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Downsizing the Hierarchical Workplace: The Role of Firing Costs.

Gerard A. Pfann[1] Ben Kriechel[2]

PRELIMINARY, PLEASE DO NOT QUOTE

Abstract: This paper finds (*i*) that *within* skill groups firing costs are higher at the top of the hierarchy than at the bottom; and (*ii*) that the difference in firing costs *between* skill groups rises with authority. To assess quantitatively how these findings influence the internal restructuring at a large firm a hierarchical decision model is estimated using personnel data from a Dutch aerospace firm in demise. The model proves to be sufficiently flexible to explain the non-monotonic changes in authority observed across the firm's entire job structure. Model simulations show that the combination of the within and between effects of firing costs give rise to a larger wage discrepancy *between* skill groups in the course of downsizing.

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[1] Corresponding author: Department of Economics, Maastricht University, PO Box 616, 6200 MD Maastricht, The Netherlands; IZA and CEPR. Tel: +31-43-388-3832; email: g.pfann@ke.unimaas.nl. [2] Research Centre for Education and the Labor Market, Maastricht University, PO Box 616, 6200 MD Maastricht, The Netherlands; and IZA. Tel: +31-43-388-3287; email: Ben.Kriechel@roa.unimaas.nl. We would like to thank Fokker's bankruptcy trustees, especially Ben Knüppe, for making the personnel data available, and Louis Deterink for sharing with us his profound knowledge and insights on corporate through-starts. We are grateful to Dan Hamermesh, Jim Malcomson, Jan van Ours, Dennis Snower, Uwe Sunde, and Bas ter Weel for their numerous helpful comments.

"Workers who walk out of the factory gate on a Friday afternoon will typically return through the same gate on a Monday morning, if not before. This commonplace fact is indicative of the dynamic nature of the firm's demand for labour. The typical firm does not hire its workforce afresh every day for the simple reason that it is much cheaper not to do so."

Stephen J. Nickell (1986): Dynamic Models of Labour Demand.
Page 473, Handbook of Labor Economics.

1. Introduction

This paper shows that employment protection rules protect workers in the upper hierarchical layers of each skill group because not only because they are more productive workers earning higher wages, but also because firing costs depend largely on individual wages. Hierarchies in workplaces are often understood as efficient outcomes of personnel assignment policies.[1] Hierarchies determine the earnings distributions within the firm.[2] Innovations may prompt adaptations in the organizational structure of the firm, especially when adjustments to shocks require changes in specializations. If one wants to understand changes in the labor market, it is necessary to understand what is going on inside firms. In a pioneering contribution Caroli and Van Reenen (2001) study the efficacy of organizational change at the establishment level on skills and productivity over time, providing evidence that organizational change reduces the demand for low skilled workers and that its impact on productivity is larger when skills levels are higher. Bresnahan *et al.* (2002) also find that skilled labor is complementary with innovations in work organization as well as with information technology and product demand shocks.

The empirical labor market literature repeatedly makes the distinction between high skilled and low skilled workers to analyze changes in the distribution of earnings or to illustrate differences in adjustment costs. But the inputs of productive skills are, especially in larger

[1] Alchian and Demsetz (1972); Calvo and Wellisz (1979); MacLeod and Malcomson (1988).
[2] Marshak and Radner (1972); Medoff and Abraham (1980); Rosen (1982); Baker, Gibbs and Holmstrom (1994).

firms, often characterized by specific organizational structures with accompanying internal labor market dynamics. The simple distinction between high and low skills conceals the role of hierarchies in the decision process to change the organization of the workplace. One of the contributions of the current paper is to show that without substitution of skills and without adjustments of individual wages, restructuring the workplace can lead to a widening productivity gap and, consequently, to increasing differences *between* average skill groups earnings within the firm. This results from changes in the composition of authority *within* skill groups. The increasing earnings difference between skill groups is enhanced by employment protection measured that we measure as idiosyncratic firing costs.

As indicated by the epitaph at the beginning of the paper, the organization of the workplace is difficult to change. It is likely that the observed lumpiness of workplace adjustments through time is caused by the large transaction costs that such operations involve: the firm's management will not adjust the productive workforce after each single shock, in, for example, learning costs, communication technology, or productivity, but will wait with an adjustment until a sufficiently large number of different shocks have occurred for the reorganization to have become inevitable.

The analysis presented in this paper uses a rich dataset of a Dutch aircraft manufacturer's restructuring plan whose development affected thousands of jobs. The reorganization took place during a single weekend between Friday March 15th and Monday March 18th, 1996. The 2:1 input ratio of manual to non-manual workers did not change; the organizational change was Hicks neutral. Factor input prices also did not change: the workers chosen to stay, returned to work on Monday earning the same wage as they did on the Friday before. The structure of jobs remained the same (no delayering in the level of the pyramid), but the number of workers at different sublevels changed such that the authority between hierarchical sublevels (control spans) also changed. As a by-product of the analysis of the role of firing costs in individual workers' layoff decisions we find that the observed adjustments in control spans are not monotonic across the entire job structure. Monotonicity is an implicit outcome of the theoretical assignment model.

The organization of the paper is as follows. The data are presented in Section 2. The hierarchical decision model is derived in Section 3. Section 4 presents the estimation results and model specifications tests. A simulation analysis of the effect of shocks on work organization is presented in Section 5. Section 6 concludes.

2. Data from a firm in demise

The aircraft manufacturer Fokker, a technologically advanced aircraft builder with its headquarters in Amsterdam, was declared bankrupt on Friday March 15th, 1996. The firm consisted of six plants. Three plants remained virtually unaltered and the other three were restructured. The reorganization took place over the weekend of March 16th and 17th, 1996. On Monday March 18th the trustees rehired 20 percent of the former workers in those three plants. The other workers were permanently displaced. In the reorganization process the total number of dismissals was dictated by the negotiations between the financial precursors and potential investors. The personnel trustees were responsible for the subsequent selection process of workers[3]. The data we use for this study incorporates the records of all tenured workers employed on the day of the bankruptcy in one of the three plants in demise.

[INSERT TABLE 1]

Table 1 presents the input of manual and non-manual workers before and after the reorganization. Precise determination of skill groups is often quite difficult. Early research on

[3] See Deterink *et al.* (1997) for the precursors' report and for an indepth description of the firm's reorganization.

changing earnings distributions showed a trend toward increased skill premiums and offered simple frameworks to investigate substitution effects among skill groups[4]. In our data the firm's internal labor market is characterized by two different ports of entry: one for manual workers and one for non-manual workers. We refer to the two types of workers as skill groups, as they had their own hierarchical structure and their own career patterns[5]. Table 1 shows that the 2:1 input ratio of manual to non-manual workers remained unchanged.

[INSERT TABLE 2]

Table 2 shows means and standard deviations of hourly wages for all workers as well as separate statistics for women and men, for low and high education, below or above medium tenure, and below and above average age. On average we find an increase of 1.9 percent points in the overall hourly compensation between skill groups. The increase, however, is much larger for low educated young workers with below-median tenure, and especially for women.

[INSERT TABLE 3]

Sometimes the determination of skill groups is directly related to educational attainment (*e.g.* Katz and Murphy, 1993; Card and DiNardo, 2002). Table 3 shows that manual workers are lower educated than non-manual workers and that education is positively correlated with the hierarchical level for both skill groups before as well as after the organizational change. Manual workers operate in three hierarchical levels (team workers, team leaders, and heads of production teams); non-manual workers operate in five levels but due to small sample sizes we merged the upper two levels (assistant engineers, engineers, senior engineers, managers). Garicano (2000) presented a theoretical explanation for the finding that more complicated tasks -- of non-manual workers -- coincide with more sublevels.

[4] Bound and Johnson, 1992; Murphy and Welch, 1992; Berman, Bound and Griliches, 1994.
[5] See Dohmen, Kriechel, and Pfann (2004) for a comprehensive description of the data.

He also showed that the impact of shocks in communication or learning costs, which would result in changes in the organizational design, lead to monotonic increases or decreases in control spans over the entire job structure.

[INSERT TABLE 4]

Table 4 shows the changes in the hierarchical job structure for each skill group. Indeed we find that even though the number of workers at different hierarchical sublevels changed, the pyramidal form of the workforce remained unaffected and no sublevels disappeared (no delayering). However, control spans did not increase or decrease monotonically. To understand this result, we will investigate the following explanation. Restructuring firms face large and mostly sunk transaction costs. Such costs will induce the firm's management to postpone substantial restructurings[6]. Once the reorganization is imminent, however, one observes the compounded response to a collection of various shocks. This response may not only affect the relative demand for individual workers, but may change the pyramidal job structure as well.

[INSERT TABLE 5]

Transaction costs of workforce restructuring are associated with firing costs. Firing costs are influenced by job security policies.[7] In the Netherlands firing costs are associated with the period of notice to terminate a job contract. The employer's term of notice (*ToN*) is legally defined in Articles 1639i and 1639j of the Netherlands Civil Code and Article 40.3 of the Bankruptcy Act. The *ToN* is equal to the time that passes between two consecutive earnings instalments not extending a period of 6 weeks. The minimum *ToN* for tenured workers is the number of weeks equal to the number of years the employee has worked full time for the same

[6] See Pindyck (1991) for a lucid explanation of the role of sunk costs on the decision to wait to invest.
[7] See Table 8.2 in Hamermesh (1993) for a list of international studies on the effects of job-security policies. Oyer and Schaefer (2002) show that changes in employment protection policies can change the distribution of wages and employment across members of protected groups of workers.

employer since adulthood (18 years and older), not extending a period of 13 weeks. The *ToN* is extended with one week for every full year during which an employee has been employed after 45 years of age, not extending a period of 13 weeks. The legal maximum *ToN* is thus 26 weeks. Figure I shows the *ToN* and firing costs of the average worker in every sublevel and skill group on March 15th, 1996. For manual workers the average is 12.0 weeks (s.d.=4.4); for non-manual workers the average is 11.9 weeks (s.d.=5.1) weeks. *ToN* increases by sublevels. For every worker in the dataset we computed firing costs as the product of *ToN,* the full time equivalent indicator times forty hours, and the hourly wage[8]. For manual workers the average is 11,900 Dutch guilders (s.d.=5,400); for non-manual workers the average is 20,800 Dutch guilders (s.d.=12,600). Firing costs increase by sublevels as well and rise steeper than *ToN*.

[INSERT FIGURE I]

The Fokker bankruptcy involved the largest displacement of workers in the history of the Netherlands. Because of this unique situation the trustees consulted teams of department heads and representatives of the workers council and the appropriate unions to formulate selection rules. These rules were based on three different types of worker attributes: *productivity* indicators related to performance on the job, *behavioral* characteristics related to citizenship, and *social* criteria related to fairness quota that were agreed upon. External observers were assigned to each selection team to keep an eye on the use of the selection rules in relation to the company's goals, to guarantee objectivity, and to prevent maintaining 'old-boys-networks'.

[8] The variable *fte* indicates a worker's number of contracted hours worked per week (for a forty-hour week *fte*=1*;* for a part-time job of 2 days a week *fte*=0.4). For manual workers the average *fte*=.983, so that 1.7% worked part-time with a minimum of .15 (six hours per week). Of all non-manual workers 1.1% worked part-time with a minimum of .40 (two days per week).

Productivity indicators listed as criteria for the selection teams included annual job *performance* scores, ranging between 1 (bad) and 6 (excellent); *tenure* is measured in years; and education is measured in eight different levels: four (basic; low; medium; high) *vocational education* levels and four *general education* levels. The educational composition of the firm's workforce reflects the traditional industrial character of the firm's production technology: 73.5 percent of all workers had vocational schooling. Social background and language skills were also listed as productivity indicators, but the personnel files did not contain data on these items.

Behavioral characteristics listed as criteria for the selection teams were communication skills, mental flexibility, creativity, interest in other people, need for structure, emotional stability, self-confidence, frustration tolerance, being a team-worker, leadership, and learning capacity. Most of these items are not available in the personnel data files. Taken together, they reflect the superior's perception of a worker's ability to implement tasks, to take responsibility, and citizenship. This perception is partially revealed by the assignment of workers to on-the-job training courses. The firm offered training *courses* to enhance firm-specific knowledge of the production process or to improve general skills. Also commuting *distance* (in kilometers) is related to the - unpaid - time a worker invests daily to go to work.

Social criteria or fairness quota included (partial or temporary) disability, cultural minority groups, single mothers, families with husband and wife both working for the same company, and the age distribution in general. Information on marriage to a co-worker, the number of children, or race is not available in the personnel data, but it does contain information on *age*, gender (1=*female*; 0=male), marital status (not married=0, including divorce; *married*=1), as well as information on temporary partial *disability* (in %).

[INSERT TABLE 5]

Table 5 reports simple multivariate logistic regressions of worker selection for each separate hierarchical level. The general impression obtained from these outcomes is that people selected for training were facing a higher firing risk across all levels. This suggests that training is assigned to workers that function below average. The social rule applied to married workers indeed reduced the firing risk. Commuters were also fired less frequently. In view of the low pseudo-R^2, however, the overall performance of explaining the workers' selection rules by these level-specific logits is quite poor. The results in Table 5 are obtained from independent sublevel regressions, which obviously are in contravention to the actual process.

3. Specifying a hierarchical decision model for workforce adjustment

Workforce adjustment at the firm level is lumpy, and restructuring firms face large and largely sunk transaction costs. According to the theory of non-convex adjustment costs[9], such costs will induce the firm's management to postpone substantial reorganizations. As a consequence thereof we observe a compounded response to a collection of various shocks all with their own impact on the organizational design as well as on the relative demand for individual workers. This section presents a simple framework to model this interdependence at different hierarchical sublevels and for different skill groups of the firm's workforce.

The general foundations for the hierarchical model were given by Tversky and Sattath (1979). In this paper we apply the set-up put forward by McFadden(1984). Figure II presents the tree structure of the hierarchical decision to fire or retain worker i in sublevel r of skill group s: (*1*) the choice of production technology is made first. This choice is translated here as the input of workers to jobs with different skills $s \in \{M; NM\}$; (*2*) the hierarchical organization for each skill group $r \in A_s$ is determined, with A_s defined as the set of sublevels contained in

[9] See Hamermesh and Pfann (1996) for a literature review.

group *s*; and (*3*) the choice of heterogeneous worker input $i \in A_{rs}$ is made, with A_{rs} being defined as the set of all workers employed in sublevel *rs*. The decision probability for a worker *i* in level *r* of skill group *s* can be stated as a product of three organizational choice probabilities $\Pr(i \mid A_{rs})\Pr(A_{rs} \mid A_s)\Pr(A_s)$.

$\Pr(i \mid A_{rs})$ is the probability of individual worker selection which decision is assumed to be taken on the basis of latent individual workers' idiosyncratic productivity written as $\Gamma^*_{irs} = x_{irs}\beta_{rs} + u_{irs}$, with x_{irs} being a vector of heterogeneous worker characteristics, u_{irs} a random component of unobservables, and β_{rs} a vector of sublevel specific constant parameters. A worker will be retained iff $\Gamma^*_{irs} > 0$, or displaced iff $\Gamma^*_{irs} \leq 0$. The variable $1\Gamma_{irs}(0,1)$ indexes this binary choice. If u_{irs} is distributed logistically, the conditional probability of worker *i* being retained in level *r* of skill group *s* yields $\Pr(i \mid A_{rs}) = \dfrac{\sum_{i|1\Gamma_{irs}=1}\left(\exp\left(x_{irs}\beta_{rs}\right)\right)}{\sum_{i|1\Gamma_{irs}=1}\left(\exp\left(x_{irs}\beta_{rs}\right)\right) + Nf_{rs}}$. The identification restrictions for the binary choice of worker selection are set equal across all sublevels and $\beta_{rs} \mid \left(1\Gamma_{irs} = 0\right) = 0$ yield, such that $\sum_{i|1\Gamma_{irs}=0}\left(1\right) = Nf_{rs}$, and Nf_{rs} is equal to the total number of fired workers in sublevel *rs.*

$\Pr(A_{rs} \mid A_s)$ determines the choice of the organizational structure for a given skill group. The hierarchy has an ordered structure. When tasks are more complicated, more levels are observed[10]. For our model we have that $A_M = \{1,2,3\}$ and $A_{NM} = \{1,2,3,4\}$. Each hierarchy has a pyramidal shape. Given the number of sublevels, modifications in authority *within* skill groups result from changes in the relative sizes of hierarchical levels (control spans). Under

[10] Garicano (2000).

uncertainty, the observed outcomes are discrete representations of an optimization problem for irreversible organizational change. This implies that the correlation among ignored components for alternative choices can arise from dependency among unobserved characteristics of several of those choices. It is therefore quite likely that unobserved preferences or characteristics will affect choices among various hierarchical sublevels in similar ways. This effect is captured by the inclusive value J_{rs} that recaps the value of alternative choices when individual workers are selected. The conditional choice of the organizational structure of skill group *s* yields the response probability $\Pr(A_{rs} \mid A_s) = \dfrac{\exp\left(z_{rs}\zeta_s + J_{rs}\kappa_{rs}\right)}{\sum_{k \in A_s} \exp\left(z_{ks}\zeta_s + J_{ks}\kappa_{ks}\right)}$.

This is the proportion of workers in sublevel *rs*; z_{rs} is a vector of variables that are common within the sublevel *rs* and determine the relative interrelated demand for workers in *rs*; ζ_s is a skill group specific vector of constant parameters. J_{rs} is the restricted inclusive value satisfying $J_{rs} = \ln\left(\sum_{i \mid 1\Gamma_{irs}=1} \left(\exp\left(x_{irs}\beta_{rs}\right)\right) + Nf_{rs}\right)$[11]. The parameter κ_{rs} measures the independence of alternative choices within sublevel *rs*. For $0 < \kappa_{rs} < 1$ cross-elasticities are biggest for workers in the same *r* and *s* sublevel[12]. The ordered nature of sublevels is given by the testable property $\kappa_{r+1,s} > \kappa_{rs}$[13], with $\kappa_{1s} = 0$. Values of $\kappa_{rs} > 1$ may indicate that the assumed ordering is not specified correctly, pointing at a misspecified hierarchical structure.

$\Pr(A_s)$ is the probability of the input of skills in the production process. If input ratios do not change, we assume that the production technology remains unchanged also. In that case

[11] Here 'restricted' refers to the identification restrictions of the binary choice of worker selection being equal for all sublevels and yielding $\beta_{rs} \mid \left(1\Gamma_{irs} = 0\right) = 0$, such that $\sum_{i \mid 1\Gamma_{irs}=0} (1) = Nf_{rs}$.

[12] See McFadden(1984), equation (3.49), page 1425.

[13] Lazear and Rosen (1981).

the size of each restructured skill group is pre-determined by the overall size of the workforce reduction. The probability of choosing skill group s reflects the relative productivity of skill group *s+1 vis-à-vis s*. In the empirical application the production input of skills remains unchanged during the reorganization with $\Pr(A_M) = \frac{2}{3}$ for manual workers and $\Pr(A_{NM}) = \frac{1}{3}$ for non-manual workers.

In summary, the contribution to the likelihood that worker i in level r of skills level s is rehired is $L_{irs}(w;\theta) = \Pr(i \mid A_{rs})\Pr(A_{rs} \mid A_s)\Pr(A_s)$, with $w_i = (x_{irs}; z_{rs})$ and $\theta = (\beta_{rs}; \zeta_s; \kappa_{rs})$.

4. An econometric investigation of the model

An econometric specification of the hierarchical decision model requires the determination of variables that are included in z_{rs} and x_{irs}. Variables included in z_{rs} explain the structure of jobs. Variables included in x_{irs} explain the selection of individual workers. Little theory is available to guide us making these choices. Hence we select variables in z_{rs} and x_{irs} on the basis of the results from a stepwise insignificance elimination procedure. Since no variable in Table 5 is significant in all sublevels we start with all variables in z_{rs} and none in x_{irs}. One by one insignificant contributors in z_{rs} are added to x_{irs}. Variables included in this procedure are similar to those stated in Table 5 except for the variable *fte* that was dropped due to a very small proportion of part-time workers (see footnote 9) and the variable *courses* that is broken down into *internal courses* offered by the firm to enhance firm-specific knowledge of the production process and *external courses* provided by outside training agencies to improve general skills[14]. For manual workers we find that $z_{r,M}$ contains the variables *performance*,

[14] Of all manual workers 89.8 percent followed one or more internal courses and 43.6 percent followed one or more external courses; for non-manual workers these numbers are 84.5 percent and 64.1 percent, respectively.

vocational education, *general education*, *external courses*, and *firing costs*, while $x_{ir,M}$ exists of *tenure*, *internal courses*, *distance*, *age*, *female*, *married*, and *disabled*. For non-manual workers $z_{r,NM}$ contains *performance*, *vocational education*, *general education*, *internal courses*, *external courses*, and *firing costs*, while $x_{ir,NM}$ exists of *tenure*, *age*, *female*, *distance*, *married*, and *disabled*. Interestingly, for both skill groups no social criteria entered z_{rs}. The number of external courses in $z_{r,M}$ and of internal and external courses in $z_{r,NM}$ are the only behavioral variables that affect the organizational design. All other variables in z_{rs} are related to productivity, behaviour, and transaction costs. Initially, the variable *ToN* was also included in z_{rs} but it was dropped when its inclusion proved to yield negative estimates for the threshold parameters indicating model misspecification.

[INSERT TABLE 6]

Table 6 presents the nested ordered logit estimates of the variables included in z_{rs} determining the organisational design. Positive signs for firing costs, external courses, and education imply values that are higher at higher sublevels. A positive sign suggests that an increase in the corresponding variable reduces the relative sizes of lower levels (narrowing the pyramid). Conversely, a negative sign implies that an increase of the corresponding variable broadens the relative size of lower levels (widening the pyramid).

A specification test

The parameter estimates $\hat{\beta}_{rs}$ of x_{irs} are not reported here. They are in line with what is reported in Table 5. In summary, we find that manual workers with low displacement probabilities are younger males with fewer internal courses. Non-manual workers had higher chances to be rehired if they were young, married, had high tenure, and lived farther away from work. The estimates for $\hat{\beta}_{rs}$ determine the estimates for the inclusive values $\hat{J}_{rs}$. The relationship between $\hat{J}_{rs}$ and the threshold parameters $\hat{\gamma}_{rs}$ reproted in Table 5 yields $\hat{J}_{rs}\hat{\kappa}_{rs} = \hat{\gamma}_{rs}$, where the κ_{rs}'s are often referred to as the parameters measuring the independence of alternatives within sublevels. Clearly, the independence parameters κ_{rs} and the thresholds $\hat{\gamma}_{rs}$ are not uniquely identified. Estimates for $\hat{\kappa}_{rs}$ can be obtained by computing $\hat{\kappa}_{rs} = \hat{\gamma}_{rs} \big/ \hat{J}_{rs}$.

[INSERT TABLE 7]

The estimates $\hat{\kappa}_{rs}$ can be regarded as a model's specification test. According to McFadden (1984) estimates of κ_{rs} that lie outside the unit interval may indicate that the assumed ordering $\kappa_{r+1,s} > \kappa_{rs}$ is not specified correctly, pointing at a misspecified structure. Table 7 shows the estimates for the threshold parameters γ_{rs}, the inclusive values J_{rs}, and the independence parameters κ_{rs}. We find that only $\hat{\kappa}_{42}$ lies outside the unit interval. This is not so surprising, as this level actually exists of two separate sublevels -- managers and heads of departments -- that we merged to obtain a large enough sub-sample.

Predicting organizational adjustments

It was shown in Table 2 that after the organizational change the pyramidal job structures remained unchanged for both types of workers, but that the numbers of workers kept at each level and therefore the control span altered non-monotonically. According to our model, authority does not have to change systematically or monotonically across the firm's entire hierarchical design. The optimal size of each sublevel depends on the probability density functions of different covariates included in z_{rs} as well as on the thresholds between sublevels which are functions of idiosyncratic worker characteristics x_{irs} in the inclusive values J_{rs}. Variations in either of these may affect the distribution of authority. To illustrate this we have examined the effects of shocks in firing costs.

[INSERT FIGURE III]

Figure III shows the predicted probability curves holding all the other explanatory variables in the model constant. It shows that hierarchical levels can change in a non-systematic way. The graph for the bottom level slopes downward for manual and non-manual workers. This means that the larger the shock, the more the volume of the first level declines relative to the upper sublevels. The graph for level 2 is non-monotonic for both skill groups. First the control span of level 2 increases. After some turning point, however, the graphs of level 1 and 2 start moving downwards together, implying that the change in control span will take place higher up in the hierarchy. Thus, Figure III shows the effect of shocks in firing costs -- *e.g.* policy shocks that reduce changes *ToN* or shocks in heterogeneous wage costs -- on the firm's organizational design. If firing costs increase, the firm will restructure so that profits will be shifted from low to high levels for the simple reason that firing workers in higher levels is more costly.

5. Reorganization of work and the earnings distribution inside the firm

We use the results from Figure III to simulate the changing distribution of earnings between manual and non-manual workers inside the firm caused by respective shocks in firing costs. The simulation exercise was conducted as follows. First, we computed the average hourly wage for all hierarchical levels. The predicted probabilities presented in Figure III allow us to compute the composition of the hourly wage distribution for each skill group relative to the shock size. Hence, changes in the earnings distribution originate from modifying compositions of levels *within* skill groups. Assuming that the shocks are similar in size for both skill groups, we can portray how the earnings between skill groups change as a result of these shocks. The outcomes of the simulations are presented in Figure IV.

[INSERT FIGURE IV]

We find that a positive shock in firing costs increases hourly wages for manual as well as for non-manual workers, but the latter increase is larger. This spread in earnings difference increases with the size of the shock. The mechanism that produces this result is as follows. The highest levels in both skill groups have the lowest chance to be reduced because their firing costs are highest compared to other levels in the same skill group. The earnings difference between the top level of manual workers and the top level of non-manual workers is larger than that for the bottom levels. Positive shocks in firing costs shift the relative demand towards the upper hierarchical levels, thus increasing the earnings *within* each skill group as well as enhancing the earnings difference *between* skill groups. This is an important new finding that provides a novel firm-level explanation for the macro-economic relationship between high firing costs and shifts in relative demand towards skilled workers. Firing costs protect the most productive workers at high levels of the organization, while they are bad news for workers at the bottom of the firm's hierarchical job structure.

6. Conclusions

We studied in detail the reorganization of a large firm. While many workers were displaced – this was the largest mass lay-off in the history of the Netherlands – the input ratio of manual to non-manual workers remained unaltered. But looking more closely to the structure of manual and non-manual jobs we found changes in authority that no optimal assignment theory would predict.

We argued that this may be the result of large transaction costs that caused the firm's management to wait with reorganizing the firm's workforce until a sufficiently large number of shocks made it imminent to act. As a result we observe compounded responses to all these shocks simultaneously. To investigate what has contributed most significantly to the observed changes in the reorganized job structures we proposed and estimated an hierarchical decision model and found the following results.

We investigated the internal restructuring of a Dutch aerospace firm characterizing precisely the changes in personnel as well as the changes in the organizational structure of the workforce. A hierarchical decision model was presented and estimated to study which factors determined the simultaneous process of selecting individual workers at different levels and of changing the span of control between levels. We found that it is necessary to model the decision process so that the interdependence is reflected in the estimation of the model. Firing costs could explain the observed changes in a firm's job structure after a restructuring operation. Firing costs were found to be important in protecting the most productive workers at the highest levels of the firm's job structure. Finally, we showed that shocks in firing costs – for example policy shocks changing the term of notice – altered the earnings distribution between skill groups in a firm.

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Table 1.

Inputs of Skills Before and After Restructuring of Workplace*

	Manual Workers		Non-Manual Workers		Total	
	N_1	Shares per row / column	N_2	Shares per row / column	N	Shares per row / column
Total	3531	.655 / 1.0	1858	.345 / 1.0	5389	1.0 / 1.0
Selected	705	.656 / .20	370	.344 / .20	1075	1.0 / .20
Displaced	2826	.655 / .80	1488	.345 / .80	4314	1.0 / .80

* This Table shows the numbers of workers employed in two different skill levels before the realization of the restructuring plan, after the selection had taken place, as well as the number of workers affected by the reorganization of the workforce of Fokker.

Table 2.

Average Hourly Wages of Manual and Non-Manual Workers*

	Skill:	Friday 03/15/1996 NM	M	NM/M	Monday 03/18/1996 NM	M	NM/M	Change (in percent points)
All workers	Mean	45.52	26.62	1.71	46.31	26.59	1.74	1.9
	St.Dev	11.96	4.13	2.90	12.37	4.11	3.01	3.8
					Women & Men			
Women	Mean	40.49	24.72	1.64	42.57	23.91	1.78	8.7
	St.Dev	9.72	3.64	2.67	9.93	4.26	2.33	-12.7
Men	Mean	45.80	26.85	1.71	46.56	26.91	1.73	1.4
	St.Dev	12.02	4.12	2.91	12.49	3.98	3.14	7.7
					Education[1]			
Educ:low	Mean	42.45	26.56	1.60	43.54	26.59	1.64	2.4
	St.Dev	9.23	4.10	2.25	10.54	4.08	2.58	14.7
Educ:high	Mean	46.84	26.85	1.74	47.70	26.56	1.80	2.9
	St.Dev	12.74	4.21	3.03	13.00	4.25	3.06	1.1
					Tenure*			
Tenure:low	Mean	42.38	24.95	1.70	42.92	24.81	1.73	1.8
	St.Dev	10.66	3.69	2.89	11.04	3.33	3.32	14.8
Tenure:high	Mean	49.53	28.35	1.75	50.29	28.61	1.76	0.6
	St.Dev	12.34	3.83	3.22	12.69	3.98	3.19	-1.0
					Age*			
Age:low	Mean	39.40	25.42	1.55	39.97	25.45	1.57	1.3
	St.Dev	8.11	3.51	2.31	7.92	3.23	2.45	6.0
Age:high	Mean	50.46	28.16	1.79	51.52	28.29	1.82	1.6
	St.Dev	12.29	4.34	2.83	12.94	4.66	2.77	-2.0

* NM=non-manual workers; M=manual workers

[1] Education: high is 8:higher vocational schooling or 9:university; Tenure: low is below median tenure of 15 years; Age: low is below average age of 39 years.

<u>Table 3.</u>

Education of Manual and Non-Manual Workers in Different Hierarchical Levels

Manual Workers

Hierarchical Level	**Friday** 03/15/1996	**Monday** 03/18/1996
L1: Team Worker	3.53 (1.39)	3.48 (1.45)
L2: Team Leader	4.71 (1.58)	4.71 (1.69)
L3: Head Production Team	5.49 (1.68)	5.18 (1.70)
All M	4.11 (1.67)	3.99 (1.68)

Non-Manual Workers

	Friday 03/15/1996	**Monday** 03/18/1996
H1 : Assistant Engineer	6.84 (1.74)	6.65 (1.70)
H2 : Engineer	7.57 (1.62)	7.51 (1.61)
H3 : Senior Engineer	7.86 (1.53)	7.82 (1.28)
H4 : Manager	8.17 (1.37)	7.94 (1.74)
All N-M	7.40 (1.70)	7.31 (1.69)

<u>Education description</u>: 1=Basic education; 2=Lower vocational degree; 3=Lower general schooling degree; 4=Apprenticeship; 5=Intermediate general schooling degree; 6=Intermediate vocational degree; 7=Higher general schooling degree; 8=Higher vocational degree; 9=University degree.

<u>Notes</u>: The general schooling degrees, like basic education, lower, intermediate and highergeneral schooling degrees are prerequisites for pursuing a given vocational or general education in the Dutch educational system. Basic education is a prerequisite for any other degree. After having completed basic education, it is possible to either follow a lower vocational schooling course or to attend any of the school forms leading to a general schooling degree. Lower general education (mavo) makes one eligible to follow intermediate vocational training or complete an apprenticeship. An intermediate general schooling degree qualifies for higher vocational schooling, a higher general schooling degree (havo) qualifies for higher vocational schooling (hbo), while the highest level general schooling degree is a prerequisite for pursuing a college or university degree. In addition, it is possible to pursue the next higher schooling level after having obtained a given schooling degree; similarly it is possible to enter the next higher level of vocational schooling after having completed vocational schooling at the level just below, e.g., after having completed intermediate vocational schooling one is eligible to enter higher vocational schooling. (see: Dohmen *et al.* 2004).

Table 4.

Changes in Organizational Design*

Manual Workers

	Friday 03/15/1996		Monday 03/18/1996		Change (in %)	
Hierarchical Level	**Size**	**Authority**	**Size**	**Authority**	**ΔS**	**ΔA**
1: Team Worker	2281	-	496	-	22	-
2: Team Leader	765	2.98	187	2.65	24	-11
3: Head Production Team	548	1.40	84	2.23	15	59

Non-Manual Workers

	Friday 03/15/1996		Monday 03/18/1996		Change (in %)	
	Size	**Authority**	**Size**	**Authority**	**ΔS**	**ΔA**
1 : Assistant Engineer	803	-	148	-	18	-
2 : Engineer	505	1.59	107	1.38	21	-13
3 : Senior Engineer	360	1.40	65	1.65	18	18
4 : Manager	207	1.74	52	1.25	25	-28

* This Table shows the number of workers at the different hierarchical levels before as well as after the restructuring had taken place. Authority is computed as the number of workers in a particular level divided by the number of workers in the level above for a given skill type. ΔS is the size selected workers as a percentage of the people working at that hierarchical level before the reorganization. ΔA is the percentage change in authority at each hierarchical level.

Table 5.
Simple Multivariate Sublevel Worker Selection Probability Estimates

	Manual Workers			Non-manual Workers			
	Level 1	**Level 2**	**Level 3**	**Level 1**	**Level 2**	**Level 3**	**Level 4**
age	-.009 (.01)	-.014 (.02)	-.020 (.03)	-.061 (.03)	-.009 (.04)	-.078 (.05)	-.074 (.06)
tenure	-.020 (.01)	-.023 (.02)	.024 (.03)	.008 (.02)	**.092** (.03)	.041 (.04)	.013 (.04)
female	-.058 (.22)	-.724 (.38)	-.157 (.65)	.665 (.39)	-.131 (.57)	.603 (.84)	.897 (1.04)
married	.094 (.12)	-.089 (.19)	.002 (.30)	**.427** (.22)	.351 (.26)	**1.063** (.40)	1.023 (.55)
vocational education	.099 (.10)	.023 (.12)	-.229 (.14)	-.117 (.09)	.120 (.12)	-.132 (.14)	-.117 (.17)
general education	-.120 (.14)	.282 (.15)	.048 (.20)	-.088 (.12)	.184 (.14)	-.285 (.16)	.125 (.17)
distance (in km)	.001 (.00)	**.008** (.00)	.001 (.01)	.005 (.00)	**.018** (.01)	.008 (.01)	**.021** (.01)
disability (in %)	**-.016** (.01)	-.004 (.01)	.001 (.01)	-.015 (.01)	-.002 (.01)	- -	- -
performance	**.191** (.04)	.061 (.06)	.105 (.10)	**.274** (.10)	.367 (.13)	-.072 (.18)	.283 (.18)
fte	**-1.570** (.79)	-1.503 (1.78)	- -	2.783 (2.28)	2.703 (2.28)	-5.886 (3.49)	1.750 (4.81)
courses	**-.017** (.01)	-.025 (.01)	-.014 (.02)	-.027 (.02)	.007 (.02)	.008 (.04)	-.004 (.06)
ToN	-.039 (.04)	-.128 (.08)	-.036 (.11)	.036 (.09)	.035 (.08)	**-.216** (.11)	.092 (.10)
firing costs	.334 (.42)	**1.379** (.70)	-.215 (.78)	.296 (.54)	**-1.011** (.44)	.785 (.43)	-.036 (.31)
log(L)	-1057.6	-404.7	-222.7	-366.7	-241.0	-157.9	-100.1
Pseudo-R^2	.027	.026	.022	.035	.072	.062	.087
Pr(select)	.217	.244	.153	.184	.212	.181	.261
N	2192	750	527	799	500	352	187

Table 6.

Variables Determining Job Structure

	Manual Workers		Non-Manual Workers	
	Mean of three sublevels [Std.Dev]	**Estimate (s.e.)**	**Mean of four sublevels [Std.Dev]**	**Estimate (s.e.)**
	PRODUCTIVITY VARIABLES			
performance	6.729 [1.44]	**-.160** (.03)	6.292 [.89]	**.144** (.05)
vocational education	1.360 [.56]	**1.274** (.06)	2.875 [.83]	**.568** (.05)
general education	1.431 [.72]	**1.129** (.08)	3.032 [1.09]	**.733** (.06)
	BEHAVIORAL VARIABLES			
internal courses	–	–	5.086 [4.34]	**-.112** (.01)
external courses	1.822 [1.32]	**.369** (.03)	2.377 [1.73]	**.056** (.03)
	TRANSACTION COSTS VARIABLES			
firing costs	11.937 [5.40]	**1.803** (.08)	20.770 [12.61]	**1.019** (.05)
N	3469		1838	
Pseudo-R^2	.193		.199	
Partial Log*L*	-2568		-1866	

[1]Standard deviations are given in squred brackets; standard errors in round ones; *p<.05* in **bold**.

Table 7.

Thresholds, Inclusive Values, and Independence Parameters[1]

	Manual Workers			Non-Manual Workers		
	threshold parameter	**inclusive value**	**independence parameter**	**threshold parameter**	**inclusive value**	**independence parameter**
Level 1	$\hat{\gamma}_{11} = 0$	$\hat{J}_{11} = 7.49$	$\hat{\kappa}_{11} = 0$	$\hat{\gamma}_{12} = 0$	$\hat{J}_{12} = 6.73$	$\hat{\kappa}_{12} = 0$
Level 2	$\hat{\gamma}_{21} = 3.40$ (.22)	$\hat{J}_{21} = 6.36$	$\hat{\kappa}_{21} = .53$ (.03)	$\hat{\gamma}_{22} = 3.73$ (.23)	$\hat{J}_{22} = 6.28$	$\hat{\kappa}_{22} = .59$ (.04)
Level 3	$\hat{\gamma}_{31} = 5.01$ (.24)	$\hat{J}_{31} = 6.14$	$\hat{\kappa}_{31} = .82$ (.04)	$\hat{\gamma}_{32} = 5.39$ (.26)	$\hat{J}_{32} = 5.93$	$\hat{\kappa}_{32} = .91$ (.04)
Level 4				$\hat{\gamma}_{42} = 7.30$ (.32)	$\hat{J}_{42} = 5.42$	$\hat{\kappa}_{42} = 1.35$ (.06)

[1] $\hat{\gamma}_{rs}$ is the *NOL* estimate of the lower profit threshold of level *r* for skill *s*; $\hat{J}_{rs}$ is the *NOL* estimate of the inclusive value; and $\hat{\kappa}_{rs} = \hat{\pi}_{rs} / \hat{J}_{rs}$. Standard errors are given between brackets.

Figure 1. **Term of Notice & Firing Costs**

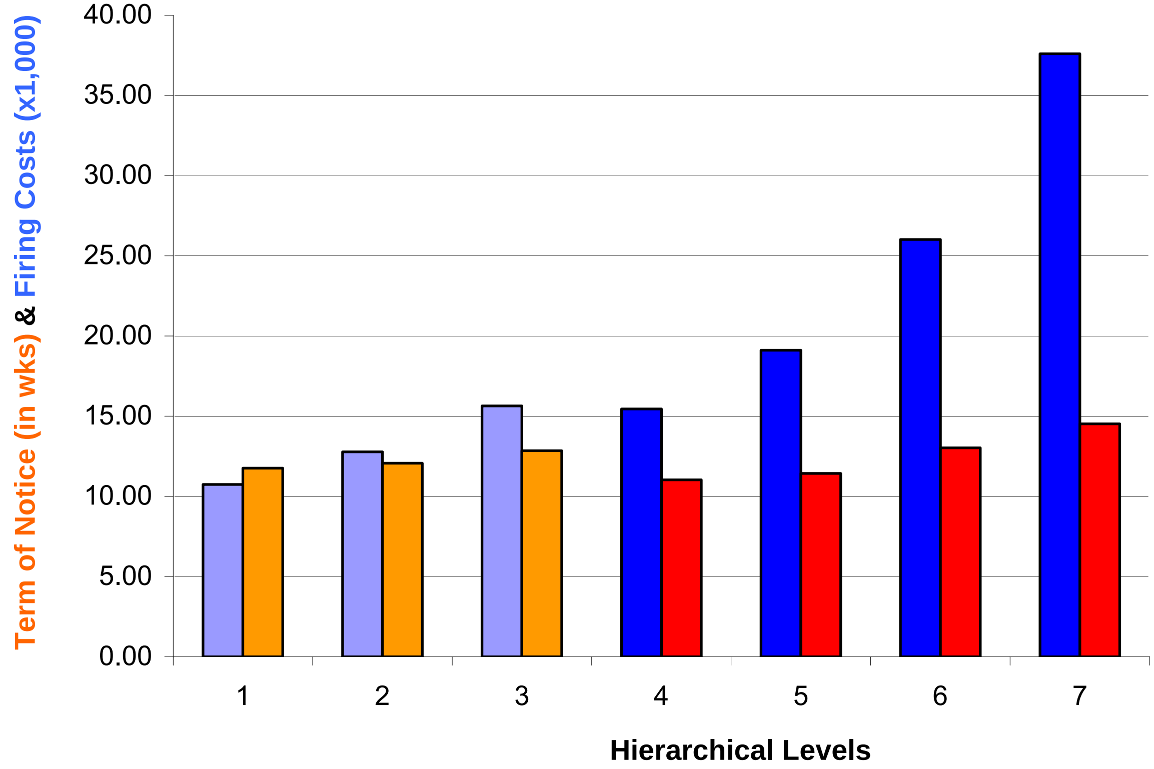


Figure II.

The Tree Structure of the Firm's Restructuring Problem

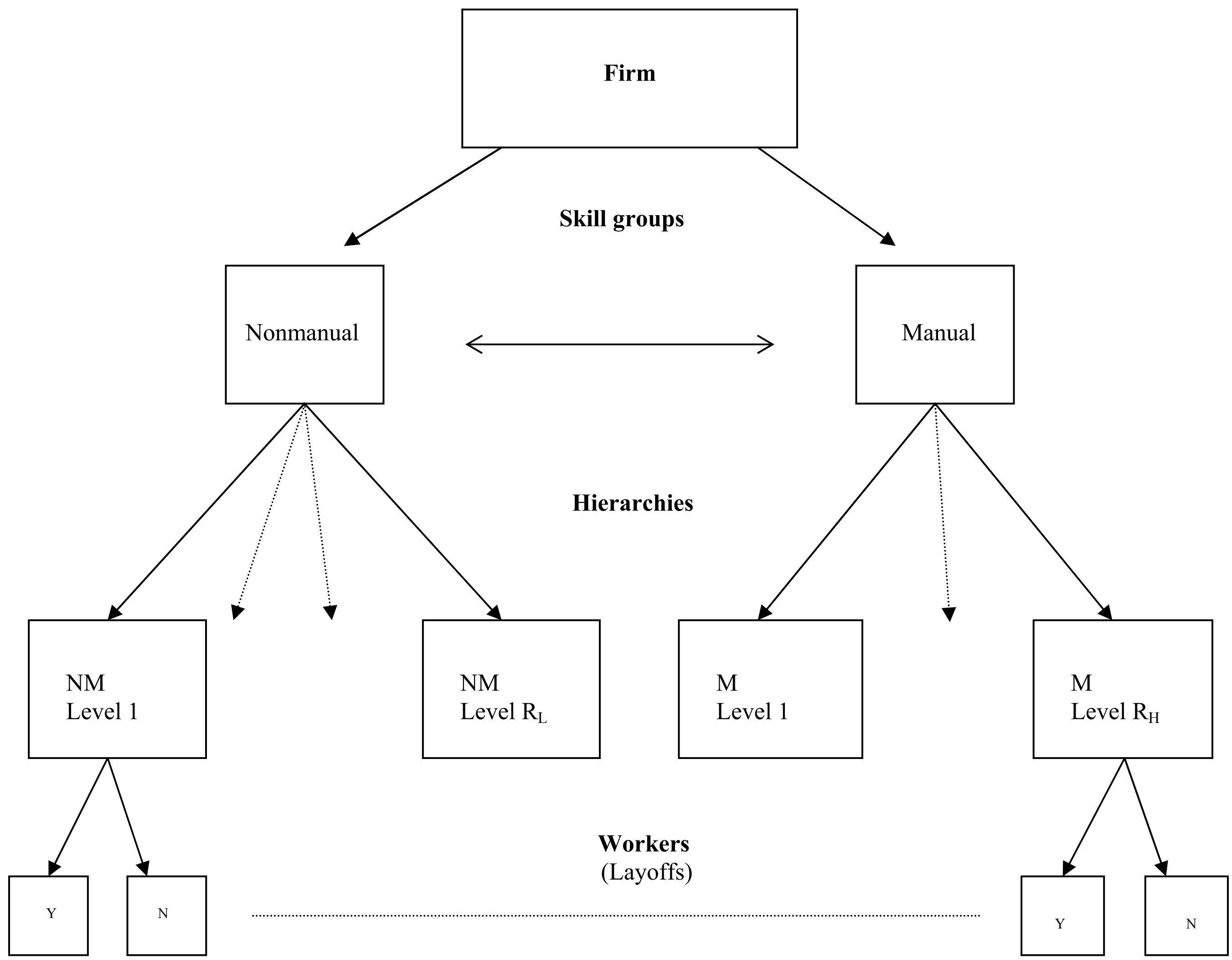
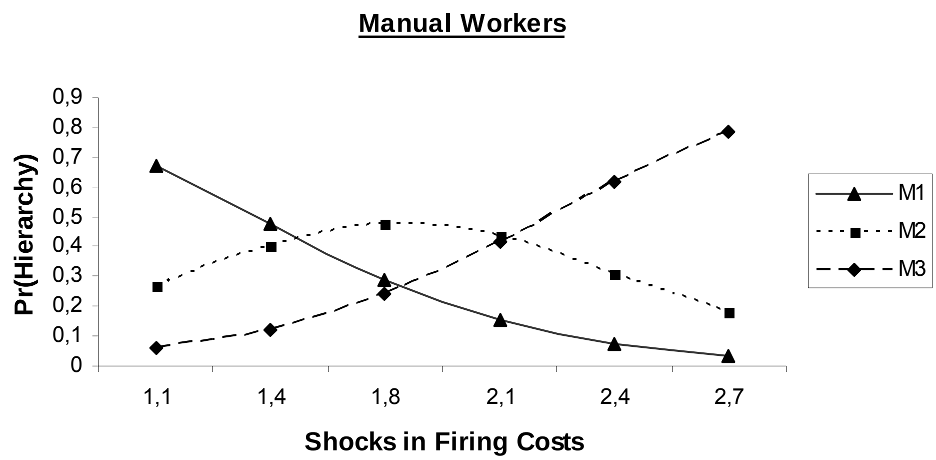


Figure III.

Effects of Shocks in Firing Costs on Job Structure of Skill Groups



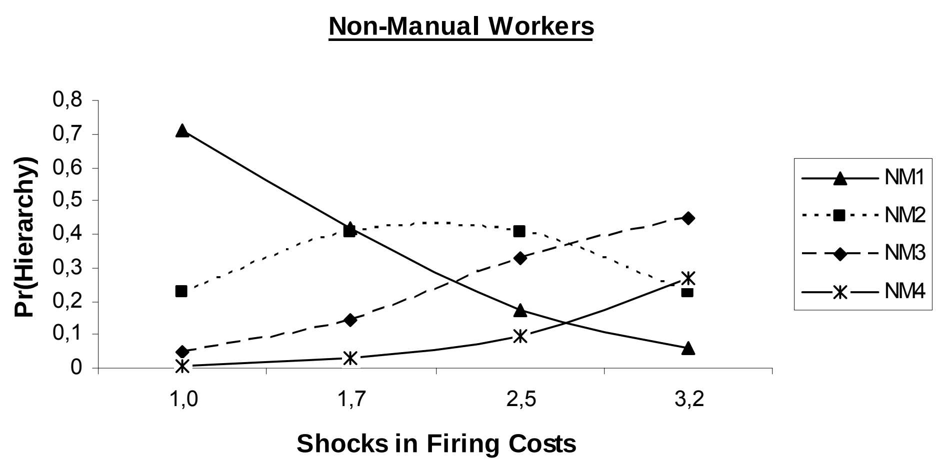
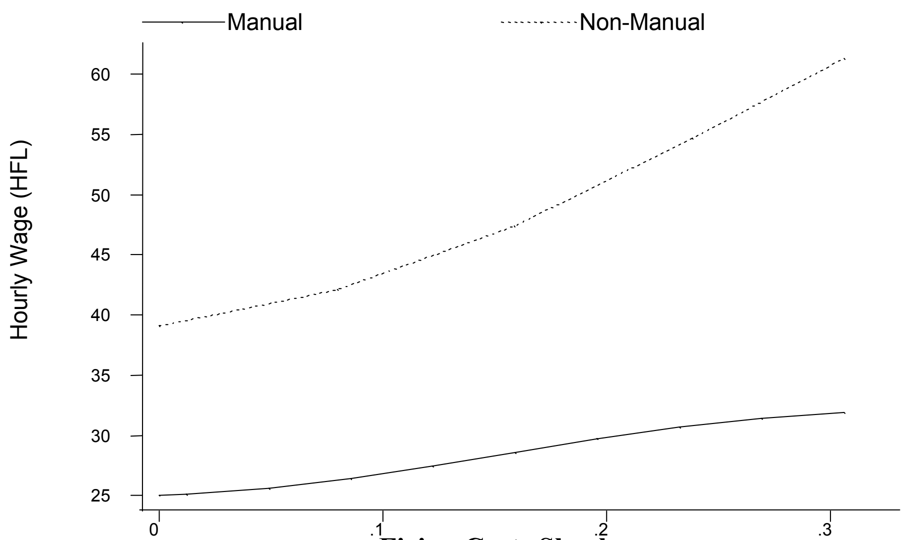


Figure IV.

Firing Costs and the Effect on the Earnings Distribution Between Skill Groups[1]



Firing Costs Shocks

[1] The reported hourly wages are in 1996 Dutch guilders (1 *Dfl* = 0.45 Euros)