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Ecological mechanism analysis of the biomechanical adaptive evolution of consumption structure in the development of digital finance: A kinetic perspective

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Abstract: This study explores how the development of digital finance indirectly promotes the biomechanical adaptability and innovation ability of residents' behavior by influencing consumption structure and payment environment. Data analysis shows that digital finance not only improves the utilization rate of personal financial services, but also generates significant heterogeneity effects among different regions and income groups. These effects can be understood from the perspective of biomechanics, which is the process by which individuals adapt to a rapidly changing technological environment. In biomechanical principles, adaptability is the key to survival. Digital finance encourages residents to optimize resource allocation, enhance consumer flexibility, and improve decision-making efficiency. This adaptation process is similar to the process by which organisms adjust their mechanisms to maintain survival and development in the face of changes in the external environment. The popularity of digital finance enables individuals to respond to market changes more quickly, thereby improving their adaptability in consumption. In addition, entrepreneurial activities and innovation levels serve as mediating variables, further stimulating residents' adaptability in the digital ecosystem, similar to the mechanism in biomechanical systems that improves survival rates through diversity and innovation. This study reveals the important role that digital finance plays in modern consumer behavior and proposes that it may become a key driving force for the evolution of socio-economic systems and human behavioral biology. By introducing the principles of biomechanics, we can have a deeper understanding of how digital finance shapes changes in individual behavior and social structure, and thereby provide theoretical support for policy making and practice.

Keywords: digital finance; resident consumption structure; biomechanical adaptability; resident consumption upgrade, survival rate; behavioral biomechanics

1. Introduction

In today's era of rapid development of information technology and artificial intelligence, digital finance has become a key force driving modern economic transformation. Since the launch of Alipay in 2004, the digital payment platform has rapidly changed people's consumption patterns and promoted the upgrading of China's and even the global consumption structure. Especially in China, the booming development of digital finance has not only improved the consumption level of residents, but also profoundly influenced their consumption patterns. This article attempts to explore from a biological perspective how digital finance indirectly promotes the development of residents' biological adaptability and innovation ability by influencing their consumption structure [1,2].

In biology, adaptability is the ability of a species or individual to respond to environmental changes and maintain survival. The core mechanism of biological adaptability is the optimization of resource allocation and innovative behavior, which helps individuals improve their survival rate in constantly changing environments. Similarly, the rise of digital finance has provided residents with unprecedented financial tools and resources, prompting them to constantly adjust their consumption decisions to adapt to the rapidly changing economic and technological environment. The development of digital finance not only provides residents with more flexible and efficient financial services, but also prompts them to gradually shift their consumption structure from basic survival needs to higher-level hedonic and developmental consumption [3,4]. This transformation, just like how individual organisms adapt and innovate to enhance their competitiveness in the face of new environments, reveals how digital finance, as a technological ecosystem, promotes the evolution and innovation of individual behavior.

From a biological perspective, individual adaptability is enhanced through innovation and diversity to improve survival rates. In the digital financial environment, the consumption structure and habits of residents are constantly evolving. Initially, residents' consumption mainly focused on survival needs such as food, housing, and basic necessities. However, with the increase in income levels and the popularity of digital financial tools, residents are beginning to invest more of their income into non-survival consumption areas such as entertainment, tourism, education, and health [5,6]. The transformation of such consumption patterns can be likened to adaptive behavior in biological systems, where individuals gradually transition to more efficient and flexible consumption patterns by optimizing resource allocation. Similar to how biological populations improve their survival opportunities by mutating and adapting to new environments, residents, driven by digital finance, optimize their consumption structure through innovative payment methods and financial services, enhancing the biological adaptability of their personal economic behavior [7].

Innovation is often closely related to the evolution of species in biology. Innovative ability enables species to cope with environmental changes and explore new living spaces. In the context of digital finance, innovation capability also plays a crucial role. With the continuous upgrading of payment technology, consumers' financial needs have become increasingly diversified. They not only need fast payment tools, but also expect to receive more personalized and convenient financial services. This demand for new financial tools has spurred new financial innovations, such as online credit, digital currencies, smart investments, etc. These innovations not only enhance residents' consumption convenience, but also promote their competitiveness in the constantly changing technological environment. Innovative financial tools and payment methods, like new adaptive mechanisms in biological systems, help residents cope with the challenges of the digital economy and continuously improve their consumption decision-making ability and survival level [8,9].

In addition, diversity in the development of digital finance also has biological significance. In biology, diversity enhances the robustness and adaptability of systems. Through digital finance, residents can not only access traditional banking services, but also experience more digital financial products such as electronic wallets, mobile payments, digital insurance, etc. The diversification of these financial instruments,

similar to the adaptive diversity of biological populations in different environments, provides residents with more choices and flexibility, enabling them to make more accurate consumption decisions based on their own needs and preferences. Just as the diversity in ecosystems enhances species' adaptability, the diversity in financial services enables residents to maintain flexibility and maximize resource allocation efficiency in a changing economic environment [10,11].

Overall, the development of digital finance not only promotes economic growth, but also drives the adaptive evolution of residents' consumption behavior in a biological sense. Digital finance provides more financial options and innovative tools to help residents optimize resource allocation, improve decision-making efficiency, and ultimately drive them towards a more diverse and efficient consumption structure. This process is not only similar to the mechanism of biological adaptation, but also provides a new perspective for us to understand the evolution of human behavior in the digital age. As digital finance continues to develop, it may become an important driving force for the evolution of socio-economic systems and human behavioral biology.

2. The data

2.1. Data source and variable description

This section presents meticulously curated provincial panel data from 2012 to 2022, encompassing 31 provinces in China. Data sources include the "China Statistical Yearbook" provincial statistical yearbooks, the China Internet Network Information Center's (CNNIC) report on China's Internet development, and the People's Bank of China's quarterly payment business report. Insights from the university's digital finance research center, found in the China Regional Financial Transaction Report and the Peking University Digital Financial Inclusion Index Report, further enrich the data [12,13].

At the core is residents' consumption structure, linked with per capita consumption habits. Using eight consumer expenditure categories from the China Statistical Yearbook, evolving contours are discerned.

Control variables, grounded in academic and theoretical elucidations, encompass factors influencing residents' consumption propensity. Instrumental variables include metrics like website numbers, CN domain names, and the Internet penetration rate. An historical artifact, derived from multiplying the 1983 Internet penetration rate with provincial postal and telecommunications data, serves as the second instrumental variable.

Intermediate variables reflect regional entrepreneurial dynamism and innovation levels, influencing the supply side. Determinants include bank card spending rates, maximum income per capita, credit balances per capita, and income shortfalls per capita.

Aligned with Engel's law, this chapter uses the proportion of development and enjoyment consumption expenditures in total consumption expenditures as a proxy variable for consumption structure in robustness testing, concluding this intellectual journey.

2.2. Statistical description

The statistical description of the explained variables in this chapter is shown in **Table 1**.

Table 1. Descriptive statistical revelations.

Variable name	Sample size	Average	Standard deviation	Minimum value	Maximum value
Survival consumption	341	0.414	0.040	0.251	0.502
Development consumption	341	0.088	0.010	0.049	0.107
Enjoyment consumption	341	0.681	0.051	0.501	0.804

The analysis of regression results involves descriptive statistics for three variables: survival consumption, development consumption, and enjoyment consumption, based on a sample size of 341. Survival consumption, with an average of 0.414, represents 41.4% of total consumption, showing moderate variability. Development consumption averages 0.088 (8.8%), indicating less variability, while enjoyment consumption averages 0.681 (68.1%), with moderate variability. The interpretation suggests the priority of survival consumption aligns with economic theory, reflecting individual preferences and constraints. Heterogeneity arises from factors like income, age, family size, and personal preferences [14,15].

In light of the aforementioned descriptive statistical revelations, a salient inference materializes: the consumption structure of Chinese denizens exhibits a conspicuous trajectory. The proportion dedicated to alimentary expenses exhibits a discernible descent, concomitant with an incremental ascent in the allocation for development and enjoyment consumption expenditures.

3. Methodology

We use a short panel fixed effects model to analyze the impact of digital financial development on residents' consumption structure.

The regression model is as follows:

$$\text{ConsC}_{it} = \beta_0 + \beta_1 \text{D F}_{it} + \beta_2 X_{it} + \varphi_i + \varphi_t + \xi_{it} \tag{1}$$

$$\text{ConsC}_{it} = \beta_0 + \beta_1 \text{D F}_{it} - 1 + \beta_2 X_{it} + \varphi_i + \varphi_t + \xi_{it} \tag{2}$$

Within this contextual framework, the subscripts i and t denote the province and time, respectively. The focal point, Cons, encapsulates the elucidated variable pertaining to residents' consumption structure. Meanwhile, the pivotal explanatory variable is represented by DF_{it}, signifying the core underpinning of digital financial development. The variable X_{it} incorporates other controlling factors capable of influencing residents' consumption structure. The nuanced interplay of province and year is encapsulated in the fixed effects φ_i and φ_t, respectively, while ξ_{it} represents the stochastic component, introducing a level of random perturbation.

In Model 2, a temporal lag of one period is introduced to the digital financial development variable in the robustness test. This strategic adjustment serves the purpose of mitigating potential endogeneity challenges stemming from reverse causality [16].

4. Empirical results

4.1. Baseline regression

Model (1) intricately computes residents' consumption structure as the dependent variable, unraveling the nuanced impact of digital financial development. The elegant results of this regression analysis are presented in **Table 2**'s tabular expanse.

Table 2. Baseline regression.

Dependent variable consumption structure	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
digital finance	0.031**	0.026**	0.018**	0.013***	0.010**	0.012***
	(2.145)	(2.298)	(2.405)	(3.408)	(2.382)	(3.303)
GDP per capita		0.094**	0.217***	0.114***	0.103**	0.101**
		(2.358)	(4.528)	(3.048)	(2.330)	(2.527)
financial development		0.034*	0.125***	0.058**	0.052	0.032
		(1.977)	(4.523)	(2.255)	(1.512)	(1.141)
urbanization			0.259***	0.382***	0.373***	0.410***
			(4.226)	(10.415)	(10.570)	(9.008)
human capital			0.008	0.021	0.015	−0.003
			(0.446)	(1.212)	(0.781)	(−0.180)
Education expenditure				−0.034**	−0.021	−0.049***
				(−2.233)	(−1.348)	(−3.676)
medical expenditures				0.058**	0.062**	0.043**
				(2.625)	(2.741)	(2.636)
social security expenditures				−0.016	−0.012	−0.032*
				(−0.901)	(−0.604)	(−1.893)
old age dependency ratio					0.018	−0.033*
					(0.796)	(−1.724)
child dependency ratio					−0.079**	−0.088**
					(−2.292)	(−2.522)
per capita disposable income						0.083***
						(6.699)
Province fixed effects	yes	yes	yes	yes	yes	yes
year fixed effects	yes	yes	yes	yes	yes	yes
Obs.	341	341	341	341	341	341
R^2	0.040	0.046	0.205	0.389	0.412	0.519

Note: "***", "**", and "*" indicate significant at the 1%, 5%, and 10% levels respectively, and the *t* statistics are in parentheses.

Regression study shows a favorable relationship between residents' diversity of consumption and the development of digital finance. In particular, a one standard deviation increase in digital financial development is equivalent to a 0.012 standard deviation increase in consumption structure after controlling for associated variables. In real terms, the consumption structure rises by 1.2% for every 10% increase in digital

financial development. This emphasizes how crucial digital banking is in influencing locals' purchasing habits.

4.2. Sub-indicator regression

The regression outcomes, delineating the ramifications of the secondary and tertiary indicators of digital financial development on the intricate framework of residents' consumption structure, are eloquently presented in **Table 3**.

Table 3. Sub-indicator regression.

Dependent variable consumption structure	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
breadth of coverage	0.008***					
	(2.904)					
Use depth		0.015***				
		(4.040)				
degree of digitalization			0.003*			
			(1.850)			
payment index				0.009*		
				(1.712)		
insurance index					0.003*	
					(1.722)	
credit index						0.015***
breadth of coverage						(3.699)
control variables	yes	yes	yes	yes	yes	yes
Province fixed effects	yes	yes	yes	yes	yes	yes
year fixed effects	yes	yes	yes	yes	yes	yes
Obs.	341	341	341	341	341	341
R^2	0.515	0.526	0.506	0.509	0.507	0.526

Note: "***", "**", and "*" indicate significant at the 1%, 5%, and 10% levels respectively, and the *t* statistics are in parentheses.

Regression analysis reveals significant impacts of both secondary and tertiary indices of digital financial development on residents' consumption structure. Controlling for variables, a one standard deviation increase in the digital financial development index corresponds to 0.008 standard deviations rise in consumption structure. In practical terms, a 10% increase in coverage breadth equates to a 0.8% rise in consumption structure.

Contrastingly, the depth of usage indicator, reflecting engagement with digital financial services, notably influences consumption structure. A 10% surge in usage depth results in a 1.5% augmentation. The digitalization degree indicator has a more muted effect, with 0.003 standard deviations increase for every one standard deviation rise, corresponding to a modest 0.3% enhancement in consumption structure.

In the tertiary tier, the payment index, mirroring residents' inclination towards digital payment tools, is a salient determinant. A 10% amplification results in a palpable 0.9% rise. The insurance index has a relatively feeble influence, with 0.003 standard deviations increase corresponding to a modest 0.3% uplift. The credit index,

reflecting residents' engagement with digital credit services, is the most impactful, with a 10% upswing resulting in a substantial 1.5% surge in consumption structure.

4.3. Robustness check

To further enhance the robustness of our analysis, we introduce a temporal lag to the core explanatory variables, lagging the level of digital finance development by a single period. This strategic use of the lagged variable method helps mitigate endogeneity concerns by temporally staggering the core explanatory variables.

Table 4. Robustness test results 1.

dependent variable consumption structure	Model 1	Model 2	Model 3	Model 4
	Fixed effects + IV	Fixed effects + IV + GMM	Fixed effects + IV1 (post office)	Fixed effects + IV2 (telephone)
Digital finance	0.003***	0.001**	0.583**	0.115***
	(3.326)	(2.092)	(2.203)	(4.450)
Control variables	yes	yes	yes	yes
Province fixed effects	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes
Unrecognizable test	0.000	0.000	0.006	0.058
Weak instrumental variables test	23.936	23.936	10.681	13.797
Overidentification test	0.410	0.410		
Obs.	341	341	341	341
R^2	0.290	0.288	0.256	0.283

Note: "***", "**", and "*" indicate significant at the 1%, 5%, and 10% levels respectively, and the *t* statistics are in parentheses.

The Generalized Method of Moments (GMM) and Instrumental Variables (IVs) are included in the fixed effects regression, which shows that digital finance has a consistently favorable and significant impact on consumption structure. A more diverse and effective consumption structure is correlated with a rise in digital finance (coefficient of 0.583). As shown in **Table 4**, with digital finance coefficients ranging from 0.001 to 0.115 and significance levels between 1% and 5%, this finding is consistent across a variety of fixed effects regressions. These strong results highlight how important digital finance is for advancing economic growth by improving the structure of consumption. With values ranging from −0.255 to 0.120, control variables highlight how complex the factors impacting consumption are, with digital banking being just one of many contributing elements. Furthermore, geographical and temporal differences in the influence of digital finance on consumption structure are indicated by the relevance of province and year fixed effects across models.

4.4. Mediation effect test

4.4.1. Test 1

This study employs residents' per capita disposable income and per capita consumer credit data as gauges for residents' income levels and the liquidity

constraints confronting them to empirical testing to ascertain their role as intermediary factors. The ensuing empirical results are meticulously delineated in **Table 5**.

Table 5. Mechanism test 1.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	Consumption structure	**Disposable income**	**Consumption structure**	**Consumption structure**	**Consumer credit**	**Consumption structure**
digital finance	0.010**	0.032***	0.012***	0.012***	0.005**	0.009***
	(2.382)	(25.002)	(3.303)	(3.303)	(2.047)	(3.303)
disposable income			0.053***			
			(6.699)			
consumer credit						0.128***
						(7.415)
control variables	yes	yes	yes	yes	yes	yes
Province fixed effects	yes	yes	yes	yes	yes	yes
year fixed effects	yes	yes	yes	yes	yes	yes
Obs.	341	341	341	341	341	341
R^2	0.412	0.822	0.403	0.519	0.474	0.520

Note: "***", "**", and "*" indicate significant at the 1%, 5%, and 10% levels respectively, and the *t* statistics are in parentheses.

It's evident that digital finance profoundly impacts consumption structure, alleviating liquidity constraints. Both Model 1 and Model 2 demonstrate a significant positive link between digital finance and consumption structure, emphasizing its pivotal role.

In Models 3 and 4, a noteworthy positive correlation between digital finance and disposable income is observed, revealing its nuanced role in enhancing residents' economic well-being. Lastly, Models 5 and 6 show a significant positive association between digital finance and consumer credit, highlighting its pivotal role in fostering consumer financial empowerment.

These empirical revelations provide tangible proof of digital finance's impact on consumption structure and enhance our understanding of its multifaceted role in shaping residents' consumption dynamics.

4.4.2. Test 2

The maturity of digital finance has reduced income uncertainty, increased residents' consumption propensity, optimized the payment pattern, reduced financial burdens, and significantly improved the consumption structure. The results of the correlation regression analysis are shown in **Table 6**.

Table 6. Mechanism test 2.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	Consumption structure	Premium income	Consumption structure	Consumption structure	Payment environment	Consumption structure
Digital finance	0.012***	0.558***	0.001**	0.012***	0.136***	0.002**
	(3.303)	(38.591)	(2.454)	(3.303)	(9.350)	(1.993)
Premium income			0.001*			
			(1.813)			
Payment environment						0.003***
						(4.833)
Control variables	yes	yes	yes	yes	yes	yes
Province fixed effects	yes	yes	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes	yes	yes
Obs.	341	341	341	341	341	341
R^2	0.519	0.763	0.530	0.519	0.363	0.582

Note: "***", "**", and "*" indicate significant at the 1%, 5%, and 10% levels respectively, and the *t* statistics are in parentheses.

Table 7 reveals regression outcomes from six models utilizing variables like consumption structure, premium income, payment environment, and digital finance to predict personal financial service utilization.

Table 7. Mechanism test 3.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	Consumption structure	Entrepreneurial activity	Consumption structure	Consumption structure	Innovation level	Consumption structure
digital finance	0.012***	0.131*	0.011***	0.012***	0.136***	0.010***
	(3.303)	(1.882)	(3.046)	(3.303)	(3.356)	(3.303)
Entrepreneurial activity			0.051			
			(0.428)			
Innovation level						0.008*
						(1.812)
control variables	yes	yes	yes	yes	yes	yes
Province fixed effects	yes	yes	yes	yes	yes	yes
year fixed effects	yes	yes	yes	yes	yes	yes
Obs.	341	341	341	341	341	341
R^2	0.519	0.316	0.572	0.519	0.191	0.613

Note: "***", "**", and "*" indicate significant at the 1%, 5%, and 10% levels respectively, and the *t* statistics are in parentheses.

In Model 2, premium income shows a noteworthy positive correlation, but in Model 3, its significance diminishes, potentially due to the inclusion of year fixed effects in Model 2. Conversely, digital finance consistently exhibits a significant

positive correlation in both Model 4 and Model 6, indicating its favorable influence on personal financial service utilization.

These findings underscore the pivotal roles of consumption structure, payment environment, and digital finance as determinants influencing personal financial service utilization.

4.4.3. Test 3

Entrepreneurship has become a driving force for technological innovation, promoted market competition, and played a vital role in shaping the development of digital finance. In order to remain invincible in the fierce market competition, entrepreneurs must continue to innovate, launch new products and services, and improve product quality at the same time. This innovative culture not only meets the diverse needs of residents, but also activates consumption patterns.

Table 8 details the empirical evidence supporting this complex interaction.

Table 8. Heterogeneity analysis 1.

Dependent variable consumption structure	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
	Fixed effects			Fixed effects + IV + GMM			Fixed effects + IV2		
	East	Central	West	East	Central	West	East	Central	West
Digital finance	0.030**	0.011***	0.006**	0.073**	0.071*	0.036***	0.443**	0.302**	0.254*
	(2.659)	(4.335)	(2.323)	(2.046)	(1.707)	(3.222)	(2.506)	(2.292)	(1.746)
Control variables	yes	yes	yes	yes	yes	yes	yes	yes	yes
Province fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
Unrecognizable test				0.056	0.026	0.001	0.014	0.047	0.000
Weak instrumental variables test				10.926	11.009	10.603	10.228	14.131	12.375
Overidentification test				0.496	0.163	0.864			
Obs.	121	88	132	121	88	132	121	88	132
R^2	0.244	0.359	0.173	0.194	0.387	0.234	0.472	0.362	0.270

Note: "***", "**", and "*" indicate significant at the 1%, 5%, and 10% levels respectively, and the *t* statistics are in parentheses.

Regression analyses confirm the significant and positive influence of digital finance on consumption structure in various models. Models 1 and 2 reveal its direct and statistically significant impact, highlighting its catalytic role in consumption elevation. Models 3 and 4, incorporating entrepreneurial activity and innovation level, emphasize their substantive and positive influence on consumption structure, showcasing the constructive roles of entrepreneurship and innovation. Conversely, Models 5 and 6 introduce the payment environment as an intermediary variable, underscoring the robust impact of digital finance on consumption structure. This emphasizes the pivotal role of the payment environment in mediating the relationship, showcasing how improvements enhance consumption ease and ubiquity. These sequential model outcomes collectively highlight the direct impact of digital finance and the crucial intermediary roles of entrepreneurial activity, innovation level, payment environment, and other contributing factors.

4.5. Heterogeneity analysis

4.5.1. Heterogeneity analysis 1

In order to examine the regional differences in the impact of digital financial development on residents' consumption structure, this study divided the sample into three regions: eastern, central and western regions, corresponding to the main economic zones. Regression analysis shown in the **Table 8**.

In Model 1, digital finance significantly and positively impacts consumption structure across China's regions. The coefficients in the eastern, central, and western regions are 0.030, 0.011, and 0.006, respectively, indicating digital finance as a crucial driver of consumption growth.

In Model 2, after controlling for factors like income, education, and age, the positive and significant impact of digital finance on consumption structure persists in all three regions.

Model 3 reveals a notably larger digital finance coefficient than Model 1, indicating a nuanced relationship. Weak instrumental variables and overidentification tests support the causal interpretation.

The impact is most significant in the economically developed eastern region, followed by the central region, and relatively smaller in the western region. Economic development, income levels, financial infrastructure, and consumption tendencies contribute to regional variations. Digital finance's role in the western region is notably weakened due to lower economic development, income levels, infrastructure, and conservative consumption habits.

4.5.2. Heterogeneity analysis 2

Table 9. Heterogeneity analysis 2.

dependent variable consumption structure	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
	Fixed effects		Fixed effects + IV + GMM		Fixed effects + IV2	
	Low income	High income	Low income	High income	Low income	High income
Digital finance	0.009***	0.028**	0.007***	0.012***	0.255***	0.458***
	(3.477)	(2.290)	(2.635)	(5.531)	(3.159)	(3.999)
Control variables	yes	yes	yes	yes	yes	yes
Province fixed effects	yes	yes	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes	yes	yes
Unrecognizable test			0.001	0.013	0.071	0.036
Weak instrumental variables test			10.190	15.832	20.025	20.881
Overidentification test			0.315	0.897		
Obs.	225	116	225	116	225	116
R^2	0.105	0.205	0.451	0.468	0.550	0.489

Note: "***", "**", and "*" indicate significant at the 1%, 5%, and 10% levels respectively, and the *t* statistics are in parentheses.

To delve deeper into potential disparities in the impact of digital financial development on the enhancement of residents' consumption structures based on income levels, this study stratifies the complete sample into high-income and low-

income cohorts, determined by regional per capita disposable income. Subsequent sub-sample regressions were conducted, and the outcomes are presented in **Table 9**.

In Model 1, the digital finance coefficient is 0.009 for low-income groups and 0.028 for high-income groups, indicating a significant positive impact on both groups' consumption structure.

Model 2, after controlling for factors like income, education, and age, maintains a positive and significant digital finance coefficient in both income groups.

Model 3 reveals a notably larger digital finance coefficient than Model 1, indicating a nuanced relationship between digital finance and consumption structure.

For low-income groups, digital finance's cost reductions enhance consumption potential, overcoming financial constraints. High-income groups prioritize consumption quality and experience, and digital finance provides choices and rich experiences, promoting an improved consumption structure.

5. Conclusion and discussion

This study explores from a biological perspective how digital finance can influence residents' consumption structure, promote their behavioral adaptability, and enhance their innovation capabilities. Similar to the adaptive mechanisms in biological systems, digital finance provides residents with a wealth of financial tools and payment methods, enabling them to optimize resource allocation, improve decision-making efficiency, and enhance their survival and development capabilities in rapidly changing economic environments. Just as biological species improve their survival rates through innovation and diversity, residents, driven by digital finance, gradually upgrade their consumption structure by constantly adapting to new technologies and consumption environments, exhibiting behavior patterns similar to adaptive evolution in biological systems.

Through analyzing the changes in residents' consumption structure, we found that digital finance not only promotes the diversification and flexibility of consumption structure, but also stimulates the emergence of innovative behavior. With the continuous innovation of financial technology, residents' consumption decisions have become more flexible and efficient, thereby promoting overall economic progress. This process not only reflects the adaptive evolution of individuals in the digital environment, but also reveals the important role of digital finance in driving the evolution of social and economic systems as well as human behavioral biology.

The innovation and diversity of digital finance, just like the evolutionary mechanism of biological populations, enable residents to continuously optimize their behavior patterns and survival strategies in a constantly changing technological and economic environment. This behavior pattern, similar to biological adaptability, not only enhances residents' adaptability in the economic environment, but also provides new perspectives and impetus for the evolution of future socio-economic systems.

Therefore, this study suggests that the development of digital finance is not only a driving force for economic growth, but also promotes the evolution of human behavior at a biological level. With the continuous innovation of digital financial technology, residents' adaptability and innovation ability will be further enhanced, providing strong support for the evolution of the future socio-economic system.

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