other characteristics			
Climbing	0.030	0	0
Manipulation	1.000	0.926	0.519
Talking	0.027	0.388	0.932
Hearing	0.134	0.551	0.932
Seeing	0.773	0.382	0.702
Controls	0.107	0	0
Direction	0.004	0	0.667
Number of observations	2,656	3,870	2,811

Table 4A: Effects of control variables on compensation (Ordinary Least Squares corrected for heteroskedasticity)

	Blue collar without construction		White collar		Managers and professionals	
Constant	1.38 ($3.97)	(13.87)*	1.61 ($5.05)	(11.94)	4.51 ($91.03)	(5.83)
Education						
· some secondary education	0.01	(3.54)	0.03	(1.10)	0.04	(0.59)
· graduated from high school	0.15	(5.32)	0.07	(2.23)	0.15	(2.50)
· some post-secondary	0.15	(4.17)	0.08	(2.53)	0.19	(2.97)
· trades certificate or diploma	0.24	(7.14)	0.10	(2.85)	0.21	(3.21)
· post-secondary cert. or diploma	0.25	(6.83)	0.18	(5.19)	0.33	(5.77)
· university degree	0.42	(6.40)	0.30	(6.96)	0.49	(8.45)
Age (experience)						
· 20-24 years	0.23	(6.57)	0.15	(7.90)	0.03	(0.46)
· 25-34 years	0.40	(12.21)	0.33	(17.63)	0.26	(4.11)
· 35-44 years	0.47	(13.79)	0.33	(15.90)	0.32	(5.08)
· 45-54 years	0.48	(12.20)	0.32	(13.16)	0.29	(4.30)
· 55-64 years	0.47	(10.75)	0.28	(9.17)	0.39	(5.56)
· 65-69 years	0.24	(1.34)	0.24	(3.75)	0.25	(2.40)
Job tenure						
· tenure	0.016	(4.91)	0.026	(9.60)	0.026	(7.02)
· tenure^2	-0.0004	(-2.85)	-0.0006	(-5.40)	-0.0006	(4.68)
Male	0.28	(11.53)	0.19	(12.65)	0.14	(5.83)
Union status	0.12	(6.12)	0.15	(7.76)	0.05	(2.45)
Firm size						
· 20- 99 employees	0.05	(1.97)	0.04	(2.25)	0.13	(4.62)
· 100-499 employees	0.13	(5.05)	0.05	(2.55)	0.21	(7.42)
· 500+ employees	0.21	(8.67)	0.10	(6.36)	0.22	(8.85)
Disabled	-0.07	(-2.54)	-0.03	(-1.31)	-0.03	(-0.84)
Member of a visible minority	-0.11	(-2.84)	-0.07	(-2.45)	-0.10	(-1.89)

* "t" statistics are presented in parentheses beside the coefficients

Table 4B: Effects of Analytical Job Characteristics on compensation (Ordinary Least Squares corrected for heteroskedasticity)

Characteristic	Blue collar without construction		White collar		Managers and professionals	
SVP	0.12	(8.24)	0.03	(2.27)	-0.43	(-3.42)
Working Conditions						
Noise	0.18	(7.12)	N/A		N/A	
Dust and smoke	-0.21	(-3.94)	N/A		N/A	
Humidity	0.01	(0.12)	N/A		N/A	
Outside	-0.22	(-2.43)	N/A		N/A	
Outside-inside	-0.17	(-4.97)	**		-1.45	(-3.66)
Hazards	-0.02	(-0.44)	-0.13	(-1.73)	-1.20	(-4.59)
Effort						
Strength	0.04	(1.47)	0.02	(0.79)	-0.70	(-5.38)
Aptitudes						
· verbal	N/A		N/A		**	
· numerical	N/A		N/A		0.45	(3.28)
Skills						
Perception						
· spatial	**		N/A		0.15	(1.50)
· of forms	-0.27	(-4.60)	N/A		-0.07	(-1.01)
· clerical	N/A		0.05	(1.32)	-0.88	(-4.57)
Dexterity						
· finger	N/A		N/A		-0.03	(-0.15)
· EHFC	N/A		N/A		-0.84	(-4.58)
· body	-0.16	(-5.53)	-0.05	(-1.31)	N/A	
Other characteristics						
Climbing	**		N/A		N/A	
Manipulation	***		-0.07	(-1.36)	0.64	(4.00)
Talking	-0.49	(-3.73)	0.03	(1.43)	0.65	(4.00)
Hearing	**		-0.05	(-1.75)	**	
Seeing	-0.31	(-4.31)	0.02	(0.72)	-0.54	(-3.62)
Controls	-0.02	(-0.29)	N/A		N/A	
Direction	-0.003	(-0.02)	N/A		-0.30	(-3.71)
R^2	0.5050		0.4546		0.3682	
N	2,656		3,870		2,811	

* "t" statistics are presented in parentheses beside the coefficients
** Variable excluded because of multicollinearity
*** Variable excluded because required by all members of the occupational category

Table 5A: Control variables - forward stepwise regressions (corrected for heteroskedasticity)

Variable	Blue collar without construction		White collar		Managers and professionals	
Constant	1.10 ($3.00)	(13.00)	1.57 ($4.82)	(15.59)	1.60 ($4.98)	(15.01)
Education						
· some secondary education	0.09	(3.48)	0.04	(1.21)	0.04	(0.61)
· graduated from high school	0.15	(5.25)	0.07	(2.30)	0.14	(2.31)
· some post-secondary	0.15	(4.20)	0.08	(2.58)	0.17	(2.77)
· trades certificate or diploma	0.23	(6.95)	0.11	(2.94)	0.20	(3.08)
· post-secondary cert. or diploma	0.25	(6.84)	0.18	(5.30)	0.32	(5.50)
· university degree	0.42	(6.53)	0.31	(7.08)	0.47	(8.01)
Age (experience)						
· 20-24 years	0.23	(6.72)	0.15	(7.96)	0.03	(0.46)
· 25-34 years	0.40	(12.59)	0.33	(17.84)	0.26	(4.09)
· 35-44 years	0.47	(14.07)	0.34	(16.09)	0.32	(5.09)
· 45-54 years	0.49	(12.50)	0.32	(13.43)	0.29	(4.28)
· 55-64 years	0.47	(10.89)	0.29	(9.26)	0.37	(5.29)
· 65-69 years	0.24	(1.29)	0.24	(3.79)	0.23	(2.14)
Job tenure						
· tenure	0.016	(4.96)	0.026	(9.57)	0.027	(7.11)
· tenure^2	-0.0004	(-2.90)	-0.0006	(-5.43)	-0.0007	(-4.76)
Male	0.28	(11.75)	0.19	(12.99)	0.13	(7.55)
Union status	0.12	(5.92)	0.15	(7.78)	0.06	(2.83)
Firm size						
· 20- 99 employees	0.05	(2.26)	0.04	(2.28)	0.14	(4.97)
· 100-499 employees	0.13	(5.33)	0.05	(2.53)	0.22	(7.68)
· 500+ employees	0.23	(9.34)	0.10	(6.35)	0.23	(9.23)
Disabled	-0.06	(-2.31)	-0.03	(-1.33)	-0.02	(-0.77)
Member of a visible minority	-0.12	(-3.03)	-0.07	(-2.50)	-0.10	(-2.83)

Table 5B: Effect of AJC's on compensation (forward stepwise corrected for heteroskedasticity)

Characteristic	Blue collar without construction		White collar		Managers and professionals	
SVP	0.08	(7.68)	0.03	(3.87)	**	
Working conditions						
Noise	0.12	(5.71)	N/A		N/A	
Dust and smoke	**		N/A		N/A	
Humidity	**		N/A		N/A	
Outside	**		N/A		N/A	
Outside-inside	-0.13	(-5.86)	**		**	
Hazards	**		**		**	
Effort						
Strength	0.08	(3.10)	**		**	
Aptitudes						
· verbal	N/A		N/A		**	
· numerical	N/A		N/A		0.07	(2.89)
Skills						
Perception						
· spatial	**		N/A		**	
· of forms	-0.20	(-4.27)	N/A		**	
· clerical	N/A		**		**	
Dexterity						
· finger	N/A		N/A		**	
· EHFC	N/A		N/A		0 .10	(2.16)
· body	-0.10	(-4.01)	-0.07	(-2.20)	N/A	
Other characteristics						
Climbing	**		N/A		N/A	
Manipulation	***		**		**	
Talking	**		0.05	(2.19)	**	
Hearing	**		-0.07	(-3.61)	**	
Seeing	**		**		0.11	(4.29)
Controls	**		N/A		N/A	
Direction	**		N/A		**	
R^2	0.5019		0.4545		0.3587	
N	2,656		3,870		2,811	

* "t" statistics are presented in parentheses beside the coefficients
** Variable excluded because of multicollinearity or not retained by the stepwise procedure
*** Variable excluded because required by all members of the occupational category

Table 6A: Control variables - Managers and Professionals - separately (forward stepwise corrected for heteroskedasticity)

Variable	Managers		Professionals			
			All characteristics		Stepwise regression	
Constant	1.52 ($ 4.58)	(6.29)	4.21 ($67.39)	(4.50)	1.82 ($ 6.16)	(14.97)
Education						
· some secondary education	-0.01	(-0.15)	0.02	(0.32)	0.02	(0.28)
· graduated from high school	0.09	(1.02)	0.14	(1.85)	0.12	(1.57)
· some post-secondary	0.09	(0.88)	0.23	(3.09)	0.21	(2.72)
· trades certificate or diploma	0.18	(1.53)	0.20	(2.68)	0.19	(2.32)
· post-secondary cert. or diploma	0.23	(2.51)	0.37	(5.40)	0.35	(4.87)
· university degree	0.37	(3.90)	0.54	(7.81)	0.51	(7.02)
Age (experience)						
· 20-24 years	0.08	(0.44)	0.00	(0.00)	-0.01	(-0.92)
· 25-34 years	0.40	(2.15)	0.19	(2.91)	0.17	(2.64)
· 35-44 years	0.49	(2.63)	0.24	(3.61)	0.22	(3.29)
· 45-54 years	0.44	(2.39)	0.21	(2.85)	0.18	(2.40)
· 55-64 years	0.47	(2.52)	0.36	(4.60)	0.33	(4.23)
· 65-69 years	0.39	(1.75)	0.18	(1.37)	0.14	(0.98)
Job tenure						
· tenure	0.02	(4.05)	0.03	(5.65)	0.028	(5.69)
· tenure^2	-0.0005	(-2.54)	-0.008	(-3.98)	-0.0008	(-4.03)
Male	0.21	(6.93)	0.09	(4.05)	0.09	(4.01)
Union status	-0.04	(-1.25)	0.10	(3.86)	0.10	(3.65)
Firm size						
· 20-99 employees	0.12	(2.21)	0.14	(4.07)	0.15	(4.51)
· 100-499 employees	0.22	(4.77)	0.19	(5.28)	0.20	(5.90)
· 500+ employees	0.24	(5.97)	0.21	(6.32)	0.23	(6.90)
Disabled	0.02	(0.36)	-0.05	(-1.46)	-0.05	(-1.41)
Member of a visible minority	-0.26	(-2.68)	-0.04	(-0.60)	-0.03	(-0.56)

Table 6B: Effect of AJC's on compensation - Managers and professionals - separately (forward stepwise corrected for heteroskedasticity)

Characteristics	Managers	Professionals	
		All characteristics	Stepwise regression
SVP	***	-0.37 (-2.83)	**
Working conditions			
Noise	N/A	N/A	N/A
Dust and smoke	N/A	N/A	N/A
Humidity	N/A	N/A	N/A
Outside	N/A	N/A	N/A
Outside-inside	N/A	-0.59 (-3.02)	**
Hazards	N/A	-1.02 (-2.42)	**
Effort			
Strength	N/A	-0.58 (-1.89)	**
Aptitudes			
· verbal	All	**	**
· numerical	-0.06 (-1.05)	0.41 (2.82)	**
Skills			
Perception			
· spatial	N/A	0.11 (1.04)	0.11 (3.27)
· of forms	N/A	-0.04 (-0.63)	**
· clerical	N/A	-1.37 (-1.69)	**
Dexterity			
· finger	N/A	**	**
· EHFC	N/A	**	**
· body	N/A	N/A	N/A
Other Characteristics			
Climbing	N/A	N/A	N/A
Manipulation	N/A	-0.11 (-0.52)	0.12 (4.16)
Talking	All	0.56 (1.70)	**
Hearing	All	**	**
Seeing	**	0.23 (1.04)	**
Controls	N/A	N/A	N/A
Direction	All	-0.22 (-1.09)	**
R^2	0.3052	0.4183	0.4127
N	1,020	1,791	1,791

* "t"statistics are presented in parentheses beside the coefficients
** Variable excluded because of multicollinearity or not retained by the stepwise procedure
*** Variable excluded because required by all members of the occupational category

APPENDIX B: CODING PROBLEMS.

1. Because of confidentiality constraints the occupational data provided in the LMAS are aggregated at the 3-digit level or higher. CCDO occupational descriptions, however, are provided at the 4-digit level. Information from the 1986 census (Statistics Canada, 1993) was used to determine the proportion of workers in each 4-digit category and the occupational characteristic was then coded according to which 4-digit category or categories formed the majority or, at least, the largest group within the LMAS category. Where two levels of a characteristic were equally divided between the workers in the category the higher level of the characteristic was coded because it includes the lower level (for example *specific vocational preparation [SVP]* and *strength*).
2. Aptitudes that are classified relative to the level attained by certain percentages of the work force (for example *verbal aptitude* and *spatial perception*) were coded "yes" if the requisite level was in the upper 1/3 of the population, otherwise "no". This approach reflects the fact that a high level of the characteristic is required for the occupation.
3. The variable *direction* was coded according to item 4 of Temperament factors.
4. Variables that are coded from 1 to n were recoded from 0 to n-1. For example *SVP*, coded 1 to 9 was recoded 0 to 8.