An Intelligent Fuzzy/Cointegration analysis for Systematic Risk

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Abstract: - This study developed a new intelligent fuzzy/cointegration analysis to examine the effects of cross-border bank M&As on the systematic risk that took place in the American, Asia, Europe, Africa and Middle East of banks. The potential diversification gains that arise from geographic or cross-border diversification are studied using a database that includes deals and bank stock return information for 114 cross-border M&As during 1998-2005. After the announcement of cross-border M&As, most of the acquirers’ systematic risk generally descends relative to banks of their home financial market. That is, there is a decrease in systematic risk with respect to the bank return and market return indexes of the home country, where the acquirer is located. The findings have important regulatory policy implications in that, the potential diversification gains have obtained in home country. Consequently, regulators in home countries may be less concerned with a rise in systematic risk following cross-border M&As, and no need to impose barriers to restrict the cross-border M&As activity. This study suggests that the proposed intelligent fuzzy/cointegration analysis is effective and robust.

Key-Words: - cross-border Mergers and Acquisitions (M&As), intelligent fuzzy/cointegration, systematic risk, diversification.

1 Introduction
The international financial market has experienced significant changes that have reshaped its exposure to global shocks. An important issue in this trend has been the increasing presence of foreign banks in emerging markets and developed countries. The worldwide integration, derive from cross-border M&As in bank have been on the rise for over a decade. focarelli and Pozzolo [1] suggest that distance, economic and cultural integration are important determinants for both the banks’ and the insurance companies’ expansion abroad. By extending its operations into new overseas markets, the acquirer bank is confronted with potentially new and risk increasing monitoring problems of the target bank, such as loan customer base, the operating cost structure, etc. DeYoung et al [2] point out the evidences on the impact of both geographic and product diversification via merger is mixed. A limited number of recent studies have examined systemic risk issues in European banking, and none of them directly examined the impact of bank M&A. Prior literatures examine the performance effects to bidders in bank acquisitions [3-5]. The effects of bank M&As have been studied by using information from M&As between local institutions in developed countries and cross-border M&As in Europe [6-7]. Micco et al. [8] show limited performance improvements in the post-acquisition period. On the contrary, foreign banks in emerging markets are found to be better performers than their domestic counterparts. On the other hand, a common argument in banking literatures is that cross-border M&As have the potential to reduce bank’s insolvency risk [9-12]. Amihud et al. [13] propose that cross-border mergers may increase the insolvency risk exposure of either one or both the acquirer and target bank regulators. Instead, Nicoló, et al. [14] find highly concentrated banking systems exhibited levels of systematic risk potential higher then less concentrated systems during the 1993-2000 period,
and argue that bank consolidation and conglomerate may not necessarily yield either safer financial firms or more resilient banking systems. A first set of studies analyzes the effects of cross-border M&As. The strand of the literatures focus on the effect of M&As on stock prices and accounting measures of performance. Pilott and Santomero [15] and Calomiris and Karceski [16] review the findings for U.S. institutions. The typical analysis of M&As using stock price data, compares the change in returns after a M&A is announced. Another strand of studies uses accounting data to assess the effect of M&As on operating performance. Chamberlain [17] analyzes a sample of M&As that took place in the U.S. in the 1980s and finds that these transactions did not yield any operating efficiencies. This result is consistent with similar evidence that shows no improvements in Return on Assets (ROA) or growth in operating income in the same period (Linder and Crane 1992). The study expands these last two strands of the literature by using accounting data of publicly bank M&As to assess the effect of cross-border acquisitions on the acquirers’ systematic risk. To analyze this effect, this study develop a new intelligent fuzzy/cointegration analysis for systematic risk and constructs a large sample of M&As that includes acquirers in developed and emerging markets.

2 Hypothesis and Methodology

The study analyzes the changes in the acquiring bank’s systematic risk after the cross-border M&As is completed compared to its risk prior to the M&As, relative to an index of all banks in three domiciles: the world, the home country (i.e., the country where the acquiring bank is located) and the host country (i.e., the country where the target bank is located).

In accordance with Amihud et al. [13] argument that after a domestic bank (acquirer) acquires a foreign bank (target), there is a rise in the share of its income that is derived from foreign markets (home country) and a decline in the share of its income that is derived from the domestic market (home country). This study examines the issue and proposes the hypothesis as follows:

**H1:** Since part of the acquirers’ return is generated by banking operation abroad (or target) which is not perfectly correlated with banking activity in the home market, as a result, as would be expected from the diversification theory, should decline after cross-border M&As.

**H2:** Since the acquirers’ return in part reflects the return on banks in countries where the target bank is doing banking activity, which is generated by banking operation abroad (or target) that is correlated with banking operation in the home market, as a result, and should increase after cross-border M&As.

Specifically, this study measures the acquiring banks’ systematic risk, its coefficient, relative to three bank indexes: world, home and host. To attain this objective, the study uses the bank return of world, home and host respective, , and . The world, home and host bank return indexes are regressing (by cointegration analysis) on the individual acquirers’ return, respectively. The estimated model for cross-border M&As of the return of stock i on day t, is as follows:

\[
R_{i,t} = \alpha_i + \beta_{world,it} R_{world,t} + \lambda_{world,it} D_{it} + \beta_{home,it} R_{home,t} + \lambda_{home,it} D_{it} + \beta_{host,it} R_{host,t} + \lambda_{host,it} D_{it} + \epsilon_{it}.
\]

Where \(R_{i,t}\) is the return on acquirer \(i\) on day \(t\), is the bank index on day \(t\), where \(K = \) world, home or host, and \(D_{it}\) is a dummy variable, \(D_{it}=0\) for days -365 to day -1 before the M&As announcement, and \(D_{it}=1\) for days +1 to day +365 after the consummation of the M&As. We can directly obtain the change in beta from this equation:

\[
\Delta \beta_{K,i,t} = \lambda_{K,i}.
\]

\[
\Delta \beta_{i,t} = \beta_{i,(after)} - \beta_{i,(before)} = \lambda.
\]

To establish the intelligent model based on fuzzy logics, the definition of fuzzy time series model is introduced by following the concepts presented by [18-20]. The definition of fuzzy time series is first presented as follows.

**Definition I. Fuzzy time series**

Let \(Y(t)(t=0,1,2,...)\), a subset of \(R_1\), be the universe of discourse on which fuzzy set \(f_i(t)(i=1,2,...)\) are defined. \(F(t)\) is a collection of \(f_1(t), f_2(t),...,\)then \(F(t)\) is called a fuzzy time series defined on \(Y(t)\).

In definition I, \(F(t)\) could be viewed as a linguistic variable. This represents for the major differences between fuzzy time series and traditional time series, whose values must be real numbers. Note that
conventional time series models fail to work when its values are linguistic ones.

**Definition II. First-order model of fuzzy time series**
Suppose F(t) is affected by F(t-1) only, then the fuzzy relation can be expressed by F(t)\(=F(t-1) \circ R(t,t-1)\), where R(t,t-1) is the fuzzy relationship between F(t-1) and F(t). And the model F(t)=F(t-1) \circ R(t,t-1) is called the first order model of F(t).

**Definition III. mth-order model of fuzzy time series**
Suppose F(t) is simultaneously caused by F(t-1) and F(t-2) and... \(F(t-m),( m>1)\), then this relation can be expressed by the following equation:
\[F(t)=[F(t-1) \times F(t-2) \times \ldots \times F(t-m)] \circ R(t,t-m),\]
which is defined as the m-th order model of F(t).

Note that the fuzzy relationship defined by \(R(t,t-m)\) or \(R(t,t-1)\) can be dependent or independent of time. For example, if \(R(t,t-m)\) is independent of t, then F(t) is called a time-invariant fuzzy time series; otherwise it is called a time-variant fuzzy time series. In case of time-invariant time series, the fuzzy relationship can be rewritten as:
\[R(t,t-1)=R\]
\[R(t,t-m)=R(m)\]
Where R contains only constant elements and Rand(m) depends on m only.

Firstly, the historical data, which can be linguistic values, are collected and analyzed. Based on the collected data, we determine the universes of discourse on which the fuzzy sets will be defined. The intelligent model is constructed by the fuzzy relationships defined in the previous step. Finally, use the historical data at time t as inputs to the forecasting model and compute the output result at time t+1, which will be the forecasted values.

### 4 Empirical Results

In the first stage, the records of bank return indexes are used to generate the linguistic fuzzy sets. Under the transformation of fuzzy relational matrix, the resulting linguistic values of bank returns can be defuzzified back into crisp values. Fig. 1 shows the results of one of sampled banks. The blue line represents for the actual fluctuation of the bank’s return, while the red and green lines represent respectively for the modeled results using first- and second-order approaches. The highly irregular trend can be generally forecasted using the current approach, especially the second-order model. Thus, the proposed approach can give satisfactory results. Further explorations are completed using the cointegration analysis. The empirical results are summarized in Table 1. The results show that 50.88% (58 M&As deals) of cross-border M&As sample adheres to this expectation, wherein 38.60% (44 M&As deals) are negative significantly at 5% for the changes in beta using bank return indexes as benchmarks. The result further confirms that cross-border bank related M&As do shift the acquirers’ systematic risk away from the home market, nevertheless not significantly, as might be expected a priori, and in accordance with the evidence of Agmon and Lessard [21]. On the other hand, the results show that 50.88% (58 M&As deals) of cross-border M&As sample adheres to this expectation, in which and are positively, wherein 44.74% (51 M&As deals) and 38.60% (44 M&As deals) are positive significantly at 5% for the changes in beta using bank return indexes as benchmarks, respectively.

These results have important regulatory implications. There is a decrease in systematic risk with respect to the bank return index of the home country, where the
acquirer is located. Thus regulators in home countries may be less concerned about imposing barriers to cross-border M&As. Furthermore, the changes of systematic risk are both increases significantly with respect to the bank return index of the world and host country, where the target is located. Thus, regulators in host countries may be more concerned regarding the effects of cross-border bank M&As on the stability of their banking systems, to impose barriers to foreign acquisitions.

The effects of cross-border bank M&As on acquirers’ systematic risk could alternatively be examined using market return indexes instead of bank return indexes. Even though using the market return index as a benchmark for the analysis would likely confound two effects, proposed by Amihud et al. [13], our assessment of systematic risk changes covers a relatively long period of time, 365 days before and after the bank M&A. If, due to a regulatory change that impacts a bank industry during that period, then the systematic risk of the acquirer banks would change though this change has nothing to do with the M&As been analyzed.

In Table 1, the evidences are less supportive of the expectation where, and for cross-border M&As. The result show that 45.61% (52 M&As deals) of cross-border M&As sample adhere to this expectation, wherein 39.47% (45 M&As deals) are negative significantly at 5% for the changes in beta using market return indexes as benchmarks. The result further confirms that cross-border bank related M&As do shift the acquirers’ systematic risk away from the home market, nevertheless not significantly, as might be expected a priori, and in accordance with the evidence of Agmon and Lessard [21]. On the other hand, the results, presented in Table 1, show that 39.47% (45 M&As deals) and 49.12% (56 M&As deals) of cross-border M&As sample adhere to this expectation, in which and are positively, wherein 35.09% (40 M&As deals) and 33.33% (38 M&As deals) are positive significantly at 5% for the changes in beta using market return indexes as benchmarks, respectively.

On the other hand, the result of acquirers’ bank return, presented in Table 1, shows that 42.98% (49 M&As deals) of cross-border M&As sample adheres to this expectation, wherein 39.47% (45 M&As deals) are negative significantly at 5% for the changes in beta using market return indexes as benchmarks. The result further confirms that cross-border bank related M&As do shift the acquirers’ systematic risk away from the home market, nevertheless not significantly, as might be expected a priori, and in accordance with the evidence of Agmon and Lessard [21]. On the other hand, the results show that 42.98% (49 M&As deals) and 49.12% (56 M&As deals) of cross-border M&As sample adheres to this expectation, in which and are positively, wherein 40.35% (46 M&As deals) and 35.09% (40 M&As deals) are positive significantly at 5% for the changes in beta using market return indexes as benchmarks, respectively.

The results have important regulatory implications. There is a decrease in systematic risk with respect to the market return index of the home country, where the acquirer is located, as in accordance with the evidence of previous study. Additionally, the changes of systematic risk are both increases significantly in systematic risk with respect to the market return index of the world and host country, where the target is located. Thus, there is further confirming that regulators in home countries may be less concerned about imposing barriers to cross-border M&As. In addition, regulators in host countries may be more concerned regarding the effects of cross-border bank M&As on the stability of their banking systems, to impose barriers to foreign acquisitions.

5 Conclusion

We proposed a new intelligent fuzzy/cointegration analysis for systematic risk and construct a large sample of M&As that includes acquirers in developed and emerging markets. This study uses a database that includes deals and bank stock return information for 114 cross-borders M&As between 1998-2005, to examine the effects of cross-border bank M&As on the systematic risk of acquiring banks, and to analysis the potential diversification gains that arise from geographic or cross-border diversification. We find that whether an acquirer systematic risk rises or falls, following a cross-border M&As, is highly distinguishing. These results show that both hypothesis are supported by the data of cross-border M&As in general for the changes in beta using bank return and market return indexes as benchmarks. Surprisingly, the effect of changes in systematic risk when using bank return index as benchmark is superior to market return index. This study provides an intelligent and robust approach for analyzing systematic risk. The satisfactory results suggest that the proposed model is reliable and feasible.

References:


Table 1: Summarized the Effects of Changes in Systematic Risk by Cointegration Analysis

<table>
<thead>
<tr>
<th>Equation</th>
<th>$\lambda_{\text{home}}$</th>
<th>$\lambda_{\text{world}}$</th>
<th>$\lambda_{\text{host}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panel A: Breakdown by M&amp;As deals</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>58</td>
<td>58</td>
<td>58</td>
</tr>
<tr>
<td>2</td>
<td>52</td>
<td>45</td>
<td>56</td>
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<tr>
<td>3</td>
<td>49</td>
<td>49</td>
<td>56</td>
</tr>
<tr>
<td>Panel B: Breakdown by M&amp;As percentage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>50.88%</td>
<td>50.88%</td>
<td>50.88%</td>
</tr>
<tr>
<td>2</td>
<td>45.61%</td>
<td>39.47%</td>
<td>49.12%</td>
</tr>
<tr>
<td>3</td>
<td>42.98%</td>
<td>42.98%</td>
<td>49.12%</td>
</tr>
</tbody>
</table>

Note: The deals and percentage indicate significantly above 5%.
$\lambda_{\text{home}}$ shows the negative significantly effect of M&As transactions and percentage.
$\lambda_{\text{world}}$ and $\lambda_{\text{host}}$ shows the positive significantly effect of M&As transactions and percentage, separately.

Fig. 1 Results of the proposed intelligent model