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Regional Digital Technology Development Level, Job Satisfaction, and Job Burnout of Adult in-Service Learners

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ABSTRACT: *The rapid expansion of the digital economy is profoundly reshaping the pressure structure of the labor market and influencing the work motivation of adult in-service learners. Based on survey data from 302 students in adult continuing education, this study uses a hierarchical linear model to systematically examine the internal mechanism by which regional digital economy development level affects job burnout. The results show that regional digital economy development level has a significant negative impact on job burnout. Job satisfaction exerts a partial mediating effect between the regional digital economy development level and job burnout. Individual employability negatively moderates the negative impact of regional digital economy development level on job satisfaction. Heterogeneity analysis indicates that the facilitating effect of regional digitalization pressure on job burnout is more pronounced in groups with younger ages, lower incomes, and liberal arts backgrounds. The conclusions of this paper can provide theoretical references and empirical evidence for improving the occupational psychological well-being of adult learners in the context of the digital economy.*

Key words*: Individual employability, Job burnout of adult in-service learners, Job satisfaction, Regional digital technology development level.*

1. Introduction

The issue of job burnout has attracted widespread attention worldwide. In 2019, the World Health Organization (WHO) officially included job burnout in the International Classification of Diseases (ICD-11), defining it as an occupational phenomenon caused by the ineffective management of long-term work stress. Among the adult continuing education population, learners take on the dual roles of professionals and students, facing the superimposed pressure of work and study, and their job burnout problem is particularly prominent. Existing studies have shown that job burnout not only seriously impairs individual occupational performance and mental health (Maslach et al., 2001) but also exerts a far-reaching negative impact on organizational effectiveness and the accumulation of human capital in the labor market (Bakker & Demerouti, 2007). Therefore, an in-depth exploration of the causes of job burnout among adult in-service learners and its influencing mechanisms is of great value for formulating effective intervention measures.

At the same time, the rapid improvement of regional digital technology development level is bringing new pressures to the working environment of adult in-service learners. Digital transformation has accelerated the restructuring of skill demands in the labor market, exposing in-service workers to continuous pressure of skill updating and threats of occupational substitution (Autor & Salomons, 2018). Such pressures are particularly intense in regions with a high degree of digital technology penetration. Existing studies have shown that digital technology has a negative impact on the occupational psychological state of in-service workers (Tarafdar et al., 2007). Based on this, there may be a systematic

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correlation between regional digital technology development level and job burnout of adult in-service learners.

However, existing research has shortcomings in the following four aspects. First, research on the antecedents of job burnout has mainly focused on individual-level job characteristics and personality traits, with few studies incorporating regional macro digital technology development level into the analytical framework, ignoring the structural impact of the macro context on individual occupational mental health. Second, the existing literature lacks systematic empirical exploration of the internal transmission mechanism of how regional digital technology development level affects job burnout, and the identification of mediating paths is seriously insufficient. Third, as the core occupational resource accumulated by adult learners through continuous learning, the moderating role of individual employability in the relationship between technological pressure and occupational mental health has not been theoretically demonstrated and empirically tested. Fourth, the contextual factors of the impact of regional digital technology development level on job burnout have not received attention.

Accordingly, relying on survey data from 302 students in adult continuing education, this study matches the district and county-level digital technology development index through the geographic coding of work units, constructs a mediating path of regional digital technology development level → job satisfaction → job burnout of adult in-service learners, and introduces individual employability as a moderating variable to systematically examine the internal mechanism and boundary conditions between regional digital technology development level and job burnout of adult in-service learners. The contributions of this paper are mainly reflected in the following three aspects. First, at the theoretical level, this paper is the first to introduce regional digital technology development level into the analytical framework of job burnout of adult in-service learners, realizing the cross-level integration of macro contextual variables and individual occupational mental health research, and enriching the application of the Technostress Theory and the Job Demands-Resources model in the field of continuing education. Second, at the mechanism level, this paper identifies the mediating path of job satisfaction in the transmission of regional digital technology pressure to job burnout, reveals the micro mechanism by which the macro technological environment affects individual mental health, and fills the gap in existing research on the exploration of internal mechanisms. Third, at the boundary condition level, this paper introduces individual employability as a moderating variable into the analysis, revealing the protective value of individual employability in alleviating the impact of digital technology shocks.

2. Literature Review

2.1. Influencing Factors of Job Burnout

Job burnout was first proposed by Freudenberger (1974) and later systematically defined by Maslach and Jackson (1981), including three core dimensions: Emotional Exhaustion, Depersonalization, and Reduced Professional Efficacy. Existing literature on the influencing factors of job burnout mainly focuses on the following three levels.

First, the job characteristic level. The Job Demands-Resources (JD-R) model (Bakker & Demerouti, 2007) is the core theoretical framework for explaining job burnout, holding that excessive job demands and scarce job resources are two independent paths leading to job burnout. Existing studies have confirmed that the continuous accumulation of job demands such as work load (Demerouti et al., 2001), role conflict (Lee & Ashforth, 1996), and job insecurity (Cheng & Chan, 2008) are important antecedents of emotional exhaustion; while job resources such as social support (Bakker et al., 2005) and occupational autonomy (Schaufeli & Bakker, 2004) have a significant buffering effect on job burnout.

Second, the individual trait level. Individual factors such as personality traits (e.g., neuroticism, emotional stability in the Big Five personality), self-efficacy, and psychological capital have been widely proven to have predictive effects on job burnout (Alarcon et al., 2009). Hobfoll's (1989) Conservation of Resources (COR) theory further points out that the abundance of an individual's resource reserves determines their psychological resilience in stressful situations, and those with resource scarcity are more likely to experience burnout. In the context of adult continuing education, learners face a significantly higher risk of burnout than the general in-service population due to the dual pressure of career and study (Richardson et al., 2012).

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Third, the organizational and contextual level. Organizational contextual variables such as organizational culture, management style, and colleague relationships have an important impact on job burnout (Leiter & Maslach, 1988). However, existing research on job burnout mainly stays at the individual and organizational levels, with extremely limited attention to the regional macro economic and technological environment, which constitutes an important gap in the existing literature.

2.2. Research on the Consequences of Digital Technology Development

The individual and organizational consequences caused by the rapid spread of digital technology have become an important research topic in the fields of management, economics, and sociology. The existing literature mainly unfolds along the following two lines.

First, the perspective of Technostress Theory. Technostress was first proposed by Brod (1984). Tarafdar et al. (2007) divided it into five dimensions: techno-overload, techno-invasion, techno-complexity, techno-insecurity, and techno-uncertainty, and empirically proved that these dimensions significantly and negatively predict employees' job satisfaction and productivity. Ragu-Nathan et al. (2008) further found that techno-insecurity is the strongest predictor of the decline in job satisfaction, and this effect is particularly prominent in a highly competitive digital environment. The regional-level digital technology development level provides a common external technological pressure context for in-service workers in the jurisdiction by shaping the skill demand structure of the labor market (Autor & Salomons, 2018).

Second, the perspective of labor market impact. Existing studies have shown that the penetration of digital technology has significantly changed the occupational structure of the labor market, triggered the systematic substitution of routine jobs, and posed a stronger threat of occupational substitution to middle-skilled workers (Acemoglu & Restrepo, 2018). This risk of technological unemployment further affects their occupational mental health by enhancing individuals' job insecurity. However, whether the macro-level impact of digital technology is transmitted to the job burnout of adult in-service learners through intermediate variables such as job satisfaction has not been specially empirically tested.

2.3. Literature Review

Overall, the existing literature has the following three shortcomings. First, research on the influencing factors of job burnout has failed to incorporate regional digital technology development level into the analytical framework, lacking systematic empirical evidence of the impact of the macro technological context on individual occupational mental health. Second, although research on the consequences of digital technology has proved its negative impact on job satisfaction, there is a serious lack of research on the internal transmission mechanism of whether and how digital technology pressure eventually evolves into job burnout, a severe occupational mental health problem. Third, the moderating role of individual employability in the relationship between regional digital technology pressure and occupational mental health has not attracted the attention of academic circles.

3. Research Hypotheses

3.1. Regional Digital Technology Development Level and Job Burnout of Adult In-service Learners

The Job Demands-Resources (JD-R) model defines job burnout as the result of long-term job demands exceeding individual resources (Bakker & Demerouti, 2007). The continuous improvement of regional digital technology development level can significantly increase the job demands faced by adult in-service learners in two aspects. On the one hand, digital transformation has accelerated the speed of skill iteration, exposing in-service workers to the continuous threat of skill obsolescence (Autor & Salomons, 2018); on the other hand, the penetration of digital technology has blurred the boundary between work and non-work, forming a continuous techno-invasion (Tarafdar et al., 2007), which further exacerbates the role conflict pressure already borne by adult learners. With the continuous accumulation of job demands, individuals' psychological resources are constantly depleted, and the level of job burnout rises accordingly (Hobfoll, 1989). Therefore, in regions with a higher level of digital technology development, the above pressure mechanism will be stronger, and the risk of job burnout among adult in-service learners will be higher. Accordingly, this paper proposes H1:

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$H_{1:}$ Regional digital technology development level has a significant positive impact on job burnout of adult in-service learners.

3.2. The Mediating Effect of Job Satisfaction

Job satisfaction is defined as one of the core job resources by the JD-R model, and its continuous depletion is a key mechanism triggering job burnout (Bakker & Demerouti, 2007; Schaufeli & Bakker, 2004). Technostress theory points out that the improvement of technological development level can systematically reduce individual job satisfaction through techno-overload and techno-insecurity (Tarafdar et al., 2007; Ragu-Nathan et al., 2008). The continuous decline in job satisfaction further weakens individuals' psychological buffering capacity to cope with occupational stress (Alarcon, 2011; Judge et al., 2001). Therefore, job satisfaction acts as a key mediating role between regional digital technology development level and job burnout. Accordingly, this paper proposes H2:

$H_{2:}$ Job satisfaction plays a mediating role between regional digital technology development level and job burnout of adult in-service learners.

3.3. The Moderating Effect of Individual Employability

The Conservation of Resources (COR) theory (Hobfoll, 1989) points out that an individual's stable resource reserves can play a resource shield role in stressful situations, buffering the erosion speed of external threats to psychological resources. Employability refers to an individual's comprehensive ability to cope with changes in the labor market and maintain and obtain an ideal employment state, covering multiple dimensions such as career planning, problem-solving ability, learning attitude, and social capital (Fugate et al., 2004; McQuaid & Lindsay, 2005). Individuals with high employability have stronger technical learning ability and career reorientation ability. When facing regional digital technology shocks, they perceive lower threats of skill obsolescence and occupational substitution, and the rate of job satisfaction being eroded by technological pressure will be correspondingly slower (Fugate & Kinicki, 2008). In contrast, individuals with low employability lack sufficient career response resources and are more likely to feel occupational powerlessness and skill scarcity in the same digital technology pressure situation, making their job satisfaction more vulnerable. Thus, individual employability is an important boundary condition for the impact of regional digital technology development level on job satisfaction. Accordingly, this paper proposes H3:

$H_{3:}$ Individual employability negatively moderates the negative effect of regional digital technology development level on job satisfaction, that is, the negative impact on adult in-service learners with high employability is significantly weaker than that on individuals with low employability.

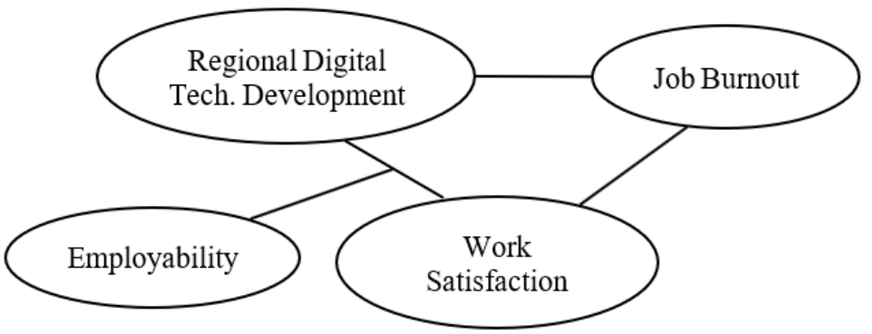


Figure 1. Research Framework.

4. Research Design

4.1. Variables and Measurement

This paper adopts a combination of questionnaire survey and secondary data matching to collect data. The individual-level questionnaire was distributed to students of the Continuing Education College, Beijing Union University, and a total of 302 valid questionnaires were recovered. District and county-level geographic coding was conducted through the respondents' background information to match the

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corresponding indicators of digital technology development in the CNRDS database. All scale items were presented using a Likert scale.

(1) Regional digital technology development index (X): The proportion of large-scale digital economy enterprises in the total number of enterprises in each region was used as a proxy indicator, with data sourced from the CNRDS database;

(2) Job burnout (Y): The short version of the Maslach Burnout Inventory (MBI-GS) developed by Schaufeli et al. (1996) was adopted, including 15 items covering dimensions such as emotional exhaustion, depersonalization, and professional efficacy;

(3) Job satisfaction (M): Referring to the Job Satisfaction Scale developed by Price & Mueller (1986), including 3 items, with higher scores indicating higher satisfaction;

(4) Employability (W): Referring to the Adult Employability Scale, including 36 items covering 8 dimensions such as career planning, interpersonal communication ability, positive mentality, problem-solving ability, social capital, learning attitude, team cooperation, and diversity of social networks;

(5) Control variables: At the individual level, gender, education level, marital and family status, employment form, working years, and after-tax monthly income were included. At the regional level, the per capita GDP level was considered.

4.2. Reliability and Validity Test

Confirmatory Factor Analysis (CFA) was conducted on the job satisfaction, employability, and job burnout scales using Mplus 8.3. Cronbach's α coefficients for each dimension of the three scales were all above 0.80, and the Composite Reliability (CR) were all greater than 0.80, meeting the basic requirements of the reliability test. Table 1 reports the fit indices of the CFA model. The fit indices of the 4-factor model were significantly better than those of the combined models, with good discriminant validity. The Average Variance Extracted (AVE) of each latent variable was greater than 0.50, and the square root of AVE was higher than the correlation coefficient with other variables (see Table 2), further confirming the convergent validity and discriminant validity.

Table 1. CFA Validation of Discriminant Fit Indices.

Model	Factors	χ^2/df	RMSEA	CFI	GFI
4-factor model	X; M; W; Y	2.231	0.056	0.937	0.854
2-factor model c	X+M; W+Y	2.306	0.059	0.928	0.841
2-factor model b	X; M+W+Y	2.289	0.058	0.931	0.845
2-factor model a	X+M+W; Y	2.318	0.060	0.925	0.838
1-factor model	X+M+W+Y	12.47	0.183	0.294	0.401

Note: X=Regional digital technology development index, M=Job satisfaction, W=Employability, Y=Job burnout.

Table 2. Descriptive Statistics and Correlation Coefficient Matrix

Variable	Mean	SD	1	2	3	4
1. Regional digital technology development index (X)	0.065	1.432	0.654			
2. Individual employability (W)	3.514	0.324	0.094***	0.573		
3. Job satisfaction (M)	5.643	0.643	-0.287**	0.312**	0.748	
4. Job burnout (Y)	5.353	0.423	0.312**	-0.287***	-0.428***	0.781

Note: N=302; The diagonal values are the square root of AVE; ***p<0.01

5. Empirical Analysis

5.1. Main Effect Test

This paper first established a null model. The intraclass correlation coefficients (ICC) of job satisfaction and job burnout were 0.087 and 0.094, respectively, both exceeding the reference threshold of 0.05. The regional-level variance had substantial explanatory value, supporting the necessity of hierarchical linear modeling. Table 3 reports the regression results of the main effect. Model (2) shows

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that the regional digital technology development index exerts a significant positive effect on job burnout (β=0.287, p<0.01), thus verifying Hypothesis H1.

Table 3. Regression Results of Main Effect Test.

Variables	(1) Job burnout	(2) Job burnout	(3) Job satisfaction	(4) Job burnout
Digital technology development index		0.287***	-0.312***	0.193***
		(0.063)	(0.071)	(0.058)
Job satisfaction				-0.428***
				(0.084)
_cons	3.214***	2.876***	5.114***	4.871***
	(0.387)	(0.412)	(0.364)	(0.398)
Controls	YES	YES	YES	YES
N	302	302	302	302
Adj R^2	0.043	0.128	0.147	0.287
F	2.341**	6.847***	8.034***	14.231***

Note: "***", "**", "*" represent the significance levels of 1%, 5% and 10% respectively; Robust standard errors are in parentheses, the same below.

5.2. Mediating Effect Test

To verify H2, this paper adopted the four-step method of Baron and Kenny (1986) for testing. It can be seen from Model (3) in Table 3 that the regional digital technology development index has a significant negative effect on job satisfaction (β=-0.312, p<0.01). Model (4) regresses job burnout on both the regional digital technology development index and job satisfaction. It can be found that the coefficients of the regional digital technology development index and job satisfaction are still significant, and job satisfaction partially mediates the significant promoting effect of the regional digital technology development index on job burnout.

Table 4 further conducted the Bootstrap test and Sobel test to comprehensively evaluate the mediating effect of job satisfaction. The point estimate of the indirect effect was 0.134, Sobel Z=3.412 (p<0.01), and the Bootstrap 95% confidence interval [0.051, 0.238] did not contain zero, indicating a significant mediating effect. In Model (4) of Table 3, the direct effect of the regional digital technology development index was still significant (β=0.193, p<0.01), indicating that job satisfaction only plays a partial mediating role, and Hypothesis H2 is verified.

Table 4. Sobel Test and Bootstrap Test.

Path	Effect value	Sobel Z	P	95% Lower	95% Upper	Conclusion
Indirect effect	0.134	3.412	0.001	0.051	0.238	Significant
Direct effect	0.193	3.328	0.001	0.132	0.214	Significant
Total effect	0.327	5.134	0.000	0.276	0.571	Significant

Note: Bootstrap = 5000 samplings, 95% confidence level

5.3. Moderating Effect Test

To test H3, this paper adopted the hierarchical regression analysis method. The employability variable was centered within the group to eliminate multicollinearity. Table 5 reports the test results. In Model (3), the coefficient of the interaction term was significant (β=0.243, p<0.01), ΔR^2=0.029, indicating that employability significantly and negatively moderates the negative impact of regional digital technology development level on job satisfaction, and Hypothesis H3 is verified. Simple slope analysis showed that the negative effect of the low employability group (mean-1SD) (β=-0.421, p<0.01) was significantly stronger than that of the high employability group (mean+1SD; β=-0.184, p<0.05), which is consistent with the predicted direction of H3.

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Table 5. Moderating Effect Test Results.

Variables	(1) Job satisfaction	(2) Job satisfaction	(3) Job satisfaction
Digital technology development index	-0.312***	-0.298***	-0.301***
	(0.071)	(0.069)	(0.068)
Individual employability		0.301***	0.287***
		(0.063)	(0.061)
Interaction term			0.243**
			(0.094)
_cons	5.114***	4.832***	4.791***
	(0.364)	(0.348)	(0.342)
Controls	YES	YES	YES
N	302	302	302
Adj R^2	0.147	0.208	0.237
ΔR^2	—	0.061	0.029
F	8.034***	11.247***	12.186***
VIF maximum	1.023	1.387	2.134

6. Endogeneity Analysis and Robustness Test

6.1. Endogeneity Analysis

Regional digital technology development level may have endogeneity bias due to omitted variables or two-way causality. For this reason, this paper uses the number of telephone subscribers per 100 people in each region in 1984 as an Instrumental Variable (IV). The validity of the instrumental variable is demonstrated based on the following two points: First, regions with more complete historical communication infrastructure have a higher penetration rate of contemporary digital technology, meeting the correlation condition; Second, the telephone popularization density in 1984 is determined by historical policies, geographical conditions and industrial layout, and theoretically does not directly affect the job satisfaction of contemporary individuals, satisfying the exogeneity condition (Gentzkow, 2006).

Table 6 reports the regression results of the Two-Stage Least Squares (2SLS) of the instrumental variable. In the first stage, the telephone density in 1984 had a significant positive effect on the digital technology development index (β=0.387, F=16.24, $p<0.01$), and the Cragg-Donald F statistic far exceeded the weak instrumental variable identification threshold, confirming the validity of the instrumental variable. The Hausman test rejected the null hypothesis of exogeneity ($p<0.05$), confirming the objective existence of endogeneity problems. The second-stage results show that the regional digital technology development level adjusted by IV still has a significant negative effect on job satisfaction (β=-0.341, $p<0.001$) and a significant positive effect on job burnout (β=0.312, $p<0.001$), and the conclusion of the main effect remains robust after controlling for endogeneity.

Table 6. Endogeneity Analysis.

Variables	(1) First stage	(2) Second stage	(3) Second stage
	Digital technology development index	Job satisfaction	Job burnout
IV	0.387***		
	(0.096)		
Digital technology development index		-0.341***	0.312***
		(0.089)	(0.081)
_cons	2.147***	5.234***	2.631***
	(0.712)	(0.401)	(0.387)
Controls	YES	YES	YES
N	302	302	302
Adj R^2 / Cragg-Donald F	0.312	9.247***	8.634***
Hausman test	—	0.043	0.037

Note: First stage F statistic (Cragg-Donald)=16.24, far exceeding the weak instrumental variable threshold of 10

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6.2. Robustness Test

6.2.1. Replacement of Estimation Model (Tobit Regression)

Since job burnout has truncation at the scale endpoint and is a limited dependent variable, this paper uses Tobit regression instead of OLS for estimation. The results in Table 7 show that the positive effect of regional digital technology development level on job burnout (β=0.293, p<0.001) and the negative effect of job satisfaction on emotional exhaustion (β=-0.441, p<0.001) remain unchanged, indicating that the conclusions of this paper are robust.

Table 7. Robustness Test – Tobit Regression.

Variables	**(1) Job burnout**	**(2) Job burnout**
Digital technology development index (X)	0.293***	0.198***
	(0.071)	(0.063)
Job satisfaction (M)		-0.441***
		(0.091)
_cons	2.987***	5.213***
	(0.423)	(0.512)
Controls	YES	YES
N	302	302
Pseudo R^2	0.087	0.134
Log likelihood	-487.214	-431.627
LR chi2	92.34***	147.21***

6.2.2. PLS-SEM

The Partial Least Squares Structural Equation Model (PLS-SEM) was used to re-estimate the main paths through SmartPLS 4.0 to avoid strict assumptions about the data distribution. The path test results of 5000 Bootstrap samplings (Table 8) are consistent with the direction of the main effect, indicating that the conclusions of this paper are robust.

Table 8. Robustness Test – PLS-SEM Path Coefficients.

Path	**Path coefficient**	**Mean**	**Standard deviation**	**T statistic**	**P**
Digital technology development index → Job burnout	-0.312	-0.309	0.068	4.588	0.000
Job satisfaction → Job burnout	-0.428	-0.424	0.071	6.028	0.000
Digital technology development index → Job satisfaction	0.193	0.191	0.059	3.271	0.001

Note: Bootstrap=5000 samplings

6.2.3. Random Sampling Analysis

70% of the 302 samples were randomly selected for 3 independent repeated regressions (Table 9) to test the sensitivity of the main effect to the sample composition. In the three samplings, the coefficient of the negative effect of digital technology development level on job satisfaction was between -0.304 and -0.321, which was highly consistent with the full sample estimate (-0.312), indicating that the main conclusions do not depend on the specific sample composition.

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Table 9. Robustness Test – Random Sampling Analysis (Dependent variable: Job satisfaction).

Variables	Full sample	Sampling 1 (70%)	Sampling 2 (70%)	Sampling 3 (70%)
Digital technology development index	-0.312***	-0.318***	-0.304***	-0.321***
	(0.071)	(0.078)	(0.075)	(0.081)
_cons	5.114***	5.087***	5.143***	5.071***
	(0.364)	(0.381)	(0.372)	(0.394)
Controls	YES	YES	YES	YES
N	302	211	211	211
Adj R^2	0.147	0.151	0.143	0.156
F	8.034***	7.412***	6.987***	7.831***

Note: All three samplings are random without replacement

7. Heterogeneity Analysis

To examine the boundary conditions of the main effect, this paper grouped the samples according to age, monthly income and major type, and estimated the impact of regional digital technology development level on job satisfaction in each subgroup respectively.

7.1. Age Heterogeneity

Regression was conducted for three groups: under 30 years old, 31–45 years old, and over 45 years old. The results shown in Columns 1–3 of Table 10 indicate that the promoting effect of regional digital technology development level on job burnout decreases with the increase of age: the effect is the strongest in the under 30 group (β=0.387, $p<0.01$), followed by the 31–45 group (β=0.312, $p<0.01$), and the weakest in the over 45 group (β=0.178, $p<0.05$). A possible explanation is that young adult learners face a stronger pressure of digital skill substitution due to lower occupational stability and higher job substitutability, resulting in a stronger sense of job burnout.

7.2. Monthly Income Heterogeneity

Grouping was conducted by after-tax monthly income: below 4000 yuan, 4000–10000 yuan, and above 10000 yuan. The results shown in Columns 4–6 of Table 11 indicate that the promoting effect of regional digital technology development level on job burnout decreases significantly with the increase of income, with the strongest effect in the low-income group (β=0.421, $p<0.01$), followed by the middle-income group (β=0.298, $p<0.01$), and the weakest in the high-income group (β=0.187, $p<0.05$). This conclusion is consistent with the prediction of the Conservation of Resources theory. Individuals with scarce economic resources have a stronger sense of occupational insecurity when facing technological threats, and job burnout is more likely to occur.

7.3. Major Type Heterogeneity

The samples were divided into liberal arts and science groups according to the respondents' major. The results shown in Columns 7–8 of Table 11 indicate that the promoting effect in the liberal arts group (β=0.341, $p<0.01$) is significantly stronger than that in the science group (β=0.241, $p<0.01$). This difference may reflect that adult learners with a science background have a stronger foundation in digital technology, and their perceived threat level is relatively low when facing regional digitalization pressure, resulting in correspondingly lower job burnout.

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Table 10. Regression Results of Heterogeneity Analysis.

Variables	(1) ≤30 years old	(2) 31–45 years old	(3) >45 years old	(4) Low income	(5) Middle income	(6) High income	(7) Liberal arts	(8) Science
Digital technology development index	0.387***	0.312***	0.178*	0.421***	0.298***	0.187*	0.341***	0.241***
	(0.087)	(0.071)	(0.094)	(0.098)	(0.074)	(0.101)	(0.076)	(0.081)
_cons	5.341***	5.114***	4.987***	5.412***	5.087***	4.876***	5.214***	4.987***
	(0.412)	(0.364)	(0.487)	(0.512)	(0.371)	(0.523)	(0.381)	(0.401)
Controls	YES	YES	YES	YES	YES	YES	YES	YES
N	94	142	66	78	156	68	163	139
Adj R^2	0.163	0.147	0.108	0.178	0.141	0.094	0.153	0.121
F	7.234***	8.034***	4.112***	8.941***	7.312***	3.687***	7.876***	5.432***

8. Conclusions and Implications

8.1. Research Conclusions

First, regional digital technology development level has a significant positive impact on job burnout of adult in-service learners. While the rapid development of the digital economy brings economic growth momentum to the region, it systematically increases the job demands of in-service workers in the jurisdiction through paths such as techno-overload and techno-insecurity, pushing up the level of job burnout. This conclusion is consistent with the core predictions of the technostress theory and the JD-R model, and this paper further verifies it through endogeneity analysis and robustness tests.

Second, job satisfaction plays a partial mediating role between regional digital technology development level and job burnout of adult in-service learners. Regional digital technology pressure first deprives individuals of their psychological buffering capacity to cope with occupational stress by reducing job satisfaction, a core occupational resource, and then pushes up the levels of emotional exhaustion and depersonalization. This transmission path reveals the micro mechanism by which the macro technological environment affects individual mental health.

Third, individual employability significantly and negatively moderates the negative impact of regional digital technology development level on job satisfaction. Adult in-service learners with high employability, relying on stronger technological adaptability and occupational resource reserves, experience significantly less erosion of job satisfaction when facing the same digital pressure.

Fourth, heterogeneity analysis reveals important boundary conditions. The promoting effect of regional digital technology pressure on job burnout is more significant among adult in-service learners with younger age, lower income, and liberal arts background. The conclusion indicates that these groups face higher occupational psychological risks.

8.2. Management Implications

(1) Continuing education institutions should systematically incorporate employability training into core curriculum objectives. This study proves that employability has a significant occupational psychological protection function, and the intervention necessity of this function is particularly prominent in the groups of liberal arts background and young learners. Continuing education institutions should systematically integrate core dimensions of employability such as career planning, problem-solving ability and digital adaptability into curriculum design, and set up special digital skill enhancement courses for liberal arts background learners to effectively improve their occupational resilience in the face of digital shocks.

(2) Employers should focus on mental health support for young and low-income in-service learners. Heterogeneity analysis shows that young and low-income in-service learners are the vulnerable groups most significantly affected by regional digital technology pressure. Employers should include such groups as priority objects for mental health support, and timely supplement their job satisfaction resources through systematic measures such as career development consulting, digital skill training and flexible work arrangements to prevent the occurrence and accumulation of burnout.

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(3) At the policy level, the coordinated governance of digital economy development and workers' occupational psychological well-being should be promoted. It is suggested that policymakers establish a regional occupational mental health assessment mechanism for workers synchronously when promoting the strategic layout of the digital economy. In view of the higher risks faced by liberal arts background and low-income groups, financial support for vocational training and employability improvement programs for these groups should be increased, and the overall improvement of labor employability should be used as a structural policy tool to cope with digital shocks.

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