Does the productivity of labour influence credit risk? New evidence from South Korea

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Published version

LIM, Hyoungh-Joo and MALI, Dafydd (2018). Does the productivity of labour influence credit risk? New evidence from South Korea. *Asia Pacific Journal Of Accounting and Economics*.

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Table 1 Model Selection

Panel A: Selection of Proxies

Key determinants of CR	Proxies
Firm performance	OI , NI, CPS, ROA, ROS, ROE
Size	Total assets , Sales Revenue, Market value of equity
Liquidity risk	Current ratio , quick ratio, cash ratio
Cash risk	CFO to TL , CFO to O.E, CFO to TA
Lev	Total liabilities/total owners' equity
Loss	Total liabilities/total assets Negative NI , Negative OI
Accrual based earnings management	DAMJ (from modified jones modes, 1995) DAKO (from performance adjusted model, 2005) ABMJ (Absolute value of DAMJ) ABKO (Absolute value of DAKO)
Real earnings management	TRM (Real earnings management measures)
Monitoring	Big4 Foreign investor Institutional investors

Panel B: Variable definitions

Dependent Variable	Sign	Definition
CR _{t+1}		Credit ratings at time t+1
Variables of Interest		
Productivity	-	Natural logarithm of Labor productivity, measured by Sales revenue / number of full time equivalents
Control Variables		
1. Firm performance & Size		
Performance	+	Profitability measured by operating income/Total assets
Size	+	Natural logarithm of prior year total assets
2. Business Risk		
Liquidity risk	+	(Current assets - Current liabilities) / Total assets
Cash risk		Cashflow from operation / Total liabilities
LEV	-	debt ratio (=total liabilities / total owner's equity)
LOSS	-	A dummy variable that takes 1 if a firm's net income is negative, 0 otherwise
3. Earnings Management		
AEM	-	Absolute value of discretionary accruals suggested by Dechow et al.(1995)
REM	-	AbCFO*(-1) + AbProd + AbSGA*(-1) suggested by Roychowdhury(2006)
4. Monitoring		
Big4	?	A dummy variable that takes 1 if a firm's auditor is Big4, 0 otherwise
Fore	+	Foreign investors' share holdings(%)
5. Fixed effect		
ID		Industry fixed effect
YD		Year fixed effect

Table 2 Sample Selection

Panel A: Productivity of labor and CR sample from 2002-2013

Initial CR Sample	2080
Excluding Post periods	362
Potential Sample	1718
Excluding firms with no financial data available	62
Final Sample	1666

Panel B: Sample selection by credit ratings

CR scores	CR	Obs	CR sores	CR	Obs
17	AAA	88	8	BBB-	153
16	AA+	70	7	BB+	61
15	AA	82	6	BB	67
14	AA-	159	5	BB-	70
13	A+	163	4	B+	42
12	A	170	3	B	28
11	A-	183	2	B-	16
10	BBB+	152	1	Below B-	36
9	BBB	126	Total		1644

Table 3 Descriptive statistics and Pearson product-moment correlation

Panel A: Descriptive statistics and mean(median) difference test

Var	1) Full(Obs: 1,666)			2) IG(Obs: 915)			3) NIG(Obs: 751)			2)-3)	
	Mean (Med)	Max (Min)	S.D.	Mean (Med)	Max (Min)	S.D.	Mean (Med)	Max (Min)	S.D.	t (z)	
CR _{t+1}	10.57 (11)	17 (1)	3.81	13.38 (13)	17 (11)	1.89	7.16 (8)	10 (1)	2.55	57.03*** (35.28)***	
Prod	6.74 (6.60)	9.78 (4.95)	0.99	6.91 (6.67)	9.78 (5.09)	1.09	6.53 (6.52)	8.92 (4.95)	0.82	8.02*** (6.29)***	
Size	20.67 (20.57)	24.39 (17.58)	1.60	21.30 (21.18)	24.84 (18.37)	1.46	19.90 (19.71)	23.33 (17.34)	1.42	19.62*** (17.58)***	
Liquidity	0.05 (0.05)	0.48 (-0.41)	0.18	0.07 (0.07)	0.43 (-0.30)	0.15	0.03 (0.02)	0.51 (-0.47)	0.20	4.21*** (4.17)***	
Profit	0.21 (0.20)	0.75 (-0.63)	0.28	0.30 (0.27)	0.77 (-0.03)	0.27	0.09 (0.09)	0.51 (-0.84)	0.24	16.69*** (19.98)***	
Cash Risk	14.73 (9.84)	102.26 (-17.84)	32.27	20.91 (14.19)	143.4 (-14.62)	40.84	7.20 (5.53)	56.88 (-20.61)	13.27	8.83*** (14.13)***	
Lev	1.53 (1.15)	8.54 (0.39)	1.95	1.06 (0.90)	4.37 (0.04)	0.89	2.09 (1.48)	14.06 (0.18)	2.63	-11.17*** (-14.79)***	
AEM	0.06 (0.04)	0.36 (0.00)	0.06	0.05 (0.03)	0.27 (0.00)	0.05	0.06 (0.04)	0.36 (0.00)	0.07	-4.56*** (-3.96)***	
REM	0.03 (0.21)	0.54 (-0.35)	0.21	-0.06 (-0.04)	0.60 (-9.36)	0.24	0.01 (-0.00)	0.49 (-0.41)	0.17	-7.67*** (-7.38)***	
Loss	0.16 (0)	1 (0)	0.36	0.07 (0)	1 (0)	0.25	0.26 (0)	1 (0)	0.44	-10.96*** (-10.59)***	
Big4	0.80 (1)	1 (0)	0.40	0.89 (1)	1 (0)	0.31	0.68 (1)	1 (0)	0.46	11.22*** (10.82)***	
Foreign	0.15 (0.08)	0.73 (0)	0.17	0.21 (0.15)	0.86 (0)	0.18	0.08 (0.02)	0.67 (0)	0.13	14.81*** (17.33)***	

Panel B: Pearson Correlations

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
1. CR _{t+1}	1										
2. Productivity	0.19***	1									
3. Size	0.52***	0.37***	1								
4. Liquidity risk	0.11***	-0.09***	-0.21***	1							
5. Profitability	0.48***	0.01	0.16***	0.26***	1						
6. Cash risk	0.26***	-0.06**	0.05**	0.23***	0.32***	1					
7. Lev	-0.34***	0.09***	0.00	-0.28***	-0.39***	-0.19***	1				
8. AEM	-0.19***	0.01	-0.07***	0.01	-0.16***	-0.07***	0.23***	1			
9. REM	-0.21***	0.22***	-0.13***	0.00	-0.15***	-0.13***	0.08***	0.01	1		
10. Loss	-0.31***	-0.06*	-0.11***	-0.19***	-0.32***	-0.16***	0.29***	0.18***	0.07***	1	
11. Big4	0.30***	0.15***	0.36***	-0.08***	0.12***	0.06**	-0.06**	-0.04*	-0.06***	-0.03	1
12. Foreign	0.43***	0.43***	0.44***	0.08***	0.31***	0.33***	-0.16***	-0.07***	-0.24***	-0.18***	0.21***

t indicates t value for mean-difference test.
z indicates wilcoxon z value for median-difference test.
*, **, *** indicate significance level at 10%, 5%, 1% respectively.
See Table 2 for variable definitions.

Table 4 Results of ordered Probit Regression analysis

$$\text{Model: } CR_{i,t+1} = \gamma_0 + \gamma_1 \text{Productivity}_{i,t} + \gamma_2 \text{Size}_{i,t} + \gamma_3 \text{LiquidityRisk}_{i,t} + \gamma_4 \text{Profitability}_{i,t} + \gamma_5 \text{CashRisk}_{i,t} + \gamma_6 \text{Lev}_{i,t} + \gamma_7 \text{AEM}_{i,t} + \gamma_8 \text{REM}_{i,t} + \gamma_9 \text{Loss}_{i,t} + \gamma_{10} \text{Big4}_{i,t} + \gamma_{11} \text{Foreign}_{i,t} + \text{ID} + \text{YD} + \varepsilon_{i,t}$$

	Sign	Full	IG	NIG
<i>Productivity</i>	+/-	0.06*** (5.93)	0.06*** (5.22)	-0.07*** (-5.47)
<i>Size</i>	+	0.34*** (16.78)	0.19*** (6.71)	0.38*** (10.84)
<i>Liquidity Risk</i>	+	0.69*** (4.37)	0.43* (1.66)	0.48** (2.30)
<i>Profitability</i>	+	0.86*** (4.52)***	0.57*** (4.16)	1.91*** (9.30)
<i>Cash Risk</i>	+	0.003*** (4.07)***	0.00*** (3.02)	-0.00 (-0.43)
<i>Lev</i>	-	-0.15*** (-7.74)	-0.07 (-1.53)	-0.07*** (-3.40)
<i>AEM</i>	-	-1.40*** (-3.41)	-2.92*** (-4.42)	-0.54 (-0.96)
<i>REM</i>	-	-0.71*** (-5.57)	-0.72*** (-4.51)	0.29 (1.24)
<i>Loss</i>	-	-0.32*** (-4.27)***	-0.31** (-2.16)	-0.08 (-0.86)
<i>Big4</i>	+	0.34*** (4.99)	0.09 (0.78)	0.17** (1.96)
<i>Foreign</i>	+	0.68*** (3.88)***	1.08*** (4.75)***	0.29 (0.96)
<i>Industry</i>		<i>Included</i>	<i>Included</i>	<i>Included</i>
<i>Year</i>		<i>Included</i>	<i>Included</i>	<i>Included</i>
<i>Chi2</i>		1197.40***	256.99***	323.64***
<i>Pseudo R2</i>		0.1346	0.0745	0.1026
<i>Obs.</i>		1666	915	751

*, **, *** indicate significance level at 10%, 5%, 1% respectively.
See Panel B of Table 1 for variable definitions.

Table 5 Comparative analysis of IG vs NIG group

Model: $CR_{i,t+1} = \gamma_0 + \gamma_1 Productivity_{i,t} + \gamma_2 IG_{i,t} + \gamma_3 Productivity * IG_{i,t} + \gamma_4 Size_{i,t} + \gamma_5 LiquidityRisk_{i,t} + \gamma_6 Profitability_{i,t} + \gamma_7 CashRisk_{i,t} + \gamma_8 Lev_{i,t} + \gamma_9 AEM_{i,t} + \gamma_{10} REM_{i,t} + \gamma_{11} Loss_{i,t} + \gamma_{12} Big4_{i,t} + \gamma_{13} Foreign_{i,t} + ID + YD + \varepsilon_{i,t}$

	Sign	Model 1	Model 2	Model 4
<i>Intercept</i>	?	-9.38*** (-9.05)	-1.57** (-2.08)	-1.86** (-2.47)
<i>Productivity</i>	-	0.00*** (5.41)	0.00** (2.27)	0.02*** (5.93)
<i>IG</i>	+		4.95*** (40.97)	4.37*** (33.43)
<i>Productivity*IG</i>				0.03*** (6.74)
<i>Size</i>	+	0.94*** (18.03)	0.43*** (11.06)	0.49*** (12.61)
<i>Liquidity</i>	+	2.09*** (4.95)	0.65** (2.16)	0.77*** (2.61)
<i>Profit</i>	-	-2.73* (-1.84)	-0.32 (-0.30)	-0.47 (1.46)
<i>Cashrisk</i>	-	0.01*** (5.92)	0.01*** (4.50)	0.01*** (4.26)
<i>Lev</i>	-	-0.41*** (-10.76)	-0.21*** (-7.56)	-0.19*** (-6.91)
<i>AEM</i>	+	-4.69*** (-4.27)	-3.64*** (-4.70)	-4.25*** (-5.52)
<i>REM</i>	-	-1.96*** (-5.81)	-1.09*** (-4.57)	-0.54** (-2.24)
<i>Loss</i>	-	-1.49*** (-6.78)	-0.60*** (-3.85)	-0.62*** (-4.01)
<i>Big4</i>		0.96*** (5.35)	0.30** (2.32)	0.41*** (3.20)
<i>Foreign</i>		2.29*** (4.81)	1.48*** (4.42)	1.38*** (4.13)
<i>Industry</i>		<i>Included</i>	<i>Included</i>	<i>Included</i>
<i>Year</i>		<i>Included</i>	<i>Included</i>	<i>Included</i>
<i>F value</i>		141.18***	400.56***	376.01***
<i>Adj R2</i>		0.4842	0.7422	0.7454
<i>Obs.</i>		1666	1666	1666

*, **, *** indicate significance level at 10%, 5%, 1% respectively.
See Panel B of Table 1 for variable definitions.

Table 6 Additional Analysis by Industry

Model: $CR_{i,t+1} = \gamma_0 + \gamma_1 Productivity_{i,t} + \gamma_2 Size_{i,t} + \gamma_3 LiquidityRisk_{i,t} + \gamma_4 Profitability_{i,t} + \gamma_5 CashRisk_{i,t} + \gamma_6 Lev_{i,t} + \gamma_7 AEM_{i,t} + \gamma_8 REM_{i,t} + \gamma_9 Loss_{i,t} + \gamma_{10} Big4_{i,t} + \gamma_{11} Foreign_{i,t} + ID + \varepsilon_{i,t}$

Positive industry		Negative industry	
Wholesale business	0.00(4.11)***	Transportation	-0.00(-3.79)***
Food & Beverage	0.02(3.48)***	Biomedical	-0.05(-2.21)**
Non-metallic minerals	0.00(3.28)***	Electricity	-0.00(-2.10)**
Construction	0.01(2.32)**		
Chemicals	0.00(4.27)***		

Table 7 Partitioning sample into expansion and recession time periods for IG/NIG firms

$$\text{Model: } CR_{i,t+1} = \gamma_0 + \gamma_1 \text{Productivity}_{i,t} + \gamma_2 \text{Size}_{i,t} + \gamma_3 \text{LiquidityRisk}_{i,t} + \gamma_4 \text{Profitability}_{i,t} + \gamma_5 \text{CashRisk}_{i,t} + \gamma_6 \text{Lev}_{i,t} + \gamma_7 \text{AEM}_{i,t} + \gamma_8 \text{REM}_{i,t} + \gamma_9 \text{Loss}_{i,t} + \gamma_{10} \text{Big4}_{i,t} + \gamma_{11} \text{Foreign}_{i,t} + ID + YD + \varepsilon_{i,t}$$

	Sign	Full		IG		NIG	
		Expansion	Recession	Expansion	Recession	Expansion	Recession
<i>Productivity</i>	+/-	0.07** (5.48)	0.06*** (2.48)	0.06*** (3.63)	0.05*** (3.65)	-0.04*** (-1.99)	-0.06** (-5.25)
<i>Size</i>	+	0.32*** (10.47)	0.31*** (11.36)	0.18*** (4.10)	0.17*** (4.44)	0.39*** (7.85)	0.35*** (6.95)
<i>Liquidity Risk</i>	+	0.48** (2.09)	0.85*** (3.93)	0.16 (0.40)	0.57* (1.76)	0.63** (2.08)	0.35 (1.19)
<i>Profitability</i>	+	0.68*** (2.64)	0.72*** (3.90)	0.79** (2.19)	0.66*** (2.72)	0.56 (1.04)	-0.46 (-0.29)
<i>Cash Risk</i>	+	0.004*** (4.27)	0.004*** (2.74)	0.003*** (2.72)	0.003** (2.03)	0.005 (1.22)	0.001 (0.31)
<i>Lev</i>	-	-0.20*** (-6.88)	-0.17*** (-7.23)	-0.10 (-1.15)	-0.11** (-2.16)	-0.10*** (-3.00)	-0.10*** (-4.05)
<i>AEM</i>	-	-0.79* (-1.83)	-2.38*** (-4.15)	-2.23** (-2.19)	-3.19*** (-3.70)	-1.55** (-1.98)	-1.98** (-2.36)
<i>REM</i>	-	-0.92*** (-3.17)	-0.88*** (-3.53)	-1.04** (-2.51)	-0.89*** (-2.81)	1.10** (2.30)	0.46 (1.00)
<i>Loss</i>	-	-0.47*** (-3.80)	-0.37*** (-3.92)	-0.49* (-1.68)	-0.29* (-1.76)	-0.29* (-1.91)	--0.29** (-2.20)
<i>Big4</i>	+	0.15* (1.70)	0.57*** (5.74)	-0.13 (-0.90)	0.38** (1.97)	0.13 (1.08)	0.26** (2.14)
<i>Foreign</i>	+	0.94*** (3.68)	0.852*** (3.35)	1.41*** (4.05)	0.98*** (3.19)	0.38 (0.91)	0.54 (1.23)
<i>Industry</i>		Included	Included	Included	Included	Included	Included
<i>Year</i>		Included	Included	Included	Included	Included	Included
<i>Chi2</i>		471.42***	658.89***	110.14***	147.74***	142.57***	132.43***
<i>Pseudo R2</i>		0.1167	0.1363	0.0762	0.0741	0.0923	0.0828
<i>Obs.</i>		756	910	389	526	367	384

Table 8 Sensitivity Analysis

$$\text{Model: } CR_{i,t+1} = \gamma_0 + \gamma_1 \text{Productivity}_{i,t} + \gamma_2 \text{Size}_{i,t} + \gamma_3 \text{LiquidityRisk}_{i,t} + \gamma_4 \text{Profitability}_{i,t} + \gamma_5 \text{CashRisk}_{i,t} + \gamma_6 \text{Lev}_{i,t} + \gamma_7 \text{AEM}_{i,t} + \gamma_8 \text{REM}_{i,t} + \gamma_9 \text{Loss}_{i,t} + \gamma_{10} \text{Big4}_{i,t} + \gamma_{11} \text{Foreign}_{i,t} + ID + YD + \varepsilon_{i,t}$$

Panel A: Investment grade firms							
<i>Productivity</i>	IG12	IG11	IG10	IG9	IG8	IG7	IG6
<i>IG</i>	0.02 (1.55)	0.04 (3.04)***	0.05 (5.22)***	0.07 (6.55)***	0.09 (8.27)***	0.08 (7.77)***	0.08 (8.04)***
<i>Control</i>	Included	Included	Included	Included	Included	Included	Included
<i>ID&YD</i>	Included	Included	Included	Included	Included	Included	Included
<i>Chi2</i>	66.26***	121.34***	245.48***	352.16***	453.92***	606.41***	694.31***
<i>Pseudo R2</i>	0.0381	0.0479	0.0712	0.0815	0.0885	0.0997	0.1055
<i>Obs.</i>	562	732	915	1067	1193	1346	1407
Panel B: Non-Investment grade firms							
<i>NIG</i>	-0.08 (-1.46)*	-0.08 (-3.28)***	-0.07 (-5.47)***	-0.03 (-7.28)***	-0.03 (-6.18)***	-0.04 (-6.65)***	-0.04 (-4.95)***
<i>Control</i>	Included	Included	Included	Included	Included	Included	Included
<i>ID&YD</i>	Included	Included	Included	Included	Included	Included	Included
<i>Chi2</i>	440.44***	323.09***	261.21***	237.24***	132.24***	101.36***	121.55***
<i>Pseudo R2</i>	0.0876	0.0792	0.0828	0.0990	0.0743	0.0856	0.1392
<i>Obs.</i>	1104	934	751	599	473	320	259