THE NONLINEARITY OF WORKING CAPITAL AND CROSS-SECTIONAL STOCK RETURNS: DO FINANCIAL CONSTRAINTS MATTER?

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Abstract

This study is the first to examine the impacts of working capital (WC) and financial constraints on cross-sectional stock returns in Taiwan. The findings indicate a non-linear relationship between WC and stock returns. Moreover, the nonlinearity between WC and cross-sectional stock returns is robust after controlling for financial constraints, risk, and growth factors, before the Covid-19 pandemic. In contrast, there is no evidence of nonlinearity between WC and stock returns throughout the Covid-19 outbreak. In addition, the study shows that any deviations from the minimum WC level enhance the stock returns cross-sectionally. It is found that a positive Deviation effect exists in the Taiwan stock exchange before the Covid-19 pandemic by employing portfolio sorting methodologies. The return difference of the long buying highest Deviation and short selling lowest Deviation portfolios earn from 0.6% to 0.9% per month after controlling for financial constraints, risks, and growth factors. Interestingly, it is determined that the deviation effect becomes negative for small stocks during the Covid-19 pandemic, implying that investors prefer small stocks to maintain minimum working capital. The results support the trade-off theory and liquidity preference theory. Finally, the study provides insights into working capital management for managers, and investment strategies for investors during the pandemic.

JEL classification: G11, G12, G14

Keywords: working capital; cross-sectional stock returns; non-linear; arbitrary profits; Covid-19.

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1. INTRODUCTION

Management of working capital involves crucial business decisions, as it can greatly affect companies' liquidity and profitability (Baños-Caballero *et al.*, 2013, 2020). While prior studies have been conducted to investigate the relationship between Working Capital (WC) and corporate value, the results are mixed. Various studies suggest that holding excess WC improves firm performance. Bates *et al.* (2009) and Palazzo (2012) state that excess cash reserves can cover uncertainties in future cash flows. Meanwhile, Faulkender and Wang (2006), and Simutin (2010), report that holding a high WC supports potential growth opportunities. Similarly, De Almeida and Eid (2014) also determined that managers can increase firm value by efficiently acquiring profitable investment channels. Therefore, they prefer holding excess WC to finance potential investments. Unfortunately, maintaining excessive working capital increases agency costs (Albuquerque & Hopenhayn, 2004). Accordingly, Deloof (2003), Wang (2002), and Knight (1972) argued that managers must make a trade-off decision between holding a high WC and corporate value. In other words, there is a negative relationship with liquidity and profitability. Other research documents the nonlinearity between WC and firm performance (Baños-Caballero *et al.*, 2013; Ben-Nasr, 2016).

Recently, some papers have investigated the relationship between stock returns and WC. Specifically, De Almeida and Eid (2014), and Kieschnick *et al.* (2013) determined a positive relationship between investment in WC and stock returns. Huang and Mazouz (2018) indicated that firms with excess cash holdings attract additional traders and increase trading turnover, leading to lower stock returns. Additionally, Aktas *et al.* (2015) reported a positive association between WC and stock returns for firms underinvesting in WC.

Previous research has reported the controversial effect of financial constraints on stock returns. For instance, Lamont *et al.* (2001) discovered a financial constraint puzzle, which argues that firms generate lower average cross-sectional stock returns when facing higher financial obstacles. Zhang (2006) suggests that capital market imperfections such as information asymmetry and agency costs raise the cost of external funding, leading to lower stock returns. In contrast, Whited and Wu (2006) argued that higher-leverage firms encounter higherdistressed risk, with their stocks generating higher risk premiums than lower-leverage firms.

Although financial constraints and WC affect stock returns, no study has tested the nonlinearity between working capital and stock returns after controlling for financial constraints. Therefore, this study aims to investigate the effect of financial restrictions and nonlinearity between working capital and stock returns in Taiwan. It is worth mentioning that the average proportion of WC in the market value of the listed firms in Taiwan is about 0.5% after controlling for industry and business cycle variations. Moreover, the sample statistics report that the average net income growth of listed firms in Taiwan is -27%, which creates financial constraints to external capital. Therefore, it is conjectured that managers reserve a minimum working capital level due to financial constraints and to balance against Taiwan's liquidity risk and stock returns. If there is nonlinearity between WC and stock returns, it is worth testing if any deviations from the WC's breakpoint affect stock returns cross-sectionally. Finally, an arbitrage investment strategy is proposed based on the deviations from the minimum WC level after controlling for financial constraint factors.

This paper enriches the body of asset pricing literature. It is thought that this study is the first to estimate WC's impacts on stock returns cross-sectionally after controlling for financial constraints. The paper contributes empirical evidence that indicates a U-shaped relationship between WC and stock returns in Taiwan. Additionally, the results suggest that the nonlinearity between WC and stock returns is robust after controlling for financial constraints, risk, and growth factors. Interestingly, the paper finds that firms underinvesting in WC generate higher stock returns than firms on the right-hand side of the minimum WC requirement. Ferreira and Vilela (2004), Faulkender and Wang (2006), and Simutin (2010) indicated that investors prefer companies that quickly generate sufficient funds to seize potential investment opportunities. Baños-Caballero *et al.* (2020) and Pham *et al.* (2018) documented that liquidity preference is even more potent than the agency cost of holding additional liquid assets. Therefore, the empirical results align with the trade-off and liquidity preference theories.

The empirical results from portfolio analysis suggest that investors generate positive arbitrary profits when they solely sort stocks by deviations from the minimum WC level. It is determined that financial constraints and growth factors empower the zero-cost arbitrary DEVIATION portfolio's equal-weighted and value-weighted returns. After controlling for financial constraints and growth factors, the monthly zero-cost arbitrage portfolio returns are around 0.7% to 0.9%. Although the arbitrary DEVIATION portfolios' returns remain positive and significant, they are slightly reduced after controlling for IVOL, TVOL, NS, and SZ. Therefore, DEVIATION is a priced factor that generates arbitrary positive returns for investors.

The paper is structured as follows. The review of the literature is discussed in Section 2. Section 3 includes the data collection and research methodology. Section 4 analyses the nonlinearity between WC and stock after considering financing constraints, risks, and growth variables. The arbitrary profits are discussed following different portfolio sorting methods in section 5. The conclusion and remarks are provided in the final section.

2. LITERATURE REVIEW

The trade-off theory indicates an inverse relationship between net working capital (NWC) and stock returns. Specifically, Kieschnick *et al.* (2013), and De Almeida and Eid (2014), suggest that the stock returns are negatively related to NWC investment. This result is robust even when using a different proxy for NWC, such as the cash conversion cycle (Zeidan & Shapir, 2017). The trade-off theory could explain the inverse relationship between WC and stock returns. Huang and Mazouz (2018) found that firms with excess cash holding attract more traders and increase trading turnover. Ferreira and Vilela (2004) also suggest that WC adversely affects stock returns when employing WC as a proxy for firm liquidity. However, Aktas *et al.* (2015) show that NWC and stock performance positively affect companies that underinvest in working capital. These authors state that excess NWC is only negatively related to stock performance for corporations with abnormally high amounts of NWC.

Previous research has revealed the significant effects of financial restrictions on stock returns. For example, Lamont *et al.* (2001) addressed a financial constraint puzzle, arguing that when enterprises face more significant financial constraints, they create lower average stock returns cross-sectionally. Lamont *et al.* (2001) also indicated a negative relationship between financial constraints and stock performance. However, Campello and Chen (2010) proved that the financial constraint puzzle statistically reacts to macroeconomic factors. According to Zhang (2006), capital market imperfections such as asymmetric information and agency costs raise external financing costs, leading to lower stock returns. Nevertheless, Whited and Wu (2006) claim that since higher-leverage firms face more distressed risk, their stocks produce higher risk premiums than lower-leverage firms.

3. DATA AND METHODOLOGY

3.1 Data

This study employs financial and market data from Taiwan Economic Journal, Taiwan's most reliable commercial data provider. TEJ has been using IFRS financial statement data from 2005. Data were therefore obtained from financial statements from 2005 through December 2020. The study methodology follows Fama and French (1992) in excluding the financial and public utility industries, and in merging monthly stock returns with annual accounting data. [5]Following Duong *et al.* (2022) and Hung and Yang (2018), observations with insufficient data to calculate all variables are excuded. Finally, the study also follows Jegadeesh and Livnat (2006) and Li *et al.* (2020) in winsorizing all variables at 5% and 95% to mitigate outlier issues. The final sample contained 82,277 firm-month observations.

3.1.Research Methodology

The study follows Hawawini *et al.* (1986) in estimating WC by subtracting current liabilities from current assets. However, Clausen and Hirth (2016) argued that variances in the competitive market between industries and business cycle variations might affect the factors. To support firm operations, WC can be higher in a booming economy and vice versa. Such factors are not captured in the one-period model. Therefore, the study follows Clausen and Hirth (2016) in adjusting the WC for industry and business cycle variations. Firstly, an adjuted WC (adjWC) was computed by subtracting the by-industry-and-year median WC from each WC and then normalizing it by the by-industry-and-year standard deviation to control variations. Finally, the study follows Bartov (1993) in mitigating the potential heterogeneity between the dependent and exploratory variables by scaling the adjWC of each firm to its monthly market value.

As prior studies have provided mixed impacts of WC on stock returns, initial testing considered the nonlinearity between WC and stock returns cross-sectionally by constructing a baseline model:

$$RET_{i,t} = \beta_{0,t} + \beta_{1,t}BM_{i,t-1} + \beta_{2,t}SZ_{i,t-1} + \beta_{3,t}WC_{i,t-1} + \beta_{4,t}WC^2_{i,t-1} + \varepsilon_{it} \quad (1)$$

The primary exploratory variable is WC. WC and the square of WC (WC^2) help detect the nonlinearity between stock returns (RET) and WC. The study follows Fama and French (1992) in adding size (SZ) and the book-to-market (BM) ratio as they are two popular variables in asset pricing studies. The study also follows Hung and Yang (2018) in computing SZ and BM as the natural logarithms of market capitalization and the book-to-market ratio.

In model 2, the study follows Chauhan and Banerjee (2018) in adding financial constraint variables (FINCON) such as return on equity (ROE), leverage (LEV), and the natural logarithm of net sales (NS) into the baseline model. Chauhan and Banerjee (2018) argued that businesses with persistent high profitability have lower financial limitations, which should increase stock returns. Meanwhile, they also stated that companies with a high debt ratio face higher interest costs since they are riskier and have higher financial constraints. Therefore, it is expected that ROE and NS affect stock returns positively. Meanwhile, the relationship between LEV and stock returns is likely to be statically negative. Thus, model 2 was constructed to examine the relationship between financial constraints and stock returns.

$$RET_{i,t} = \beta_{0,t} + \beta_{1,t}BM_{i,t-1} + \beta_{2,t}SZ_{i,t-1} + \beta_{3,t}WC_{i,t-1} + \beta_{4,t}WC^2_{i,t-1} + \beta_{5,t}FINCON_{i,t-1} + \varepsilon_{i,t-1} \quad (2)$$

Following Ang *et al.* (2006), idiosyncratic volatility (IVOL) and total volatility (TVOL) were employed as factors of RISK in the baseline model. A negative and significant relationship is expected between RISK and cross-sectional stock returns.

[5] Fama and French (1992) recommend a six-month gap to ensure investors have all the published financial statements.

$$RET_{i,t} = \beta_{0,t} + \beta_{1,t}BM_{i,t-1} + \beta_{2,t}SZ_{i,t-1} + \beta_{3,t}WC_{i,t-1} + \beta_{4,t}WC^2_{i,t-1} + \beta_{5,t}IVOL_{i,t-1} + \beta_{6,t}TVOL_{i,t-1} + \varepsilon_{i,t-1} \quad (3)$$

In model 4, the study follows Tong (2008) in adding growth variables such as the growth in net income (NIG) and total assets (TAG) into the baseline model. The growth variables represent agency costs and information asymmetry, which subsequently affect stock returns. Following Tong (2008), Fama and French (2008), and Lam and Wei (2011), a significant relationship is expected between the growth variables and cross-sectional stock returns.

$$RET_{i,t} = \beta_{0,t} + \beta_{1,t}BM_{i,t-1} + \beta_{2,t}SZ_{i,t-1} + \beta_{3,t}WC_{i,t-1} + \beta_{4,t}WC^2_{i,t-1} + \beta_{5,t}NIG_{i,t-1} + \beta_{6,t}TAG_{i,t-1} + \varepsilon_{i,t-1} \quad (4)$$

Finally, all exploratory variables were combined in one model to examine cross-sectionally the impacts of WC, financial constraints, growth, and risk factors, on stock returns. Appendix A displays the complete explanations of the variables.

$$RET_{i,t} = \beta_{0,t} + \beta_{1,t}BM_{i,t-1} + \beta_{2,t}SZ_{i,t-1} + \beta_{3,t}WC_{i,t-1} + \beta_{4,t}WC^2_{i,t-1} + \beta_{5,t}IVOL_{i,t-1} + \beta_{6,t}TVOL_{i,t-1} + \beta_{7,t}FINCON_{i,t-1} + \beta_{8,t}NIG_{i,t-1} + \beta_{9,t}TAG_{i,t-1} + \varepsilon_{i,t-1} \quad (5)$$

In each model, the study follows Khoa *et al.* (2020) in obtaining the WC turning point that balances the liquidity risks and benefits of investing in WC by computing $|\beta_3/(2*\beta_4)|$. It is expected that the WC coefficient in all equations will be significantly negative and align with the trade-off theory. Additionally, it is expected that the coefficient of WC^2 will be positive, consistent with the liquidity preference theory. Consequently, the study aims to determine the minimal level of WC that minimizes the stock returns.

Following Tong (2008) and Khoa *et al.* (2020), the study tests whether deviations from the minimum WC level affect stock returns cross-sectionally. If there is evidence of a U-shape relation between WC and stock returns, any deviations from the minimum WC level are likely to increase stock returns. Therefore, the study follows Tong (2008) and Khoa *et al.* (2020) in constructing a WC benchmark model.

$$WC_{i,t-1} = \beta_{0,t-1} + \beta_{1,t-1}BM_{i,t-1} + \beta_{2,t-1}SZ_{i,t-1} + \beta_{3,t-1}IVOL_{i,t-1} + \beta_{4,t-1}TVOL_{i,t-1} + \beta_{5,t-1}FINCON_{i,t-1} + \beta_{6,t-1}NIG_{i,t-1} + \beta_{7,t-1}TAG_{i,t-1} + u_{i,t-1} \quad (6)$$

The study then follows Tong (2008) in examining whether the WC residuals from the benchmark specification affect the stock returns. Following Tong (2008) and Khoa *et al.* (2020), DEVIATION is defined as the absolute value of the residuals computed in Equation (5). Above-Minimum Dummy is defined as a dummy variable that equals 1 if the residual is positive and equals 0 otherwise. The study then follows Tong (2008) and Khoa *et al.* (2020) in developing an INTERACT variable to determine whether deviations from the minimum WC can lower stock returns. In Equation 6, WC and WC^2 are replaced with the DEVIATION variable to test whether the deviations from the minimum WC level affect stock returns in the entire sample. In Equation (6a), regression model 6 is run for the sample below the WC minimum level. The DEVIATION coefficient should be positively significant, implying that any deviations from the left-hand side of the minimum WC level reduce stock returns. In Equation (6b), regression model 6 was run for the entire sample with the INTERACT variable. It is expected that the coefficient of deviation will be positive, and the total value of the coefficients of DEVIATION and INTERACT are positive and statistically significant. It is expected that the study will determine the significantly favorable effects of deviations from both sides of the WC minimum level on cross-sectional stock returns.

$$RET_{i,t} = \beta_{0,t} + \beta_{1,t}DEVIATION_{i,t-1} + \beta_{2,t}BM_{i,t-1} + \beta_{3,t}SZ_{i,t-1} + \beta_{4,t-1}IVOL_{i,t-1} + \beta_{5,t-1}TVOL_{i,t-1} + \beta_{6,t}FINCON_{i,t-1} + \beta_{7,t-1}NIG_{i,t-1} + \beta_{8,t-1}TAG_{i,t-1} + \varepsilon_{i,t-1} \quad (7)$$

$$RET_{i,t} = \beta_{0,t} + \beta_{1,t}DEVIATION_{i,t-1} + \beta_{2,t}BM_{i,t-1} + \beta_{3,t}SZ_{i,t-1} + \beta_{4,t-1}IVOL_{i,t-1} + \beta_{5,t-1}TVOL_{i,t-1} + \beta_{6,t}FINCON_{i,t-1} + \beta_{7,t-1}NIG_{i,t-1} + \beta_{8,t-1}TAG_{i,t-1} + \varepsilon_{i,t-1} \quad (7a)$$

$$RET_{i,t} = \beta_{0,t} + \beta_{1,t}DEVIATION_{i,t-1} + \beta_{2,t}INTERACT_{i,t-1} + \beta_{3,t}BM_{i,t-1} + \beta_{4,t}SZ_{i,t-1} + \beta_{5,t-1}IVOL_{i,t-1} + \beta_{6,t-1}TVOL_{i,t-1} + \beta_{7,t}FINCON_{i,t-1} + \beta_{8,t-1}NIG_{i,t-1} + \beta_{9,t-1}TAG_{i,t-1} + \varepsilon_{i,t-1} \quad (7b)$$

Finally, portfolio sorting methods were conducted between deviations from the minimum WC level and control variables to test whether deviation from the minimum WC level is an arbitrary factor cross-sectionally. Following Hung and Yang (2018), it is expected that the zero-cost portfolio of long-buying stocks will have the highest deviations from the minimum WC and short-selling stocks with the slightest deviations from the minimum WC stocks will generate positive and significant returns.

4. EMPIRICAL FINDINGS

4.1 Descriptive statistics

Table I reports summary statistics for the characteristics of the sample firms. The average monthly stock return is -0.1% per month, while its standard deviation is 9.9%. Also, the average WC of the sample is 0.5%. It is worth noting that WC has an average value of 0.005, implying that for each 1,000 TWD market capitalization, 5 TWD is tied in WC. Moreover, the average values of SZ, BM, LEV, IVOL, TVOL, NS, ROE, NIG, and TAG were 22.378, -6.830, 0.021, 9.397, 2.015, 14.528, 0.025, -0.270, and 0.051, respectively.

4.2 The Non-Linear Relationship Between Working Capital and Stock Returns

Fama and MacBeth's (1973) regressions were conducted to estimate the effects of WC and other control variables on stock returns. In model 1, two popular variables: BM and SZ, were examined. The results suggest that the coefficients for WC are negative and statistically insignificant. However, the coefficients of WC^2 are positively significant at a 5% confidence level.

In model 2, the study follows Chauhan and Banerjee (2018) in adding the financial constraint variables. The results from model 2 indicate that the coefficients of WC and WC^2 are statistically significant. The control variables were statistically significant, except SZ and NS. The results from model 2 suggest the existence of nonlinearity between WC and

Table 1 Descriptive Statistics

Variable	N	Mean	Std Dev	Median	Minimum	Maximum
RET	82,277	-0.142	9.936	0.000	-52.596	45.863
WC	82,277	0.005	0.092	0.003	-0.416	0.597
SZ	82,277	22.378	1.222	22.228	20.065	25.371
BM	82,277	-6.830	0.615	-6.766	-8.307	-5.245
LEV	82,277	0.021	0.029	0.006	0.000	0.111
IVOL	82,277	9.397	4.419	8.570	2.652	28.872
TVOL	82,277	2.015	0.996	1.855	0.395	5.602
NS	82,277	14.528	1.398	14.411	11.910	18.110
ROE	82,277	0.025	0.045	0.020	-0.133	0.220
NIG	82,277	-0.270	1.703	-0.183	-7.436	5.612
TAG	82,277	0.051	0.130	0.034	-0.243	0.561

Note: Table 1 reports the descriptive statistics for Taiwan-listed companies from 2005 through 2020. All variable definitions are reported in Appendix A. The final sample contained 82,277 firm-month observations cross-sectional stock returns. Acheampong *et al.* (2014) and Duong et al. (2022) indicated that high-leverage stocks generate low returns as insolvent firms encounter more restrictions in accessing external capital. Thus, a higher leverage ratio leads to higher financing costs and subsequently reduces stock returns.

Additionally, there is a positive relationship between ROE and cross-sectional stock returns. Lamont *et al.* (2001) indicated that higher profitability companies have fewer financial constraints to external financing instruments. Petersen and Rajan (1997) also showed that more profitable firms have greater access to trade credit from suppliers. Therefore, profitable firms save financing costs, generating higher stock returns than less profitable firms. While these findings are in line with Lamont *et al.* (2001) and Acheampong *et al.* (2014), they are inconsistent with Whited and Wu (2006).

In model 3, the financial constraint variables were replaced with risk factors such as IVOL and TVOL. It was determined that the coefficients of WC and WC^2 remain statistically significant. Therefore model 3 also reports nonlinearity between WC and stock returns. Model 3 suggests inverse impacts of IVOL and TVOL on cross-sectional stock returns. However, the coefficient of IVOL is statistically insignificant. Although the results are inconsistent with Ang *et al.* (2006), they are consistent with George and Hwang (2010) and Ang *et al.* (2009).

Model 4 determined the effects of WC and growth variables on stock returns cross-sectionally. Similar to model 1, it was determined that the WC coefficient is negative and insignificant. Meanwhile, the coefficient of WC^2 is positive and significant. Model 4 suggests a positive relationship between Net Income Growth and stock returns. This result is consistent with Lamont *et al.* (2001) as higher-growth firms earn higher stock returns. Although model 4 indicates evidence of an asset growth anomaly, the coefficient of TAG is insignificant. This finding is inconsistent with Cooper *et al.* (2008).

Model 5 reports the combined impacts of WC and nine control variables on stock returns. The results indicate that the coefficients of WC and WC^2 also remain statistically significant. The negative WC coefficient suggests managers make a trade-off between liquidity and stock returns (Huang & Mazouz, 2018). These results indicate that increased WC drags the stock returns down to the breakpoint. After that, holding excess WC increases stock returns cross-sectionally. The results align with Pham *et al.* (2018) as the positive effect of asset liquidity on innovation helps firms reduce capital costs. Pham *et al.* (2018) also suggested that increasing WC helps firms reduce the negative impacts of cash flow volatility and external financing costs. Consequently, surplus WC supports firms to improve performance and increase stock returns.

The coefficients of SZ are statistically insignificant in the five models. These results are consistent with James and Edmister (1983) who argued that there is no correlation between returns and company size when trading activity is held constant. Meanwhile, BM remains positive and significant across all models, consistent with Fama and French (1992).

Model 5 also reports that financial constraints have mixed impacts on stock returns. The coefficient of LEV was negatively significant, indicating that firms with high leverage ratios face high financial constraints, leading to lower stock returns (Acheampong *et al.*, 2014). Meanwhile, the NS has insignificant impacts on cross-sectional stock returns. Finally, ROE positively affects stock returns and reports that a firm with high profitability exhibits fewer financial constraints, leading to higher stock returns. These findings align with Lamont *et al.* (2001) and are inconsistent with Whited and Wu (2006).

Model 5 shows that the coefficients of total returns volatility are negative and significant. Our findings are consistent with George and Hwang (2010); Ang *et al.* (2009). However, the IVOL is negative and insignificant, inconsistent with Ang *et al.* (2006). Finally, the findings suggest the existence of an asset growth anomaly in Taiwan due to the TAG is negative and significant, consistent with Cooper *et al.* (2008).

In the sampling data, 51.96% of observations are on the left-hand side of the turning point. In other words, 48.04% of observations exceed the minimum level of WC in Taiwan, which is on the right-hand side of the turning point. This raises the question of whether deviations from the left-hand side or right-hand side of the turning point affect stock returns in Taiwan. Accordingly, the study follows Tong (2008) in employing a dummy variable to divide firms into a left-hand side and right-hand side sample of the minimum WC level. Models 7, 7a, and 7b were then run to answer the above question.

After detecting a non-linear relationship between stock returns and WC, WC was estimated using Equation (6). Some results for the explanatory variables are presented in Table 3. With the exception of TAG and NS, the explanatory variables are significantly associated with WC. Firm size is positively related, suggesting that a greater size can decrease information asymmetry. Therefore,

Table 2 Firm-level Regression Models

RET					
	(1)	(2)	(3)	(4)	(5)
WC	-0.630	-1.220***	-1.230***	-0.672	-1.636***
	(-1.41)	(-2.76)	(-2.84)	(-1.56)	(-3.87)
WC^2	11.490**	13.279***	9.883**	11.249**	11.232***
	(2.46)	(2.83)	(2.30)	(2.44)	(2.62)
SZ	0.043	-0.033	0.009	0.044	-0.024
	(0.62)	(-0.38)	(0.14)	(0.63)	(-0.29)
BM	0.803***	0.816***	0.621***	0.803***	0.659***
	(5.36)	(5.19)	(5.18)	(5.41)	(5.01)
LEV		-3.894***			-3.731***
		(-3.00)			(-3.11)
IVOL			-0.038		-0.036
			(-1.56)		(-1.52)
TVOL			-0.407***		-0.348***
			(-3.54)		(-3.14)
NS		0.081			0.044
		(1.31)			(0.79)
ROE		6.835***			6.428***
		(3.41)			(3.60)
NIG				0.045*	0.013
				(1.68)	(0.53)
TAG				-0.170	-0.868***
				(-0.44)	(-2.88)
ADJ.R^2	0.028	0.046	0.063	0.033	0.079
Break Point	0.027	0.046	0.062	0.030	0.073

Note: For each month, a cross-sectional regression was conducted at the corporate level for the return in that month using a portion of lagged independent factors. All variable definitions are reported in Appendix A. Squared WC is computed as WC2, capturing the non-linear relationship between WC and stock returns. The breakpoint is calculated as |βWC / 2βWC2|.

larger firms effectively reach suppliers for trade credit transactions. As a result, large corporations could reduce their working capital as they have higher supplier trade credits.

Similarly, firms with a higher market-to-book ratio include lower information asymmetry, allowing firms to decrease their working capital. While WC is negatively associated with leverage (LEV), it is positively related to profitability (ROE). A well-performed company will raise its working capital in preparation for future expansion. Firms may substitute a component of their working capital by utilizing long-term debt, leading to a negative relationship between WC and LEV. This result also shows that volatility risk can reduce the enterprise's working capital. Stock return volatility (TVOL) and idiosyncratic volatility (IVOL) increase distress risk. According to the pecking order theory, retained earnings and cash holdings are initially preferred to be employed due to of the lowering financial costs. Consequently, firms with higher stock return volatility and idiosyncratic volatility have lower cash holdings and working capital as they make a trade-off between risk and liquidity. These results align with Khoa *et al.* (2020), trade-off theory and the pecking order theory.

Table 4 reports the results of DEVIATIONS from minimum WC and stock returns. It shows that deviations remain positive and significant at a reasonable level across all samples, implying that any deviations from the minimum level of WC increase stock returns. The last column of Table 4 presents regression with the interaction term. The findings from model 7b show that DEVIATIONS are also positive and significant. However, the coefficients of the INTERACT term are negative and significant, suggesting that the below-minimum WC side enhances stock returns more than the above-minimum WC side. In other words, firms with a below-minimum WC level can gain higher stock returns than

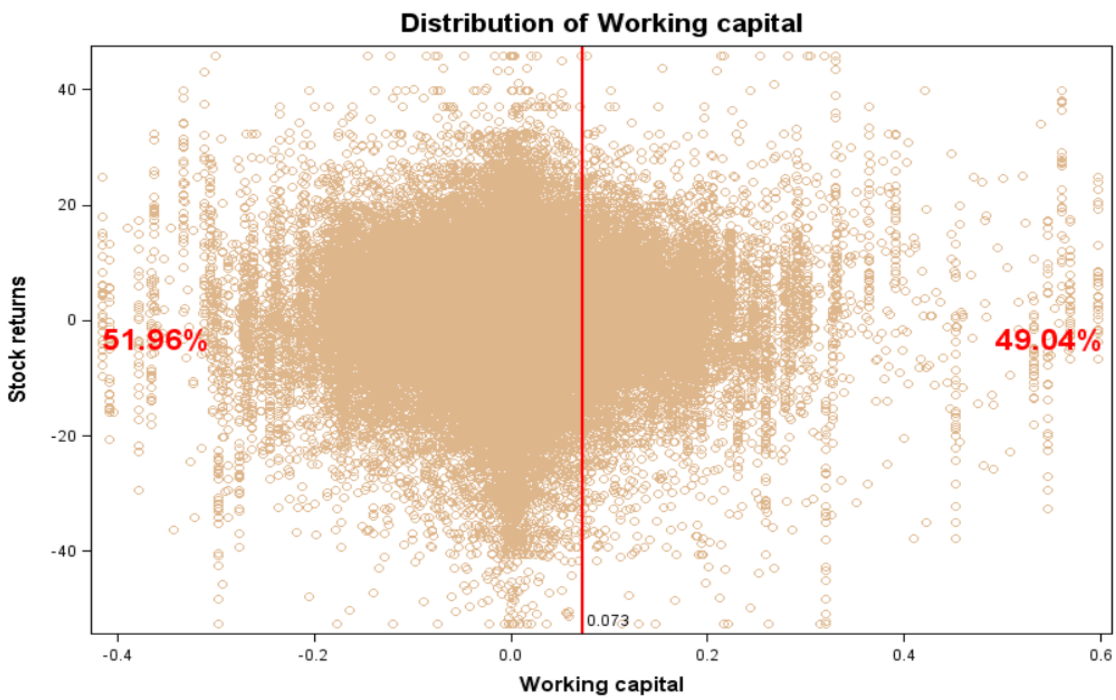

Figure 1 Distribution of Working Capital

Table 3 Benchmark Specification

BM	SZ	IVOL	LEV	ROE	TAG	NS	NIG	TVOL	ADJ.R
0.042***	0.041***	-0.002***	-0.528***	0.177***	0.003	0. 0001	-0.002***	-0.002***	0.272
(26.22)	(34.35)	(-11.14)	(-20.69)	(21.46)	(1.39)	(-0.59)	(-7.15)	(-3.06)	

Note: All variables are winsorized at 5% and 95% levels. T-values are in parentheses. WC is the dependent variable. All variable definitions are reported in Appendix A

those with WC exceeding the minimum WC. Thus, the study follows Tong (2008) in estimating the total value of the DEVIATION and INTERACT coefficients. It is determind that the total value of the sums is positive, with results indicating that deviation on either side of the minimum WC increases stock returns.

Consistent with predictions, Table 4 confirms a large and statistically significant U-shaped relationship between WC and stock returns. A trade-off relationship exists between liquidity and stock returns for firms that do not meet the WC minimum level.

However, the findings indicate that excess WC allows continuous production and fewer financial constraints to external financing. Therefore, firms may also quickly seize potential opportunities when they have excess WC. This finding is also consistent with Pham *et al.* (2018) as stockpiling WC above the minimum level of WC positively affects stock returns. Unfortunately, these results are inconsistent with the findings of Tong (2008) and Khoa *et al.* (2020) as the research applies Fama Macbeth's (1973) regressions rather than panel data regressions.

Table 4 Deviation and Interaction from The Required WC

	RET		
	Model 7	Model 7a	Model 7b
DEVIATION	1.368*	3.448***	3.257***
	(1.71)	(3.69)	(3.51)
INTERACT			-3.211***
			(-3.99)
SZ	-0.087	-0.064	-0.088
	(-1.10)	(-0.76)	(-1.11)
BM	0.603***	0.428***	0.589***
	(4.67)	(3.52)	(4.55)
LEV	-3.061**	-3.182*	-2.992**
	(-2.54)	(-1.86)	(-2.49)
IVOL	-0.033	-0.047*	-0.035
	(-1.42)	(-1.85)	(-1.47)
TVOL	-0.344***	-0.303***	-0.347***
	(-3.11)	(-2.70)	(-3.14)
NS	0.049	0.026	0.048
	(0.88)	(0.43)	(0.86)
ROE	6.140***	5.931***	6.112***
	(3.43)	(2.78)	(3.42)
NIG	0.016	0.024	0.014
	(0.66)	(0.87)	(0.60)
TAG	-0.902***	-0.879**	-0.925***
	(-2.99)	(-2.49)	(-3.06)
ADJ.R^2	0.078	0.077	0.079

Note: all parameters are winsorized at the 5% and 95% levels excepts DEVIATION and INTERACT variables. T-values are in parentheses. All variable definitions are reported in Appendix A. In model 5, DEVIATION is the absolute value of the residuals. INTERACT is the interaction term between DEVIATION and the above-minimum dummy. The above-minimum dummy equals 1 if the WC exceeds the minimum level and equals 0 otherwise

5. ARBITRARY PORTFOLIO SORTING METHODS

5.1 Univariate Sorting by Deviation

This section tests whether a zero-cost arbitrary portfolio can be constructed by sorting all stocks into quintile portfolios based on DEVIATION. The study follows Duong *et al.* (2022), Ang *et al.* (2006), and Hung and Yang (2018) in performing monthly univariate sorting stocks based on their DEVIATION. Portfolio 1 (low DEVIATION) contains stocks with the lowest DEVIATION, while portfolio 5 (high DEVIATION) contains stocks with the highest DEVIATION over the past month. The zero-cost portfolio is defined as long-buying stocks with the highest DEVIATION and short-selling stocks with the lowest DEVIATION. Table 5 reports the average monthly value-weighted and equal-weighted raw returns and Fama and French's (1993) three-factor alphas for all DEVIATION portfolios. The returns of zero-cost arbitrary portfolios and their alphas are all significantly positive, indicateing a positive relationship between DEVIATION and future stock returns. Table 5 suggests that investors generate positive arbitrary profits when they perform univariate sorting by DEVIATION. This finding matches the firm-level regression result, indicating that DEVIATION has a positive relationship with stock returns.

5.2 Bivariate sorting by deviation and control variables

This section examines whether arbitrary DEVIATION portfolio returns are pronounced after controlling for financial constraints, risks, and growth factors. Therefore, it was examined whether other firms' characteristics help explain the positive DEVIATION effect. The study follows Duong *et al.* (2022), Ang *et al.* (2006), Hung and Yang (2018) in performing a sequential double-sorting procedure to control for a set of characteristics, including BM, SZ, IVOL, NIG, LEV, ROE, TAG, NS, and TVOL. Table 6 reports the average monthly value-weighted and equal-weighted raw returns and Fama and French's (1993) three-factor alphas for all DEVIATION portfolios after controlling for the firm's characteristics. Table 6 reports that the returns of zero-cost arbitrary portfolios and their alphas are all positive, suggesting that the DEVIATION effect is robust after controlling for risks, growth, and financial constraints. The findings suggest that financial constraints, such as LEV and

Table 5 Univariate Sorting By WC

Quintiles	Value-weighted Portfolios	Equal-weighted Portfolios
Low WC	-0.510	-0.194
2	-0.441	-0.162
3	-0.588	-0.167
4	-0.415	-0.136
High WC	0.008	0.062
Return difference	0.518**	0.256*
	(2.57)	(1.73)
Alpha difference	0.519**	0.257*
	(2.54)	(1.75)

Note: Quintile portfolios are sorted stocks based on the average WC over the previous month. Portfolio 1 (5) is the portfolio of stocks with the lowest (highest) WC over the past month. The table reports the value-weighted and equal-weighted average monthly returns. The last two rows present the differences in monthly returns and the Fama and French three-factor alpha difference between portfolios 5 and 1. The average raw return is expressed as a percentage. T-statistics are presented in parentheses.

Table 6 Bivariate Sorting by WC and Fundamental Variables

Panel 6A: value-weighted portfolios

Quintile	SZ	BM	LEV	IVOL	TVOL	NS	ROE	NIG	TAG
Low WC	-0.347	-0.292	-0.405	-0.428	-0.465	-0.526	-0.393	-0.543	-0.499
2	-0.369	-0.119	-0.496	-0.258	-0.277	-0.382	-0.422	-0.543	-0.454
3	-0.310	-0.282	-0.400	-0.465	-0.384	-0.530	-0.550	-0.571	-0.521
4	-0.074	-0.253	-0.253	-0.390	-0.413	-0.527	-0.437	-0.410	-0.351
High WC	0.159	0.035	-0.005	-0.040	-0.061	-0.239	-0.084	-0.065	-0.052
Return difference	0.352	0.327*	0.285	0.389**	0.404**	0.288	0.309*	0.478***	0.447**
	(1.37)	(1.74)	(1.20)	(2.04)	(2.22)	(1.64)	(1.84)	(2.75)	(2.49)
Alpha difference	0.415	0.318*	0.301	0.366*	0.387**	0.264	0.299*	0.485***	0.457**
	(1.50)	(1.67)	(1.25)	(1.87)	(2.06)	(1.45)	(1.75)	(2.73)	(2.49)

Panel 6B: Equal-weighted portfolios

Quintile	SZ	BM	LEV	IVOL	TVOL	NS	ROE	NIG	TAG
Low WC	-0.341	-0.171	-0.150	-0.138	-0.161	-0.225	-0.121	-0.190	-0.197
2	-0.393	-0.089	-0.134	-0.078	-0.082	-0.095	-0.120	-0.152	-0.145
3	-0.192	-0.163	-0.033	-0.217	-0.169	-0.136	-0.181	-0.166	-0.177
4	-0.038	-0.186	-0.044	-0.195	-0.171	-0.164	-0.155	-0.139	-0.145
High WC	0.276	0.016	0.049	0.003	0.009	-0.049	0.025	0.028	0.066
Return difference	0.432	0.187	0.101	0.140	0.170	0.176	0.146	0.218	0.263*
	(1.60)	(1.22)	(0.56)	(1.01)	(1.18)	(1.10)	(1.12)	(1.58)	(1.89)
Alpha difference	0.522*	0.192	0.105	0.142	0.170	0.170	0.134	0.221	0.258*
	(1.80)	(1.26)	(0.58)	(1.02)	(1.18)	(1.03)	(1.03)	(1.61)	(1.85)

Note: Value-weighted portfolios (Panel A) and equal-weighted portfolios (Panel B) were formed for each month. Stocks were double-sorted based on the working capital after controlling for firm size (SZ), book-to-market ratio (BM), leverage ratio (LEV), Idiosyncratic volatility (IVOL), total volatility (TVOL), Net income growth (NIG), Net sales (NS), return on equity (ROE) and Total asset growth (TAG). Stocks were first sorted into quintiles using the control variable. Then within each quintile, stocks were sorted into quintile portfolios based on the working capital over the previous month. Therefore, quintile 1 (5) contains stocks with the lowest (highest) WC. The following table presents the average returns across the fifth control quintile to produce quintile portfolios with dispersion in WC but with similar control variables. The row near the end shows how the High WC and Low WC portfolios performed differently regarding monthly returns. The appropriate t-statistics are in parentheses. Raw and adjusted average returns are reported as percentages

ROE, enhance the zero-cost arbitrary DEVIATION portfolio returns. For instance, panel 6a indicates the value-weighted average monthly returns difference between High DEVIATION and Low DEVIATION portfolios after controlling for financial constraints variables such as LEV and ROE was 0.93% and 0.70% per month, respectively.

Similarly, panel 6b reports that the equal-weighted average monthly returns difference between High DEVIATION and Low DEVIATION portfolios are 0.71% and 0.53% per month, respectively. The findings indicate that the NIG and TAG empower the zero-cost arbitrary DEVIATION portfolio equal-weighted and value-weighted returns. However, after controlling for IVOL, TVOL, NS, and SZ, the arbitrary DEVIATION portfolio returns are reduced. Finally, Table 6 indicates that arbitrary portfolio value-weighted and equal-weighted returns remain positive but insignificant after controlling for BM. In short, Table 6 recommends that the DEVIATION effect is priced after controlling for risks, growth, and financial constraints factors. Therefore, the findings suggest that investors should perform bivariate sorting methods between DEVIATION and LEV, ROE, NIG, and TAG to capture higher zero-cost arbitrary profits.

6. CONCLUSION

This study is the first to examine the impacts of WC and financial constraints on cross-sectional stock returns in Taiwan. The findings provide evidence of the U-shaped relationship between working capital and stock returns in the Taiwan market, where about 52% of firms do not meet the minimum WC level. Moreover, financial constraints have mixed effects on cross-sectional stock returns in Taiwan. Furthermore, the nonlinearity between WC and stock returns is robust after controlling for financial constraints, risks, and growth factors. Finally, the findings indicate that deviations from both sides of the minimum WC level generate higher stock returns. The empirical results are consistent with the trade-off theory and liquidity preference theory.

Portfolio analysis was performed to test whether investors earn arbitrary profits by trading on the DEVIATION from the minimum WC level. The results of the study suggest that investors generate positive profits by sorting stocks by WC. A sequential double-sorting procedure was also employed to test whether the positive DEVIATION effect is robust after controlling for financial constraints, risks, and growth factors. The findings indicate that financial constraints and growth factors empower the zero-cost arbitrary DEVIATION portfolio equal-weighted and value-weighted returns. Although the arbitrary DEVIATION portfolio returns remain positive and significant, they are slightly reduced after controlling for IVOL, TVOL, NS, and SZ. Therefore, DEVIATION is a priced factor that generates arbitrary positive returns for investors.

ACKNOWLEDGMENTS: We also thank anonymous reviewers for their constructive feedback, which helped in revising the manuscript.

FUNDING STATEMENT: This study was supported by Ton Duc Thang University and Ho Chi Minh City Open University.

CONFLICT OF INTEREST STATEMENT: There is no conflict of interest to disclose.

DATA AVAILABILITY STATEMENT: The data used in this study is available upon reasonable request.

ETHICS STATEMENT: This study does not involve animals or humans.

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Appendix A: Variable Definitions

Notations	Definitions	Measuring
BM	Book-to-market ratio	Natural logarithm of the total book value of equity divided by the market value of equity
SZ	Size	Natural logarithm of market value in June
adjWC	Adjusted Working capital	(Working capital - median $_{\text{by industry and year}}$ working capital)/standard deviation $_{\text{by industry and year}}$ working capital
WC	Working capital	Adjusted Working capital scaled by market value
IVOL	Idiosyncratic volatility	the rolling standard deviation of the residual values from the Fama and French model
NIG	Net income growth	(Net income - Net income$_{t-1}$)/Net income$_{t-1}$
LEV	Leverage	Long-term debt, scaled by total assets
ROE	Return on equity	Net income divided by average total equity of year t and year t -1
TAG	Total assets growth	(Total assets - Total assets $_{t-1}$)/ Total assets $_{t-1}$
NS	Net Sales	Natural logarithm of Net sales
TVOL	Total stock volatility	The volatility of daily raw returns over the previous month.
DEVIATION		Deviation from optimal WC is defined as the absolute value of the residuals in Equation (5)
INTERACT		The interaction term between DEVIATION and Above-optimal dummy. The above-optimal dummy equals one if the actual WC is higher than the optimal WC and equals 0 otherwise.