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Original Research Article

The effect of wage growth in research and development on firms' productivity: Evidence from a Chinese firm database

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Samuel Moon Jung

The Graduate Center, The City University of New York, USA.

Author's E-mail:
christmasnoon@gmail.com

China's economic reforms were successful in its move from a planned economy to a socialist market economy despite huge limitations such as socialism and the dominance of state ownership. In the 3rd course of reforms in China, privately-owned companies exceeded 50% of the national GDP (Gross Domestic Product) and further expanded. This paper illustrates the effect of research and development (R&D) and science and technology (S&T) wage growth on firms' productivity after the Chinese corporate governance reform. According to the literature, R&D and S&T wage growth are critical contributors to firms' productivity. First, by examining Chinese companies' data from 1995 to 2004 during the 3rd course of reforms, this study investigated how state-owned companies are less profitable than those undergoing privatization and foreign acquisition. Secondly, analysis of compensation ratio variables such as average wage of R&D and S&T labor reveals that firms' productivity is positively correlated with the average wage of R&D or S&T labor. These results are consistent with the literature, which suggest that firms with better incentive structures perform better in a transition economy.

Key words: Firm performance, compensation structure.

JEL codes: D24; J31; O32.

INTRODUCTION

Numerous studies confirm that a company's compensation structure affects its performance (Bartel, 1995; Fleisher, 2005; Jefferson, 2006; Aw et al., 2007; Lallemand et al., 2009). Compensation structure is often linked to the form of ownership and the incentive structure in a firm. This paper focuses on Chinese corporate governance reform to illustrate how an incentive structure works in Chinese companies and how it affects their performance.

China's economic reforms were successful in moving China from a planned economy to a socialist market economy, spurring impressive economic growth rates. Incidentally, much of this Chinese economic growth resulted from economic transitional gains in allocative efficiency that followed the stage of market and ownership reform. Economic transition began in 1978 and was carried out in four major courses of reforms viz: 1978-1984, 1985-1994, 1995-2004, and 2005-present. The transition between 1995 and 2004 was a major course of reform, which achieved rapid economic growth (Figure 1).

During the course of this reform, large-scale privatization occurred where all state enterprises, aside from a few large monopolies, were liquidated and their assets sold to private investors. The number of state-owned enterprises decreased by 48% (Brandt et al., 2008). In the process of corporate restructuring in China, ownership of some companies moved from state owned to non-state owned. As a result, some companies increased the wage in the field of R&D (Research and Development) and S&T (Science

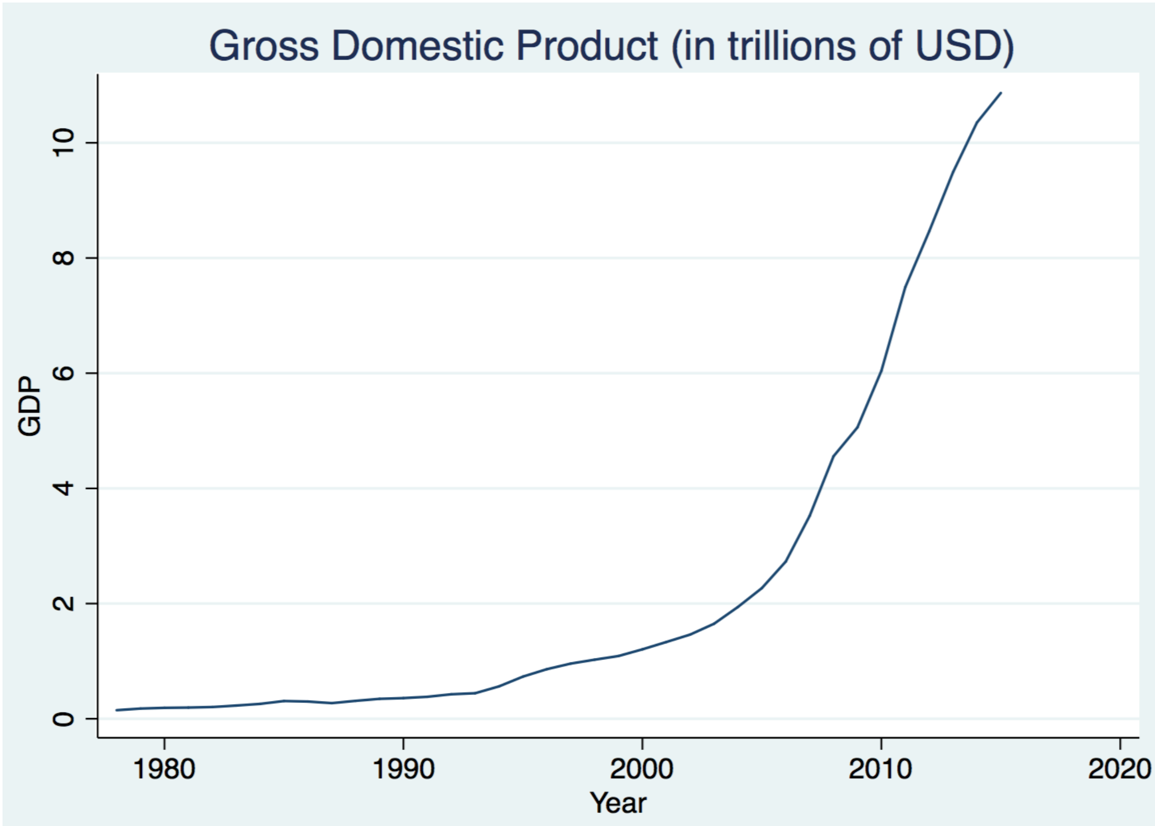

Figure 1. China's Gross Domestic Product (in trillions of USD) between 1978 and 2015

and Technology). At the same time, most state owned enterprises also increased their R&D and S&T compensation. (Table 1)

Examining Chinese companies' panel data from 1995 to 2004 reveals the effect of an incentive structure on a firm's productivity during this heavy economic transition period. Before 2005, 71% of the enterprises included in the sample reported having R&D or S&T labor, while the rest did not. Upon examination and comparism of these two types of companies in China, this paper analyzes the effect of the wage dispersion between R&D and S&T staff as compared to the average wage on firm level productivity. Wage dispersion is measured by the difference between the wages of R&D and S&T workers compared to those in the total labor force.

This research demonstrates that companies with a higher compensation ratio, such as wages of R&D and S&T labor are more efficient while companies with a lower compensation ratio are relatively inefficient. To evaluate the effect of compensation ratios, this paper measures the average wage of R&D labor, controlling for the overall ratio between the numbers of R&D labor and total labor. Similarly, in the analysis of compensation ratios, the average wage of S&T labor and the overall ratio between S&T labor and total labor were also explored. Quantitative ratios between R&D/S&T workers and the total work force were controlled, since a high wage paid to a single R&D or S&T worker in a large firm is likely to have a far less impact on productivity compared to when the same wage differential was in force (for instance) for half of the work force comprised of R&D and S&T workers.

The paper hypothesizes that the presence of either R&D labor or S&T labor leads to positive value added in excess of the value added contribution of non-R&D or S&T workers. For example, if there are more highly-paid R&D laborers in the firms, they will have more positive value added in terms of firm performance because companies pay R&D workers relatively higher wages than workers in other fields. Consequently, companies with more R&D workers enjoy higher productivity and generate higher profits as a result of technological contributions made by R&D labor. Similarly, S&T labor in companies also contributes towards creating value added in terms of a firm's performance.

Beyond the relatively large value added contribution of R&D and S&T workers, it is further hypothesized (as the central test of this research paper) that higher compensation to these workers results in higher levels of firm productivity. This is likely due to their direct effect on the firm's performance based on innovative technology. Both the ratio of R&D and S&T workers to the total labor

Table 1. Descriptive statistics

Year	Statistic	Value added (1000RMB)	Capital (1000RMB)	Labor (Person)	S&T labor (Person)	R&D labor (Person)	S&T wage (1000RMB)	R&D wage (1000RMB)
1995	Mean	41,915	54,496	15,567	57.9	12.3	299.5	88.5
	STD	330,150	335,250	5,169	284.8	109.9	1,672.1	930.9
	Obs	22,812	22,812	22,812	20,636	20,636	20,636	20,636
1996	Mean	43,772	58,799	1,588	59.5	17.9	252.5	120.2
	STD	344,440	355,765	4,846	279.9	130.6	1,549.4	996.2
	Obs	23,448	23,448	23,448	23,046	23,046	23,046	23,046
1997	Mean	46,228	81986	1,556	59.9	17.9	277.5	-
	STD	378,253	2,578,420	4,822	298.3	120.5	1,989.1	-
	Obs	47,756	47,252	47,204	46,814	46,814	46,814	-
1998	Mean	49,740	72,947	1,443	59	15.8	354	-
	STD	390,448	413,998	4,377	297.7	108.5	2,699.2	-
	Obs	23,145	23,145	23,145	22,778	22,778	22,778	-
1999	Mean	58,197	84,832	1,387	63.7	18.7	448.2	217.5
	STD	468,691	461,115	4,350	325.4	140.8	3,815	905.7
	Obs	22,458	21,980	21,980	21,993	21,993	21,993	21,993
2000	Mean	72,387	97,887	1,288	57.8	13.0	745.5	301.6
	STD	694,724	621,965	3,901	272.9	87.7	6,852	1507.1
	Obs	20,659	20,659	20,659	19,620	19,620	19,620	19,620
2001	Mean	77,821	107,889	1,200	57.2	15.6	812.7	406.2
	STD	649,410	65,892	3,590	277.1	92.8	4,612	2507.4
	Obs	22,704	22,704	22,704	22,017	22,017	22,017	22,017
2002	Mean	89,719	113,177	1,179	58.9	25.7	1,099	615.4
	STD	648,561	584,718	3,613	282.1	165.3	12,111	11062.8
	Obs	22,328	22,328	22,328	22,293	22,289	22,328	22,328
2003	Mean	108,576	129,358	1,207	63.4	29.8	1,459.43	846.0
	STD	769,238	875,008	2,995	296.4	173.6	14,111.2	12,867.1
	Obs	23,610	23,610	23,610	21,950	21,950	21,950	21,950
2004	Mean	138,147	140,119	1,267	52.1	23.5	1600.6	891.1
	STD	933,390	1,460,390	3,237.9	283.9	172.4	1,776.0	1,636.9
	Obs	27,680	27,680	27,680	27,680	27,680	27,680	27,680

Source: China Statistical Yearbook (1995 ~ 2004)

force and the ratio of their wages were added because firms with intensive R&D workers are likely to be more productive, regardless of the wage ratio. For this reason, I identified the independent effect of the numeric ratio of R&D and S&T workers to total workers and their compensation ratios.

The research results below support the hypothesis that given a certain ratio of R&D or S&T labor to the total labor force, the greater the compensation ratio and productivity of the firm.

Literature review

Jefferson (1999) investigated the assignments of property rights that are required to create markets in labor quality, which raises efficiency, its complementary factors of production, and overall performance of firms. He found that one of the reasons for unexploited labor market quality is that workers are employed and rewarded for the quantity of their work but not for their specific skill or effort. Therefore, the more skilled workers are, the more likely that they will not be efficiently employed. Since compensation based on the quantity of labor services is more evenly distributed than compensation for a different skill and effort, the unreformed system exhibits a substantial degree of wage compression. Jefferson (1999) argued that the ability of skilled and motivated workers to migrate from the state sector to higher-wage opportunities in the non-state sector results in adverse selection in the state sector, which further depresses its average productivity and wages. This process of adverse selection in which skilled workers are paid the average productivity of the work force rather than being compensated on the basis of their individual productivities creates deterioration in relative firm productivity.

Nadiri and Prucha (1997) modeled the production structures of six major OECD countries to analyze the sources of output and labor productivity growth. They found disembodied technical change to be the most important source of output and labor productivity growth in all countries. The major finding was that R&D capital contributed only modestly to the growth of output and labor productivity thus reflecting the small share of R&D investment in total output at the total economy level. The accumulation of physical capital was the second major contributor. As a result of the substantial growth in physical capital and the high rate of technical change, the economies of Japan, Germany, France and Italy experienced a substantial narrowing in the gap between their levels of GDP per capita relative to the United States'. Therefore, the sources of catch-up among OECD countries were the high rate of technical change (R&D capital) and the high rate of physical capital accumulation in Japan and other European countries, with the exception of the United Kingdom.

Fleisher and Wang (2001) examined incentive-wage effects on production, managerial and technical workers in urban and rural Chinese non-agricultural enterprises and reported strong evidence of productivity enhancing wage behavior among enterprises in all ownership categories. They estimated an indirect efficiency wage component of reported wage payments and then estimated the impact of these excess wage payments on productivity. They also categorized enterprises' employees into skilled and unskilled workers and examined the incentive effects of wage payments. The authors exploited the panel feature of the sample of rural enterprises to address the issue of Granger causality between productivity and efficiency wage payments. As a result, considerable support was found for the hypothesis that firms in China pay wages that have positive incentive effects.

Similarly, it is further shown that S&T and R&D workers are the main variables for finding their impact on firms' performance. If there are more S&T and R&D workers than in another company, there is a reason to believe that S&T and R&D workers may be trained and have higher performance than unskilled workers. Likewise, if there are more highly-paid S&T and R&D workers, the number of highly-paid S&T and R&D workers may affect the company's performance.

According to Fleisher and Wang (2001), the labor force can be categorized into two groups ─ trained and untrained. Intuitively, a trained labor force will have a higher wage than an untrained or less-trained one since its contribution to production is larger. From this point of view, the labor force in technical work can be categorized into two groups ─R&D labor and S&T labor. Here, R&D labor is referred to as more trained labor than S&T labor. For example, in a firm there are simple technicians maintaining computers or a system, but they are better trained than unskilled labor. Also, in the same firm there are more trained researchers with higher academic degrees than simple technicians. The average wage of R&D is 323,704 RMB, whereas the average for S&T is 54,160 RMB. This difference implies that the contribution of R&D labor is much larger than S&T. This is because higher marginal productivity means higher wage.

The above-mentioned studies highlight the relationship between labor quality and productivity in firms thus suggesting that the greatest commitment to training demonstrates the highest level of productivity. As an extension of these studies, the paper further aims to show the impact of a compensation structure on firm performance in China. In this study, R&D and S&T workers are considered as high quality workers and it is attempted to capture their individual effect on directing a firm to enhance its performance.

MODEL

The primary sets of research questions intended to explore in this study are as follows: First, are companies with higher proportions of R&D and S&T workers more likely to have higher productivity? Second, are companies with more highly paid R&D and S&T workers more likely to achieve higher productivity? To answer these questions, the basic approach to gauge the impact of R&D and S&T to productivity growth is taken from Nadiri and Prucha (1997). The Cobb – Douglas production function is used for all analysis:

Production function:

$$\ln VA_{it} = a_0 + a_1 \ln A_{it} + a_2 \ln K_{it} + a_3 \ln L_{it} + e_{it} \quad (1)$$

Productivity function:

$$\ln A_{it} = b_0 + b_1 \ln(W_{STavg} / W_{Totalavg})_{it} + b_2 \ln(L_{ST} / L_{Total})_{it} + q_{it}$$
(2a)
$$\ln A_{it} = f_0 + f_1 \ln(W_{RDavg} / W_{Totalavg})_{it} + f_2 \ln(L_{RD} / L_{Total})_{it} + h_{it}$$
(2b)

where VA_{it} is the value added; K_{it} is total fixed capital calculated by the sum of fixed capital invested in fixed assets such as land, buildings, vehicles, plant, and all equipment that stay in the business permanently; L_{it} is total workers, W_{STavg} is the total S&T wage bill divided by the total number of S&T workers; $W_{Totalavg}$ is the total labor bill divided by total number of workers; L_{ST} is the number of S&T workers, and L_{Total} is the number of total workers. Similar to most of the literature, this study determined the productivity performance of a firm by using value added computed as sales less purchases from outside plus change in inventory of work-in-process and finished goods. For equation 2(a);

W_{STavg} / $W_{Totalavg}$, the compensation variables measure the ratio of the average wage paid to S&T workers to the average wage of the total work force and;

L_{ST} / L_{Total} is the quantity ratio for the measure of the number of S&T workers in the companies relative to their work force.

Similarly, for equation2(b);

W_{RDavg} is the total R&D wage bill divided by the total number of R&D workers and;

L_{RD}, used as a quantity measure, is the number of R&D workers in the company.

Since this research focuses on compensation structures in Chinese companies, the models proposed in this study examined the explicit role of incentive structures, both S&T and R&D wage ratios.

In order to measure the impact of S&T and R&D efforts on firms' performance, productivity equations (2a) and (2b) were substituted into the production function, as summarized by equation (1). A model was constructed and estimated which consists of the following two equations:

The first estimation equation substituted (2a) into (1):

$$\ln VA_{it} = g_0 + g_1 \ln(W_{STavg} / W_{Totalavg})_{it} + g_2 \ln(L_{ST} / L_{Total})_{it} + a_2 \ln K_{it} + a_3 \ln L_{it} + g_{it}$$
(3a)

where $g_0 = a_0 + a_1 b_0$, $g_1 = a_1 b_1$, $g_2 = a_1 b_2$, and $g_{it} = a_1 q_{it} + e_{it}$

The second estimation equation substituted (2b) into (1):

$$\ln VA_{it} = d_0 + d_1 \ln(W_{RDavg} / W_{Totalavg})_{it} + d_2 \ln(L_{RD} / L_{Total})_{it} + a_2 \ln K_{it} + a_3 \ln L_{it} + d_{it}$$
(3b)

where $d_0 = a_0 + a_1 f_0$, $d_1 = a_1 f_1$, $d_2 = a_1 f_2$, and $d_{it} = a_1 h_{it} + e_{it}$

In the two equations, the S&T and R&D wage ratios are the ratios of compensation in Chinese companies. Equations (3a) and (3b) examine the impact of compensation measures of S&T and R&D workers on companies' productivity. In this paper, compensation ratios such as wage and quantitative ratios for the number of S&T and R&D workers are the key dependent variables of interest.
The fore-mentioned methodology explains the components of the empirical methodology and describes the statistical relevance of estimation techniques. A set of wage ratios and a number of S&T and R&D variables thought to have independent effects on compensation ratio were used throughout the analysis.

DATA

Dataset of characteristics of Chinese companies between 1995 and 2004 taken from the China Statistical Yearbook (National Bureau of Statistics of China) were used for analyses. In Table 1, after dropping missing variables, the list of companies grew from 22,812in 1995 to 27,680 in 2004. In total, there were 233,127 observations of enterprises throughout the period along with some missing variables. The dataset consists of wage and number of R&D workers, S&T workers, and total labor force for each of these enterprises during a given year, value added, and total capital. Note that R&D workers are a subset of S&T workers and all variables are annual.

At first glance, a significant presence of R&D and S&T workers was noticed in corporations, as China was in the process of transferring to capitalism between 1995 and 2004. State-owned firms also have a substantial number of R&D and S&T workers. In addition, total wages for R&D and S&T workers increased. Overall, 102,796 observations of the enterprises (43% of the total) have S&T workers while 51,323 observations of the enterprises (21% of the total) have R&D workers. The mean S&T labor is 50.42, and the number of S&T workers ranges from 0 to 22,979. The mean of R&D labor is14.05, and the number of R&D workers ranges from 0 to 12,051. Among Chinese corporations that reported having R&D and S&T labor, the S&T and R&D labors' wages ranges from 0 to 1,505,330 (RMB). The mean of S&T wages is 54,160(RMB)while for R&D wages is327,704(RMB).

ESTIMATION RESULTS

Pooled Regression

In Table 2, the first column illustrates the impact of S&T quantitative and wage ratio on companies' productivity. Productivity rises when S&T labor's share in the work force and the ratio of the wage of S&T workers to the total work force increases. Companies with larger proportions of S&T workers in their workforce are observed to have higher productivity. The S & T quantitative ratio has a positive

Table 2. The impact of quantitative and wage ratios on firm productivity (Dependent variable = lnVA).

Variable	Coefficient of Equation (3a)	Variable	Coefficient of Equation (3b)
lnK	0.615***	lnK	0.638***
lnL	0.329***	lnL	0.294***
lnL_{ST}	1.227***	lnL_{RD}	1.770***
lnW_{ST}	0.010***	lnW_{RD}	0.001***
Adj R-sq	0.538	Adj R-sq	0.571
Observations	103,534	Observations	28,585

Table 1 includes the full sample while Tables 2 and 3 are restricted to those firms that include S&T or R&D labor.
***Indicates significance at the 1% level.
Figures in parentheses are t-statistics.

coefficient and is significant. As shown in Table 2, the magnitude of the elasticity of productivity with respect to the number of S&T workers in the companies relative to their work force, which is the S&T quantitative ratio, is 1.227. Based on the calculation shown in the Appendix, this productivity elasticity implies a $1,355 increase in value added, which is the measure of productivity for every 1% change in S&T quantitative ratio defined by the following equation:

$$\text{S\&T quantitative ratio} = \frac{\text{Total number of SandT labor}}{\text{Total number of labor}}$$

Next, controlling for inputs of total capital and labor, estimates of the pooled regression show that the S&T wage ratio is associated with higher productivity and is statistically significant. As shown in Table 2, the magnitude of the elasticity of productivity with respect to the ratio of the average wage paid to S&T workers to the average wage of the total work force is 0.010. Based on the calculation shown in the Appendix, this productivity elasticity implies a $939 increase in value added for every 1% change in the S&T wage ratio defined by the following equation:

$$\text{S\&T wage ratio} = \frac{\text{Total SandT wage /Total SandT labor}}{\text{Total Non SandT wage/Total number of non SandT labor}}$$

The second column reveals the significant impact of R&D labor's quantitative and wage ratio on the companies' productivity levels. The variable of the R&D quantitative ratio has a positive coefficient and is statistically significant. As shown in Table 2, the magnitude of the elasticity of productivity with respect to the number of R&D workers in the companies relative to their work force, which is R&D quantitative ratio, is 1.770. This productivity elasticity translates into a $1,954 increase in value added, the measure of productivity, for every 1% change in the R&D quantitative ratio defined by the following equation:

$$\text{R\&D quantitative ratio} = \frac{\text{Total number of RandD labor}}{\text{Total number of labor}}$$

Estimates of the pooled regression show that the R&D wage ratio is associated with higher productivity and is statistically significant as well. As shown in Table 2, the magnitude of the elasticity of productivity with respect to the ratio of the average wage paid to R&D workers to the average wage of the total work force is 0.001. Based on the calculation shown in the Appendix, this productivity elasticity implies a $793 increase in value added and the measure of productivity for every 1% change in the R&D wage ratio which is defined by the following equation:

$$\text{R\&D wage ratio} = \frac{\text{Total RandD wage /Total RandD labor}}{\text{Total Non RandD wage/Total number of non RandD labor}}$$

Similarily, Nadiri and Prucha (1997) placed the impact of R&D investment on productivity at elasticities of 0.029 (United States), 0.018 (Japan), 0.0235 (Germany), 0.026 (United Kingdom), 0.020 (France) and 0.006 (Italy). Thus, the study's baseline impact of R&D expenditure in hiring additional R&D labor on firm's productivity is quite large while the impact of R&D expenditure passing on to the R&D workers in terms of higher wages is relatively smaller than major OECD countries.

Restricted regression

Tables 3 and 4 are restricted to the subset of enterprises with S&T workers (Table 3) or R&D workers (Table 4), whereas Table 2 includes the full sample and estimation results for equations (3a) and (3b) in the model – the productivity equation. By controlling for the inputs of capital, labor, S&T variables, and R&D variables, estimates of equations (3a) and (3b) show that the wages and numbers of S&T and R&D are associated with higher productivity.

Table 3. Restricted to firms that include S&T labor (Dependent variable = lnVA).

Variable	**Coefficient**
lnK	0.633***
lnL	0.330***
lnW_{ST}	0.039***
lnL_{ST}	2.896***
Adj R-sq	0.507
Observations	35,517

Wst (=W_{STavg} / $W_{Total\ avg}$): the ratio of the average wage paid to S&Tworkers to the average wage of the total work force.
Lst (=L_{ST} / L_{Total}): the quantity ratio for the measure of the number of S&T workers in the companies relative to their work force.

Table 4. Restricted to firms that include R&D labor only (Dependent variable = lnVA).

Variable	**Coefficient**
lnK	0.630***
lnL	0.308***
lnW_{RD}	0.079***
lnL_{RD}	3.290***
Adj R-sq	0.565
Observations	12,419

Wrd (=W_{RDavg} / $W_{Total\ avg}$): the ratio of the average wage paid to R&D workers to the average wage of the total work force.
Lrd (=L_{RD} / L_{Total}): the quantity ratio for the measure of the number of R&D workers in the companies relative to their work force.

The estimation reported in Table 3 illustrates that the ratios of average and total average wages and the number of S&T workers and total workers have a statistically significant effect on Chinese companies' firm performance. The coefficient of lnW_{st}, the ratio of average S&T wages and total average wages, shows that the estimated elasticity of productivity with respect to the ratio of average S&T wages and total average wages is 0.039. Based on the calculation shown in the Appendix, this productivity elasticity translates into a $4,179 increase in value added for every 1% change in S&T wage ratio. Unlike the pooled regression, in the restricted regression the estimated elasticity of productivity with respect to the ratio of average S&T wages and total average wages rises to 0.039 from 0.010. In addition, the coefficient of lnL_{st} indicates that the estimated elasticity of productivity with respect to the ratio of the number of S&T workers and total workers in the companies is 2.896. This elasticity implies a $31,970 increase in value added for every 1% increase in the ratio of the number of S&T workers and total workers in the companies.

The results reported in Table 4 reveal that the ratios of average and total wages and the number of R&D workers and total workers have a statistically significant effect on the productivity of Chinese companies. The coefficient of lnW_{RD} indicates that the estimated elasticity of productivity with respect to the ratio of average R&D and total workers' wages is 0.079. This elasticity translates into an $87,213 increase in value added for every 1% increase in the ratio of average R&D and total workers' wages. Moreover, the coefficient of lnL_{RD} shows that the estimated elasticity of productivity with respect to the ratio of the number of R&D workers and total workers in the companies is 3.290. This elasticity implies a $363,284 increase in value added for every 1% increase in the ratio of average R&D and total workers' wages.

Fixed effect

The relationship between wages and number of R&D (or S&T) workers and firm productivity was also explored.

Table 5. Fixed effect with S&T workers (Dependent variable = lnVA).

Variable	Coefficient
lnK	0.163*** (34.11)
lnW_{ST}	0.008*** (2.95)
lnL_{ST}	0.063*** (17.11)
R-sq (within)	0.0320
R-sq (between)	0.2789
R-sq (overall)	0.2413
Observations	76,470

***Indicates significance at the 1% level.
Figures in parentheses are t-statistics.

Table 6. Fixed effect with R&D workers only (Dependent variable = lnVA).

Variable	Coefficient
lnK	0.144*** (8.73)
lnW_{RD}	0.068*** (3.45)
lnL_{RD}	2.231*** (6.82)
R-sq (within)	0.0412
R-sq (between)	0.2798
R-sq (overall)	0.2631
Observations	13,390

***Indicates significance at the 1% level.
Figures in parentheses are t-statistics.

Each firm has its own individual characteristics that may or may not influence the predictor or outcome variables as the business practices of a company may influence its stock price. Thus, the effects of time-invariant characteristics were removed to allow the net effect of wages and the number of R&D (or S&T) workers on firm productivity to be assessed. In addition, after fixed effect estimations with S&T and R&D workers, F-test revealed that all of the coefficients in the models are different from zero, which means that these fixed effect models are acceptable.

Table 5 shows the results of fixed effect with S&T workers only. The estimates shown in Table 5 indicate that the wages and the number of S&T workers only contribute to the firm's performance. The coefficient of lnL_{ST} shows that the elasticity of productivity with respect to the S&T labor's share in the workforce is 0.063. This estimated elasticity translates into $6,954 for every 1% increase in the S&T labor's share in the workforce. In addition, the coefficient of lnW_{ST} shows that the estimated elasticity of productivity with respect to the ratio of the average wage paid to S&T workers to the average wage of the total work force is 0.008 thus translating into an $8,831 increase in value added for every 1% increase in this S&T wage ratio.

The estimates of the fixed effect with R&D workers (Table 6) illustrate that the number of R&D workers contributes significantly only to the firm's performance. The coefficient of lnL_{RD} states that the elasticity of productivity with respect to R&D labor's share in the workforce is 2.231. Based on the calculation shown in the Appendix, it suggests a $246,296 increase in value added for every 1% change in R&D wage ratio. In addition, the coefficient of lnW_{RD} shows that the estimated elasticity of productivity with respect to the ratio of the average wage paid to R&D workers to the average wage of the total labor force is 0.068, thus translating into a $75,070 increase for every 1% change in R&D wage ratio.

CONCLUSION

In summary, this paper specifically focuses on the impact of a compensation structure, such as S&T and R&D, on firm-level performance. By using a dataset of Chinese companies between 1995 and 2004, the wage ratios of S&T and R&D, the ratios of S&T or R&D, workers to total workers, and their impact on firm-level performance were investigated.

Since many missing values were generated and there are several ambiguous variables in a large portion of the population of Chinese companies as this research made inferences from a dataset of Chinese companies between years 1995 and 2004.

The analysis in this paper produced several important findings. First, there are statistically significant relationships between wage ratios, S&T and R&D and firm-level performance. The fixed effect models found that the wage ratios of S&T and R&D workers have a positive and significant effect on firm performance. Second, controlling for information on the number of S&T and R&D workers hired in Chinese companies increases the firm's value added, referred to as firm-level performance. The fixed effect also found that the number of S&T and R&D workers hired in Chinese companies has a positive and significant effect on firm performance.

This paper illustrates the microeconomics of technological innovation in transition economies based on a national dataset by analyzing the wage and quantitative ratios for S&T and R&D workers. The main findings in this paper are that higher wages for S&T and R&D workers increase firm-level performance and a greater number of S&T and R&D workers in Chinese companies improved their firms' productivity.

Since the effect of S&T and R&D were analysed separately, further research should ask what the marginal effect of the other is when one is also in the equation? In addition, the coefficients from the two stages with their standard errors at some future point in time were also estimated; determination of whether the impact of R&D and S&T wage growth on firms' productivity varies depending on urban companies or rural enterprises. In addition, as discussed by Fleisher and Wang (2001), private returns on schooling are consistently low because R&D (or S&T) labor and administrative workers are underpaid relative to manufacturing labor. As such, it is suggested to investigate how the low incentive wage structure of R&D and S&T labor deteriorates returns on schooling and further labor market segmentation in the long run.

Conflict of Interests

The author declare that there is no conflict of interests regarding the publication of the paper

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APPENDIX

Approximation of a 1% change in ratio

A: Value added (Dependent Variable)
B: Each ratio (Independent Variable)

$$\frac{d\ln A}{d\ln B} = \frac{dA/A}{dB/B}$$

$$\because \frac{d\ln A}{dA} = \frac{1}{A} \quad \Rightarrow d\ln A = \frac{dA}{A}$$

$$\text{Since } \frac{dA/A}{dB/B} = \text{coefficient},$$

$$\frac{dA}{A} = \frac{dB}{B} * (coefficient)$$

$$\frac{dA}{dB} = \frac{A}{B} * (coefficient)$$

The means for A and B were used. In order to calculate an approximation of a 1% change in the ratio, it was repeated for the whole sample period and then the average of 1% changes for the entire sample period was then calculated.

Example:

From Table 1 for 2004, the S&T ratio is 52.1/1267 (= 0.0411208) and a 1% change to that would be 0.01*0.0411208=0.0411208.
dA in RMB = (138147 / 0.0411208)*1.227*0.000411208 = 11,453 RMB
This is an approximation of how much a 1% change in the ratio would, on average for 2004, increase RMB value added by 11,453 RMB.
In the same way, these procedures were repeated for the whole sample period from1995 to 2004. Therefore, an approximation of a 1% change in the S &T quantitative ratio is 8,914RMB or an average of $1,355 from 1995 to 2004.