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Analyse Empirique des Caractéristiques de l'Entreprise dans la Formation des Salaires

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Sommaire

Cette thèse analyse le rôle des caractéristiques de l'entreprise sur la détermination des salaires. L'approche dans chaque partie se base sur l'idée que les salaires ne sont pas seulement fonction des compétences du travailleur mais aussi de la façon dont ces compétences sont exploitées par l'entreprise sachant qu'elle possède ses propres caractéristiques. Trois principales caractéristiques de l'entreprise sont abordées : la structure hiérarchique des postes, la taille de l'entreprise et les pratiques de gestion des ressources humaines. Les notions de capital humain, d'avantages comparatifs et d'auto-selection appliquées aux dimensions mesurables et non mesurables des compétences du travailleur dans les différents postes ou entreprises constituent le support théorique de l'analyse de la formation des salaires dans l'entreprise.

Différents types de données sont utilisées pour l'analyse empirique. Les données allemandes de type longitudinal du German Socio-Economic Panel permettent d'étudier la dynamique des salaires et la mobilité des travailleurs qui découle de la relation de long terme entre le travailleur et l'entreprise. Les données canadiennes de l'Enquete sur la Population Active et américaines du Current Population Survey pour l'année 1998 sont utilisées pour établir une comparaison de la structure des salaires selon la taille de la firme pour les deux pays. Finalement, des données sur les pratiques de ressources humaines d'entreprises américaines pour les années 1994 et 1997 sont analysées afin d'étudier leurs effets sur la dispersion des salaires dans l'entreprise.

La dynamique des salaires et la mobilité dans les entreprises allemandes révèlent l'importance de la qualité (non mesurée par l'économètre) de l'appariement entre les compétences du travailleur et le niveau du poste dans l'échelle hiérarchique des emplois. Les structures de salaire selon la taille de l'entreprise sont similaires au Canada et aux Etats Unis dans le cas des compagnies non syndiquées. Dans le cas des entreprises syndiquées au Canada, les résultats montrent des différences significatives dans la rémunération des compétences du travailleur entre les petites et grandes compagnies. Finalement, les politiques de ressources humaines qui visent à augmenter le niveau de participation des employés aux fonctionnement de l'entreprise ont des effets différents sur la dispersion des salaires dans les entreprises du secteur manufacturier comparé au secteur non manufacturier. Les résultats suggèrent que les effets de l'organisation du milieu de travail dépendent plus de l'intération entre technologie de production et compétences de la main d'oeuvre spécifiques au secteur de production, que du choix d'une ou plusieurs pratiques de ressources humaines particulières.

Summary

The objective of this thesis is to analyze the impact of firms' characteristics on wage outcomes. Each chapter is based on the general idea that wages do not only depend on the workers' skills but also on how these skills are valued by the firm with given characteristics. Three firms' characteristics are considered: the hierarchical structure of the firm's job ladder, firm size and the firm's workplace organization. The analysis of within firm wage determination is based on the theoretical notions of human capital accumulation, comparative advantage and non-random selection applied to the measured and unmeasured part of the worker's skills across the different jobs or firms.

The empirical analysis is based on three different data sets. The longitudinal data from the German Socio-Economic Panel allow the study of wage dynamics and intrafirm mobility describing the employer-employees long term relationship. Canadian and American data from the Labour Force and Current Population Survey for the year 1998 are used to compare the wage structure by firm size for the two countries. Finally, data on workplace practices from the National Employer Survey of American firms for the years 1994 and 1997 are analyzed to explore the links between practices adoption and within firm wage dispersion.

Wage dynamics and intrafirm mobility within German firms reveal that unmeasured ability matters in explaining the assignment of workers onto the rungs of the firm's job ladder. Firm-size wage structure are similar in Canada and the United States for non unionized firms. For unionized firms in Canada, the results show significant differences in the way large and small firms reward measured and unmeasured skills. Finally, workplace practices toward more employee involvement are found to have different effects on wage dispersion in manufacturing and non manufacturing firms. The results suggest the workplace practices effect on wage dispersion would rather be due to the sector-specific mix of technology use and workforce skill than to the choice of a particular practice or a bundle of practices.

Introduction

La relation salariale, définie par l'échange d'un service du travail contre le paiement d'un salaire, présente des spécificités qui la distinguent des autres relations marchandes. Par exemple, elle est régie par des règles de promotion, et d'avancement à l'ancienneté qui sont propres à chaque entreprise. L'analyse dans cette thèse part de l'existence de certains faits empiriques observés par plusieurs études analysant différentes entreprises selon lesquels le salaire ne reflète pas uniquement la productivité du travailleur tel que prédit par la théorie néoclassique du marché du travail. Ces faits révèlent que les caractéristiques de l'entreprise telles que l'industrie dans laquelle elle opère (Krueger et Summers (1988)), sa taille (Brown et Medoff (1989)), et la structure des postes (Baker, Gibbs et Holmstrom (1994)) ont un impact sur le salaire du travailleur.

L'objectif de cette thèse est de mettre en évidence l'importance de prendre en compte l'intéraction entre les différentes dimensions des compétences et les spécificités de l'entreprise dans l'analyse de la détermination des salaires. Trois aspects des spécificités de l'entreprise sont abordés : la structure hiérarchique des emplois dans l'entreprise, la taille de la compagnie et les politiques de ressources humaines qui définissent l'organisation du milieu de travail de l'entreprise.

Le premier chapitre analyse la relation salariale d'un point de vue dynamique. Les différentes théories existantes de la détermination des salaires n'étant pas en mesure d'expliquer les faits stylisés observés, Gibbons et Waldman (1999) combinent différents éléments de ces théories et proposent un modèle de détermination des salaires dans l'entreprise basé sur le principe d'accumulation de capital humain, d'attribution des tâches aux travailleurs et d'apprentissage de la partie de l'habileté non observable des travaillleurs. Dans ce modèle, les salaires sont fonction de la productivité de l'appariement compétences-type d'emploi.

Dans ce chapitre, nous nous proposons de tester le modèle de Gibbons et Waldman (1999) afin d'étudier la dynamique des salaires et la mobilité des travailleurs dans les entreprises caractérisées par une structure hiérarchique des postes. L'estimation du modèle repose sur la méthode des moments généralisés appliquée aux données en panel de l'enquête allemande GSOEP sur la période 1986-1996. Elle contient de l'information détaillée sur les niveaux de responsabilité des postes occupés par les travailleurs dans leur entreprise ainsi que sur leurs décisions de mobilité interne.

L'utilisation du GSOEP permet de voir dans quelle mesure les politiques salariales des firmes allemandes (aux prises avec les exigences des associations patronales et syndicales) reflètent une plus ou moins grande individualisation des salaires par rapport à des règles bureaucratiques rigides. En fait, d'après les résultats des estimations, la dynamique des salaires révèle au contraire l'importance d'un effet d'habileté individuelle non mesurée et la présence de rendements de cette habileté significativement distincts entre les niveaux hiérarchiques des postes. L'effet d'apprentissage de cette habileté n'est par contre pas apparent dans les résultats. Ceci est peut-être lié au fait qu'il existe un système de stage en entreprises très répandu en Allemagne grâce auquel le contact entre employeurs et travailleurs peut se faire avant la fin des études et de l'entrée sur le marché du travail.

Le deuxième chapitre étudie la structure des salaires selon la taille de l'entreprise. En particulier, étant donnés les résultats empiriques sur l'effet taille dans l'estimation des différences de salaires entre travailleurs à même caractéristiques productives dans des entreprises de différente taille, l'analyse considère la possibilité que les entreprises de grandes et petites tailles ont des politiques salariales exploitant différemment les habiletés observables et non observables du travailleur. Du côté des travailleurs, la taille de la firme est une variable de choix. Certains travailleurs ont un esprit d'initiative qui pourrait être plus facilement mis en évidence dans les petites entreprises. D'autres ont un esprit d'entreprise qui pourrait être mieux utilisé dans une grande entreprise. Il en résulte un choix entre acquérir un moindre niveau d'éducation formelle et entrer dans une petite entreprise ou obtenir plus d'années d'éducation et choisir une grande compagnie.

Afin de mettre en évidence cette idée, nous utilisons une approche basée sur un modèle de choix endogène de grande ou petite entreprise. Une comparaison utilisant les données américaines et canadiennes (CPS et LFS 1998) suggère que les structures de salaire selon la taille de l'entreprise sont similaires au Canada et aux Etats Unis dans le cas des compagnies non syndiquées. Dans le cas des entreprises syndiquées, il existe des différences significatives dans la rémunération des compétences du travailleur entre les petites et grandes compagnies.

Le dernier chapitre explore les liens entre la dispersion des salaires et les pratiques de ressources humaines qui visent à encourager la participation des employés à certaines des décisions de l'entreprise. Les données viennent du National Employer Survey qui fourni de l'information sur les pratiques de ressources humaines d'entreprises américaines. La dispersion des salaires est définie par le ratio des salaires moyens des employés aux deux extrémités de l'échelle des emplois, le ou les directeurs de l'entreprise et les employés à la production ou en lien direct avec la marchandise vendue par l'entreprise. En général, l'adoption de ces pratiques a un effet significatif sur le ratio des salaires et l'effet est similaire quelque soit le type de pratique utilisée. L'effet est par contre différent entre les entreprises du secteur manufacturirer et non manufacturier. Cela suggère que les effets de l'organisation du milieu de travail dépendent plus de l'intération entre technologie de production et compétences de la main d'oeuvre spécifiques au secteur de production, que du choix d'une ou plusieurs pratiques de ressources humaines particulières.

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Chapter 1

The Role of Comparative Advantage and Learning in Wage Dynamics and Intrafirm Mobility: Evidence from Germany

1.1 Introduction

The question of how wages are determined is central to the study of labour economics. The large body of theoretical work that attempts to understand the factors governing wage outcomes offers several possible explanations. Some of the models are based on the concepts of human capital (Becker (1975), Hashimoto (1981)), learning (Harris and Holmstrom (1982)), and matching (Jovanovic (1979)). Other models look at the role of incentives in compensation. Examples include tournament theory (Lazear and Rosen (1981)) and efficiency wage theory (Shapiro and Stiglitz (1984)).

The large variety of theoretical explanations has generated an extensive empirical literature which has attempted to both utilize and distinguish between the competing theories. This literature has focused on aspects of the question such as the return to interfirm mobility on the part of workers (Bartel and Borjas (1981), Simonet (1998), Topel and Ward (1992)), the covariance structure of earnings across workers and firms (Parent(1995), Topel and Ward (1992)), and inter-industry wage differentials (Krueger and Summers (1988), Gibbons and Katz (1992)). Thus far, little empirical work has been done on questions relating to how jobs are assigned to workers and the resulting effects on the evolution of intrafirm wage structures and mobility within the firm.

This paper presents an empirical study of the common features characterizing the wage policy of firms. More precisely, it analyzes what is driving the dynamics of wages and the workers mobility within the firm. On one extreme, one might think about pay settings and job assignments being regulated according to automatic bureaucratic rules, applying to everyone. On the other extreme, pay raises and promotions would be determined by the worker's level of ability where only high ability workers would benefit from it. Another possibility is one in which wage growth and mobility would be driven by random productivity shocks. To analyze the question I use the theoretical framework proposed by Gibbons and Waldman (1999) in which, given a hierarchical structure of job levels within firms, the determination of wages depends on how the worker's abilities are evaluated within a job rank, given that each job rank has different skill requirements. The model specifies a wage equation integrating the elements of human capital accumulation, job assignment based on comparative advantage and learning about the worker's ability to explain the dynamics of wages and promotions inside firms. This paper analyzes the importance of these elements in explaining the wage policy of firms.

The idea that the structure of wages within firms might be empirically important is not new to labour economists. Previous empirical studies on the subject, however, have mainly been restricted to providing analysis of specific questions on wage determination within the firm without real attempt at relating them to the predictions of a formal theory. Other studies present stylized facts specific to one or a few firms and although very informative, the conclusions remain restricted to the type of firm analyzed.

Doeringer and Piore (1971) are among the first to present a detailed descriptive analysis of the compensation schemes within a small sample of American firms, but attempts to formalise their analysis are still in the early stages. One strand of the literature which examines these issues, follows in the footsteps of Doeringer and Piore by using detailed observations on one or a few firms. Chiappori, Salanié and Valentin(1999) take an econometric approach, using data on a large French firm, to study questions related to "early starter-late beginner" effects (a prediction of the learning theory) on the wages of individuals who remain within the institution. However the data is specific to one firm, and they restrict the analysis to one particular aspect of the dynamics of wages and promotions. Namely, they test the fact that for two workers in a firm having the same level of wage in one period, the worker with the lowest wage the period before (defined as the "late beginner") has a higher expected wage next period. Baker, Gibbs and Holmstrom (1994 a,b) study several aspects of the internal wage structure of one medium sized U.S firm but their analysis is a descriptive one. An alternate approach is taken by McCue (1996), who uses the Panel Study of Income Dynamics to examine the importance of promotions and intrafirm mobility on wage growth. She estimates hazard models of intrafirm mobility but does not attempt to relate her findings to the theoretical literature.

A number of stylized facts emerge from the empirical literature on the internal wage policy and mobility within the firm since the last twenty years. First, the main finding on intrafirm mobility concerns serial correlation in promotion rates. [1] Holding tenure in the current job constant, promotion rates decrease with tenure in the previous job. A related finding (although reported in only one firm) is that demotions are really rare. [2] Second, nominal wage cuts are very rare but real wage cuts are much more common. Partly because nominal wage increases are rather insensitive to inflation, zero nominal increases are not rare. [3] Third, the dynamics of wages within the firm exhibit serial correlation in the sense that a real wage increase (decrease) today is serially correlated with a real wage increase (decrease) tomorow. [4] Finally, studies that analyze the relationship between wages and intrafirm mobility find that wage increases upon promotion are larger than

[1] Rosenbaum (1984), Spilerman and Petersen (1993), Baker, Gibbs and Holmstrom (1994 a,b), Podolny and Baron (1995) and Chiappori and al. (1996).

[2] Baker, Gibbs and Holmstrom (1994 a,b)

[3] Baker, Gibbs and Holmstrom(1994 a,b) in the case of one firm and Card and Hyslop (1995) find identical conclusions using the CPS and PSID. A related finding is found in Peltzman (2000). Using data from the BLS, it is found that output prices increase more than they decrease in response to shocks in the cost of inputs. Increases in firm's labor costs would therefore induce real wage decreases.

[4] Hause (1980), Lillard and Weiss (1979) and Baker, Gibbs and Holmstrom (1994 a,b).

without promotion.[5] However, wage increases upon promotion are small compared to the difference in average wages between two job levels. In other words, significant variations in wages remain within each level so that wages are not tied to levels. In addition, wage increases forecast promotions in the sense that those who receive larger wage increases get promoted more rapidly.[6]

Collectively, these observations pose a challenge to the existing theoretical literature, as none of the existing theories can explain all of these stylized facts. In response to this challenge, Gibbons and Waldman (1999) propose a synthesized model which combines on the job human capital accumulation, job assignment based on comparative advantage and learning dynamics. The predictions of their model are consistent with most of the stylized facts found in the empirical literature. The objective of this paper is to implement empirically the Gibbons and Waldman model and perform the estimation on a large sample of firms in order to test its ability to explain the common features characterizing the wage policy of firms. In addition, estimating the model on the sample of workers remaining with their firm and comparing the results to those obtained from the sample that includes firm changers allows to distinguish between firm specific effects and individual specific effects transferable across firms in the analysis of the wage dynamics.

The estimation is performed using GMM techniques applied to the longitudinal data from the German GSOEP over the period 1986-1996. This survey provides information on the workers mobility between and within the firm and, more importantly for the analysis hereafter, detailed information on the rank of the worker in his current occupation is available. The German case is an interesting application of the model because the German labour market is thought to differ significantly from the U.S labour market (which provides many of the observations which motivate Gibbons and Waldman's research). Particularly, as shown by Simonet (1998), interfirm job mobility declines much earlier in a workers' career in Germany than in the U.S. This suggests the possi-

[5] Murphy (1985) Baker, Gibbs and Holmstrom (1994 a,b) and McCue (1996).

[6] Baker, Gibbs and Holmstrom (1994 a,b). McCue (1996) finds that a high wage today is positively correlated to promotion tomorrow, and, in the same spirit, Topel and Ward (1992) find that prior wage growth affects mobility even after controlling for the current wage.

bility that *intra*-firm mobility may be more important in Germany than in the United States. In addition, because of the strength of trade unions and their close relationship with employer's associations, German firms have to deal with bureaucratic rules governing the setting of wages and job assignments, which could affect the returns to intrafirm mobility on the part of German workers. Therefore it is not clear, a priori, whether the factors of comparative advantage and learning, which seem to explain the U.S experience, are more or less important in Germany.

The paper is organized as follows. Section II provides a description and a first analysis of the data. Section III sketches the theoretical model of Gibbons and Waldman and establishes the framework of the econometric analysis and how this relates to the theory. Section IV presents the results of the estimations, and Section V concludes the paper.

1.2 The Data

The data for the analysis come from the German Socio-Economic Panel. The GSOEP is a representative longitudinal study of private households conducted every year in Germany since 1984. This survey is unique for the analysis hereafter because it provides information on movements between and within firms through a question about changes in the worker's employment situation in the previous year. Most importantly, there is detailed information on the rank occupied by the worker within his current occupation. To my knowledge, this type of information is not available in any other surveys. These two pieces of information are central to the study of wage and mobility dynamics within the firm. Another advantage is that information is collected over a large sample of individuals and therefore, the analysis of wage dynamics and intrafirm mobility can be done for a large sample firms.

1.2.1 Data Selection

I considered information on the usual individual characteristics such as age, education, sex, marital status and nationality. Information on bonuses received during the previous year and on the duration of the employment contract (unlimited or limited length) are also available. Wages are given on a monthly basis, corresponding to the month preceding the time of the survey. For the firm's characteristics, the counterpart of using survey data is that precise information on that part is limited. I used the type of industry, whether the firm belongs to the public sector and firm size.

The panel spans the years 1985 to 1996 because information on mobility within the firm is not available in 1984. Since it covers the German reunification, I have excluded data on the former East German population to keep the pre and post unification samples comparable. I have selected individuals aged between 20 and 65 who are working at the time of the survey on a full-time basis. I have excluded self-employed workers and put a restriction on wages excluding any observations below 500 DM per month.[7] Finally, I considered the sample of workers remaining with their firm over all the period, reporting either mobility within the firm or no change in job situation. This leaves us with a sample consisting of 11159 observations (3487 workers). Appendix 1 describes the data selection in more details and provides the sample means of the main variables used.

The objective of the next two subsections is to describe the data and to examine, in the spirit of the Gibbons and Waldman model, the links between intrafirm mobility, wage growth and hierarchical levels of jobs for German workers. Two questions will be addressed: What are the main determinants of intrafirm mobility? By which channels does intrafirm mobility influence the determination of wages from one hierarchical level to the next? That is, how are individual skills effects and hierarchical level effects reflected in the wage premium associated to being in a higher rank on the job ladder? The analysis of these points is based on a logit model of the probability of intrafirm mobility and on inter-rank wage differentials estimations.

[7]Since in Germany, the minimum wage varies by industry, this bound should give a reasonable minimum in order to exclude outliers for wages without loosing observations on low wage workers such as trainees.

1.2.2 Intrafirm Mobility and Individual and Firm Characteristics

In this subsection, I examine the effect of worker and firm characteristics on intrafirm mobility. The estimation method is based on a binomial logit model in which the benefit from moving within the firm is a function of observable characteristics. The alternative to the choice of intrafirm mobility is no changes in employment situation within the firm. [8]

Starting with a set of base characteristics, I look at the effect of adding particular variables of interest on the probability of intrafirm mobility. Among these variables are lagged bonuses and lagged rate of wage growth. [9] If mobility within the firm is driven by the evolution of the workers productive abilities, previous wage growth, where wages reflect the evaluation of abilities, should significantly increase the chances of future mobility within the firm. In the same vein, obtaining a bonus is a signal of improvement in the worker's productive abilities and should have a positive impact on future mobility.

Among the base characteristics, I include dummies for nationality, sex and marital status. Years of education are divided into three levels: primary (up to 10 years), high school (11 to 13 years) and college (14 years and more). Finally, I considered a quadratic function of tenure defined as the number of years worked with the firm. Concerning the characteristics related to the firm, I include a dummy for large firms (2000 employees or more), the duration of the employment contract (unlimited or not), eight industry dummies [10] and a public sector dummy.

Results are shown in column 2 of Table 1.1 [11] for the baseline model (column 3 shows the marginal effect of each variables on the probability of intrafirm mobility), and column 4 and 5 for the effect of adding lagged bonuses and lagged wage growth. Column 6 shows the specification containing all the variables and column 7 the marginal

[8] Appendix 2 presents the frequencies of the different types of mobility.

[9] The lag is such that bonuses and wage growth are considered the year before mobility within the firm.

[10] I used the International Standard Industrial Classification (ISIC).

[11] Given that the dependent variable has few responses ($y = 1$) compared to non responses, using a probit model might produce different results. I reestimated the model with the normal distribution. Results (available on request) are similar in which they lead to the same conclusions in terms of marginal effect coefficient and significance of the coefficients.

effect of these variables.

From column 2, one can see that college degrees increase significantly the probability of intrafirm moves (relative to primary school). We can notice the negative effect of tenure within the firm on intrafirm mobility suggesting that workers mobility within the firm occurs mostly at the beginning of the worker's career. In addition, we see that married individuals have a significantly lower probability of intrafirm mobility. On the other hand, nationality and gender have no significant impact. For the characteristics related to the firm, we unsurprisingly see that being in a large firm significantly increases the likelihood of intrafirm mobility and but that the future mobility is independent of whether the firm is in the public sector or whether the labour contract is of determinate length.

Introducing lagged bonus, as in column 4, has a particular impact on the variables. One can first see that the impact is significantly negative: having received a bonus last year decreases the chance of intrafirm mobility today. One interpretation is that bonus would substitute rather than complement intrafirm mobility. On the other hand, bonus and promotion could be closely related and not distinguishable, the negative impact of lagged bonus could then reflect that last year's mobility (and bonus received) is negatively correlated to the chance of mobility today.

Introducing lagged wage growth in column 5 also has a noticeable impact on the other variables. First, it increases significantly the probability of intrafirm mobility next period. The coefficient is particularly large compared to the others. In addition, college education is no longer significant. The results for all the other variables remain unchanged compared to column 2 so that the main effect of controlling for lagged wage growth is on college education. Lagged wage growth may be a more accurate measure of individual skills than the level of education, providing a better signal of ability for mobility decisions. Finally, the results of column 6 where both the lagged bonus and the wage growth are added are similar to those of column 5. Controlling for the lagged bonus does not alter the relatively strong impact of lagged wage growth on intrafirm mobility.

Based on the idea that part of wage growth reflects the worker's productive abilities, the significant impact of lagged wage growth on intrafirm mobility provides a first piece of evidence supporting the role of ability as driving the worker's mobility within the firm. In order to raffine the analysis of the interactions between intrafirm mobility and the dynamics of wages within the firm, the next section investigates the relation between the wages and the different ranks that the worker can reach within his or her job. In particular, I am interested in the way individual characteristics compared to job related characteristics are reflected in wages. To analyze this point, I use the information on the different ranks of each occupation to establish inter-rank wage differentials.

1.2.3 Inter-Rank Wage Differentials

This section analyzes the contribution of job ranks relative to individual characteristics on wages by estimating the impact of the worker's skills on inter-rank wage differentials. In a second step, I present preliminary evidence on the importance of unobserved ability in the determination of wages and analyze whether comparative advantage based on measured ability is important.

An interesting feature of the GSOEP survey that is rarely found in other surveys is that it provides information on the level or rank occupied by the worker in his current job. Occupations are grouped in five categories: Blue-collar, white-collar, civil servant, trainee and self-employed. I considered the first three given that self-employment is not relevant for the analysis and that the trainee category is not in itself an occupation. [12] Each occupation is divided in several levels according to the qualification and responsibility requirements. Since the number of ranks is not the same for all the jobs, I have defined 4 ranks based on a more general qualification criterion:

1. unskilled or semi-skilled work
2. skilled work
3. highly skilled work

[12]Individuals reporting trainees who were also reported in one of the other occupations have been retained.

4. executive work

Appendix 3 reports the raw wage differentials (relative to the first rank) and average individual characteristics by rank. The differentials increase along the ladder but in different proportion depending on the type of occupation with white-collared workers showing the highest differentials in each rank. Although one might expect that these rank wage premium reflect the increasing responsibilities and tasks complexity related to the higher ranks, one can observe a positive correlation with measures of individual ability such as education. The link with the other characteristics is however less clear. A global measure of the workers's individual characteristics would be more convenient for the analysis of the interaction between the worker's abilities and job rank and its effect on wage outcomes.

In order to obtain a global impact of individual characteristics on wages, I summarized the individual characteristics into one variable interpreted as the worker's skill. To do so, I considered a OLS regression of the wage level on education, marital status, sex, nationality, experience and squared experience, industry and occupation type for the entire original sample of workers. I used the estimated coefficients related to education, marital status, gender, nationality and experience to compute the estimated wage based on these characteristics for workers remaining with their firm. [13]

Column 1 of Table 1.2 presents the results of a regression of wages on rank dummies with controls for occupations and industries. One can notice that those coefficients are significant and are lower than the raw wage differentials in the first column of the Appendix 3 Table (0.49, 1.67 and 2.46 in the aggregate definition of ranks) when no controls have been considered. Column 2 of Table 1.2 considers the impact of adding the skill variable on rank effects. It shows that the skill variable is highly significant and controlling for skills reduces the impact of the rank dummies. However, the wage differentials are still significant, increasing by rank from 0.12 for rank 2 to 0.68 for rank 3 and 1.20 for rank 4 (all with respect to rank 1).

The next column of Table 1.2 presents the results of a fixed-effect estimation in

[13]This index, reported in the last column of the Table of Appendix 3, has been normalized to 0.

order to assess the presence of unmeasured (by the econometrician) individual ability. Assuming that it is time invariant and equally valued in the different ranks, it is possible to eliminate (or control for) this term by using first difference method. If unmeasured ability does not matter in the determination of wages, the fixed-effect estimation results should be similar to the OLS results. One can see from Column 3 that the fixed-effect coefficients on ranks have dropped significantly, although still significant. This suggests that part of the rank wage premium is explained by unmeasured skills and part of it still reflects rank effects.

The notion that workers have a comparative advantage in some job ranks is equivalent to say that along the successive rungs of the job ladder, skills are differently rewarded and that workers sort themselves into a given rank. Column 4 of Table 1.2 considers the possibility that comparative advantage and self-selection operate on measured skills. To take this into account, I included to the baseline regression of column 1, interactions of the skill index and the worker's job rank. One can see that the coefficients on the interactions are significant. A test of equality of these coefficients leads to the rejection of the null ($\chi^2(3)$ of 103.43) which confirms the existence of distinct valuations of measured skills in each rank.

The analysis of Section II has shown that past wage growth has a noticeable impact on the likelihood of mobility within the firm. The wage premium associated with the different ranks that the worker can attain in his career do not entirely reflect the differentials in task and responsibility requirements (rank effects) but also the differentials in measured individual skills. Moreover, there is evidence that each job level is differently sensitive to measured skills so that workers may self-select into the different levels having a comparative advantage in one level based on their measured skills. Finally, the results on the first difference estimation lead us to suspect that unmeasured ability may also matter in the explanation of the inter-rank wage differentials and thus, in the wage dynamics. All together these results suggest that the worker's ability seem to be a good candidate in the explanation of what is driving the wage dynamics and mobility within the firm. The next section present a the Gibbons and Waldman model in which ability drives job level assignments and wage dynamics.

1.3 Model and Econometric Framework

This section summarizes the Gibbons and Waldman model of intrafirm mobility and wage determination and highlights the model's main predictions. The aim of the model is to characterize the relationship between a worker's career path and the evolution of his wage within the firm. It integrates wage determination and job assignments in a dynamic context, where the wage policy of the firm is based on comparative advantages and learning. In other words, it endogenizes workers' choices of job rank as workers are assigned to the job rank that better reward their productive abilities. In addition, it endogenizes mobility between job ranks because, if the productive abilities of the workers are not perfectly observed, both the firm and the worker learn about it and changes in expected ability lead the worker to move to another rank of the job ladder.

More precisely, firms are modeled as consisting of various potential job assignments and, because jobs are differently sensitive to ability, comparative advantage determines the assignment rule on the basis of output maximization. The dynamics is introduced in the model by considering that output grows with the workers' accumulation of human capital or productive abilities each period. In addition, output grows at a different speed depending on the level of innate ability of the worker. All the workers end up reaching the upper level of the job ladder but some get there faster than others. When innate ability is not perfectly observed, learning takes place and wages and mobility within the firm are driven by the evolution of expected ability.

1.3.1 Summary of the Model

The model consists of identical firms operating in a competitive environment and producing output using labour as the only input. All firms consist of a three-level job ladder where jobs are indexed by $j = 1, 2$ or 3. Jobs are defined in advance, independent of the people who fill them. Both firms and workers are risk-neutral and have a discount rate of zero.

A worker's career lasts for T periods. Worker i has innate ability, denoted by θ_i, which can be either high (θ_H) or low (θ_L). The worker has also effective ability, η_{it}, defined as the product of his innate ability and some function f of his labor-market experience x_{it} prior to period t:

$$\eta_{it} = \theta_i f(x_{it}) \text{ with } f' > 0 \text{ and } f'' \leq 0 \tag{1.1}$$

The production technology is such that if worker i is assigned to job j in period t then he produces output y_{ijt} where:

$$y_{ijt} = d_j + c_j(\eta_{it} + \varepsilon_{ijt}) \tag{1.2}$$

where d_j is the value of job j independent of the worker's characteristics and c_j measures the sensitivity of job j to effective ability. The constants c_j and d_j are known to all labor-market participants and it is assumed that $c_3 > c_2 > c_1$ and $d_3 < d_2 < d_1$. ε_{ijt} is a noisy term drawn independently from a normal distribution with mean zero and variance σ^2. Wages are determined by spot-market contracting. More precisely, at the beginning of each period, all firms simultaneously offer each worker a wage for that period and each worker chooses the firm that offers the highest wage. Hence, competition among firms yields wages equal to expected output.

$$w_{ijt} = Ey_{ijt} = d_j + c_j\eta_{it} = d_j + c_j\theta_i f(x_{it}) \tag{1.3}$$

Efficient task assignment is obtained in the sense that a worker is assigned to the job that maximizes his expected output.

In the case of perfect information, θ_i, is common knowledge at the beginning of the worker's career and therefore η_{it} is always known. In this case, job assignments and wages in equilibrium are given according to the following rule:

1. If $\eta_{it} < \eta'$ then worker i is assigned to job 1 in period t and earns $w_{it} = d_1 + c_1\eta_{it}$.
2. If $\eta' < \eta_{it} < \eta''$ then worker i is assigned to job 2 in period t and earns $w_{it} = d_2 + c_2\eta_{it}$.
3. If $\eta_{it} > \eta''$ then worker i is assigned to job 3 in period t and earns $w_{it} = d_3 + c_3\eta_{it}$.

where η' (η'') denotes the effective ability level at which a worker is equally productive at jobs 1 and 2 (2 and 3). In equilibrium, the workers climb the successive rungs of the job ladder as they gain experience.

The model under perfect information can explain most of the stylized facts of the empirical literature. Particularly, the model exhibits the absence of demotions, serial correlation in wage increases and in promotion rates, and the fact that wage increases predict promotions and explain only a fraction of the difference in average wages across levels.

More precisely, there are no demotions in equilibrium because effective ability increases monotonically. Serial correlation in wage increases occurs because effective ability grows differently for each worker due to their different levels of innate ability. That is, for a given level of experience, high ability workers will get higher wage increases than low ability workers and the same ordering will hold for wage increases at all experience levels.

The model is able to explain serial correlation in promotion rates for the same reasons. If η' and $\eta'' - \eta'$ are both sufficiently large then high ability workers are promoted to job 2 more quickly and spend less time on job 2 before being promoted to job 3. Moreover, since those who receive larger wage increases are also those who are promoted to job 2 earlier in their careers, wage increases predict promotions.

Finally, wage increases upon promotion explain a fraction of the difference between average wages across levels because, on average, part of the workers at higher levels are more experienced and the difference between average wages at different levels is given by the average experience or effective ability accumulated. This difference is bigger than the average wage increase at promotion which captures the value of only one year of experience.

In the case of perfect information, however, the explanation for the large wage increases upon promotion is not fully satisfactory. The model predicts average wage increases at promotion are higher than if the worker remains in his current job because increases in effective ability are valued in part at the rate of the current job (c_j) and in part at the higher rate of the next job (c_j) if promotion occurred. For the same reason, however, the model predicts that the average wage increases after promotion which, according to the empirical findings, should not be the case. Moreover, the monotonicity of the effective ability accumulation function precludes the possibility of real wage decreases.

When information on innate ability is imperfect (but symmetric), workers and firms start with the initial belief p_0 that a given worker is of innate ability θ_H and with $1 - p_0$ that he is θ_L. Learning takes place at the end of each period when the realization of a worker's output for that period is revealed. Learning occurs gradually because of the productivity shock ε_{ijt}, which introduces noise into the output produced.

To be precise, each period a worker's output provides a noisy signal, z_{it}, about his effective ability where:

$$z_{it} = (y_{ijt} - d_j)/c_j = \eta_{it} + \varepsilon_{ijt}$$

Note that z_{it} is independent of job assignment so that learning takes place identically across jobs. The agents' expectations of the innate ability of worker i with x years of prior labor-market experience at period t will therefore be conditioned on the history of signals extracted from the observed outputs. Formally, this expectation is defined as:

$$\theta_{it}^e = E(\theta_i | z_{it-x}, ..., z_{it-1})$$

Because output is a linear function of effective ability, expected output at the beginning of period t, and therefore wages, will be based on expected effective ability (conditional on the information set of $t-1$). Task assignment in each period is then based on the maximization of current expected output.

The addition of imperfect information and learning does not change the ability of the model to explain the stylized facts discussed previously and allows the model to explain the possibility of real wage decreases. The main argument is based on the fact that this time, wages depend on expected innate ability whose evolution is now driven by the evolution of agents' beliefs. Because agents have rational expectations, expected innate ability follows a martingale process:

$$\theta^e_{it} = \theta^e_{it-1} + u_{it} \tag{1.4}$$

This means that the best *prediction* of future expected innate ability is current expected ability. In other words, any changes in current beliefs should be caused by the arrival of new information contained in the observed current output and could not be predicted from previous realized outputs.

The main difference with the perfect information case is that now, a worker's expected innate ability can fall from one period to the next if u_{it} is negative, and if the decrease is sufficiently large, it will dominate the increase due to human capital accumulation and next period wage will fall. For the same reason, there will be a positive frequency of demotions.

Serial correlation in wage increases continues to hold under the restriction of no demotions.[14] The reasoning is the same as in the perfect information case. Worker who experience large wage increases between t and $t+1$ are worker for whom expected innate ability at $t+1$ has increased. This means that on average, the worker's expected effective ability will grow faster in the future. Large wage increases are thus positively correlated to large wage increases in the future.

The model gives predictions consistent with the fact that wage increases predict promotion. A large wage increase indicates an increase in expected innate ability which means that on average effective ability will grow more quickly in the future so that the worker will need less time to reach the target level of expected effective ability needed for promotion.

Finally, the size of the average wage increase on promotion is larger than the average wage increases before and, this time, after promotion. The worker promoted at the end of the period had a larger increase in expected effective ability than the worker not

[14]However, serial correlation in promotion rates is not a clear prediction of the model with learning. No matter how informative a worker's history of past output is, an extreme value of the next period output can radically change the beliefs for that period. See Gibbons and Waldman for a discussion on this point.

promoted. The wage increase will then be higher for this reason and also because the increase in expected ability will be valued at a bigger rate ($c_{j+1} > c_j$). After the promotion, the expected change in expected innate ability is zero so the wage increase is smaller on average than the wage increase at promotion. Wage increase at promotion explain a fraction of the difference in average wages across levels by the same argument on age and length of human capital accumulation as in the perfect information case.

In summary, the model under perfect information based on comparative advantage in the assignment of workers to job levels can explain the observed serial correlation in wage increases and promotion rates, the fact that wage increases predict promotions but that they explain only a fraction of the difference in average wages across levels. The introduction of learning allows the possibility of real wage decreases and that average wage increases are higher upon promotion than before and after promotion. Under particular hypothesis on η' and $\eta'' - \eta'$, defining intervals of effective ability in each job levels, the model leads to the prediction on absence of demotions. Thus, the model can explain the stylized facts highlighted in the literature on wages and intrafirm mobility.

The results of Section II, which suggest first the presence of an unmeasured individual ability term and second, that there is evidence of workers' self-selection due to comparative advantage on measured ability, are consistent with the Gibbons and Waldman model. Given that unmeasured (or unobserved) ability is correlated with measured ability, evidence on the fact that workers also have a comparative advantage on unmeasured ability is expected to be found. To test more rigorously whether the model is supported by the data, a more sophisticated method than the first difference method has to be used. In the next Section, I present the econometric specification of the model and the estimation method which takes into account the comparative advantage and the learning principles based on innate ability.

1.3.2 Econometric Specification

Empirical evidence on inter-industry wage differentials has created controversy on the estimation method used to explain them. Gibbons and Katz (1992) have presented a theoretical model which emphasizes the importance of both endogenous mobility driven by the dynamic evolution of an unmeasured ability term and endogenous choice of industry or self selection of workers into industries due to the different sensitivity of industries' technologies with respect to this ability term. The model of Gibbons and Waldman formalizes these ideas in the context of the wage policy of the firm with endogenous choice of job levels and endogenous mobility between these job levels. The purpose of this Section is to present an econometric specification of the dynamic of wages implied by the model of Gibbons and Waldman where the endogeneity problems induced by the comparative advantage and the learning hypotheses can be accounted for and the relative importance of their effects on the dynamics of wages can be estimated.

The specification accounts for the general case of comparative advantage and learning (the model under imperfect information). That is, the process for wages, equation (1.3) is written using the expectation of workers' ability, θ^e_{it}.

In order to control for measurable individual characteristics, I included the skill variable defined previously. Employing dummies, D_{ijt}, indicating the rank j of individual i at time t, the equation to be estimated can be written as:

$$w_{ijt} = \sum_{j=1}^{J} D_{ijt} d_j + \sum_{j=1}^{J} D_{ijt} X_{it} \beta_j + \sum_{j=1}^{J} D_{ijt} c_j \theta^e_{it} f(x_{it}) + \mu_{it} \qquad (1.5)$$

where μ_{it} is a measurement error independent of rank assignment, and X_{it} corresponds to the skill variable. Comparative advantage is characterized by the fact that the coefficients β_j and c_j vary by rank and learning is represented by the conditional expectation θ^e_{it}.

Estimating equation (1.5) with OLS would give inconsistent estimates. The comparative advantage hypothesis implies that rank assignment is endogenous, so θ^e_{it} is correlated with the rank dummies. In addition, this term cannot be eliminated by first-differencing (1.5) because it is interacted with the D_{ijt} terms. Holtz-Eakin, Newey and Rosen (1988) analyze models in which a fixed effect is interacted with year dummies and show that consistent estimates can be obtained by quasi-differencing the equation of interest and using appropriate instrumental-variable techniques. Lemieux (1998) applies this method to a model in which the return to a time-invariant unobserved characteristic is different in the union and the non-union sector. Gibbons, Katz and Lemieux (1997) also use this method to analyze wage differentials by industry and occupation in the presence of unmeasured and unobserved ability interacted with industry and occupation dummies. I apply this method to estimate the wage equation (1.5).

1.3.3 Estimation Method

The first step is to eliminate θ^e_{it} by quasi-differencing equation (1.5) in the following manner:

$$\theta^e_{it} = \frac{w_{ijt} - \sum_j^J D_{ijt} d_j - \sum_j^J D_{ijt} X_{it} \beta_j - \mu_{it}}{\sum_j^J D_{ijt} c_j f(x_{it})} \tag{1.6}$$

The martingale property of beliefs in innate ability which links θ^e_{it} and θ^e_{it-1} implies that we can substitutes a lagged version of this equation into (1.5). The final equation is therefore given by:

$$\begin{aligned} w_{ijt} &= \sum_{j=1}^{J} D_{ijt} d_j + \sum_{j=1}^{J} D_{ijt} X_{it} \beta_j + \frac{\sum_j^J D_{ijt} c_j f(x_{it})}{\sum_j^J D_{ijt-1} c_j f(x_{it-1})} w_{ijt-1} \\ &- \frac{\sum_j^J D_{ijt} c_j f(x_{it})}{\sum_j^J D_{ijt-1} c_j f(x_{it-1})} [\sum_{j=1}^{J} D_{ijt-1} d_j + \sum_{j=1}^{J} D_{ijt-1} X_{it-1} \beta_j] + e_{it} \end{aligned} \tag{1.7}$$

$$\text{where} \quad e_{it} = \mu_{it} + \sum_{j=1}^{J} D_{ijt} u_{it} - \frac{\sum_j^J D_{ijt} c_j f(x_{it})}{\sum_j^J D_{ijt-1} c_j f(x_{it-1})} \mu_{it-1} \tag{1.8}$$

This equation cannot be estimated using non-linear least square because w_{ijt-1} is correlated with μ_{it-1}. Moreover, because of the presence of learning, the new information on innate ability at time t, u_{it}, is correlated with D_{ijt} since beliefs on ability influences the current rank affiliation. These problems can be solved by choosing appropriate instruments for w_{ijt-1} and D_{ijt}, and consistent estimates will be obtained. Calling Z_i the set of instruments, these variables have to satisfy the following condition:

$$E(e_{it}Z_i) = 0 \tag{1.9}$$

The objective is then to minimize the following quadratic form:

$$\min_{\beta} e(\beta)'Z(Z'\Omega Z)^{-1}Z'e(\beta) \tag{1.10}$$

where $Z'\Omega Z$ is the covariance matrix of the vector of moments $Z'e(\beta)$, Ω is the covariance matrix of the error term e_{it} and β is the vector of parameters. Under homoscedasticity and serial independence of the error terms, $\Omega = I$ (up to a constant σ^2 which disappears in the minimization of (1.10)), so that the weighting matrix is equal to $Z'Z$ and the method gives a consistent Non-Linear Instrumental Variables estimator. An efficient estimator is obtained by estimating Ω. I will consider the two types of estimation using the SAS Non Linear IV procedure.

Finally, the unmeasured ability term θ_{it} in the error term of equation (1.5) has to be normalized to zero over the observations in order to identify all the parameters. [15] This is done by adding the following equation to the optimization of (1.10):

$$(1/TN)\sum_i \sum_t \underline{\theta_{it}} = 0 \tag{1.11}$$

where N is the number of individuals, T is the number of periods for each individual and $\underline{\theta_{it}}$ satisfies equation (1.6).

Instruments are chosen using the identification assumption for estimation of panel data equations that imposes strict exogeneity of right-hand side variables or more formally:

$$E(\mu_{it}/X_{i1}...X_{iT}, D_{ij1}...D_{ijT}, \theta_i) = 0 \tag{1.12}$$

The estimation has first been done under the assumption of perfect information on the ability term θ_i, focusing on the impact of comparative advantage and self-selection

[15] A proof of the necessity of this constraint is given in Lemieux (1998).

of workers into the different ranks with innate ability known to all market participants. In this case, the innovation driving the martingale process for beliefs disappears from the error term of equation (1.7) and the instruments are chosen to correct the correlation of lagged wage with the error term μ_{it-1}, resulting from the quasi-differencing method.

Condition (1.12) provides a set of potential instruments since it states that conditional on observed innate ability, individual characteristics and rank assignments each period are independent of the error term in the wage equation (1.5). In addition, since according to the production technology (equation (1.2)), new information contained in the observation of current output has the same impact across ranks, conditional on innate ability and other measurable characteristics, the current choice of job level is random. In the spirit of Lemieux's estimation of comparative advantage mentioned before, I consider as instruments for the lagged wage the history of job level or rank dummy variables. In particular, interaction terms between D_{ijt-1} and D_{ijt} which give information on the career path of the worker between $t-1$ and t, should help predict w_{ijt-1}. Indeed, according to the Gibbons and Waldman model, the choice of a job level is influenced by innate ability and should therefore be correlated to the wage but uncorrelated to the error term μ_{it} because of condition (1.12).

In the imperfect information case, the presence of learning introduces another correlation problem. Now that innate ability evolves over time as beliefs change, the current choice of job rank D_{ijt} is correlated to the changes in beliefs between t and $t-1$ (reflected in the martingale innovation u_{it} which appears in the error term e_{it}). Therefore, D_{ijt} will have to be instrumented. The choice of instruments will be facilitated thanks to the martingale process for innate ability which implies that changes in beliefs today are uncorrelated to changes in beliefs the period before. Therefore, it is possible to use the choice of job level in the previous periods, D_{ijt-2} and D_{ijt-1}, because they are correlated to the changes in expected ability in period $t-2$ and $t-1$ (helping predict D_{ijt}) but are uncorrelated to the current changes u_{it} and thus, uncorrelated to the error term e_{it} in the quasi-differencing equation. As before, interaction between D_{ijt-2} and D_{ijt-1} will also be considered. This set of variables will also provide valid instruments for w_{ijt-1} for the same reasons as in the case of perfect information.

The estimation results will be presented in two parts. First, equation (1.7) is estimated under the assumption of perfect information to emphasize the impact of comparative advantage on θ_i (observed by the market but unmeasured by the econometrician). Second, the estimation is performed for the model with comparative advantage and learning about θ_i.

Note that in both cases the element $\frac{f(x_{it})}{f(x_{it-1})}$, representing the ratio of accumulated experience in t with regard to $t-1$, has to be specified. According to the Mincer wage equation, wages when studied in log, are specified by a polynomial function of experience. Since wages here are in level, it should be reasonable to assume an exponential function of this same polynomial in experience. This leads to the following functional form for the ratio $g(x_{it}) = \frac{f(x_{it})}{f(x_{it-1})}$ [16]:

$$g(x_{it}) = b_0 e^{-b_1 x_{it}} \tag{1.13}$$

Going back to the Gibbons and Waldman model, the estimation of a ratio higher than unity will confirm that the function f of human capital accumulation is non constant and monotonically increasing with experience. In other words, it will show evidence of unmeasured (unobserved in the learning case) heterogeneity in the accumulation of human capital and therefore in wage increases and mobility. According to the model, the evolution of the worker's productive ability over time (defined as the product of ability θ_i and the experience funtion f) is driven by an unmeasured ability term and since it enters linearly in the wage function, the wage dynamics will be driven by this θ_i term. As seen in Section II, this implies serial correlation in wage increases and in promotion rates as the firm observes (or expects) that some individuals perform better than others, it assigns them to higher ranks. They receive higher wage increases not only as a result of mobility between ranks but also within a rank as they vary across workers of different type θ_i [17].

[16] Assuming $f(x_{it}) = e^{\alpha_0 + \alpha_1 x_{it} - \alpha_2 x_{it}^2}$ then $g(x_{it}) = e^{\alpha_1 + \alpha_2 - 2\alpha_2 x_{it}}$.

[17] With an estimated b_1 significant, the ratio will vary with experience which implies that accumulation of human capital would not only vary across workers but also over time.

1.4 Results and Interpretations

The analysis of the results is presented in four parts. The first part focuses on the estimation of the wage dynamics for workers remaining inside their firm (Table 1.3). The second part performs the same estimations but this time with the sample including workers changing firms to study the possible differences in the impact of measured and unmeasured (unobserved) ability on the wage dynamics (Table 1.4). The third part concentrates on the estimation of the human capital accumulation ratio (Table 1.5). The last part considers the estimation with non homoscedastic errors and the problem of classification errors in the rank variables (Table 1.6).

1.4.1 Wage Dynamics Within Firms

Results, shown in the first part of Table 1.3, confirm the importance of non random selection of workers based on unmeasured ability. The coefficients c_j which evaluate the impact of unmeasured ability in each rank j are significant. Starting at 1 (normalization) for rank L, they range from 1.043 for the middle rank M, to 1.475 for the upper rank U and 1.600 for the executive rank E. They are significantly different from one another according to the joint test ($\chi^2(3)$ of 15.00) and, expcept for rank M, are also significantly different from the lower rank L ($\chi^2(1)$ of 10.10 for U and 4.69 for E). These results suggest distinct and increasing returns to unmeasured ability by hierarchical level.

The inter-rank wage differentials d_j have dropped by about 80% compared to the OLS results in column (4) of Table 1.2 when only comparative advantage on measured skills is considered. The coefficients related to measured skills by rank (the β_j) are still significantly different from one another ($\chi^2(3)$ of 6.12 for the joint test) implying that comparative advantage on measured ability is still important but compared to column (4) of Table 1.2, its impact is smaller. One can also notice that their impact is now decreasing with ranks, ranging from 0.735 in rank L to being not significantly different from 0 in the highest rank E. In summary, non random selection or comparative advantage of workers based on unmeasured ability seems to capture an important part of the variation in the dynamics of wages within the firm and the part related to measured ability becomes less and less important as workers go up the ladder. Although significantly reduced, the rank effects are still significant.

The second part of Table 1.3 reports the results of the model when learning about unobserved ability is considered. One can see that only the rank effect for the middle rank M is significant. Moreover, except for rank M and c_M, the slopes associated with unobserved ability are not different from one another and not different from the lower rank slope. The slopes associated with measured ability remain significant at all rank. Generally, the standard errors of the coefficients are larger than in the case with no assumption of learning. Results are more imprecise and hard to interpret. In fact, except for the middle rank M, the c_j which measure the impact of unmeasured ability (unobserved in this case) in each rank are no longer increasing in ranks. From these results, it is rather difficult to conclude on the effects of learning on the wage dynamics. The overall imprecision of the results might come from the use of second and third lags of the variables for the instruments. This lead to a substantial loss of observations.

In both estimations, the human capital accumulation ratio has been estimated as a constant term b_0 and one can see that in the comparative advantage case, it is significantly different from one. Its estimated value of 1.024 gives, in log, a 2.37 % growth rate for the function f of human capital accumulation. In other words, controlling for all other measurable individual characteristics, one more year of experience within the firm is associated with a 2.37 % wage increase for the average worker. In the specification with learning, the ratio is not significantly different from one, implying that the function f is constant or that there is no evidence of unobserved heterogeneity in the workers' human capital accumulation.

Finally, note that in both estimations, the over-identification test [18] shows that the instruments used are valid since the null cannot be rejected.

Summarizing the overall results, one can say that the dynamics of wages and the workers' mobility within the firm are characterized by the importance of non random

[18] The statistic of the test uses the optimized value of the objective function times the number of observations. The distribution is $\chi^2(l-p)$ where p is the number of parameters and l is the number of instruments.

selection of workers into job ranks and by the presence of unmeasured heterogeneity in human capital accumulation leading to the result that wage increases are serially correlated. The unconclusive results on the presence of learning as the factor driving the worker's mobility across job ranks, suggests that German workers are not mobile within the firm. Once they enter the firm, they get to the job rank that best suit their productive abilities and remain in that job thereafter. A possible explanation for that is the importance of the apprenticeship system in Germany. In this system, individuals receive training within a firm for a certain period of time while still completing school. During that period, both the firm and the worker can get information on the productivity of the employer-employee match and both can use it in their future employment decisions. Since the sample studied considers individuals just after entering the labor force on a permanent basis, those working while still completing school have not been considered.

The results on serial correlation in wage increases (controlling for measurable individual characteristics) is in contrast with the literature mentioned earlier on the absence of serial correlation when estimating the covariance structure of wages and wage residuals (Abowd and Card (1989) and Topel and Ward (1992). However, it is in accordance with studies that analyzed the question with particular samples of workers (Hause (1980) who uses a sample of white-collar Swedish males and Lillard and Weiss (1979) who study a sample of American scientists). In the analysis so far, I considered the sample of workers remaining with their firms and the heterogeneity captured in the results could be worker-firm specific rather than individual specific. To examine whether the effects of heterogeneity in human capital accumulation, comparative advantage and learning driving the wage dynamics are more individual or worker-firm specific, I estimate, in the next Section, the model over a sample that includes firm changers.

1.4.2 Wage Dynamics Within and Between Firms

The results from performing the estimations on the sample of workers moving within and between firms are presented in Table 1.4. They are similar to those obtained with the sample of firm stayers concerning the presence of non random selection and comparative advantage. One can notice increasing effect of unmeasured ability and decreasing effect of measured skills with ranks. Rank effects are also still significant. Also, the second part of the Table shows, as before, no clear evidence of learning.[19]

In the comparative advantage case, the differences between the estimations over the two samples lies in the magnitude of the slope coefficients related to unmeasured ability and measured skills for the different ranks. The slope associated with unmeasured ability at the highest executive rank E and the ones related to measured skills at the lower ranks L, M and U are now higher. More precisely, for the slope coefficients on unmeasured ability, the effect c_E is twice as high as the one at the lowest rank L which is higher than in the previous results (c_E is 2.02 compared to 1.6 in Table 1.3). On the other hand, the coefficients associated with middle and upper ranks c_M and c_U are similar to those of Table 1.3. The slope coefficient on measured skills is non significant at the highest rank E like in the previous case but the coefficients β_L, β_M and β_U are much higher now than in Table 1.3.

These results suggest that the impact of unmeasured ability on the wage dynamics seems to be more individual specific at the executive rank. At the lower ranks, the inclusion of firm changers did not change the impact of unmeasured ability as much. On the other hand, the impact of measured skills is higher at these ranks when observations on the worker's mobility between firms are included in the sample. It can be concluded from these results that the effect of unmeasured ability at the lower, middle and upper ranks does not seem to result from an individual specific ability effect that would be transferable across firms but should result from a worker-firm specific match quality effect.

In summary, the wage policy of firms is characterized by the importance of non random selection of workers into job ranks and the existence of unmeasured heterogeneity in wage increases. This result is surprising given that the German labor market is regulated by unions and employers' associations which would suggest that pay settings are more related to bureaucratic rules. On the other hand, I find evidence that the

[19]Because learning does not seem to be supported by the data, the analysis thereafter focuses on the specification with comparative advantage only.

rank effects d_j are still significant even after controlling for measured and unmeasured characteristics. Note that these coefficients always increase with ranks which is not in accordance with the Gibbons and Waldman model's assumption that they should be decreasing with ranks. In the model, wages are set according to a piece-rate pay system based on expected output. Both the slopes and intercepts are parameters that are given to the firm but depend on the equilibrium allocation of the workers' skills to job ranks. Workers with low level of skills or performance are assigned to (and also choose) low job ranks, where the wage puts the least weight on skills, i.e. with a high intercept and a flat slope. The highly skilled worker ends up in a high job rank with a wage mostly based on skills (with a low intercept and a high slope). This negative correlation between the intercept and the slope is not as clear when wages are not only function of skills but also depend on the firm's bureaucratic rules. The results here suggest that the intercepts or rank effects reflect more administrative settings specific to the job such as task complexity and responsibility requirements which increase with rank independently of the worker's skill level.

1.4.3 Human Capital Accumulation

The results so far come from the estimation of the wage equation with a constant ratio of human capital accumulation. Workers accumulate years of experience within the firm at different rates but no matter what period of time in the worker's career, one additional year of experience has the same impact. One might think however that the impact is stronger at the beginning than at the end of the worker's career. I reestimated the model considering the more general functional form given in (1.13). Results are shown in Table 1.5 for the comparative advantage case[20]. The ratio has been estimated as a function of the number of years of tenure with the firm. The estimation using the number of years of potential experience did not lead to the convergence of the objective function in the optimization process. Also, convergence could not be reached for no other functional form for the ratio than the one shown in table V, where the coefficient

[20] Results with learning, available on request, did not lead to a significant estimation of the coefficients b_0 and b_1.

b_0 is constrained to be equal to one. Finally, the two parts of the Table relate to the estimations on the two different samples used previously.

For the results on the presence of non random selection of workers into job ranks, one can see that the conclusions are the same as before. The coefficients on measured and unmeasured ability and the rank effects are similar to those from the first part of Tables 1.3 and 1.4 with comparative advantage only and a constant ratio. For the results on the estimation of the ratio, the impact of tenure (coeffient b_1) is significant but very small and, contrary to what was expected, it is positive.[21] The ratio is in fact very close to one for the first year of tenure (ratio of 1.001) and still remains close to it after 10 years (ratio of 1.01) leading to estimated wage increases of 0.1 % and 1 % respectively. Therefore, one can reasonably conclude that the ratio does not seem to vary with the worker's tenure in the firm.

1.4.4 Discussion of the Results

Despite the preceding evidence on non random selection of workers onto the hierarchical levels of the firm's job ladder and on unmeasured ability driving the dynamics of wages, there are several issues to keep in mind in anlysing the results. Among those is the assumption of homoscedasticity of the error term. Since this might be a strong hypothesis, I reestimated the equation, using an estimate of Ω in a second step, where the first step estimates by NLIV with $\Omega = I$, using the residuals from the estimation in the first step to estimate Ω (Hansen (1982)). The results of this estimation are presented in the first part of Table 1.6 for the comparative advantage case.

Generally, correcting for possible heteroscedasticity and/or autocorrelation of the error term lead to more imprecise estimates. The results are quite different from those in Table 1.3 in terms of the magnitude and also standard errors of the coefficients. Moreover, the value of the statistic of the overidentification test is now quite high (58.99) leading to reject the hypothesis of valid instruments.

The fact that the statistic of the test (based on the optimized value of the objective

[21] According to the human capital theory, one additional year of experience should have a decreasing impact with increasing years of experience with the firm.

function) has a larger value when the covariance of the moments is estimated does not have a clear explanation since there is no reason to expect that $(Z'\Omega Z)^{-1}$ should be larger than $(Z'Z)^{-1}$. On the other hand, Altonji and Segal (1994) show that although the choice of the weighting matrix as the variance of the moments gives an efficient GMM estimator asymptotically, it leads to an estimator which has poor small sample properties. Using Monte Carlo experiments they find that the estimator is biased because sampling errors in the moments to be estimated are correlated with sampling errors in the weighting matrix (which is a function of the covariance of these moments). This may explain why the coefficients found and the value of the objective function are very different. Given that the sample is not unreasonably large the results without the estimation of the weighting matrix, which still provide consistent estimates, may be favored.

Another issue that has to be stressed is the presence of classification errors in the reported occupation ranks from year to year. Assuming that these errors are serially uncorrelated, I reestimated the model with comparative advantage using the second lags of the variables. Results, reported in second part of Table 1.6 are slightly different from those of Table 1.3. All the coefficients have larger standard errors and the b_j coefficients lose their expected increasing order by rank. This suggests that classification errors might be important.

1.5 Conclusion

In this paper, I have analyzed the relative importance of different factors explaining what is driving the dynamics of wages and the workers mobility within firms. To do this, I implemented empirically the theoretical model proposed by Gibbons and Waldman (1999) that combines the notions of human capital accumulation, job level assignments based on comparative advantage and learning about the worker's ability to characterize the wage policy of firms.

Using survey data for a large sample of workers I can draw conclusions on the common features arising from the wage policy of firms for a large sample of firms.

The longitudinal dimension of the data allows me to analyze the wage and mobility dynamics. Based on the German GSOEP over the years 1986 to 1996, the results can be summarized in the following points.

The main common features characterizing the wage policy of German firms are the importance of non random selection of workers into job ranks and the evidence of heterogeneity in human capital accumulation leading to serial correlation in wage increases. Whether the source of heterogeneity is more individual specific or related to the quality of the match worker-firm seems to depend on the job rank considered. The unmeasured ability term at the executive rank has a larger effect on the wage dynamics when it is estimated over the sample of workers moving inside the firm as well as changing firms. The effects at the lower, middle and upper ranks of the worker's occupation are similar whether or not firm changers are included in the sample.

The results of this paper reveal the importance of the question of assignment of workers to job ranks on our understanding of wage dynamics within as well as between firms. The evidence on the presence of non-random selection of workers onto the rungs of the job ladder brings an additional explanation for the fact that the distribution of wages differ from the distribution of individual productivities at the level of the firm. These results show that wage dynamics within the firm depend not only on the worker's ability (innate ability or quality of the match worker-firm) but also on how productive this ability (or match) is within a specific job rank. In addition, the fact that the rank premia remain significant even after controlling for measured and unmeasured heterogeneity in the wage dynamics suggests that the firm's administrative rules constitute another relevant explanatory factor.

The estimation of the model of Gibbons and Waldman lead to a relatively good description of the German case and it would obviously be interesting to compare them with US data. To my knowledge, there is no American survey data with a question on the job rank of the worker. However, it would be possible to construct variables on job levels by using the three-digit codes from the US Census which provide a detailed classification of occupations. Future research should investigate this issue because if the model of Gibbons and Waldman provides a reasonable explanation of wage dynamics in German firms it may be even more relevant in US firms (where the mobility of the workers, on which the model is based, is higher than in Germany).

The model of Gibbons and Waldman is based on the assumption that all firms are identical and therefore have the same hierarchical structure and the same production technology. Further research could investigate the possibility that firms of different size differ in their internal organization as suggested by the empirical evidence on the impact of firm size on wage outcomes (see for example Brown and Medoff (1989)). This could imply that the productivity of a given worker-job-level match is different in large and small firms. The effects of this kind of assumption on the ability to explain wage dynamics is a possibility that future research might consider.

Finally, one thing that is absent in the model of Gibbons and Waldman is the role of incentives in the determination of the wage policy of firms. This is clearly a relevant point when modeling the factors driving the worker's mobility within the firm and the resulting wage increases. Lazear (2001) analyzes the question of explaining the observed decline in the worker's productivity after a promotion. Using the Gibbons and Waldman theoretical framework, he explains the firm's strategic decision of who and when to promote workers in order to minimize the post promotion productivity decline. Given that the Gibbons and Waldman model is easily implementable empirically, future research should investigate the possible empirical applications of the augmented model that considers the role of incentives.

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Table 1.1: Logit Estimation of Intrafirm Mobility[a]

Model[b]	Baseline Specification	Marg. Effect	Lagged Bonus	Lagged Wage Gr.	All Variables	Marg. Effect
High Sc.	0.293	0.011	0.249	0.048	0.052	0.001
	(0.181)		(0.189)	(0.337)	(0.336)	
College	0.566***	0.022	0.557**	0.508	0.505	0.010
	(0.216)		(0.225)	(0.387)	(0.236)	
Tenure[c]	-0.086***	-0.002	-.0008	-0.098**	-0.100**	-0.001
	(0.022)		(0.027)	(0.041)	(0.041)	
German	0.138	0.005	0.262	0.112	0.106	0.002
	(0.227)		(0.229)	(0.431)	(0.432)	
Female	-0.181	-0.007	-0.275***	-0.088	-0.088	-0.002
	(0.119)		(0.126)	(0.203)	(0.203)	
Married	-0.334***	-0.013	-0.299***	-0.316*	-0.315*	-0.006
	(0.112)		(0.116)	(0.192)	(0.192)	
Size	0.634***	0.025	0.733***	0.531***	0.526***	0.010
	(0.112)		(0.121)	(0.180)	(0.180)	
Contract	-0.149	-0.006	0.214	-0.322	-0.335	-0.006
	(0.221)		(0.241)	(0.389)	(0.388)	
Public	0.188	0.007	0.225	0.268	0.257	0.005
	(0.174)		(.180)	(0.267)	(0.270)	
Lbonus	-	-	-1.888***	-	0.329	0.006
			(0.144)		(0.441)	
LwageGr[c]	-	-	-	2.280***	2.293***	0.041
				(0.744)	(0.744)	

a-The number of observations for $y = 1$ is 638 over a total of 14493.
b-All specifications include dummies for industry, occupations and a quadratic function of experience and tenure. The last two specifications including lagged wage growth contain a cubic function of the growth rate. ***= significant at 1 %. **= significant at 5 %. *=significant at 10 %. c-The associated beta shown in the Table corresponds to the partial effect of the linear part of the non linear function.

Table 1.2: Wage Differentials by Job Rank

Models[a] Variables[b]	(1) OLS	(2) OLS	(3) FE	(4) OLS with CA
Skill	-	1.589***	1.653***	-
		(0.034)	(0.092)	
Rank L		-	-	-
Rank M	0.357***	0.121***	0.021*	0.20***
	(0.019)	(0.016)	(0.015)	(0.020)
Rank U	1.373***	0.684***	0.157***	0.70***
	(0.039)	(0.035)	(0.019)	(0.039)
Rank X	2.195***	1.204***	0.219***	0.92***
	(0.077)	(0.068)	(0.032)	(0.119)
Skill*Rank L	-	-	-	1.21***
				(0.041)
Skill*Rank M	-	-	-	1.53***
				(0.065)
Skill*Rank U	-	-	-	1.99***
				(0.082)
Skill*Rank X	-	-	-	2.37***
				(0.180)
Adj. R2	0.48	0.62	0.11	0.63
Observations	11159	11159	11159	11159
Test of Equality of slopes				103.43
p-value of the χ^2-test				.000

a-The dependent variable is wage in level in thousand of marks. Standard errors have been computed using the White correction.

b-Also included are dummies for the type of contract, large firm size, public sector, occupations, industries and years.

Table 1.3: Wage Dynamics Within Firms[a]

COMPARATIVE ADVANTAGE

Specification[b] 1	Low	Middle	Upper	Executive
	Rank L	Rank M	Rank U	Rank E
Ranks	d_L	d_M	d_U	d_E
	-	0.051	0.095*	0.195***
		(0.035)	(0.053)	(0.062)
Skill*Ranks				
Unmeasured	c_L	c_M	c_U	c_E
	1	1.043***	1.475***	1.600***
		(0.081)	(0.149)	(0.277)
Measured	β_L	β_M	β_U	β_E
	0.735***	0.728***	0.411***	0.032
	(0.121)	(0.139)	(0.157)	(0.349)
Ratio	b_0			
b_0	1.023***			
	(0.006)			
Tests[c] for Equality	Joint	M=L	U=L	E=L
of Slopes c_j	15.00 (0.00)	0.28 (0.59)	10.10 (0.00)	4.69 (0.03)
of Slopes β_j	6.12 (0.10)	0.01 (0.92)	3.70 (0.05)	4.04 (0.04)
of Ratio $b_0 = 1$	16.27 (0.00)			
Overidentification Test[c]	17.10 (0.99)			

COMPARATIVE ADVANTAGE AND LEARNING

Specification[b] 2	Low	Middle	Upper	Executive
	Rank L	Rank M	Rank U	Rank E
Ranks	d_L	d_M	d_U	d_E
	-	0.104**	0.006	0.036
		(0.038)	(0.047)	(0.092)
Skill*Ranks				
Unobserved	c_L	c_M	c_U	c_E
	1	1.204***	1.021***	0.967***
		(0.133)	(0.127)	(0.182)
Measured	β_L	β_M	β_U	β_E
	0.473**	0.364**	0.609***	0.492*
	(0.192)	(0.150)	(0.133)	(0.262)
Ratio	b_0			
b_0	1.008***			
	(0.006)			
Tests[c] for Equality	Joint	M=L	U=L	E=L
of Slopes c_j	9.47 (0.03)	2.33 (0.13)	0.03 (0.86)	0.03 (0.86)
of Slopes β_j	3.83 (0.28)	0.63 (0.43)	0.53 (0.47)	0.00 (0.95)
of Ratio $b_0 = 1$	2.00 (0.15)			
Overidentification Test[c]	13.11 (0.99)			

a-Dependent variable is wage in level in thousand of marks. Also included are dummies for the type of contract, large firm size, public sector, occupations, industries and years.

b-Estimation using $\Omega = I$. Number of observations is 11159 in the comparative advantage case and 9891 in the learning case.

c-χ^2-test with p-value in parenthesis.

Table 1.4: Wage Dynamics Within and Between Firms[a]

COMPARATIVE ADVANTAGE

Specification[b] 1	Low	Middle	Upper	Executive
	Rank L	Rank M	Rank U	Rank E
Ranks	d_L	d_M	d_U	d_E
	-	0.058*	0.118**	0.181*
		(0.032)	(0.051)	(0.076)
Skill*Ranks				
Unmeasured	c_L	c_M	c_U	c_E
	1	1.079***	1.486***	2.019***
		(0.080)	(0.177)	(0.362)
Measured	β_L	β_M	β_U	β_E
	0.989***	0.986***	0.746***	0.019
	(0.121)	(0.134)	(0.138)	(0.377)
Ratio	b_0			
b_0	1.024***			
	(0.006)			
Tests[c] for Equality	Joint	M=L	U=L	E=L
of Slopes c_j	14.72 (0.00)	0.97 (0.32)	7.58 (0.00)	7.94 (0.00)
of Slopes β_j	7.00 (0.07)	0.00 (0.95)	2.28 (0.13)	6.64 (0.01)
of Ratio $b_0 = 1$	13.80 (0.00)			
Overidentification Test[c]	21.48 (0.88)			

COMPARATIVE ADVANTAGE AND LEARNING

Specification[b] 2	Low	Middle	Upper	Executive
	Rank L	Rank M	Rank U	Rank E
Ranks	d_L	d_M	d_U	d_E
	-	0.077*	0.004	-0.018
		(0.044)	(0.047)	(0.115)
Skill*Ranks				
Unmeasured	c_L	c_M	c_U	c_E
	1	1.078***	0.897***	1.032***
		(0.126)	(0.118)	(0.213)
Measured	β_L	β_M	β_U	β_E
	0.634***	0.672***	0.807***	0.363
	(0.183)	(0.144)	(0.124)	(0.294)
Ratio	b_0			
b_0	1.009***			
	(0.006)			
Tests[c] for Equality	Joint	M=L	U=L	E=L
of Slopes c_j	9.72 (0.02)	0.38 (0.54)	0.76 (0.39)	0.02 (0.88)
of Slopes β_j	3.89 (0.27)	0.11 (0.74)	1.03 (0.31)	0.71 (0.40)
of Ratio $b_0 = 1$	2.08 (0.15)			
Overidentification Test[c]	14.47 (0.99)			

a-Dependent variable is wage in level in thousand of marks. Also included are dummies for the type of contract, large firm size, public sector, occupations, industries and years.

b-Estimation using $\Omega = I$. Number of observations is 11929 in the comparative advantage case and 10439 when learning is considered.

c-χ^2-test with p-value in parenthesis.

Table 1.5: Wage Dynamics and Human Capital Accumulation Ratio[a]

WITHIN FIRMS

Estimation[b] 1	Low	Middle	Upper	Executive
	Rank L	Rank M	Rank U	Rank E
Ranks	d_L	d_M	d_U	d_E
	-	0.098*	0.129***	0.223***
		(0.040)	(0.046)	(0.054)
Skill*Ranks				
Unmeasured	c_L	c_M	c_U	c_E
	1	1.166***	1.393***	1.459***
		(0.097)	(0.128)	(0.246)
Measured	β_L	β_M	β_U	β_E
	0.697***	0.587***	0.499***	0.217
	(0.113)	(0.149)	(0.149)	(0.313)
Tenure Ratio	b_0	b_1		
$b_0 e^{b_1 x_{it}}$	1	0.001***		
		(0.0004)		
Tests[c] for Equality	Joint	M=L	U=L	E=L
of Slopes c_j	18.67 (0.00)	2.85 (0.09)	9.44 (0.00)	3.48 (0.06)
of Slopes β_j	5.48 (0.14)	1.27 (0.26)	1.72 (0.19)	2.36 (0.12)
Overidentification Test[c]	19.39 (0.95)			

WITHIN AND BETWEEN FIRMS

Estimation[b] 2	Low	Middle	Upper	Executive
	Rank L	Rank M	Rank U	Rank E
Ranks	d_L	d_M	d_U	d_E
	-	0.104***	0.156***	0.214*
		(0.037)	(0.042)	(0.065)
Skill*Ranks				
Unmeasured	c_L	c_M	c_U	c_E
	1	1.202***	1.353***	1.766***
		(0.095)	(0.145)	(0.310)
Measured	β_L	β_M	β_U	β_E
	0.903***	0.842***	0.829***	0.249
	(0.112)	(0.141)	(0.129)	(0.334)
Tenure Ratio	b_0	b_1		
$b_0 e^{b_1 x_{it}}$	1	0.001***		
		(0.0005)		
Tests[c] for Equality	Joint	M=L	U=L	E=L
of Slopes c_j	16.28 (0.00)	4.54 (0.03)	5.95 (0.01)	6.10 (0.01)
of Slopes β_j	5.04 (0.17)	0.84 (0.35)	0.27 (0.60)	3.86 (0.05)
Overidentification Test[c]	21.85 (0.88)			

a-Dependent variable is wage in level in thousand of marks. Also included are dummies for the type of contract, large firm size, public sector, occupations, industries and years. Both estimat--ions are performed for comparative advantage case.

b-Estimation using $\Omega = I$. Number of observations is 11159 for the sample of moves within firms and 11927 when moves between firms are included.

c-χ^2-test with p-value in parenthesis.

Table 1.6: Wage Dynamics Estimation[a]

ESTIMATION WITH NON HOMOSCEDASTIC ERRORS

Estimation[b] 1	Low	Middle	Upper	Executive
	Rank L	Rank M	Rank U	Rank E
Ranks	d_L	d_M	d_U	d_E
	-	0.108*	0.088	0.155*
		(0.061)	(0.089)	(0.087)
Skill*Ranks				
Unmeasured	c_L	c_M	c_U	c_E
	1	1.212***	1.583***	1.285***
		(0.159)	(0.214)	(0.349)
Measured	β_L	β_M	β_U	β_E
	1.134***	1.088***	0.965***	1.098
	(0.168)	(0.205)	(0.270)	(0.320)
Ratio	b_0			
b_0	1.003***			
	(0.008)			
Tests[c] for Equality	Joint	M=L	U=L	E=L
of Slopes c_j	8.71 (0.03)	1.78 (0.18)	7.39 (0.00)	0.67 (0.41)
of Slopes β_j	1.27 (0.73)	0.43 (0.51)	0.81 (0.39)	0.02 (0.89)
of Ratio $b_0 = 1$	0.13 (0.72)			
Overidentification Test[c]	58.99 (0.00)			

ESTIMATION WITH SECOND QUASI-DIFFERENCING

Estimation[d] 2	Low	Middle	Upper	Executive
Ranks	d_L	d_M	d_U	d_E
	-	0.019	0.135**	0.187
		(0.076)	(0.068)	(0.117)
Skill*Ranks				
Unmeasured	c_L	c_M	c_U	c_E
	1	0.874***	0.826***	1.129***
		(0.199)	(0.219)	(0.275)
Measured	β_L	β_M	β_U	β_E
	1.192***	1.268***	1.283***	0.987
	(0.261)	(0.158)	(0.167)	(0.336)
Ratio	b_0			
b_0	1.029***			
	(0.012)			
Tests[c] for Equality	Joint	M=L	U=L	E=L
of Slopes c_j	16.27 (0.00)	0.40 (0.53)	0.62 (0.43)	0.22 (0.64)
of Slopes β_j	1.78 (0.62)	0.16 (0.68)	0.15 (0.70)	0.35 (0.55)
of Ratio $b_0 = 1$	5.42 (0.02)			
Overidentification Test[c]	31.76 (0.80)			

a-Dependent variable is wage in level in thousand of marks. Also included are dummies for the type of contract, large firm size, public sector, occupations, industries and years. Both estimat--ions are performed for the comparative advantage case.

b-Estimation of Ω using the residuals from NLIV with $\Omega = I$ in a first step.

c-χ^2-test with p-value in parenthesis.

d-Estimation using variables in t and $t-2$ in the wage equation. Number of observations is 7775.

Appendix 1: Data Selection

First selection:
First selection on age and employement status (full-time, regular part-time or training within the firm). The sas dataset has 61787 observations.

Sample selection for the frequency computations:
Constructions of dummies for individual characteristics, industries and mobility (from the information on changes in employment situation). Selection of monthly nominal wages over 500 marks and computation of wage growth. Exclusion of self-employed workers and computation of weights as relative to the mean weight. The resulting dataset has 41793 observations. Final corrections of intersections between industries and occupations gives the dataset used for the frequency analysis with 32493 observations.

Selection for logit and wage estimations (OLS and GMM):
Supplementary exclusion because of problems in the construction of dummies for ranks within occupations (trainee is considered as a position with two levels trainee or student trainee but these two levels are not comparable with the ranks of white-collared or of other type of positions). They have thus been excluded. Moreover, one of the levels for white-collar workers is non tenured foreman which is difficult to associate with one of the 4 ranks considered. They have thus been excluded. The use of lags in estimations reduced the number of observations to 11929. Further selection of workers who remain within their firm (without change or with intrafirm mobility) lead to the use of 11159 observations for the logit model and the OLS and GMM estimations.

Sample Statisctics (Weighted) GSOEP- All Workers

Real monthly Wage (DM 1985) after Tax	2280.9
Years in School	11.5
Age	36.2
Percentage Female	42.3
Percentage German	90.9
Percentage Blue-Collars	40.2
Percentage White-Collars	47.5
Percentage Civil Servant	9.8
Percentage Trainees	2.5
Number of Observations	32492
Number of Individuals	6171

Sample Statisctics (Weighted) GSOEP- Workers Within Firm

Real monthly Wage (DM 1985) after Tax	2177.72
Years in School	11.1
Age	41.7
Percentage Female	38.5
Percentage German	70.3
Percentage Blue-Collars	53.4
Percentage White-Collars	38.4
Percentage Civil Servant	8.2
Number of Observations	11159
Number of Workers	3487

Appendix 2: Frequency of Mobility and Wage Growth

The possible answers to the question on the changes in employment situation since the preceding year are as follows:

1. no change
2. have a job with a new employer
3. became self-employed
4. have changed position within the firm
5. took up a job for the first time in my life
6. gone back to work after a break

I have categorized the different changes in employment situation into four groups: "No changes" "Separations", "Intrafirm Mobility" and "Other". Answers 2 and 3 are considered as separations, 4 as intrafirm mobility and 6 as other types of moves. I considered workers in the firm for at least one period so observations on answer 5 have been excluded from the sample. Frequencies conditional on potential experience and gender are presented in the Appendix 2.1 Table below. 89% of the workers surveyed experience no changes in employment situation. Among the 11% who are mobile, one half experienced separations while intrafirm mobility accounts for one fourth of the moves. Note also that all types of mobility declines with experience. The percentage of separations is high during the first ten years of experience but decreases rapidly after. Intrafirm mobility declines less rapidly than separations. Note that men experience fewer changes in employment situation than women.

Mean wage growth associated with the four categories of changes is provided in the Appendix 2.2. Based on the difference in the log of current and lagged real wages after deductions for tax and social security (compared to gross earnings, net earnings have been reported more frequently). The Table shows that the mean wage growth resulting from intrafirm mobility is relatively important and quite close to the wage growth workers experience after separations. Since separations are defined to include only moves to a new employer or to self-employment, one might suspect that most of those separations are voluntary and therefore associated with important wage growth.

APPENDIX 2.1: FREQUENCY OF MOBILITY BY EXPERIENCE (GSOEP)

Experience	No Change	Separation	Intrafirm Mobility	Other	N
Men					
0-10	70.6	17.6	5.7	6.2	2869
11-20	87.6	7.4	3.6	1.5	5368
21-30	94.3	2.6	2.2	0.9	5483
31-	96.7	1.8	1.3	0.7	7010
Total	90.1	5.5	2.7	1.7	20730
Women					
0-10	73.2	15.9	5.8	5.1	2468
11-20	84.2	6.5	3.2	6.0	2983
21-30	89.4	4.8	1.9	3.9	2955
31-	95.5	1.2	1.3	0.4	3356
Total	86.4	6.7	2.8	4.1	11762
Total	88.8	5.9	2.7	2.5	32492

APPENDIX 2.2: WAGE GROWTH ASSOCIATED WITH MOBILITY (GSOEP)

Experience	No Change	Separation	Internal Mobility	Other	N
Men					
0-10	.049 (*.005*)	.113 (*.02*)	.102 (*.02*)	.073 (*.04*)	.063 (*.005*)
11-20	.029 (*.002*)	.072 (*.01*)	.080 (*.01*)	.031 (*.14*)	.033 (*.002*)
21-30	.016 (*.002*)	.059 (*.03*)	.033 (*.01*)	.056 (*.04*)	.017 (*.002*)
31-	.009 (*.002*)	.010 (*.04*)	.045 (*.01*)	-.213 (*.14*)	.010 (*.002*)
Total	.020 (*.001*)	.082 (*.01*)	.071 (*.008*)	.024 (*.04*)	.025 (*.001*)
Women					
0-10	.039 (*.004*)	.125 (*.02*)	.158 (*.03*)	.036 (*.09*)	.060 (*.005*)
11-20	.026 (*.003*)	.111 (*.03*)	.078 (*.02*)	.065 (*.05*)	.034 (*.004*)
21-30	.022 (*.003*)	.048 (*.02*)	.042 (*.02*)	.061 (*.08*)	.024 (*.003*)
31-	.014 (*.003*)	.144 (*.05*)	.029 (*.01*)	.149 (*.04*)	.016 (*.003*)
Total	.023 (*.002*)	.107 (*.01*)	.099 (*.01*)	.077 (*.03*)	.030 (*.001*)
Total	.021 (*.001*)	.092 (*.008*)	.081 (*.007*)	.048 (*.03*)	.027 (*.001*)

APPENDIX 3: AVERAGE CHARACTERISTICS BY RANK

Rank [a]	Wage Diff[b]	Edu. (Yr)	Exp. (Yr)	Woman (%)	German (%)	Married (%)	Skill Index
Blue-C							
Unskilled	0	9.4	27.8	63.3	64.5	63.7	-0.29
Semi-skilled	0.37	9.8	26.8	41.1	79.2	60.8	-0.14
Skilled	0.66	10.6	22.4	9.5	89.2	49.5	0.01
Foreman	1.05	10.4	26.6	3.1	92.8	80.5	0.09
Master Crafts.	1.11	10.9	25.9	1.42	98.4	61.3	0.11
White-C							
Simple duties	0	10.9	22.2	81.8	94.6	48.4	-0.30
Qualified	0.64	11.8	21.7	62.7	96.5	50.7	-0.12
Managerial	2.09	14.3	21.9	25.1	96.2	65.5	0.31
C.E.O	2.85	13.8	27.0	0.59	98.2	48.9	0.34
Civil Servant							
Lower	0	10.7	25.4	14.4	100	64.5	0.01
Middle	0.50	11.5	21.5	23.1	100	58.2	0.07
Upper	1.23	14.9	22.3	36.7	99.6	64.2	0.30
Executive	2.24	17.7	24.6	14.8	99.8	77.5	0.65
Aggregate [c]							
Rank 1	0	10.1	25.5	58.9	82.7	56.9	-0.21
Rank 2	0.49	11.3	21.9	39.0	94.0	50.8	-0.05
Rank 3	1.67	13.9	22.7	25.1	96.6	67.1	0.28
Rank 4	2.46	16.1	25.3	14.4	99.1	66.2	0.52

a-Based on a sample of 32492 observations (6171workers).
b-Mean wage differentials relative to the first rank monthly average real wage is (in thousand of marks) 1.37 for blue-collared, 1.41 for white-collared, 1.93 for civil servants and 1.58 for level 1 of the aggregate positions.
c-For the blue-collars, rank 1 is composed of unskilled and semi-skilled work.

Chapter 2

Wage Structure by Firm Size: A comparison of Canada and the United States

2.1 Introduction

A largely documented stylized fact in the empirical literature on wage determination is that large firms pay more than small firms for observationally equivalent workers and jobs. The estimated size-wage premium is about 35% in the United States and 20% in Canada. Different factors have been proposed to explain these size- wage differentials among which the fact that large firms require a more qualified workforce or that they pay higher wages to compensate for harder working conditions or to avoid unionization. Empirical studies that analyzed the question have adopted a common approach. It consists in reviewing the various possible explanations by including factors characterizing them in a Mincer- type wage equation and analyze the resulting reduction in the impact of firm size. In this type of analysis, factors used such as workers' characteristics or union status are assumed to influence wages equally in large and small firms.

This paper uses a different perspective to analyze the impact of firm size on wage outcomes. It considers whether and to which extent firms of different size are characterized by different wage policy. Large and small firms have specific working environment in which the various dimensions of the worker's skills (measured and unmeasured) may not be identically productive. The idea is to investigate the possibility that the workers' skills are differently treated in large versus small firms. Moreover, unions tend to reduce the part of the remuneration that values individual skills and are more concentrated in large than small firms (Freeman (1980), Lemieux (1998)). Therefore, differences in the evaluations of these skills in the wage policy of large versus small unionized and non unionized firms is an empirical question.

First observed by Moore (1911) with Italian data, the relationship between firm-size and wages seems to prevail in most of the labour markets. In the United States, the size-wage gap has been the subject of interest of numerous empirical studies. First reported by Lester (1967), it is Brown and Medoff (1989) who provide the most exhaustive analysis of the employer size-wage effect. They consider several possible reasons why large firms pay more: differences in the quality of the workforce and in working conditions, large firms face a higher threat of unionization, have the ability to pay high wages, have smaller pools of applicants relative to vacancies or have higher monitoring costs. Although some of these explanations contribute to reduce the size-wage gap, none of them can fully explain it and there remains a significant wage premium for workers in large firms. In the same vein, a similar approach has been taken for Canada by Morissette (1993) and Reilly (1993) and the conclusions are similar to those in the U.S. case.

Recent availability of data relating firms' characteristics to characteristics of their workers has allowed to analyze more rigorously the effect of unobserved heterogeneity on the part of workers and firms. Papers by Abowd, Kramarz and Margolis (1999) and Abowd and Kramarz (1999) provide a statistical framework in which compensations are decomposed into measurable characteristics and firm and worker unobserved heterogeneity. Using French and American data, they find that firm-size wage differentials are due 70% to firm heterogeneity and 30% individual heterogeneity. The case of Germany has been studied by Criscuolo (2000) using longitudinal data on workers that also include firm identification, the various controls for worker and job related observable characteristics as well as the fixed-effect estimations to take into account unobserved workers and firms heterogeneity did not reduce the size wage gap by much.

However, in all of the preceding studies, firm size is treated as an exogenous variable. The approach used excludes the possibility that firm size could be a choice variable on the part of the worker as a result of the fact that firms of different size have specific wage policy. For example, given the difficulty and cost associated with measuring performance, large firms should hire workers with more easily observed productivity attributes and the compensation scheme should put more weight on easily observable attributes and less on traits that are not directly observable. Garen (1985) proposes a theoretical model in which the cost of acquiring information about personnel rises with firm size. Large firms screen workers with less accuracy and therefore, offer a compensation scheme that value more easily observable characteristics like education and put less weight on ability traits. Using data from the NLS for the year 1969 and information on IQ tests to proxy ability, he regresses the log of wages on education and the IQ variable both interacted with firm size. Because he does not have a precise measure for firm size[1] and the sample used is small (about 700 observations), he finds some but very weak evidence that the IQ variable has a lower impact in larger firms.

Idson and Feaster (1990) consider the possibility that firm size is endogenous. Using American data from the 1979 May CPS, they estimate the employer-size wage gap correcting for self- selectivity bias. They find that the selectivity bias reduces the estimated gap since they obtain positive selection in small firms and negative selection in large firms. This suggests that unobserved or unmeasured traits drive the workers' choice of large or small firms. Their analysis focuses only on improving the estimation of the size-wage gap but their results on selection support the idea that firm of different size have different wage policy.

This paper presents and estimates a statistical framework in which there is non-random assignment of workers into large and small firms. The worker's skills (measured and unmeasured) are not identically productive in small and large firms. This implies

[1] The NLS has no variables corresponding to firm or establishment size the respondent is employed in. Garen computes a measure of firm size using information on industry. The measure used is the percentage of an industry's labour force employed in establishments of greater than 500 employees.

different wage structures by firm size and workers, maximizing their utility, choose the firm size where their abilities are best suited This results in a particular distribution of the workers' skills across firm size. The objective is therefore to analyze the possibility that firm size affects wages through the non random selection process of workers into firms of different size.

The analysis is applied to cross-sectional data from the LFS for Canada and the March CPS United States for the year 1998. Although similar persistent size-wage gaps have been observed in both countries, the wage profiles by firm size may be quite different in Canada, where unions influence the labour market, than in the United States. The estimation method is first based on OLS to analyze the possibility of different returns to measured skills such as education and experience in large and small firms. When unmeasured workers' characteristics are considered in the wage profiles the estimation relies on an endogenous switching regression estimated using the Heckman two-step method.

The paper is organized as follows. The first Section describes the data and analyzes firm-size differentials for the two countries, in the same spirit as the current literature. Section 3 presents the statistical framework of a model of allocation of workers into firm of different size and describes the estimation method. The results, presented in Section 4, are divided into two parts. The first part compares the wage profiles by firm size for both countries. The second part describes the results from the analysis by firm size and union status. Section 5 discusses the robustness of the results and summarizes the relationship between firm size and union status using the wage decomposition method proposed by Oaxaca and Blinder (1973). Section 6 concludes.

2.2 Description of the Data

This section presents the variables and sample selection used on the LFS and March CPS for the year 1998. Descriptive statistics on the main variables used in the two dataset are presented in Appendix Tables 2.A1.a and 2.A1.b.

2.2.1 Variables and Sample Selection

Whenever possible, variables in both dataset have been defined similarly. Since education is reported categorically in both surveys, I considered the following four categories: university, post secondary, secondary and no diploma (which includes individual reporting partial secondary or without diploma) for Canada, and college, associate college, high school and less than high school for the Unites States.[2] Because age is reported categorically in the LFS, I have created dummies for age in both countries. Other variables similar in both dataset include gender, race, marital status, occupation and industry dummies. For firm size, a dummy indicating that the firm has more than 500 employees at all locations has been created to define large firms for both countries.

The main difference between the two surveys is that the LFS provides information on establishment size. It also contains worker's tenure in his current job but it is not available in the march CPS survey. Potential experience will serve for analyses using cross-country comparison. Finally, wages are given on an hourly basis for all workers in the LFS but not in the CPS. Using information on usual hours worked per week, I computed hourly wages for the United States.[3]

I selected individuals aged between 20 and 65 working full-time. I restricted both samples to observations for which firm-size effects are relevant namely non self-employed individuals working in all industries except construction. The number of observations is 69521 for Canada and 28117 for the United States. The next subsection presents the results of a cross-sectional OLS estimation of employer-size wage differentials, in the same spirit as in the empirical literature, for the two countries.

[2] I call associate college what is reported as associate degree- occupational/vocational or associate degree-academic program. Also individuals reporting some college but no degree are included in the high school diploma category.

[3] The CPS contains several questions related to hourly, weekly or yearly wages. I combined the information from the three different sources to compute hourly wages. For individuals reporting yearly wages, I divided wages by 51 weeks times the reported number of usual hours worked.

2.2.2 Employer-Size Wage Differentials

Since Mincer wage equation, several empirical studies on the determinants of wage and wage growth have analyzed the possible departures from the basic wage specification that includes education and a quadratic in experience. One reason is that it is derived from a model of optimal investment in human capital and, therefore, only describes the supply side of the labour market. These studies' approach consists in adding to the wage equation, variables that can best describe and capture variations in wages related to the different dimensions of the demand side of the labour market (firm, occupation and industry dummies). This led to the controversial results on the presence firm-size (and inter- industry) wage differentials, even after controlling for a wide set of work related and workers' characteristics.

In this Section, I replicate the results on firm-size wage gaps using data from the LFS and CPS for 1998. I regress the log of wages on a dummy variable characterizing large firms and add control variables to see how it affects the magnitude and significance of the coefficient on firm size. Results are reported in columns (I) to (V) of Table 2.1. Note that for Canada, column (I') and (II') shows the results with additional control for establishment size.

Column (I) for both countries shows the average size-wage gap for all workers with no controls added. It is of 22% for Canada and is 27.9% for the United States.[4] Their magnitude has not changed much over time since the coefficients are similar to the one estimated in Morissette (1993) using the Canadian Labour Market Activity Survey (LMAS) for the year 1986 and in Oi and Idson (1999) with the May 1983 CPS. Note that when establishment size is introduced (column (I') of the Table for Canada), the size-wage gap related to the size of the company is reduced by half but the establishment size-wage gap is still important, estimated at 24.1%. Both establishment and company size have a significant impact on wages but establishment size seems to have a larger impact than company size.

Column (II) presents the results when education and experience (and tenure for

[4]The percentage is the anti-log of the regression coefficient minus one.

Canada) are added to the wage equation. The coefficients associated with firm size drop for both countries compared to column (I), more for Canada than the United States. This must be due to the additional control for tenure with the firm which is absent in the US data. Column (II') shows the results with establishment and firm size. One can see that adding workers characteristics has a stronger impact on firm than establishment size. The establishment size-wage gap is 15.4% and 3.4% for firm size.

The effect of union membership[5] shown in column (III), does not reduce the size-wage gap by much in the United States, the reduction is more important in Canada. The addition of industries and occupations (columns (IV) and (V)) reduces the effects of firm and establishment size for Canada but leaves a size-wage gap related to establishment size equal to 11.9%, controlling for firm size. In addition, the coefficient on firm size is small but still significant. For the United States, the size-wage gap is 14.2% with no control for establishment size. Comparing with Canada, an estimation with no control for establishment size leads to a coefficient on firm size of 0.059 which is half the size of the coefficient estimated in the U.S. case. Firm size has a stronger impact on wages in the United States than in Canada. On the other hand, the possibility to control for establishment size in the Canadian data allows to see that establishment size has a stronger impact on wage outcomes than firm size.

2.3 Statistical Framework

The main difficulty in the analysis of wage determination is that it refers to a general equilibrium context and therefore has to deal with disentangling the effects on wages of simultaneous movements in labour supply and demand, not easy to handle empirically. However, the literature on assignment and the distribution of earnings, first studied by Roy (1951) and developed after by Sattinger (1975 and 1993), provides an understanding of a mechanism by which wages reflect the interdependence of supply and demand factors. Wages, based on the value of the firm's marginal product, do not depend only on the worker's skills, but also on the way skills are assigned to the tasks involved in the

[5]The dummy for union membership also include workers covered by collective agreements.

firm's production process. In this context, the worker's abilities will not be identically productive in all firms given that firms differ in their production technologies.

The next Section describes a model of assignment of workers into firms of different size with the worker's skills rewarded differently in large and small firms. It provides a statistical framework and the estimation method to analyze the implications of non-random assignment of workers into firms of different size based on the worker's measured and unmeasured skills.

2.3.1 Formalization

Assume two types of firms, indexed by $j = S$ (small), L (large), which differ by size and technology used. The only input is labour and it is given in efficiency units. Workers, indexed by $i = 1, ..., N$, are characterized by a vector of productive abilities, (S_i, θ_i), where S_i denotes observed skills such as the level of education and θ_i is ability, unobserved by the econometrician and imperfectly observed by firms. The production technology of firm j exhibits constant returns to scale with respect to labour:[6]

$$Q^j = \sum_{i=1}^{N^j} n_i^j (S_i)^{\alpha_j} (\theta_i)^{\beta_j}, \; j = S, L \tag{2.1}$$

where N^j is the total number of employees in firm j and n_i^j is the number of employees of type i (endowed with (S_i, θ_i)) in firm j. There is one output to produce whose price is normalised to one. The profit maximizing condition for both types of firms implies the following conditions on the marginal product of workers with abilities (S_i, θ_i):

$$w_i^j = \frac{\partial Q^j}{\partial n_i^j} = (S_i)^{\alpha_j} (\theta_i)^{\beta_j} \tag{2.2}$$

The wage offered by large and small firms will therefore be, in log form:

$$lnw_i^L \;\; = \;\; \alpha_L lnS_i + \beta_L ln\theta_i, \;\; \text{for large firms} \tag{2.3}$$

[6]It is assumed that firms of different size have different production technology and that both have constant returns to scale to simplify the analysis. Other assumptions on returns to scale would involve finding the optimal size for both firms which is beyond the scope of this paper.

$$lnw_i^S = \alpha_S lnS_i + \beta_S ln\theta_i, \text{ for small firms} \tag{2.4}$$

On the workers' side, it is assumed that workers are exogenously given abilities (S_i, θ_i) so that investment in human capital is ignored. Workers are utility maximizers and the utility associated with working in a large or small firm is assumed to depend on the firm's attributes such as the wage rate and the working environment that are firm-size specific. Also workers choose a large (small) firm because they have a comparative advantage in that firm (compared to a small (large) firm) that increases their well-being. Letting V_i^j denotes the utility of working in a firm of size j, $j = L, S$, a worker chooses a large firm if his utility is maximized, that is if $V_i^L > V_i^S$. Define Z_i as a vector of individual characteristics that affect the utility of being in a large (or small firm), the indirect utility function is:

$$\begin{aligned} lnV_i^j &= \psi_0 + \psi_1 lnw_i^j + \psi_{2j} Z_i \\ &= \psi_0 + \psi_1 \alpha_L lnS_i + \psi_{2j} Z_i + \psi_1 \beta_L ln\theta_i, \quad j = L, S \end{aligned} \tag{2.5}$$

where (2.5) results from replacing the wage equation offered by large or small firm given in (2.3). Utility is not directly observed but the net gains associated with the choice of, let's say, a large firm is represented by:

$$lnV_i^L > lnV_i^S \quad \leftrightarrow \quad \psi_1(\alpha_L - \alpha_S)lnS_i + (\psi_{2L} - \psi_{2S})Z_i + \epsilon_i > 0 \tag{2.6}$$

where $\epsilon_i = \psi_1(\beta_L - \beta_S)ln\theta_i$ is an individual disturbance error affecting utility. Representing the net gain from choosing a large firm by the latent variable U_i^* and redefining the coefficients in terms of ϕ_1 and ϕ_2, we have:

$$\begin{aligned} U_i = 1 \;\; iff \;\; U_i^* > 0 \quad &\leftrightarrow \quad \phi_1 lnS_i + \phi_2 Z_i + \epsilon_i > 0 \\ U_i = 0 \;\; iff \;\; U_i^* \leq 0 \quad &\leftrightarrow \quad \phi_1 lnS_i + \phi_2 Z_i + \epsilon_i \leq 0 \end{aligned} \tag{2.7}$$

The allocation of workers into firm size and the wages received will therefore be given by the following allocation rule: The worker with endowment (S_i, θ_i) chooses a large firm iff:

$$U_i^* > 0 \quad \leftrightarrow \quad \theta_i > g(\alpha_S - \alpha_L, \beta_L - \beta_S, S_i, \psi_1, \psi_2)$$

This inequality defines the conditional distribution of the worker's innate ability, θ_i, given S_i across firm size.

2.3.2 Estimation

This section presents the equations to be estimated and the estimation method used to test whether and to which extent there is evidence of different wage structures by firm size. This will be done in two steps. As a first approach of the question, I consider the case where measured skills are differently evaluated in large and small firms. To do so, I interact a firm size dummy with variables on education and experience and estimate the resulting wage equation with OLS. The possibility of different wage profile by firm size is tested with χ-squared tests for equality of the coefficients between large and small firms. The second step includes the case where the worker's unmeasured skills are also differently productive in small and large firms (for example the ability to take initiatives at work and be independent could be appreciated more in small than large firms where the internal organization is stricter). In this case, the statistical model relates to a switching equation with endogenous switching and can be summarized in the following equations:

$$\begin{aligned} lnw_i^L &= X_i\gamma_L + u_{iL} \\ lnw_i^S &= X_i\gamma_S + u_{iS} & (2.8) \\ U_i^* &= W_i\delta - \epsilon_i & (2.9) \end{aligned}$$

$$\begin{aligned} \text{where } u_{iL} &= \beta_L ln\theta_i \\ u_{iS} &= \beta_S ln\theta_i \\ \epsilon_i &= \psi_1(\beta_L - \beta_S)ln\theta_i & (2.10) \end{aligned}$$

Normality assumption on the vector of error terms and the correlation between u_{iL}, u_{iS} and ϵ_i define the Mills ratio to be added in the wage equation in order to taken into account self-selectivity. Denote by $\sigma_{\epsilon L}$ and $\sigma_{\epsilon S}$ the covariance between ϵ and u_{iL} and u_{iS} respectively. Assuming normality of the vector of error terms defined in (2.10), the mean wage of workers in large (small) firms given that they chose to work in a large (small) firm is:

$$E[lnw_i^L|U_i^* > 0] = X_i\gamma_L + E[u_{iL}|\epsilon_i < W_i\delta] = X_i\gamma_L - \sigma_{\epsilon L}\frac{\phi(W)}{\Phi(W)} \quad (2.11)$$

$$E[lnw_i^S|U_i^* \leq 0] = X_i\gamma_S + \sigma_{\epsilon S}\frac{\phi(W)}{1-\Phi(W)} \quad (2.12)$$

The estimation has been performed using the Heckman two-step method in the following way. The first step considers a probit model to estimate the worker's probability to choose a large firm and computes the resulting mill's ratio. The second step estimates the wage profiles augmented by the mill's ratio. The resulting estimations provide information on the effects of education and experience on wages in small and large firms as well as the effect of the Mills ratio in each case. The estimated coefficient associated with this term corresponds to the covariance between the error terms in the wage profiles and the error term in the selection equation.

Variables in the matrix W describe the gains associated with the worker's decision to choose a large firm. They include individual characteristics X from equations (2.8) and variables that influence the choice of firm size Z without directly influencing the workers' individual wage. These variables have been chosen using information on the worker's city size and effective hours worked in the firm. It is assumed that the worker's living environment such as living in a large or a small city is correlated with his choice of working environment like working in a large or a small organization. In other words, any unobserved variables influencing the choice of city size should also influence the choice of firm size. To control for the fact that firms in some industries may also have preferences in being located in large (or small) cities, I used the interaction between the worker's city size and industry. This way, the variation used is considered within an

Correlation between Firm and City Size and Effective Hours

Correlation		Canada Firm size	United States Firm size
City Size		-0.16	-0.18
By Industry:			
	Agriculture	0.001	-0.15
	Durable/Non Durable	-0.05	-0.32
	Transport	0.06	0.64
	Trade	0.05	0.17
	Finance	0.06	0.59
	Services	0.001	0.14
	Civil Service	0.03	0.48
Effective Hours		0.02	0.20

industry with no direct effect of city size on the individual's wage.

For the number of effective hours worked (as opposed to usual hours worked), the idea is that the actual work load may be different in small and large firms. Because small firms have more informal administration and also have to keep up with the production pace of large firms, workers may put additional hours of overtime more easily than in large firms. The table below summarizes the correlation between firm size and city size and firm size and actual hours worked.

For both countries, the correlation between firm size and effective hours worked is positive. The correlation with city size is positive in non manufacturing sectors but not over all industries. Note also that the coefficients are much smaller for Canada. This may come from the fact that the LFS only provides information on whether the individual belongs to one of the three biggest metropolitan areas in Canada, namely Vancouver, Montreal and Toronto. This restricts the range of possible size to four categorical values.[7] In the CPS, the variable describes a larger range of possible size from under 100,000 individuals to 5 millions, taking seven possible values.

[7]Note that because city size applies to Vancouver, Montreal and Toronto only, I performed the analysis of Section 3 using only observations for the three associated provinces, namely British Columbia, Québec and Ontario.

2.4 Results

2.4.1 Wage Profiles by Firm Size

This section considers whether the data support evidence of different wage policy by firm size, first in terms of measured skills such as education and experience, and then with respect to unmeasured skills.

Firm-Size and Measured Skills

Results are presented in Table 2.2 for both countries. The column following the coefficient column presents the value of the χ squared statistic from a test of equality of the coefficients in large and small firms with the p-value in parenthesis.

The results for both countries are quite different. In Canada, there is evidence of a different impact by firm size at all education level with χ squared statistics of 7.98, 3.01, 8.49 and 15.38 for workers with no secondary, secondary, post secondary and university diploma respectively. On the other hand, there is no significant differences in the evaluation of experience in small and large firms.[8] In the US case, there is no significant differences in the evaluation of education for small and large firms but the differences are significant for experience. Although the difference is small, large firms seems to reward significantly more experience than small firms.

A surprising finding in Canada is that the impact of education is higher in *small* than in large firms. Compared to workers with no secondary education in small firms, a university diploma in small firms adds 0.38 more to the wage and 0.32 in large firms, a difference close to 18%. This suggests that high educated workers would actually be better suited in small firms contrary to the common view that large firms attract more educated workers.

Overall, the comparison of the results for the two countries suggests that education seems to be an important factor driving the allocation of workers into large and small firms in Canada but not in the United States. On the other hand, it is possible that

[8] Results are similar whether a quadratic function of tenure is included or not.

in the U.S. case, the selection of workers into large and small firms is based mostly on unmeasured skills. The next subsection analyzes this possibility.

Firm-Size and Unmeasured Skills

Table 2.3 shows the results of the endogenous switching model in which it is assumed (and tested) that workers select themselves into large and small firms according to measured and unmeasured skills.

The analysis of the results will be done in two parts. On one hand, there is the result on the coefficient associated with the Mills ratio whose significance reveals the importance of unmeasured skills and self-selection based on unmeasured skills. The sign of the coefficient indicates the direction of the selection. [9] The other part of the analysis is related to the impact that the inclusion of the Mills ratio has on the other coefficients of the wage equation. Results are presented in Table 2.3.

One can see from the left part of the Table for Canada that the Mills ratio in the wage equation for large firms is significantly negative but not significant for small firms, suggesting positive selection in large firms. In other words, large firms attract better workers in terms of unmeasured ability. Note that secondary education is not anymore significant and university only weakly significant in the wage profile for large firms after unmeasured ability has been taken into account.

The right part of Table 2.3 shows the results for the United states. As in Canada, there is evidence of positive selection based on unmeasured skills given the negative sign of the Mills ratio in the wage profile for large firms. Contrary to Canada, education keeps a significant impact in the wage equation for large firms when corrected from unmeasured self-selection.

Summarizing the results of the last two subsections, evidence of a different wage structure by firm size is more pronounced in Canada than in the United States. It

[9] Given the definitions of the net gains associated with choosing a large firms, the mean wage of workers given that they choose a large firm can either increase (negative sign or positive selection) or decrease (positive sign or negative selection) by the addition of the Mills ratio depending on the covariance between the error term in the selection equation and the error term in the wage equation in large firms.

translates into different evaluation of education in large and small firms in Canada and a different way to reward experience in U.S. large and small firms. When selection on unmeasured skills is taken into account, although in both countries there is evidence of a positive selection in large firms, the results on the impact of the other variables are different for the two countries. In Canada, education is weakly significant in the wage equation for large firms suggesting that the selection operates mostly on unmeasured ability. In the United States, the inclusion of the Mills ratio reduces the impact of education and experience but their effect on wages remains significant and important.

Because of the importance of unions in Canada (34.9% of the workers in the sample are unionized or covered by collective agreements) and given the findings that unions tend to reduce the impact of the worker's characteristics on wages (Freeman (1984), Lemieux(1993)), it is interesting to analyze separately the wage profile by firm size for unionized and non unionized firms. In the next subsection, I divided the samples into two samples of non unionized and unionized workers and re-run the preceding estimations.

Firm-Size and Union Status

Tables 2.4 and 2.5 show the results of OLS estimations for non unionized and unionized workers respectively. One can see that for non unionized firms, the results are this time similar for the two countries. There is no significant differences in the evaluation of education by large and small firms. Experience is differently rewarded in large firms. Table 2.5 for unionized firms shows significant wage profiles by firm size in Canada where a university diploma is more evaluated in small than large firms. Because unions are almost absent in the US labour market (only 2.3 % of the workers in the sample), the results for the United States are more imprecise and there is no significant differences in the wage profile by firm size.

To get a complete picture of the wage profile by firm size, the next step analyzes the role of unmeasured skills from applying the Heckman two-step estimation to the two samples of non unionized and unionized workers. Results are presented in Table 2.6 and 2.7 respectively.

Table 2.6 shows the results for non unionized workers in Canadian and American firms. They have similar estimated Mills ratio suggesting again positive selection in large firms. Including the selection term in the wage equation has a similar impact on education and experience in both countries. The coefficients are reduced but remain significant suggesting that the selection mechanism into large and small firms is not completely driven by unmeasured skills.

In the unionized case, the results for the United States are again not conclusive since the Mills ratios are not significant (right part of Table 2.7). For Canada (left part of Table 2.7), the Mills ratio is again significantly negative in large firms and this time, it is significantly positive in small firms. This implies positive selection in both large and small unionized firms. The inclusion of the ratio in each wage equation reduces the impact of education and experience in both large and small firms but more in large firms. These results suggest that unmeasured skills matter in the wage policies of both large and small firms and seem to suggest that education matters more in small than large unionized firms.

Summarizing the results of this Section, wage profiles by firm size in both countries are similar for non unionized firms with no differences in wage profiles by firm size in terms of education but significant differences for experience. There is evidence of positive selection in large firms implying that large firms attract better workers in terms of unmeasured characteristics. For unionized firms, the results for the United States are not conclusive but for Canada, there is evidence of positive selection in large and small firms. Education and experience have larger impact on wage outcomes in small firms even after including the Mills ratio. This suggests that both measured and unmeasured skills influence the wage policies of large and small firms and the selection mechanism.

Finally, from the results specific to Canada, establishment size has a stronger impact on wages than firm size and the inclusion of tenure did not change the result on the different evaluation of experience in large and small firms. In addition, there is no significant differences in the impact of tenure in small and large firms. [10]

[10] Results not shown but available upon request.

2.5 Discussion

This Section discusses the preceding results on the role of unmeasured skills in the wage profile by firms size. It also extends the conclusions on the differences in the wage profiles by firm size and union status by applying the wage decomposition method proposed by Oaxaca/Blinder to analyze the size-union-wage gap.

2.5.1 The Role of unmeasured Skills

To take into account the role of unmeasured skills as a possible factor driving the assignment of workers into large and small firms, the appropriate method in the case of an analysis with cross-sectional data is the Heckman two-step method. This method proposes a correction of the selection bias due to the fact that workers may not be randomly allocated into large and small firms and may rather choose the firm according to its size. The correction procedure requires to include a correction term into the wage equation, the Mills ratio, computed in a first step with a probit model to estimate the probability of choosing a large firm.

The use of a probit model comes from the estimation of the selection equation defined in equations (5) and (11) and the assumption that the error terms in the wage and selection equations are log-normally distributed. One disadvantage of this method is that, with a minimum set of explanatory variables in the probit equation (like including only the variables in the wage equation), the Mills ratio is always identified in the wage equation because of the non linearity of the probit function. Considering additional variables that may influence the choice of a large firm without directly influencing the worker's wage provides a way to bring more economical content to the Mills ratio and the selection equation. Two variables have been used for that matter, a dummy for the number of hours worked that are more than 40 hours and dummies for city size interacted with industry. A question arises as to whether these variables have a significant impact in the selection equation.

The lower half of Tables 2.3, 2.6 and 2.7 show the results from the estimation of the selection equation for all, non unionized and unionized firms respectively. One can see that the dummy for effective hours worked is significant in Canada for non unionized and unionized firms and suggests that this variable increases the probability of choosing a large firm. It is significant only in U.S. unionized firms. I re-estimated the model without including the dummy for hours and found very similar results in terms of the magnitude and significance of the estimation of the Mills ratio in the wage equation. [11] For the variables on city size, the result of the F statistics to test the joint significance of these variables rejects the hypothesis that their effect are jointly equal to 0.

In summary, the results from the Heckman estimations seem to be robust to changes in the sepcification of the selection equation. From these results, one can conclude on the existence of non random selection of the workers into firms of different size. On the other hand, the approach used does not allow to measure the relative impact of measured and unmeasured skills in the selection mechanism. Obtaining panel data that follow workers over several years and trace the change in employers and employer's size would help characterizing more precisely whether and the extent to which workers have a comparative advantage in firms of different size based on unmeasured skills.

The analysis so far has described the role of the worker's measured and unmeasured skills in the wage profile by firm size. Given the difference in the results for non unionized and unionized firms, it would be interesting to decompose the analysis of the wage profiles by union and firm-size to obtain a measure of the part explained by size and the part explained by unions. To do so, I performed a size-union wage decomposition using the Oaxaca- Blinder method. The next subsection presents the method and the results. They show which part of the differences in the evaluation of the worker's characteristics is due to firm-size and which is due to unions.

2.5.2 Size-Union-Wage Gap and Workers Characteristics

In order to get a distinct measure of the part of the gap explained by firm size and the one explained by union, I decompose the union-size wage gap in the following way:

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[11] Results are available upon request.

$$\underbrace{W_{LNU} - W_{SNU}}_{\text{Total effect}} = \underbrace{(W_{LNU} - W_{LU})}_{\text{Union in Large}} + \underbrace{(W_{LU} - W_{SU})}_{\text{Size in Union}} + \underbrace{(W_{SU} - W_{SNU})}_{\text{Union in Small}} \tag{2.13}$$

$$\underbrace{W_{LU} - W_{SU}}_{\text{Total effect}} = \underbrace{(W_{LU} - W_{LNU})}_{\text{Union in Large}} + \underbrace{(W_{LNU} - W_{SNU})}_{\text{Size in NonUnion}} + \underbrace{(W_{SNU} - W_{SU})}_{\text{Union in Small}} \tag{2.14}$$

Note that with the wage equation estimated over the four sub- samples of large and small non unionized and unionized firms, the aggregate size-wage gap is given by the sum of equations (2.13) and (2.14): [12]

$$\underbrace{W_L - W_S}_{\text{Size effect}} = \underbrace{(W_{LU} - W_{SU})}_{\text{Size in Union}} + \underbrace{(W_{LNU} - W_{SNU})}_{\text{Size in NonUnion}} \tag{2.15}$$

Where wages are in log and wage differences decompose into the following:

$$W_{LK} - W_{SK} = \Sigma_K[\ \underbrace{(X_{LK} - X_{SK})\beta_{LK}}_{\text{Difference in Endowments}} + \underbrace{(\beta_{LK} - \beta_{SK})X_{SK}}_{\text{Difference in Betas}}\ ], \quad K = U, NU \tag{2.16}$$

Table 2.8 presents the results from the union-size-wage gap for Canada and the United States. The results of the table show the overall impact of the variables as well as the impact through education and experience.

The two main columns of the Table for each country show the decomposition by firm size in unionized (upper half) and non unionized (lower half) and by union status in small (upper half) and large (lower half) firms respectively. The last row shows the total size-wage gap over non unionized and unionized firms (first column) and the total union-wage gap over large and small firms (second column). Each column is subdivided into three columns that describe the part due to differences in endowments or in the explanatory variables in the wage equations, the part due to differences in the estimated

[12]Self-selection of workers into large and small firms is taken into account by including the mills ratio in each of the four equations. The Mills ratio's computation is based on two probit estimations for the probability of choosing a large firm, one over the sample of non unionized workers and the other for unionized workers. Selection bias and non random assignment based on unmeasured ability is considered between large and small firms but not between unionized and non unionized firms.

coefficients and the last column named total is the sum of these two parts.

Considering first the decomposition of the size-wage gap in unionized and non unionized firms for both countries (first and third column), one can see from the sub-column total that for Canada, size in unionized firms represents 44.2% of the total size-wage gap when it is only 23.8 % for the United States. In both countries, the differences mainly come from differences in the betas (0.151 for Canada and 0.193 for the United States).

Analyzing by type of characteristics, one can see that in both countries, education, and especially university, accounts for a larger part in non unionized than unionized firms. Experience contributes much more to the size-wage gap than education with a total effect of -0.064 in unionized firms and 0.101 in non unionized firms in Canada. Note that the effect is negative in unionized Canadian firms implying that experience is more rewarded in small than large firms as found in the previous section. It is also the case for post secondary and secondary education but not for university.

Considering the decomposition of the union-wage gap in large and small firms (columns 2 and 4), one can see that for Canada it is similar in small and large firms, with 55.1% of the total union- wage gap in small firms. It is not the case in U.S. firms where 95.5% of the union gap is in small firms. The average union wage differential in large firms is -0.007 which is surprisingly small and negative. A critic of the Oaxaca-Blinder method is that the result is not invariant to the constant term (Jones (1983)). Given that its definition depends on the base category chosen in the estimation (I omitted single white male workers in the primary sector with no high school education), I performed the estimation changing some of the characteristics of the base category but did not obtain a larger average wage differential. This result may be due to the small sample size for unionized workers.

In summary, the results show evidence that in the union-size wage gap, the size effect is only slightly larger in non unionized than in unionized firms for Canada. It is substantially larger for the United States. The union effect in the union-size wage gap is slightly larger in small than in large firms in Canada and a lot larger in U.S. small firms. Note that these last results are based on the assumption of random assignments of workers into unionized and non unionized firms. Only firm size is considered an endogenous variable. An extension of these results would consider a correction for selectivity for both firm size and union status by including the Mills ratio computed from a bivariate probit.

2.6 Conclusion

The objective of this paper is to explain the link between firm size and wage outcomes through the nonrandom selection of workers into firms of different size. Using cross-sectional data for Canada and the United States, I test whether large and small firms have distinct wage profiles that reward measured skills such as education and experience differently. I investigate the impact of unmeasured skills by considering a Heckman two-step estimation to test the importance of self-selection based on unobserved skills. In addition, given that I compare the wage profiles for Canadian and U.S. firms, I analyzed the wage profiles over the samples of unionized and non unionized workers.

The results show some evidence of different wage structure by firm size. It is more pronounced in Canada than in the United States. It translates into different evaluation of education in large and small firms in Canada and a different way to reward experience in U.S. large and small firms. When selection on unmeasured skills is taken into account, there is evidence of positive selection in large firms in both countries for non unionized workers. For unionized workers, there is no significant results for the United States and evidence of positive selection in both large and small unionized firms in Canada. In addition, from the Oaxaca/Blinder union-size decomposition, the results show evidence that in the union-size wage gap, the size effect is slightly larger in non unionized than in unionized firms for Canada and substantially larger for the United States.

These results shed light on the importance of the non random allocation of workers into firms of different size. High (unobserved) ability workers seem to have a comparative advantage in working in large firms. There is however no clear conclusions on the type of workers ending up in small firms since the Mills ratios were not significant.

The estimation used and the approach to the nonrandom selection problem has considered only one side of the selection process: workers of different skills choosing firms of different size. On the other hand, the allocation of workers into firm of different size is the result of the decisions of both the workers to join a large or a small firm and the firms to hire them. With panel data on employer's size, one could apply the econometric framework proposed by Lemieux (1998) to estimate the effects of unions on wage outcomes. The approach is based on the estimation of a union wage policy function that reward workers'observed and unobserved skills. The panel data estimator used is robust to nonrandom selection on the two sides of the market and allows to estimate separate effects for unobserved ability in the union and non union sectors. Treating firm size as a time invariant characteristics or at least constant for some period of time, the use of this panel data estimator would allow to precisely identify wage policy functions by firm size with distinct effects of measured and unmeasured skills.

Finally, the results from the union-size wage gap decomposition strongly suggest that skill rewards depend on the interaction of both firm size and union status. It would therefore be interesting to apply the econometric method to the estimation of wage policy by firm-size and union status.

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Table 2.1: Firm Size Wage Differentials[a], Canada-United States

Canada[b]	(I)	(I')	(II)	(II')	(III)	(IV)	(V)
Large Firm	0.200***	0.11***	0.093***	0.037***	0.029***	0.019***	0.013***
	(0.005)	(0.006)	(0.004)	(0.004)	(0.004)	(0.004)	(.004)
Large Establishment		0.216***		0.139***	0.131***	0.121***	0.113***
		(0.007)		(0.006)	(0.006)	(0.006)	(0.006)
Union					0.069***	0.043***	0.080***
					(0.004)	(0.004)	(0.004)
University			0.583***	0.580***	0.578***	0.565***	0.371***
			(0.006)	(0.006)	(0.006)	(0.007)	(0.006)
Post secondary			0.299***	0.297***	0.296***	0.289***	0.204***
			(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Secondary			0.177***	0.177***	0.179***	0.175***	0.127***
			(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Experience			0.023***	0.023***	0.022***	0.021***	0.019***
			(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Tenure			0.035***	0.034***	0.033***	0.033***	0.030***
			(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Industry	No	No	No	No	No	Yes	Yes
Occupation	No	No	No	No	No	No	Yes
R2	0.04	0.06	0.38	0.39	0.39	0.41	0.49

United States[b]	(I)	(II)	(III)	(IV)	(V)
Large Firm	0.246***	0.159***	0.158***	0.152***	0.133***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Union			0.033***	0.030***	0.079**
			(0.013)	(0.013)	(0.013)
College		0.869***	0.869***	0.852***	0.613***
		(0.016)	(0.016)	(0.016)	(0.018)
Ass. College		0.550***	0.549***	0.520***	0.363***
		(0.018)	(0.018)	(0.018)	(0.018)
High School		0.379***	0.379***	0.355***	0.274***
		(0.012)	(0.014)	(0.014)	(0.014)
Experience		0.041***	0.041***	0.039***	0.038***
		(0.001)	(0.001)	(0.001)	(0.001)
Industries	No	No	No	Yes	Yes
Occupations	No	No	No	No	Yes
R2	0.03	0.27	0.27	0.29	0.33

a-Based on a sample of 65921 observations for Canada and 25812 for the United States. Dependent variable is log of hourly wages. Standard Errors in parenthesis.
b- Base categories are no High School education, small firms and primary sector.

Table 2.2: Wage Structure by Firm Size[a]

Variables[b]	Size	Canada Coeff	χ^2-test[c]	USA Coeff	χ^2- test[c]
Large Establishment		0.120***		-	
		(0.007)			
No Secondary	Large	1.979***	7.98	1.922***	0.53
/ No High School		(0.017)	(0.005)	(0.045)	(0.467)
	Small	1.926***		1.899***	
		(0.012)		(0.043)	
Secondary	Large	0.123***	3.01	0.153***	0.04
/ High School		(0.011)	(0.083)	(0.018)	(0.841)
	Small	0.147***		0.158***	
		(0.008)		(0.016)	
Post Secondary	Large	0.186***	8.49	0.220***	0.02
/ Asso. college		(0.012)	(0.004)	(0.021)	(0.88)
	Small	0.226***		0.216***	
		(0.008)		(0.021)	
University	Large	0.319***	15.38	0.461***	0.12
/ College		(0.014)	(0.000)	(0.020)	(0.728)
	Small	0.382***		0.470***	
		(0.011)		(0.019)	
Experience	Large	0.027***	0.15	0.029***	4.50
		(0.001)	(0.701)	(0.001)	(0.033)
	Small	0.026***		0.024***	
		(0.001)		(0.001)	

a-Based on a sample of 39321 observations for Canada (only Québec, Ontario and BC) and 25812 observations for USA. Standard errors in parenthesis.

b-Dependent variable is log hourly wages. Estimations without constant term. Also includes industry and occupation dummies. Estimates relative to workers in small establishments of small firms in the primary sector.

c-Test of equality of slopes between large and small firms, p-value in parenthesis.

Table 2.3: Heckman Two-Step Estimations[a], Canada-United States

Variables[b]	Canada > 500 Uncorrected	Canada ≤ 500 Uncorrected	Canada > 500 Corrected	Canada ≤ 500 Corrected	United States > 500 Uncorrected	United States ≤ 500 Uncorrected	United States > 500 Corrected	United States ≤ 500 Corrected
University	0.362***	0.361***	0.061*	0.379***	0.473***	0.442***	0.395***	0.393***
/ College	(0.014)	(0.010)	(0.035)	(0.024)	(0.023)	(0.022)	(0.041)	(0.042)
Post Secondary	0.213***	0.212***	0.055***	0.220***	0.235***	0.183***	0.175***	0.147***
/ Asso. College	(0.011)	(0.007)	(0.020)	(0.013)	(0.024)	(0.023)	(0.036)	(0.035)
Secondary	0.147***	0.137***	-0.012	0.145***	0.155***	0.146***	0.106***	0.117***
/ High School	(0.011)	(0.007)	(0.020)	(0.013)	(0.020)	(0.017)	(0.039)	(0.027)
Experience	0.027***	0.026***	0.026***	0.026***	0.029***	0.023***	0.028***	0.022***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)
Mills Ratio[d]			-0.887***	-0.073			-0.213*	0.139
			(0.185)	(0.170)			(0.144)	(0.129)
N	13684	25541			12562	9706		
Selection[c]	**Equation**							
Variables			Marg. Effect					
Hours > 40			0.015**				0.001	
			(0.005)				(0.006)	
Union			0.181***				0.139***	
			(0.006)				(0.015)	
Public			0.189***				0.293***	
			(0.009)				(0.009)	
Industry*City			Yes				Yes	
F-test (p-value)			30.41	(0.000)			28.06	(0.000)

a-Based on a sample of 39321 observations for Québec, Ontario and British Columbia and 25812 observations for the United States.

b-Dependent variable is log of hourly wages. Race, married, union, industry and occupation dummies are included in the wage equation for both countries. Establishment size is also included for Canada.

c-The probit includes variables in the wage equation interactions between large cities and industries.

d-Standard error computed using bootstrapping.

Table 2.4: Wage Structure by Firm Size, *Non Unionized* Firms[a]

Variables[b]	Size	**Canada** Coeff	χ^2-test[c]	**USA** Coeff	χ^2- test[c]
Large Establishment		0.175***		-	
		(0.011)			
No Secondary	Large	1.882***	6.68	1.923***	0.40
/ No High School		(0.023)	(0.009)	(0.046)	(0.529)
	Small	1.815***		1.901***	
		(0.015)		(0.044)	
Secondary	Large	0.174***	0.76	0.156***	0.00
/ High School		(0.019)	(0.384)	(0.019)	(0.99)
	Small	0.155***		0.156***	
		(0.010)		(0.016)	
Post Secondary	Large	0.243***	0.22	0.220***	0.12
/ Asso. college		(0.019)	(0.636)	(0.022)	(0.728)
	Small	0.232***		0.209***	
		(0.010)		(0.021)	
University	Large	0.389***	0.07	0.463***	0.03
/ College		(0.021)	(0.792)	(0.022)	(0.862)
	Small	0.383***		0.468***	
		(0.013)		(0.019)	
Experience	Large	0.032***	7.07	0.029***	4.21
		(0.001)	(0.008)	(0.001)	(0.040)
	Small	0.026***		0.024***	
		(0.001)		(0.001)	

a-Based on a sample of 23894 observations for Canada (only Québec, Ontario and BC) and 24799 observations for USA. Standard errors in parenthesis.

b-Dependent variable is log hourly wages. Estimations without constant term. Also includes industry and occupation dummies. Estimates relative to workers in small establishments of small firms in the primary sector.

c-Test of equality of slopes between large and small firms, p-value in parenthesis.

Table 2.5: Wage Structure by Firm Size, *Unionised* Firms[a]

Variables[b]	Size	Canada Coeff	χ^2-test[c]	USA Coeff	χ^2- test[c]
Large Establishment		0.066***		-	
		(0.008)			
No Secondary	Large	2.289***	19.12	1.757***	0.01
/ No High School		(0.024)	(0.000)	(0.129)	(0.924)
	Small	2.156***		1.742***	
		(0.023)		(0.168)	
Secondary	Large	0.096***	1.41	0.108**	0.78
/ High School		(0.013)	(0.234)	(0.047)	(0.377)
	Small	0.117***		0.192**	
		(0.012)		(0.082)	
Post Secondary	Large	0.152***	4.52	0.195***	2.68
/ Asso. college		(0.013)	(0.033)	(0.061)	(0.101)
	Small	0.190***		0.395***	
		(0.012)		(0.108)	
University	Large	0.259***	16.99	0.386***	1.00
/ College		(0.017)	(0.000)	(0.062)	(0.318)
	Small	0.344***		0.490***	
		(0.016)		(0.097)	
Experience	Large	0.020***	3.19	0.030***	0.47
		(0.001)	(0.074)	(0.005)	(0.493)
	Small	0.024***		0.022***	
		(0.001)		(0.009)	

a-Based on a sample of 15331 observations for Canada (only Québec, Ontario and BC) and 1342 observations for USA. Standard errors in parenthesis.

b-Dependent variable is log hourly wages. Estimations without constant term. Also includes industry and occupation dummies. Estimates relative to workers in small establishments of small firms in the primary sector.

c-Test of equality of slopes between large and small firms, p-value in parenthesis.

Table 2.6: Heckman Two-Step Estimations[a], Non Unionized Firms, Canada-United States

Variables[b]	Canada > 500 Uncorrected	≤ 500	> 500 Corrected	≤ 500	United States > 500 Uncorrected	≤ 500	> 500 Corrected	≤ 500
University	0.420***	0.372***	0.285***	0.355***	0.471***	0.441***	0.359***	0.395***
/ College	(0.024)	(0.013)	(0.045)	(0.029)	(0.019)	(0.022)	(0.044)	(0.043)
Post Secondary	0.260***	0.226***	0.192***	0.218***	0.233***	0.178***	0.147***	0.145***
/ Asso. College	(0.020)	(0.010)	(0.028)	(0.015)	(0.025)	(0.024)	(0.038)	(0.036)
Secondary	0.193***	0.150***	0.123***	0.142***	0.155***	0.110***	0.085***	0.118***
/ High School	(0.019)	(0.010)	(0.028)	(0.015)	(0.012)	(0.018)	(0.032)	(0. 028)
Experience	0.031***	0.027***	0.031***	0.027***	0.028***	0.023***	0.027***	0.023***
	(0.001)	(0.001)	(0.002)	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)
Mills Ratio[d]			-0.369***	0.078			-0.313*	0.145
			(0.148)	(0.185)			(0.211)	(0.163)
N	6242	17652			11681	9421		
Selection[c]	**Equation**							
Variables			Marg. Effect					
Hours > 40			0.012**				0.004	
			(0.006)				(0.006)	
Union			-				-	
Public			0.194***				0.308***	
			(0.019)				(0.009)	
Industry*City			Yes				Yes	
F-test (p-value)			26.14	(0.000)			27.18	(0.000)

a-Based on a sample of 23894 observations for Québec, Ontario and British Columbia and 24799 observations for the United States.

b-Dependent variable is log of hourly wages. Race, married, union, industry and occupation dummies are included in the wage equation for both countries. Establishment size is also included for Canada.

c-The probit includes variables in the wage equation interactions between large cities and industries.

d-Standard error computed using bootstrapping.

Table 2.7: Heckman Two-Step Estimations[a], Unionized Firms, Canada-United States

Variables[b]	Canada > 500 Uncorrected	Canada ≤ 500 Uncorrected	Canada > 500 Corrected	Canada ≤ 500 Corrected	United States > 500 Uncorrected	United States ≤ 500 Uncorrected	United States > 500 Corrected	United States ≤ 500 Corrected
University	0.288***	0.317***	0.156***	0.207***	0.451***	0.359***	0.489***	0.343***
/ College	(0.018)	(0.013)	(0.035)	(0.035)	(0.072)	(0.126)	(0.082)	(0.144)
Post Secondary	0.171***	0.171***	0.094***	0.114***	0.242***	0.364***	0.278***	0.350***
/ Asso. College	(0.014)	(0.012)	(0.022)	(0.020)	(0.070)	(0.108)	(0.078)	(0.124)
Secondary	0.110***	0.103***	0.028	0.042**	0.149***	0.197***	0.190***	0.181***
/ High School	(0.013)	(0.012)	(0.022)	(0.021)	(0.054)	(0.088)	(0.069)	(0.111)
Experience	0.021***	0.023***	0.018***	0.027***	0.030***	0.019***	0.029***	0.018***
	(0.001)	(0.001)	(0.002)	(0.001)	(0.006)	(0.010)	(0.006)	(0.010)
Mills Ratio[d]			-0.477***	0.421**			0.157	0.037
			(0.115)	(0.159)			(0.241)	(0.268)
N	7742	7889			881	285		
Selection[c]	**Equation**							
Variables			Marg. Effect					
Hours > 40			0.019**				-0.062**	
			(0.009)				(0.027)	
Union			-				-	
Public			0.174***				0.105***	
			(0.011)				(0.035)	
Industry*City			Yes				Yes	
F-test			16.46	(0.000)			17.47	(0.000)

a-Based on a sample of 15331 observations for Québec, Ontario and British Columbia and 1342 observations for the United States.

b-Dependent variable is log of hourly wages. Race, married, union, industry and occupation dummies are included in the wage equation for both countries. Establishment size is also included for Canada.

c-The probit includes variables in the wage equation interactions between large cities and industries.

d-Standard error computed using bootstrapping.

Table 2.8: Size-Union Wage Gap Decomposition and Worker Characteristics[a]

Size-Union Wage Gap	**Canada** Due to ΔX	Due to $\Delta\beta$	Total	Due to ΔX	Due to $\Delta\beta$	Total	**USA** Due to ΔX	Due to $\Delta\beta$	Total	Due to ΔX	Due to $\Delta\beta$	Total
		W_{LU}	$-W_{SU}$		W_{US}	$-W_{NUS}$		W_{LU}	$-W_{SU}$		W_{US}	$-W_{NUS}$
All Variables	-0.007	0.151	0.144	0.198	0.013	0.212	-0.119	0.193	0.072	0.096	0.054	0.150
University	0.015	-0.007	0.007	0.000	-0.023	-0.023	-0.006	0.012	0.006	0.020	-0.031	-0.010
Post Secondary	-0.002	-0.006	-0.008	0.002	-0.037	-0.035	-0.001	-0.017	-0.018	0.003	0.010	0.013
Secondary	-0.000	-0.003	-0.003	-0.002	-0.031	-0.032	0.009	-0.045	-0.035	-0.006	0.000	-0.006
Experience	0.001	-0.066	-0.064	0.084	-0.103	-0.018	0.018	0.114	0.132	0.044	-0.104	-0.060
		W_{LNU}	$-W_{SNU}$		W_{UL}	$-W_{NUL}$		W_{LNU}	$-W_{SNU}$		W_{UL}	$-W_{NUL}$
All Variables	-0.187	0.369	0.182	0.232	-0.058	0.174	0.090	0.140	0.230	-0.012	0.005	-0.007
University	0.031	-0.003	0.028	-0.000	-0.043	-0.043	0.049	-0.009	0.040	-0.027	-0.017	-0.044
Post Secondary	-0.004	-0.001	-0.005	0.002	-0.039	-0.037	0.000	-0.001	-0.000	-0.000	-0.004	-0.004
Secondary	-0.000	0.000	-0.000	-0.001	-0.034	-0.035	-0.004	-0.024	-0.028	0.009	-0.022	-0.013
Experience	-0.005	0.106	0.101	0.078	-0.263	-0.184	0.013	0.161	0.174	0.063	-0.165	-0.102
Total		W_L	$-W_S$		W_U	$-W_{NU}$		W_L	$-W_S$		W_U	$-W_{NU}$
All Variables	-0.194	0.520	0.326	0.430	-0.045	0.385	-0.022	0.333	0.302	0.084	0.059	0.143

a-Based on a sample of 39321 observations for Québec, Ontario and British Columbia and 25812 observations for the United States.

APPENDIX 3.A1.a: Descriptive Statistics by Firm Size[a], (LFS 98)

Variables	Total ($N = 69521$)	Large Firm (> 500)	Small Firm (≤ 500)
Large Firm	33.3	1	0
Small Firm	66.7	0	1
Large Establishment	-	-	-
Small Establishment	-	-	-
Union	34.9	50.2	27.4
Public	18.4	31.1	12.0
University	20.2	26.9	16.9
Post Secondary	35.4	34.6	35.9
Secondary	29.6	28.3	30.3
No Secondary	14.8	10.2	16.9
Age 20-29	23.5	20.1	25.2
Age 30-39	31.0	29.9	31.6
Age 40-49	28.3	31.2	26.6
Age 50-65	17.2	18.8	16.6
Experience	20.5	21.0	20.2
Tenure (years)	7.6	9.4	6.7
Female	40.2	44.3	41.3
Married	65.2	69.5	66.5
Log(wage)[b]	2.73	2.86	2.67

a-Based on a sample of 69521 observations.
b-hourly wages reported.

APPENDIX 3.A1.b: Descriptive Statistics by Firm Size[a], (CPS 98)

Variables	Total ($N = 28121$)	Large Firm (> 500)	Small Firm (≤ 500)
Large Firm	54.8	1	0
Small Firm	45.2	0	1
Large Establishment	-	-	-
Small Establishment	-	-	-
Union	5.1	6.2	2.4
Public	17.8	25.2	7.5
College	32.1	32.6	22.3
Associate college	9.2	9.6	9.1
High School	51.1	51.4	56.5
Less than HS	7.6	6.4	12.1
Age 20-29	19.5	17.7	21.5
Age 30-39	29.6	29.5	29.7
Age 40-49	28.7	30.1	27.2
Age 50-65	21.9	22.4	21.3
Experience	21.9	21.8	21.2
Female	40.2	44.8	39.2
Married	65.2	63.5	62.2
Log(wage)[b]	2.79	2.85	2.72

a-Based on a sample of 25812 observations.

b-hourly wages computed.

Chapter 3

Human Resource Management Practices and Wage Dispersion in U.S. Establishments

3.1 Introduction

Starting in the 1980s, there has been an increasing interest in the use of what has been commonly called "innovative" or "high- performance" workplace practices in the United States. The interest grew mainly after observing the success of Japanese firms using management practices such as Total Quality Management (TQM), self-managed teams and job rotation, all aimed at increasing employee involvement in the workplace and in job-related decisions. With the recent availability of plant-level data on that matter, researchers have started to analyze whether these practices actually deserve their label "high-performance" by estimating the impact of their adoption on firms' performance.

Although improvement in firm's productivity has been the main focus of analysis, a related aspect concerns the effect of the practices on working conditions for the different categories of workers within the firm. The use of self-directed teamwork or job rotation requires additional training and effort costly for the firm and also for its workers. Questions therefore arise as to how did it translate in terms of working conditions for the employees in the firm and in particular, what is the impact of the adoption of these practices on wage outcomes within the firm.

The purpose of this paper is to explore the links between the presence of such workplace practices and wage dispersion within the firm. The analysis focuses on three practices mainly used by firms, regular meetings to discuss work-related problems, self-directed teamwork and job rotation. The measure used for wage dispersion is the average wage ratio of the two extremes of the occupation spectrum within the firm, namely managers and production workers. The links between workplace practices adoption and within-firm wage dispersion can be viewed in several ways: through the assumption that wages reflect individual productivity as well as through the firm's willingness to establish pay equity for better social relations in the workplace. In a broader perspective, changes in the organization of the workplace can be viewed as part of the general trend of advances in information technology that affects the skill mix of the workforce, demand for skilled labor and therefore, wage inequality.

The adoption of new workplace practices may change very differently individual productivity for managers and front-line workers resulting in different implications in terms of wage dispersion within the firm. Production or front-line workers are precisely the practices' main targets. Productivity improvements on their part are therefore expected but some workers may be reluctant and inefficient when working in self-directed team or job rotation. At the same time, the implementation of the new practices also influences manager tasks. Often more senior in the company, managers have to adapt to the fact that workers at the lower end of the hierarchy are getting new responsibilities in places, like job-related decisions, where they had more control in the traditional system.

In addition, for the implementation of the practices to be effective in increasing firm's performance, wage compression may be necessary. Milgrom and Roberts (1988) and Lazear (1989) emphasize the importance of social relations in the workplace that would have a direct impact on output. Both papers show that inducing too much competition in the workplace may lead to output-reducing behavior such as influence-seeking activity or sabotage of a co-worker's productivity, for the purpose of obtaining a career advantage. With a high amount of interdependence among co-workers, the loss of productivity resulting from such behaviors can be minimized by reducing wage differentials.

Practices such as regular meetings to discuss work-related problems could be accompanied with wage compression in order to enhance cooperation between the bottom and the top of the firm's hierarchy. In the case of self-directed teamwork or job rotation however, implications in terms of wage compression or dispersion (as defined by the manager-production workers wage ratio) are less clear. Although both requires more interdependence among co-workers, it is more among production workers themselves than with managers. The degree of wage dispersion will depend on the choice of incentive-based compensations associated with the use of job rotation or teamwork. Another part of the analysis of this papers considers whether the use of profit sharing affects the impact of the practices on wage dispersion.

Finally, Bresnahan, Brynjolfsson and Hitt (1999) emphasize complementarities in computerization, workplace organization and increased demand for skilled workers in explaining the skill-biased technical changes responsible for the growth in wage inequality over the past two decades. Using a cross-sectional survey of organizational practices and labor force characteristics matched panel to data on information technology (IT) and firms characteristics over the period 1987-1994, they find evidence that IT use is correlated with increases in the demand for various indicators of human capital and workforce skills. They also find that IT is correlated with work organization practices involving more decentralized decision-making and greater use of team.

Despite the vast empirical literature studying innovative practices in the workplace, few studies have focused the analysis on the relationship with wage outcomes. Black and Lynch (1996, 1997 and 2000) consider principally firm's productivity measured as the establishment's total sales per worker. Cappelli and Neumark (2000) analyze the ratio of the company's sales per worker over labor costs to obtain a measure of firm's efficiency. The effect of the practices on wage outcomes has been studied by Cappelli and Carter (2000). They look at the impact of various workplace practices on wages for the different categories of workers within the firm, from managers, supervisors, clerical workers and technicians to production workers. They find that the practices have different impact for each type of workers and that they mainly influence managers and production workers'wages. One can therefore expect to find different implications of the use of the practices in terms of wage dispersion.

An advantage of considering the wage ratio compared to separate analyses by categories of workers is that it allows to control for firm specific unobserved heterogeneity if the unobserved heterogeneity term affects similarly the wages of all categories of workers. One may find that the practices increase the wages of production workers in firms that have adopted them compared to those that did not but this may result from the fact that high- wage firms tend to be the ones to adopt the practices.

The analysis in this paper uses the same data as the studies just mentioned from the National Employer Survey (NES). They consist in two nationally representative samples of U.S. private establishments interviewed in 1994 and 1997. The surveys provide detailed information on employers human resource management practices such as recruitment strategies, organization of the workplace and training investments. They also report information on the company's equipment and technology and on average characteristics of its workforce where the information is available for the different categories of workers (managers, supervisors, clerical workers, technicians and production or front-line workers). The paper's approach differs from the preceding studies in several ways.

First, the workplace practices (job rotation, teamwork and work- related meetings) are considered as dummy variables rather than in their original format, in terms of percentage of non-managerial and non- supervisory workers in the firm under the given practice. Second, the practices are not analyzed individually but rather as different combinations of practices. Theoretical models proposed by Holmstrom and Milgrom (1994) and Milgrom and Roberts (1995) emphasize the importance of analyzing the firm's organizational decisions as part of a system of human resource management policies. Productivity gains are obtained from exploiting complementarities in practices and changes in only one practice brings little benefit to firm's performance. For example, Milgrom and Roberts (1995) show that teamwork will be more effective in combination with job flexibility, training and communication. This is confirmed by empirical studies showing evidence of the importance of bundles of practices (Arthur (1992), MacDuffie (1995)).

Third, the analysis consider the overall sample of firms in the manufacturing and non manufacturing sector. Because the practices were first implemented in manufacturing firms, most of the empirical studies have focused their analysis on that sector. Extending the analysis to all sectors provides a broader perspective of the question. Finally, the analysis considers the two years separately (although some of the firms are present in both years) because no firm identifier is available in public version of the data. The analysis in this paper will therefore remain at an exploratory stage.

The paper is organized as follows. Section 2 briefly summarizes the research on "high performance" workplace practices. Section 3 describes the data. Presenting first the variables common to two NES surveys, measures of workplace practices are next described in terms of workers' percentage and of dummy variables. The last subsection deals with the problem of data limitations on workers characteristics. Section 4 presents the results of OLS estimations of the manager- production workers wage ratio on the workplace practices. The results are shown in two parts. The first part uses the same approach as the current literature and analyzes the practices in terms of workers percentage. The second part presents the analysis using dummy variables. Section 5 concludes.

3.2 Background

Over the last 25 years, a growing number of U.S. firms have adopted new workplace practices that refer to flattened- hierarchical decision making (more worker participation in decisions and fewer middle managers), greater flexibility in job definitions and contingent pay system like profit sharing or stock option.

This interest for improvement in the workplace organization is however not new. Parks (1995) places the question of workplace performance improvement in a historical context expressing the view that "the new direction in employee participation, workplace technology, and labor force characteristics may be reviving practices that failed to flourish in the past". A question arises as to whether firms that have adopted the practices some time in the past two decades experience now higher productivity compared to businesses that did not adopt them.

With the increasing availability of firm-level data since the last 20 years, empirical studies have started to look at the impact of the practices on establishment level outcomes. This section very briefly reviews the results of their research focusing mainly on the links between employee involvement practices, firm's productivity and wage outcomes.

3.2.1 Workplace Practices and Firm's Performance

From the various empirical studies analyzing the impact of the practices on firm's performance, one can conclude that the evidence is mixed and seems to depend on the type of dataset used. Results from case studies or intra-industry data indicate a substantial positive link with performance and analyses based on large samples of firms show only a weak impact.

Ichniowski, Kochan, Levine, Olson and Strauss (1996) review the findings from a broad set of studies using American firms and summarize the results into the following conclusions. Innovative workplace practices designed to enhance worker participation, flexibility in the design of work and decentralization of managerial tasks can improve firm's productivity. The results from case studies and samples of U.S. plants within specific industries seem to show that changes in workplace practices have important effects on the performance of establishments that experience it. On the other hand, although a majority of U.S. establishments have adopted some forms of innovative work practices such as teamwork, job rotation or pay-for-performance, only a small percentage have adopted a full system with an extensive set of practices.

There has been a couple of studies analyzing the question with more heterogenous dataset such as national cross-industry data and in particular, with the data from the National Employer Survey (NES). In general, results do not always show that the practices have a significant impact on performance.

Black and Lynch (1996 and 1997) study the impact of different measures of workplace practices, information technology and human capital investments on firms' productivity (measured as sales by workers) using the first wave of the NES 1994. Estimating a Cobb-Douglas production function augmented with practices variables, they find that establishments with little or no direct participation of employees in decision making had substantially lower productivity than plants that had adopted new workplace practices.

Black and Lynch (2000) address the methodological problems associated with using cross-sectional estimations and exploit the first and second waves (1994 and 1997) of firms from the NES. They use the resulting panel of (manufacturing) firms to provide a longitudinal analysis of the effect of the workplace practices on firms' productivity and on the log of the average establishment hourly wage. Surprisingly their results with fixed-effect estimations to control for firms heterogeneity, are similar to the cross-sectional ones. They find that firms that re-engineer their workplaces between 1994 and 1997 toward more employee involvement experienced higher productivity.

Interested in the same issues on workplace practices and productivity, Neumark and Capelli (1999) consider longitudinal data using information about establishment performance, productive inputs and other plant level characteristics from the 1977 Longitudinal Research Database. In order to incorporate information on workplace practices, they match this dataset to the NES in 1994 and the second wave of the NES in 1997. They use the two long panels of firm-level data from 1977 to 1993 and 1977 to 1996 to perform fixed-effect analyses. These data allow them to measure changes in establishment's performance and labor costs per worker before and after the introduction of the workplace practices which took place in the 1980's. They consider three sets of regressions using three different dependent variables: productivity, measured as sales per employee, labor costs per worker and the ratio of the two, to measure efficiency resulting from the implementation of the practices. Their fixed-effect results suggest that work practices that transfer power to employees may rise productivity but the statistical significance of the results is weak. They find that these practices on average raise labour costs per employee and therefore average compensation but the net result is no apparent effect on efficiency.

Although the results are based on the same sample of firms, they do not seem to be consistent across the two studies. A criticism that has been addressed to Cappelli and Neumark's dataset is that because it uses establishments that existed in 1977, it automatically excludes the companies "born" after 1977. The firms created in the 1980's could actually be the one more inclined to experiment new form of work organization in the 1990's. This could explain the finding on the weak impact of workplace practices on firms' productivity.

On the other hand, using a panel that covers the 3 years between 1993 and 1996, as analyzed in Black and Lynch (2000), may not provide sufficient variation in the data if the number of practices changers between the two years is small. In addition, the similarity in the results between the cross-sectional analysis with the NES 1993 and the longitudinal fixed-effect analysis using both waves is suspicious. One may conclude from this that firm-specific unobserved heterogeneity does not matter but this would be surprising given the numerous empirical findings on firm effects and the impact of firm size on wage outcomes (Abowd, Kramarz and Margolis (1999), Brown and Medoff (1989)).

3.2.2 Practices and Wage Outcomes

Cappelli and Carter (2000) avoid the problems associated with the use of the NES data in a panel form by analyzing the impact of the workplace practices on wage outcomes pooling together the two years of the NES and correcting for the fact that some firms appear in both samples. They propose a cross-sectional analysis of the relationship between computers, workplace practices and wage outcomes. They perform separate wage regressions by category of workers in the firm (managers, supervisors, clerical workers, technicians and front-line workers). After adding finer controls for workers individual characteristics [1], their results show evidence that some of the practices (mainly job rotation and work-related meetings) have a significant impact on the wages of managers and front-line workers.

[1] They match the NES data with data on individual employees (using the 1990 Decennial Census) in the New Worker-Establishment Characteristics Database.

The objective of this paper is to analyze the following questions: Is there a link between employee involvement workplace practices and within-firm wage dispersion? If there is a link then for which type of practices? The next section presents the data used and discusses the method and variables considered to explore these questions.

3.3 Data

This Section introduces the dataset used in this paper and discusses issues such as practices variable choice and measurement method for the analysis. Since the data come from establishment-level survey, information on workers is limited. The last subsection discusses this point.

3.3.1 Data description

The data come from the National Employer Survey (NES), an establishment-level survey of employment practices conducted by the Bureau of the Census for the National Center on Education Quality of the Workforce (EQW). The survey was first administered in 1994 to a nationally representative sample of private establishments with more than 20 employees. It was repeated again in 1997 using the same sampling frame as in 1994 based on the Bureau of the Census SSEL file. Public sector employers, not-for-profit institutions and corporate head quarters were excluded from the sample. The 1997 sample has a longitudinal component of about 900 companies that participated in both surveys but the longitudinal link is not publicly available.

These surveys provide detailed information on employers human resource management practices such as recruitment strategies, organization of the workplace and training investments. They also report information on the company's equipment and technology and on average characteristics of its workforce where the information is available for the different categories of workers (managers, supervisors, clerks, technicians and production or front-line workers).

The questionnaires for the two surveys are not identical as the NES 1994 has a detailed section related to training investments and the NES 1997 has additional questions about school-to-work transition and community involvement. On the other hand, there is a common set of core questions on firms and workers characteristics as well as on the organization of the workplace. In particular, there is information on the value of the firm's fixed capital stock, the age of the equipment, the amount spent on new equipment during the current year, and finally, the establishment's industry and size and whether it is a multi-establishment company.

The firm's workforce characteristics include the percentage of workers of each category and average education, the proportion of women and minorities, the percentage of workers hired during the current year and whether the employees are represented by a union or covered by collective bargaining agreements.

Information on wages comes from a question on the average pay for each category of full-time workers in the establishment and is reported in either of the following ways: hourly, weekly, monthly or annual. I used hourly wages and since average hours per week for each type of workers are asked in a subsequent question, I computed average hourly pay for each case where pay were not reported on an hourly basis. Note that in the NES 1994, average weekly hours worked are not asked to managers. Since the NES questions always concern full-time workers, I computed hourly pay for managers based on a 40 hours week of work. [2]

Questions related to the organization of the workplace are identical except for one. The NES 1994 asked whether the establishment has adopted a Total Quality Management program, which is not asked in the NES 1997. In place, it is asked whether the establishment has undergone re-engineering. Since TQM is a form of re-engineering of the workplace, both questions provide similar information (although more specific for 1994 than 1997) and I considered the variables in the same manner in the estimations for each year. The final samples, with non missing observations on all variables, contain information for 885 establishments in 1994 and 892 in 1997.

The next subsection describes the other workplace practices and discusses mea-

[2] Note also that for for workers reporting annual pay, I computed hourly pay dividing by weekly hours times 51 weeks of work per year.

surement issues in analyzing the effect of (past) adoption of the practices (intensity of adoption versus adoption against non adoption). The last subsection deals with the problem of insufficient information on workforce characteristics. In particular, the NES does not provide information on years of experience or tenure of its employees.

3.3.2 Workplace Organization and Practices Variables

The NES contains detailed information on the practices related to the level of employee involvement, the organization of the establishment's workplace, the use of stock option or profit sharing. Table 3.1 presents the means of the different variables on workplace practices for the year 1994 and 1997.

Considering first the year 1994 for all sectors (first column), one can see that among the three practices related to employee involvement, job-related meetings is the practice that is mostly applied in establishments with, on average overall establishments, 52.2 % of the non-managerial and non-supervisory workers under this practice. Job rotation and self-directed teamwork, when adopted by firms, is used by 14.4% and 13% of the workforce respectively.

Comparing with the year 1997 for all sectors again (column 4), one can see an increase in the percentage of non-managerial and non- supervisory workers using the practice for the three involvement practices. Looking at the practices by manufacturing and non manufacturing sectors, one observes that the job rotation is used by more workers in manufacturing establishments whereas for non manufacturing businesses, it is meetings and teamwork. The percentages have increased between 1994 and 1997 in both sectors for the three practices but teamwork is this time adopted by more workers in manufacturing establishments.

Among the variables describing the organization of the workplace, the number of management levels and the number of workers per supervisor in the company reflect the degree of hierarchy and authority in the organization. Overall sectors these two measures have decreased between 1994 and 1997, suggesting a change in the type of internal organization of the establishments during the two years.

The Dummy variables for the use of Benchmarking, TQM or re- engineering have not changed much during the two years. The most striking feature from the Table is that the proportion investing in training for working in teams has almost doubled between the two years. At the same time, the proportion of establishments using profit sharing or stock option as part of the compensation system has declined by almost half.

It is interesting to see that very few establishments use all of the preceding practices all together (3% in 1994 and 2% in 1997) but at the same time, very few companies do not use any of them (2% in 1994 and 1% in 1997). This leads to questions such as what are the practices most employed by firms and are they used individually or as bundles?

The first half of Table 3.2 considers the preceding workplace and organization practices but this time, showing the frequencies rather than analyzing the intensity of use. I built two types of dummy variables shown in the two columns of the Table for each year: to indicate that the establishment uses at least the given practice and that the given practice is the only practice used by the establishment.

Looking at the column "At least", one can clearly see that meetings is the practice adopted by the majority of firms (86% in 1994 and 84% in 1997). Moreover, although teamwork and job rotation are not used by a large percentage of workers, between 40 and 50% of the establishments use them. From the column "Only", one can clearly see that the practices tend to be used as bundles rather than individually.

Given the results of the last, I selected the three practices mainly used and computed a set of dummy variables describing the eight possible outcomes from individual use to the use of two or all of the practices and none of the practices. The remaining of the analysis will focus on these particular bundles, controlling for the other practices variables. The second half of Table 3.2 shows the frequencies for the different possible bundles. [3]

Note that the dummy variables have been created using a large definition of practices adoption. More precisely, as long as 1% of the workers in the firm are under the given practice, I considered that the establishment has adopted the practice. Since the sample

[3]Appendices A.94 and A.97 show the means of all the variables used in the analysis hereafter by type of practices bundles.

includes large and medium establishments, 1% may represent a reasonable minimum. Table 3.3 show the average percentage of (non-managerial and non-supervisory) workers under the given practices dummies defined at the 1% level.

One can see from Table 3.3 that the average percentages vary a lot from one practice to the other, whether they are considered individually as combinations. They vary between 15 and 70% in 1994 and between 6 and 80% in 1997. Job rotation is the practice that hardly reaches 50% of workers. Therefore, letting the definition of the adoption start at a percentage of workers higher than 1% leads to the question of which ideal percentage should apply. Moreover, choosing any percentage higher than 25% implies that teamwork and job rotation cannot be analyzed as individual practices. To avoid this problem, I kept the 1% definition.

3.3.3 Data limitations

As a plant-level dataset, the NES does not have detail variables on establishment's workforce characteristics. In particular, workers' average experience or tenure are not available. These variables affect individual wages and would certainly explain a substantial part of the manager-production workers wage differentials. In the analysis hereafter, I consider inter-establishment variations in these wage differentials and whether part of these variations can be explained by the adoption of the practices. I therefore verified first if the lack of control for managers and production workers' average experience modifies the cross-establishment variations in wage differentials.

To do so, I used the March CPS for the year 1994 and 1997 in which there is information on workers' education and age to construct potential experience and information on the company size. To characterize variations in managers-production workers wage differentials, I used information on firm size and industry of the workers. In the March CPS, firm size is a discrete variable that takes 6 values from firms with less than 10 employees to firms with more than 1000 employees. I classified industries according to the same method as in the NES, with 20 different industries. I next selected individuals reporting managerial occupations and defined as production or front-line workers anyone reporting a profession directly linked to the firm's production. I estimated the wage differentials by regressing the log of hourly wages on a dummy for managerial occupations. The cross-establishment variations in wage differentials are defined by interacting the manager dummy to dummies defining the interaction of size and industry.

Table 3.4 present the results of the estimations. Four series of regressions have been performed: an estimation of the raw wage differentials (column (1)), a regression with the inclusion of workers controls such as gender, race and union status (column (2)), a regression where education is added as an additional control (column (3)), a regression where experience and experience squared are added as additional controls (column(4)). The idea is to see whether cross- establishment variations approximated by cross-"industry*size" variations in the differentials is affected by the inclusion of the experience variables. To test that point, a F-test for the joint equality of the wage differentials is performed.

Inter-establishment variations in wage differentials have been approximated first in a large way by interacting dummies for manufacturing and non manufacturing firms and for large (more than 500 employees), medium (between 100 and 500 employees) and small firms. The last part of the table show the results of the estimations with a more detailed division of industries and firm size. More precisely, 6 different types of firm size are interacted with 20 different types of industries. The results show the F-test from the regressions.

Looking at the estimated wage differentials in the first estimations with a large definition of establishment, one can see a clear drop in the coefficients when education is added to the specification (2). The drop is much weaker when experience is added to specification (2). Experience has an impact on the manager-production workers wage differentials but the question is whether the effect is similar across establishments. An F-test for the joint equality of the differentials across manufacturing and non manufacturing large, medium and small firms show that including experience does not eliminate the variations in wage differentials (the test reject the null of equality of the wage differentials). With a finer characterization of establishments (bottom of the table), one arrives to the same conclusions.

In summary, manager-production-worker wage dispersion within establishments does not seem to be strongly modified by controlling for experience. Moreover, the variations across establishments are better explained by education than experience.

Another important limitation of these data set is that there is no information on the date the firm started to adopt the practice. It is therefore difficult to identify properly the effects specifically related to the use of the practices. The analysis in this paper is based on the assumption that all firms that adopted the practices, have done so during the same period within the last 25 years.

3.4 Workplace Practices and Wage Dispersion

This Section presents the results from OLS estimations of the log of the manager-production workers wage ratio on workplace practices controlling for the establishment's production technology and workforce characteristics. Following the existing literature, the first part looks at the impact of work-related meetings, teamwork and job rotation measured in terms of the percentage of workers under the given practice. The second part show the results when the practices are considered as exogenous dummy variables. [4]

3.4.1 Wage Dispersion and Practices' Intensity

Tables 3.5 and 3.6 show the results for the year 1994 and 1997 respectively. In each Table, the three first columns describe three different specifications. Starting with a base specification in which the log of the wage ratio is regressed on the establishment's workforce and technology, I add variables on the establishment's degree of computer usage and on the organization of the workplace. The third specification is the one in which involvement practices are included in the regression. The last two columns consider the third specification over the sample of manufacturing and non manufacturing establishments.

Among the workforce characteristics, education differential has the strongest impact for both years. Consistent with human capital theory and empirical studies using micro-

[4] It is assumed that past adoption decisions are independent of the current characteristics of the establishment and its workers.

level data, wages are higher for more educated workers so that a higher differential in years of education increases wage dispersion. The variables on the percentage of women and minorities both increase wage dispersion. The results for 1997 are consistent with those from Black and Lynch (2000) using the NES 1997. The union dummy is not significant but this result is consistent with Black and Lynch (2000) in which the union variable is not significant in the wage regressions (for all and by categories of workers). [5]

Concerning variables on firm's technology, none are significant in 1994 but the percentage of equipment between 1 and 4 years old has a strong positive impact on the wage ratio in the NES 1997. This result is consistent with Black and Lynch (2000) who find that this variable increase the wage of managers. A possible interpretation is that only managers are benefiting from the returns in the given equipment's investment.

The percentage of non-managers using a computer is not significant in both years. Although this variable has been found [6] to influence positively the wages of both managers and production workers, the impact is not stronger for one or the other, resulting in no effect on the wage ratio. Surprisingly, the percentage of managers using computer reduces wage dispersion in the non manufacturing sector. with the NES 1994 and 1997 pooled data, Cappelli and Carter (2000) find that this variable has a significant positive impact on the wage of both manager and production workers and the result here suggest that the impact is stronger for production workers. This variable probably proxies for unobserved heterogeneity in the workforce's ability. High- ability management may translate into higher wages for the production workers in the company.

Among the workplace organization variables, neither benchmarking, nor reengineering or TQM have an impact on wage dispersion. Although surprising, this result is consistent with Black and Lynch (2000) who don't find any significant impact of reengineering on wages for all categories of workers in the NES 1997 and with Cappelli and Carter (2000) who find positive impacts of the same magnitude on the wages of both managers and production workers. The degree of firm's hierarchy in decision making (the number of management levels) reduces wage dispersion in the NES 1993 suggesting

[5]It is significant in their study only when interacted with the work-related meeting practice.

[6]Black and Lynch (2000) and Cappelli and Carter (2000).

that having additional managers in the company reduces their average wage. On the other hand, this variable has no significant impact in NES 1997.

The span of control represented by the number of workers per supervisors has no impact on the wage ratio in the NES 1993 and in the NES 1997, it slightly decreases wage dispersion in manufacturing establishments and increases it in non manufacturing ones. More supervision (less workers by supervisors) may have different effect on wages given that it is costly (requiring more supervisors) and that it can increase the workers productivity leading to lower or higher wages for the production workers (supervised). The results suggest that supervision seems to be more efficient (than costly) in manufacturing firms and more costly in non manufacturing firms. It is also consistent with the fact that workers' performance and output is easier to measure and therefore, to supervise in manufacturing than non manufacturing firms .

The three involvement practices defined by the percentage of workers participating in regular work-related meetings, teamwork and job rotation have no impact on wage dispersion in the NES 1993. Only the proportion of non-managerial workers working in team has an impact in the NES 1997 in non manufacturing firms. As the proportion of non-managerial workers participating in self- directed team increase, the manager-production worker wage ratio increases. This suggests that this practice affects the productivity of both type of workers differently. Managers may be the only one benefiting (with higher wages) from the increased productivity of the production workers participating in teamwork.

Cappelli and Carter find a strong negative impact of job rotation on production worker wages in the manufacturing sector and stronger than for managers. The results here show that this does not translate into significant changes in the wage ratio. The same for work-related meetings which, according to their results, seems to increase the wages of production workers in the manufacturing sector.

Variables on computer use, workplace organization practices and involvement practices may not be individually significant because of colinearity problems among them. One can test their joint impact by computing a F-test for joint significance of the variables in the explanation of the wage ratio (cross-establishment variations). The results of the F-test are shown below each set of computer use, workplace organization and involvement practices variables. One can see that the null of joint significance of the variables for computer use is rejected in each year. The workplace organization practices are jointly significant in the non manufacturing sector in both years. The involvement practices are jointly significant in 1997 but, as with the test for significance of individual practices, there is no joint significance in 1994.

From these first set of results, one can see that the involvement practices do not seem to have an impact (except for teamwork) on wage dispersion or wage compression when measured as the percentage of participating workers. It is possible that rather than the intensity with which the practice is used, the adoption or presence of the practices is related to wage dispersion. The next section discuses this point.

3.4.2 Wage Dispersion and Practices' Choice

To analyze the impact of the presence of a given practice on the firm's wage dispersion, I created a set of practice bundles which include the three involvement practices analyzed earlier and the different combinations of two of them as well as the three together. I regressed the wage ratio on the same set of control variables as before (the workforce characteristics, the firm's technology and workplace organization) but this time, including the practices dummies rather the variables in percentage. Table 3.7 shows the results by years and sectors. The first column present the results form a regression of the wage ratio and the two next columns show the results with separate regressions for managers and production for comparison purpose.

The analysis of wage dispersion in terms of the choice of practices brings additional information compared to the preceding results on practices' intensity. This time, not only teamwork affects wage dispersion but also regular work-related meetings, taken individually and in combination with teamwork and/or job rotation.

Results are very different for manufacturing and non manufacturing firms and for both years 1994 and 1997.[7] Practices that have a significant impact on wage dispersion

[7] To ensure that the differences in the results over time are not due to the approximation used for

(compared to wage dispersion in firms not using any of the practices) have the same impact (always positive or always negative) within a sector. The impact is however different in both sectors and varied also over time.

Practices in 1994 were associated with wage dispersion in the manufacturing sector and wage compression in the non manufacturing sector. The reverse happens in 1997. The differences in the results by sector and over time suggest unsurprisingly that firms in manufacturing and non manufacturing sector have their own specificity which makes them use and react differently to decisions about organizational technology adoption. There may also be differences in the firm's type of compensation system associated with the practices and the next Section considers in particular the use of profit sharing.

3.4.3 Practices and Profit Sharing

The variable on profit sharing or stock option comes from a question separate from the question on workers' average wages. It is however possible that workers reporting annual wages have included the value of profit sharing and stock option in their responses on wages. Cappelli and Carter (with the same data) tested and rejected this possibility by interacting a dummy for annual wage reporters to the profit sharing variable in their wage regressions. The effect of profit sharing and stock options on wage outcomes will therefore be independent of the additional value associated with these benefits.

I considered separate regressions for the three practice bundles that include the work-related meeting practice, the practice adopted by most of the firms. For example, the MT dummy considers firms that adopt either work-related meetings or teamwork or both of them (controlling separately for job rotation). To see whether the use of profit sharing affects the impact of the practices on wage dispersion, I interacted the practice dummy to the profit sharing dummy. Tables 3.8 and 3.9 show the results for 1994 and 1997 respectively.

One can see again differences in the manufacturing and non manufacturing sectors and over time. In 1994, the use of profit sharing do not seem to significantly influence

hourly wages in the NES 1994, I used the same approximation with the 1997 data. Results are shown in appendix A4.6 and one can see that they are similar with or without the approximation for hours.

wage dispersion. It is the case in manufacturing sector either when used alone or associated with a given practice. Only the use of the practice alone influences wage dispersion (MJ or MTJ). In the non manufacturing sector, the impact is significant only when interacted with the practice (MJ or MTJ but not MT). In this case, the effect is not different from before, the use of both profit sharing and the practice is associated with wage compression.

In the 1997 data, there is evidence that the use of profit sharing has an impact on wage dispersion when used individually in both sectors (NOMT*SOPS is significant). Like the other practice effects in the NES 1997, it is associated with wage compression in manufacturing firms and wage dispersion in non manufacturing ones. In the non manufacturing sector, the use of profit sharing also has a significant impact on the wage ratio when associated with the given practice. One can see that the use of profit sharing associated with the given practice has different implications in terms of wage dispersion. The use of MT or MTJ (as we saw previously) is associated with wage dispersion in non manufacturing firms but the use of profit sharing reduces the manager-production workers wage ratio.

In summary, compared to establishments not using any of the involvement practices, firms that use them have a significantly different wage distribution within the firm. More precisely, given the measured used for wage dispersion, these practices have an impact on wages that is significantly different for managers and production workers. The results also show that the impact on wage dispersion is the same whatever type of practices (meetings, teamwork or job rotation or combinations of them) adopted. On the other hand in the 1997 data, the impact differs whether it is associated or not with the use of profit sharing. In addition, the impact is different in manufacturing and non manufacturing firms and over time. Comparing the years 1994 and 1997, manufacturing firms seem to have switched from wage dispersion to wage compression and the reverse for non manufacturing firms.

Further conclusions from these results are limited by the fact that the data are not longitudinal so there is no possibility to control for firm unobserved heterogeneity and endogeneity in the choice of the practices. Moreover, the ability to properly exploit the practices chosen may not be directly and immediately observable by firms and there may be some learning opering on the part of firms. This may explain why the impact on wage dispersion has changed over the two years studied.

3.5 Conclusion

In this paper, I explored the link between workplace organization practices and wage dispersion within the firm. Using the ratio of average wages for managers and production workers as a measure of wage dispersion and dummy variables indicating whether the establishment uses practices such as regular work-related meetings, teamwork or job rotation or any combination of these practices, I performed OLS regressions on two samples of nationally representative U.S. establishments for the years 1994 and 1997.

The results suggest that, compared to establishments not using any of the involvement practices, firms that adopt regular work-related meeting and/or self-managed team and/or job rotation have significantly different wage dispersion. There are differences in the effect of the practices on wage dispersion between manufacturing and non manufacturing firms and over time. Manufacturing firms seem to have switched from wage dispersion to wage compression and the reverse for non manufacturing firms. The impact on wage dispersion is the same whatever type of practices (meetings, teamwork or job rotation or combinations of them) adopted. On the other hand in the 1997 data, the impact differs whether it is associated or not with the use of profit sharing.

Further conclusions from these results are difficult given the limitations of the dataset used. The inter-establishments variations captured in the results do not take into account several aspects that are important when analyzing firms' technology, organizational structure and wage outcomes.

Using the longitudinal aspect of the data would allow an analysis of the dynamic interaction between the firm's implementation of the workplace practices and wage outcomes. It would also allow a better control for firm heterogeneity. Black and Lynch (2000) and Cappelli and Neumark (2001) have exploited the longitudinal aspect of the NES data using fixed- effect method but their results are not consistent with one another.

One can wonder whether the fixed-effect method is the most appropriate econometric approach to the question of choosing innovative workplace practices and the impact on the firm's productivity and wage policy. Indeed, not only can unobserved plant characteristics be correlated with the choice of a new workplace practice, but this same choice may also affect firms differently. Depending on their workforce characteristics (such as the quality level of the managers and the other employees), firms may find more or less valuable the adoption of a new form of work organization. The gains associated with this choice would therefore be a function of the firm's specific characteristics. In other words, choosing a practice that allows for more teamwork may have either a benefic or detrimental effect on firm's performance if the manager and workers have more or less the skills to exploit it properly.

Moreover, as a result of data limitations, the studies so far have measured the impact of workplace practices on establishments outcome in an aggregate way, analyzing their impact on the firm's average wage and on performance measured in sales per worker. It is certainly the case that these practices have had a different impact on different types of workers and therefore resulted in changes in the composition of the workforce. Using the same data on workplace practices and matching them to detail longitudinal information on the workers wage within the firm would allow an analysis at the individual level within firms looking at the impact on the workers' wage and productivity dispersion within the firm.

Finally, having information on the time at which firms implemented the new workplace practices would allow to identify precisely the source of variations that comes from the practices. It would also give information on the length of time since the use of the practices allowing to emphasize learning effects on the part of the firm.

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Table 3.1: Workplace Organization and Practices, Means[a] for NES 1994 and 1997

Year	**1994**			**1997**		
Variables	All	Manuf.	Non Man.	All	Manuf.	Non Man.
Involvement						
Meeting (% wkrs)	52.21	39.15	56.54	63.17	50.62	66.83
	(1.45)	(1.90)	(2.14)	(1.40)	(1.80)	(2.20)
Team (% wkrs)	14.46	11.59	15.42	17.82	19.83	17.23
	(0.90)	(1.16)	(1.36)	(1.03)	(1.40)	(1.61)
Job Rot. (% wkrs)	13.05	16.51	11.90	20.38	25.92	18.76
	(0.85)	(1.37)	(1.17)	(1.06)	(1.46)	(1.65)
Workplace						
# Management Lvls	2.05	1.92	2.09	1.71	2.12	1.59
	(0.06)	(0.06)	(0.09)	(0.08)	(0.18)	(0.07)
# Wkrs/Supervisor	14.5	15.64	14.12	11.5	13.99	10.77
	(0.59)	(0.93)	(0.83)	(0.38)	(0.56)	(0.57)
Benchmarking	0.28	0.24	0.30	0.26	0.28	0.26
	(0.02)	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)
TQM/Re-engineering	0.32	0.40	0.30	0.29	0.31	0.29
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Training Team	0.49	0.47	0.50	0.88	0.81	0.90
	(0.02)	(0.02)	(0.03)	(0.01)	(0.02)	(0.02)
Pay						
Stock Opt.-Prof. Sha.	0.76	0.75	0.76	0.40	0.49	0.37
	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)
All Practices	0.03	0.02	0.03	0.02	0.02	0.02
	(0.01)	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)
No Practices	0.02	0.06	0.01	0.01	0.02	0.00
	(0.00)	(0.01)	(0.00)	(0.00)	(0.01)	(0.00)
ComputerUse						
% Managers	0.75	0.70	0.77	0.82	0.83	0.81
	(0.01)	(0.02)	(0.02)	(0.01)	(0.01)	(0.02)
% Others	0.43	0.26	0.49	0.57	0.32	0.64
	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)
N	885	492	393	892	545	347

a-Standard errors in parenthesis.

Table 3.2: Practices Variables and Bundles, NES 1994 and NES 1997

INDIVIDUAL PRACTICE FREQUENCIES

Year	**1994**		**1997**	
Variables	At least	Only	At least	Only
Involvement				
Meetings	0.863	0.029	0.846	0.012
Team	0.387	0.002	0.397	0.005
Job Rotation	0.433	0.005	0.506	0.002
Workplace				
Benchmarking	0.283	0	0.262	0.003
TQM/Reengineering	0.325	0.001	0.294	0.002
Training	0.493	0.001	0.507	0.877
Pay				
Stock Opt.-Prof. Sha.	0.759	0.049	0.401	0.003
N	885	885	892	892

PRACTICE BUNDLE FREQUENCIES

Year		**1994**			**1997**	
Variables	All	Manuf.	Non Man.	All	Manuf.	Non Man.
Wkr $\geq$ 1 %						
One Practice						
Meetings (M)	0.321	0.326	0.320	0.247	0.202	0.260
Team (T)	0.007	0.001	0.009	0.023	0.017	0.024
Job Rotation (J)	0.032	0.054	0.025	0.014	0.032	0.009
Two Practices						
MT	0.150	0.112	0.163	0.130	0.124	0.131
MJ	0.172	0.184	0.168	0.247	0.248	0.247
TJ	0.010	0.028	0.004	0.023	0.037	0.019
All/No Practices						
MTJ	0.220	0.153	0.242	0.222	0.260	0.211
NOMTJ	0.089	0.143	0.071	0.095	0.080	0.099
N	885	492	393	892	545	347

Table 3.3: Percentage of Employee Involvement by Practice Dummy

Practices	Meeting	Team	Job Rot.	Meeting & Team	Meeting & Job Rot.	Team & Job Rot.	All
Year				**1994**			
Sector				**Manuf.**			
% Meet.	46.75	0	0	54.97	49.41	0	56.82
	(3.55)			(5.05)	(4.17)		(3.81)
% Team	0	15.16	0	43.80	0	33.74	37.44
		(8.28)		(4.36)		(11.65)	(2.91)
% Job Rot.	0	0	36.59	0	34.31	24.35	49.56
			(9.66)		(3.36)	(6.04)	(3.65)
N	116	2	14	62	91	10	103
Sector				**Non Man.**			
% Meet.	71.02	0	0	74.62	43.08	0	59.82
	(3.37)			(4.41)	(4.35)		(4.72)
% Team	0	55.01	0	37.73	0	39.16	35.75
		(21.28)		(4.09)		(17.66)	(3.35)
% Job Rot.	0	0	19.31	0	31.34	24.32	25.11
			(5.96)		(3.43)	(12.54)	(3.11)
N	107	3	13	49	65	4	73
Year				**1997**			
Sector				**Manuf.**			
% Meet.	60.30	0	0	59.06	67.89	0	55.10
	(3.97)			(3.97)	(3.58)		(2.82)
% Team	0	6.39	0	35.07	0.00	79.49	47.71
		(0.60)		(3.04)		(11.17)	(2.77)
% Job Rot.	0	0	44.76	0	47.19	27.97	45.22
			(12.57)		(3.02)	(8.14)	(2.60)
N	84	7	9	78	112	7	160
Sector				**Non Man.**			
% Meet.	77.29	0	0	77.52	82.69	0	76.45
	(3.40)			(5.40)	(3.56)		(3.27)
% Team	0	70.51	0	53.01	0	28.65	38.10
		(16.05)		(5.01)		(2.63)	(3.24)
% Job Rot.	0	0	21.76	0	38.27	27.94	40.75
			(4.77)		(3.79)	(3.17)	(3.77)
N	80	6	9	45	76	4	82

Table 3.4: Wage[a] Dispersion and Experience
March CPS 1994 and 1997

Manager/Prod. Wage Diff.[als]	(1) No Controls	(2) + Fem, Mino, Union	(3) (2) + Educ.	(4) (2) + Exp.
1994				
Manuf*Large	0.709	0.773	0.635	0.718
	(0.046)	(0.045)	(0.043)	(0.043)
Manuf*Medium	0.811	0.849	0.670	0.766
	(0.081)	(0.077)	(0.074)	(0.075)
Manuf*Small	0.760	0.760	0.600	0.693
	(0.070)	(0.067)	(0.064)	(0.064)
Non Manuf*Large	0.377	0.419	0.349	0.391
	(0.033)	(0.032)	(0.030)	(0.030)
Non Manuf*Medium	0.411	0.415	0.347	0.377
	(0.053)	(0.051)	(0.049)	(0.049)
Non Manuf*Small	0.399	0.456	0.365	0.403
	(0.034)	(0.033)	(0.032)	(0.032)
F-Test[b] (p-value)	128.6 (0.000)	157.2 (0.000)	107.2 (0.000)	139.1 (0.000)
1997				
Manuf*Large	0.729	0.800	0.640	0.737
	(0.055)	(0.054)	(0.052)	(0.052)
Manuf*Medium	0.692	0.720	0.567	0.699
	(0.093)	(0.090)	(0.086)	(0.086)
Manuf*Small	0.725	0.796	0.629	0.748
	(0.089)	(0.085)	(0.082)	(0.082)
Non Manuf*Large	0.480	0.512	0.425	0.477
	(0.037)	(0.036)	(0.035)	(0.035)
Non Manuf*Medium	0.508	0.519	0.413	0.509
	(0.064)	(0.061)	(0.059)	(0.059)
Non Manuf*Small	0.410	0.437	0.335	0.399
	(0.041)	(0.040)	(0.039)	(0.038)
F-Test[b] (-p-value)	102.0 (0.000)	124.3 (0.000)	80.2 (0.000)	115.2 (0.000)
Detailed Variables Industry*size				
1994				
F-Test[b] (p-value)	16.4 (0.000)	15.7 (0.000)	11.2 (0.000)	14.5 (0.000)
1997				
F-Test[b] (p-value)	12.5 (0.000)	11.9 (0.000)	8.3 (0.000)	11.3 (0.000)

a-Based on a sample of 5423 observations for 1994 and 3828 for 1997. Individual hourly wages for managers and production workers. Base category is front-line in small manufacturing firms. Standard errors in parenthesis, adjusted using the White correction.
b-Test of joint equality of coefficients.

Table 3.5: Workplace Organization and Practices and Wage Dispersion[a] - NES 1994

Specifications[b]	(1)	(2)	(3)	(3) Manuf.	(3) Non Man.
Workforce					
Education Differential	0.725***	0.735***	0.742***	1.122***	0.606**
(in log)	(0.227)	(0.214)	(0.215)	(0.271)	(0.254)
% Women	-0.006	-0.018	0.026	0.124	-0.018
	(0.123)	(0.129)	(0.127)	(0.125)	(0.170)
% Minorities	0.416***	0.384***	0.379***	0.341***	0.216*
	(0.138)	(0.113)	(0.111)	(0.118)	(0.149)
% New Hired	0.047	0.084	0.105	0.339	-0.115
	(0.165)	(0.170)	(0.174)	(0.288)	(0.180)
Union Dummy	-0.056	-0.051	-0.051	0.051	-0.091
	(0.057)	(0.057)	(0.056)	(0.076)	(0.083)
Technology					
% Equipment < 1 yr	-0.143	-0.111	-0.115	-0.274	0.039
	(0.176)	(0.171)	(0.173)	(0.276)	(0.201)
% Equipment 1-4 yr	-0.143	-0.161	-0.144	0.185	-0.234
	(0.143)	(0.128)	(0.114)	(0.174)	(0.144)
% Equipment > 11 yr	-0.154	-0.180	-0.167	-0.171	0.048
	(0.129)	(0.121)	(0.115)	(0.119)	(0.159)
Capital Stock	0.028	0.019	0.020	-0.035	0.026
$ value, in log	(0.021)	(0.018)	(0.019)	(0.028)	(0.023)
New Equipt	0.016	0.018	0.018	0.017	0.022
$ value, in log	(0.020)	(0.020)	(0.019)	(0.022)	(0.024)
Computer Use					
% Managers		-0.141	-0.151	-0.070	- 0.268**
		(0.093)	(0.090)	(0.107)	(0.132)
% Others		0.093	0.093	0.011	0.117
		(0.088)	(0.087)	(0.104)	(0.111)
F-Test		1.33	1.59	0.17	1.96
		(0.265)	(0.205)	(0.848)	(0.143)

a-The dependent variable is the log of the average wage ratio for managers and production workers.
b-Also include variables on the ratio of production workers over manager, industry, firm-size and union dummies. Standard errors in parenthesis, adjusted using the White correction.

Workplace Organization and Practices and Wage Dispersion[a] - NES 1994
(Continued)

Specifications[b]	(1)	(2)	(3)	(3) Manuf.	(3) Non Man.
Workplace Organization					
# Management Levels		-0.110**	-0.104**	-0.034	-0.123**
		(0.045)	(0.044)	(0.049)	(0.058)
# Wkrs/Supervisor		0.052	0.056	0.062	0.047
		(0.036)	(0.035)	(0.041)	(0.048)
Benchmarking		-0.007	-0.009	-0.013	-0.005
		(0.057)	(0.057)	(0.068)	(0.076)
TQM Circles		-0.047	-0.047	0.048	- 0.082
		(0.061)	(0.061)	(0.065)	(0.090)
Training Team		0.044	0.047	0.111	0.038
		(0.050)	(0.052)	(0.075)	(0.068)
F-Test		2.88	2.73	1.20	2.04
		(0.014)	(0.018)	(0.309)	(0.074)
Involvement Practices					
Meeting (% wkrs)			-0.008	-0.097	0.016
			(0.061)	(0.067)	(0.088)
Team (% wkrs)			0.048	-0.034	0.094
			(0.123)	(0.104)	(0.139)
Job Rotation (% wkrs)			-0.052	-0.026	0.087
			(0.103)	(0.075)	(0.184)
F-Test			0.20	0.58	0.31
			(0.894)	(0.632)	(0.819)
Pay					
Stock Option-Profit Sharing		0.016	0.020	- 0.048	0.113*
		(0.065)	(0.063)	(0.067)	(0.084)
R2	0.309	0.351	0.352	0.405	0.392
N	727	727	727	453	274

a-The dependent variable is the log of the average wage ratio for managers and production workers.
b-Also include variables on the ratio of production workers over manager, industry, firm-size and union dummies. Standard errors in parenthesis, adjusted using the White correction

Table 3.6: Workplace Organization and Practices and Wage Dispersion[a] - NES 1997

Specifications[b]	(1)	(2)	(3)	(3) Manuf.	(3) Non Man.
Workforce					
Education Differential	0.799***	0.829***	0.806***	0.165	0.999***
	(0.267)	(0.249)	(0.239)	(0.171)	(0.310)
% Women	0.362**	0.321**	0.335**	0.157	0.393**
	(0.142)	(0.129)	(0.129)	(0.127)	(0.179)
% Minorities	0.048	0.121	0.132	0.213***	0.140
	(0.110)	(0.107)	(0.101)	(0.078)	(0.144)
% New Hired	-0.164	0.018	0.053	0.145	0.104
	(0.192)	(0.163)	(0.165)	(0.164)	(0.238)
Union Dummy	-0.049	-0.032	-0.025	-0.028	-0.009
	(0.090)	(0.083)	(0.079)	(0.056)	(0.134)
Technology					
% Equipment < 1 yr	0.035	0.005	-0.0002	0.535***	0.084
	(0.163)	(0.162)	(0.159)	(0.194)	(0.212)
% Equipment 1-4 yr	0.275**	0.393***	0.401***	0.353***	0.555***
	(0.138)	(0.122)	(0.118)	(0.111)	(0.177)
% Equipment > 11 yr	0.082	0.158	0.172	0.047	0.398**
	(0.152)	(0.131)	(0.124)	(0.093)	(0.208)
Capital Stock	-0.012	0.003	0.007	- 0.003	0.012
$ value, in log	(0.022)	(0.019)	(0.019)	(0.021)	(0.022)
New Equipt	0.011	0.001	0.001	-0.045	0.009
$ value, in log	(0.022)	(0.020)	(0.020)	(0.019)	(0.027)
Computer Use					
% Managers		-0.019	0.018	-0.005	-0.004
		(0.091)	(0.083)	(0.084)	(0.103)
% Others		0.085	0.088	0.062	0.046
		(0.078)	(0.079)	(0.082)	(0.103)
F-Test		1.22	0.88	0.31	0.11
		(0.297)	(0.416)	(0.730)	(0.896)

a-The dependent variable is the log of the average wage ratio for managers and production workers.
b-Also include variables on the ratio of production workers over manager, industry, firm-size and union dummies. Standard errors in parenthesis, adjusted using the White correction.

Workplace Organization and Practices and Wage Dispersion[a] - NES 1997
(Continued)

Specifications[b]	(1)	(2)	(3)	(3) Manuf.	(3) Non Man.
Workplace Organization					
# Management Levels		0.029	0.016	0.001	0.033
		(0.054)	(0.052)	(0.043)	(0.075)
# Wkrs/Supervisor		0.103	0.106**	- 0.077**	0.167***
		(0.042)	(0.041)	(0.033)	(0.054)
Benchmarking		-0.079	-0.096	-0.064	-0.127
		(0.058)	(0.059)	(0.042)	(0.093)
Reengineering		-0.052	-0.048	-0.001	-0.087
		(0.058)	(0.056)	(0.046)	(0.086)
Training Team		-0.194***	-0.185***	0.007	-0.267***
		(0.068)	(0.068)	(0.067)	(0.099)
F-Test		3.69	3.66	1.51	4.07
		(0.003)	(0.003)	(0.186)	(0.002)
Involvement Practices					
Meeting (% wkrs)			-0.027	0.023	-0.055
			(0.063)	(0.056)	(0.090)
Team (% wkrs)			0.178**	-0.079	0.325***
			(0.079)	(0.085)	(0.113)
Job Rotation (% wkrs)			-0.049	0.094	-0.024
			(0.092)	(0.070)	(0.158)
F-Test			1.74	1.11	3.10
			(0.158)	(0.343)	(0.028)
Pay					
Stock Option-Profit Sharing		-0.109*	- 0.111*	-0.009	-0.159*
		(0.061)	(0.060)	(0.044)	(0.094)
R2	0.270	0.339	0.352	0.302	0.461
N	673	673	673	454	219

a-The dependent variable is the log of the average wage ratio for managers and production workers.
b-Also include variables on the ratio of production workers over manager, industry, firm-size and union dummies. Standard errors in parenthesis, adjusted using the White correction.

Table 3.7: Workplace Practices Dummies and Wage Dispersion[a]

1994 Dependent[b] Variables	Manufact. Wage Ratio	Manufact. Wage Manager	Manufact. Wage Ft-line	Non Manufact. Wage Ratio	Non Manufact. Wage Manager	Non Manufact. Wage Ft- line
M	0.137*	0.027	-0.083**	-0.235*	-0.171	0.093
	(0.083)	(0.081)	(0.041)	(0.124)	(0.122)	(0.112)
T	0.189	0.284	-0.134	-0.271	-0.294	0.074
	(0.222)	(0.237)	(0.088)	(0.252)	(0.204)	(0.232)
J	0.166	0.118	-0.019	-0.321**	-0.302*	-0.073
	(0.112)	(0.113)	(0.052)	(0.155)	(0.163)	(0.142)
MT	0.146	-0.007	-0.083*	-0.318**	-0.059	0.192
	(0.119)	(0.119)	(0.048)	(0.157)	(0.128)	(0.135)
MJ	0.095	-0.003	-0.073*	-0.346***	-0.283**	0.079
	(0.095)	(0.095)	(0.042)	(0.135)	(0.123)	(0.114)
TJ	0.070	0.160	0.099	-0.248	0.103	0.298
	(0.184)	(0.121)	(0.106)	(0.197)	(0.273)	(0.239)
MTJ	0.184*	0.058	-0.100**	-0.125	0.115	0.222*
	(0.102)	(0.106)	(0.050)	(0.136)	(0.135)	(0.127)
R2	0.410	0.345	0.621	0.494	0.649	0.675
N	460	467	493	291	321	298

1997 Dependent[b] Variables	Manufact. Wage Ratio	Manufact. Wage Manager	Manufact. Wage Ft-line	Non Manufact. Wage Ratio	Non Manufact. Wage Manager	Non Manufact. Wage Ft- line
M	-0.073	-0.167	-0.099*	0.138	-0.029	-0.155
	(0.115)	(0.121)	(0.059)	(0.168)	(0.168)	(0.111)
T	-0.017	-0.047	-0.011	0.367*	0.494**	0.154
	(0.169)	(0.210)	(0.081)	(0.203)	(0.230)	(0.149)
J	-0.078	-0.118	-0.056	-0.066	-0.603**	- 0.487***
	(0.122)	(0.126)	(0.099)	(0.295)	(0.277)	(0.146)
MT	-0.319***	-0.279**	0.035	-0.020	-0.071	- 0.064
	(0.115)	(0.121)	(0.065)	(0.201)	(0.176)	(0.105)
MJ	-0.047	-0.143	-0.096*	0.011	-0.163	-0.153*
	(0.111)	(0.121)	(0.056)	(0.174)	(0.155)	(0.110)
TJ	-0.173	-0.017	0.156**	-0.104	-0.988***	- 0.735***
	(0.208)	(0.261)	(0.073)	(0.299)	(0.281)	(0.225)
MTJ	-0.224**	-0.168	0.027	0.183	-0.103	- 0.309***
	(0.102)	(0.109)	(0.060)	(0.177)	(0.149)	(0.110)
R2	0.378	0.393	0.654	0.494	0.591	0.716
N	392	392	412	196	200	200

a-Also include variables on the ratio of production workers over manager, industry, firm-size and union dummies. Standard errors in parenthesis, adjusted using the White correction. b-The dependent variables are the log of the ratio of average wages for managers and production workers and the log wage for the two categories separatly.

Table 3.8: Workplace Practices and Profit Sharing - NES 1994

Dependent Variables	Manufact. Wage Ratio	Manufact. Wage Manager	Manufact. Wage Ft-line	Non Manufact. Wage Ratio	Non Manufact. Wage Manager	Non Manufact. Wage Ft- line
Regression 1						
MT Practice						
MT	0.106	0.072	0.021	-0.158	0.000	0.226*
	(0.141)	(0.131)	(0.055)	(0.148)	(0.137)	(0.135)
MT*SOPS	-0.133	-0.114	0.031	-0.144	-0.167*	- 0.057
	(0.110)	(0.099)	(0.044)	(0.111)	(0.095)	(0.075)
NOMT*SOPS	-0.081	0.014	0.147***	-0.107	-0.009	0.135
	(0.106)	(0.105)	(0.051)	(0.149)	(0.163)	(0.140)
R2	0.375	0.316	0.608	0.430	0.562	0.651
N	470	477	508	298	329	305
Regression 2						
MJ Practice						
MJ	0.224*	0.166	0.013	-0.172	-0.009	0.162
	(0.126)	(0.120)	(0.062)	(0.181)	(0.168)	(0.123)
MJ*SOPS	-0.148	-0.121	0.041	-0.147*	-0.149	- 0.020
	(0.098)	(0.089)	(0.040)	(0.103)	(0.080)	(0.068)
NOMJ*SOPS	0.021	0.106	0.153**	-0.077	0.065	0.120
	(0.124)	(0.117)	(0.063)	(0.191)	(0.192)	(0.143)
R2	0.380	0.320	0.606	0.436	0.599	0.657
N	470	477	508	298	329	305
Regression 3						
MTJ Practice						
MTJ	0.239*	0.163	0.004	-0.064	0.098	0.152
	(0.133)	(0.125)	(0.064)	(0.178)	(0.199)	(0.155)
MTJ*SOPS	-0.145	-0.123	0.039	-0.172*	-0.182**	- 0.034
	(0.096)	(0.087)	(0.040)	(0.102)	(0.088)	(0.071)
NOMTJ*SOPS	0.022	0.102	0.150**	0.083	0.189	0.085
	(0.124)	(0.119)	(0.063)	(0.186)	(0.236)	(0.180)
R2	0.381	0.320	0.607	0.437	0.568	0.648
N	470	477	508	298	329	305

Table 3.9: Workplace Practices and Profit Sharing - NES 1997

Dependent Variables	Manufact. Wage Ratio	Manufact. Wage Manager	Manufact. Wage Ft-line	Non Manufact. Wage Ratio	Non Manufact. Wage Manager	Non Manufact. Wage Ft- line
Regression 1						
MT Practice						
MT	-0.199*	-0.182	0.004	0.322***	0.174	-0.128
	(0.109)	(0.130)	(0.062)	(0.113)	(0.110)	(0.103)
MT*SOPS	0.004	0.029	0.031	-0.242***	-0.085	0.145**
	(0.047)	(0.049)	(0.034)	(0.081)	(0.085)	(0.059)
NOMT*SOPS	-0.406***	-0.239*	0.149**	0.647***	0.620***	0.023
	(0.133)	(0.145)	(0.076)	(0.207)	(0.214)	(0.186)
R2	0.329	0.346	0.575	0.473	0.605	0.740
N	465	466	506	235	239	240
Regression 2						
MJ Practice						
MJ	-0.222*	-0.256*	-0.048	0.113	-0.126	- 0.224**
	(0.132)	(0.153)	(0.068)	(0.131)	(0.131)	(0.097)
MJ*SOPS	0.001	0.033	0.038	-0.212**	-0.056	0.145**
	(0.044)	(0.047)	(0.033)	(0.081)	(0.084)	(0.061)
NOMJ*SOPS	-0.376**	-0.284	0.078	0.341	0.420**	0.119
	(0.166)	(0.180)	(0.082)	(0.223)	(0.205)	(0.168)
R2	0.358	0.356	0.592	0.441	0.586	0.737
N	465	466	506	235	239	240
Regression 3						
MTJ Practice						
MTJ	-0.252*	-0.292*	-0.055	0.348***	0.165	- 0.157
	(0.138)	(0.165)	(0.079)	(0.128)	(0.124)	(0.115)
MTJ*SOPS	0.003	0.038	0.041	-0.239***	-0.082	0.145**
	(0.046)	(0.047)	(0.033)	(0.082)	(0.085)	(0.058)
NOMTJ*SOPS	-0.533***	-0.389**	0.107	0.685***	0.655***	0.020
	(0.155)	(0.179)	(0.087)	(0.223)	(0.218)	(0.196)
R2	0.336	0.360	0.574	0.473	0.605	0.742
N	465	466	506	235	239	240

Appendix A.94: Workforce and Firm Weighted-Average Characteristics by Practices

Practices	Meeting	Team	Job Rot.	Meeting & Team	Meeting & Job Rot.	Team & Job Rot.	All	None
Workforce								
Ed. Managers	14.80	13.50	15.19	14.79	14.83	15.43	14.99	14.32
	(0.11)	(0.66)	(0.28)	(0.13)	(0.15)	(0.30)	(0.11)	(0.13)
Ed. Ft-line	12.51	11.36	11.96	12.45	11.99	12.31	11.96	11.68
	(0.09)	(0.35)	(0.22)	(0.13)	(0.09)	(0.39)	(0.09)	(0.13)
Ed. Supervisor	12.77	13.34	10.80	13.16	13.20	12.37	12.56	11.30
	(0.14)	(0.50)	(0.41)	(0.16)	(0.15)	(0.67)	(0.14)	(0.34)
Ed. Service	12.50	12.13	11.22	11.87	11.84	12.63	12.46	12.59
	(0.12)	(0.17)	(0.43)	(0.17)	(0.15)	(0.38)	(0.11)	(0.17)
Ed. Technicians	10.74	11.55	10.22	11.84	11.94	12.36	12.58	11.61
	(0.18)	(1.26)	(0.43)	(0.26)	(0.22)	(0.79)	(0.18)	(0.30)
% Women	0.36	0.07	0.37	0.44	0.49	0.40	0.43	0.29
	(0.02)	(0.03)	(0.05)	(0.03)	(0.02)	(0.07)	(0.02)	(0.03)
% Minorities	0.20	0.11	0.31	0.22	0.23	0.24	0.19	0.16
	(0.01)	(0.03)	(0.06)	(0.02)	(0.02)	(0.08)	(0.01)	(0.03)
% Newhired	0.24	0.26	0.22	0.25	0.23	0.18	0.18	0.17
	(0.01)	(0.06)	(0.03)	(0.03)	(0.02)	(0.04)	(0.01)	(0.02)
% Managers	11.20	7.80	8.79	13.90	11.90	9.64	12.51	19.00
	(0.61)	(2.52)	(1.14)	(1.29)	(0.84)	(2.13)	(0.87)	(1.96)
% Ft-line	63.07	64.98	73.77	58.97	58.68	59.85	50.89	51.58
	(1.73)	(11.56)	(4.62)	(2.29)	(2.00)	(6.72)	(2.24)	(2.92)
% Supervisors	5.61	2.42	4.80	7.07	8.66	6.80	9.25	6.06
	(0.36)	(1.91)	(0.88)	(0.51)	(0.43)	(1.35)	(0.55)	(0.79)
% Service	11.90	12.93	5.11	10.42	12.84	10.41	13.29	14.77
	(0.87)	(3.22)	(1.59)	(0.95)	(1.07)	(1.98)	(0.92)	(1.61)
% Technicians	8.31	11.95	7.53	10.30	8.76	13.31	14.35	8.59
	(1.06)	(7.07)	(3.54)	(1.39)	(1.01)	(4.74)	(1.29)	(1.02)
Pay								
Managers	2.97	2.77	2.96	2.99	2.84	3.13	3.23	3.05
	(0.03)	(0.11)	(0.08)	(0.04)	(0.04)	(0.07)	(0.04)	(0.06)
Ft-line	2.28	2.28	2.01	2.34	2.23	2.48	2.40	2.37
	(0.03)	(0.09)	(0.08)	(0.04)	(0.04)	(0.13)	(0.03)	(0.04)
Supervisors	2.75	2.82	2.68	2.68	2.69	2.87	2.89	2.69
	(0.02)	(0.16)	(0.08)	(0.04)	(0.02)	(0.06)	(0.03)	(0.04)
Services	2.29	2.20	2.35	2.31	2.24	2.34	2.31	2.19
	(0.02)	(0.08)	(0.08)	(0.03)	(0.02)	(0.05)	(0.02)	(0.05)
Technicians	2.62	2.61	2.61	2.74	2.53	2.67	2.82	2.47
	(0.03)	(0.07)	(0.07)	(0.04)	(0.03)	(0.06)	(0.03)	(0.03)
% Stck Opt./PS	0.81	0.70	0.40	0.65	0.82	0.54	0.78	0.75
	(0.02)	(0.20)	(0.09)	(0.04)	(0.03)	(0.13)	(0.03)	(0.05)

Appendix A.94: Workforce and Firm Weighted-Average Characteristics by Practices

Practices	Meeting	Team	Job Rot.	Meeting & Team	Meeting & Job Rot.	Team & Job Rot.	All	None
Firm								
% < 1 yr	0.16	0.02	0.12	0.27	0.10	0.19	0.10	0.13
	(0.01)	(0.01)	(0.02)	(0.03)	(0.01)	(0.08)	(0.01)	(0.01)
% 1-4 yr	0.38	0.14	0.35	0.27	0.39	0.39	0.48	0.38
	(0.01)	(0.10)	(0.04)	(0.02)	(0.02)	(0.08)	(0.02)	(0.03)
% 5-10 yr	0.33	0.31	0.38	0.36	0.36	0.28	0.31	0.26
	(0.01)	(0.10)	(0.04)	(0.03)	(0.02)	(0.06)	(0.02)	(0.02)
% > 11 yr	0.13	0.53	0.16	0.09	0.16	0.14	0.11	0.23
	(0.01)	(0.12)	(0.05)	(0.02)	(0.02)	(0.05)	(0.01)	(0.04)
Sales ($/1000)	32.90	42.52	18.55	26.04	28.27	123.19	26.58	9.79
	(7.41)	(16.29)	(10.94)	(11.02)	(8.49)	(80.13)	(6.99)	(1.71)
Capital ($/1000)	3.89	2.71	2.98	6.83	11.65	4.02	8.12	1.78
	(1.00)	(3.27)	(3.65)	(3.23)	(3.70)	(2.05)	(2.69)	(0.72)
New Eqpt. ($/1000)	1.06	0.26	0.36	0.38	0.64	0.62	0.90	0.26
	(0.26)	(0.71)	(0.37)	(0.14)	(0.20)	(0.41)	(0.30)	(0.09)
% Unionized Firms	0.12	0.08	0.15	0.09	0.18	0.22	0.11	0.16
	(0.02)	(0.12)	(0.07)	(0.02)	(0.03)	(0.11)	(0.02)	(0.04)
% Manuf. Firms	0.25	0.04	0.41	0.19	0.27	0.70	0.17	0.40
	(0.03)	(0.09)	(0.09)	(0.03)	(0.03)	(0.12)	(0.03)	(0.06)
Workplace								
# Mng Levels	1.57	0.23	1.42	2.26	2.35	1.83	2.49	2.12
	(0.09)	(0.22)	(0.21)	(0.13)	(0.14)	(0.29)	(0.14)	(0.17)
# Wkrs Superv.	15.18	17.98	29.72	9.63	12.28	16.64	17.46	11.25
	(0.70)	(5.82)	(4.23)	(0.71)	(0.62)	(4.15)	(2.13)	(1.62)
% Benchmarking	0.17	0.00	0.23	0.22	0.37	0.25	0.53	0.07
	(0.02)	(0.00)	(0.08)	(0.04)	(0.04)	(0.12)	(0.04)	(0.03)
% TQM	0.29	0.01	0.10	0.30	0.43	0.36	0.43	0.11
	(0.03)	(0.05)	(0.06)	(0.04)	(0.04)	(0.13)	(0.04)	(0.04)
% Training Team	0.45	0.09	0.39	0.43	0.54	0.31	0.75	0.11
	(0.03)	(0.13)	(0.09)	(0.04)	(0.04)	(0.12)	(0.03)	(0.04)
% Mng using PC	0.77	0.70	0.59	0.83	0.63	0.83	0.82	0.69
	(0.02)	(0.12)	(0.06)	(0.03)	(0.03)	(0.08)	(0.02)	(0.04)
% Other using PC	0.47	0.57	0.32	0.58	0.35	0.27	0.43	0.25
	(0.03)	(0.19)	(0.05)	(0.04)	(0.03)	(0.08)	(0.03)	(0.04)
% Practices	0.295	0.007	0.033	0.150	0.200	0.017	0.220	0.078
N	261	6	29	133	177	15	261	69

Appendix A.97: Workforce and Firm Weighted-Average Characteristics by Practices

Practices	Meeting	Team	Job Rot.	Meeting & Team	Meeting & Job Rot.	Team & Job Rot.	All	None
Workforce								
Ed. Managers	14.47	13.66	13.94	15.27	14.16	14.82	14.78	14.17
	(0.12)	(0.35)	(0.40)	(0.13)	(0.13)	(0.35)	(0.11)	(0.21)
Ed. Ft-line	12.37	12.33	12.38	12.82	12.35	12.20	12.84	12.68
	(0.10)	(0.24)	(0.45)	(0.15)	(0.09)	(0.40)	(0.10)	(0.17)
Ed. Supervisor	12.98	13.05	13.02	13.22	12.59	12.95	13.95	12.35
	(0.11)	(0.36)	(0.38)	(0.14)	(0.07)	(0.52)	(0.11)	(0.10)
Ed. Service	12.43	12.27	12.57	12.78	12.56	12.03	12.59	12.26
	(0.06)	(0.19)	(0.19)	(0.10)	(0.07)	(0.50)	(0.06)	(0.10)
Ed. Technicians	13.57	13.57	14.52	13.38	13.33	13.17	14.18	12.95
	(0.12)	(0.50)	(0.40)	(0.14)	(0.13)	(0.71)	(0.09)	(0.25)
% Women	0.39	0.14	0.37	0.34	0.49	0.31	0.47	0.27
	(0.02)	(0.03)	(0.06)	(0.02)	(0.02)	(0.05)	(0.02)	(0.02)
% Minorities	0.23	0.18	0.33	0.22	0.25	0.12	0.25	0.12
	(0.02)	(0.04)	(0.06)	(0.02)	(0.02)	(0.03)	(0.01)	(0.02)
% Newhired	0.22	0.07	0.25	0.16	0.23	0.26	0.23	0.17
	(0.01)	(0.03)	(0.05)	(0.01)	(0.02)	(0.05)	(0.01)	(0.02)
% Managers	13.97	8.05	11.99	18.15	10.73	16.90	12.03	16.17
	(0.79)	(1.24)	(2.00)	(1.61)	(0.53)	(2.06)	(0.42)	(1.07)
% Ft-line	63.04	60.50	47.89	52.75	61.29	50.48	59.15	50.05
	(1.71)	(7.20)	(6.25)	(2.26)	(1.65)	(6.29)	(1.71)	(2.81)
% Supervisors	5.50	6.11	13.73	7.83	8.29	9.54	6.48	6.69
	(0.49)	(1.97)	(2.88)	(0.67)	(0.42)	(2.47)	(0.35)	(0.62)
% Service	9.81	9.54	16.08	9.40	9.01	13.68	11.40	15.48
	(0.77)	(2.25)	(2.49)	(0.68)	(0.94)	(3.13)	(0.69)	(1.25)
% Technicians	8.00	15.80	10.97	12.69	11.10	9.59	11.30	12.05
	(0.95)	(4.28)	(4.27)	(1.45)	(1.26)	(4.42)	(1.02)	(1.69)
Pay								
Managers	2.96	3.61	2.97	3.11	2.92	2.65	3.03	3.06
	(0.04)	(0.13)	(0.11)	(0.03)	(0.03)	(0.14)	(0.04)	(0.07)
Ft-line	2.30	2.84	2.23	2.60	2.26	2.24	2.33	2.65
	(0.05)	(0.12)	(0.09)	(0.03)	(0.03)	(0.09)	(0.03)	(0.04)
Supervisors	2.71	3.14	2.50	2.74	2.65	2.37	2.92	2.76
	(0.03)	(0.10)	(0.11)	(0.03)	(0.03)	(0.12)	(0.02)	(0.04)
Services	2.29	2.39	2.26	2.41	2.40	2.22	2.47	2.30
	(0.02)	(0.06)	(0.07)	(0.02)	(0.02)	(0.07)	(0.02)	(0.05)
Technicians	2.48	2.83	2.71	2.63	2.63	2.55	2.79	2.59
	(0.03)	(0.04)	(0.05)	(0.04)	(0.02)	(0.06)	(0.02)	(0.05)
% Stck Opt./PS	0.45	0.29	0.24	0.49	0.32	0.09	0.53	0.19
	(0.04)	(0.13)	(0.10)	(0.04)	(0.03)	(0.09)	(0.03)	(0.05)

Appendix A.97: Workforce and Firm Weighted-Average Characteristics by Practices

Practices	Meeting	Team	Job Rot.	Meeting & Team	Meeting & Job Rot.	Team & Job Rot.	All	None
Firm								
% < 1 yr	0.12	0.16	0.06	0.16	0.22	0.05	0.10	0.08
	(0.01)	(0.06)	(0.01)	(0.02)	(0.02)	(0.03)	(0.01)	(0.01)
% 1-4 yr	0.46	0.31	0.46	0.38	0.26	0.34	0.39	0.30
	(0.03)	(0.08)	(0.09)	(0.03)	(0.02)	(0.06)	(0.01)	(0.03)
% 5-10 yr	0.26	0.39	0.21	0.30	0.28	0.43	0.35	0.40
	(0.02)	(0.11)	(0.05)	(0.02)	(0.02)	(0.05)	(0.01)	(0.03)
% > 11 yr	0.16	0.13	0.27	0.16	0.24	0.18	0.17	0.22
	(0.02)	(0.06)	(0.07)	(0.02)	(0.02)	(0.07)	(0.01)	(0.03)
Sales ($/1000)	14.42	29.52	25.76	16.70	11.54	3.59	18.16	20.84
	(3.57)	(10.96)	(16.24)	(4.42)	(3.76)	(2.06)	(3.16)	(7.51)
Capital ($/1000)	4.98	2.24	6.57	5.84	6.08	1.42	6.54	4.01
	(1.84)	(0.61)	(4.54)	(3.67)	(5.36)	(0.47)	(2.34)	(3.70)
New Eqpt. ($/1000)	0.36	0.24	0.59	0.75	0.38	0.31	0.63	0.55
	(0.11)	(0.15)	(0.46)	(0.36)	(0.18)	(0.23)	(0.17)	(0.58)
% Unionized Firms	0.15	0.28	0.20	0.13	0.06	0.14	0.10	0.10
	(0.03)	(0.13)	(0.10)	(0.03)	(0.02)	(0.11)	(0.02)	(0.04)
% Manuf. Firms	0.18	0.17	0.52	0.22	0.23	0.37	0.26	0.19
	(0.03)	(0.11)	(0.12)	(0.04)	(0.03)	(0.15)	(0.03)	(0.05)
Workplace								
# Mng Levels	1.48	1.61	2.00	1.98	1.82	2.15	1.79	1.36
	(0.08)	(0.14)	(0.21)	(0.46)	(0.09)	(0.34)	(0.09)	(0.17)
# Wkrs Superv.	11.30	11.97	9.62	10.38	12.46	7.20	13.22	8.18
	(0.85)	(2.36)	(1.81)	(1.03)	(0.71)	(1.05)	(0.85)	(0.82)
% Benchmarking	0.23	0.03	0.25	0.40	0.17	0.11	0.38	0.21
	(0.03)	(0.05)	(0.10)	(0.04)	(0.03)	(0.09)	(0.03)	(0.05)
% Rengineering	0.34	0.11	0.08	0.29	0.26	0.45	0.39	0.08
	(0.04)	(0.09)	(0.07)	(0.04)	(0.03)	(0.15)	(0.03)	(0.04)
% Training Team	0.85	0.75	0.80	0.87	0.89	0.73	0.95	0.85
	(0.03)	(0.12)	(0.09)	(0.03)	(0.02)	(0.13)	(0.01)	(0.05)
% Mng using PC	0.79	0.58	0.72	0.85	0.74	0.82	0.90	0.90
	(0.03)	(0.12)	(0.07)	(0.03)	(0.03)	(0.09)	(0.01)	(0.03)
% Other using PC	0.42	0.44	0.59	0.52	0.70	0.66	0.65	0.48
	(0.03)	(0.13)	(0.10)	(0.04)	(0.03)	(0.14)	(0.02)	(0.05)
% Practices	0.203	0.014	0.021	0.152	0.232	0.013	0.300	0.063
N	181	13	19	136	207	12	181	56

Appendix A4.5: Workplace Practices and Wage Dispersion
(Hourly wage rates with the same hour approximation as with the NES 1994)

1997	**Manufact.**			**Non Manufact.**		
Dependent Variables	Wage Ratio	Wage Manager	Wage Ft-line	Wage Ratio	Wage Manager	Wage Ft- line
M	-0.136	-0.231**	-0.099*	0.257	0.082	-0.156
	(0.109)	(0.112)	(0.059)	(0.163)	(0.164)	(0.111)
T	-0.079	-0.109	-0.012	0.525**	0.656***	0.155
	(0.144)	(0.186)	(0.081)	(0.205)	(0.231)	(0.149)
J	-0.103	-0.143	-0.057	0.053	-0.488*	-0.487***
	(0.131)	(0.132)	(0.100)	(0.315)	(0.296)	(0.146)
MT	-0.313***	-0.272**	0.036	0.083	0.023	-0.065
	(0.108)	(0.117)	(0.066)	(0.200)	(0.176)	(0.106)
MJ	-0.041	-0.138	-0.096*	0.060	-0.118	-0.153
	(0.106)	(0.110)	(0.056)	(0.173)	(0.151)	(0.110)
TJ	-0.229	-0.073	0.156**	-0.130	-1.004***	- 0.736***
	(0.207)	(0.258)	(0.073)	(0.301)	(0.284)	(0.226)
MTJ	-0.258***	-0.202**	0.027	0.317*	0.013	- 0.310***
	(0.097)	(0.100)	(0.061)	(0.177)	(0.147)	(0.111)
R2	0.389	0.381	0.655	0.506	0.616	0.716
N	392	392	412	197	201	200

Appendix A4.6: Workplace Practices Frequencies and Profit Sharing

Year	1994			1997		
	All	Manuf.	Non Manuf.	All	Manuf.	Non Manuf.
One Pract.						
M*PS	0.261	0.246	0.266	0.110	0.112	0.110
M*NOPS	0.060	0.080	0.053	0.137	0.090	0.151
T*PS	0.005	0.001	0.006	0.006	0.014	0.004
T*NOPS	0.002	0	0.003	0.016	0.002	0.020
J*PS	0.013	0.026	0.009	0.003	0.011	0.001
J*NOPS	0.019	0.028	0.016	0.011	0.021	0.008
Two Pract.						
MT*PS	0.097	0.082	0.102	0.063	0.074	0.060
MT*NOPS	0.053	0.030	0.061	0.066	0.050	0.071
MJ*PS	0.140	0.158	0.134	0.079	0.111	0.069
MJ*NOPS	0.032	0.026	0.034	0.168	0.136	0.178
TJ*PS	0.005	0.014	0.002	0.002	0.008	0
TJ*NOPS	0.005	0.014	0.001	0.021	0.029	0.018
All/No Pract.						
MTJ*PS	0.172	0.145	0.180	0.118	0.133	0.114
MTJ*NOPS	0.048	0.008	0.061	0.104	0.127	0.097
NOMTJ*PS	0.066	0.081	0.061	0.018	0.027	0.016
NOMTJ*NOPS	0.023	0.061	0.010	0.077	0.053	0.083

Synthèse

Cette thèse présente une étude empirique de l'intéraction entre les compétences du travailleur et les caractéristiques de l'entreprise dans la formation des salaires. L'approche dans chaque partie se base sur l'idée que les salaires ne sont pas seulement fonction des compétences du travailleur mais aussi de la façon dont ces compétences sont exploitées par l'entreprise qui possède ses propres caractéristiques. Trois principales caractéristiques de l'entreprise sont abordées : la structure hiérarchique des postes, la taille de l'entreprise et les pratiques de gestion des ressources humaines.

Le premier chapitre de cette thèse teste le modèle de Gibbons et Waldman en utilisant des données allemandes qui possèdent de l'information précise sur la hiérarchie des emplois dans l'entreprise. Nous utilisons une spécification économétrique et une méthode d'estimation qui permettent de tenir compte de l'intéraction entre les compétences mesurables et non mesurables et le niveau du poste dans la hiérarchie des emplois dans l'entreprise.

La dynamique des salaires révèle l'importance de l'attribution des tâches aux travailleurs dans l'entreprise. En d'autres termes, l'analyse de la formation des salaires doit tenir compte des effets liés à l'autosélection des travailleurs dans les différents niveaux de l'échelle des emplois. Les résultats concernent le cas de l'Allemagne et, avec l'obtention d'informations précises sur la structure des emplois, ils devraient s'appliquer au cas américain dont sont tirés les faits stylisés qui ont motivé le modèle de Gibbons et Waldman.

Prenant une perspective plus large de la question, le deuxième chapitre considère l'interaction entre les compétences des travailleurs et la taille des entreprises, les exigences et responsabilités des postes pouvant varier entre les grandes et petites entreprises. Elle met en évidence la possibilité que l'auto-selection des travailleurs ou l'allocation des compétences mesurables et non mesurables des travailleurs s'effectue entre les entreprises de différente taille. Une comparaison des structures de salaire selon la taille de l'entreprise avec des données en coupe transversale canadiennes et américaines montre que les effets d'auto- selection des travailleurs entre les entreprises de différente taille sont importants et d'autre part, qu'ils dépendent aussi de la syndicalisation des entreprises.

Le troisième chapitre se place au niveau de l'organisation du milieu du travail des entreprises. Elle explore les liens entre les pratiques de gestion des ressources humaines et les différentiels de salaires entre les managers et les travailleurs à la production dans l'entreprise. Les résultats suggèrent que l'application de politiques de gestion du personnel a des effets différents en terme de salaire pour ces deux catégories de travailleurs et que ces effets sont aussi différents selon le secteur de production (manufacturier ou non manufacturier).

L'analyse de cette thèse a permis de confirmer empiriquement le fait que les salaires doivent tenir compte de l'intéraction entre les compétences des travailleurs, la technologie de production et les politiques d'organisation du travail et du personnel qui sont propres à l'entreprise. L'analyse de la relation employeur-employés doit néanmoins faire face aux problèmes de mesure imparfaite de la qualité de la force de travail mais aussi de la qualité de l'organisation de cette force de travail. Idéalement, elle devrait pouvoir prendre en compte les effets de sélection à la fois des travailleurs au niveau de leur choix de poste ou d'entreprise mais aussi des entreprises au niveau de leur choix de technologie et de gestion du personnel. Avec la disponibilité croissante des banques de données fournissant de l'information détaillée sur les caractéristiques des travailleurs et de l'entreprise qui les emploie, la recherche empirique sur la relation employeur-employés pourra continuer de se développer dans cette perspective.