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The level of technology employed and the internal hierarchical wage structure

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This study demonstrates that the level of firm-specific technology significantly enlarges the wage gaps of managers. Firm-specific technology is found to be more powerful than industrial risk or the promotion rate in explaining the wage gaps of managers.

I. Introduction

In recent decades, labour economists have focused their attention on the empirical analysis of the internal labour market, in particular the internal wage structure. Two types of research have prevailed. One approach has been to employ the detailed internal labour market data of a single large-scale firm, while the other approach has been to use the data collected from many firms. Baker *et al*. (1993, 1994) are examples of the former, and Eriksson (1999) and Beaumont and Harris (2003) exemplify the latter. Although the data of Baker *et al*. (1993, 1994) provide insights into the internal labour economics, a single-firm data set is not capable of suggesting how a firm's characteristics determine the dispersion of pay among a firm's hierarchical levels of managers. Eriksson (1999) used a data set of 2600 executives from 210 Danish firms to investigate how the number of tournament participants and operational risk influence the dispersion of pay, and concluded that there existed a convex relationship between pay and job levels, and that a larger number of contestants and more variable business conditions led to larger dispersions of pay. While Eriksson's data contained only executives and did not cover jobs at lower levels, Beaumont and Harris (2003) covered job levels other than managers, but their job levels were divided into only two levels, namely, nonmanual and manual workers.

It needs to be asked what type of firms long for skilled managers more. A firm that operates on a large-scale is able to earn more and it is also possible for it to lose more. Large firms are therefore more keen on acquiring skilled managers since the marginal benefit of a skilled manager is much larger for large firms. Moreover, if a tournament with a high degree of competition is compensated with more in terms of a reward for winning, then the tournament is able to attract more skilled participants.

Additionally, firms with advanced technology are also eager to have skilled managers. Three theories underpin the view that the wage gap is larger between high-level and low-level managers in more technology-oriented firms. First, the most important strategy for technology-oriented firms to survive is R&D. This is because new products usually phase out old products, and give rise to a short life cycle in the case of technological products. Furthermore, patents secure the profits of technology-oriented firms, and hence strengthen their competitive power in the market. This implies that the management of the top-level managers is crucial in leading this type of firm to succeed, and, therefore, it is all the more

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necessary to set up a high-reward tournament to attract more skilled managers to participate in the tournament. Second, top-level managers certainly have to possess more human capital to run technology-oriented firms, and hence it is natural for them to earn a higher wage. Third, although technology-oriented firms might enjoy speedy growth, they might also suffer great loss. The business risk in technology-oriented firms is greater than in other firms. Hence, top-level managers in technology-oriented firms have to be compensated for the business risk that they are faced with.

Therefore, it is likely that firms with a high level of technology-related employment are more willing to set up a tournament with more rewards in order to induce more qualified competitors. The purpose of this study is to investigate whether or not the level of technology employed in a firm enlarges the dispersions in pay in the firm's internal hierarchical wage structure.

II. Data sources and statistics

The data used are those included in the 2002 Survey on Earnings by Occupation compiled by the Council of Labor Affairs of the Taiwan government. The survey covers all industries, and was conducted in July 2002. There were 8101 firms in the sample. The survey asked each firm respondent to fill in the number of employees, the sums of the wages based on 4-digit occupations, and to provide answers to other questions. The average wage for each occupation can be obtained by dividing the sum of the wages by the number of employees in that occupation. Employees in the survey can be divided into seven 2-digit occupational categories, i.e. supervisors, clerks and other staff, engineers and professionals, technicians and associate professionals, service workers and salesmen, technological workers and nontechnological workers. To lay emphasis on the job levels of managers, all three levels of supervisors are used. As a result, occupations are divided into nine categories as shown in Tables 1 and 2. Table 1 shows that the larger the firm's scale, the smaller will be the proportion of high-level managers. Table 2 presents the average wage (New Taiwan dollar, NT$) for each occupation in accordance with the firm's scale. In general, the larger the firm's scale, the higher the average wage. It would appear that the wage gaps among the high-level managers are larger for large-scale firms.

III. Empirical models and results

The explanatory variables within the simple OLS regression include a public dummy variable (1 if a public firm), the number of workers (representing the firm's scale), the promotion rate, the professional rate, 22 area dummy variables (where Kaohsiung city is the comparison base), four industrial dummy variables (where traditional manufacturing industry is the comparison base), as well as the variances and the growth rates of 2-digit industrial production values. Since the firms' production data are not available, the production variances and growth rates are calculated based on the 2-digit industries for the period 1998 to 2002. The variances are calculated from the data for 20 quarters, while the growth rates are calculated from yearly data. There are 52 2-digit industries, and the classification of the industries is more subtle than the classification of the five industrial dummy variables used in the model. The industrial variances and growth rates are used to represent the firms' risk and perspective, respectively. The promotion rate is calculated based on the number of workers at the higher level divided by the number of workers at the lower level. The professional rate is calculated in accordance with the number of engineers and professionals divided by the total number of workers in a firm. The professional rate represents the level of technology employed by the firm. The higher the ratio, the higher the specific technology the firm employs.

In addition to the wage gaps between level 1 and level 2 managers and level 2 and level 3 managers, three more wage gaps are investigated. The first is the wage gap in gap, i.e. [(level 1–level 2)–(level 2–level 3)]. The other two are the wage gaps between professionals and associate professionals, and between technological and nontechnological workers. The wage gap in gap is used to examine whether the wage gap between the top two hierarchical levels of managers is significantly larger than the wage gap between level 2 and level 3 managers, as the tournament theory expects. The other two types are the wage gaps between two hierarchical jobs, other than managers. They are comparison groups and are used as the control group. As the factors enlarging the wage gap between two hierarchical levels of managers also increase, in the same way, the wage gaps between the other job levels, it is difficult to underpin the tournament theory, since the tournament theory fundamentally argues that the wage gaps between the two hierarchical levels of managers are more substantial in terms of inducing the work effort of low-level managers. For example, given a 1% decline in the promotion rate, the tournament theory

Table 1. Proportions of 9 occupations based on firm's scale

Scale (Number of workers)	Level 1 Manager (%)	Level 2 Manager (%)	Level 3 Manager (%)	Clerical and Staff (%)	Engineers and Professionals (%)	Technicians and Associate Professionals (%)	Service Workers and Salesmen (%)	Technological Workers (%)	Nontechnological Workers (%)
Above 500	0.5	2.0	7.5	16.8	10.8	15.3	8.2	14.3	24.7
300–499	1.0	2.1	5.6	9.6	11.0	8.4	17.6	19.0	25.7
200–299	1.2	2.2	4.9	8.6	9.7	7.7	21.3	17.8	26.7
100–199	1.7	2.6	5.3	10.1	9.7	8.1	17.0	18.7	26.9
50–99	2.1	3.0	5.1	10.2	9.3	8.2	20.1	18.3	23.7
30–49	2.8	3.5	5.4	10.0	8.9	8.2	20.3	19.9	20.9
10–29	3.8	4.2	5.4	9.4	9.7	9.8	19.4	20.2	18.2
5–9	5.7	5.6	6.4	9.9	9.4	11.4	18.1	18.2	15.3
Less than 4	7.8	7.8	9.2	9.7	11.6	11.5	14.7	14.5	13.2

Table 2. Average monthly wages of 9 occupations based on firm's scale (NT$)

Scale (Number of workers)	Level 1 Manager	Level 2 Manager	Level 3 Manager	Clerical and Staff	Engineers and Professionals	Technicians and Associate Professionals	Service Workers and Salesmen	Technological Workers	Nontechnological Workers
Above 500	163 633	100 033	69 128	39 491	54 011	43 487	35 135	41 824	30 921
300–499	138 885	85 160	61 693	35 131	47 772	38 782	31 584	38 264	27 649
200–299	121 248	83 511	59 430	35 176	46 473	37 683	29 932	38 058	27 731
100–199	107 508	75 350	55 016	32 681	45 065	35 989	29 725	36 043	26 581
50–99	98 298	67 359	51 957	30 513	43 827	35 475	26 802	35 024	24 596
30–49	81 610	61 539	49 119	28 771	44 851	33 805	25 508	33 060	23 558
10–29	62 510	51 689	43 986	26 003	43 224	33 079	24 017	31 570	22 901
5–9	49 724	45 531	42 608	23 760	37 812	30 589	25 204	29 315	23 170
Less than 4	44 551	39 955	36 318	22 450	35 571	32 275	22 020	28 437	20 946

Table 3. Regression results of wage gaps within a firm

	Level 1–Level 2		Level 2–Level 3		(Level 1–Level 2)–(Level 2–Level 3)		Professional-associate professional		Technological worker -nontechnological worker	
	Model I		Model II		Model III		Model IV		Model V	
	Coeff	*t*	Coeff	*t*	Coeff	*t*	Coeff	*t*	Coeff	*t*
Constant	39838	11.50***	27194	15.23***	11579	3.04***	11270	8.62***	9320	10.45***
Public	3218	0.26	−1604	−0.87	8855	0.65	1716	0.9	−1867	−1.80*
Number of workers	0.81	1.13	0.94	2.31**	−0.43	−0.61	0.01	0.05	−0.38	−1.43
Promotion rate	−7507	−8.12***	−2622	−5.62***	971	0.94	14.5	0.80	9.1	1.62
Professional rate	68228	7.71***	19875	4.91***	37234	3.76***	3165	0.68	−1961	−1.13
Technological manufacturing	1729.38	0.64	−655.70	−0.43	4978.36	1.46	29.41	0.28	−931.13	−1.2
Construction and Utilities	−12664	−2.82***	−8523	−6.4***	−12163	−1.95*	−120	−0.11	1348	1.50
Finance and Insurance	25559	3.77***	8582	4.37***	12837	1.47	8173	2.46**	2910	0.82
Other services	−7743	−1.84*	−2828	−2.27**	−8592	−1.42	4782	2.68***	586	0.78
Agriculture, fishing and mining	−16225	−3.77***	−10006	−3.61***	−12650	−2.08**	−1051	−0.39	5015	3.06***
Industrial variance	4.48	0.80	3.45	1.98**	2.57	0.39	−3.12	−1.67*	−0.24	−0.23
Industrial growth	48218	1.84*	3957	0.33	38528	1.39	28407	1.87*	10756	1.52
R^2	0.099		0.095		0.04		0.054		0.038	
Number of observations	3242		3154		2337		1740		1941	

Note: To savespace, the 22 area dummy variables are not presented in Table 3.

implies that the wage gap between the top two hierarchical levels of managers is significantly larger than in the case of the other levels of managers. Since not all firms have all levels of occupations, the numbers of observations are subject to data availability, and hence these five models have different numbers of observations.

Table 3 shows that the wage gap between level 1 and level 2 managers is negatively related to the promotion rate and positively related to the professional rate. The wage gap between level 2 and level 3 managers leads to similar results, but with an additional result that the wage gap is greater in larger firms. Moreover, both the promotion rate and professional rate are insignificant in the regressions of the wage gaps between hierarchical occupations other than managers. These results support the tournament theory. However, the promotion rate is not significant in the regression of the wage gap in gap, i.e. [(level 1–level 2)–(level 2–level 3)], but the professional rate is still significant at the 1% level in this regression. It appears that the level of technology employed is a more important factor underpinning the tournament theory. Furthermore, the technological manufacturing industry and finance and insurance industry are examples of industries in which it takes much longer for skilled managers to establish their business. The results for the finance and insurance industry dummy variable coincide with expectations. It seems that the dummy variable of the technological manufacturing industry does not meet this expectation. However, without industrial variance and growth rate explanatory variables, both the dummy variables of the technological manufacturing and finance and insurance industries are positively significant at least at the 5% level in Models I to III in Table 3. The coefficients of the technological manufacturing industry in Models I to III, without the industrial variance and growth rate explanatory variables, are 10 285, 2488 and 11 284, respectively, and their corresponding *t*-values are 2.96, 2.46 and 2.54, respectively. It is likely that the variance and growth of industrial production are correlated with the dummy variable of the technological manufacturing industry, which implies that the wage gap between the managers of hierarchical levels are partially compensated by the instability of the business and reflect the growth of the business.

IV. Conclusions

Existing studies have verified that business risk and the number of contestants enlarge the wage gaps within the hierarchical wage structure of managers. This study demonstrates that the level of firm-specific technology also significantly enlarges the wage gaps within the hierarchical wage structure of managers. It is likely that the firm-specific technology is more powerful than other factors in terms of explaining the wage gaps within the hierarchical wage structure of managers.

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