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The Effects of Job Mismatch on Pay, Job Satisfaction, and Performance

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Abstract: The purpose of this study is to analyze the effects of job mismatch on pay, job satisfaction, and performance of doctoral level researchers, based on the job-environment fit theory. The study analyzed 2273 sample data used in the survey, based on the '2013 Ph D. Research Survey' from the Institute for Science and Technology Policy (STEPI) in Korea. The results showed that the degree of job-mismatch of doctors has a significant effect on overall pay, job satisfaction, and performance. Specifically, job mismatch of the Ph.D. workforce both negatively affected pay and job satisfaction. In addition, in terms of the relationship between job mismatch, pay, job satisfaction, and job performance, the mediating effect of pay and job satisfaction was confirmed. The implication of the research is that it is crucial to approach the accomplishment of an outstanding workforce based on the concept of job mismatch so that excellent and highly educated human resources can be placed in the right place to maximize their individual qualities and academic knowledge. Considering that job mismatch eventually has a negative impact on research performance through the mediation of pay and job satisfaction, it is necessary to promote strategies to utilize advanced talent, which includes job mismatch, economic incentives, such as salaries, and psychological compensation, such as job satisfaction.

Keywords: job mismatch; skill mismatch; job satisfaction; Ph.D. workforce human resource policy

1. Introduction

Job mismatch is a potential threat in the new normal and fourth industrial revolution period, which is characterized by rapid technological progress, stagnant economic growth, low-fertility, and aging societies [1,2] Human capital becomes more significant than before, particularly for high-quality talented human capital development.

In particular, as the accumulation and application of professional knowledge and information based on ideas and creativity are recognized as a crucial resource, there has been a growing demand for talented human capital with high capability, emphasizing various discussions on the treatments and conditions for a high-skilled workforce.

Korea, however, has been experiencing a "brain drain", in which high-skilled human resources continuously relocate abroad, and this may result in job mismatch and dissatisfaction at the level of high-quality R&D (Rechearch & Development) human resources as well as lead them to lower their job performances and competitiveness. As a matter of fact, according to the '2017 Global Talent Report' announced by the International Institute for Management Development [3], Korea's Human Capital Competitiveness Index is 55.82, which ranks Korea 39th highest among 61 countries in the world. Especially, the Appeal Index, which is judged based on the level of brain drain, quality of life, and professional income tax rate, was recorded to be 46.43, the lowest among the surveyed factors. On the other hand, when evaluating Korea's talent competitiveness in four areas of investment, supply,

talent level, and utilization environment, while Korea's educational investment is high, human capital competitiveness, including quality of education, labor skill level, and environment of utilizing human resources, was found to be low [4]. Thus, special policy concerns should be taken into consideration to secure high-quality human capital, and foster their activities and capabilities.

On the other hand, the constrained mobility within the labor market due to various factors and its consequential labor demand and supply makes highly educated workers unable to get proper jobs. In such a reality, the knowledge, skills, and capacities required by specific jobs can be divergent from the human resources in the given workforce, and these differences are called 'job mismatch'. Meanwhile, it is evident that the problem of mismatch in the labor market has been mainly discussed in terms of labor supply-demand mismatch at a macro level, while there are relatively few studies on job mismatch at an individual level. However, job mismatch has a significant effect on labor market performance [5]; it should not be overlooked, since job mismatch has been considered as a factor to negatively affect macroeconomic efficiency aside from individual wage level, job satisfaction, and group performance.

In this context, the purpose of this study is to examine the effect of high-quality doctorate researchers' job mismatch on pay, job satisfaction, and performance based on the job-environment fit theory. Hence, the study aims to draw policy implications for creating an environment that enhances researchers' satisfaction and performance by allowing them to thoroughly exercise their abilities in the right places.

2. Theoretical Framework

2.1. Job Fit Theory

Job fit refers to the degree to which job characteristics that an individual worker performs and the knowledge, skills, and capacities necessary for job performance correspond or are appropriate [6]. Job fit is a sub-concept of the person-environment fit theory. According to the theory, the higher the fitness of an individual's job characteristics in the job environment is, the higher the individual job performance [7]. Specifically, the person-environment fit theory consists of individual-organizational fit, individual-group fit, and individual-job fit. Among these, the individual-job fit shows the highest relevance to job performance [8]. In other words, job fit has been discussed regarding how well individual characteristics correspond to job characteristics, which has focused on the factors related to the job characteristics and factors related to those of job seekers or workers in the labor market, who are an economically applicable workforce.

In the labor market, personal characteristics are generally explored in a variety of aspects, including academic background, gender, age, major, job competence, and interest, and psychological factors, such as aptitude and attitude [8–10]. From the perspective of the job characteristics theory, each different job characteristic is considered as the factors forming personal attitude and awareness of job. Hackman and Oldham [11] suggested five characteristics of skill variety, job identity, job significance, autonomy, and feedback as a measure of job characteristics. Identity refers to the degree to which the job is involved in the entire process instead of just a part of the job. Significance is the degree to which the job influences members both inside and outside the group. Autonomy refers to the degree to which an individual has discretion when planning and performing the job, and feedback refers to the degree to which an individual is aware of the information about the results of his or her job performance [11].

A variety of evaluations on job characteristics have been developed, including the following representative factors: DHOC (Dictionary of Holland Occupational Codes) is categorized as RIASEC (R: Reality type, I: Investigative type, A: Art type, S: Social type, E: Enterprise type, C: Custom type), based on the job environmental characteristic; and PCI (Position Classification Inventory), which assigns codes according to how often such contents are applied to perform the job in terms of the activities, skills, abilities, and personality characteristics required by the work environment.

This job fit is also utilized for job mismatch, from the perspective of highlighting the discrepancy between job characteristics and personal characteristics, which refers to the degree to which a worker's

educational attainment, proficiency, major, and interested fields correspond to the level of difficulty or required competence of a specific job [12]. Research on job mismatch has extended along with the seminal 1981 study by Duncan and Hoffman [13]. Specifically, the job mismatch research can be classified into education mismatch, skill mismatch, and subject mismatch. Education mismatch is the level of discrepancy between the educational attainment of an actual worker and that of the job requirement, which can lead to over education or under-education in that educational attainment is estimated as an objective indicator called academic background. Skill mismatch explains the level of discrepancy between the skills of each individual worker and the skills required by the job characteristics [14], aligning with the human capital theory. Furthermore, as higher education becomes popular, the notion of mismatch is attracting attention [15]. The study of subject mismatch was not studied much more than the study of education mismatch or skill mismatch; however, this field is highly applicable to analyzing high education curricula and job fit by identifying the level of correspondence between workers' majors and job characteristics [16].

Education mismatch is the most frequently studied field among other types of job mismatch because academic background as a signal is a salient indicator per se, and it is assumed that academic background as a mediator variable represents practical contents of the signal and skills, knowledge, and types of capacity required for actual job performance [15]. On the other hand, Chevalier [17] conceptualized education mismatch as a kind of job mismatch for an over-educated population, classifying the population into genuine over-educated and apparent overeducated. According to him, the genuine over-educated results from a lack of skills that trigger job dissatisfaction, while the apparent over-educated results from over-skillfulness that does not trigger job dissatisfaction. Furthermore, wage loss of the genuine over-educated group far outweighs that of the apparent overeducated group. On the one hand, the negative effects of job mismatch, which cannot be explained by education mismatch and various types of mismatch, need be discussed simultaneously [15], which calls for the a comprehensive approach on job mismatch, considering that the discussions regarding skill mismatch and subject mismatch as well as education mismatch have been extended. Consequently, more comprehensive approaches taking each type into account, aside from education mismatch, are required. Di Paolo and Mané [18] suggested a concept of genuine matching (GM) and apparent matching (AM). The phenomenon in which respondents perceive themselves as neither overeducated nor over-skilled can be explained by genuine matching (GM). On the other hand, apparent matching (AM) occurs when respondents perceive themselves to be over-skilled rather than being overeducated.

As mentioned above, a number of studies on job mismatch have revealed that job mismatch negatively affects the labor market, including low wages and low job satisfaction [19]), and the majority of them have examined the impacts of over-education on wages and job satisfaction, focusing on education mismatch [20,21]. To illustrate, Giuseppe et al. [22] analyzed the effects of overeducation of the doctoral degree, workforce, dissatisfaction resulting from job mismatch, and over-skill at a pay level. He found that significantly lower wages have a correlation with overeducation and skill dissatisfaction, although there is no wage penalty from the over-skilled. Furthermore, individuals who experience both overeducation and skill dissatisfaction are reported to have a particularly high wage penalty. Montt [23] explored how skill supply and labor market demand dynamics influence mismatch, using the data from the OCED(Organization for Economic Cooperation and Development) Survey of Adult Skills (PIAAC). He analyzed the cross-national estimates on mismatch and mismatch wage penalty, which showed workers who are overqualified and mismatched by work fields suffer from the wage penalty.

Research on the impacts of job mismatch on individual and group performance has been conducted as well. Specifically, the job mismatch studies have mainly dealt with the changes in the environmental job characteristics, stemming from the development and intensification of particular technologies. For example, Francesco et al. [24] examined the correlation between groups' job mismatch in the IT (Information Technology) application and its productivity, considering the existing job requirements as well as the development of the IT technology and industries. Wade and Parent [25]

examined the impacts of skill mismatch of webmaster workers on group performance. On the other hand, Pala et al. [26] examined the impacts of education mismatch on individual performance, and another study found that not only individual job satisfaction, but also educational mismatch and skill mismatch can subsequently influence wage level and job search activity [5].

Based on the existing job mismatch studies, the present study attempts to ascertain the following hypotheses to examine the impacts of job mismatch of doctoral researchers on job satisfaction. A detailed hypothesis for each hypothesis is also tested to figure out the impacts on job satisfaction and performance depending on the types of job mismatch.

Hypothesis 1 (H1). *Job mismatch has a negative effect on pay and job satisfaction.*

Hypothesis 1-1 (H1-1). *Job mismatch has a negative effect on pay.*

Hypothesis 1-2 (H1-2). *Job mismatch has a negative effect on job satisfaction.*

Hypothesis 2 (H2). *Job mismatch has a negative effect on performance.*

Hypothesis 2-1 (H2-1). *Job mismatch has a negative effect on research performance.*

Hypothesis 2-2 (H2-2). *Job mismatch has a negative effect on patent performance.*

2.2. Pay, Job Satisfaction, and Job Performance

There have been various approaches in defining job satisfaction. Job satisfaction refers to a positive emotional response of employees regarding job and job experiences, and the degree to which individuals are aware of psychological satisfaction and physical rewards, which involve the entire emotional and cognitive evaluation, including rewards, satisfaction, dissatisfaction, and frustration discovered by themselves [27].

Furthermore, job satisfaction also includes the positive or negative evaluation that a worker feels toward his or her job, job performance, and job environment [28]. Han [29] considered job satisfaction as the emotional response comparing the expectations that an individual wants to gain during the job performance and the outcomes that were actually gained. Integrating all these various concepts, job satisfaction is a state of positive and negative emotion that a member in an organization feels toward internal and external factors of the organization. Besides, job satisfaction can be seen to have complex, manifold features from the organizational, job, and personal characteristics [30,31].

Due to the diverse approaches to define job satisfaction, scholarly attempts to comprehend such a variety of interpretations have continued. These various concepts of job satisfaction can largely be explained by the discrepancy theory and equity theory (Recited in [32]). The discrepancy theory can be supported by the two-factors theory of Herzberg (1971), Herzberg, Mausner, and Synderman (1959), the needs theory by Maslow (1943) and Alderfer (1969), and the intrinsic motivation theory by Hackman and Oldham (1976). According to the discrepancy theory, dissatisfaction derives from the discrepancy between given jobs and individuals' values, beliefs, desires, and perceptions of desirable jobs. According to the equity theory (e.g., Adams (1963)), satisfaction derives from the balance between individually recognized input regarding the job and its results.

In addition, since the concept of job satisfaction is associated with a variety of influencing factors related to job and job performance, the factors affecting job satisfaction have constantly been discussed. A representative study by [33] classified internal psychological and external physical motivation as motivations affecting job satisfaction. The internal psychological motivation explains a sense of achievement, recognition, and job content, while the external physical motivation involves wage and working conditions.

On the other hand, Smith, Kendal, and Hulin [34] suggested the Job Description Index (JDI), which evaluates job satisfaction, specifically using the five areas of job, rewards, promotion, coworker, and boss. The Minnesota Satisfaction Questionnaire (MSQ) suggested by [35] examined influencing factors, such as rewards, a sense of independence, boss, human relationships, and working conditions. Ref. [36] developed the Job Satisfaction Survey (JSS) and suggested 36 influencing factor indicators in nine areas of rewards, promotion, boss, additional benefits, recognized rewards, operational process, coworkers, job characteristics, and communication.

Previous studies on job satisfaction have largely examined the impacts of job satisfaction at an individual level, such as wage and job turnover, and their impacts at a group level, such as group commitment and group performance. For instance, Furnham et al. [37] introduced the Big Five Personality Traits, including nervousness, extroversion, openness, friendliness, and integrity, to explain the impacts of personal characteristics on job satisfaction.

Furthermore, Millette and Gagnè [38] and Huang and Van de Vliert [39] examined the impacts of motivation on job satisfaction. On the other hand, the research on the impacts of job satisfaction has identified that individual motivations are likely to be related to pride and loyalty to an organization, revealing that they can ultimately influence not only an individual's job performance, but also group productivity and efficiency [40,41]. Based on the meta-analysis of 300 research results, Judge et al. [42] also found that job satisfaction has a positive effect on job performance.

One of the important aspects in discussing job satisfaction is economic rewards, since money is the most frequently-cited reason for employment [43]. In the previous studies, monetary factors have been continuously pointed out as quite significant in job satisfaction.

Likewise, a concept of job satisfaction related to economic rewards, including wage, is pay satisfaction. Heneman and Schwab [44] suggested the Pay Satisfaction Questionnaire by dividing pay satisfaction into four categories of pay level satisfaction, welfare satisfaction, pay rise satisfaction, and pay system satisfaction. Specifically, wage level is found to have a strong correlation with wage satisfaction, considering that wage satisfaction affects the overall job satisfaction [34]. As such, a number of studies have recognized its importance in evaluating job satisfaction [45,46]. On the other hand, international comparative studies have shown that the correlation between income per capita and life satisfaction tends to decrease in developed countries. In this regard, the effects of wage on life satisfaction and a sense of happiness have been widely examined at national or micro-individual levels. However, the effects of actual wage on job satisfaction rather than wage satisfaction have not been significantly studied [47]. Furthermore, Currall et al. [48] reported that pay satisfaction at an individual level can predict performance and influence group satisfaction as well.

In this regard, a variety of factors are multi-dimensionally combined in job satisfaction. With the emphasis on quality of life, happiness, and wellbeing of individuals and a society, job satisfaction cannot be overlooked by employees as well as employers. In addition, the lack of a comprehensive analysis on the causal relationship between wage, job satisfaction, and performance calls for more attention to its necessity. As the influence between job satisfaction-related factors can be differently applied to a particular job and organization, a variety of environmental characteristics should be considered. Therefore, this study aims to examine the impacts of pay on job satisfaction and job performance, using a particular job group case of 'doctoral researchers'.

Hypothesis 3 (H3). *Pay has a positive effect on job satisfaction.*

Hypothesis 4 (H4). *Pay has a positive effect on job performance.*

Hypothesis 4-1 (H4-1). *Pay has a positive effect on research performance.*

Hypothesis 4-2 (H4-2). *Pay has a positive effect on patent performance.*

Hypothesis 5 (H5). *Job satisfaction has a positive effect on job performance.*

Hypothesis 5-1 (H5-1). *Job satisfaction has a positive effect on research performance.*

Hypothesis 5-2 (H5-2). *Job satisfaction has a positive effect on patent performance.*

3. Method

3.1. Research Model

Based on the previous research, a research model was established to analyze the influence between job mismatch, job satisfaction, and individual job performance. Job mismatch focused on skill mismatch. Many studies on job disagreement have been focused on the analysis of over-education or under-education, which can be described as education mismatch. There is a dearth of literature on skill mismatch, and as such, it was necessary to study this [49]. Hence, the term 'skill mismatch' is very broad, which includes various concepts, such as skill gaps, skill shortages, and skill obsolescence. Accordingly, in this study, the independent variable 'job mismatch' was examined by focusing on skill mismatch. Skill mismatch is the gap between the individual capacity perceived by the Ph.D. workforce and the current job requirements. First, the effects of job mismatch of the Ph.D. workforce on wage and job satisfaction were analyzed. Then, the effects of pay level and job satisfaction on job performance were analyzed. Finally, the effects of pay on job satisfaction were analyzed.

3.2. Samples and Method

The subject of the study is the Ph.D. workforce. The survey data used in the analysis is the '2013 Ph.D. Research in Korea', which provides the sampled micro-data on the Ph.D. workforce, education, jobs, achievements, and international mobility of Ph.D. holders in Korea. The survey has been regularly conducted by the Institute for Science and Technology Policy (STEPI), of which credibility is guaranteed from the national statistical data specified in the National Approval Statistics Survey since 2011. The subject samples include Ph.D. holders who were residing in Korea in 2012 at the time of survey and were limited to those who were currently working and able to respond to the analysis variables, and had working experience as a researcher. The total number of the survey respondents from the data collection to refinement process is 2273. The general characteristics of the respondents are shown in Table 1. For the data analysis, SEM (structural equation modeling) applying SPSS 22.0 and AMOS 21.0 were used.

Table 1. The characteristics of the respondents.

Characteristics		N (%)	
Gender	Male	2019	(88.8)
	Female	254	(11.2)
Age	20 s	1	(0)
	30 s~40 s	533	(23.4)
	50 s~60 s	1608	(70.7)
	over 70 s	131	(5.8)
Major	Science	429	(18.9)
	Technology	1005	(44.2)
	Medical science	213	(9.4)
	Agriculture	115	(5.1)
	Social Science	362	(15.9)
	Humanities	149	(6.6)
Organization	Private	477	(21.0)
	Public	485	(21.3)
	University	1209	(53.2)
	NPO (Non Profit Organization)	65	(2.9)
	Etc.	37	(1.6)

3.3. Measuring Instruments

The dependent variables estimated the respondents' academic achievements, such as the number of publications in domestic and international journals, as well as practical achievements, such as the number of patent registrations and applications. Job mismatch, as the independent variable, was examined by focusing on skill mismatch; skill mismatch was estimated as the cognitive discrepancy between the quality and capacity in 17 items recognized by individuals at the time of receipt of their doctoral degree and those required by the job. The evaluation of the level of job mismatch can be classified into perceived fit and actual fit depending on the measurement method [50]. The perceived fit is estimated based on the job fit evaluation from an individual's current job. The actual fit is evaluated based on the individual's characteristics and job characteristics. The actual fit estimates the degree to which the two measures correspond to each other. The perceived fit has an advantage of explaining individual behaviors on the individual cognitive basis [51,52], while the actual fit enables us to speculate independent characteristics of individuals and the job environment as well as make more objective estimates compared to the perceived fit [6]. This study applied the measures of the perceived fit based on the questionnaire regarding how well individual characteristics, such as job, academic background, skills, and major, evaluated by themselves correspond to the job. Job satisfaction, as the independent variable and parameter, utilized the evaluation results from 10 items, including environment, region, accountability, and autonomy. The operational definitions for each variable are described in Table 2.

Table 2. The dimension.

Dimension		Explanation	Variables
Job mismatch		The gap between the qualities and capacities of individuals recognized at the time of doctoral degree acquisition versus the qualifications and capacities recognized as necessary for the current job	MISMATCH
Pay		Current annual salary	ln_PAY
Job satisfaction		Rated on a 5-point Likert scale of satisfaction on 10 items in total: Welfare, job security, geographical location, working environment, promotion opportunities, intellectual stimulation, level of responsibility, level of independence, social contribution, social status	JOBSATIS_1~JOBSATIS_10
Performance	Research performance	Publications in domestic and international journals, translation works	ln_OUT, ln_IN, ln_CNT
	Patent performance	Patent applications, registration outcomes	ln_PATENTCNTln_PATENTRCNT

4. Findings and Discussion

4.1. Factor Analysis and Reliability Testing

Prior to analyzing the structural equation, an exploratory factor analysis (EFA) was conducted. As a factor extraction method, principle component analysis was performed, which were extracted based on unique values to simplify the factorial load value. The oblimin oblique factor rotation method was adopted on the basis of paper records and the previous studies on the correlation between the patents. According to the analysis result, the criterion to judge the model fit was found to be higher than 0.8 from the KMO (Kaiser–Meyer–Olkin) test, and the Bartlett's test confirmed the appropriateness. Meanwhile, the communality of each variable was generally higher than 0.5, which was considered to be a suitable variable.

The factor analysis revealed in Table 3, that the cumulative variance explanation power was 71.96%. The variance explanation power of patent performance was 44.61% and the variance explanation

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power of research performances was 27.34%, respectively. The Cronbach's α value was 0.516 for research performance and 0.854 for patent performance, making the factor analysis results reliable.

Table 3. The factor analysis.

Dimension		Factor Loading	Communality	Eigen Value	Cumulative	Cronbach's α
Research performance	OUT	0.651	0.516			
	IN	0.331	0.735	1.367	27.34	0.516
	CNT	0.041	0.720			
Patent performance	PATENTCNT	0.901	0.823			
	PATENTRCNT	0.893	0.804	2.231	44.61	0.854
KMO = 0.606, Bartlett's = 3263 ***						

Notes: *** $p < 0.001$.

According to exploratory factor analysis results and the Confirmatory Factor Analysis (CFA) on job satisfaction with the latent variable was found to be relatively unsatisfactory. The Chi-square (χ^2) value and *p* value were 18,222.45 (df = 87) and 0.000, respectively. The GFI value was 0.814; the NFI value was 0.838; the IFI value was 0.802; the TLI value was 0.838; the CFI value was 0.865; and the RMSEA value was 0.094. Both significance testing results between each factor and observation variable were significant at the 99% confidence level, while the construct reliability and variance extracted index were also found to embrace the intensive validity and discriminant validity. The construct validation and variance extracted index were found to have the intensive validity and discriminant validity. The validity and validity of the construct validation and variance extracted index were also significant. However, the Squared Multiple Correlation value was set up by eliminating items, such as geographical location satisfaction and translation work performance, without the conceptual validity among the observed variables to increase the model fit.

According to the results of Confirmatory Factor Analysis (CFA) on the modified model, the Chi-square (χ^2) value was 804.52 (df = 60); the *p*-value was 0.000; the NFI value was 0.932; the IFI value was 0.912; the TLI value was 0.918; the GFI value was 0.916; the CFI value was 0.937; and the RMSEA value was 0.074, indicating that all the model fits improved in comparison with the original model (Table 5). The results of the significance test between each factor and the observation variables were also found to be significant. The construct reliability and variance extracted index by each factor were also found to be high, indicating that the intensive validity and discriminant validity were verified. The concept validity considered as the standardized coefficient value of the observed variables was confirmed as well

4.2. Structure Equation Analysis Results

Based on the results of the measurement model analysis, a path model and a structure equation analysis model were set up to examine the effect of job mismatch on wage, job satisfaction, and research and patent performance (Figure 1).

As for the analysis method, the covariance structure analysis was conducted to verify the model fit, and the maximum likelihood was applied to the model to speculate (Table 4). As a result of the analysis, the model fit was found to be eligible for accepting the analysis model. Specifically, the Chi-square (χ^2) value was 1300.336 (df = 112), and the *p*-value was 0.000. The GFI (0.935), AGFI (0.901), and IFI (0.909), which was the absolute fit index, indicated that the level of model error, which was above 0.9, confirmed the appropriateness, although it was not perfect. On the other hand, the NFI (0.902) and CFI (0.909) values, which measured the relative fit index, enabled us to obtain a generally acceptable level of the model fit.
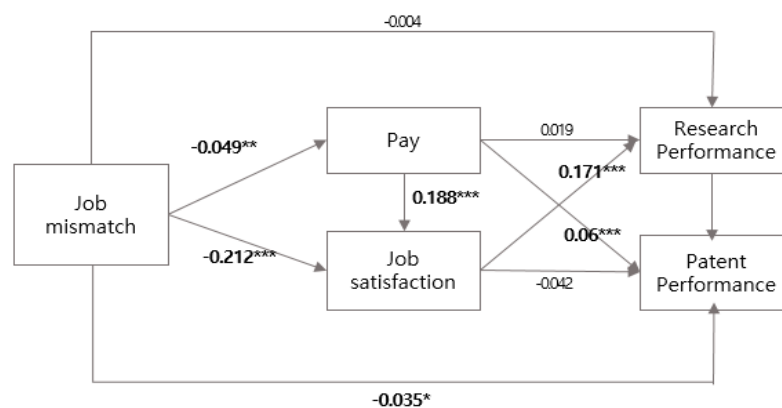
Table 4. The model fit.

Model Fit	Absolute Fit Index				Relative Fit Index	
	GFI	AGFI	IFI	RMSEA	NFI	CFI
	0.935	0.901	0.909	0.063	0.902	0.909

The analysis results are shown in Table 5 and Figure 1. First, the effect of job mismatch level on wage and job satisfaction was found to be significant, and thus, Hypothesis 1 was supported. In the 95% confidence level, higher job mismatch negatively affected wages, while higher job mismatch negatively affected job satisfaction at the 99% confidence level. Second, job mismatch had no significant effect on research performance, while it negatively affected patent performance at the 90% confidence level, and thus, Hypothesis 2-1 was rejected and Hypothesis 2-2 was supported. Third, wage positively affected job satisfaction at the 99% confidence level, and thus, Hypothesis 3 was supported. Fourth, wage had no significant impact on research performance while having a significant effect on patent performance at the 99% confidence level, and thus, Hypothesis 4-1 was rejected and Hypothesis 4-2 was supported. Fifth, job satisfaction positively affected research performance at the 99% confidence level while having no significant effect on patent performance, and thus, Hypothesis 5 was supported and Hypothesis 5-2 was rejected.

Table 5. The Structure Evaluation Model analysis.

Path				Coefficients	Standardized Coefficients	S.E.	C.R.
Pay	←	jobmismatch	H1	−0.006	−0.049	0.002	−2.437 **
Job satisfaction	←	jobmismatch	H1	−0.018	−0.212	0.00	−9.902 ***
research	←	jobmismatch	H2	−0.637	−0.004	3.244	−0.196
patent	←	jobmismatch	H2	−3.980	−0.035	2.311	−1.722 *
Job satisfaction	←	Pay	H3	0.132	0.188	0.016	8.508 ***
research	←	Pay	H4	23.554	0.019	27.301	0.863
patent	←	Pay	H4	55.460	0.060	19.467	2.849 ***
research	←	Job satisfaction	H5	304.475	0.171	42.958	7.088 ***
Patent	←	Job satisfaction	H5	−54.357	−0.042	32.199	−1.688

* p < 0.10, ** p < 0.05, *** p < 0.001.

Figure 1. The SEM analysis. Note: * p < 0.10, ** p < 0.05, *** p < 0.001.

5. Conclusions and Implications

Recently, with the increasing accessibility to science and technology in all social sectors as exemplified in the fourth industrial revolution, the interest in 'human capital', the critical subject of creating and realizing new ideas, is on the rise. To contribute to enhancing the proper placement and effective utilization of highly educated professionals, this study examined the effects of job mismatch

on wage, job satisfaction, and performance of the Ph.D. workforce. The results and implications are as follows.

First, job mismatch of the Ph.D. workforce showed negative effects on pay and job satisfaction. It means that the larger the gap between the qualifications evaluated by the Ph.D. workforce themselves and the actual competencies required in the current job, the more negative the effect it has on the pay level and job satisfaction. In this regard, it was identified that there are negative effects of education mismatch on pay, as shown in a number of previous studies [53,54], and skill mismatch also has negative effects on pay. Considering that the majority of the survey respondents have a Korean doctoral degree, it implies a mismatch between the domestic Ph.D. human resource education system and the utilization demands for the highly educated on-site workforce. Efforts to seek a constant equilibrium between demand and supply of a highly educated workforce, such as necessary job and capacity of the doctoral level workforce required in the field, are crucial. A creative personnel system to make the most of the individual qualities and academic knowledge of the highly educated human resources placed in the right place should be fostered. In terms of job mismatch of the Ph.D. workforce, it has been pointed out that the inadequate job and actual utilization of the Ph.D. workforce, research conditions, and treatments lead to the deterioration of the national competitiveness, including a brain drain.

Second, the mediating effect of wage and job satisfaction on the relationship between job mismatch, wage level, job satisfaction, and performance of the Ph.D. workforce was found. Job mismatch has a significant effect on research performance and patent performance through wage and job satisfaction. As [40,41,55] have revealed the relationship between job satisfaction and performance, the case of Korea's highly educated workforce also has a relationship between job satisfaction and performance. Considering that researchers' individual achievements directly affect organizational competitiveness, organizations need to constantly manage job satisfaction for individual researchers. In addition, given that material and economic compensation, such as wage level, affects job satisfaction, which is further linked to job performance, the basic compensation structure, such as wage, should be established. Also, fostering research-centered culture and system development to secure the psychological and subjective satisfaction, such as responsibility and autonomy, is also needed.

Third, the necessity of focusing on differentiated research personnel management based on performance goals, such as research performance and patent performance, is suggested. The results of this study demonstrate that there were differences in the factors affecting research performance and patent performance. Job mismatch and wage did not significantly affect research performance, but did affect patent performance. Job satisfaction had a significant effect on research performance, but had no significant effect on patent performance. In other words, if the purpose of an organization is to promote a researcher's academic achievements, an incentive structure focusing on the psychological rewards, such as autonomy, independence, honor, and welfare, is needed. On the other hand, if it emphasizes patent performance, an economic compensation structure, such as wage, should be more important.

To summarize, this study analyzed the effect of fitness between job characteristics and personal characteristics on wage, job satisfaction, and performance in terms of individual-job fit, focusing on a particular group, 'the Ph.D. workforce', It is necessary to pay close attention to job fit when employing the highly educated Ph.D workforce. The significance of this study is to demonstrate that these efforts lead not only to individual economic compensation and job satisfaction, but, further, to economic achievements, such as research performance and patent start-up. In particular, considering that human resource, that is, human capital, is a key factor in the national competitiveness, this study provides a policy implication in creating an environment in which highly qualified human resource can fully exercise its competence and potentials in domestic fields.

Despite these findings and implications, this study has the following limitations. First, the study only analyzed the factors of the labor supply part of the Ph.D. workforce due to the limitations of data, and did not consider variables in accordance with the characteristics of the labor demand part, such as private institutions, public institutions, and universities. In addition, the study did not include the

factors of corporation size (sales, etc.) and organization culture that might influence individual job satisfaction and performance. Therefore, such multidimensional considerations and panel analysis with time series data are needed in future research. Future studies can explore the effective utilization of the Ph.D. workforce, including panel analysis, through the accumulation and comprehensive utilization of data related to Ph.D. workforce statistics and other related statistics. Finally, various qualitative and quantitative methodologies that can estimate job disagreement should be developed and verified.

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