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Does Banking Competition Improve Industry Performance? Evidence from Taiwan

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Abstract

This paper investigates how the degree of the banking sector competition affects the operating performance of non-banking industrial sectors that are typically dependent on external financing. The empirical analysis adopts the H-statistic competition index proposed by Panzar and Rosse and uses Taiwan's industry-level and bank-level panel data over the period from 1999:07 to 2013:06. The empirical results find that an increase in the degree of bank competition leads to weaken the industry performance, especially during non-crisis period. Furthermore, such effects may be different, attributive to industry heterogeneity.

Keywords: Industry performance; Bank competition; H-statistic; Panzar-Rosse method

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Introduction

Due to the consolidation of the banking system over past decades, there has been a long-lasting literature on how a change in market structure of banking system affects the firm's and industry's operating performance. In this paper, we provide new evidence on how banking completion affects the performance of manufacturing industries by studying Taiwan case.

In the literature, there are ambiguous effects of banking competition on industrial growth. On the one hand, a lack of banking competition (i.e., an increase of monopoly power) leads to higher bank rates and fees, resulting lower availability of credits for firms and therefore lower economic growth. On the other hand, higher bank monopoly power gives banks higher incentives to build close relationships with borrowers, increasing the availability and demand of credit for firms [1,2]. Mover, higher monopoly power gives banks higher information rent (due to asymmetric information), which would lead the banks to reallocate funds toward more productive firms and therefore to increase economic growth [3-5].

For empirical studies, by using Panzar and Rosse H-statistic [6] instead of market structure as a measure of banking competition, Claessens and Laeven [7] found financially dependent sectors generally grow faster for the countries with higher competition in banking sector. Deidda and Fattouh [8] suggested that a negative effect of concentration on industrial growth in low-income countries, but statistically insignificant in high-income countries. Cetorelli and Strahan [9] indicate that the banks with more competitiveness provide more loans, especially to small firms, and consequently foster economic growth. Liu et al. [10], using data from 48 markets, showed that higher levels of banking

competition and banking stability lead to an increase in industrial growth.

On the other hand, Marquez [4] found that, due to information asymmetry, increasing the number of competing banks may actually push interest up, because of less incentive for efficient screening of banks, which may become harmful for non-financial sectors. The seminal work by Cetorelli and Gambera [11] found that the availability of credit is greater in higher concentrated markets of banking, therefore resulting in higher economic growth. Maudos and Fernandez de Guevara [12] showed that that increase of monopoly power of banks enhances economic growth. Fernandez de Guevaraand MaudosDe Guevara and Maudos [13], using Lerner Index to measure banking competition, showed that bank market power affects economic growth on an inverted-U shape way. Mitchener and Wheelock [14] found that banking market concentration generally had a positive impact on manufacturing sector growth in the early twentieth century United States. Hoxha [15], using Panzar-Rosse method to measure banking competition, found that industries that rely more on external financing perform better in countries where the banking competition is lower. Most recently, Leroy [5] found that total factor productivity of the most financially dependent industries grows more slowly in economics where banking competition is fiercer.

Their findings are different across industries attributive to their industrial characteristics. In particular, the firm's and industry's operating performance relies on their access to funds through either the internal financing or external financing. Thus, this paper aims to investigate how a change in degree of the competition among banks affects the operating performance of industrial sectors, especially for those firms that are typically dependent on external financing.

In the late 1980, the banking system in many countries encounters financial deregulation and liberalization (For example, the mergers and acquisitions of banks in the U.S. after the late 1980s, while Japan and Europe are eminent in the early 1990s). Along the international stream, the Taiwanese government has started to amend the Banking Act since 1989 and to implement financial reforms and deregulations since 2002. As a result, the number of banks, reaching its peak of 53 in 2000, quickly turns into a downtrend to 38 banks in 2008.

Thus, the emerging economy such as Taiwan is worthy to consider an interesting case studied herein. This study attempts to investigate whether the degree of the banking sector competition improves or hinders the operating performance of industrial sectors, especially for those firms that are relatively dependent on external financing. Due to the data availability, our empirical analysis uses Taiwan's biannual industry-level and bank-level panel data over the period from 1999:07 to 2013:06. We first follow the Panzar and Rosse's [6] method to estimate the H-statistic and then take it as a competition index of banking sector in our main exploration. Furthermore, we compare the operating performance between crisis-period and non-crisis period. To deepen our discussion, we also split our whole sample into different groups to examine whether the industry characteristics (such as external financial dependence, scale, liability-to-asset ratio and gross profit margin) change their operating performance.

Our empirical results find that an increase in the degree of bank competition weakens the industry performance, especially in non-crisis period and for those industries with large scale and high liability-to-asset ratio. Moreover, the industry with higher external financial dependence has a better performance, and which is generally further boosted up by a higher degree of bank competition. This result resembles the findings in Claessens and Laeven [7], but is opposed to Hoxha [15].

The contribution of this paper is twofold. Firstly, to the best of our knowledge, this is the first paper to use H-statistic for analyzing how bank competition influences the performance of other industries in Taiwan. Secondly, our findings imply that those policies trying to increase competition for banking sector may reduce the industry performance. It thus prompts governments or regulators to be much aware of the effectiveness of controlling bank competition.

The remaining structure of this paper is outlined as follows. **Reforms in Taiwan Banking** provides a brief review of reforms in Taiwan banking sector. **Empirical Specification and Data** layouts our empirical procedure and data description. Section 4 gives the empirical results and discussions. Last section draws our conclusion and policy implications.

Reforms in Taiwan Banking Sector

To meet the global trends of financial liberalization and modernization, Taiwan's government was devoted to building an efficient system to attract global investors to the local financial markets. With the enactment of the Commercial Bank Establishment Promotion Decree in 1991, the government abolished the ban against private banks and the number of banks in Taiwan then increased from 26 to 42 and to 54 in 1992 and 2002, respectively. The structure of the Taiwan banking industry has thus dramatically changed since 1991, which has caused a much higher degree of competition among banks. However, the competition among Taiwan banks may have been reduced during the Asian financial crisis in 1997-1998 (Unlike its neighbors South Korea and Japan, the Taiwan economy is dominated by small and medium sized businesses rather than large business groups. This is deemed as the main reason for its survival during the Asian financial crises). But after the abolishment of the foreign financial investment limit in 1999, an enormous influx of foreign capital led to historic gains in the Taiwan stock market in February 2000, which stimulated the competition among banks.

During the global depression of deflation from 2000-2003, Taiwan was pushed into its first whole year of negative growth in 2001 since 1947. Many firms shut down and many banks increased their bad loans and poor asset qualities. The ratio of non-performing loans (NPL) was much higher on average than in other Asian countries. For example, by 2001, the NPL ratio in the Taiwan banking industry reached 7.5%, while it was only 2.9% and 5.2% in Korea and Hong Kong, respectively (These statistics are based on information from the Asia Development Bank and official national sources). To improve the asset quality and

operating efficiency of banks, the Financial Institution Merger Act and the Financial Holding Company Act were respectively enacted in 2000 and 2001 to create synergy for banks, and the First Financial Reform was launched in 2001 to reduce the NPL of each bank to below 5% and to increase the BIS (bank of international settlement) ratio to above 10% in two years. On the basis of the First Financial Reform, Taiwan's government passed the Act for Establishment and Administration of the Financial Restructuring Fund in 2001 and established the Resolution Trust Corporation (RTC) Funds to help resolve the trouble with private banks. As a result, the reforms successfully reduced the NPL ratio down to 3.22%, 2.8%, and 2.13% at the end of 2004, 2005 and 2006, respectively (Financial Supervisory Commission Press Release) [16]. Twelve FHCs were established in 2002 and the number increased to fourteen by the end of 2006. They are supervised and regulated under the Financial Supervisory Commission (FSC), which was established in 2004. In addition, the correspondence between DBU (designated bank unit) with banking intermediaries in China was started in 2002 and the Act of Real Estate Securitization was passed in 2003. All of these contributed to increase competition among banks during these time periods.

The other problem for Taiwan banks during the deregulation was weak competitiveness compared to other Asian countries, which is attributed to the over-banking problem in the industry. In general, the banking industry in Taiwan had smaller size, lower market concentration, and lower returns. For example in 2004, the top-five held 37% market share of total assets in Taiwan, while they held 89%, 76%, 73%, 55% in Korea, Hong Kong, Singapore, and Japan, respectively. The top-three ROE was 3.57% in Taiwan, while it was 4.30%, 10.88%, and 5.83% in Korea, Hong Kong, and Singapore, respectively (Financial Supervisory Commission, Taiwan; The Asset) [17]. Moreover, about 60% of the market share was owned by the government, which is deemed as a factor for the lack of international competitiveness of the Taiwan banking industry. Therefore, the Taiwan government launched the Second Financial Reform in 2004 to stimulate consolidations among financial institutions, to lead to higher levels of international competitiveness and to build up Taiwan as a regional financial service center. The reform had four major goals:

1. To cut the number of state-owned banks in half by the end of 2005.
2. To reduce the fourteen FHCs to seven by the end of 2006.
3. To create at least three banks with market share over 10% through mergers by the end of 2005.
4. To introduce foreign capitals to invest in at least one financial institution.

Empirical Specification and Data

Model specification

To analyze the effects of bank competition on industry performance, we modify Hoxha's [15] framework to set up the following Model (1):

$$GPA_{jt} = \alpha + \beta_1 H_t + \beta_2 EFD_{jt} + \beta_3 FDI_t + \beta_4 Crisis_t + \beta_5 GRY_t + u_{jt} \quad (1)$$

Where *jt* denotes the industry *j* at the biannual period *t*. The dependent variable GPA_{jt} is the industry performance, measured by the ratio of gross profit to total assets. Notation H_t refers to the bank competition index, which is estimated by Panzar-Rosse [6] approach in the next section. The EFD_{jt} stands for the degree of industry's external financial dependence, which is the industry's capital expenditure minus operating cash flow and then divided by capital expenditure. Notation FDI_t represents the financial development indicator, defined as the ratio of private credit to real GDP. The $Crisi_{st}$ and the GRY_t indicate the dummy for financial crisis period and the growth rate of real GDP, respectively.

To capture the moderating effects, we follow Rajan and Zingales [18] to include an interaction between the financial development indicator and industry's external financial dependence in model (2):

$$GPA_{jt} = \alpha + \beta_1 H_t + \beta_3 FDI_t + \beta_4 Crisis_t + \beta_5 GRY_t + \beta_6 EFD_{jt} * FDI_t + u_{jt} \quad (2)$$

In equation (2), a positive (negative) β_6 means that, for a financial market with higher development, an industry performance boosted up (brought down) by the increase of bank-financing is higher. When the financial market is highly developed, the firms in industries can relatively easily raise funds needed from banks, which may then boost their performance. Thus, β_6 is expected to be positive. Furthermore, we follow Claessens and Laeven [7] as well as Hoxha [15] to contain an interaction between the bank competition index and industry's external financial dependence in model (3):

$$GPA_{jt} = \alpha + \beta_1 H_t + \beta_3 FDI_t + \beta_4 Crisis_t + \beta_5 GRY_t + \beta_6 EFD_{jt} * \mathrm{H}_t + u_{jt} \quad (3)$$

In equation (3), a positive (negative) β_6 means that, for a financial market with higher competition (i.e., higher *H*), an industry performance boosted up (brought down) by the increase of bank-financing is higher. When the financial market is highly competing, on the one hand the firms in industries is easier to raise funds needed, but on the other hand the lower profit (due to highly competition) may lower down credit quality of banks, resulting in funds going to inefficient firms (Claessens and Laeven, 2005; Hoxha, 2013). Accordingly, the magnitude of the two driving forces determines the sign of parameter β_6. Notice that, different from three above-mentioned papers we contain no variable *EFD* in both models to avoid multi-collinearity problem. That is because the correlation of *(EFD, EFD*FDI), (EFD, EFD*H)* and *(EFD*FDI, EFD*H)* turns out to be 0.9972, 0.9457, and 0.9503, respectively.

Data description

To reach our goal, we use firm-level, bank-level and macroeconomic variables. They are collected from the Taiwan Economic Journal (TEJ) Database (including TEJ Bank and TEJ Finance DB) and the Central Bank of the Republic of China (Taiwan). Due to data availability and compatibility, the sample covers the period from 1999s2 to 2013s1, amounting to 28 biannual periods. During this time span, there are 57 domestic commercial banks as well as medium and small business banks,

Table 1 Variable description (Note: Dollar variables are all in the unit of millions NT dollars).

Notation	Definition	Calculation
Bank-Level Variables		
RTA	Ratio of Operating Income to Total Assets	Operating Income/Total Assets
ROA	Return on Assets	Pre-Tax Net Income/Total Assets
PF	Price of Fund	Interest Expenses/(Interbank Loans + Time Deposits Transferred from Post Office + Deposits and Remittance + Financial Bond + Other Liabilities)
PK	Price of Capital	Other Operating Expenses/Fixed Assets
PL	Price of Labor	Personnel Expenses/Total Assets
TA	Total Assets	-
FA	Fixed Assets	-
EQ	Bank Equity	-
H	H-statistic	Competition Index of Banking sector
Industry-Level Variables		
GPA	Industry performance	Gross Profit/Total Assets
EFD	External Financial Dependence	(Capital Expenses–Operating Cash Flows)/ Capital Expenses
LAR	Ratio of Total Liabilities to Total Assets	Total Liabilities/Total Assets
Macroeconomic Variables		
FDI	Financial Development Indicator	Private Credit/GDP
Crisis	*Crisis* year dummy	*Crisis* = 1 for periods in 2001s2, 2002s1, 2005s1, 2005s2, 2008s2 and 2009s1, while Crisis = 0 otherwise
GRY	Growth Rate of Real GDP	

Note: Dollar variables are all in the unit of millions NT dollars.

and 831 companies publicly listed on the Taiwan Stock Exchange (TSE).The industry-level variables are transformed from the arithmetic average of individual firm-level imputation according to the 19 classifications of TEJ. **Table 1** explains the definitions and notations of variables used herein.

Industry-level variables

As mentioned in **Model Specification**, the ratio of gross profit to total assets (*GPA*) is our dependent variable in the regression models. It captures the financial robustness and profitability of an industry so that it is helpful for investors to predict the industry's valuation in the stock market. Accordingly, the ratio of gross profit to total assets (*GPA*) is a good proxy for the operating performance of industries throughout our analysis.

Besides, industry's external financial dependence (*EFD*) is one of our explanatory variables. Following Rajan and Zingales [18], it is defined as the industry's capital expenses minus operating cash flows and then divided by capital expenses (Rajan and Zingales [18] showed that the external financial dependence has a positive impact on industry's growth). When the corresponding value is positive, it implies the industry needs to seek for external funds because industry's capital expenses cannot be covered by internal funds. Conversely, when the corresponding value is negative, it refers to the case that an industry has sufficient internal funds to pay for capital expenditures. We are interested in the amount of desired investment that cannot be financed through internal cash flows generated by the same business. Therefore, we set the degree of external financial dependence (*EFD*) to be zero when the internal finance happens. To avoid having results affected by outliers, we delete the observations below the 0.5th percentile and above the 99.5th percentile.

To deepen our exploration, we take a closer look at the industry characteristics, such as external financial dependence (*EFD*), industry scale measured by total assets, and ratio of total liabilities to total assets (*LAR*). We split the whole sample into three groups using above-mentioned industry characteristics: the low one contains those industries with *EFD*/scale/*GPA*/*LAR* below the 30th percentile, the medium one includes those industries from the 30th to 70th percentiles, and the high one has those industries above the 70th percentile, respectively. We accordingly investigate whether the industry characteristics cause differential impacts of bank competition on industry operating performance.

Macroeconomic variables

To consider the effects of macroeconomic environment on industry operating performance over time, we take the financial development indicator (*FDI*), crisis periods (*Crisis*) and growth rate of real GDP (*GRY*) as control variables.

As for the financial development indicator (*FDI*), it is gauged by the ratio of private credit to GDP, assessing how banks utilize their

funds. Some theorists [19] argue that well-functioned financial markets and institutions help a firm overcome problems of moral hazard and adverse selection, thus reducing the firm's cost of raising money from outsiders as well as risk diversification. A high degree of financial development should benefit for evaluating the investment projects and be more likely to reach funds than a low degree of financial development. Rajan and Zingales [18] verify that well-developed financial market should help firms or industries typically dependent on external financing for their growth.

Banks may have different strategies for making loans when facing the financial crisis. We thus take this into consideration by controlling crisis-period effects. Initiating the early warning indicator of Taiwan's financial crisis, Lee and Chiang [20] identify the event's peak of systematic financial crisis, especially during the period of non-performing loans greater than 10% and government's emergency act (for example, deposit guarantee system and bank relief payouts over 2% of GDP), and subsequently specify the financial crisis periods, which are within pre- and post-six months of event's peak. In our research span, those peaks appear in the events of housing market recession in December 2001, dual-card crisis in August 2005, global financial tsunami in October 2008. Nevertheless, we create a dummy variable, dubbed as *Crisis*, to ascertain the financial crisis periods; that is, *Crisis* = 1 for the crisis period in 2001s2, 2002s1, 2005s1, 2005s2, 2008s2 and 2009s1, while *Crisis* = 0 otherwise.

Bank-level variables

Bank-level variables are mainly used to measure the market structure of banking sector. We estimate the H-statistic proposed by Panzar and Rosse [6] and take it as the competition index of banking sector in this study.

By using the data of input-price, PR model becomes much useful, especially when the cost function of a bank is not able to be estimated. Claessens and Laeven [7] is the first one to study the effect of an industry's bank-financing dependence on its performance, and how the effect varies for different bank competition, which is measured by the PR model.

The Panzar and Rosse [6] approach premises that banks in different market structures will use different pricing strategies in response to cost changes in inputs. Market competition in the PR model is measured as the sum of the elasticity of the reduced-form revenues with respect to input prices, which is referred to as the "H-statistic."

Consider a firm's profit scheme. Referring to *R* as revenues, *C* as costs, *y* as the output, was a vector of factor prices, s and t as vectors of exogenous variables, the first-order condition for maximizing a firm's profit is *Ry*(*y,s*)-*Cy*(*y,w,t*) = 0, which yields equilibrium output *y** = *y*(*s,w,t*) and then the reduced-form revenue $R^*(y^*, s) \equiv \tilde{R}(s,w,t)$. The sum of input-price elasticity is obtained as $\sum_{i=1}^{n} \frac{\partial \tilde{R}}{\partial w_i} \frac{w_i}{R} \equiv H$. In econometrics models, the logarithm-form of revenues (the dependent variable) and input prices (the independent variables) can offer interpretation of coefficients in elasticity. If *H* = 1 (*H* = 0), every 1% input-price change lowers 1% (zero) revenue change in response, indicating no (full) monopoly power for the firm. Thus, $H \leq 0$ indicates a monopoly market; $H \geq 1$ is a perfect competition market; and 0<*H*<1 is a monopolistic competition market. We estimate the following regression equation for each quarter in the period 1999-2013 to obtain quarterly PR H-statistics:

$$RTA_{it} = \beta_{0t} + h_{1t}PF_{it} + h_{2t}PK_{it} + h_{3t}PL_{it} + \beta_{1t}TA_{it} + \beta_{2t}FA_{it} + \beta_{3t}EQ_{it} + u_{it} \quad (4)$$

where subscript it denotes firm *i* at quarter *t* for *t* =1,…*T* and *i* = 1,…*n*. The measure of quarterly degree of competition $H_t = h_{1t} + h_{2t} + h_{3t}$. All variables in equation (4) are in logarithm form. *RTA* is the ratio of total revenue to total assets; *PF*, *PK*, and *PL* are the three input prices. *PF* (price of fund) is the ratio of interest expenses to deposits and other liabilities; *PK* (price of capital) is the ratio of other non-interest expenses to fixed assets; and *PL* (price of labor) is the ratio of personnel expenses to total assets. *TA* (total assets), *FA* (fixed assets), and *EQ* (equity) are used to account for the influence of bank-specific factors.

We use cross-sectional monthly data in each quarter for estimating equation (4). Monthly data of banks are collected from Monthly Statistics Report of the Central Bank of Republic of China (Taiwan). The sample consisted of all banks in Taiwan's banking industry from 1999-2013. The number of banks varied every year, ranging from 32 to 43. Thus, each quarter will contain at least 96 observations. All data is reported in NT dollars as the reference currency.

Note that the PR model assumes banks to operate in their long-run equilibrium phase, i.e., every bank's profit $\pi \equiv R(y,s) - C(y,w,t) = 0$ holds in the long run. This yields the long-run equilibrium output *y*** = *y*(*s,w,t*) and the reduced-form profit $R^{**}(y^{**}, s) - C^{**}(y^{**}, w, t) \equiv \tilde{\pi}(s,w,t)$. The sum of input-price coefficients can be obtained from $\sum_{i=1}^{n} \frac{\partial \tilde{R}}{\partial w_i} \frac{w_i}{\pi}$ and must equal zero under long-run equilibrium. Thus to perform a long-run equilibrium test, we substitute for profit as the dependent variable in equation (4) and estimate:

$$ROA_{it} = \beta_{0t} + h_{1t}PF_{it} + h_{2t}PK_{it} + h_{3t}PL_{it} + \beta_{1t}TA_{it} + \beta_{2t}FA_{it} + \beta_{3t}EQ_{it} + u_{it} \quad (5)$$

where the quarterly data *ROA* is the return of assets. The testable hypothesis for long-rum equilibrium is $H_t = h_{1t} + h_{2t} + h_{3t} = 0$.

Empirical Results

Estimation of H-statistic

Our estimation uses two-step method. At the first step, we estimate Equation (4) and Equation (5) to obtain the H-statistic competition index of banking sector as described in **Bank-Level Variables**. At the second step, we take the H-statistic as one of regressors and estimate regression (1-3). For each model, we also compare the results between crisis period and non-crisis period.

Table 2 presents the estimation results of biannual H-statistic over the period from 1999s2 to 2013s1.Columns 2-5 are the results of Equation (1) from pooled OLS estimation, while Column 6 is the test results of Equation (2) after controlling for industry-specific fixed effects. Numbers in Columns 4-6 are T-statistic for each test, respectively. Row 5 and 6 of **Table 3** shows that the minimum

Table 2 Estimation results of H-statistic.

Period	H-statistic	$\overline{R}^2$	H_0: $H = 0$	H_0: $H = 1$	Equilibrium Test
1999s2	0.8665	0.5317	7.9622***	-1.2267***	-
2000s1	0.4041	0.2901	7.1667***	-10.5679***	-
2000s2	0.7031	0.3719	11.7747***	-4.9723***	-
2001s1	0.775	0.4041	8.9993***	-2.6123***	1.3234
2001s2	0.8859	0.1651	7.0192***	-0.9042	0.858
2002s1	1.0102	0.3463	9.3229***	0.0938	1.6259
2002s2	0.8584	0.3358	7.4964***	-1.2361	-1.0047
2003s1	0.9961	0.5926	12.5489***	-0.0495	-1.0439
2003s2	0.7808	0.5282	9.2478***	-2.5956***	-1.6065
2004s1	1.0499	0.704	14.5421***	0.6906	-0.7522
2004s2	0.745	0.5686	8.1653***	-2.7955***	0.3211
2005s1	0.9358	0.664	12.3239***	-0.8453	-2.3252**
2005s2	0.9824	0.5537	12.9595***	-0.2325	-1.0123
2006s1	0.5571	0.5777	4.2538***	-3.3814***	-2.2830**
2006s2	0.7204	0.6505	6.4860***	-2.5179**	-3.9679***
2007s1	1.3128	0.697	9.7878***	2.3320**	-3.6063***
2007s2	0.71	0.5223	5.9651***	-2.4369**	-0.5003
2008s1	0.7561	0.7405	5.5142***	-1.7791*	0.3655
2008s2	0.8603	0.7099	7.6021***	-1.2349	1.4281
2009s1	1.1191	0.6827	7.6508***	0.8142	0.9293
2009s2	1.1569	0.6091	9.0070***	1.2213	0.9134
2010s1	1.1811	0.6244	7.5867***	1.1634	-0.4692
2010s2	1.2954	0.547	8.0549***	1.8368*	-0.4459
2011s1	1.3652	0.4849	7.5906***	2.0305**	1.1887
2011s2	0.8863	0.3788	4.8383***	-0.6204	-2.0257**
2012s1	1.4152	0.5765	10.0172***	2.9390***	-2.1318**
2012s2	1.012	0.5851	8.5118***	0.1011	-1.4975
2013s1	1.5426	0.6126	12.4562***	4.3814***	-2.3704**

Note: *, **, and *** denotes statistical significance from zero at the 10%, 5%, and 1% level, respectively. Columns 2-5 are the results of Equation (4) from pooled OLS estimation: $RTA_{it} = \beta_{0t} + h_{1t}PF_{it} + h_{2t}PK_{it} + h_{3t}PL_{it} + \beta_{1t}TA_{it} + \beta_{2t}FA_{it} + \beta_{3t}EQ_{it} + u_{it}$, while Column 6 is the test results of Equation (5) from fixed-effect estimation: $ROA_{it} = \beta_{0t} + h_{1t}PF_{it} + h_{2t}PK_{it} + h_{3t}PL_{it} + \beta_{1t}TA_{it} + \beta_{2t}FA_{it} + \beta_{3t}EQ_{it} + u_{it}$. Numbers in Columns 4-6 are T-statistic for each test, respectively. Notice that, to obtain the amount of elasticity in the estimation, each explanatory variable takes its log form, which requires omitting those observations with non-positive data. It takes about only 10% of the whole sample.

value of H-statistic is 0.4041 which appears in 2000s1 and the maximum one is 1.5426 in 2013s1. In the period of 2002s1, 2004s1, 2007s1, 2009s1-2011s1 and 2012s1-2013s1, the banking sector seems to be perfectly competitive, implying an over-banking problem. In the remaining 17 periods, the banking sector seems to be monopolistically competitive. Rigorously, we confirm this judgment using the Wald test. Column 4 and Column 5 are to test for the null of *H*=0 and *H*=1, respectively. The results verify that banking sector does not have full monopoly power in all 28 periods, but banking sector is monopolistically competitive in 15 periods and perfectly competitive in 13 periods. Furthermore, we examine the validity of H-statistic for measuring the degree of bank competition by checking the condition of *H*=0 in the long-run equilibrium. We use a moving average of two years to compute the long-run H-statistic after controlling for industry-specific fixed effects, and consequently conduct the Wald test for each biannual period. Column 6 of **Table 2** shows that we cannot reject the null of *H*=0 in 18 out of 25 periods, indicating the validity of H-statistic for measuring the degree of bank competition.

Figure 1 plots the time series of H-statistic competition index over the period from 1999s2 to 2013s1. The H-statistic competition index starts to move upwards in 2000s1. The first financial reform is implemented in 2002. To extend the scale of financial institutions, two of important Acts are promulgated. The Financial Institutions Merger Act namely encourages the mergers and acquisitions of financial institutions, while the Financial Holding Company Act allows financial institutions to operate their business across different industries. After that, the objective of the second financial reform in 2004 is to cut the financial institutions having major government participations and financial holding companies by half. The H-statistic competition index becomes relatively smooth, meaning the efficacy of suppressing the over-banking situation. The H-statistic competition index, due to economic recovery, reaches a peak in 2007s1. The subprime mortgage problem and global financial crisis during 2007-2008 render the number of banks reduced and so does the degree of bank competition. Overall, the H-statistic competition index goes upward-trending henceforth.

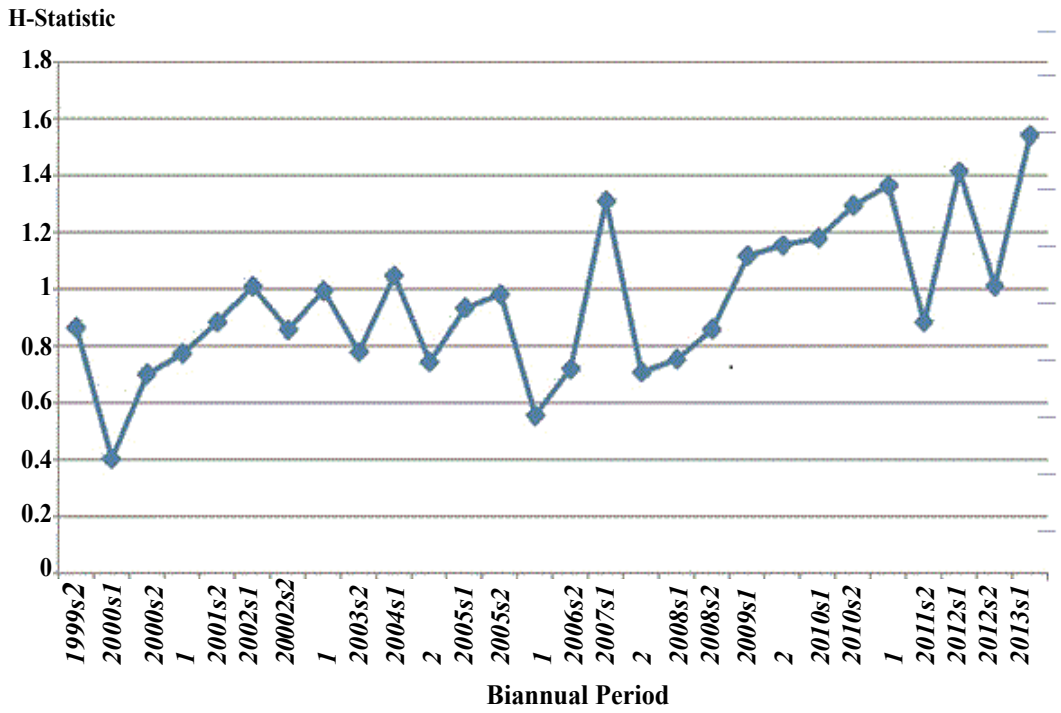

Figure 1 H-statistic competition index of banking sector.

Table 3 Descriptive statistics.

Variable	GPA	EFD	FDI	H	GRY	Crisis
Observation	532	532	532	532	532	532
Mean	0.037	-1.3961	11.5463	0.9601	3.9523	0.2143
Std. Deviation	0.0268	2.1445	0.5489	0.2626	4.0483	0.4107
Maximum	0.1453	4.4045	12.7388	1.5426	13	1
Minimum	-0.0704	-13.9426	10.3657	0.4041	-7.35	0

Note: *GPA* ≡ the ratio of gross-profit to asset, *EFD* (External Financial Dependence) ≡ the ratio of the capital expenses minus operating cash flows to the capital expenses, *FDI* (Financial Development Indicator) ≡ the ratio of the private credit to GDP, *H* ≡ *H* statistic, *GRY* ≡ growth rate of real GDP, and *Crisis* (Crisis year dummy) equals 1 for periods in 2001s2, 2002s1, 2005s1, 2005s2, 2008s2 and 2009s1, while equals 0 otherwise.

Main estimation of industry performance

Table 3 exhibits the descriptive statistics of variables chosen in the regression models (1-3). The maximum and minimum *GPA* occurred in 2008s2 and in 2005s2, respectively, both of which are in the period of financial crisis. It may indicate that financial crisis would increase the variance of *GPA*. The negative external financial dependence (*EFD*) implies manufacturing sectors generally needs no external financing, with the maximum and minimum value occur in 2007s1 and 1999s2. The Financial development index (*FDI*) has its minimum at 2003s2 and hit the maximum at 2009s1 after financial reforms. As for the competition degree of banking sector, the biggest monopoly power happened at 2000s1, right before the financial reform launching, and then reaches maximum competition degree at 2013s1, indicating financial reforms do matter.

To start our panel estimation, we first apply the commonly used Hausman test to decide the cross-section specification between fixed effects and random effects. The Chi-square statistic from Hausman test is 0 with a probability value equal to 1 (Our inclusion of aggregate time effect in the regression might cause a zero value of Chi-square statistic). This result shows that we cannot reject the null hypothesis even at the 10% significance level, indicating that the random-effects model is more efficient and consistent than the fixed-effect model. We thus employ cross-section random-effects estimations. Furthermore, the Durbin-Wu-Hausman test and Ramsey RESET test are utilized to verify the non-existence of endogeneity bias and mis-specification, respectively. The J statistic from Durbin-Wu-Hausman test is 1.3792 with a probability value equal to 0.2402 while the F statistic from Ramsey RESET test is 1.3520 with a probability value equal to 0.2454. In this sense, our models avoid endogeneity bias and are well-specified.

Table 4 arranges the estimation results. The column of Model (1) shows that the H-statistic value is negative and statistically significant at the 10% level, meaning that an increase in the degree of bank competition drives down the industry profits. This is because an increase in competition of banking sector, which plays a role of financial intermediaries, exacerbates the asymmetric problem between lenders and borrowers, leading

to more difficulties in firm's financing. Consequently, the well-rated firms obtain smaller amount of loans made by banks and thereby reduce their investment and profits. Marquez [4] discovers that an increase in the degree of bank competition generates the information dispersion and renders the inefficiency of loan market. Meanwhile, there are many small-scale banks in that market, but these banks have weak incentive to maintain a long-term relationship with firms so as to make firms less likely to access their funds. Besides, the coefficient of financial development indicator (*FDI*) is significantly positive at the 1% level, indicating that a highly developed banking sector improves industry performance. This is because a high degree of financial development refers to more private credits, which firms have more chances to reach for their investment, subsequently stimulating their growth. This concept is in conformity with Schumpeter [19] and Rajan and Zingales [18]. They recognized that the development of banking sector have a positive impact on evaluating firm's investment projects, especially for new and potential firms, so as to benefit industry growth. The coefficient of real GDP growth rate (*GRY*) is significantly positive at the 1% level, implying that a good macroeconomic environment fosters industry performance. The coefficient of crisis dummy is significantly positive at the 1% level as well. The reason might be that banks have more deposits, due to outbound speculation withdrawn by private sector and hedging funds injected by government, and are willing to make more loans, causing firms to obtain more funds for investment. In this sense, the crises happening in banking sector is not necessary to have an adverse influence on industry performance. The coefficient of external financial dependence (*EFD*) is significantly positive at the 5% level, revealing that an increase in the degree of external financial dependence renders the bank-dependent borrowers to gain more funds, spending more investment and enhancing industry performance.

Next, we re-estimate Model (1) to investigate the difference between crisis period and non-crisis period and present the results in columns 2 and 3 of **Table 4**, respectively. As shown, most of the results depict analogous patterns as above-mentioned, except for the effects of H-statistic and external financial dependence. The H-statistic value in crisis period is insignificant but the value in non-crisis period has a significantly negative effect on industry performance. As for the coefficients of external financial dependence, they are insignificant in both periods.

The column of Model (2) in **Table 4** shows the results of replacing the external financial dependence (*EFD*) with an interaction term between external financial dependence and financial development indicator (*EFD*FDI*). The H-statistic value is still negative and statistically significant at the 10% level. The coefficient of interaction term (*EFD*FDI*) is positive and statistically significant at the 5% level, suggesting that more bank-dependent firms have a better performance in a higher financial development environment. This finding is in accordance with Rajan and Zingales [18] and Huang and Huang (2012), which a more perfect financial development is helpful in accessing the external funds for financially dependent firms so as to promote their growth. The consistent significance of other variables gives the same wave as discussed for Model (1). Comparing the results shown in columns 5 and 6 of **Table 4**, the interaction terms (*EFD*FDI*) are insignificant in both crisis and non-crisis periods, whereas the remaining variables behave similar to the previous examination.

The column of Model (3) in **Table 4** demonstrates the results with an alternative interaction term between external financial dependence and H-statistic competition index (*EFD*H*). The H-statistic value is significantly negative. The coefficient of interaction term (*EFD*H*) is positive and statistically significant at the 5% level, finding that more bank-dependent firms have a better performance in a higher degree of banking sector competition. This remark corresponds to the study of Claessens and Laeven [7], which a higher degree of bank competition lessens the hold-up problems and reduces financial intermediation costs (such as agency costs and monitoring costs) so that financially dependent firms are more willing to and able to seek for external financing. Comparing the results placed in columns 8 and 9 of **Table 4**, the interaction terms (*EFD*H*) are insignificant in both crisis and non-crisis periods, whereas the remaining variables have the same responses as the previous exploration.

Besides, we notice the error terms may exist heteroscedasticity, inflating *T* statistic estimated by the least squares method and thereby making the estimation results very significant. We thus take the robust covariance into account to re-estimate the regression models. The modified covariance causes the significance of tests to become more restrained and reliable. The panel corrected standard error (PCSE) with cross-section weights is listed in the basket of **Table 4**. The significance in all cases gives the same reaction as previous outcomes, except for the external financial dependence and interaction between external financial dependence (*EFD*) and financial development indicator (*EFD*FDI*). Both *EFD* and *EFD*FDI* now turn into significant in crisis period. This might be because banks are over-lending in crisis period, enhancing financially dependent firms to reach more funds and gain more profits.

Extension of group estimation

Next, we take a closer look at the industry characteristics, such as external financial dependence (*EFD*), industry scale measured by total assets, and ratio of total liabilities to total assets (*LAR*). We split the whole sample into three groups: the low one contains those industries with *EFD*/scale/*GPA*/*LAR* below the 30th percentile, the medium one includes those industries from the 30th to 70th percentiles, and the high one has those industries above the 70th percentile, respectively. We exhibit the estimation results in **Tables 7-9** in that order.

Table 5 displays the regression results with three different degrees of external financial dependence. The H-statistic value in a medium *EFD* group is significantly negative at the 10% level, steering that the degree of banking sector competition adversely affects the performance of industries which are moderately dependent on external funding. In contrast, the values in both low and high *EFD* groups are insignificant, stating that this little response of a change in bank competition to industry performance in both low and high *EFD* groups. The plausibility is because the firms with highly financial dependence may have established a long-

Table 4 Estimation results.

Variable	Model (1)	Crisis Period	Non-Crisis Period	Model (2)	Crisis Period	Non-Crisis Period	Model (3)	Crisis Period	Non-Crisis Period
			Period			Period			Period
Constant	-0.164955	-0.329445	-0.150245	-0.16666	-0.333728	-0.150832	-0.167761	-0.335391	-0.151186
	(0.018749)***	(0.057885)***	(0.019054)***	(0.018586)***	(0.057569)***	(0.018874)***	(0.018549)***	(0.057519)***	(0.018813)***
	[0.018965]***	[0.058331]***	[0.019320]***	[0.018800]***	[0.058002]***	[0.019145]***	[0.018761]***	[0.057971]***	[0.019067]***
H	-0.005273	-0.003766	-0.005874	-0.005261	-0.003645	-0.005871	-0.003756	-0.000146	-0.005297
	(0.002934)*	(0.024195)	(0.002812)**	(0.002934)*	(0.024239)	(0.002812)**	(0.003008)**	(0.024571)	(0.002901)*
	[0.002957]*	[0.024265]	[0.002839]**	[0.002957]*	[0.024303]	[0.002838]**	[0.003033]	[0.024532]	[0.002933]*
FDI	0.017543	0.032205	0.01661	0.017694	0.032542	0.016663	0.01765	0.032365	0.016643
	(0.001584)***	(0.005613)***	(0.001615)***	(0.001573)***	(0.005596)***	(0.001603)***	(0.001580)***	(0.005624)***	(0.001609)***
	[0.001603]***	[0.005642]***	[0.001638]***	[0.001591]***	[0.005625]***	[0.001625]***	[0.001598]***	[0.005655]***	[0.001631]***
GRY	0.002883	0.004989	0.001999	0.002878	0.004998	0.001998	0.002886	0.005013	0.001997
	(0.000236)***	(0.000527)***	(0.000281)***	(0.000236)***	(0.000529)***	(0.000281)***	(0.000236)***	(0.000528)***	(0.000281)***
	[0.000239]***	[0.000528]***	[0.000285]***	[0.000239]***	[0.000530]***	[0.000285]***	[0.000239]***	[0.000529]***	[0.000286]***
Crisis	0.008914	-	-	0.00893	-	-	0.008896	-	-
	(0.002154)***	-	-	(0.002154)***	-	-	(0.002155)***	-	-
	[0.002170]***	-	-	[0.002169]***	-	-	[0.002172]***	-	-
EFD	0.001066	0.001806	0.0004	-	-	-	-	-	-
	(0.000473)**	(0.001094)	(0.00052)	-	-	-	-	-	-
	[0.000480]**	[0.001012]*	[0.000537]	-	-	-	-	-	-
*EFD*FDI*	-	-	-	0.000094	0.000145	0.000036	-	-	-
	-	-	-	(0.000041)**	(0.000092)	(0.000046)	-	-	-
	-	-	-	[0.000042]**	[0.000085]*	[0.000047]	-	-	-
*EFD*H*	-	-	-	-	-	-	0.001052	0.001727	0.000407
	-	-	-	-	-	-	(0.000497)**	(0.001141)	(0.000548)
	-	-	-	-	-	-	[0.000509]**	[0.001059]	[0.000561]
Observation	532	114	418	532	114	418	532	114	418
$\overline{R}^2$	0.292543	0.5064	0.239702	0.292804	0.505157	0.239839	0.291583	0.503923	0.239504

Note: *, **, and *** denotes statistical significance from zero at the 10%, 5%, and 1% level, respectively. Numbers in ( ) denote the standard errors from OLS estimation. Numbers in [ ] denote the panel corrected standard errors (PCSE) with cross-section weights. All models are controlled for industry-specific random effects

Table 5 Estimation results with different external financial dependence.

Variable	High EFD	Medium EFD	Low EFD
Constant	-0.132135***	-0.166780***	-0.199412***
	(0.031598)	(0.028391)	(0.038502)
H	-0.002302	-0.007387*	-0.006392
	(0.004741)	(0.004399)	(0.006124)
EFD	0.001486**	0.000763	0.002078**
	(0.000652)	-(0.001076)	(0.00092)
FDI	0.013518***	0.017578***	0.021765***
	(0.002646)	(0.002378)	(0.003257)
Crisis	0.006223*	0.008666***	0.012840***
	(0.003464)	(0.003224)	(0.004539)
GRY	0.002758***	0.002961***	0.003100***
	(0.000378)	(0.000371)	(0.000486)
Observation	168	196	168
$\overline{R}^2$	0.309896	0.309603	0.285863

Note: *, **, and *** denotes statistical significance from zero at the 10%, 5%, and 1% level, respectively. Numbers in ( ) denote the standard errors from cross-section random-effect estimation. The sample is split into three groups by the external financial dependence (EFD): The low one contains those industries with EFD below the 30th percentile, the medium one includes industries from the 30th to 70th percentiles, and the high one has those industries above the 70th percentile

Table 6 Estimation results with different industry scales.

Variable	Large Scale	Medium Scale	Small Scale
Constant	-0.171059***	-0.190635***	-0.132842***
	(0.032158)	(0.034483)	(0.030864)
H	-0.011696**	-0.007024	0.003388
	(0.004958)	(0.005288)	(0.004839)
EFD	0.0003	0.001073	0.001188
	(0.000777)	(0.000883)	(0.000811)
FDI	0.018224***	0.020009***	0.014227***
	(0.00265)	(0.002936)	(0.002589)
Crisis	0.013240***	0.008508**	0.005141
	(0.003633)	(0.003879)	(0.003584)
GRY	0.003080***	0.003271***	0.002219***
	(0.000392)	(0.000441)	(0.000389)
Observation	168	196	168
$\overline{R}^2$	0.325721	0.292269	0.235298

Note: *, **, and *** denotes statistical significance from zero at the 10%, 5%, and 1% level, respectively. Numbers in ( ) denote the standard errors from cross-section random-effect estimation. The sample is split into three groups by the industry scale: The small one contains those industries with total assets below the 30th percentile, the medium one includes industries from the 30th to 70th percentiles, and the large one has those industries above the 70th percentile

term relationship with banks, while the firms with low financial dependence may have utilized their own or internal funding. Moreover, the degree of external financial dependence in a medium *EFD* group has little influence on industry performance, whereas such effects for both low and high *EFD* groups are apparent. The reactions of industry performance to a change in financial development (*FDI*), real GDP growth (*GRY*) and crisis period (*Crisis*) are significantly similar to previous analysis.

Table 6 shows the differentials among three groups of industry scales, measured by total assets. The H-statistic value in a large-scale group is significantly negative at the 5% level; in contrast, the values in both medium- and small-scale groups are insignificant. The rationality is that the small banks have a relatively low ability to evaluation process in face of an increase in the degree of banking sector competition so these small banks do not attempt to build up a long-term relationship with large-scale firms, consequently diminishing these firms' profits at such an underfunded position. In addition, the degree of external financial dependence (*EFD*) in three cases has little influence on industry performance. The crisis period (*Crisis*) in a small-scale group is insignificant but the positive impacts are statistically evident. Our inference is that banks considerably lend to large- and medium-scale industries in crisis period, driving up industry performance. Both financial development indicator (*FDI*) and real GDP growth (*GRY*) behave significantly and coherently.

Table 7 presents the disparities among three groups classified by the ratio of total liabilities to total assets (*LAR*). The H-statistic value in a high *LAR* group is significantly negative at the 1% level, and the values in both medium and low *LAR* groups are insignificant. The reason is that the small banks have a relatively low ability to evaluation process in face of increasing bank competition so these small banks cut down their loans made to the firms with a high *LAR*, subsequently weakening these firms' operating performance. The degree of external financial dependence (*EFD*) only affects the performance of industries with a medium *LAR*, but appears no statistical evidence on those with high and low *LARs*. Again, the responses of industry performance to a change in financial development (*FDI*), real GDP growth (*GRY*) and crisis period (*Crisis*) bear a striking resemblance to previous investigation.

Table 8 manifests the regression outcomes of three groups divided by the ratio of gross profit to total assets (*GPA*). Both the

Table 7 Estimation results with different liability-to-asset ratio.

Variable	High LAR	Medium LAR	Low LAR
Constant	-0.151402***	-0.162489***	-0.180790***
	(0.033521)	(0.027837)	(0.037351)
H	-0.015321***	-0.004104	0.003255
	(0.005381)	(0.004248)	(0.005853)
EFD	0.00025	0.001380**	0.000779
	(0.001294)	(0.000628)	(0.000847)
FDI	0.016924***	0.016970***	0.018703***
	(0.002837)	(0.002342)	(0.003132)
Crisis	0.008206**	0.009881***	0.008498**
	(0.003917)	(0.003126)	(0.004252)
GRY	0.003006***	0.002764***	0.002885***
	(0.000422)	(0.000346)	(0.00047)
Observation	168	196	168
$\overline{R}^2$	0.273273	0.349089	0.261651

Note: *, **, and *** denotes statistical significance from zero at the 10%, 5%, and 1% level, respectively. Numbers in ( ) denote the standard errors from cross-section random-effect estimation. The sample is split into three groups by the ratio of total liabilities to total assets (*LAR*): The low one contains those industries with LAR below the 30th percentile, the medium one includes industries from the 30th to 70th percentiles, and the high one has those industries above the 70th percentile

Table 8 Estimation results with different gross profit-to-asset ratio.

Variable	High GPA	Medium GPA	Low GPA
Constant	-0.206477***	-0.183673***	-0.099551***
	(0.041058)	(0.028787)	(0.023697)
H	-0.006083	-0.006165	-0.003434
	(0.006483)	(0.004612)	(0.003734)
EFD	0.001337	0.001153	0.000937
	(0.001011)	(0.000789)	(0.000585)
FDI	0.022763***	0.019137***	0.010335***
	(0.003507)	(0.00247)	(0.002026)
Crisis	0.015453***	0.009494***	0.001757
	(0.004759)	(0.003379)	(0.002739)
GRY	0.003599***	0.003027***	0.001995***
	(0.000515)	(0.000371)	(0.000303)
Observation	168	196	168
$\overline{R}^2$	0.206093	0.265378	0.236167

Note: *, **, and *** denotes statistical significance from zero at the 10%, 5%, and 1% level, respectively. Numbers in ( ) denote the standard errors from cross-section random-effect estimation. The sample is split into three groups by the ratio of gross profit to total assets (*GPA*): The low one contains those industries with *GPA* below the 30th percentile, the medium one includes industries from the 30th to 70th percentiles, and the high one has those industries above the 70th percentile

H-statistic value and external financial dependence (*EFD*) have no impact on industry performance in all cases. The effect of crisis period (*Crisis*) on the performance of industries with a small *GPA* is little significant, but the effects with large and medium *GPAs* are significantly positive. The latter is because banks make considerable loans to the firms with large and medium GPAs in crisis period, augmenting these firms' profits. Other two variables, financial development indicator (*FDI*) and real GDP growth (*GRY*), behave in the same manner.

The degree of external financial dependence refers to external funding sought by firms' financing strategies. By the same token, total liabilities defined in accounting terms are calculated by the sum of liquid liabilities, long-term liabilities, other liabilities and reserves. To discern these two types of debt concepts, we thus replace the degree of external financial dependence (*EFD*) with the ratio of total liabilities to total assets (*LAR*) to re-estimate Model (1). As shown in **Table 9**, all results are the same as our discussions for Model (1) in **Table 4**, even though we further separate the sample into the crisis and non-crisis periods. The ratio of total liabilities to total assets (*LAR*) also has a significantly positive influence on industry performance in non-crisis period, indicating that the industries with a higher debt ratio, even containing the long-term debt, perform better. However, this statement cannot be held in crisis period.

Table 9 Estimation results with liability-to-asset ratio in Model (1).

Variable	Model (1)	Crisis Period	Non-Crisis Period
Constant	-0.183045***	-0.342021***	-0.162977***
	(0.018245)	(0.058009)	(0.018579)
H	-0.006676***	-0.002794	-0.007128**
	(0.002905)	(0.024944)	(0.002797)
FDI	0.015221***	0.031706***	0.014745***
	(0.001675)	(0.006684)	(0.001691)
GRY	0.002776***	0.005085***	0.001947***
	(0.000233)	(0.000591)	(0.000276)
LAR	0.001037**	0.000313	0.000807***
	(0.000237)	(0.000581)	(0.00025)
Crisis	0.007440***	-	-
	(0.002134)	-	-
		-	-
Observation	532	114	418
$\overline{R}^2$	0.313983	0.494621	0.261208

Note: *, **, and *** denotes statistical significance from zero at the 10%, 5%, and 1% level, respectively. Numbers in ( ) denote the standard errors from cross-section random-effect estimation

Conclusions

There is a substantial change in Taiwan's banking sector since financial liberalization in 1985 and twice financial reforms in 2002 and 2004, respectively. In the over-banking situation, due to financial liberalization, the Taiwanese government encourages bank merges to expand bank scales by implementing the first financial reform in 2002 and enforces a half reduction in the number of publicly-owned banks and bank holding companies through the second financial reform in 2004.These policies effectively impede an upward trending of banking sector competition. The U.S. subprime mortgage crisis in 2007 causes the global financial crisis, hindering the degree of banking sector competition as well. During this time span, the degree of banking sector competition is fluctuated because of shifts in financial system and policies. Hence, we are very concerned about how the degree of banking sector competition affects the operating performance of non-banking industrial sectors.

To reach our goal, the empirical investigation of this study employs Taiwan's industry-level and bank-level panel data over the period from 1999:07 to 2013:06 and measures the competition index using the H-statistic proposed by Panzar and Rosse [6].

Our empirical results find that an increase in the degree of bank competition results in worse industry performance, especially for those periods non-crisis and for those industries with large scale and high liability-to-asset ratio. We also find that, generally in Taiwan evidence, an industry which depends on more bank-financing has better operating performance, which is generally further boosted up by a higher degree of bank competition. This result resembles the findings in Claessens and Laeven [7], but is in sharp contrast to Hoxha [15]. Therefore, our findings prompt governments and/or regulators to be aware of the effectiveness of policies or regulations concerning bank competition. The increase of banking sector competition may result in worse performance of the industries.

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