



# Can Digital Inclusive Finance Improve Business Export Resilience?

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**Abstract.** Export resilience is an important foundation for firms' trade growth and sustainable development, and a strong support for maintaining the global competitiveness of manufacturing industries. This paper explores the intrinsic relationship among digital inclusive finance (DIF), level of financing constraints, and firms' export resilience based on the DIF index at the provincial level and panel data of A-share listed companies in Shanghai and Shenzhen (China) from 2011 to 2015. This empirical study finds that DIF has a significant contributing effect on firms' export resilience. Corporate financing constraints play a mediating effect in the DIF impact on corporate export resilience. Lastly, the effects of DIF are markedly pronounced for private and small-scale enterprises. This study provides a theoretical basis and policy insights for enterprises to enhance export resilience and promote DIF.

**Keywords:** DIF · corporate export resilience · financing constraints

## 1 Introduction

In recent years, the international economic situation has become complicated, trade protectionism has continuously intensified, and global inflationary pressure has remained. The survival and development of enterprises face political, economic, and other multifaceted risks, and whether or not they can develop resilience and optimize transformation during crises is the key to securing their future development. Digital financial inclusion promotes sharing of information in the financial sector and reduces transaction costs and services. Such an inclusion helps enterprises allocate resources and resist risks in a complex and dynamic environment.

This paper empirically examines the impact of digital inclusive finance (DIF) on firms' export resilience, thereby bridging the gap in the related research. The current study explores the important paths through which DIF affects firms' export behavior from a micro perspective, finds and verifies the mediating role of financing constraints, and reveals the main mechanism of action of DIF on firms' export resilience. Lastly, this paper comparatively analyzes the heterogeneous effects of DIF on the export behavior of different types of enterprises, and provides theoretical bases and practical guidance for specific enterprises to enhance their export resilience.

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2 Theoretical Analysis and Hypotheses

Enterprise export resilience refers to the ability of enterprises to withstand risks and recover exports, reflecting the ability of enterprise exports to avoid decline under external shocks and the speed of enterprise exports to achieve recovery after shocks. First, DIF can assess enterprise credit and risk at lower costs, help alleviate information asymmetry, and establish a complete credit risk system. Thus, enterprise financing channels are broadened and extensive financial support are provided for export-oriented enterprises to recover, maintain, and enhance trade levels. Second, DIF strongly promotes change in the foreign trade business model, stimulates the potential of market demand, and provides critical support for intergenerational change of consumption, geographical extension of consumption, and upgrading of consumption content [1]. Thus, DIF helps enterprises optimize the structure of export products and maintain long-term competitive advantages. Third, DIF provides a stable financial foundation for enterprises to implement long-cycle and high-risk innovation activities, and alleviates the negative effects of financial mismatches constraining enterprise innovation; hence, the technological competitiveness of enterprises' products is enhanced and export resilience is built to withstand the impact of trade environment uncertainty [2]. Accordingly, we formulate our first hypothesis: This leads to the hypothesis.

H1: DIF can enhance the export resilience of enterprises.

DIF maximizes emerging technologies to accelerate information sharing and substantially reduce threshold restrictions of traditional finance, thereby improving the availability of financing for SMEs [3]. It breaks the original way of providing financial services, significantly reducing human and material resources in the delivery process [4]. Thus, the flourishing development can solve the problems faced by enterprises with large capital gaps, single financing channels, and high financing costs, thereby easing financing constraints.

Financing constraints significantly inhibit firms' export behavior, including weakening their willingness to participate in exports and reducing the amount of their export trade [5]. Moreover, financing constraints are important factors limiting the upgrading of the quality of firms' export products, marginal growth of export binary, increase in the domestic value added rate of exports, and increase in the technical complexity of exports. Severe financing constraints can increase all types of risks for enterprises and indirectly affect their export resilience. For example, severe financing constraints may force firms to increase credit and debt levels significantly, further exacerbating leverage risk. Owing to credit rationing, financing constraints expose firms to higher liquidity risks [6] and reduce the support of corporate capital for long-term and productivity-enhancing investment projects, thereby constraining productivity growth. Thus, we present our second hypothesis:

H2: DIF can help alleviate the financing constraints of enterprises, thereby improving their export resilience.

### 3 Study Design

#### 3.1 Sample Selection and Data Sources

This paper selects 2011–2015 as research period and constructs a panel data set with Shanghai and Shenzhen A-share listed companies as research objects. To improve data reliability, unrelated companies are excluded, and data with evident abnormalities and incomplete data are excluded. Continuous variables are subject to a 1% tailing process on each side. The final unbalanced panel data set with 6014 observations is obtained.

#### 3.2 Variable Setting

##### 1) The DIF Index (DIFI).

The DIF index (DIFI) is based on the Ant Group data and uses the hierarchical analysis method, which is a common method for index compilation, to construct index data covering 33 indicators from three dimensions to measure the level of digital financial inclusion development at the provincial, municipal, and county levels in China [7]. This paper uses DIFI at the provincial level from 2011 to 2015 as benchmark indicator, while DIFI at the municipal level is used as proxy indicator for robustness testing.

##### 2) Enterprise Export Resilience (RES).

This paper refers to Wei Yunyan et al. [8] and uses the difference between the growth rates of enterprise export values in 2011–2015 and 2008 to construct an index of enterprise export resilience, which is calculated as follows:

$$RES_{i,t} = Growrate_{i,t} - Growrate_{i,2008}.$$

In the preceding formula, the smaller the calculated RES value, the less resilient the growth rate of export value of enterprise  $i$  in the corresponding year  $t$  compared with 2008, the relatively less resilient the export trade of the enterprise. Note that the export growth rate of the firm-HS3-digit industry in 2008 is the basis for the subsequent comparison. To ensure the comparability of the before-and-after data and continuity of the study effects, only export units that existed continuously from 2007 onwards are retained in this study. Moreover, export enterprises with multiple discontinuous stages after 2007 are excluded.

##### 3) Financing Constraint Index (KZ).

This paper refers to Fu-Xiu Jiang et al. [9] and uses the KZ index to measure the level of corporate financing constraints. The calculation formula is as follows:

$$KZ = -\frac{OCF}{Asset} + 3.14Leverage - 36.37\frac{Dividends}{Asset} - 1.31\frac{Cash}{Asset} + 0.28TobinQ \quad (1)$$

where OCF, Asset, Dividends, and Cash are net operating cash flow, total assets at the beginning of the period, dividends payable, and cash holding level, respectively; and Leverage and TobinQ denote gearing ratio and Tobin's Q value, respectively. The larger the KZ index, the higher the level of financing constraint and the more severely affected by the financing constraint of the firm.

Table 1. Variable definition table

Variable Types	Variable Names	Variable Symbols	Definitions
Explained variables	Enterprise export resilience	<i>RES</i>	Van and Jaarsma's (2007) <i>RES</i> export resilience indicator
Explanatory variables	DIF	<i>DIFI</i>	Refer to Peking University Digital Inclusion Index
Intermediate variables	Level of financing constraints	<i>KZ</i>	Kaplan and Zingales' (1997) <i>KZ</i> index
Control variables	Enterprise size	<i>SIZE</i>	Natural logarithm of total assets at the end of the year
	Nature of business	<i>SOE</i>	State-owned enterprises 1, non-state-owned enterprises 0
	Business growth	<i>GROW</i>	Operating income growth rate
	Corporate performance	<i>ROA</i>	Net income / Total assets at year-end
	Financial leverage	<i>LEV</i>	Ratio of total liabilities to total assets
	Cash dividends	<i>CD</i>	Actual cash dividends paid in the year are taken as a logarithm
	Capital intensity	<i>CE</i>	Ratio of net fixed assets to total assets of the enterprise
	Size of independent directors	<i>DDS</i>	Number of independent directors

4) **Control Variables (Controls).**  
This paper draws on Wei Yunyan et al. [8] and sets a total of eight control variables. All variables in this paper are defined in Table 1.

3.3 Model Construction

To test H1, this paper constructs a panel data model with firm export resilience and digital financial inclusion development index as explanatory variables:

$$RES_{i,t} = \alpha_0 + \alpha_1 DIFI_{i,t} + \sum \alpha_i * Controls + \sum Indus_{i,t} + \sum Year_{i,t} + \varepsilon_{i,t} \quad (2)$$

In Eq. (2), Indus and Year control for industry- and year-level fixed effects, respectively. The random disturbance term is  $\varepsilon_{i,t}$ .  $\alpha_1$  measures the impact of the degree of digital

inclusion on firms' export resilience. If  $\alpha_1$  is significantly positive, then the higher the degree of digital inclusion financial development in the region, the stronger the export resilience of enterprises. Hence, H1 holds.

Furthermore, this paper examines the channels through which digital financial inclusion affects firms' export resilience by referring to the sequential test of mediating effects proposed by Zhonglin Wen and Baojuan Ye [10]. The procedure of the intermediary effect test is as follows:

$$RES_{i,t} = \alpha + \beta_1 DIFI_{i,t} + \mu Controls + Indus + Year + \varepsilon_{i,t}, \quad (3)$$

$$KZ_{i,t} = \alpha + \varphi DIFI_{i,t} + \mu Controls + Indus + Year + \varepsilon_{i,t}, \quad (4)$$

$$RES_{i,t} = \alpha + \beta_2 DIFI_{i,t} + \tau KZ_{i,t} + \mu Controls + Indus + Year + \varepsilon_{i,t} \quad (5)$$

where the mediating variable  $KZ_{i,t}$  is the firm's level of financing constraints. If Eqs. (4) and (5) in  $\varphi$ , then the  $\tau$  coefficients are statistically significant and in the expected direction, indicating the existence of a mediating effect. That is, the developed degree of DIF will affect the export resilience of enterprises by changing their level of financing constraints. Hence, H2 holds. If  $\varphi$ , and  $\tau$  at least one of them is statistically insignificant, this paper is supplemented with a bootstrap test to determine whether or not the mediating effect exists.

## 4 Analysis of Empirical Results

### 4.1 Descriptive Statistics

Table 2 presents the descriptive statistical results of each research variable. The statistical results of the control variables are consistent with the actual situation of listed companies in China.

### 4.2 Correlation Analysis

Pearson correlation analysis shows that the correlation coefficient between RES and DIFI is 0.156 and significant at the 1% level. This result indicates that the degree of regional DIF development is significantly and positively correlated with the export resilience of enterprises in the region. Hence, H1 is initially verified. The correlation coefficients of KZ with RES and DIFI are  $-0.308$  and  $-0.275$ , respectively, and both are significant at the 1% level. The correlation coefficients of KZ with RES and DIFI are  $-0.308$  and  $-0.275$ , respectively, and both are significant at the 1% level. This result indicates that corporate financing constraints are significantly and negatively related to corporate export resilience and digital financial inclusion. In addition, absolute values of the correlation coefficients among the variables are generally below 0.5. This result indicates that there is no problem of multicollinearity among the variables.

Table 2. Descriptive statistics results

Variables	Average value	Standard deviation	Median	Minimum value	Maximum value
RES	1.223	0.556	1.170	−1.031	3.639
DIFI	4.969	0.948	5.169	3.487	5.628
KZ	0.624	0.057	0.850	−3.003	1.949
SIZE	3.088	0.495	3.081	2.985	3.264
SOE	0.431	1.165	0	0	1
GROW	−2.137	1.022	−2.030	−5.944	0.506
ROA	−3.432	0.610	−3.242	−6.542	−1.635
Lev	−0.944	0.080	−0.794	−2.822	−0.103
CD	2.867	1.113	2.862	2.687	3.091
CE	−1.864	0.131	−1.620	−6.215	−0.360
DDS	3.609	0.948	3.506	3.506	4.046

Note: To mitigate heteroskedasticity, all continuous variables are treated as natural logarithms in this paper

4.3 Analysis of Regression Results

Table 3 presents the regression results of DIFI and firms’ export resilience. The regression coefficient of DIFI on RES remains significantly positive at the 1% level. This result indicates that DIF can significantly improve the export resilience of enterprises regardless of the fixed or random effect model. Thus, H1 is confirmed.

The coefficients of GROW and ROA are significantly positive, indicating that the increase in revenue profit is conducive to the recovery of export trade. The coefficients of LEV are significantly negative, indicating that the increase in the share of corporate debt inhibits the export resilience of enterprises and weakens export competitiveness. Hausman test shows that the fixed-effects model is significantly better than the random-effects model. Therefore, the fixed-effects model is used in all subsequent analyses for regression.

4.4 Analysis of the Mechanism of Action

Table 4 shows the regression test results of the mediating effect of enterprise financing constraints. In particular, column (1) shows the regression result when no mediating variable is included. Columns (2) and (3) include the mediating variable KZ. The regression results are as follows: higher level of development of DIF can significantly improve enterprise export resilience, the development of DIF significantly alleviates enterprise financing constraints, and financing constraints will reduce export resilience. Columns (1) to (3) show the following influence path: development of DIF → alleviate the level of corporate financing constraints → improve corporate export resilience. Thus, H2 is verified.

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**Table 3.** Impact of DIF on firms’ export resilience

	<i>FE</i>	<i>RE</i>
<i>DIFI</i>	0.367***	0.320***
	(26.03)	(33.03)
<i>SIZE</i>	−6.605***	−4.421***
	(−11.86)	(−17.24)
<i>SOE</i>	−0.031	0.137***
	(−0.48)	(7.61)
<i>GROW</i>	0.004	−0.003
	(0.73)	(−0.63)
<i>ROA</i>	0.171***	0.195***
	(15.67)	(22.27)
<i>LEV</i>	−0.519***	−0.678***
	(−23.85)	(−47.02)
<i>CD</i>	0.144	0.238
	(0.78)	(1.63)
<i>CE</i>	0.004	−0.036***
	(0.29)	(−4.07)
<i>DDS</i>	−0.005	0.051
	(−0.07)	(1.09)
<i>Constant</i>	19.667***	12.717***
	(12.07)	(21.68)
Hausman test	372.69***	
<i>Observations</i>	5,302	5,302
<i>R-squared</i>	0.439	0.809

Note: \*, \*\*, and \*\*\* indicate that correlations between variables are statistically significant at the 10%, 5%, and 1% levels, respectively; t-values are in parentheses

4.5 Heterogeneity Analysis

This paper also analyzes the effects of the nature of firm ownership and firm size. Bank loans are the main financing method for most enterprises, but traditional financial institutions are more willing to provide funds to politically connected enterprises owing to information asymmetry and bank discrimination [11]. State-owned enterprises have the credit backing of the government and enjoy more advantages in terms of policies, making it easier to obtain credit support compared with private enterprises and, therefore, resulting in a lower degree of financing constraints [12]. Compared with large enterprises, SMEs have less information transparency and correspondingly higher service costs and

Table 4. Tests for the mediating effects of financing constraints level

	(1)	(2)	(3)
VARIABLES	RES	KZ	RES
DIFI	0.412*** (28.69)	−0.744*** (−16.74)	0.257*** (15.90)
KZ			0.068***
KZ			−0.072*** (−8.21)
SIZE	−9.640*** (−17.52)	12.477*** (7.26)	−7.500*** (−24.36)
SOE	0.029 (0.41)	−0.082 (−0.36)	0.093*** (5.30)
GROW	−0.017*** (−3.41)	−0.038** (−2.41)	−0.055*** (−7.55)
ROA	0.189*** (16.75)	−0.038 (−1.18)	0.256*** (21.48)
CD	0.665*** (3.57)	−5.590*** (−9.51)	0.841*** (3.94)
CE	−0.024* (−1.79)	0.176*** (3.90)	−0.070*** (−6.87)
DDS	−0.005 (−0.07)	0.045 (0.21)	0.178*** (3.07)
Constant	27.724*** (17.02)	−18.745*** (−3.82)	21.202*** (37.86)
Year	YES	YES	YES
Industry	YES	YES	YES
Observations	6,014	3,750	3,750
R-squared	0.343	0.253	0.656

Note: \*, \*\*, and \*\*\* indicate that correlations between variables are statistically significant at the 10%, 5%, and 1% levels, respectively; t-values are in parentheses

financial risks of external fund providers, leading to greater financing constraints faced by SMEs; in general, SMEs have more scarce internal resources and commonly face the problem of difficult and expensive financing [13]. Accordingly, this paper expects that DIF is more effective in improving the export resilience of private and small-scale enterprises.

The regression results, which are consistent with expectations, are shown in Table 5.



**Table 5.** Heterogeneity analysis of the nature of ownership and firm size

VARIABLES	Full sample	Private	State-owned	Small-scale	Large-scale
	RES	RES	RES	RES	RES
DIFI	0.412***	0.510***	0.265***	0.625***	0.238***
	(28.69)	(22.93)	(15.71)	(22.16)	(15.64)
SIZE	−9.640***	−7.682***	−8.228***	−5.467***	−6.454***
	(−17.52)	(−9.91)	(−10.29)	(−4.46)	(−9.32)
SOE	0.029	−0.003	0.006	−0.023***	−0.005
	(0.41)	(−0.36)	(1.02)	(−2.67)	(−0.96)
GROW	−0.017***	0.154***	0.163***	0.125***	0.179***
	(−3.41)	(10.01)	(11.39)	(6.31)	(15.04)
ROA	0.189***	−0.517***	−0.669***	−0.573***	−0.580***
	(16.75)	(−19.36)	(−17.35)	(−18.24)	(−17.32)
CD	0.665***	−0.292	0.602**	0.287	0.314
	(3.57)	(−1.14)	(2.45)	(0.87)	(1.57)
CE	−0.024*	0.004	−0.049**	0.017	−0.039**
	(−1.79)	(0.21)	(−2.17)	(0.78)	(−2.14)
DDS	−0.005	−0.022	0.035	−0.035	−0.005
	(−0.07)	(−0.23)	(0.41)	(−0.30)	(−0.07)
Constant	27.724***	23.814***	23.685***	14.943***	19.214***
	(17.02)	(10.76)	(10.15)	(4.18)	(9.62)
Year	YES	YES	YES	YES	YES
Indus	YES	YES	YES	YES	YES
Test for differences between groups		0.000***		0.000***	
Chi2		28.45		95.59	
Observations	6,014	2,962	2,340	2,135	3,167
R-squared	0.343	0.495	0.481	0.597	0.446

Note: \*, \*\*, and \*\*\* denote that correlations between variables are statistically significant at the 10%, 5%, and 1% levels, respectively; t-values are in parentheses

5 Robustness Test

5.1 Substitution of Explanatory Variables

This paper refers to M. S. Zhang et al. [14] and include the absolute value of firm exports Quant and firm export product quality Qual as new explanatory variables. Data for firm export absolute finance are obtained from the CMES database of export values taken logarithmically, and firm export product quality is referred to Khandelwal et al. [15].

Table 6. Robustness test results

VARIABLES	Substitution of variable settings		Changing the estimation model	Change time interval		Change of sample scope
	Number of products exported	Product export quality	Company clustering	[2011, 2013].	[2013, 2015]	GEM
	(1) Quan	(2) Qual	(3) RES	(4) RES	(5) RES	(6) RES
DIFI	0.667***	1.041***	0.367***	0.093***	1.156***	1.004***
	(24.60)	(24.90)	(20.27)	(9.15)	(33.56)	(15.56)
SIZE	−10.869***	−17.204***	−6.605***	−3.356***	−4.341***	−13.877***
	(−10.14)	(−10.42)	(−8.59)	(−10.65)	(−13.93)	(−8.44)
SOE	−0.089	−0.136	−0.031	0.153***	0.141***	0.259
	(−0.73)	(−0.72)	(−0.48)	(7.14)	(6.80)	(1.02)
GROW	0.012	0.017	0.004	0.004	−0.013**	0.002
	(1.24)	(1.18)	(0.67)	(0.67)	(−2.48)	(0.16)
ROA	0.276***	0.433***	0.171***	0.235***	0.171***	0.141***
	(13.12)	(13.36)	(12.62)	(21.36)	(15.14)	(4.56)
LEV	−1.033***	−1.597***	−0.519***	−0.637***	−0.764***	−0.601***
	(−24.69)	(−24.75)	(−16.94)	(−34.77)	(−44.09)	(−11.85)
CD	−0.061	−0.087	0.144	0.247	0.279	0.922*
	(−0.17)	(−0.16)	(0.73)	(1.33)	(1.51)	(1.68)
CE	0.038	0.053	0.004	−0.023**	−0.047***	−0.060*
	(1.35)	(1.23)	(0.20)	(−2.10)	(−4.40)	(−1.76)
DDS	−0.030	−0.044	−0.005	0.007	0.034	0.119
	(−0.24)	(−0.23)	(−0.06)	(0.12)	(0.61)	(0.67)
Constant	33.416***	52.595***	19.667***	10.562***	7.633***	35.612***
	(10.66)	(10.88)	(8.59)	(14.90)	(11.13)	(7.59)
Year	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes
Firm	No	No	Yes	No	No	No
Observations	5,302	5,302	5,302	3,009	3,528	752
R-squared	0.417	0.421	0.439	0.811	0.799	0.635

The regression results after replacing the variables are shown in columns (1) and (2) of Table 6. Results indicate that DIF can effectively improve the quantity and quality of firms’ export products, thereby improving their export resilience. This result is consistent with the previous findings.

5.2 Change in Estimation Method and Sample Scope

This paper further tests the robustness of the main regressions through firm-level clustering analysis, replacing the time interval of policy shocks and transforming the sample size. To avoid the impact of firm-level aggregation effects on the regression coefficients, column (2) of Table 7 shows the regression results after controlling for firm-level fixed effects and clustering the firm-level standard errors. Columns (4) and (5) set the sample intervals as 2011–2013 and 2013–2015, respectively. Lastly, column (6) sets the sample scope to be GEM-listed companies only as SME representative. With the new model settings, the regression coefficients of DIFI are positively significant at the 1% level, which is consistent with the previous findings.

5.3 Instrumental Variable Method

This paper intends to mitigate the two-way causality and endogeneity problem caused by omitted variables through the instrumental variables approach.

This study shows that although the main form of digital finance is online, its development is still influenced by geospatial factors. It demonstrates that the farther away from Hangzhou, the more difficult it is to promote. The two-stage least squares method is used to eliminate the endogeneity problem of the model. The results of the first stage of the instrumental variable regression are shown in column (1) of Table 7. The results indicate that the farther the provincial capital from Hangzhou, the lower the level of local digital finance development. This outcome confirms the correlation between the instrumental variable Distance and endogenous explanatory variable DIFI, which is consistent with the exogeneity characteristic of the instrumental variable. Column (2) shows the test results of the instrumental variables, which are consistent with the results of the main regression. That is, the findings of this paper remain robust after solving the potential endogeneity problem.

Table 7. Regression results of the instrumental variable method

VARIABLES	(1) Phase I DIFI	VARIABLES	(2) Phase II RES
Distance	−0.248*** (0.004)	DIFI	0.118** (0.099)
Constant	−1.7421*** (0.336)	Constant	10.187*** (0.311)
Controls	Yes	Controls	Yes
Observations	5,091	Observations	5,091
R-squared	0.082	R-squared	0.727

Note: \*, \*\*, and \*\*\* indicate that correlations between variables are statistically significant at the 10%, 5%, and 1% levels, respectively; standard deviations are in parentheses

6 Research Findings and Insights

This paper explores the effects, mechanisms of action, and heterogeneity effects of DIF on firms’ export resilience. The results show that the development of DIF can significantly improve the export resilience of enterprises. However, some research findings have important practical implications. First, the government should increase the application of emerging technologies in the financial sector, broaden the breadth and depth of DIF, deepen the role of DIF in the real economy, and optimize the credit, business, and financial environments. Second, financial institutions should actively promote the digital transformation of banks and increase the application rate of digital finance in banks. Accordingly, promoting the digital transformation of banks can enable small and micro enterprises to directly enjoy the convenience and focus of DIF, thereby reducing financing constraints and financial risks. Lastly, enterprises should strive to improve employees’ digital inclusive financial literacy, fully utilize digital financial product innovation to improve the efficiency of working capital use, reduce information asymmetry and financing difficulties and expensive financing, and provide sufficient financial and technical support for the long-term and stable increase of enterprise export resilience.

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