An Intelligent Web-based GRA/Cointegration analysis for Systematic Risk

Shu Ling Lin and Shun Jyh Wu

Abstract—A new intelligent web-based grey relational analysis (GRA)/cointegration analysis is proposed 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 in this paper. 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. Cointegration analysis is first developed to obtain the relationship between financial variables and web-based GRA is then applied to establish the ranking and clustering of all acquirer events. 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. Grey relational analysis is demonstrated to be well developed to the clustering and ranking of cross-border M&As events. This study suggests that the proposed intelligent web-based GRA/cointegration analysis is effective and robust.

Keywords—cross-border Mergers and Acquisitions (M&As), cointegration, grey relational analysis (GRA), systematic risk.

I. INTRODUCTION

The international financial market has experienced significant changes that have reshaped its exposure to global shocks. An important issue I 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 b 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, Nicolò, 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 conglomeration 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. Piloff 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 by Linder and Crane DB [18] that shows no improvements in Return on Assets (ROA) or growth in operating income in the same period. The study expands these last two strands of the literature by using accounting data of publicity bank M&As to assess the effect of cross-border acquisitions on the acquirers’ systematic risk. The grey relational analysis (GRA) has been used in predicting of linear motion guide [19],[20]. In the financial research, a hybrid model combining grey prediction and rough set approach that predicts the failure firms based on past financial performance data [21], and applying grey group model to forecast the earning per share [22]. The results demonstrate that the grey model is a competitive and competent one in prospective analysis. To analyze the M&A effect, this study develop a new intelligent GRA/cointegration analysis for systematic risk and constructs a large sample of M&As that includes acquirers in developed and
emerging markets.

II. HYPOTHESIS AND METHODOLOGY

A. Hypothesis and Empirical Model

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 (host 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:

$H^{I}: \text{Since part of the acquirers’ return is generated by banking operation abroad (or target) which is not perfectly correlated with banking activity in the home market, as a result, the acquiring bank’s systematic risk (} \lambda_{\text{home}} \text{) should decline after cross-border M&As.}$

$H^{II}: \text{Since the acquirers’ return in part reflects the return on banks in countries where the target bank is doing banking activity, which is generated by banking operation abroad (or target) that is correlated with banking operation in the host market, as a result, } \lambda_{\text{world}} \text{ and } \lambda_{\text{host}} \text{ should increase after cross-border M&As.}$

The study expects that a cross-border M&As would decrease the acquirers’ $\beta$ with respect to the home bank return and increase its $\beta$ with respect to the world and host bank return.

Specifically, this study measures the acquiring banks’ systematic risk, its $\beta$ 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, $RB_{\text{world}}$, $RB_{\text{home}}$ and $RB_{\text{host}}$.

This is obtained by regressing the world, home and host bank return indexes on the individual acquirers’ return, respectively. The estimated model for cross-border and domestic M&As of the return of stock $i$ on day $t$, $R_{i,t}$, are as follows:

$$R_{i,t} = \alpha_i + \beta_{\text{world},i} RM_{\text{world},t} + \lambda_{\text{world},i} RM_{\text{world},t} D_{t}$$

$$+ \beta_{\text{home},i} RM_{\text{home},t} + \lambda_{\text{home},i} RM_{\text{home},t} D_{t} + \beta_{\text{host},i} RM_{\text{host},t} + \lambda_{\text{host},i} RM_{\text{host},t} D_{t} + \epsilon_{i,t}$$

Where $R_{i,t}$ is the return on acquirer $i$ on day $t$, $RB_{K,t}$ is the bank index on day $t$, where $K = \text{world}$, $\text{home}$ or $\text{host}$, and $D_t$ is a dummy variable, $D_t = 0$ for days -365 to day -1 before the M&As announcement, and $D_t = 1$ for days +1 to day +365 after the consummation of the M&As. We can directly obtain the change in beta from (4): $\Delta \beta_{K,t} = \lambda_{K,t}$.

$$\Delta \beta_{K,t} = \beta_{K,t}(\text{after}) - \beta_{K,t}(\text{before}) = \lambda_{K,t}$$

B. Definition of web-based grey relational analysis (GRA)

To establish the prediction model based on grey relational analysis (GRA), the definition of GRA model is introduced by following the concepts presented by [23],[24]. The definition of grey relational analysis (GRA) is first presented as follows.

A system which has none of information is defined as a black system, while a system which is full of information is called white. Thus, when the information of a system is either incomplete or undetermined, it is defined as grey system. The grey number represents an element with incomplete information. The grey relation is the relation with incomplete information. This section describes the basic definitions of grey relational analysis, GRA. The inner product and metric of two vectors are first defined. What follows are properties of norm space, grey relational space, grey relational grade for both globalized and localized grey relationships.

**Definition 1.** Let the set $X$ be a vector space to apply grey relational analysis, and the vectors $x, y$ are elements of $X$.

First, the inner product of $x$ and $y$ and metric of vectors is defined as follows:

$$\langle x, y \rangle = \|x\|_2 \|y\|_2 \cos \theta$$

$$\|x\|_2 = \sqrt{\sum_{i=1}^{n} x_i^2}$$

The $X$ is content with the vector space axiom. Eq. (5) is satisfied with the inner product axiom. Both axioms are in set theory [24].

**Definition 2.** The metric between two vectors $x, y$ with the distinguish coefficient $\xi$ is defined as follows:
\[ |x-y|_\xi = \sqrt[\xi]{\sum_{i=1}^{n} |x_i - y_i|^\xi} \]  

(8)

Where \( \xi \geq 1 \).

Eq. (8) defines Minkowski distance [25]. The Euclidean distance is the special case of Eq. (8) at \( \xi = 2 \), and city-block distance is also the special case of Eq. (8) at \( \xi = 1 \).

**Axiom 1.** The \( X \) is a norm space, as consisted with the following three properties.

1. \( \|x\|_\xi \geq 0 \)
2. \( \|ax\|_\xi = |a| \cdot \|x\|_\xi \)
3. \( \|x+y\|_\xi \leq \|x\|_\xi + \|y\|_\xi \)

The third property in \( L_p \) norm has been proved mathematically.

**Definition 3.** The following two features that are able to extract from traditional GRA concept are describe as follows:

1. The metric between two sequences is calculated, and normalized the grey relational grade with distinguish coefficient.
2. Grey relational grade has the order relation of each sequence.

**Definition 4.** The \( \Gamma \) is a grey relational space, such as \( X \times X \). The current GRA is a process that transfers Banach space into the grey relational space, and is content with Def. 3. The former is described by

\[ f : X \rightarrow \Gamma \]  

(9)

**Definition 5.** The variables \( x_0 \) and \( x_i \) are both n-dimensional vectors, such as \( x_0, x_i \in X \), which is the replaced sequence in GRA. Note that \( x_0 \) is a reference vector, and \( x_i \) is an inspected vector, where \( i = 1,2,...,m \).

**Definition 6.** The grey relational grade \( \gamma_{ij} \) is defined as a value obtained by grey relational analysis, which is given for the ordered pair \( \Gamma \subset X \times X \).

**Definition 7.** The localized grey relational grade \( \gamma_{0i} \) can be defined as follows:

\[ \gamma_{0i} = \frac{\Delta_{\max} - \Delta_{0i}}{\Delta_{\max} - \Delta_{\min}} \]  

(10)

Where

\[ \Delta_{0i} = \|x_0 - x_i\|_\xi \]

\[ \Delta_{\max} = \max_{\forall i} \{\Delta_{0i}\} \]

\[ \Delta_{\min} = \min_{\forall i} \{\Delta_{0i}\} \]

**Theorem 1.** The globalized grey relational grade \( \gamma_{ij} \) can be represented as follows:

\[ \gamma_{ij} = 1 - \frac{\Delta_{ij}}{\Delta_{\max}} \]  

(11)

Where \( i, j = 1,2,...,m \), \( \Delta_{ij} = \|x_i - x_j\|_\xi \), \( \Delta_{\max} = \max_{\forall i} \max_{\forall j} \{\Delta_{ij}\} \).

Eq. (11) is equivalent to Eq. (10), such as

\[ \gamma_{ij} = \frac{\Delta_{\max} - \Delta_{ij}}{\Delta_{\max} - \Delta_{\min}} \]  

(12)

In Eq. In Eq. (12), \( \Delta_{\min} = \Delta_{ii} = 0 \) because \( \Delta_{ii} \) becomes a oneself metric at \( i = j \). Hence, Eq. (12) is described as follows:

\[ \gamma_{ij} = \frac{\Delta_{\max} - \Delta_{ij}}{\Delta_{\max} - \Delta_{\min}} = 1 - \frac{\Delta_{ij}}{\Delta_{\max}} \]

**Definition 8.** In the current GRA model, the grey relational matrix \( \Gamma \) is defined as follows.

\[ \begin{bmatrix}
\gamma_{11} & \gamma_{12} & \cdots & \gamma_{1m} \\
\gamma_{21} & \gamma_{22} & \cdots & \gamma_{2m} \\
\vdots & \vdots & \ddots & \vdots \\
\gamma_{m1} & \gamma_{m2} & \cdots & \gamma_{mm}
\end{bmatrix} \]  

(13)

The current GRA have the following properties, and several differences from traditional GRA can be found in [26].

**Theorem 2.** Localized grey relational grade has the following three properties:

1. **Normality:** \( 0 \leq \gamma_{0i} \leq 1 (\gamma_{0i} \in [0, 1]) \)

   Isolation:
   \[ \|x_0 - x_i\|_\xi = \Delta_{\max} \Rightarrow \gamma_{0i} = 0 \]

   Closeness:
   \[ \|x_0 - x_i\|_\xi = \Delta_{\min} \Rightarrow \gamma_{0i} = 1 \]

2. **Coincidence:**
   i) \( \gamma_{ii} = 1 \)
Table 2 shows the statistics summary of acquirer banks’ daily return, bank return and market return relative to three indexes: world, home, and host, respectively. The study finds that the mean value of targets’ stock returns for cross-border M&As are both higher than the bank return and market return relative to three indexes: world, home and host. The evidences imply that the targets’ stock returns for cross-border M&As increases relative to market return of banks in the acquirers’ home country. Alternatively Table 2 presents the results of total risk increasing hypothesis is supported by the standard deviation of a target’s stock return. There is a significantly indication of a highest in the targets’ total risk relative to its home bank indexes as well as market indexes for cross-border M&As. The result implies that, after the M&As, the operations of the acquirer and target became more integrated, which in turn is likely to have increased the correlation between their return and thus increased their total risk, compared to risk prior to M&As. Overall, the evidence is that in cross-border M&As, the acquirers’ total risk does not rise relative to the host country. Thus, the results show that while the target’s total risk does not decline after cross-border M&As, as would be expected from the diversification theory, it does riskier relative to target bank. The above evidences imply that in general, cross-border M&As do not lead acquirers to engage in post-merger risk shifting or risk increasing behavior. This result has important regulatory implications. Bank regulators that are concerned with the total risk of their domestic banking institutions need not be overly concerned that cross-border M&As strategies cause a threat to domestic bank industry stability. Consequently, regulators in acquirer’s countries may be less concerned about imposing barriers to foreign direct investment.

III. DATA AND STATISTICS SUMMARY

For the analysis of systematic risk, the study compares the magnitude of acquirer’s risk one year after the M&As with its risk one year prior to the M&As announcement. Specifically, this study analyzes data from +1 to +365 days after an M&As is completed and compare the results with data –1 to -365 days before an M&As is announced. This study measures the changes in systematic risk using bank return and market return indexes as benchmarks. The event window is the 731-date period surrounding the announcement of the M&As, from 365 days before the M&As announcement to 365 day after it was announced (days -365 to +365). Cybo-Ottone and Murgia [6] find significant leakage effects for cross-border mergers in the days just prior to announcements of European bank mergers. Consequently, the event window of 731 days captures possible leakages of information before the merger is announced. We amalgamate the cointegration model with intelligent GRA approach to provide a more robust and effective solution for the current analysis. The forecasted results are then explored by using (1-3). We examine M&As where at least one partner is financial industry and the partners are headquartered in different countries for cross-border M&As. We use those M&As where the acquirer owns at least 51%–100% of the target after the M&As, and the M&As must be completed by December 2005. The following section presents the empirical results.

In Table 3, the results of coefficients of (1), (2) and (3) for all events are listed. All negative numbers are listed in parentheses. To provide further evidences, these coefficients are summarized in Table 4 according to the sign of each value. This study expects most cases to fall into the expectation where \( \lambda_{\text{home},i} < 0 \), \( \lambda_{\text{world},i} > 0 \) and \( \lambda_{\text{host},i} > 0 \) for cross-border M&As. The results of (1) 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 [28]. 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 \( \lambda_{\text{world},i} \) and \( \lambda_{\text{host},i} \) 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.

Furthermore, in Table 4, the evidences are less supportive of the expectation where \( \lambda_{\text{home},i} < 0 \), \( \lambda_{\text{world},i} > 0 \) and \( \lambda_{\text{host},i} > 0 \) for cross-border M&As. The results in (2) show that 45.61% (52 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 [28]. On the other hand, the results, presented in Table 4, show that 39.47% (45 M&As deals) and 49.12% (56 M&As deals) of cross-border M&As sample adheres to this expectation, in which \( \lambda_{\text{world},i} \) and \( \lambda_{\text{host},i} \) 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.

The result of acquirers’ bank return, presented in (3) of Table 4, 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 [28]. On the other hand, the results, presented in Table 4, 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 \( \lambda_{\text{world},i} \) and \( \lambda_{\text{host},i} \) 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.

Finally, grey relational analysis is conducted using the coefficients in Table 3 as source data. All \( \lambda_{\text{home},i} \), \( \lambda_{\text{world},i} \) and \( \lambda_{\text{host},i} \) obtained from (1) to (3) are applied to generate grey relationship. The optimum benchmark value of \( \lambda_{\text{home},i} \) for GRA model is the event that have minimum value, while those for \( \lambda_{\text{world},i} \) and \( \lambda_{\text{host},i} \) are the corresponding maximum values. The results are obtained and listed in Table 4. There are four GRA clustering models in this table, depending on which equation’s coefficients are used. The first column shows the GRA ranking of all events, in which the first place represents better and positive effects of decreasing systematic risk while the last position means the positive effects of decreasing systematic risk is not obvious. The next pairs of columns show the results based on coefficients of (1), (2), (3) and all the three equations, respectively. Each pair of column lists the ranking of event number as well as the Gamma values of GRA analysis. The event having higher value of Gamma represents that it has closer grey relationship with the optimum benchmark. All events are clustered into three major groups according to the distribution of grey relationships, which are shown in Fig. 1-4. In Table 4, the first and the third groups are shadowed. The first group represents for the best diversification effect after cross-border M&As. These international financial banks are suggested to be the better targets for investment.

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 Agmon and Lessard [28]. 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.

V. CONCLUSION

We proposed a new intelligent web-based GRA/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&A, is highly distinguishing. These results show that both \( H_1 \) and \( H_2 \) 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. Grey relational analysis was proved to be an effective tool for the clustering and ranking of cross-border M&As events. The first group which has higher value of Gamma by web-based GRA analysis represents for the best diversification effect after cross-border M&As. These international financial banks are suggested to be the better targets for investment. 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 and suggests that future research should aim to overriding policy concerns related to systemic stability.
REFERENCES


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Table 1: sample description: number of M&As deals

<table>
<thead>
<tr>
<th>Country</th>
<th>Acquirers</th>
<th>Targets</th>
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<td>Panel A: Breakdown by country</td>
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<table>
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<th>Panel B: Breakdown by region</th>
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<td>Total</td>
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<table>
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<td>2005</td>
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<td>Total</td>
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### Table 2: statistics summary

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<tr>
<th>Variables</th>
<th>Obs.</th>
<th>Mean</th>
<th>Median</th>
<th>Max</th>
<th>Min</th>
<th>Std</th>
<th>SD</th>
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<td>Daily return</td>
<td>118210</td>
<td>0.0003</td>
<td>0.0000</td>
<td>0.2242</td>
<td>-5.0556</td>
<td>0.0337</td>
<td>-87.2252</td>
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<td>World bank return</td>
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<td>0.0002</td>
<td>0.0006</td>
<td>0.0556</td>
<td>-0.0488</td>
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<td>118210</td>
<td>0.0004</td>
<td>0.0000</td>
<td>0.3546</td>
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<td>Host bank return</td>
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Source: Daily return: DataStream, Mergent online, Yahoo Finance.

World bank return, Home bank return, Host bank return, World market return, Home market return, Host market return: DataStream, Yahoo Finance.

### Table 3: the coefficients in (1)-(3) by cointegration analysis

<table>
<thead>
<tr>
<th>Event No</th>
<th>Acquirer</th>
<th>Coefficients in (1)</th>
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<th>Coefficients in (3)</th>
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<td></td>
<td>$\lambda_{world}$</td>
<td>$\lambda_{host}$</td>
<td>$\lambda_{home}$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$\lambda_{world}$</td>
<td>$\lambda_{host}$</td>
<td>$\lambda_{home}$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$\lambda_{world}$</td>
<td>$\lambda_{host}$</td>
<td>$\lambda_{home}$</td>
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<td>1</td>
<td>Banco Bradesco SA</td>
<td>(0.107)</td>
<td>0.462 (4.788)</td>
<td>3.299</td>
</tr>
<tr>
<td></td>
<td>Banco Bradesco SA</td>
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<td>0.462 (4.788)</td>
<td>3.299</td>
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</tr>
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<td>1.331 (0.596)</td>
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<tr>
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<tr>
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<td>1.331 (0.596)</td>
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<td>1.331 (0.596)</td>
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DataStream, Yahoo Finance.
<table>
<thead>
<tr>
<th>Bank/Company</th>
<th>Total Equity</th>
<th>Total Assets</th>
<th>Regulatory Capital</th>
<th>Tier 1 Capital</th>
<th>Tier 2 Capital</th>
<th>Core Capital</th>
<th>Core Capital Adequacy Ratio</th>
<th>Tier 1 Capital Adequacy Ratio</th>
<th>Tier 2 Capital Adequacy Ratio</th>
<th>Core Capital Adequacy Ratio</th>
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<tr>
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<td>3,763,400</td>
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<td>58.37%</td>
<td>65.55%</td>
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<td>30.30%</td>
<td>30.30%</td>
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<td>11,500</td>
<td>65,000</td>
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<td>30.30%</td>
<td>30.30%</td>
<td>30.30%</td>
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<tr>
<td>Standard Chartered Bank PLC</td>
<td>42,734</td>
<td>1,469,500</td>
<td>115,300</td>
<td>98,500</td>
<td>16,800</td>
<td>70,700</td>
<td>29.30%</td>
<td>30.30%</td>
<td>30.30%</td>
<td>30.30%</td>
</tr>
<tr>
<td>Standard Chartered Bank PLC</td>
<td>42,734</td>
<td>1,469,500</td>
<td>115,300</td>
<td>98,500</td>
<td>16,800</td>
<td>70,700</td>
<td>29.30%</td>
<td>30.30%</td>
<td>30.30%</td>
<td>30.30%</td>
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<tr>
<td>Deutsche Bank AG</td>
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<td>1,469,500</td>
<td>115,300</td>
<td>98,500</td>
<td>16,800</td>
<td>70,700</td>
<td>29.30%</td>
<td>30.30%</td>
<td>30.30%</td>
<td>30.30%</td>
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<tr>
<td>Erste Bank</td>
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<td>1,469,500</td>
<td>115,300</td>
<td>98,500</td>
<td>16,800</td>
<td>70,700</td>
<td>29.30%</td>
<td>30.30%</td>
<td>30.30%</td>
<td>30.30%</td>
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<td>KBC Bank &amp; Insurance</td>
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<td>98,500</td>
<td>16,800</td>
<td>70,700</td>
<td>29.30%</td>
<td>30.30%</td>
<td>30.30%</td>
<td>30.30%</td>
</tr>
<tr>
<td>ABN-AMRO Holding NV</td>
<td>42,734</td>
<td>1,469,500</td>
<td>115,300</td>
<td>98,500</td>
<td>16,800</td>
<td>70,700</td>
<td>29.30%</td>
<td>30.30%</td>
<td>30.30%</td>
<td>30.30%</td>
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<td>Dexia SA</td>
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<td>16,800</td>
<td>70,700</td>
<td>29.30%</td>
<td>30.30%</td>
<td>30.30%</td>
<td>30.30%</td>
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<td>SNS Bank NV</td>
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<td>115,300</td>
<td>98,500</td>
<td>16,800</td>
<td>70,700</td>
<td>29.30%</td>
<td>30.30%</td>
<td>30.30%</td>
<td>30.30%</td>
</tr>
</tbody>
</table>

**Notes:**
- All numbers are in Euros.
- Regulatory Capital includes Tier 1 and Tier 2 capital.
- Core Capital Adequacy Ratio is calculated as Core Capital / Total Risk-Weighted Assets (RWA).
- Tier 1 Capital Adequacy Ratio is calculated as Tier 1 Capital / RWA.
- Tier 2 Capital Adequacy Ratio is calculated as Tier 2 Capital / RWA.
### Table 4: 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>
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<tbody>
<tr>
<td>Panel A: Breakdown by M&amp;As deals</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1  &amp; 58 &amp; 58 &amp; 58</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2  &amp; 52 &amp; 45 &amp; 56</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3  &amp; 49 &amp; 49 &amp; 56</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Panel B: Breakdown by M&amp;As percentage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1  &amp; 50.88% &amp; 50.88% &amp; 50.88%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2  &amp; 45.61% &amp; 39.47% &amp; 49.12%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3  &amp; 42.98% &amp; 42.98% &amp; 49.12%</td>
<td></td>
<td></td>
<td></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.

### Table 5: the rankings of acquirer events by web-based GRA analysis

<table>
<thead>
<tr>
<th>GRA Ranking</th>
<th>Results Based on the Coefficients of (1)</th>
<th>Results Based on the Coefficients of (2)</th>
<th>Results Based on the Coefficients of (3)</th>
<th>Results Based on the Coefficients of (1-3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Event No</td>
<td>GAMMA</td>
<td>Event No</td>
<td>GAMMA</td>
<td>Event No</td>
</tr>
<tr>
<td>1</td>
<td>100</td>
<td>1.0000</td>
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</tr>
<tr>
<td>2</td>
<td>15</td>
<td>0.8328</td>
<td>7</td>
<td>0.6106</td>
</tr>
<tr>
<td>3</td>
<td>14</td>
<td>0.6288</td>
<td>13</td>
<td>0.5761</td>
</tr>
<tr>
<td>4</td>
<td>46</td>
<td>0.5802</td>
<td>93</td>
<td>0.5633</td>
</tr>
<tr>
<td>5</td>
<td>37</td>
<td>0.3808</td>
<td>34</td>
<td>0.5571</td>
</tr>
<tr>
<td>6</td>
<td>13</td>
<td>0.3710</td>
<td>14</td>
<td>0.5558</td>
</tr>
<tr>
<td>7</td>
<td>6</td>
<td>0.3685</td>
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<td>8</td>
<td>34</td>
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<td>37</td>
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<td>0.3447</td>
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<tr>
<td>14</td>
<td>57</td>
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<td>15</td>
<td>16</td>
<td>0.3237</td>
<td>69</td>
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<td>52</td>
<td>0.3234</td>
<td>64</td>
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<td>17</td>
<td>93</td>
<td>0.3234</td>
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Fig. 1 distribution of grey relationship relative to event number based on (1)

Fig. 2 distribution of grey relationship relative to event number based on (2)

Fig. 3 distribution of grey relationship relative to event number based on (3)

Fig. 4 distribution of grey relationship relative to event number based on (1) to (3)