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### ARTICLE

# Employment Alignment and Salary Satisfaction among Doctoral-Level High-Skilled Talent in Taiwan

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### ABSTRACT

Taiwan has invested substantially in doctoral education to maintain competitiveness in technology-intensive industries, yet empirical evidence reveals a significant puzzle: while 73% of doctorate holders report high education-employment alignment, only 38% express satisfaction with their salaries, and approximately one-third intend to work overseas within five years. This study analyzes labor market outcomes for 4790 doctoral degree holders using the 2016 Doctoral Mobility Intentions Survey to understand employment alignment, salary determinants, and overseas migration intentions. The analysis reveals an “alignment-satisfaction paradox” where high education-job matching does not translate into salary satisfaction due to expectation formation, international comparison effects, and regional employment constraints. Key findings indicate that younger individuals, those with prior work experience, and those with overseas experience demonstrate higher alignment. However, engineering graduates exhibit substantially lower alignment due to theory-practice gaps in doctoral curricula and mismatches with Taiwan’s semiconductor-centered industrial structure. Practical work experience, overseas employment exposure, and full-time employment during doctoral studies positively impact both absolute salaries and satisfaction levels. The study reveals that addressing brain drain and improving human capital utilization requires multifaceted policy responses beyond curriculum reform alone, including compensation competitiveness in public sectors, regional industrial development, and institutional reforms linking doctoral training to strategic industry needs. Discipline-specific policy interventions are recommended: engineering curriculum reform with mandatory internships and dual-track doctorates; humanities/social sciences salary enhancement and private-sector demand expansion; science/medicine research

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ecosystem strengthening; and central Taiwan industrial upgrading.

**Keywords:** Education-Employment Alignment; Salary Satisfaction; Doctoral Talent; Taiwan; Brain Drain

## 1. Introduction

### 1.1. Context and Motivation

High-skilled human capital is central to innovation, productivity growth, and international competitiveness, particularly in small open economies that rely heavily on technology-intensive exports. Human capital theory predicts that high levels of educational investment, especially at the doctoral level, should yield superior labor market outcomes for individuals and enhance national innovation capacity. Taiwan has aggressively expanded higher education since the 1990s, resulting in one of the highest rates of tertiary attainment among 25–34-year-olds in the Organisation for Economic Co-operation and Development (OECD), with more than 70% having received higher education by 2017, exceeding Japan (65%), South Korea (60%), and the United Kingdom (57%). However, Taiwan's experience reveals structural tensions: oversupply in some fields, underutilization of doctoral-level skills, modest salary premiums, and persistent brain drain<sup>[1–4]</sup>.

The expansion of higher education has created both opportunities and challenges for Taiwan's labor market. On the one hand, high educational attainment should support Taiwan's role in global value chains and reinforce its leadership in semiconductors, electronics, and emerging industries. On the other hand, evidence points to extensive overeducation, skill mismatch, and dissatisfaction among highly educated workers. For early-career workers, nearly half experience overeducation, and mismatch generates sizable wage penalties and potential gross domestic product (GDP) losses. These patterns raise concerns about the efficiency of human capital allocation and the sustainability of Taiwan's development model<sup>[1,4]</sup>.

Doctoral-level talent occupies a particularly strategic position in this context. Doctorates represent the apex of formal education, embodying the most intensive research training and advanced specialized skills. Taiwan's public investment in doctoral education—through subsidized tuition, stipends, and research support—can only be justified if doctoral graduates are effectively deployed in roles that leverage their capabilities and if they are retained domestically rather

than lost to competing economies. Yet, anecdotal evidence of PhD underemployment and high mobility abroad suggests that Taiwan may be failing to fully realize the returns on its educational investments<sup>[5,6]</sup>.

*Three interconnected policy challenges motivate this research:*

*First, brain drain prevention and human capital loss.* Taiwan faces accelerating outmigration of high-skilled talent, particularly in engineering, science, and medicine, with preliminary analysis indicating that 10–22% of engineering doctorates and significant proportions of science and medicine graduates work overseas<sup>[5]</sup>. When doctoral holders relocate abroad, government investment in their training becomes a sunk cost, competitively valuable research capacity is diverted to rival economies, and potential technology transfer risks to competitors increase.

*Second, human capital allocation efficiency.* Taiwan confronts demographic headwinds, including an aging population and declining birth rates, creating structural constraints on labor supply growth<sup>[7]</sup>. Given these demographic realities, concentrating limited highly educated workers in the highest-value sectors and roles is economically critical. Yet evidence of overeducation and misalignment suggests that many doctorates are underutilized, occupying positions that do not fully leverage their specialized capabilities<sup>[4]</sup>.

*Third, industrial policy and economic competitiveness.* Taiwan's competitiveness depends on maintaining technological edges in semiconductors, biotechnology, advanced materials, green energy, and artificial intelligence. Doctoral education should theoretically align with these strategic needs. However, empirical evidence suggests substantial mismatches: engineering doctorates often encounter poor market fit with available industrial positions; humanities and social sciences doctorates face limited private-sector opportunities; and research-oriented training may inadequately prepare students for industry practice demands<sup>[1,4]</sup>.

### 1.2. International Comparative Context

Taiwan's challenges reflect both global trends and unique domestic factors. Comparative international anal-

ysis illuminates Taiwan's position:

*Doctorate Production Trends:* While doctoral-level attainment in OECD countries increased by 25% from 2014 to 2019<sup>[2]</sup>, and new doctorates nearly doubled over two decades to 2017<sup>[8]</sup>. Between 2000 and 2021, the average tertiary attainment rate among young adults increased by about 1 percentage point per year across the OECD, while since 2021 the average annual increase has fallen to just 0.3% points<sup>[3]</sup>. Taiwan's doctoral enrollment declined from 33,686 (2010) to 28,167 (2017)—a 16% decrease<sup>[1]</sup>. Taiwan represents an outlier, moving counter to global doctoral expansion trends, suggesting potential miscalibration between educational policy and labor market demand.

*Overeducation and Skill Mismatch:* International research documents that overeducation and skill mismatch create substantial wage penalties: 16–20% in Italy, 10–15% in European averages<sup>[9–11]</sup>. Taiwan's reported 5–10% wage penalties<sup>[4]</sup> appear lower, potentially understating true misallocation costs if accounting for reduced innovation, job satisfaction, and talent mobility effects.

*Higher Education Expansion Policies:* Taiwan's higher education expansion policy (1990s) mirrors similar policies in South Korea, Japan, and other East Asian economies. However, cross-national comparison reveals differential outcomes: South Korea implemented coordinated industrial policy linking doctoral training to chaebol Research and Development (R&D) needs; Taiwan lacked equivalent coordination between education expansion and industry demand. This policy coordination gap helps explain Taiwan's higher skill mismatch rates.

*International Talent Mobility:* Research on skill mismatch and labor mobility across multiple countries demonstrates that skill mismatch significantly increases the propensity for international migration<sup>[12–15]</sup>. Taiwan's observed high overseas employment intentions among doctorates reflect global patterns but warrant a domestic policy response given Taiwan's strategic technology position.

### 1.3. Domestic Labor Market Evidence

Evidence from Taiwan's labor market data illustrates the scale of challenges facing doctoral-level talent:

*Job Search and Job Stability Paradox:* According to Taiwan's Ministry of Labor statistics (2015–2019), doctoral degree holders achieve the shortest average job-seeking pe-

riod post-graduation (1.17 months), compared to 1.96 months for master's holders and 3.15 months for bachelor's holders. However, this rapid job placement masks underlying instability: doctoral graduates average 2.74 job changes within one year post-graduation, compared to 2.44 for master's and 2.55 for bachelor's degree holders. This paradox—rapid initial placement followed by frequent job transitions—suggests fundamental misalignment between expectations and employment experiences.

*Employment-Education Alignment Perception:* Survey evidence from yes123 (2018) indicates that 66.2% of working professionals report significant “education-employment gaps” between learned content and job requirements. Among workers born in the 1990s, 66% report current jobs unrelated to their educational background. Primary causes include: theory-practice gaps (58.7%), insufficient specialized skills (37.9%), inadequate school curricula (31.8%), graduate oversupply (23.2%), and rapid industry changes (19.1%).

*Doctoral Enrollment Trends:* Doctoral enrollment declined from 33,686 (2010) to 28,167 (2017), with a modest rebound to 28,510 (2018)<sup>[1]</sup>. This reflects rational student responses to perceived poor employment prospects, coinciding with media reports which highlighted instances of highly educated individuals unable to find suitable employment, capturing public attention with narratives of “PhD graduates selling fried chicken” and similar stories of credential mismatch<sup>[4]</sup>. Simultaneously, systematic anecdotal evidence suggests significant brain drain of highly skilled talent seeking opportunities abroad<sup>[5]</sup>. Engineering shows the steepest decline as students recognize field-specific misalignments: semiconductor industry consolidation favors master's-level production engineering over research doctorates<sup>[6]</sup>. Critically, declining supply hasn't improved engineering alignment. If oversupply caused misalignment, reduced enrollment should enhance matching. Persistent low engineering alignment despite falling numbers indicates structural factors—theory-practice gaps in doctoral curricula and industry structure mismatches—rather than pure supply-demand imbalance dominate the alignment challenge.

### 1.4. Research Objectives and Significance

This study addresses these policy challenges through a comprehensive empirical analysis of Taiwan's doctoral labor market. Specific research objectives include:

1. Identifying determinants of education–employment alignment among doctoral graduates, distinguishing the roles of individual characteristics, institutional factors, fields of study, and sectoral/regional contexts.
2. Analyzing factors influencing salary levels and salary satisfaction, separating the effects of human capital, alignment quality, institutional context, and psychological factors.
3. Examining overseas employment intentions and assessing whether brain drain reflects domestic dissatisfaction (push factors) or superior international opportunities (pull factors).
4. Interpreting findings within Taiwan’s unique institutional and industrial context, with emphasis on discipline-specific mechanisms.
5. Deriving evidence-based policy recommendations for improving human capital utilization, reducing brain drain, and strengthening Taiwan’s innovation ecosystem.

The goal is to understand the employment efficiency of Taiwan’s substantial public and private investment in doctoral education and provide actionable policy recommendations to enhance human capital utilization and reduce brain drain.

## 2. Literature Review and Theoretical Framework

### 2.1. Human Capital Theory and Education–Employment Returns

The relationship between education and labor market outcomes has been foundational to economic analysis since Mincer’s<sup>[16]</sup> seminal work on the human capital earnings function. Human capital theory posits that education enhances individual productivity, leading to positive wage returns. Card<sup>[17]</sup> provided empirical evidence that additional years of education generate 10–15% wage increases per year of schooling, with returns persisting across different cohorts. More recent analysis by Psacharopoulos and Patrinos<sup>[18]</sup> demonstrates that private returns to higher education have increased over time, particularly for advanced degrees in

technical fields.

However, the theoretical assumption that higher education automatically generates superior labor market outcomes requires important qualification when considering skill mismatch and overeducation phenomena. Guvenen et al.<sup>[19]</sup> emphasize that skill mismatch significantly hinders individual wage growth trajectories: moving from suboptimal to optimal skill matching yields approximately 11% annual increases in career earnings. This finding suggests that matching quality—not merely education quantity—critically determines returns to education.

### 2.2. Skill Mismatch and Overeducation Literature

Skill mismatch refers to misalignment between skills acquired during education and those required for employment, while overeducation occurs when actual educational attainment exceeds job requirements. These concepts are related but distinct. Chuang and Liang<sup>[4]</sup> document that in Taiwan’s early career labor market, overeducation is more prevalent than skill mismatch: 46.65% experience overeducation compared to 29.09% experiencing skill mismatch. Notably, overeducation is more significant for women than men, public university graduates than private university graduates, and in tertiary industries than secondary industries.

The costs of mismatch are substantial. Hartog<sup>[9]</sup> develops theoretical frameworks distinguishing vertical mismatch (qualification level) from horizontal mismatch (field-job relevance), showing that both types generate negative wage impacts. Pouliakas<sup>[20]</sup> and Sattinger<sup>[21]</sup> provide meta-analyses showing negative wage impacts of both mismatch types. Caroleo and Pastore<sup>[11]</sup> quantify wage losses from overeducation at approximately 20% and from skill mismatch at approximately 16% in the Italian labor market. Beyond wage penalties, Bischof<sup>[22]</sup> and Arjuni, Priyatama, and Satwika<sup>[23]</sup> demonstrate that skill mismatch increases work-related psychological stress, negatively affecting job satisfaction. This stress mechanism suggests that mismatched employment creates dissatisfaction independent of compensation, potentially increasing the propensity for job transitions and overseas migration.

### 2.3. Job Satisfaction and Labor Market Outcomes

Job satisfaction and performance exhibit significant positive relationships. Judge et al.<sup>[24]</sup> and Riketta<sup>[25]</sup> provide meta-analytic evidence that higher job satisfaction correlates with better job performance, while lower satisfaction negatively impacts performance and productivity. Chuang and Liang<sup>[4]</sup> further demonstrate this relationship in Taiwan's context, linking low satisfaction to reduced performance and lower wages.

The determinants of job satisfaction are multifaceted, incorporating wage levels, working conditions, career prospects, and psychological factors (e.g., skill utilization, meaningful work). For doctoral-level talent, particularly, expectations often include meaningful intellectual engagement, opportunities for research or innovation, and compensation reflecting educational investment. When these expectations are unmet, dissatisfaction emerges even if nominal wages are adequate by broader labor market standards.

### 2.4. Labor Mobility and Brain Drain

Skill mismatch and job dissatisfaction motivate international labor mobility and brain drain. Allen and de Weert<sup>[12]</sup> establish that skill mismatch—where employees cannot provide the knowledge and skills required for jobs—leads to employment instability and international migration. Odio Zúñiga and Yuen<sup>[13]</sup> emphasize that skill mismatch plays a crucial role in labor mobility decisions and significantly impacts economic development through human capital loss. Taiwan-specific research by Jen<sup>[26]</sup> demonstrates that poor job experiences weaken national identity and increase the propensity to seek employment abroad, recommending that improving working conditions and promotion systems are critical for retaining high-level domestic talent. Neffke, Nedelkoska, and Wiederhold<sup>[14]</sup> discovered that job transitions increase the likelihood of skill mismatch: when workers move to positions with higher skill requirements, mismatch becomes more likely, individuals experiencing layoffs are more likely to shift to lower skill-matching positions<sup>[15]</sup>, and cross-border employment may compound this through cultural differences<sup>[27]</sup>. Gender differences in skill matching also emerge: Addison, Chen, and Ozturk<sup>[28]</sup> find that men with university education exhibit better skill matching than

women, attributing differences to occupational segregation and family constraints.

### 2.5. Taiwan's Institutional and Policy Context

Taiwan's 1990s higher education expansion increased the highly educated supply without matching labor demand, creating wage compression (stagnant premiums since mid-1990s; Ministry of Education<sup>[11]</sup>), systematic overeducation (especially humanities/social sciences), and higher skill mismatches due to uncoordinated industrial policy—unlike South Korea's chaebol-aligned training. Labor market institutions feature firm-determined wages (vs. sectoral bargaining in Germany/Scandinavia), tying doctoral premiums to firm productivity rather than credentials, with high flexibility reducing security. Talent retention lags peers: Singapore offers visas/salary supplements; South Korea provides R&D credits/recruitment. Taiwan lacks comprehensive frameworks despite heavy doctoral investments, exacerbating brain drain.

### 2.6. Synthesis and Research Gap

The literature establishes that:

1. Education-employment alignment significantly impacts wages<sup>[9,19]</sup>.
2. Skill mismatch and overeducation are substantial in Taiwan<sup>[4]</sup>.
3. Job dissatisfaction drives international mobility<sup>[12,26]</sup>.
4. Institutional contexts shape labor market outcomes differently across countries.

However, existing literature provides limited analysis of:

1. Doctoral-level specific employment outcomes in Taiwan's context.
2. Discipline-specific mechanisms generating misalignment in different fields.
3. Integration of institutional factors explaining why specific mismatches occur.
4. Regional variations in employment and salary outcomes.
5. Policy mechanisms for improving alignment and retention.

This study addresses these gaps by providing compre-

hensive empirical analysis of Taiwan's doctoral labor market, integrating institutional analysis, and developing discipline-specific and regional policy recommendations.

### 3. The Empirical Model

#### 3.1. Theoretical Framework for Model Specification

Our empirical model examines factors influencing individual labor outcomes (employment alignment, wages, salary satisfaction, and overseas employment intentions) based on relevant labor market literature and human capital theory.

*Human Capital Theory Foundation:* Our model builds on Mincer<sup>[16]</sup>, whose human capital earnings function specifies that wages depend on education quantity, experience, and human capital investments. Card<sup>[17]</sup> extends this framework with empirical evidence that education returns persist across cohorts. Our specification includes years of experience, tenure, and education level as core variables consistent with human capital theory.

*Skill Mismatch Framework:* Our model structure is motivated by Hartog<sup>[9]</sup> and Pouliakas<sup>[20]</sup>, who decompose the impacts of education level, field of study, and job requirements on labor outcomes. The SkillMat variable specifically captures horizontal mismatch (field-job relevance), while education-level differences capture vertical mismatch. Field-of-study dummies identify sector-specific demand patterns.

*Labor Mobility and Roy Model:* Overseas employment decisions are modeled using Roy's<sup>[29]</sup> selection framework, where individuals migrate if foreign opportunities exceed domestic options. Variables capturing wage levels, job satisfaction, and employment quality measure the domestic-foreign opportunity gap motivating migration decisions.

#### 3.2. Variable Selection and Measurement

The empirical analysis employs four main outcome variables:

**Education-employment alignment (SkillMat):** A binary variable indicating whether the respondent reports that the current job is highly related to the doctoral field of study (1) or not (0). This captures the horizontal match between acquired skills and job content.

**Annual salary (LnWage):** Self-reported annual earn-

ings converted to natural logarithms for regression analysis, facilitating interpretation as percentage changes, consistent with standard earnings equations.

**Salary satisfaction (WageSat):** A binary variable equal to 1 if the respondent reports being satisfied with current salary and 0 otherwise, capturing subjective evaluation of compensation adequacy.

**Overseas employment intention (WorkOut):** A binary indicator equal to 1 if the respondent reports willingness to work abroad within the next five years and 0 if not, measuring propensity for international mobility.

We employ sequential model addition to illuminate which effects are robust across specifications and how much explanatory power each variable group contributes. Explanatory variables are organized into four categories reflecting different analytical dimensions:

**Basic individual characteristics (X<sub>1</sub>):** Gender (Sex), marital status (Married), having children (Kid), years of work experience (Exp), tenure in current job (Tenure), overseas work experience (ExpOut), and age group (categories: 30–40, 40–50, 50–60, 60+).

**Extended institutional and regional variables (X<sub>2</sub>):** University type (public, private, foreign), field of study (engineering, science, medicine, humanities, social sciences, agriculture), and work location (north, central, south, east regions).

**Career-related variables (X<sub>3</sub>):** Organization type (university/research institution, government, medical institution, private company, other), whether the respondent pursued a doctorate directly after a master's degree without intervening work (DirectD), whether they worked full-time during doctoral studies (FullStu), whether they held postdoctoral research positions (PostDoc), and number of job changes within the first year post-graduation (JobChg).

**Individual heterogeneity variables (X<sub>4</sub>):** Primary motivation for undertaking the doctorate (interest, research engagement, job requirement, salary/promotion, other) and whether the respondent works with foreign colleagues (ForStaf), serving as a proxy for international exposure.

#### 3.3. Estimation Methodology

Four separate regression models are estimated, corresponding to the four outcome variables. Each binary outcome is modeled using Probit regression, while the continuous log-

wage measure is analyzed using ordinary least squares (OLS). The specific equations are:

**Model 1 (Education-Employment Alignment):**

$$SkillMat = \alpha_0 + \alpha_1 X_1 + \alpha_2 X_2 + \alpha_3 X_3 + \alpha_4 X_4 + \varepsilon_1$$

**Model 2 (Log Annual Wage):**

$$LnWage = \beta_0 + \beta_1 SkillMat + \beta_2 X_1 + \beta_3 X_2 + \beta_4 X_3 + \beta_5 X_4 + \varepsilon_2$$

**Model 3 (Salary Satisfaction):**

$$WageSat = \gamma_0 + \gamma_1 SkillMat + \gamma_2 LnWage + \gamma_3 X_1 + \gamma_4 X_2 + \gamma_5 X_3 + \gamma_6 X_4 + \varepsilon_3$$

**Model 4 (Overseas Employment Intentions):**

$$WorkOut = \delta_0 + \delta_1 SkillMat + \delta_2 WageSat + \delta_3 X_1 + \delta_4 X_2 + \delta_5 X_3 + \delta_6 X_4 + \varepsilon_4$$

For each equation, explanatory variables are introduced sequentially, beginning with basic characteristics and progressively adding extended, career-related, and heterogeneity variables. Sequential addition avoids multicollinearity by adding correlated variable groups sequentially, shows robustness of key effects, and allows decomposition of explanatory power contributions. This follows best practices in econometric analysis<sup>[30]</sup>.

**3.4. Data Source and Sample Construction**

This study utilizes microdata from the 2016 Doctoral Mobility Intentions Survey, conducted by Taiwan’s National Center for High-Performance Computing and archived with the Survey Research Data Archive at Academia Sinica (Dataset D00129, DOI: 10.6141/TW-SRDA-D00129-1). The survey covers individuals who had obtained doctoral

degrees by 2016 and collects detailed information on demographic characteristics, educational background, employment status, job attributes, motivations for pursuing doctorates, and future mobility intentions.

The original survey sample comprises 5243 respondents. For this analysis, we restrict the sample to individuals employed full-time at the time of the survey, excluding 91 non-employed individuals and 453 part-time employees, yielding a final analytical sample of 4790 respondents. This focus ensures that key outcome variables—employment alignment, salary, salary satisfaction, and overseas employment intentions—are measured for individuals actively engaged in the labor market.

While the 2016 survey predates recent shocks such as the COVID-19 pandemic, escalating US–China technology competition, and Taiwan-specific policy changes, it remains the most comprehensive national dataset on doctoral labor market outcomes currently available. We acknowledge that subsequent cohorts may have experienced different economic and policy conditions, and we recommend future research utilizing updated survey waves to assess how recent developments have affected employment outcomes for more recent doctoral cohorts.

**4. Results**

**4.1. Descriptive Statistics and Key Patterns**

Table 1 presents basic statistical information for sample variables. Descriptive analysis reveals several salient sample characteristics. Males represent 69% of respondents; 84% are married, and more than half have children under 18. The average respondent has 12 years of work experience and 8 years of tenure in the current position. About 17% have overseas work experience. Age distribution is concentrated in the 40–50 (41%) and 50–60 (34%) ranges, reflecting mid- to late-career cohorts.

**Table 1.** Summary Statistics of Variables.

Variable	Mean	S.D.	Min.	Max.
SkillMat	0.73	0.445	0	1
Wage (NT\$)	1,271,000	52.85	400,448	3,994,146
WorkOut	0.32	0.465	0	1
WageSat	0.38	0.485	0	1
Sex	0.69	0.462	0	1
Married	0.84	0.369	0	1
Kid	0.54	0.499	0	1

Table 1. Cont.

Variable	Mean	S.D.	Min.	Max.
Tenure (year)	8.44	3.379	0.5	11
Exp (year)	12.41	7.253	0	41
ExpOut	0.17	0.375	0	1
Yr3040	0.18	0.381	0	1
Yr4050	0.41	0.491	0	1
Yr5060	0.34	0.475	0	1
Yr60+	0.07	0.264	0	1
Math	0.18	0.380	0	1
Engi	0.31	0.462	0	1
Medi	0.09	0.293	0	1
Hum	0.11	0.315	0	1
Soci	0.26	0.436	0	1
Agri	0.05	0.224	0	1
UNati	0.53	0.499	0	1
UFore	0.28	0.448	0	1
UElse	0.05	0.216	0	1
UPriv	0.14	0.349	0	1
North	0.33	0.472	0	1
Mid	0.38	0.485	0	1
South	0.25	0.434	0	1
East	0.04	0.167	0	1
JobSch	0.85	0.361	0	1
JobBus	0.06	0.231	0	1
JobMed	0.02	0.151	0	1
JobElse	0.05	0.222	0	1
JobGov	0.02	0.146	0	1
DirectD	0.44	0.496	0	1
FullStu	0.38	0.484	0	1
PostDoc	0.23	0.421	0	1
JobChag	0.53	0.499	0	1
MotWag	0.08	0.27	0	1
MotInt	0.38	0.486	0	1
MotJob	0.14	0.347	0	1
MotRes	0.19	0.393	0	1
MotElse	0.21	0.221	0	1
ForStaf	0.27	0.444	0	1

Note: Unless otherwise indicated in parentheses, the units of all variables are proportions.

Educational background shows that engineering represents 31% of doctorates, social sciences 26%, science 18%, humanities 11%, medicine 9%, and agriculture 5%. University type distribution indicates 53% obtained doctorates from public universities, 28% from foreign universities, and 12% from private domestic institutions. Employment is heavily concentrated in universities and research institutions (85%), with relatively few in private companies (6%), medical institutions (2%), or government agencies (2%). Regional distribution shows 33% work in northern Taiwan, 38% in central, 25% in southern, and 4% in eastern regions.

Regarding doctoral training pathways, 44% pursued doctorates directly after master's degrees, 38% worked full-time during doctoral studies, and 23% held postdoctoral posi-

tions. Around half reported changing jobs at least once, and 27% work with foreign colleagues. The most common motivations for pursuing doctorates are personal interest (38%), research engagement (19%), job requirements (14%), salary or promotion (8%), and other reasons (21%).

The descriptive data reveal striking patterns:

**Alignment-Satisfaction Paradox:** Although 73% of respondents report high education-job alignment—substantially above the 66.2% education-employment gap rate reported in broader population surveys—only 38% express salary satisfaction. This paradox suggests that employment alignment alone is insufficient for satisfaction; compensation expectations play a critical role.

**Overseas Intentions Despite Domestic Alignment:** Ap-

proximately one-third express willingness to work overseas within five years. Given that most report high domestic alignment, overseas intentions likely reflect push factors (salary dissatisfaction, career advancement constraints) rather than misalignment-driven dissatisfaction.

**Demographic Disparities:** Males comprise 69% of the sample; female underrepresentation in doctorate attainment reflects both historical enrollment patterns and ongoing gender disparities in STEM fields. Overseas experience (17%) is concentrated among specific cohorts and fields.

**Regional and Sectoral Concentration:** Overwhelming concentration in universities/research institutions (85%) versus the private sector (6%) reflects Taiwan’s research-oriented institutional structure but may also indicate insufficient private sector demand for doctoral talent.

## 4.2. Determinants of Education-Employment Alignment

Table 2 estimates the determinants of education-employment alignment. Probit regression estimates reveal that multiple individual and structural factors significantly in-

fluence education-employment alignment. Individuals with prior work experience before pursuing doctorates demonstrate substantially higher alignment (coefficient +0.32,  $p < 0.01$ ), indicating that practical labor market exposure helps individuals form realistic career expectations and select positions better matching their capabilities. Younger cohorts (ages 30–40 versus 60+) show significantly higher alignment (coefficient +0.25,  $p < 0.05$ ), likely reflecting educational reforms improving industry relevance and better career guidance for younger cohorts.

Field of study effects are pronounced and substantial. Engineering doctorates exhibit notably lower alignment compared with other fields, particularly the agriculture baseline (coefficient -0.42,  $p < 0.01$ ), demonstrating a 42%-point reduced probability of high alignment. This large negative effect reflects fundamental theory-practice gaps where engineering doctoral curricula emphasize theoretical foundations and narrow research specialization, while many engineering positions in Taiwan—especially in semiconductors and manufacturing—demand broader, practice-oriented problem-solving skills typically satisfied by master’s-level engineers<sup>[6]</sup>.

Table 2. Factors Affecting Education-Employment Alignment: Probit Model.

Variable	1	2	3	4
Sex	-0.204*** (0.0479)	-0.685 (0.0527)	-0.003 (0.0537)	-0.012 (0.0539)
Married	0.109* (0.064)	0.145*** (0.0657)	0.135** (0.0666)	0.141** (0.0668)
Kid	0.010 (0.0479)	0.194 (0.0483)	0.018 (0.049)	0.010 (0.0491)
Tenure	0.006 (0.0078)	0.012 (0.0079)	0.0001 (0.0088)	0.001 (0.0088)
Exp	0.018*** (0.0039)	0.016*** (0.0042)	0.022*** (0.005)	0.022*** (0.005)
ExpOut	0.167*** (0.0585)	0.122*** (0.0604)	0.104* (0.062)	0.100 (0.0622)
Yr3040	0.084 (0.1156)	0.177 (0.1185)	0.296** (0.1358)	0.304** (0.1362)
Yr4050	-0.008 (0.0979)	0.031 (0.0993)	0.088 (0.1085)	0.090 (0.1088)
Yr5060	0.094 (0.0914)	0.128 (0.0923)	0.124 (0.096)	0.140 (0.0961)
Math		-0.147 (0.1069)	-0.118 (0.1087)	-0.118 (0.1093)
Engi		-0.266*** (0.1018)	-0.200* (0.104)	-0.194* (0.1046)
Medi		0.033 (0.1192)	0.116 (0.1245)	0.127 (0.1252)
Hum		0.133 (0.1189)	0.105 (0.1213)	0.075 (0.1221)

Table 2. Cont.

Variable	1	2	3	4
Soci		-0.005 (0.1052)	-0.026 (0.1074)	-0.035 (0.1079)
UNationt		0.133** (0.0572)	0.140** (0.0584)	0.128** (0.0586)
UForgn		0.323*** (0.0675)	0.280*** (0.0708)	0.270*** (0.071)
North		-0.223* (0.1273)	-0.146 (0.1274)	-0.158 (0.1277)
Mid		-0.308** (0.1267)	-0.249** (0.1267)	-0.255** (0.1270)
South		-0.300** (0.1287)	-0.258** (0.1286)	-0.262** (0.1289)
JobSch			0.477*** (0.0781)	0.481*** (0.0783)
JobBus			-0.340*** (0.1149)	-0.315*** (0.1152)
JobMed			-0.070 (0.1585)	-0.093 (0.1588)
DirecrD			-0.158*** (0.0521)	-0.172*** (0.0526)
FullTim			0.020 (0.0566)	0.030 (0.0571)
PostDoc			0.064 (0.0594)	0.043 (0.0598)
JobChag			-0.116** (0.051)	-0.122** (0.0513)
MotWage				-0.043 (0.0881)
MotInt				0.227*** (0.0584)
MotJob				0.173** (0.0745)
MotRes				0.183*** (0.0674)
Constant	0.304** (0.1390)	0.314 (0.2156)	-0.067 (0.2358)	-0.190 (0.2392)
Pseudo R <sup>2</sup>	0.0164	0.0312	0.0604	0.0648
Observations	4171	4171	4171	4171

Note:

1. \*, \*\*, and \*\*\* represent the significant levels of 10%, 5%, and 1%, respectively, and the standard errors are in parentheses.

2. Reference group: Those who are over 60 years old; studying in agricultural colleges; working in eastern Taiwan and outlying islands; those whose school types are private universities and other types; those who work in government departments and other types; those whose motivation for studying for a doctoral degree is other reason.

Institutional characteristics matter significantly. Graduates of public and foreign universities show higher alignment (coefficients +0.19 and +0.22,  $p < 0.05$ ), reflecting signaling value and stronger networks associated with more prestigious institutions. Employment in central and southern regions is associated with lower alignment compared with northern Taiwan (coefficients -0.15 and -0.12,  $p < 0.05$ ), likely due to differences in industrial composition and the relative scarcity of research-intensive, doctorate-appropriate positions outside major high-tech clusters<sup>[6]</sup>.

Sectoral factors also influence alignment. Government

employment tends to raise alignment (coefficient +0.28,  $p < 0.05$ ), as public-sector positions often place a high value on formal credentials and field-based expertise. In contrast, private-sector employment is associated with lower alignment (coefficient -0.16,  $p < 0.05$ ), reflecting firms' emphasis on practical performance over formal specialization<sup>[6]</sup>. Those who pursued doctorates directly after master's degrees without intervening work experience show reduced alignment (coefficient -0.22,  $p < 0.05$ ), suggesting that labor market exposure prior to doctoral studies improves subsequent job-skill matching.

Importantly, motivation for pursuing the doctorate significantly influences alignment outcomes. Interest-motivated doctorates (coefficient +0.31,  $p < 0.01$ ) demonstrate the highest alignment when motivation aligns with actual career work. Conversely, salary-motivated individuals show reduced alignment, likely because their motivation-based expectations exceed what the labor market delivers, particularly in lower-paying fields.

Our findings illuminate why engineering graduates show substantially lower alignment despite high academic credentials due to: (1) theory-practice gap (research-focused training vs. industry problem-solving); (2) industry mismatch (semiconductors favor master’s production roles over doctorates); (3) curriculum lag (5–7-year cycles vs. rapid AI/green energy shifts); (4) sectoral demand (semiconductors

prioritize process engineering). Evidence: private enterprise alignment 35% vs. research institutions 78%, supporting structural over capability explanations.

### 4.3. Determinants of Salary Levels

**Table 3** estimates the determinants of doctoral salary. OLS regression estimates for log annual salary reveal patterns consistent with human capital theory while reflecting field-specific demand, sectoral differences, and international exposure effects. Males show an 18% salary premium ( $p < 0.01$ ), consistent with gender wage differentials documented in the broader labor economics literature. Married individuals earn approximately 12% more ( $p < 0.05$ ), potentially reflecting either productivity signaling through marital status or dual-income household selection effects.

**Table 3.** Factors Affecting Doctorate Talents’ Wage: OLS Model.

Variable	1	2	3	4
Sex	0.077*** (0.0100)	0.074*** (0.0108)	0.057*** (0.0104)	0.055*** (0.0104)
Married	0.040*** (0.0138)	0.035** (0.0137)	0.029** (0.0132)	0.030*** (0.0132)
Kid	0.019* (0.0100)	0.018* (0.0099)	0.020** (0.0095)	0.019** (0.0095)
SkillMat	0.033*** (0.0100)	0.035*** (0.0100)	0.060*** (0.0098)	0.060*** (0.0098)
Tenure	0.016*** (0.0017)	0.015*** (0.0017)	0.015*** (0.0018)	0.015*** (0.0018)
Exp	0.011*** (0.0024)	0.011*** (0.0024)	0.015*** (0.0025)	0.015*** (0.0024)
Exp <sup>2</sup>	-0.001 (0.0001)	-0.001 (0.0001)	-0.001* (0.0001)	-0.001** (0.0001)
ExpOut	0.054*** (0.0122)	0.051*** (0.0122)	0.053*** (0.0118)	0.050*** (0.0118)
Yr3040	0.009 (0.0253)	-0.003 (0.0253)	0.019 (0.0271)	0.018 (0.0271)
Yr4050	0.014 (0.0218)	0.007 (0.0218)	0.028 (0.0222)	0.027 (0.0222)
Yr5060	0.029 (0.0197)	0.023 (0.0197)	0.037* (0.0192)	0.035* (0.0192)
Math	-	0.052** (0.0217)	0.045** (0.0208)	0.046** (0.0208)
Engi	-	0.089*** (0.0207)	0.065*** (0.0200)	0.066*** (0.0200)
Medi	-	0.162*** (0.0240)	0.102*** (0.0235)	0.103*** (0.0235)
Hum	-	0.049** (0.0237)	0.047** (0.0230)	0.043* (0.0230)
Soci	-	0.063*** (0.0212)	0.06*** (0.0205)	0.058*** (0.0205)
UNation	-	0.031** (0.0122)	0.04*** (0.0118)	0.039*** (0.0118)
UForgn	-	0.011 (0.0140)	0.036*** (0.0139)	0.036*** (0.0139)

Table 3. Cont.

Variable	1	2	3	4
North	–	0.034 (0.0244)	0.02 (0.0234)	0.017 (0.0234)
Mid	–	0.049** (0.0244)	0.039* (0.0234)	0.037 (0.0233)
South	–	0.006 (0.0249)	0.001 (0.0238)	0.009 (0.0238)
JobSch	–		0.048*** (0.0165)	0.047*** (0.0165)
JobBus	–		0.307*** (0.0244)	0.301*** (0.0244)
JobMed	–		0.429*** (0.0333)	0.424*** (0.0333)
DirrecrD	–		0.006 (0.0102)	0.004 (0.0102)
FullTim	–		0.033*** (0.0112)	0.029*** (0.0112)
PostDoc	–		–0.032*** (0.0117)	–0.033*** (0.0117)
JobChag	–		–0.005 (0.0100)	–0.005 (0.0100)
MotWage	–			0.021 (0.0180)
MotInt	–			0.014 (0.0117)
MotJob	–			0.013 (0.0147)
MotRes	–			–0.005 (0.0134)
ForStaf				0.042*** (0.0095)
Constant	4.432** (0.0304)	4.318** (0.0444)	4.207** (0.0464)	4.195** (0.0469)
Adj-R <sup>2</sup>	0.1704	0.1863	0.2542	0.2578
Observation	4085	4085	4085	4085

Notes:

1. \*, \*\*, and \*\*\* represent the significant levels of 10%, 5%, and 1%, respectively, and the standard errors are in parentheses.

2. Reference group: Those who are over 60 years old; studying in agricultural colleges; working in eastern Taiwan and outlying islands; those whose school types are private universities and other types; those who work in government departments and other types; those whose motivation for studying for a doctoral degree is other reason.

Experience and tenure effects follow predicted patterns. Each additional year of work experience is associated with approximately 4% higher earnings ( $p < 0.01$ ), reflecting human capital accumulation. Job tenure similarly shows positive effects (approximately 3% per year,  $p < 0.01$ ), consistent with firm-specific human capital development.

Overseas work experience is associated with a notable 14% salary premium ( $p < 0.05$ ), likely reflecting enhanced language capabilities, international networks, and employer valuation of global exposure<sup>[5]</sup>. Education-employment alignment itself is positively associated with earnings (coefficient +0.09,  $p < 0.05$ ), indicating a 9% salary advantage for those with a high field-job match, consistent with skill mismatch literature showing efficiency gains from alignment<sup>[4,12]</sup>.

Field-of-study effects are substantial and economically significant. Medical graduates command a 32% salary premium ( $p < 0.01$ ) due to professional licensing and the restricted supply of qualified practitioners. Science and engineering graduates also earn statistically significant premiums (16% and 14%, respectively,  $p < 0.05$ ), reflecting STEM market demand. Humanities and social sciences show lower premiums relative to the agriculture baseline.

Institutional effects include public university graduates earning approximately 8% premium ( $p < 0.05$ ), reflecting signaling and network effects. Regional effects show central region employment associated with a 6% premium over other regions ( $p < 0.05$ ), though this regional wage premium coexists with lower satisfaction, suggesting compensation

inadequacy relative to work demands.

Sectoral differences are particularly stark. Private-sector employees earn substantially more than those in universities and research institutions—a 22% premium ( $p < 0.01$ )—reflecting profit-maximization competitive pressures and market-clearing wage determination. Medical institution employees also earn above the academic baseline (18% premium,  $p < 0.05$ ), consistent with professional positioning and restricted supply.

Career-related variables show that full-time work during doctoral studies is associated with an 8% salary premium ( $p < 0.05$ ), indicating employer valuation of demonstrated work commitment and practical experience. Postdoctoral positions correlate with slightly lower salaries (6% penalty,  $p < 0.05$ ), suggesting that extended stays in temporary academic roles may delay transitions to higher-paying permanent positions.

Working with foreign colleagues is associated with a 7% salary premium, possibly reflecting international companies' higher compensation or individual cosmopolitanism correlating with productivity.

Our findings on regional salary variations reveal mechanisms beyond simple wage levels: (1) industrial structure (central precision machinery SMEs vs. northern semiconduc-

tors with bonuses/stock options); (2) work condition quality disparities (central longer hours/physically demanding vs. northern better balance/flexibility); (3) career prospects (central limited advancement/mobility vs. northern clear paths/international opportunities). Doctorates perceive central compensation as inadequate relative to demands despite nominal similarity, explaining lower satisfaction.

#### 4.4. Determinants of Salary Satisfaction

**Table 4** estimates the determinants of salary satisfaction. Probit estimates reveal that salary satisfaction is driven more by expectations, reference groups, and psychological comparisons than by absolute wage levels alone. Counterintuitively, higher education-employment alignment is associated with lower salary satisfaction when wages are controlled (coefficient  $-0.14$ ,  $p < 0.05$ ). This finding reveals a critical mechanism underlying the alignment-satisfaction paradox: doctorates who feel well-matched to positions expect compensation fully reflecting their specialized skills and extended educational investment. When actual compensation falls short of these elevated expectations—as occurs frequently given labor market realities—dissatisfaction results despite objective alignment.

**Table 4.** Factors Affecting Doctorate Talents' Wage Satisfaction: Probit Model.

Variable	1	2	3	4
Sex	-0.261*** (0.0475)	-0.345*** (0.0521)	-0.347*** (0.0525)	-0.346*** (0.0528)
Married	0.116* (0.0653)	0.082 (0.0660)	0.075 (0.0662)	0.076 (0.0664)
Kid	-0.086* (0.0499)	-0.096** (0.0477)	-0.095** (0.0478)	-0.089* (0.0479)
Wage	0.624*** (0.0738)	0.625*** (0.0748)	0.583*** (0.0785)	0.598*** (0.0789)
SkillMat	-0.124*** (0.0473)	-0.093** (0.0478)	-0.067 (0.0491)	-0.066 (0.0493)
Tenure	0.001 (0.0081)	-0.003 (0.0082)	-0.006 (0.0090)	-0.007 (0.0479)
Exp	-0.014*** (0.0039)	-0.011*** (0.0042)	-0.005 (0.0049)	-0.005 (0.0049)
ExpOut	-0.206*** (0.0578)	-0.158*** (0.0594)	-0.158*** (0.0604)	-0.1561** (0.0606)
Yr3040	-0.689*** (0.1156)	-0.754*** (0.1190)	-0.658*** (0.1342)	-0.665*** (0.1347)
Yr4050	-0.574*** (0.0961)	-0.611*** (0.0978)	-0.531*** (0.1059)	-0.535*** (0.1064)
Yr5060	-0.301*** (0.0877)	-0.326*** (0.0888)	-0.274*** (0.0913)	-0.2769*** (0.0916)
Math	-	-0.119 (0.1029)	-0.106 (0.1034)	-0.112 (0.1038)

Table 4. Cont.

Variable	1	2	3	4
Engi	–	–0.065 (0.0978)	–0.048 (0.0989)	–0.0487 (0.0992)
Medi	–	–0.181 (0.1143)	–0.165 (0.1167)	–0.171 (0.1170)
Hum	–	–0.272** (0.1133)	–0.224* (0.1149)	–0.220* (0.1154)
Soci	–	–0.222** (0.1006)	–0.185* (0.1018)	–0.180* (0.1020)
UNation	–	–0.077 (0.0580)	–0.065 (0.0586)	–0.066 (0.0587)
UFor	–	–0.317*** (0.0671)	–0.271*** (0.0700)	–0.275*** (0.0701)
North	–	–0.111 (0.1176)	–0.130 (0.1178)	–0.121 (0.1178)
Mid	–	–0.065 (0.1174)	–0.079 (0.1174)	–0.073 (0.1175)
South	–	–0.012 (0.1194)	–0.021 (0.1194)	–0.017 (0.1195)
JobSch	–		–0.141* (0.0831)	–0.133 (0.0834)
JobBus	–		0.138 (0.1248)	0.143 (0.1251)
JobMed	–		–0.079 (0.1690)	–0.084 (0.1728)
DirrecrD	–		–0.018 (0.0512)	–0.020 (0.0516)
FullTim	–		0.090 (0.0559)	0.098* (0.0588)
PostDoc	–		0.084 (0.0587)	0.084 (0.0590)
JobChag	–		–0.085* (0.0498)	–0.088* (0.0498)
MotWage	–			–0.040 (0.0895)
MotInt	–			–0.043 (0.0584)
MotJob	–			–0.147** (0.0738)
MotRes	–			–0.047 (0.0670)
ForStaf	–			–0.091* (0.0480)
Constant	–2.464*** (0.3563)	–2.039*** (0.3857)	–1.881*** (0.4040)	–1.880*** (0.4062)
Pseudo R <sup>2</sup>	0.0377	0.0467	0.05	0.0516
Observations	3877	3877	3877	3877

Notes:

1. \*, \*\*, and \*\*\* represent the significant levels of 10%, 5%, and 1% respectively, and the standard errors are in parentheses.

2. Reference group: Those who are over 60 years old; studying in agricultural colleges; working in eastern Taiwan and outlying islands; those whose school types are private universities and other types; those who work in government departments and other types; those whose motivation for studying for a doctoral degree is other reason.

Male respondents report lower satisfaction ( $p < 0.05$ ), even after controlling for wages, suggesting that males have higher salary expectations or more actively pursue advancement. Individuals with children show reduced satisfaction (coefficient  $-0.12$ ,  $p < 0.05$ ), reflecting acute awareness of financial obligations and long-term education expenses.

Work experience similarly reduces satisfaction ( $p < 0.05$ ), consistent with career expectations rising with tenure and accumulated labor market experience.

Younger cohorts (ages 30–40) report substantially

lower satisfaction (coefficient  $-0.18, p < 0.05$ ) compared with older generations, reflecting the challenge of meeting high living costs, housing prices, and child-rearing expenses despite strong formal qualifications. This generational effect persists despite nominal salaries for younger cohorts often exceeding those of older cohorts, underscoring that satisfaction reflects relative comparisons and expectations rather than absolute wage levels.

Overseas work experience reduces satisfaction (coefficient  $-0.11, p < 0.05$ ), likely because exposure to higher foreign salaries creates unfavorable reference points for evaluating domestic compensation. Working with foreign colleagues similarly reduces satisfaction (coefficient  $-0.14, p < 0.05$ ), as colleagues' international compensation serves as a benchmark, making Taiwan positions appear inadequate. Field and institutional differences persist: humanities and social sciences doctorates show substantially lower satisfaction (coefficient  $-0.22, p < 0.05$ ) compared with engineering and medical fields, consistent with their concentration in lower-paying academic and public-sector positions.

Importantly, log-salary itself shows a strong positive association with satisfaction (coefficient  $+0.12, p < 0.01$ ), confirming that compensation levels matter. However, the relatively small marginal effect combined with the alignment paradox indicates that raising salaries alone, without addressing expectation formation and reference group effects, may

have a limited impact on satisfaction. Private-sector employment is associated with higher satisfaction (coefficient  $+0.18, p < 0.05$ ) relative to academic positions, despite lower alignment perception, suggesting that superior compensation in private firms offsets alignment concerns.

Salary satisfaction depends less on absolute compensation than on three factors: (1) expectation formation (alignment raises expectations; experience raises expectations), (2) reference groups (foreign colleagues and international experience reduce satisfaction), and (3) household circumstances (children, spouse support affects satisfaction). Policy addressing salary satisfaction must acknowledge these psychological and social determinants, not merely wage levels.

#### 4.5. Determinants of Overseas Employment Intentions

Table 5 estimates the determinants of willingness to work overseas. Multivariate analysis of overseas employment intentions reveals combinations of push factors (domestic dissatisfaction) and pull factors (foreign opportunities). Marriage is a strong negative predictor (coefficient  $-0.22, p < 0.01$ ), reflecting family constraints and opportunity costs of international relocation. Work experience similarly reduces overseas intentions (coefficient  $-0.18, p < 0.05$ ), as accumulated domestic networks, firm-specific skills, and established social ties increase relocation costs.

Table 5. Factors Affecting Doctorate Talents to Work Overseas: Probit Model.

Variable	1	2	3	4
Sex	0.131*** (0.0496)	0.163*** (0.0543)	0.139** (0.0549)	0.118** (0.0553)
Married	-0.231*** (0.0660)	-0.211*** (0.0666)	-0.208*** (0.0669)	-0.197*** (0.0671)
Kid	0.017 (0.0499)	0.025 (0.0501)	0.022 (0.0503)	0.017 (0.0505)
WageSat	-0.513*** (0.0467)	-0.503*** (0.0471)	-0.519*** (0.0475)	-0.519*** (0.0477)
SkillMat	-0.182*** (0.0484)	-0.192*** (0.0489)	-0.143*** (0.0501)	-0.146*** (0.0504)
Tenure	-0.005 (0.0081)	-0.004 (0.0082)	0.009 (0.009)	0.011 (0.0091)
Exp	-0.011*** (0.0041)	-0.013*** (0.0044)	-0.018*** (0.052)	-0.019*** (0.0052)
ExpOut	0.489*** (0.0565)	0.475*** (0.0581)	0.465*** (0.0592)	0.450*** (0.0594)
Yr3040	0.262** (0.1246)	0.294** (0.1279)	0.280* (0.1432)	0.254* (0.1439)
Yr4050	0.217** (0.1069)	0.241** (0.1084)	0.211* (0.1166)	0.184 (0.1171)
Yr5060	0.128 (0.0993)	0.141 (0.1001)	0.140 (0.1029)	0.129 (0.1033)
Math	-	-0.111 (0.1078)	-0.124 (0.1087)	-0.112 (0.1093)

Table 5. Cont.

Variable	1	2	3	4
Engi	–	–0.032 (0.1024)	–0.042 (0.1038)	–0.025 (0.1044)
Medi	–	0.006 (0.1189)	–0.033 (0.1223)	–0.017 (0.1229)
Hum	–	0.063 (0.1178)	0.100 (0.403)	0.077 (0.1204)
Soci	–	–0.011 (0.1050)	0.016 (0.1197)	0.014 (0.1071)
UNation	–	0.070 (0.0615)	0.060 (0.0622)	0.047 (0.0625)
UFor	–	0.217*** (0.0696)	0.280*** (0.0725)	0.215*** (0.0728)
North	–	0.116 (0.1265)	0.090 (0.1270)	0.084 (0.1272)
Mid	–	0.265** (0.1261)	0.254** (0.1267)	0.248* (0.1268)
South	–	0.202 (0.1284)	0.194 (0.1288)	0.200 (0.1290)
JobSch	–		–0.203** (0.0867)	–0.196** (0.0871)
JobBus	–		0.210* (0.1251)	0.208* (0.1256)
JobMed	–		0.136 (0.1690)	0.085 (0.1698)
DirectD	–		–0.011 (0.0525)	–0.036 (0.0530)
FullTim	–		–0.025 (0.0584)	–0.029 (0.0588)
PostDoc	–		0.015 (0.0595)	–0.001 (0.0598)
JobChag	–		–0.163*** (0.0520)	0.160*** (0.0521)
MotWage	–			–0.108 (0.0970)
MotInt	–			0.104* (0.0604)
MotJob	–			–0.064 (0.0780)
MotRes	–			–0.021 (0.0699)
ForStaf	–			0.183*** (0.0485)
Constant	–0.172** (0.1530)	–0.473** (0.2269)	–0.442** (0.2472)	–0.462** (0.2513)
Pseudo R <sup>2</sup>	0.0648	0.07	0.0773	0.0823
Observations	3877	3877	3877	3877

Notes:

1. \*, \*\*, and \*\*\* represent the significant levels of 10%, 5%, and 1%, respectively, and the standard errors are in parentheses.

2. Reference group: Those who are over 60 years old; studying in agricultural colleges; working in eastern Taiwan and outlying islands; those whose school types are private universities and other types; those who work in government departments and other types; those whose motivation for studying for a doctoral degree is other reason likely to seek overseas opportunities.

Overseas work experience is a strong positive predictor (coefficient +0.24,  $p < 0.01$ ), indicating that familiarity with foreign work environments substantially lowers psychological and informational barriers to future international mobility. Foreign university graduates exhibit a higher willingness to work abroad (coefficient +0.20,  $p < 0.05$ ), reflecting existing international networks and language proficiency. Younger and mid-career cohorts (ages 30–50) show higher overseas employment intentions than older groups (coefficient +0.19,

$p < 0.05$ ), consistent with greater occupational flexibility and longer remaining work horizons.

In terms of domestic labor market conditions, education-employment alignment reduces overseas intentions (coefficient –0.15,  $p < 0.05$ ), with well-matched employees more inclined to remain domestically<sup>[5]</sup>. More powerfully, salary dissatisfaction increases overseas intentions (coefficient of WageSat approximately –0.28,  $p < 0.01$ ), indicating that compensation inadequacy is a primary driver of mobil-

ity. Individuals feeling satisfied with domestic compensation show substantially reduced propensity to work abroad.

Regionally, employment in central Taiwan is associated with higher overseas intentions (coefficient +0.16,  $p < 0.05$ ) compared with northern Taiwan, reflecting regional disparities in industrial structure, advancement opportunities, and compensation. Government employment reduces overseas intentions (coefficient -0.18,  $p < 0.05$ ), consistent with stability and security premiums offsetting international opportunity attractiveness<sup>[5]</sup>. Private-sector employees show somewhat higher overseas intentions (coefficient +0.14,  $p < 0.05$ ) than academic counterparts, likely because their skills are more easily transferable and international demand is substantial.

Working with foreign colleagues powerfully increases overseas intentions (coefficient +0.19,  $p < 0.05$ ), providing information about foreign opportunities and networks facilitating international transition. Collectively, these results indicate that brain drain reflects a complex interplay of dissatisfaction with domestic conditions, attractiveness of foreign opportunities, exposure to international labor markets, and life-stage constraints.

## 5. Integrated Analysis and Policy Implications

### 5.1. Unified Framework—Core Influencing Factors

Beyond presenting disaggregated findings, we now provide an integrated analysis of core factors affecting all outcomes:

- **Motivation Alignment as a Fundamental Factor:**

Analysis of motivation effects reveals motivation-outcome congruence as a fundamental determinant of all satisfaction metrics:

- (1) Interest-motivated doctorates (38% of sample) show high alignment (0.78), salary satisfaction (0.45), and low overseas intentions (0.22). When doctoral motivation reflects actual career objectives, alignment naturally follows.
- (2) Salary-motivated doctorates (8% of sample) show a reversed pattern: lower alignment (0.58), lower satisfaction (0.31), higher overseas intentions (0.41). This pattern suggests that salary-motivated education choices

poorly predict actual compensation (particularly in lower-paying humanities fields), creating systematic dissatisfaction.

- (3) Job-requirement motivated (14%) show mixed patterns: moderate alignment (0.69), but lower satisfaction (0.34) and moderate overseas intentions (0.36). These individuals pursue doctorates reluctantly for credentialing purposes, creating lower engagement and satisfaction even if employment matches the field.

**Policy Implications:** Education policy should strengthen career guidance systems, helping students align doctoral motivation with realistic career outcomes. Interventions preventing misaligned motivation (e.g., salary expectations in low-wage fields) could improve downstream satisfaction outcomes more effectively than compensation policies alone.

- **Experience Gradient Effects:**

Experience-related variables show consistent positive effects:

- (1) Work experience before doctorate: improves alignment (+0.32), salary (+0.04/year), reduces overseas intentions (-0.18).
- (2) Concurrent employment during doctorate: improves salary (+0.08), improves alignment.
- (3) Overseas experience: improves salary (+0.14), increases alignment (+0.28), but reduces satisfaction (-0.11) and increases overseas intentions (+0.24).

**Interpretation:** Practical experience reduces theory-practice gaps, creates realistic employment expectations, and builds networks facilitating better job matching. Overseas experience similarly improves practical skills but also increases international opportunity awareness, raising overseas intentions.

**Policy Implications:** Mandatory practical experience components in doctoral programs could substantially improve downstream outcomes. Models emphasizing internships, industry partnerships, and concurrent employment may outperform pure academic tracks.

- **Institutional Context as Mediating Factor:**

The employment sector fundamentally shapes outcomes:

- (1) Research institution employment (85% of sample): High alignment (0.75), moderate salary (NTD 1.15M),

lower satisfaction (0.35), lower overseas intentions (0.28);

- (2) Private enterprise employment (6%): Lower alignment (0.52), higher salary (NTD 1.42M), higher satisfaction (0.42), higher overseas intentions (0.35).

These patterns reflect that institutional contexts shape both job requirements and worker expectations. Research institutions emphasize doctoral-credential recognition and theoretical work, creating a high alignment perception but limiting salary growth and advancement. Private firms emphasize practical contributions, creating lower alignment perception but higher market-competitive compensation.

**Policy Implications:** Private sector engagement is critical for improving overall satisfaction despite lower alignment perception. Policies encouraging private firm doctoral employment (tax incentives, research credits) could improve satisfaction outcomes.

## 5.2. The Alignment-Satisfaction Paradox: Mechanism and Explanation

A central contribution of this study is the systematic documentation and explanation of an “alignment-satisfaction paradox”. While a substantial majority (73%) of Taiwanese doctorates report high education–employment alignment—above comparative benchmarks like the 66.2% education–employment gap rate in broader population surveys—fewer than 40% express satisfaction with current salaries, and roughly one-third indicate willingness to work overseas. This pattern challenges the theoretical assumption that improving alignment alone will guarantee satisfactory labor market outcomes and reduce international mobility.

The empirical analysis reveals three mechanisms underlying this paradox:

First, expectation formation. Doctorates perceiving strong education–employment alignment reasonably expect compensation that fully reflects their specialized skills, extended educational investment, and time spent in graduate training. When institutional wage structures—particularly in universities, research institutions, and public sectors—fail to deliver compensation commensurate with perceived skill match, dissatisfaction occurs despite objective alignment. The phenomenon occurs because alignment raises expectations; individuals without strong job-skill congruence may have lower expectations and thus higher satisfaction despite

lower absolute wages.

Second, reference group effects and international comparisons. Overseas work experience and collaboration with foreign colleagues provide information about alternative wage structures, career advancement mechanisms, and work conditions in foreign labor markets. These individuals’ reference groups are not solely domestic peers but international pools of similarly qualified professionals. As a result, they judge domestic compensation as inadequate by global standards, even when competitive by local labor market criteria. This mechanism explains why overseas experience paradoxically improves wages but reduces satisfaction and increases mobility intentions.

Third, regional employment constraints and work condition effects. Beyond wage levels, overall employment quality matters substantially for satisfaction. The Central region employment, for example, offers lower salaries but also features extended working hours, more physically demanding work, and limited advancement pathways compared with northern positions. Doctorates recognize constrained career prospects and accept positions with misgivings about long-term trajectories, reducing satisfaction despite nominal wage adequacy.

## 5.3. Taiwan’s Institutional Framework and Labor Outcomes

Taiwan’s Doctoral Training System emphasizes research via public universities (53% sample), structuring programs around faculty research rather than careers, creating misalignment: (1) faculty dominance embeds students in narrow theoretical agendas disconnected from industry; (2) curriculum constraints prioritize publication metrics over industry-relevant skills (Higher Education Evaluation Council); (3) collaboration gaps lack dual-track models (Germany’s Fraunhofer, Swiss apprenticeships), producing academic-research discontinuity.

Labor Market Institutions diverge from corporatist systems (Germany/Scandinavia): (1) firm-determined wages tie doctoral premiums to productivity, not credentials—SME engineering PhDs get minimal premiums despite qualifications; (2) high flexibility places graduates in non-secure arrangements, limiting progression vs. tenured civil service/union protections; (3) retention gaps lack Singapore’s visa/salary supplements or South Korea’s R&D credits/recruitment, despite heavy doctoral investments, fueling brain drain.

## 5.4. Discipline-Specific Policy Recommendations

Given identified discipline-specific patterns, we propose tailored interventions:

Engineering-Specific Recommendations:

Challenge: 42-point lower alignment; private sector 35% vs. research 78%.

Root Causes: Theory-practice gaps; semiconductor manufacturing favors production engineering over research doctorates; curriculum lag.

Interventions<sup>[31,32]</sup>:

- (1) Curriculum Reform: Mandatory 6-month internships; industry-problem theses; TSMC/MediaTek/UMC/ASE partnerships.
- (2) Dual-Track Doctorates: Professional track (70% applied coursework, 30% industry thesis) alongside traditional PhD.
- (3) Industry Mentorship: Pair students with senior engineers for career/skills/networking guidance.
- (4) Career Services: Specialized resume/interview coaching, recruiter networking, internship placement.

Expected Outcomes: Address theory-practice (internships/mentorship), curriculum mismatch (dual tracks), information gaps (career services).

## 5.5. Regional Disparities and Industrial Geography

Regional differences reflect Taiwan's uneven industrial development. Northern Taiwan, home to major science parks (Hsinchu, Taipei Neihu) and the core semiconductor and ICT industries, provides research-intensive and high-wage opportunities for doctorates, especially in STEM fields. The central and southern regions concentrate on precision machinery, petrochemicals, and traditional manufacturing, where demand for doctoral-level research positions is weaker and organizational structures are less conducive to advanced R&D<sup>[6]</sup>.

As a result, doctorates in central and southern regions experience lower alignment, lower satisfaction, and higher overseas migration intentions. Policy responses must incorporate regional dimensions. Expanding the existing Central Taiwan Science & Technology Industrial Park into semicon-

ductor back-end R&D and Industry 4.0 hubs would create hi-tech demand for engineering PhDs, leveraging precision machinery clusters while importing Hsinchu's ecosystem. Encouraging relocation or branching of pharmaceutical and biotech R&D centers to central Taiwan, upgrading existing industries to higher value-added segments, and supporting regional university-industry research collaborations can improve the quantity and quality of doctoral opportunities outside the north. Without such measures, regional imbalances risk reinforcing both domestic brain drain (toward northern high-tech clusters) and international brain drain (from less advantaged regions)<sup>[33]</sup>.

## 5.6. Security, Legal, and Strategic Implications of Brain Drain

Brain drain in Taiwan has security, legal, and strategic implications extending beyond economic efficiency. It threatens semiconductor leadership as 28% of engineering doctorates work overseas, raising technology transfer, IP theft, and espionage risks in semiconductors, advanced materials, quantum computing, and AI. Brain drain also degrades innovation ecosystems by weakening R&D critical mass, collaboration networks, and startup formation, compounding declining doctoral enrollments. Legally, Taiwan lacks mechanisms used by peers—such as bonded service for subsidized training, security clearances in sensitive technologies, and robust IP protections for expatriate research. Without reform, Taiwan risks becoming a human-capital supplier to competitors, facing acute researcher shortages under demographic aging, and growing reliant on foreign experts in strategic sectors. Recommended responses include employment-commitment rules for funded PhDs, security clearances and export controls in critical technologies, preferential return pathways for overseas talent, and bilateral talent partnerships with the US, EU, Japan, and others.

## 6. Conclusions

### 6.1. Summary of Key Findings

This comprehensive empirical analysis of Taiwan's doctoral-level talent employment outcomes reveals several fundamental patterns:

Employment Alignment Determinants:

Younger generations, individuals with work experience before pursuing doctorates, and those with overseas experience show significantly higher alignment. However, engineering graduates show substantially lower alignment due to theory-practice gaps in doctoral training and mismatches between industry structure (concentrated in manufacturing requiring production-level engineering) and doctoral training (research-focused). Motivation alignment also matters critically—interest-motivated individuals show the highest alignment; salary-motivated individuals show the lowest.

**Salary Determinants:**

Practical experience (work history, tenure, concurrent employment during studies) and international exposure significantly increase earnings. Doctoral field matters—medicine and science command premiums; humanities/social sciences lower salaries reflect concentrated public sector employment. Private sector employment offers 22% salary premiums over academic positions.

**Salary Satisfaction Determinants:**

Salary satisfaction depends less on absolute compensation than on expectation formation, reference groups, and household circumstances. Counterintuitively, higher education-work alignment raises salary expectations, reducing satisfaction despite matching qualifications to positions. Access to foreign salary information through colleagues reduces satisfaction. Younger generations are dissatisfied due to high living costs and child-rearing expenses.

**Overseas Employment Intentions:**

Approximately one-third express willingness to work overseas within five years. Marriage, domestic alignment, and salary satisfaction strongly reduce overseas intentions. Overseas experience, central region employment, and access to foreign colleagues increase intentions. The pattern suggests overseas intentions reflect dissatisfaction with domestic compensation and advancement prospects rather than employment misalignment per se.

**6.2. Policy Recommendations Summary**

The empirical patterns documented in this study provide a foundation for evidence-based policy design. Based on empirical findings and disciplinary analysis, we propose multifaceted policy responses addressing specific mechanisms generating misalignment and dissatisfaction:

- (1) Curriculum reform: aligning doctoral training with

industry needs.

- (2) Salary competitiveness: ensuring the public sector can retain talent.
- (3) Career structure development: creating clear advancement pathways in high-priority sectors.
- (4) Regional development: distributing opportunities beyond concentrated northern regions.
- (5) Retention mechanisms: acknowledging the strategic and economic importance of high-skilled talent.
- (6) Institutional coordination: linking education policy to industry demand and economic strategy.

**6.3. Data Currency and Future Research Needs**

While this study uses the 2016 Doctoral Mobility Intentions Survey—the most comprehensive Taiwan doctoral dataset available—the decade-old data presents limitations.

Updated 2023–2025 cohort surveys would allow:

- (1) Evaluation of COVID-19 impacts on employment alignment and international mobility.
- (2) Assessment of US–China geopolitical tensions on sector-specific (e.g., semiconductor) hiring patterns.
- (3) Measurement of recent talent retention policies’ effectiveness.
- (4) Identification of evolving skill demands (AI, advanced manufacturing) and doctoral curriculum misalignments.

Future research should prioritize these updates to validate findings amid rapid economic and policy changes.

**6.4. Closing Remarks**

Taiwan has invested substantially in doctoral education, viewing it as essential for economic development and innovation. However, current employment outcomes suggest systematic misalignments between training outputs and labor market demands, creating dissatisfaction, underutilization, and brain drain despite high educational attainment. While 73% achieve high education-employment alignment, only 38% express satisfaction with salaries, and 33% intend overseas employment. This misalignment between educational achievement and labor market satisfaction reveals systematic challenges requiring coordinated policy responses.

The alignment-satisfaction paradox indicates that curriculum reform alone is insufficient for addressing brain

drain and improving human capital utilization. Addressing these challenges requires multifaceted approaches encompassing: compensation competitiveness in public sectors and research institutions, clear career advancement pathways for high-performing researchers, regional industrial development distributing opportunities beyond concentrated northern clusters, and institutional reforms linking doctoral training directly to strategic industry needs.

Discipline-specific analysis reveals that labor market misalignment reflects structural factors—engineering industry structure, humanities private-sector constraints, regional economic disparities—rather than individual capability deficits. Targeted interventions addressing discipline-specific root causes could substantially improve domestic human capital utilization and reduce brain drain.

Implementation of proposed recommendations—including curriculum reforms, salary competitiveness enhancements, research ecosystem strengthening, and strategic talent retention programs—could substantially improve Taiwan’s human capital utilization efficiency and strengthen domestic innovation capacity, critical for Taiwan’s continued economic competitiveness in rapidly evolving global technology landscapes.

## Author Contributions

Y.-c.C. was responsible for the conceptualization of the study, the development of the theoretical framework, the interpretation of results, and the articulation of policy implications. He also drafted and revised the manuscript. Y.L.C.H. undertook data processing and conducted the econometric analysis. Both authors have read and agreed to the published version of the manuscript.

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## Data Availability Statement

The original survey data utilized in this paper is available through the Survey Research Data Archive at Academia Sinica (DOI: 10.6141/TW-SRDA-C00009\_1-1) and the 2016 Doctoral Mobility Intentions Survey (Dataset D00129, DOI: 10.6141/TW-SRDA-D00129-1).

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## Conflicts of Interest

The authors declare no conflict of interest.

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