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### The determinants of bank stock return's co-movements in East Asia

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#### Abstract

We examine co-movements of bank stock returns in eight East Asian countries after the 1997 crisis and attempt to determine the factors that influence them. Unlike Bautista and al (2008) who focus on a measure of the contribution of banks to systemic risk, we consider the return correlations among banks within each country which are used as a dependent variable in weighted least squares regressions. The factors were chosen from a wide range of accounting and market-based indicators, but also macroeconomic and financial development data, using a stepwise procedure. The study finds that financial development is one of the significant determinants of return co-movement but that the share of interbank activities in the balance sheet is not a significant factor. A strong link is found between the bank return co-movements and bank default risk measured by a z-score. To a lesser extent, the share of loan activities in a bank's balance sheet, which is a proxy of opacity, is also a significant factor of the level of correlation.

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## 1 Introduction

Banking system failures often lead to a deceleration of economic activity that turns into a deep crisis. We try to determine the possible reasons for banking system breakdowns, which can be deduced from the characteristics of member institutions. Problems of a systemic nature have been extensively examined in the banking and finance literature; but while banking sector systemic risk analysis has thrived in developed economies, there are only a few studies of bank domestic contagion for the Asian region.<sup>1</sup> In most of these studies, systemic risk is measured by the co-movement of bank stock returns within a country.

We use correlation measures to analyze the movements of bank stock returns. We however go one step further by investigating the factors that influence the magnitude of these correlations and therefore what variables policy makers could monitor when attempting to detect breakdowns in financial systems. We follow a two-step empirical procedure. Exponentially weighted moving-average correlations of market-adjusted bank stock returns are first computed. These are then averaged for each bank and used as the dependent variable in a cross-section regression with various accounting and market-based indicators as regressors. This study is an extension of the research undertaken by Bautista et al (2008). In their paper, the correlations are used to construct a measure of the contribution of each bank to systemic risk which is then used as a dependent variable in binary probit regressions. The present study uses a different and more general approach. We focus on the explanation of the level of correlation and not on the explanation of the contribution to systemic risk. The level of correlation is directly used as a dependent variable in a weighted least squares regression. Moreover, this study focuses exclusively on correlations among banks within a country unlike in Bautista et al (2008) which covers both domestic and cross border correlations in order to determine whether the nature of cross border contagion is significantly different from domestic contagion. Eventually, we also consider general macroeconomic conditions and the level of financial development as factors that might influence the level of correlation and that should be controlled for. The countries covered by this study are Hong Kong, Indonesia, Korea, Malaysia, Philippines, Singapore, Taiwan, and Thailand.

## 2 Methodology and Data

We proceed in two steps. First, for each country the correlations of weekly stock return data of every individual bank with all the other banks are computed. Second, the average correlation of each bank with the other banks is used as the dependent variable in a cross-section equation with accounting and market-based variables as regressors. These variables are introduced to capture various bank specific characteristics such as size, performance, opacity, illiquidity, and risk.

To isolate the contagion effects, the influence of market movements are filtered out by using the residuals of a standard market model:

$$R_{it} = \alpha_i + \beta_i R_{m(t)t} + r_{it} \quad (1)$$

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<sup>1</sup> See the following and their references: De Nicolo and Kwast (2002), Demirgüç-Kunt et al (2006), Gropp and Vesala (2005) and Gropp and Moermann (2004). For an extensive analysis of the Asian Crisis, see Baig and Goldfajn (1998).

$R_{it} = \log(P_{i,t}/P_{i,t-1})$  is the bank  $i$  stock return,  $R_{m(i)t} = \log(P_{m(i),t}/P_{m(i),t-1})$  is the market return computed on the basis of domestic indexes, and  $r_{it}$  is the filtered bank return, which is the residual of an OLS regression of equation (1). The  $P_{i,t}$ s are the stock prices.

The correlation of bank  $i$  stock return with all the other bank returns indexed by  $j$ , within the same country, is an exponentially weighted moving-average correlation between  $r_{i,t}$  and  $r_{j,t}$ , evaluated at time  $t$ :

$$\rho_{ij,t} = \frac{\sum_{s=0}^k \lambda^s r_{i,t-s} r_{j,t-s}}{\left[ \left( \sum_{s=0}^k \lambda^s r_{i,t-s}^2 \right) \left( \sum_{s=0}^k \lambda^s r_{j,t-s}^2 \right) \right]^{1/2}} \quad (2)$$

The lag length  $k$  is set to 51, and  $\lambda = 0.94$  as in Engle (2002). The co-movements of a given bank's return with the returns of all the other banks established in the same country are then averaged across all years:

$$\bar{\rho}_i = \frac{1}{N} \sum_{j=1}^N \frac{1}{T} \sum_{t=1}^T \rho_{ij,t} \quad \text{for } j \neq i \quad (3)$$

The second step in the process conducts a cross-section regression of the average correlation of bank  $i$  as defined in (3) against  $m$  market-based and accounting variables as well as a dummy variable,  $\text{findev}_i$ , reflecting general macroeconomic conditions and the level of financial development :

$$\bar{\rho}_i = \lambda_0 + \lambda_1 x_{i1} + \dots + \lambda_m x_{im} + \gamma \text{findev}_i + \varepsilon_i \quad (4)$$

To avoid the consequences of the heteroskedastic nature of the calculated  $\bar{\rho}_i$  (see Saxonhouse (1976)), we use the weighted least squares method where all the variables of the model are weighted by the estimated standard deviation  $s(\bar{\rho}_i)$  of  $\bar{\rho}_i$ :

$$s(\bar{\rho}_i) = \sqrt{\frac{\frac{1}{N} \sum_{j=1}^N \frac{1}{T} \sum_{t=1}^T (\rho_{ij,t} - \bar{\rho}_i)^2}{NT}}$$

Weekly stock price data were obtained from Datastream from 2000 to 2005 to compute market adjusted returns, correlations, and market-based regressors. The accounting-based explanatory variables, which are averaged over the 2000-2005 period, use bank balance sheet and income statement data that come from Bankscope. After eliminating the banks with inactively traded stocks, the sample is restricted to 122 banks from the eight countries. Sixty seven accounting and market-based indicators are used, which can be categorized into nine groups: size, capital adequacy, asset quality, earnings, liquidity, interbank activity, balance sheet structure, income statement structure, and market risk indicators (systematic risk, specific risk, total risk and

default risk measured by a z-score (Boyd and Graham (1986)). Because of the large number of accounting and market-based indicators, we conduct stepwise regressions on Equation (4) to isolate the variables that have the best explanatory power.<sup>2</sup> The dummy variable  $findev_i$ , that takes the value of 1 for Singapore, Hong Kong and Taiwan and 0 otherwise, was included in the regressions to account for differences in financial development. This dummy also reflects the differences in inflation and growth levels. These three countries present the lowest levels of both inflation and growth.

### 3 Hypotheses and Estimation Results

Our aim is to study the determinants of co-movements of stock prices within the banking industry. We focus on the correlations of the residuals of the market model to consider firm-specific risk and how this might affect other firms in the same industry. Because intermediation theory considers banks as opaque firms (Diamond, 1984), specifically banks heavily involved in the transformation of deposits in loans (asymmetric information), market participants are expected to react promptly to any bad news affecting a specific bank by overselling stocks of such financial institutions. Also, because banks are subject to runs (Diamond and Dybvig, 1983), potentially illiquid institutions and particularly those that are more reliant on deposits are vulnerable to a specific negative shock affecting any other firm in the industry. Alternatively, intra-industry links, which are an important feature of the banking industry (interbank operations) and a major source of contagion, should play a prominent role in the reaction of market participants. A negative event (decrease in the stock return) of a given institution is more likely to affect other institutions that are more involved in interbank lending and/or interbank deposits. Eventually, higher risk taking and higher default risk is also expected to increase the vulnerability of a given bank. We therefore consider standard accounting-based and market-based risk indicators as potential explanatory variables.

To check for robustness and because we are specifically concerned about co-movements of negative returns, the dependent variable is defined in two ways. We first consider the correlation of all the returns (negative or positive). We also compute the dependent variable by taking the correlations of simultaneously negative returns only. To ensure that our results are not influenced by a high variability in the correlations of an individual bank's stock returns with the returns of all the other banks, we also run the regressions on a sample restricted to observations of the dependent variable with a coefficient of variation lower than 2. In other words, because the dependent variable is the mean correlation of returns of a given bank with the returns of all the other banks, we need to make sure, for each bank, that a high (low) average correlation is consistent with systematically high (low) individual correlations and that high correlations are not partially offset by low correlations. Eventually, to further check for robustness, we re-estimate the equations induced by the stepwise process on 10000 bootstrapped samples.

Table 1 shows the results of two sets of WLS stepwise regressions corresponding to the two definitions of the dependent variable. The table shows that correlations are significantly higher for more financially developed countries. Higher default risk as measured by a lower value of the

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<sup>2</sup> The full list of this sub-set of explanatory variables can be found in Bautista et al (2008). Descriptive statistics are available from the authors on request.

z-score<sup>3</sup> is associated with a higher value of the dependent variable. A larger share of loan activities in total assets (opacity proxy) is also associated with higher correlations in the specification where all of the returns (negative or positive) are taken into account. When only negative returns are considered, the z-score variable is still significant along with the ratio of loan loss provisions to net interest revenue (proxy of exposure to credit risk). The results can be compared and contrasted with those obtained by Bautista et al (2008) which find that liquidity risk indicators and bank opaqueness proxies are significant factors of domestic contagion. It appears that the effects of the liquidity risk variables may have been captured by the financial development dummy in conjunction with default risk measure.

Table 1: Stepwise WLS regressions

$$\text{Estimated Equation : } \bar{\rho}_i = \lambda_0 + \sum_{k=1}^m \lambda_k x_{ik} + \gamma \text{findev}_i + \varepsilon_i \text{ where } \bar{\rho}_i = \frac{1}{N} \sum_{j=1}^N \frac{1}{T} \sum_{t=1}^T \rho_{ij,t} \text{ for } i \neq j$$

*Findev* is a dummy variable which equals 1 for Singapore, Hong Kong, Taiwan and zero otherwise. The explanatory variables  $x_{ik}$  are selected on the basis of a stepwise procedure where the selection criterion is a threshold P-Value of the estimated coefficient of 5%. The stepwise procedure is carried out on the full (unrestricted) sample. The equation is subsequently estimated on, first, a restricted sample of banks for which the coefficient of variation of the mean correlation is lower than 2 and, second, on the basis of 10000 bootstrapped samples. There are two sets of results : “All correlations” (the individual pairwise correlations are evaluated on the basis of all the returns) and “Correlations of Negative returns” (the individual pairwise correlations are only evaluated for returns that are simultaneously lower than zero). \*\*\*, \*\* and \* indicate significance respectively at the 1%, 5% and 10% levels.

All correlations Variable	Unrestricted sample		Restricted		Bootstrapped	
	Coef	t-stat	Coef	t-stat	Coef	t-stat
Mean z-score <sup>3</sup>	-0.010***	-7.309	-0.011***	-5.911	-0.009***	-6.280
Capital funds/net loans	-0.001***	-2.577	0.001***	0.824	-0.001	-0.658
Net loans/total assets	0.003***	5.134	0.003***	3.393	0.003***	3.645
Findev	0.161***	8.460	0.166***	7.835	0.155***	6.676
Constant	0.138***	2.802	0.195***	2.755	0.143*	1.944
No. Of Observations	75		45		75	
Adj. Unweighted R <sup>2</sup>	0.670		0.612		-	
Correlations of negative returns only Variable	Unrestricted sample		Restricted		Bootstrapped	
	Coef	t-stat	Coef	t-stat	Coef	t-stat
Mean z-score	-0.005***	-4.361	-0.005***	-4.370	-0.005***	-3.547
Loan loss provisions/net interest revenue	0.001***	3.833	0.001***	3.687	0.001**	2.312
Loan loss provisions/gross loans	-0.011***	-2.925	-0.012***	-3.304	-0.008	-1.021
Findev	0.083***	5.833	0.076***	5.636	0.089***	4.889
Constant	0.355***	12.793	0.367***	13.390	0.331***	8.829
No. Of Observations	75		70		75	
Adj. Unweighted R <sup>2</sup>	0.502		0.445		-	

<sup>3</sup> z-score is defined as :  $\frac{1 + \bar{R}_{i,t|t-51}}{\sigma(R_{i,t|t-51})}$  where  $\bar{R}_{i,t|t-51}$  and  $\sigma(R_{i,t|t-51})$  are, respectively, the mean and the standard

deviation of bank i returns within a [t-51, t] interval. In our cross section regressions we consider the mean value of the score for each bank over the 2000-2005 period.

## 4 Conclusion

The aim of this paper is to analyze the co-movements of stock prices of 122 banks in East Asia. We find a strong link between the co-movements of residuals and the level of financial development. Bank default risk measured by a z-score and to a lesser extent the share of loan activities in the balance sheet (which is considered as a proxy of bank opacity) are also significant factors. However, interbank activity is not a significant factor of co-movements. Unlike the findings of Bautista and al (2008), our results suggest that market participants are not concerned about liquidity. We find that market participants mainly consider the level of default risk (probability of failure) when they take the decision of selling bank stocks when a negative event affects a given bank in the banking system.

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