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EFFECTS OF FORCED DISTRIBUTION RATING SYSTEMS ON WORKFORCE PRODUCTIVITY AND POTENTIAL IN COMPANIES WITH INTERNAL PROMOTION: A MONTE-CARLO SIMULATION.

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Through simulation we investigate how characteristics of forced distribution rating systems (FDRS), which require firing a certain percentage of the workforce each year, might interact with ratings reliability, selection validity, selection ratio, and voluntary turnover to improve average workforce performance potential. Results confirm that improvement of workforce performance potential is slightly higher than previous studies, and maintain that a FDRS could lead to noticeable improvement in the first several years. Greater improvement is associated with a higher percentage of firing. The effects of different selection procedures (external hiring, internal promotion or a combination of these two procedures) added to a FDRS are also investigated. These results of performance potential using a FDRS with different selection procedures are quantified in terms of productivity comparing each model, taking in consideration the cost of filling vacancies and the costs of hiring.

Introduction

How to improve performance of workforce and productivity is perhaps one of the most challenging issues for companies today. Rating systems can be used to improve performance potential by identifying high and low performers. Probably the determination of who shall or who shall not be promoted is the most important use of ratings (Odiorne, 1963).

Performance rating systems can be classified into two general categories: absolute and relative systems (Cascio, 1991). Absolute ratings assess individuals against the same standards, and relative ratings are required to assess individuals in relation to another. Heneman (1986) and Nathan&Alexander (1988) examined the differences between relative and absolute ratings, and found out that relative formats have stronger correlations with results orientated criteria like production quantity and sales volume. Forced Distribution Rating Systems (FDRS) are relative rating systems which evaluate performance, forcing raters to assign ratees into at least three categories (top, middle and bottom) and are often tied to termination decisions. The most basic approach of FDRS is sometimes referred as a "totem pole" because it involves ranking all employees in a particular workgroup from best to worst (Grote, 2005). FDRS and other relative approaches have been argued to be more accurate than absolute systems as FDRS require raters to objectively find differences between ratees and leave distributional biases behind (Goffin, Gellatly, Paunonen, Jackson, & Meyer, 1996; Heneman, 1986; Jelley & Goffin, 2001; Nathan & Alexander, 1988; Roch, Sternburgh, & Caputo, 2007).

When it comes to performance improvement, proponents and critics of forced ranking have both found support for their positions within the limited available existing research. Even FDRS supporters acknowledge that their fairness and usefulness largely depend on how they are implemented and whether or not they are accompanied by other changes in the overall performance management system. While there are no hard and fast statistics regarding which companies have succeed with the process and which have not, most observers agree that FDRS is more favorably in companies with a high-pressure, results orientated culture (Bates, 2003) and seemed to be more acceptable at high-tech, manufacturing and financial service organizations, rather than in the public sector and retail sector (Todd & Ramachandran, 2007). When done correctly, FDRS ensures that company resources are directed toward those who contribute the most or have the potential to make a positive difference. These resources include compensation and other rewards like internal promotions.

"Forced Distribution Rating Systems are probably the most controversial issue in management today" (D. Grote in Bates, 2003, p. 64). Since 2000, articles about FDRS (also known as forced ranking) have appeared in such prominent international media outlets like The New York Times, The Economist, The Chicago Tribune, Financial Times and so on. The practice of FDRS gained fame based on the endorsement of General Electric CEO Jack Welch. The latest estimate is that up to 20 percent of all U.S. business organizations and up to 25 percent of Fortune 500 firms use some type of FDRS (Sears & McDermott, 2003)). As many as a quarter of the Fortune

500 companies, including Cisco Systems, Hewlett-Packard, Microsoft, Lucent, Conoco, EDS, and Intel, may be currently using some type of performance management system built around that principle (Melsler, 2003). Nevertheless given the intense interest in FDRS, it is surprising that there is virtually no published research that can inform practitioners about their effectiveness.

A prominent study on the field of FDRS was conducted by Scullen, Bergey and Aiman-Smith (2005). Scullen et al. demonstrated for the first time the efficacy of FDRS by means of a simulation obtaining performance potential in a scope of 30 years. The present study sought to extend Scullen's study attending the limitations they highlighted in their discussion. Our study comprehends the following improvements: a) inclusion of a non-zero correlation between turnover and potential b) firing the lowest performers of the company (instead of firing the poorest performers of each workgroup) and c) evaluation of productivity by adding the costs per hire and the costs of replacement. Furthermore to emulate the reality of modern companies we decided to define a multilevel structure (executives, managers and workers) and we also considered the effects of using internal promotion or not.

Method

A Monte-Carlo simulation has been implemented in order to study the most important factors of FDRS. The variables which are used are: (a) the percentage of workers that must be fired in each cycle; (b) the reliability of the ratings used to determine those employees that will be fired; (c) the validity of the method used to select new employees; (d) the company's selection ratio and (e) the company's voluntary turnover rate. All these variables and other important issues are described with more detail later.

Simulation (Independent) Variables

Percentage fired. The literature offers little guidance as to the percentage of workers fired each year in the typical forced distribution system. We decided to fix the people to be fired with a percentage of 5% or 10% because published information about companies who use FDRS are using these values. We also made the consideration that ranking system was going to fire the lowest ranked, without discerning in which category (executive, manager or worker), and in which workgroup they belonged. In real organizations if a group is underperforming, executives or managers use to act and replace people or train the underperformers. As it had not been studied before, it was interesting to see what happened to performance potential if the people we fired was not necessary one of each workgroup, but the worst percentage of rating of the year.

Reliability of ratings. Of the various types of reliability coefficients that are available, inter-rater reliability is most appropriate for this study. Therefore, to reflect a reasonable range of reliability values, we included values of 0.50 and 0.70 in our study.

Selection validity. Research indicates that most organizations use a variety of valid selection devices (Barber & Wesson, 1999). Schmidt and Hunter (1998) showed that true validities for commonly used selection methods range from about 0.00 to 0.50. To capture a reasonable range of values, we chose to model validities of 0.30, 0.50 and 0.70. Note that these are true validities, defined as correlations between observed selection scores and performance *true* scores.

Selection ratio. The selection ratio is the number of people hired divided by the number of applicants. Kirnan et al. found the average selection ratio to be 0.19. We maintained it constant with a pool of 5 employees applying for each position when we were using external selection. Procedure for internal promotion will be explained in more detail later.

Factors held constant

The number of organizations in each cell was 100.

Voluntary turnover. Research has shown that the relationship between job performance and voluntary turnover is complex (Maertz & Campion, 2004). "While there are no hard and fast statistics regarding which companies have succeed with the process and which have not, most observers agree that FDRS is more favorably in companies with a high-pressure, results orientated culture" (Bates, 2003). As shown in the latest studies concerning relationship between performance and turnover (Sturman, M. C., Shao, L., & Katz, J. H. (2012), we

considered that the United States fixed best in a “High Performing Orientated” Culture. As a result turnover is best represented with a U-shape as shown below:

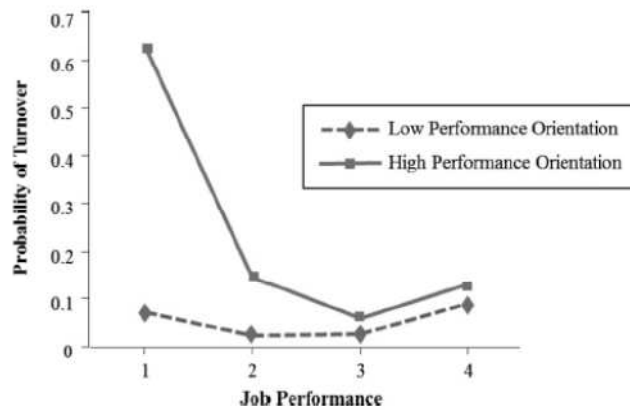


Figure 1: Relationship between Performance and Probability of Turnover for different levels of job performance.

The figure shows a rating score ranging from 1 to 4, where 1 means low performing and reaches 4 meaning high performing. For our simulation we took the mean value of each performance group: 1-2 job low job performance with turnover rate of 38.5%; 2-3 middle performance with turnover rate of 11.5% and or 3-4 high performance with a turnover of 11%. With this information and with statistics of the percentage of number of workers who are rated into low, middle or high performance in enterprises as Enron, Ford, General Electric, Hewlett Packard and Microsoft, we assumed that a 10% of the workers are rated as low performing, another 10% as high performing, and the 80% left falls in the category of mid performance.

Multilevel organization: In order to get the best resemblance of a big (more than 1000 workers) industrial organization, we considered a workforce consisting of three different types of positions: executives, managers and workers. There were a total of ten executives per firm, with also ten managers in charge, which in turn had another ten employees under their immediate dependence. This makes a total workforce of 1110 workers (see Figure 2). The workgroup size of ten members was based on research showing that this is approximately equal to the average span of control in U.S. industries (McClenahan, 1989). The number of simulated periods was 10 years, because we made the assumption that it was not realistic to implement Human Resources strategies for a longer period than this. We also considered that all three type of workers could be rated in regular functioning of a company, this meant we had to include this possibility in our code.

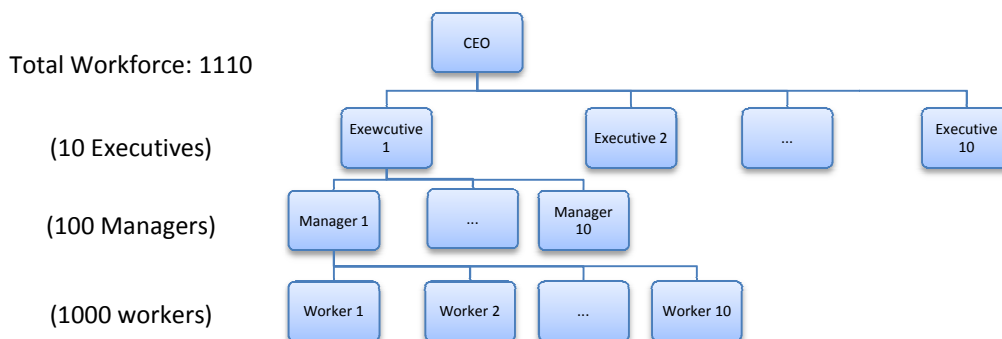


Figure 2: Illustration of Organizational Chart used throughout the simulation.

Workforce performance potential. The workforce performance potential was held constant across time periods. In addition to the normal worker potential, an employee who was applying for an executive or a manager position, would get a manager or executive potential, which would result from his initial worker potential attenuated by a consistency constant. These new potentials were needed in order to distinguish managerial skills potential from non-managerial potential. Details can be found later in the “simulation design”.

Dependent variable. The dependent variable in this simulation was workforce performance potential, defined as the average performance potential among a firm's employees in a given year. Performance potential, refers to a true-score measure of a worker on the full range of knowledge, skills, abilities, and personality or other characteristics that influence the level at which that individual will perform on the job. We note that workforce performance potential is not the same as the average performance rating received by group members, nor is it necessarily the same as the actual performance of the group or organization.

Simulation Design

Our simulation included two values for the percentage of employees to be fired (5% and 10% annually), two values for reliability (0.50 and 0.70), three values for validity (0.20, 0.30 and 0.50), one value for the selection ratio (5 external applicants or the available internal applicants), and one value for voluntary turnover depending on the value of each worker's rating. All values were completely crossed, resulting in a 2 x 2 x 3 x 1 x 1 design. This yields 12 unique combinations of variable settings. The first model will include only external applicants to fill the empty positions; the second will select the best applicant choosing between five external and the available internal workers for manager and executive positions; and the third model will only permit internal promotion for new manager and executive vacancies.

Algorithm

Visual Basic for Applications within Microsoft Excel was used for this simulation. The pseudocode in Figure 3 outlines the logical flow of the algorithm. Descriptions of the steps, where needed, follow next.

To get each simulation started, all our variables such as validity, reliability, percentage fired and consistency were set manually. In Step 1 we created a multilevel structure for each 100 firms per simulation, as mentioned before each firm had an initial set of 10 executives, 100 managers and 1000 workers. In order to use a FDRS it was a requirement for our model that all the positions we were going to study were placed in well defined groups because workers had to be rated each year by their immediate superior manager or executive. Also if we wanted to create a turnover sheet depending on their performance we needed to structure the information and relate each individual with at least their initial potential and unique identification number. We also needed to know in which group the workers were located to implement possible promotions to see if they were taken in consideration for the vacancies which would be appearing year after year (only when internal promotion was used). To solve these technical requirements, all the positions were related to each other through an organizational chart shown before in Figure 2 with the information per position: worker identification, type of position, initial potential and rating for the year.

In Steps 2 and 3 the selection procedure for each position was determined by a selection ratio of 0.5, this meant that there was a pool of 5 applicants. Each applicant had his own initial true WorkerPotential score, which were drawn randomly from a standard normal distribution (mean = 0 and SD = 1). The WorkerPotential assigned to an individual applicant remained with that person for the duration of the simulation.

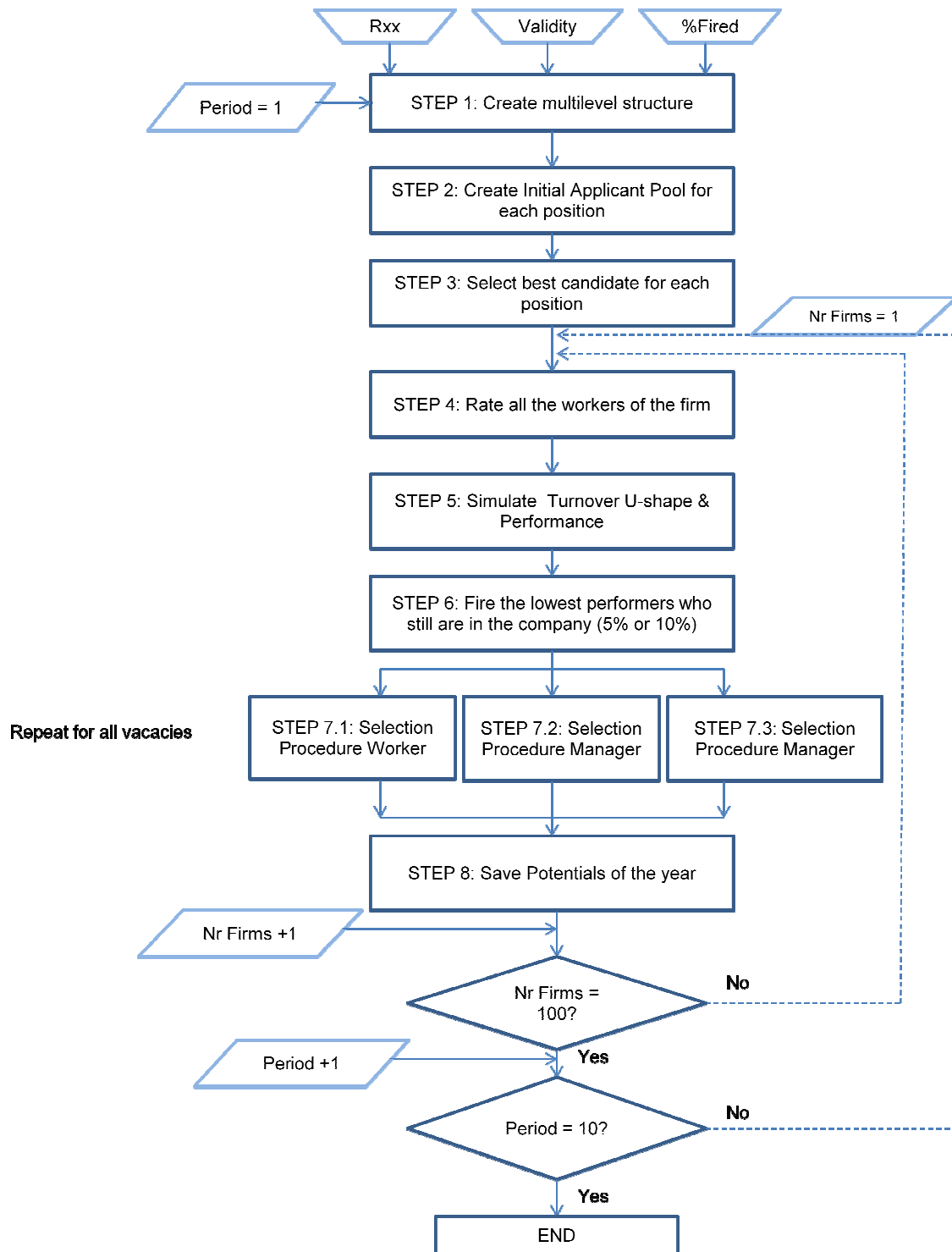


Figure 3: Flowchart algorithm design

The world of labor has changed dramatically over the past decade, even structures are becoming less hierarchical and more collaborative there still are differences between managerial and non managerial skills. Code switching between cultures, wielding digital influence and dividing attention deliberately are considered by The Harvard Business Review Jan/Feb2012, Vol. 90 to be the three skills every 21st century manager needs. Taken this into consideration, in our simulation, when applying for a manager or executive position the potential could not be the same as when applying for a worker position. Equation 1 was used to introduce a factor of consistency which was defined as 0.5 to attenuate a normal work potential and giving as a result a new potential when applying for a manager position:

$$\begin{aligned} \text{Equation 1: Potential Manager } (i) \\ = \text{Consistency} * \text{WorkerPotential}(i) + \sqrt{1 - \text{Validity}^2} * \text{Error}(i) \end{aligned}$$

These managerial skills become more important when applying for an executive position, as a result we introduced the same consistency factor to attenuate the manager potential when applying for an executive position:

$$\begin{aligned} \text{Equation 2: Potential Executive } (i) \\ = \text{Consistency} * \text{ManagerPotential}(i) + \sqrt{1 - \text{Validity}^2} * \text{Error}(i) \end{aligned}$$

After obtaining these three different Initial Potentials we used Equation 3 to select the best candidate for each position through an application score (AppScore).

$$\begin{aligned} \text{Equation 3: AppScore}(i) \\ = \text{Validity} * \text{TypeofWorkerPotential}(i) + \sqrt{1 - \text{Validity}^2} * \text{Error}(i) \end{aligned}$$

where $\text{AppScore}(i)$ is the application score for $\text{Applicant}(i)$ and Validity is the simulated level of true validity for the selection method. $\text{TypeofWorkerPotential}$ is the true potential of $\text{Employee}(i)$, and Error is a factor that represents the variance in the observed AppScores that is not associated with Potential . Error values were also drawn randomly from a standard normal distribution. With the coefficients for the Potential and Error terms in Equation 1 being Validity and Validity^2 , respectively, the correlation between AppScore and Potential is equal to Validity (Ghiselli, Campbell, & Zedeck, 1981, Ch. 7). "our conceptualizing of performance potential as a true-score overall measure of the full set of individual differences factors that influence job performance means that the correlation between test scores and performance potential should be very similar to the correlation between test scores and true performance." (Scullen et al., 2005).

Then the applicant with the highest AppScore in each applicant pool was hired. It was more realistic to create a separate applicant pool for each of the positions in an organization than to have one large applicant pool for filling all of the jobs in the organization because an organization's current workforce at any point in time is likely to include workers hired at different times and from different applicant pools. With all of the initial workforces populated in Step 4 we simulated the ratings for each worker, manager or executive at the end of the year. The employees' rating was based on Equation 4:

$$\text{Equation 4: Rating}(i, j) = \text{TypeofWorkerPotential}(i) * \sqrt{Rxx} + \text{Error}(i, j) * \sqrt{1 - Rxx}$$

where $\text{Rating}(i, j)$ is the rating received by $\text{Employee}(i)$ in the j -th year and \sqrt{Rxx} , is the simulated level of interrater reliability. $\text{TypeofWorkerPotential}(i)$ is defined as before. $\text{Error}(i, j)$ values were drawn randomly from a standard normal distribution. Error values for a given employee's Rating were redrawn every year. The coefficients for the $\text{TypeofWorkerPotential}$ and Error terms (\sqrt{Rxx} and $\sqrt{1 - Rxx}$, respectively) result in a correlation of \sqrt{Rxx} between Ratings and Potential (Ghiselli et al., 1981, Ch. 7). This is the desired value because (a) it yields an interrater correlation of $\sqrt{Rxx} * \sqrt{Rxx} = Rxx$, consistent with the definition of interrater reliability, and (b) the square of the correlation between true scores and ratings would be Rxx , This is appropriate because in theory a generalizability coefficient or ICC equals the square of the correlation between observed scores and true or universe scores (McGraw & Wong, 1996).

The generalizability coefficient ICC, and interrater reliability in our data all equal R_{xx} , because $Error(i,j)$ values were redrawn every year, a given employee's *Rating* generally varied somewhat from year to year. However, the expected value of that workers' *Rating* remained constant at his or her *InitialPotential* value because the originally assigned *InitialPotential* values were maintained throughout the simulation.

After this, employees were ranked within their workgroups according to their *Ratings*. Note that the employees with the lowest *Ratings* were not necessarily those with the lowest *InitialPotential* values.

In Step 5 we created a voluntary turnover schedule for each firm. To generate a unique departure schedule for each firm in the simulation all employees who were working in the company at the end of the year needed to be rated through their year performance. Depending on their performance (low, mid or high performers) through the year, a different percentage of turnover was used. As explained before, the performance would have a fix percentage of turnover which was higher for lower performers and lower for mid or high performers. The departure schedule for each level of performance layed out which employees would voluntarily leave each organization during each period of the simulation being chosen randomly year after year. When we invoked voluntary turnover for each year the appropriate number of employees from each firm, as determined by the schedule, were selected to depart from the firm.

In Step 6 the number of workers who had to be fired was determined by multiplying all employees (always 1110 in this simulation) by the percentage fired (5% or 10%). As in companies all employees can be fired, we considered the employees with the lowest *Ratings* were fired independently of their category (workers, managers or executives) or workgroup.

All departed employees caused weather by *FDRS* or by *turnover* were replaced by a selection procedure explained in Steps 7.1, 7.2 and 7.3.

Step 7 created an applicant pool for each opening. As before, firms had a selection ratio of 0.5 so there were five applicants per opening. Each applicant was assigned an *InitialTypeofWorkerPotential* in the same way as was done with the initial workers (i.e., drawn randomly from a standard normal distribution). Equation 3 was used to generate an application score for each applicant. In the initial simulation, as we only considered an external applicant pool for the new hirings, the applicant with the highest *AppScore* (but not necessarily the highest *Potential*) in each pool was added to that workgroup, replacing the employee who had been dismissed. Because *AppScore* rankings do not necessarily match the *Potential* rankings, selected applicants might or might not have been among the best available.

After this, in Step 8 we computed the *mean Potential* of each firm's workforce for the year just completed. We needed to compute the general average Potential and also average potentials for workers, managers and executives separately. This served as our measure of the workforce performance potential of the firm for that year.

Finally, unless the simulation had reached its 10-year time limit, the program returned to Step 4 to increment the time clock and then repeated the cycle of rating, voluntary turnover, firing the lowest performers, and then hiring replacements.

Internal promotion.

"The proportion of workers in the plant who received formal evaluations through an *appraisal system* was positively associated with the use of internal promotions" (Bayo & Ortín,2006). As our study simulates industrial firms which have more than one firm we considered introducing internal promotion at the same time as a *FDRS* and as a way of influence positively in employees morale and emulating better the reality.

For this, we simulated three different models of hiring politics for new vacancies created year after year: a) selecting only external candidates (explained before); b) selecting both external and internal candidates; c) selecting only internal candidates. The difference between these three models would differ in the selection procedure used to hire new managers and executives, searching the best candidate weather inside or outside the firm in the internal or external applicant pool. Selection procedure for normal workers remained the same in the three models, as we always needed an external pool to cover these vacancies.

The second model "Internal and External Promotion" used a selection procedure for each opening considering 5 external applicants and also the available internal applicants. For managers, a selection procedure would start comparing the best internal versus the best external applicant. The external selection procedure would remain the same as without using internal promotion, but for the internal procedure only people from inside the working group, the 10 workers or the ones who were currently working and which had to be in the same team as

the manager, could apply for the job. To select the best internal applicant we used Equation (x) to obtain the application score.

The same procedure was used in order to rate Executives, but in this case the internal applicants had to be Managers which were already working for the company or new applicants from the external pool.

When the best internal and the best external applicant were chosen, the one with the highest application score would get the job, and in equal score, we decided to select the internal candidate, in order to reward Business know-how in some way.

For manager or executive vacancies, in case the best applicant was intern, the old position of the best intern applicant would become a new vacancy to be covered.

In our third model "Only Internal Promotion" we substitute a managerial or an executive vacancy with the available internal applicants from the working groups below the vacancy. The applicants were selected with the same conditions and procedure as in model 2, but we did not contemplate external candidates for managers and executives. Again we needed an external pool for the workers vacancies.

Results

For our first model "Only External Hiring" we simulate 100 scenarios (or companies) with the different combinations of validity, reliability and percentage fired. Each scenario comprising 1110 employees was simulated over 10 years. This produced an output matrix for the dependent variable, workforce performance potential. Results showed that FDRS can improve workforce potential, in the sense that, on average, lower-potential workers can be identified and replaced by workers with higher potential. In all of our scenarios, workforce performance potential at the end of the simulation was higher than it was at the beginning. Because *Potential* values were standardized in the applicant population, those values can be interpreted as applicant population z scores. The average improvement over the duration of the simulation was 0.42 *SD* units (range = 0.27 to 0.61 *SDs*). This means that the performance potential of the average employee at the end of the simulation was 0.42 *SDs* higher than the potential of the average employee at the beginning of the simulation, where the *SD* unit of interest is the *SD* of potential in the applicant population.

Tables 1 to 3 show expected outcomes for the four combinations of validity, reliability and percentage fired. Year 0 results apply to the initial workforces, before the FDRS was put into effect. FDRS effects began to appear at Year 1 (in the first year we didn't implement FDRS, we only created the workforce for each company) and continued until the end of the simulation. The firms in Table 1 have the less valid (0.20) selection procedures coupled with different reliability (0.50 or 0.70) and percentage of fired (5% or 10%). These firms should be expected to perform lower because they have the worst selection procedures and can't apply them as selectively as in Table 2 (validity 0.3) and Table 3 (validity 0.5). We can conclude with these three tables that results become higher when validity is lower, percentage fired is higher and reliability is higher.

Scenario	Reliability	Validity	Percentage Fired	Year					
				0	2	4	6	8	10
2	0.50	0.20	5	0.226	0.363	0.472	0.517	0.574	0.591
76	0.70	0.20	5	0.256	0.417	0.527	0.604	0.648	0.652
10	0.50	0.20	10	0.280	0.470	0.586	0.658	0.673	0.715
13	0.70	0.20	10	0.252	0.553	0.662	0.761	0.765	0.789

Table 1. Model 1. Average Workforce Performance Potential when Validity = 0.20

Scenario	Reliability	Validity	Percentage Fired	Year					
				0	2	4	6	8	10
54	0.50	0.30	5	0.325	0.490	0.558	0.601	0.658	0.713
82	0.70	0.30	5	0.348	0.518	0.616	0.648	0.723	0.769
37	0.50	0.30	10	0.367	0.580	0.701	0.738	0.792	0.795
28	0.70	0.30	10	0.335	0.579	0.652	0.746	0.795	0.861

Table 2. Model 1. Average Workforce Performance Potential when Validity = 0.30

Scenario	Reliability	Validity	Percentage Fired	Year					
				0	2	4	6	8	10
71	0.50	0.50	5	0.549	0.683	0.771	0.828	0.878	0.923
5	0.70	0.50	5	0.588	0.748	0.822	0.876	0.930	0.951
91	0.50	0.50	10	0.549	0.743	0.849	0.925	0.956	0.990
42	0.70	0.50	10	0.537	0.705	0.799	0.876	0.922	0.964

Table 3: Model 1: Average Workforce Performance Potential when Validity = 0.50

After this general patterns of a FDRS with “Only External hiring” we are going to analyze results comparing this model with our other two models: “Internal and External Hiring” and “Only Internal Promotion”.

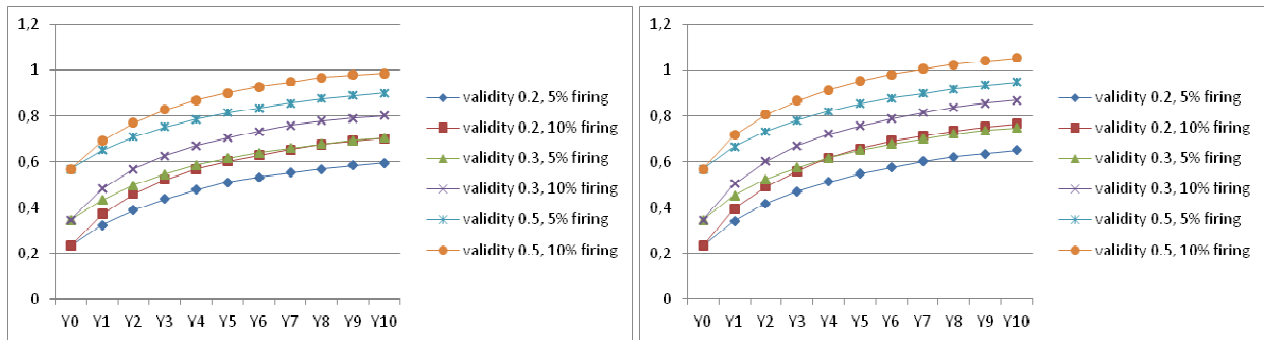


Figure 4: Improvement of Potential in average for “Only External Hiring” Rxx 0.5 (left) and Rxx 0.7 (right) for all validities and percentage of firing.

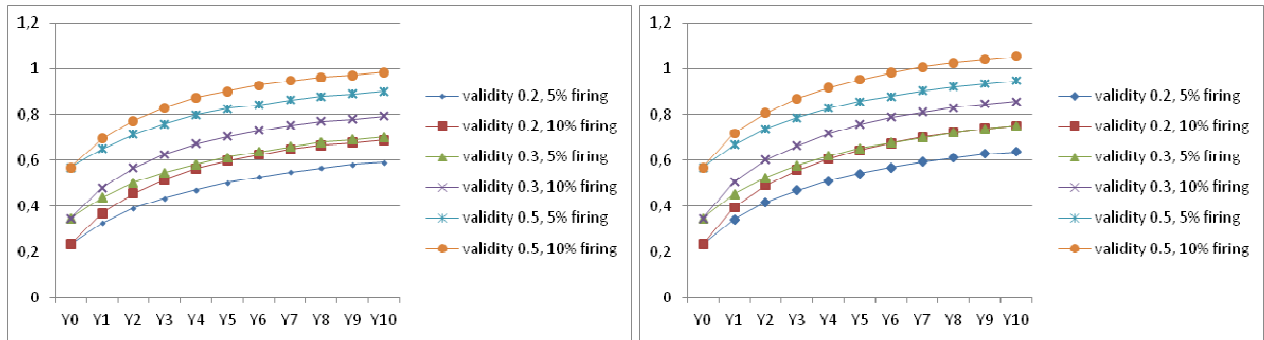


Figure 5: Improvement of potential “Internal and External hiring” Rxx 0.5 (left) and Rxx 0.7 (right) for all validities and percentage of firing.

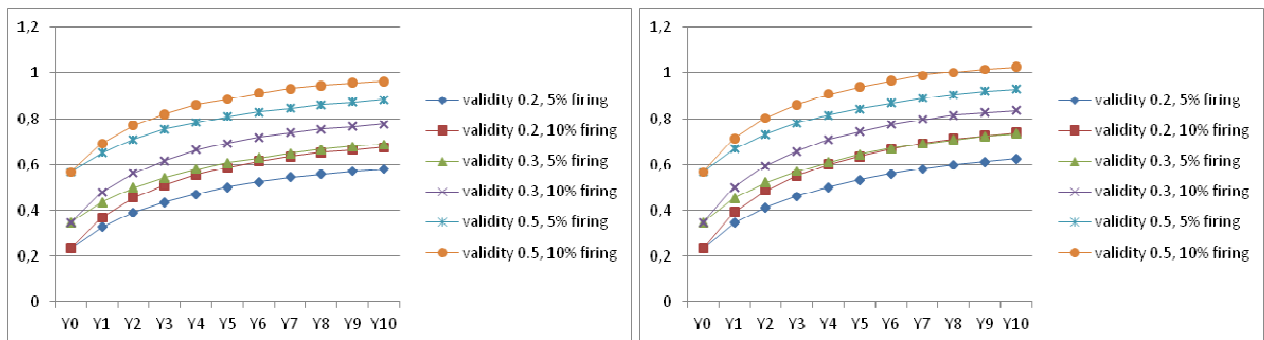


Figure 6: Improvement of potential “Only Internal hiring” Rxx 0.5 (left) and Rxx 0.7 (right) for all validities and percentage of firing.

If we compare our three models we find evidence that with a Reliability of 0.70 potential results in year 10 are higher than 1 when validity is 0.50 and 10% of firing in all cases. Results in improvement of performance potential are similar in all of our models.

A FDRS with higher percentage of firing (10%) results in higher performance potential values, and a lower percentage of firing (5%) obtains lower results. Best results in average are slightly higher for “External Hiring”, starting in year 4. In previous years the average difference is almost invisible as we can observe in Figure 7:

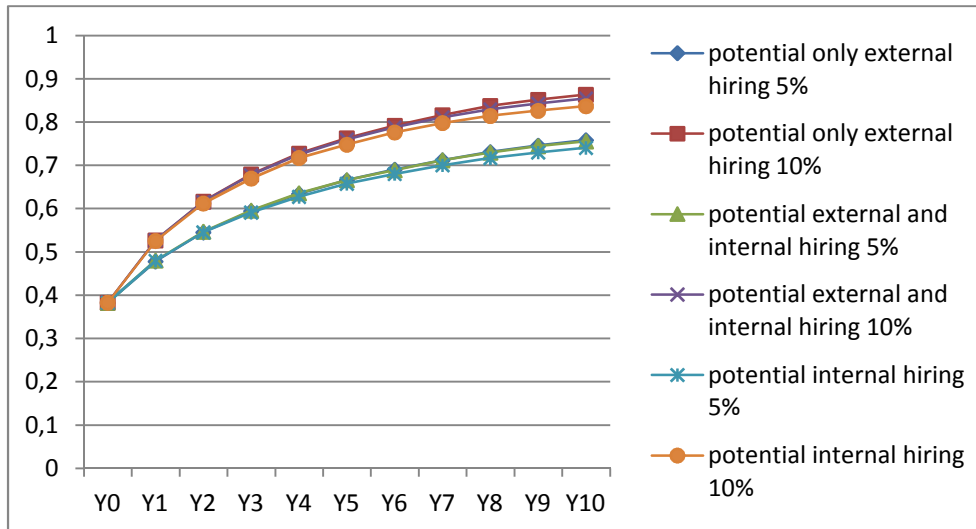


Figure 7: Comparison of improvement of potential for the different scenarios with all the type of workers together (executives, managers and workers).

When we observe the final results of potential of workforce over ten years with more detail (see Table 4), we notice that we get the highest levels of potential with all the FDRS of 10%, it is at least curious that in all cases results of potential are similar (0.48 – 0.47 – 0.45 respectively). Results are lower for a FDRS of 5%, which also have similar results (0.38 – 0.37 – 0.36). So for a 10-year usage of FDRS it doesn't really make a difference which kind of selection we are using, what really makes the difference is the percentage of FDRS. As long as the periods increase, the difference between the “only external hiring FDRS 10%”, with which we obtain the best results, becomes bigger comparing results with the other two models of FDRS of 10%.

	only external hiring 5%	only external hiring 10%	internal and external hiring 5%	internal and external hiring 10%	only internal promotion 5%	only internal promotion 10%
Y0	0,383	0,383	0,383	0,383	0,383	0,383
Y1	0,478	0,527	0,481	0,528	0,480	0,526
Y2	0,545	0,617	0,547	0,616	0,546	0,612
Y3	0,594	0,679	0,596	0,678	0,591	0,670
Y4	0,634	0,727	0,636	0,726	0,628	0,718
Y5	0,666	0,763	0,666	0,760	0,658	0,748
Y6	0,690	0,792	0,689	0,788	0,680	0,776
Y7	0,712	0,816	0,712	0,811	0,700	0,798
Y8	0,731	0,837	0,730	0,830	0,717	0,814
Y9	0,746	0,852	0,744	0,843	0,730	0,826
Y10	0,758	0,864	0,756	0,855	0,741	0,837
DIFFERENCE	0,375	0,481	0,372	0,472	0,357	0,454

Table 4: Comparison of Improvement of Performance Potential of workforce over the years for the different scenarios “Only External hiring”, “Internal and External hiring” and “Only Internal Promotion”.

Minimum and maximum expected performance.

If we talk about percentage of improvement, it seems evident that the higher the percentage of firing the better the results of percentage of maximum improvement over ten years. Whichever the model we implement we achieve results which run between a maximum of 320% of average improvement for a FDRS of 5% fired in 10 years, and more than 400% with a FDRS of 10% fired also in 10 years.

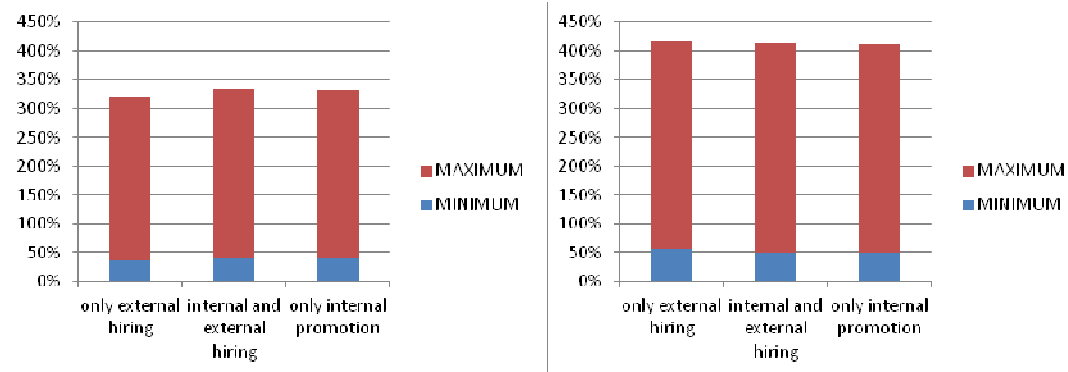


Figure 8: Minimum and maximum performance for 3 scenarios with a FDRS of 5% (left) and 10% (right): “Only Internal hiring”, “Internal and External hiring” and “Only Internal promotion”.

Average Percentage Improvement of Workforce Performance Potential

With the results of the simulations we are able to compare the effects of percentage of firing over the years for our three models of selection procedure: external hiring, internal and external hiring and internal promotion:

	only external hiring 5%	only external hiring 10%	internal and external hiring 5%	internal and external hiring 10%	only internal promotion 5%	only internal promotion 10%
Y1	25%	37%	25%	38%	25%	37%
Y2	14%	17%	14%	17%	14%	16%
Y3	9%	10%	9%	10%	8%	9%
Y4	7%	7%	7%	7%	6%	7%
Y5	5%	5%	5%	5%	5%	4%
Y6	4%	4%	3%	4%	3%	4%
Y7	3%	3%	3%	3%	3%	3%
Y8	3%	3%	3%	2%	2%	2%
Y9	2%	2%	2%	2%	2%	1%
Y10	2%	1%	1%	1%	1%	1%
TOTAL	73%	89%	72%	88%	70%	86%

Table 5: Comparison of percentage of Improvement of Performance Potential of workforce over the years for the different scenarios “Only Internal hiring”, “Internal and External hiring” and “Only Internal promotion”.

If we consider only the results of workforce potential improvement over the years, we observe that the model which obtains the most percentage of improvement is “Only external hiring” with a FDRS of 10%. Although the other models with a 10% of firing obtain very similar results. The three models of a FDRS of 5% in total average also have similar results.

The first 2 years all the models are high improving, and results are quite different depending on which kind of FDRS (5% or 10%) and type of selection procedure we choose. Results are in average 37% for the firing of 10% and 25 for the 5%. The second year results are still extremely high, 17% of improvement for the 10% firing and 14% for the FDRS of 5%. For year 3 and 4 we can expect improvements over 7%. From year 5 to 10 we only gain improvements of 5% or less, so all models lose a lot of efficiency.

Percentage of Workforce Performance Potential Improvement compared to previous studies

As we suggested in our introduction, there are not many previous studies of FDRS. Our study confirms with previous simulations that the system is more efficient in the first years of usage, but this improvement is higher, and it is confirmed in the three models we simulated:

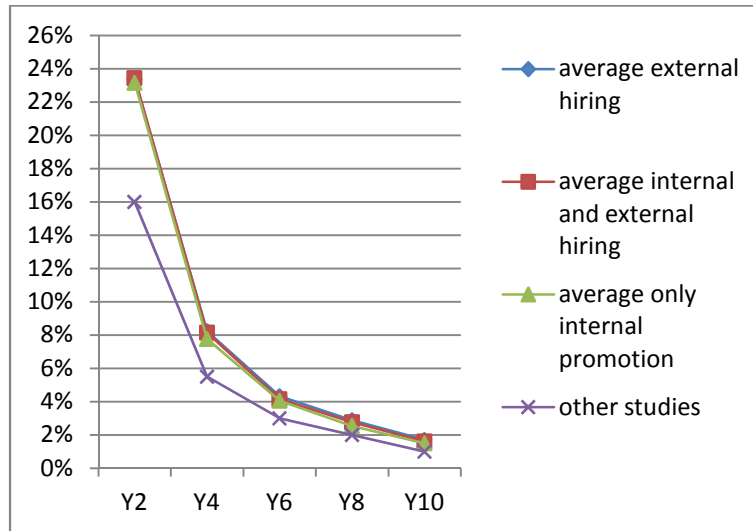


Figure 9: Average Percentage Annual Improvement in Workforce Performance Potential across all scenarios and percentage of firing compared to other studies.

Number of internal promotions and external hirings

For the first model “only external hiring”, as the name is telling us, we only consider external candidates for our hirings. Every year in average 2.1 external executives are hired per company (rotation of 2 out of 10 executives) and the number of external managers we hire in average is 21 per year and company (rotation of 21 out of 100 managers). Both rotations are higher for the FDRS of 10% than for the FDRS of 5%.

The “only internal hiring” only promotes existing workers to managerial and executive positions, and recruit external workers for “worker” positions. We assume that the effect of using internal promotion is positive for the workforce, because the years of service for a company in some way can lead to a reward if you are high performing. In terms of rotation results are very similar to the “only external hiring” model.

Our last model “internal and external hiring” is also similar in terms of average rotation of managers and executives, but in this case for manager and executive positions we make the selection of the best candidate including in the selection procedure internal and external candidates. Results indicate that in a 61% of the cases the internal wins the workplace and versus a 49% of external candidate winners.

So we can conclude that in terms of rotation our three models are similar, that in case of competing for the same workplace normally internal candidates win, and that in a spanless way offering the possibility to internal workers to promote results in satisfaction.

FDRS in terms of productivity

After obtaining individual potentials year after year for each type of workers, and knowing the average of workers leaving the company caused by turnover or the FDRS for each model, we thought it could be interesting to compare the three models in terms of productivity of industrial businesses.

Productivity: For this study we considered productivity as the average year salary of a worker multiplied by the individual potential of a worker. As we have three types of workers (workers, managers or executives) we use the next Formula:

$$\sum_{n=1}^{1110} Average\ year\ salary(n, j) * Individual\ Potential(n) \quad j = 1, 2, 3$$

We made the assumption that the average gross year salary of a worker is 20.000\$, 40.000\$ for a manager and an executive would earn 80.000\$ in average per year. We use the average individual potential of each worker to determine the initial expected productivity for the three models (only external promotion, internal and external promotion and only internal promotion). We decided to differentiate the FDRS of 5% and 10%, because as mentioned before results are very different in terms of potential improvement and workers who leave the company.

Time to Fill (external applicants): In according to the Society for Human Resource Management (Benchmarking Database 2011-2012) the time-to-fill is the number of days it takes to fill a position. Large organizations with more than 1000 workers had a higher average time-to-fill, 43 days, compared with 29 days for smaller organizations. It is evident that this has an effect on productivity as people are not working so we subtract to the initial productivity the cost to fill vacancies. This equation was used to estimate the cost to fill:

$$\text{Cost to Fill vacancies} = \frac{\text{Nr. days to Fill}}{365} * \text{Nr. of hirings} * \text{Average Productivity}$$

Cost per hire. The costs per hiring are the costs associated with the sourcing, recruiting and staffing activities born by an employer to fill an open position in the organization. In according to the Society for Human Resource Management (Benchmarking Database 2011-2012) the cost of each selection procedure for internal applicants for industrial organizations for more than 1000 workers was fixed to 4.285\$ per person hired. Organizations with less than 1000 workers reported cost per hire of 3.079\$.

$$\text{Cost of hiring} = \sum_{n=1}^3 \text{Cost per worker (n)} * \text{Nr_External_Hirements(n)}$$

Where n is the type of worker (worker, manager or executive), and the costs we considered are 2,142.5\$ for workers, 4,285\$ for managers and 42,850 for executives.

Note: we considered the cost of internal promotion as 0\$.

PRODUCTIVITY	ONLY EXT 5%	ONLY EXT 10%	INT & EXT 5%	INT & EXT 10%	ONLY INT 5%	ONLY INT 10%
TOTAL Y10:	18.631.766	21.221.859	18.778.696	21.233.308	18.302.846	20.688.396
COST TO FILL VACANCIES						
TOTAL Y10:	418.232	601.378	421.530	601.702	410.848	586.261
COST OF HIRING						
EXTERNAL EXECUTIVES	1,8	2,4	0,7	0,9	0,0	0,0
EXTERNAL MANAGERS	18,2	23,7	7,0	9,3	0,0	0,0
EXTERNALWORKERS	191,5	240,9	191,4	241,3	190,6	239,8
ALL TYPE OF INTERNAL W	0,0	0,0	12,4	15,5	20,9	27,2
TOTAL:	565.406	720.523	470.065	595.401	408.361	513.772
RESULT Y10:	17.648.128	19.899.959	17.887.101	20.036.205	17.483.637	19.588.364

Table 6: Comparison of the three models ("Only External Promotion", "Internal and External Promotion" and "Only Internal Promotion") with a FDRS of 5% or 10% in terms of productivity.

In terms of productivity we can confirm numerically that when we use internal promotion the cost of hiring per year becomes lower for a FDRS of 5% and for a FDRS of 10%. Because the number of vacancies differs depending of the percentage of firing, the cost to fill vacancies is lower for a FDRS of 5% than for FDRS of 10%. If we could know the different time to fill an executive or a worker position, the difference between the models which use internal promotions and the ones which do not would increase, creating more benefits for the internal promotion models.

“From a theoretical perspective, three explanations as to why firms might make greater use of internal promotion than external recruitment have been postulated: specific human capital; private information and adverse selection; and moral hazard problems.” (Bayo & Ortín, 2006). In case of introducing a FDRS in a company, results show that the models which use internal promotion (“Only Internal Hiring” and “Internal and External Hiring”), have greater results also in terms of productivity.

Discussion

Raters and ratees have reported termination-tied FDRS to be undesirable (Whiting & Kline, 2007) or unfair (Blume, Baldwin, & Rubin, 2009; Schleicher, Bull, & Green, 2009). Additionally, the use of FDRS has been linked to decreased ratee job satisfaction, increased turnover intentions (Whiting & Kline, 2007), and decreased rater confidence (Schleicher et al., 2009). “The financial and emotional costs of replacing workforce will exceed any performance gains one might attain” (Weatherly, 2004). Well-known authors, including Jeffrey Pfeffer and Malcolm Gladwell, condemn FDRS as dysfunctional and suggest that such systems are hazardous to an organization’s culture and performance. Another identified negative impact of FDRS is legality. Courts have said that legal challenges to dismissals that are justified by allegations of poor performance will likely be accepted if deficiencies in that person’s work cannot be established. If a company cannot prove that its performance appraisal system identifies poor performers accurately, it will likely lose its case in court.

Grote (2005) cites several different surveys demonstrating that many employees are less than satisfied with their company’s abilities to differentiate between talent. He cites a 2002 Hay Group employee attitude survey reporting that 32 percent of the employees surveyed from 335 companies agreed that poor performance was tolerated. Its use has demonstrated increased productivity, profitability, and shareholder value for those companies that used it at least during the first years of usage. It was found that about 40 percent of the employees designated with the lowest ratings would voluntarily resign. FDRS drives truth into a process that is frequently eroded by grade inflation and helps leaders identify managers who are good at finding top talent.

We recommend that practitioners interested in using FDRS need to at least be mindful of the kind of concerns employees will have about the process. FDRS It is possible to address many of the concerns through the design of a FDRS and integrate it with other aspects of performance management, having in mind that as studies reveal, a simple FDRS seems to lose its effectiveness after a couple of years of usage.

Conclusions

Our simulation of a FDRS introduces new concepts which haven’t been studied before in simulations of FDRS: big companies with multilevel structure following a span of control of 10, turn-over based on performance Sturman, M. C., Shao, L., & Katz, J. H. (2012), more values for validity, firing the lowest performers of the entire workforce, evaluation of productivity by adding the costs per hire and the costs of replacement and considering internal promotion instead of external hiring.

The average improvement over a ten year duration of the simulation is 0.42 *SD* units. Results of performance potential increase when validity decreases, percentage fired is higher and reliability is also higher.

In all the three types of hiring (“Only External Hiring”, “External and Internal Hiring” and “Only Internal Promotion”), we find evidence that best results appear with a Reliability of 0.70, validity of 0.50 and 10% of firing.

A FDRS with higher percentage of firing (10%) obtains in average higher performance potential values, and lower percentage of firing (5%) result in lower results. Although results are similar for the three models, after year 4 the difference increases and the model which obtains better results is the “Only External Hiring”. In previous years the average difference is almost unexisting.

Also for improvement in percentage of performance potential the higher the percentage of firing the higher the results obtained over the years. Whichever the model of promotion and selection we implement the highest results were found for all the models are 320% of average

improvement for a FDRS of 5% fired over 10 years, and 400% of improvement for FDRS of 10% over 10 years. During the first 2 years all the models are highly improving, and results are quite different depending on which kind of FDRS (5% or 10%) and type of selection procedure we choose. For the first year of implementation the increase in percentage of performance potential is 37% for the FDRS of 10% and 25% for the FDRS of 5%. The second year results are still extremely high, 17% of improvement for the FDRS of 10% and 14% for the FDRS of 5%. For year 3 and 4 we can expect improvements over 7%. From year 5 to 10 we only gain improvements of 5% or less, so all models lose a lot of efficiency.

Our study confirms with previous simulations that the system is more efficient in the first years of usage, but this improvement is higher than previous results, this happens in the three models we simulated. One reason for this phenomenon can be that our model fires the lowest performing workers considering all the workers and not only one of each workgroup as seen in previous studies.

In terms of rotation of executives, managers and workers our three models are similar. In case of selecting candidates for one workplace normally internal candidates are better than external candidates, and that in a spanless way offering the possibility to internal workers to promote can result in satisfaction.

In terms of productivity we consider the costs of hiring and costs of time to fill vacancies, than the "Only Internal Hiring" and the "Internal and External Hiring" model are better than the "Only External Hiring".

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Annex I: Code for Initializing variables

```
Private PotentialVector(1 To 1110), AppscoreVector(1 To 1110) As
Double
Private CountVector As Integer
Sub fdrs()
Dim NrFirms, NrManagers, NrExecutives, Nrworkers, i As Integer
CountVector = 1
For i = 1 To 1110
PotentialVector(i) = 0
AppscoreVector(i) = 0
Next i
For NrFirms = 1 To 100
For NrExecutives = 1 To 10
SelectionExecutive
For NrManagers = 1 To 10
SelectionManager
For Nrworkers = 1 To 10
Selection
Next Nrworkers
Next NrManagers
Next NrExecutives
For i = 1 To 1110
Sheets(1).Cells(i + 3, NrFirms + 2) = PotentialVector(i)
Sheets(2).Cells(i + 3, NrFirms + 2) = AppscoreVector(i)
Next i
CountVector = 1
Next NrFirms
End Sub

Function Selection()
Dim Validity, Appscore, NewAppscore, Potential, FinalPotential As
Double
Appscore = -99
NewAppscore = -99
Potential = -99
FinalPotential = -99
Validity = 0.5
For i = 1 To 5
Potential = WorksheetFunction.NormSInv(Rnd())
NewAppscore = Validity * Potential + Sqr(1 - Validity * Validity)
* WorksheetFunction.NormSInv(Rnd())
If NewAppscore > Appscore Then
FinalPotential = Potential
Appscore = NewAppscore
End If
Next i
PotentialVector(CountVector) = FinalPotential
AppscoreVector(CountVector) = Appscore
CountVector = CountVector + 1
End Function
Function SelectionManager()
Dim Validity, Appscore, NewAppscore, Potential, FinalPotential As
Double
Appscore = -99
NewAppscore = -99
Potential = -99
FinalPotential = -99
Validity = 0.5
For i = 1 To 5
Potential = WorksheetFunction.NormSInv(Rnd())
Potential = Consistency * Potential + Sqr(1 - Validity * Validity)
* WorksheetFunction.NormSInv(Rnd())
NewAppscore = Validity * Potential + Sqr(1 - Validity * Validity)
* WorksheetFunction.NormSInv(Rnd())
If NewAppscore > Appscore Then
FinalPotential = Potential
Appscore = NewAppscore
End If
```

```

    Next i
    PotentialVector(CountVector) = FinalPotential
    AppscoreVector(CountVector) = Appscore
    CountVector = CountVector + 1
End Function
Function SelectionExecutive()
    Dim Validity, Appscore, NewAppscore, Potential, FinalPotential As
Double
    Appscore = -99
    NewAppscore = -99
    Potential = -99
    FinalPotential = -99
    Validity = 0.5
    For i = 1 To 5
        Potential = WorksheetFunction.NormSInv(Rnd())
        Potential = Consistency * Potential + Sqr(1 - Validity * Validity)
    * WorksheetFunction.NormSInv(Rnd())
        Potential = Consistency * Potential + Sqr(1 - Validity * Validity)
    * WorksheetFunction.NormSInv(Rnd())
        NewAppscore = Validity * Potential + Sqr(1 - Validity * Validity)
    * WorksheetFunction.NormSInv(Rnd())
        If NewAppscore > Appscore Then
            FinalPotential = Potential
            Appscore = NewAppscore
        End If
    Next i
    PotentialVector(CountVector) = FinalPotential
    AppscoreVector(CountVector) = Appscore
    CountVector = CountVector + 1
End Function

```

Annex II: Code for Model 1 “only external hiring”

```
Sub fdrs()
Dim CountExtEx, CountExtMan, Fire, CountVector, Period, NrFirms,
NrManagers, NrExecutives, Nrworkers, i, j As Integer
Dim WorkerAverage, ManagerAverage, ExecAverage, random, Rxx,
Potential, FinalPotential, Info(1 To 1110, 1 To 2) As Double
Rxx = 0.5
Period = 1
Fire = 0.05 * 1110
CountVector = 1
For i = 1 To 1110
    Info(i, 1) = i
    Info(i, 2) = Sheets(1).Cells(i + 3, 2)
    Sheets(2).Cells(i + 1, 2) = Info(i, 1)
    Sheets(2).Cells(i + 1, 3) = Info(i, 2)
Next i

For Period = 1 To 10
    For NrFirms = 1 To 100
        WorkerAverage = 0
        ManagerAverage = 0
        ExecAverage = 0
        For i = 1 To 1110
            Sheets(2).Cells(i + 1, 4) = Sheets(1).Cells(i + 3, NrFirms +
2)
            Sheets(2).Cells(i + 1, 5) = Sheets(2).Cells(i + 1, 4) *
Sqr(Rxx) + WorksheetFunction.NormSInv(Rnd()) * Sqr(1 - Rxx)
        Next i
        Columns("B:E").Select
        ActiveWorkbook.Worksheets("Hoja2").Sort.SortFields.Clear
        ActiveWorkbook.Worksheets("Hoja2").Sort.SortFields.Add
Key:=Range("E2:E1111") _
, SortOn:=xlSortOnValues, Order:=xlAscending,
DataOption:=xlSortNormal
        With ActiveWorkbook.Worksheets("Hoja2").Sort
            .SetRange Range("B1:E1111")
            .Header = xlYes
            .MatchCase = False
            .Orientation = xlTopToBottom
            .SortMethod = xlPinYin
            .Apply
        End With
        For i = 1 To 42
            random = Rnd() * (111 - 1) + 1
            Sheets(2).Cells(random + 1, 4) = -9
            Sheets(2).Cells(random + 1, 5) = -9
        Next i
        For i = 1 To 102
            random = Rnd() * (999 - 111) + 111
            Sheets(2).Cells(random + 1, 4) = -9
            Sheets(2).Cells(random + 1, 5) = -9
        Next i
        For i = 1 To 12
            random = Rnd() * (1110 - 999) + 999
            Sheets(2).Cells(random + 1, 4) = -9
            Sheets(2).Cells(random + 1, 5) = -9
        Next i
        random = 1
        For i = 1 To Fire
            While (Sheets(2).Cells(random + 1, 4) = "-9")
                random = random + 1
            Wend
            Sheets(2).Cells(random + 1, 4) = "-9"
            Sheets(2).Cells(random + 1, 5) = "-9"
            random = random + 1
        Next i
        Columns("B:E").Select
        ActiveWorkbook.Worksheets("Hoja2").Sort.SortFields.Clear
```

```

        ActiveWorkbook.Worksheets("Hoja2").Sort.SortFields.Add
Key:=Range("B2:B1111") _
        , SortOn:=xlSortOnValues, Order:=xlAscending,
DataOption:=xlSortNormal
    With ActiveWorkbook.Worksheets("Hoja2").Sort
        .SetRange Range("B1:E1111")
        .Header = xlYes
        .MatchCase = False
        .Orientation = xlTopToBottom
        .SortMethod = xlPinYin
        .Apply
    End With
    For i = 1 To 1110
        If Info(i, 2) = "3" Then
            If Sheets(2).Cells(i + 1, 4) = "-9" Then
                SelectionProcedureWorker i, NrFirms, WorkerAverage
            Else
                Sheets(1).Cells(i + 3, NrFirms + 2) =
Sheets(2).Cells(i + 1, 4)
                WorkerAverage = WorkerAverage + Sheets(2).Cells(i + 1,
4)
            End If
        End If
        If Info(i, 2) = "2" Then
            If Sheets(2).Cells(i + 1, 4) = "-9" Then
                SelectionProcedureManager i, NrFirms, CountExtMan,
ManagerAverage
            Else
                Sheets(1).Cells(i + 3, NrFirms + 2) =
Sheets(2).Cells(i + 1, 4)
                ManagerAverage = ManagerAverage + Sheets(2).Cells(i +
1, 4)
            End If
        End If
        If Info(i, 2) = "1" Then
            If Sheets(2).Cells(i + 1, 4) = "-9" Then
                SelectionProcedureExecutive i, NrFirms, CountExtEx,
ExecAverage
            Else
                Sheets(1).Cells(i + 3, NrFirms + 2) =
Sheets(2).Cells(i + 1, 4)
                ExecAverage = ExecAverage + Sheets(2).Cells(i + 1, 4)
            End If
        End If
    Next i
    Sheets(1).Cells(1116, NrFirms + 2) = "=AVERAGE(R[-1112]C:R[-
3]C)"
    Sheets(1).Cells(1117, NrFirms + 2) = WorkerAverage / 1000
    Sheets(1).Cells(1118, NrFirms + 2) = ManagerAverage / 100
    Sheets(1).Cells(1119, NrFirms + 2) = ExecAverage / 10
    Next NrFirms
    Sheets(1).Cells(1116, 2) = CountExtMan
    Sheets(1).Cells(1116, 1) = CountExtEx
    Sheets("Hojal").Select
    Rows("1116:1119").Select
    Selection.Copy
    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone,
SkipBlanks _
        :=False, Transpose:=False
    Selection.Insert Shift:=xlDown,
CopyOrigin:=xlFormatFromLeftOrAbove
    CountExtEx = 0
    CountExtMan = 0
Next Period
End Sub

Private Function SelectionProcedureWorker(i, NrFirms, WorkerAverage)
    Dim NewAppscore, Validity, Appscore, Potential, FinalPotential As
Double
    Validity = 0.2

```



```

    Appscore = -99
    Potential = -99
    FinalPotential = -99
    NewAppscore = -99
    Consistency = 0.5
    For j = 1 To 5
        Potential = WorksheetFunction.NormSInv(Rnd())
        NewAppscore = Validity * Potential + Sqr(1 - Validity * Validity)
    * WorksheetFunction.NormSInv(Rnd())
        If NewAppscore > Appscore Then
            Appscore = NewAppscore
            FinalPotential = Potential
        End If
    Next j
    WorkerAverage = WorkerAverage + FinalPotential
    Sheets(1).Cells(i + 3, NrFirms + 2) = FinalPotential
End Function
Private Function SelectionProcedureManager(i, NrFirms, CountExtMan,
ManagerAverage)
    Dim NewAppscore, Validity, Appscore, Potential, FinalPotential As
Double
    Dim Position, Consistency As Integer
    Validity = 0.2
    Appscore = -99
    Potential = -99
    FinalPotential = -99
    NewAppscore = -99
    Consistency = 0.5
    Position = 0
    For j = 1 To 5
        Potential = Consistency * Sheets(2).Cells(i + j + 1, 4) + Sqr(1 -
Validity * Validity) * WorksheetFunction.NormSInv(Rnd())
        NewAppscore = Validity * Potential + Sqr(1 - Validity * Validity)
    * WorksheetFunction.NormSInv(Rnd())
        If NewAppscore > Appscore Then
            Appscore = NewAppscore
            FinalPotential = Potential
        End If
    Next j
    CountExtMan = CountExtMan + 1
    ManagerAverage = ManagerAverage + FinalPotential
    Sheets(1).Cells(i + 3, NrFirms + 2) = FinalPotential
End Function
Private Function SelectionProcedureExecutive(i, NrFirms, CountExtEx,
ExecAverage)
    Dim NewAppscore, Validity, Appscore, Potential, FinalPotential As
Double
    Dim Position, Consistency As Integer
    Validity = 0.2
    Appscore = -99
    Potential = -99
    FinalPotential = -99
    NewAppscore = -99
    Consistency = 0.5
    Position = 0
    For j = 1 To 5
        Potential = Consistency * Sheets(2).Cells(i + j + 1, 4) + Sqr(1 -
Validity * Validity) * WorksheetFunction.NormSInv(Rnd())
        Potential = Consistency * Potential + Sqr(1 - Validity * Validity)
    * WorksheetFunction.NormSInv(Rnd())
        NewAppscore = Validity * Potential + Sqr(1 - Validity * Validity)
    * WorksheetFunction.NormSInv(Rnd())
        If NewAppscore > Appscore Then
            Appscore = NewAppscore
            FinalPotential = Potential
        End If
    Next j
    CountExtEx = CountExtEx + 1
    ExecAverage = ExecAverage + FinalPotential
    Sheets(1).Cells(i + 3, NrFirms + 2) = FinalPotential

```

End Function

Annex III: Code for Model 2 “internal and external hiring”

```
Sub fdrs()  
Dim CountIntEx, CountIntMan, CountExtMan, CountExtEx, Fire,  
CountVector, Period, NrFirms, i, j As Integer  
Dim WorkerAverage, ManagerAverage, ExecAverage, random, Rxx,  
Potential, FinalPotential, Info(1 To 1110, 1 To 2) As Double  
Rxx = 0.5  
Period = 1  
Fire = 0.1 * 1110  
CountVector = 1  
CountIntEx = 0  
CountIntMan = 0  
CountExtMan = 0  
CountExtEx = 0  
For i = 1 To 1110  
    Info(i, 1) = i  
    Info(i, 2) = Sheets(1).Cells(i + 3, 2)  
    Sheets(2).Cells(i + 1, 2) = Info(i, 1)  
    Sheets(2).Cells(i + 1, 3) = Info(i, 2)  
Next i  
For Period = 1 To 10  
    For NrFirms = 1 To 100  
        WorkerAverage = 0  
        ManagerAverage = 0  
        ExecAverage = 0  
        For i = 1 To 1110  
            Sheets(2).Cells(i + 1, 4) = Sheets(1).Cells(i + 3, NrFirms +  
2)  
            Sheets(2).Cells(i + 1, 5) = Sheets(2).Cells(i + 1, 4) *  
Sqr(Rxx) + WorksheetFunction.NormSInv(Rnd()) * Sqr(1 - Rxx)  
        Next i  
        Columns("B:E").Select  
        ActiveWorkbook.Worksheets("Hoja2").Sort.SortFields.Clear  
        ActiveWorkbook.Worksheets("Hoja2").Sort.SortFields.Add  
Key:=Range("E2:E1111") _  
        , SortOn:=xlSortOnValues, Order:=xlAscending,  
DataOption:=xlSortNormal  
        With ActiveWorkbook.Worksheets("Hoja2").Sort  
            .SetRange Range("B1:E1111")  
            .Header = xlYes  
            .MatchCase = False  
            .Orientation = xlTopToBottom  
            .SortMethod = xlPinYin  
            .Apply  
        End With  
        For i = 1 To 42  
            random = Rnd() * (111 - 1) + 1  
            Sheets(2).Cells(random + 1, 4) = -999  
            Sheets(2).Cells(random + 1, 5) = -999  
        Next i  
        For i = 1 To 102  
            random = Rnd() * (999 - 111) + 111  
            Sheets(2).Cells(random + 1, 4) = -999  
            Sheets(2).Cells(random + 1, 5) = -999  
        Next i  
        For i = 1 To 12  
            random = Rnd() * (1110 - 999) + 999  
            Sheets(2).Cells(random + 1, 4) = -999  
            Sheets(2).Cells(random + 1, 5) = -999  
        Next i  
        random = 1  
        For i = 1 To Fire  
            While (Sheets(2).Cells(random + 1, 4) = "-999")  
                random = random + 1  
            Wend  
            Sheets(2).Cells(random + 1, 4) = "-999"  
            Sheets(2).Cells(random + 1, 5) = "-999"  
            random = random + 1  
        Next i  
    Next NrFirms  
Next Period
```

```

Next i
Columns("B:E").Select
ActiveWorkbook.Worksheets("Hoja2").Sort.SortFields.Clear
ActiveWorkbook.Worksheets("Hoja2").Sort.SortFields.Add
Key:=Range("B2:B1111") _
, SortOn:=xlSortOnValues, Order:=xlAscending,
DataOption:=xlSortNormal
With ActiveWorkbook.Worksheets("Hoja2").Sort
.SetRange Range("B1:E1111")
.Header = xlYes
.MatchCase = False
.Orientation = xlTopToBottom
.SortMethod = xlPinYin
.Apply
End With
For i = 1 To 1110
If Info(i, 2) = "1" Then
If Sheets(2).Cells(i + 1, 4) = "-999" Then
SelectionProcedureManager i, NrFirms, CountIntEx,
CountExtEx, ExecAverage
Else
Sheets(1).Cells(i + 3, NrFirms + 2) =
Sheets(2).Cells(i + 1, 4)
ExecAverage = ExecAverage + Sheets(2).Cells(i + 1, 4)
End If
End If
If Info(i, 2) = "2" Then
If Sheets(2).Cells(i + 1, 4) = "-999" Then
SelectionProcedureManager i, NrFirms, CountIntMan,
CountExtMan, ManagerAverage
Else
Sheets(1).Cells(i + 3, NrFirms + 2) =
Sheets(2).Cells(i + 1, 4)
ManagerAverage = ManagerAverage + Sheets(2).Cells(i +
1, 4)
End If
End If
If Info(i, 2) = "3" Then
If Sheets(2).Cells(i + 1, 4) = "-999" Then
SelectionProcedureWorker i, NrFirms, WorkerAverage
Else
Sheets(1).Cells(i + 3, NrFirms + 2) =
Sheets(2).Cells(i + 1, 4)
WorkerAverage = WorkerAverage + Sheets(2).Cells(i + 1,
4)
End If
End If
Next i
Sheets(1).Cells(1116, NrFirms + 2) = "=AVERAGE(R[-1112]C:R[-
3]C)"
Sheets(1).Cells(1117, NrFirms + 2) = WorkerAverage / 1000
Sheets(1).Cells(1118, NrFirms + 2) = ManagerAverage / 100
Sheets(1).Cells(1119, NrFirms + 2) = ExecAverage / 10
Next NrFirms
Sheets(1).Cells(1118, 2) = CountIntMan
Sheets(1).Cells(1118, 1) = CountExtMan
Sheets(1).Cells(1119, 2) = CountIntEx
Sheets(1).Cells(1119, 1) = CountExtEx
Sheets("Hojal").Select
Rows("1116:1119").Select
Selection.Copy
Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone,
SkipBlanks _
:=False, Transpose:=False
Selection.Insert Shift:=xlDown,
CopyOrigin:=xlFormatFromLeftOrAbove
CountIntEx = 0
CountIntMan = 0
CountExtEx = 0
CountExtMan = 0

```

```

Next Period
End Sub
Private Function SelectionProcedureWorker(i, NrFirms, WorkerAverage)
    Dim NewAppscore, Validity, Appscore, Potential, FinalPotential As
Double
    Validity = 0.3
    Appscore = -99
    Potential = -99
    FinalPotential = -99
    NewAppscore = -99
    For j = 1 To 5
        Potential = WorksheetFunction.NormSInv(Rnd())
        NewAppscore = Validity * Potential + Sqr(1 - Validity * Validity)
    * WorksheetFunction.NormSInv(Rnd())
        If NewAppscore > Appscore Then
            Appscore = NewAppscore
            FinalPotential = Potential
        End If
    Next j
    Sheets(1).Cells(i + 3, NrFirms + 2) = FinalPotential
    WorkerAverage = WorkerAverage + FinalPotential
    Sheets(2).Cells(i + 1, 4) = FinalPotential
    Sheets(2).Cells(i + 1, 5) = Appscore
End Function
Private Function SelectionProcedureManager(i, NrFirms, CountIntMan,
CountExtMan, ManagerAverage)
    Dim IntNewAppscore, NewAppscore, Validity, IntAppscore, Appscore,
IntPotential, Potential, IntFinalPotential, FinalPotential As Double
    Dim Position, Consistency As Integer
    Validity = 0.3
    Appscore = -99
    Potential = -99
    FinalPotential = -99
    NewAppscore = -99
    IntAppscore = -99
    IntFinalPotential = -99
    IntPotential = -99
    IntNewAppscore = -99
    Consistency = 0.5
    Position = 0
    For j = 1 To 5
        Potential = Consistency * Sheets(2).Cells(i + j + 1, 4) + Sqr(1 -
Validity * Validity) * WorksheetFunction.NormSInv(Rnd())
        NewAppscore = Validity * Potential + Sqr(1 - Validity * Validity)
    * WorksheetFunction.NormSInv(Rnd())
        If NewAppscore > Appscore Then
            Appscore = NewAppscore
            FinalPotential = Potential
        End If
    Next j
    For j = 1 To 10
        IntPotential = Sheets(2).Cells(i + j + 1, 4)
        If IntPotential <> "-999" Then
            IntPotential = Consistency * Sheets(2).Cells(i + j + 1, 4) +
Sqr(1 - Validity * Validity) * WorksheetFunction.NormSInv(Rnd())
            IntNewAppscore = Validity * IntPotential + Sqr(1 - Validity *
Validity) * WorksheetFunction.NormSInv(Rnd())
            If IntNewAppscore > IntAppscore Then
                IntAppscore = IntNewAppscore
                IntFinalPotential = IntPotential
                Position = i + j + 1
            End If
        End If
    Next j
    If (IntAppscore >= Appscore) Then
        CountIntMan = CountIntMan + 1
        Sheets(1).Cells(i + 3, NrFirms + 2) = IntFinalPotential
        Sheets(2).Cells(Position + 1, 4) = -999
        Sheets(2).Cells(Position + 1, 5) = -999
        ManagerAverage = ManagerAverage + IntFinalPotential
    End If
End Function

```

```

Else
    CountExtMan = CountExtMan + 1
    Sheets(1).Cells(i + 3, NrFirms + 2) = FinalPotential
    Sheets(2).Cells(i + 1, 4) = FinalPotential
    Sheets(2).Cells(i + 1, 5) = Appscore
    ManagerAverage = ManagerAverage + FinalPotential
End If
End Function
Private Function SelectionProcedureExecutive(i, NrFirms, CountIntEx,
CountExtEx, ExecAverage)
    Dim IntNewAppscore, NewAppscore, Validity, IntAppscore, Appscore,
IntPotential, Potential, IntFinalPotential, FinalPotential As Double
    Dim Position, z, Consistency As Integer
    Validity = 0.3
    Appscore = -99
    Potential = -99
    IntPotential = -99
    FinalPotential = -99
    NewAppscore = -99
    IntAppscore = -99
    IntFinalPotential = -99
    IntNewAppscore = -99
    Consistency = 0.5
    Position = 0
    z = 0
    For j = 1 To 5
        Potential = Consistency * Sheets(2).Cells(i + j + 1, 4) + Sqr(1 -
Validity * Validity) * WorksheetFunction.NormSInv(Rnd())
        Potential = Consistency * Potential + Sqr(1 - Validity * Validity)
* WorksheetFunction.NormSInv(Rnd())
        NewAppscore = Validity * Potential + Sqr(1 - Validity * Validity)
* WorksheetFunction.NormSInv(Rnd())
        If NewAppscore > Appscore Then
            Appscore = NewAppscore
            FinalPotential = Potential
        End If
    Next j
    For j = 1 To 10
        IntPotential = Sheets(2).Cells(i + j + 1, 4)
        If IntPotential <> "-999" Then
            IntPotential = Consistency * Sheets(2).Cells(i + 2 + z, 4) +
Sqr(1 - Validity * Validity) * WorksheetFunction.NormSInv(Rnd())
            IntNewAppscore = Validity * IntPotential + Sqr(1 - Validity *
Validity) * WorksheetFunction.NormSInv(Rnd())
            If IntNewAppscore > IntAppscore Then
                IntAppscore = IntNewAppscore
                IntFinalPotential = IntPotential
                Position = i + 2 + z
            End If
        End If
        z = z + 11
    Next j
    If (IntAppscore >= Appscore) Then
        CountIntEx = CountIntEx + 1
        Sheets(1).Cells(i + 3, NrFirms + 2) = IntFinalPotential
        Sheets(2).Cells(Position + 1, 4) = -999
        Sheets(2).Cells(Position + 1, 5) = -999
        ExecAverage = ExecAverage + IntFinalPotential
    Else
        CountExtEx = CountExtEx + 1
        Sheets(1).Cells(i + 3, NrFirms + 2) = FinalPotential
        Sheets(2).Cells(i + 1, 4) = FinalPotential
        Sheets(2).Cells(i + 1, 5) = Appscore
        ExecAverage = ExecAverage + FinalPotential
    End If
End Function

```

Annex IV: Code for Model 3 "only internal promotion"

```
Sub fdrs()
Dim CountIntEx, CountIntMan, Fire, CountVector, Period, NrFirms, i, j
As Integer
Dim WorkerAverage, ManagerAverage, ExecAverage, random, Rxx, Info(1 To
1110, 1 To 2) As Double
Rxx = 0.5
Period = 1
Fire = 0.05 * 1110
CountVector = 1
CountIntMan = 0
CountIntEx = 0
For i = 1 To 1110
    Info(i, 1) = i
    Info(i, 2) = Sheets(1).Cells(i + 3, 2)
    Sheets(2).Cells(i + 1, 2) = Info(i, 1)
    Sheets(2).Cells(i + 1, 3) = Info(i, 2)
Next i
For Period = 1 To 1
    For NrFirms = 1 To 100
        WorkerAverage = 0
        ManagerAverage = 0
        ExecAverage = 0
        For i = 1 To 1110
            Sheets(2).Cells(i + 1, 4) = Sheets(1).Cells(i + 3, NrFirms +
2)
            Sheets(2).Cells(i + 1, 5) = Sheets(2).Cells(i + 1, 4) *
Sqr(Rxx) + WorksheetFunction.NormSInv(Rnd()) * Sqr(1 - Rxx)
        Next i
        Columns("B:E").Select
        ActiveWorkbook.Worksheets("Hoja2").Sort.SortFields.Clear
        ActiveWorkbook.Worksheets("Hoja2").Sort.SortFields.Add
Key:=Range("E2:E1111") _
, SortOn:=xlSortOnValues, Order:=xlAscending,
DataOption:=xlSortNormal
        With ActiveWorkbook.Worksheets("Hoja2").Sort
            .SetRange Range("B1:E1111")
            .Header = xlYes
            .MatchCase = False
            .Orientation = xlTopToBottom
            .SortMethod = xlPinYin
            .Apply
        End With
        For i = 1 To 42
            random = Rnd() * (111 - 1) + 1
            Sheets(2).Cells(random + 1, 4) = -999
            Sheets(2).Cells(random + 1, 5) = -999
        Next i
        For i = 1 To 102
            random = Rnd() * (999 - 111) + 111
            Sheets(2).Cells(random + 1, 4) = -999
            Sheets(2).Cells(random + 1, 5) = -999
        Next i
        For i = 1 To 12
            random = Rnd() * (1110 - 999) + 999
            Sheets(2).Cells(random + 1, 4) = -999
            Sheets(2).Cells(random + 1, 5) = -999
        Next i
        random = 1
        For i = 1 To Fire
            While (Sheets(2).Cells(random + 1, 4) = "-999")
                random = random + 1
            Wend
            Sheets(2).Cells(random + 1, 4) = "-999"
            Sheets(2).Cells(random + 1, 5) = "-999"
            random = random + 1
        Next i
        Columns("B:E").Select
    Next NrFirms
Next Period
End Sub
```

```

        ActiveWorkbook.Worksheets("Hoja2").Sort.SortFields.Clear
        ActiveWorkbook.Worksheets("Hoja2").Sort.SortFields.Add
Key:=Range("B2:B1111") _
        , SortOn:=xlSortOnValues, Order:=xlAscending,
DataOption:=xlSortNormal
    With ActiveWorkbook.Worksheets("Hoja2").Sort
        .SetRange Range("B1:E1111")
        .Header = xlYes
        .MatchCase = False
        .Orientation = xlTopToBottom
        .SortMethod = xlPinYin
        .Apply
    End With
    For i = 1 To 1110
        If Info(i, 2) = "1" Then
            If Sheets(2).Cells(i + 1, 4) = "-999" Then
                SelectionProcedureExecutive i, NrFirms, CountIntEx,
ExecAverage
            Else
                Sheets(1).Cells(i + 3, NrFirms + 2) =
Sheets(2).Cells(i + 1, 4)
                ExecAverage = ExecAverage + Sheets(2).Cells(i + 1, 4)
                End If
            End If
            If Info(i, 2) = "2" Then
                If Sheets(2).Cells(i + 1, 4) = "-999" Then
                    SelectionProcedureManager i, NrFirms, CountIntMan,
ManagerAverage
                Else
                    Sheets(1).Cells(i + 3, NrFirms + 2) =
Sheets(2).Cells(i + 1, 4)
                    ManagerAverage = ManagerAverage + Sheets(2).Cells(i +
1, 4)
                End If
            End If
            If Info(i, 2) = "3" Then
                If Sheets(2).Cells(i + 1, 4) = "-999" Then
                    SelectionProcedureWorker i, NrFirms, WorkerAverage
                Else
                    Sheets(1).Cells(i + 3, NrFirms + 2) =
Sheets(2).Cells(i + 1, 4)
                    WorkerAverage = WorkerAverage + Sheets(2).Cells(i + 1,
4)
                End If
            End If
        Next i
        Sheets(1).Cells(1116, NrFirms + 2) = "=AVERAGE(R[-1112]C:R[-
3]C)"
        Sheets(1).Cells(1117, NrFirms + 2) = WorkerAverage / 1000
        Sheets(1).Cells(1118, NrFirms + 2) = ManagerAverage / 100
        Sheets(1).Cells(1119, NrFirms + 2) = ExecAverage / 10
    Next NrFirms
    Sheets(1).Cells(1119, 2) = CountIntEx
    Sheets(1).Cells(1118, 2) = CountIntMan
    Sheets("Hoja1").Select
    Rows("1116:1119").Select
    Selection.Copy
    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone,
SkipBlanks _
        :=False, Transpose:=False
    Selection.Insert Shift:=xlDown,
CopyOrigin:=xlFormatFromLeftOrAbove
    CountIntEx = 0
    CountIntMan = 0
Next Period
End Sub
Private Function SelectionProcedureWorker(i, NrFirms, WorkerAverage)
    Dim NewAppscore, Validity, Appscore, Potential, FinalPotential As
Double
    Validity = 0.2

```



```

    Appscore = -99
    Potential = -99
    FinalPotential = -99
    NewAppscore = -99
    For j = 1 To 5
        Potential = WorksheetFunction.NormSInv(Rnd())
        NewAppscore = Validity * Potential + Sqr(1 - Validity * Validity)
    * WorksheetFunction.NormSInv(Rnd())
        If NewAppscore > Appscore Then
            Appscore = NewAppscore
            FinalPotential = Potential
        End If
    Next j
    Sheets(1).Cells(i + 3, NrFirms + 2) = FinalPotential
    WorkerAverage = WorkerAverage + FinalPotential
    Sheets(2).Cells(i + 1, 4) = FinalPotential
    Sheets(2).Cells(i + 1, 5) = Appscore
End Function
Private Function SelectionProcedureManager(i, NrFirms, CountIntMan,
ManagerAverage)
    Dim IntNewAppscore, Validity, IntAppscore, IntPotential,
IntFinalPotential As Double
    Dim Position, Consistency As Integer
    Validity = 0.2
    IntAppscore = -99
    IntPotential = -99
    IntFinalPotential = -99
    IntNewAppscore = -99
    Consistency = 0.5
    Position = 0
    For j = 1 To 10
        IntPotential = Sheets(2).Cells(i + j + 1, 4)
        If IntPotential <> "-999" Then
            IntPotential = Consistency * Sheets(2).Cells(i + j + 1, 4) +
Sqr(1 - Validity * Validity) * WorksheetFunction.NormSInv(Rnd())
            IntNewAppscore = Validity * IntPotential + Sqr(1 - Validity *
Validity) * WorksheetFunction.NormSInv(Rnd())
            If IntNewAppscore > IntAppscore Then
                IntAppscore = IntNewAppscore
                IntFinalPotential = IntPotential
                Position = i + j + 1
            End If
        End If
    Next j
    CountIntMan = CountIntMan + 1
    Sheets(1).Cells(i + 3, NrFirms + 2) = IntFinalPotential
    ManagerAverage = ManagerAverage + IntFinalPotential
    Sheets(2).Cells(Position + 1, 4) = -999
    Sheets(2).Cells(Position + 1, 5) = -999
End Function
Private Function SelectionProcedureExecutive(i, NrFirms, CountIntEx,
ExecAverage)
    Dim IntNewAppscore, Validity, IntAppscore, IntPotential,
IntFinalPotential As Double
    Dim Position, z, Consistency As Integer
    Validity = 0.2
    IntPotential = -99
    IntAppscore = -99
    IntFinalPotential = -99
    IntNewAppscore = -99
    Consistency = 0.5
    Position = 0
    z = 0
    For j = 1 To 10
        IntPotential = Sheets(2).Cells(i + j + 1, 4)
        If IntPotential <> "-999" Then
            IntPotential = Consistency * Sheets(2).Cells(i + 2 + z, 4) +
Sqr(1 - Validity * Validity) * WorksheetFunction.NormSInv(Rnd())
            IntNewAppscore = Validity * IntPotential + Sqr(1 - Validity *
Validity) * WorksheetFunction.NormSInv(Rnd())

```

```
        If IntNewAppscore > IntAppscore Then
            IntAppscore = IntNewAppscore
            IntFinalPotential = IntPotential
            Position = i + 2 + z
        End If
    End If
    z = z + 11
Next j
CountIntEx = CountIntEx + 1
Sheets(1).Cells(i + 3, NrFirms + 2) = IntFinalPotential
ExecAverage = ExecAverage + IntFinalPotential
Sheets(2).Cells(Position + 1, 4) = -999
Sheets(2).Cells(Position + 1, 5) = -999
End Function
```