# Optimized Economic Capital for Emerging Markets Portfolio: Integrated Approach to Risk Assessment

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# Contribution

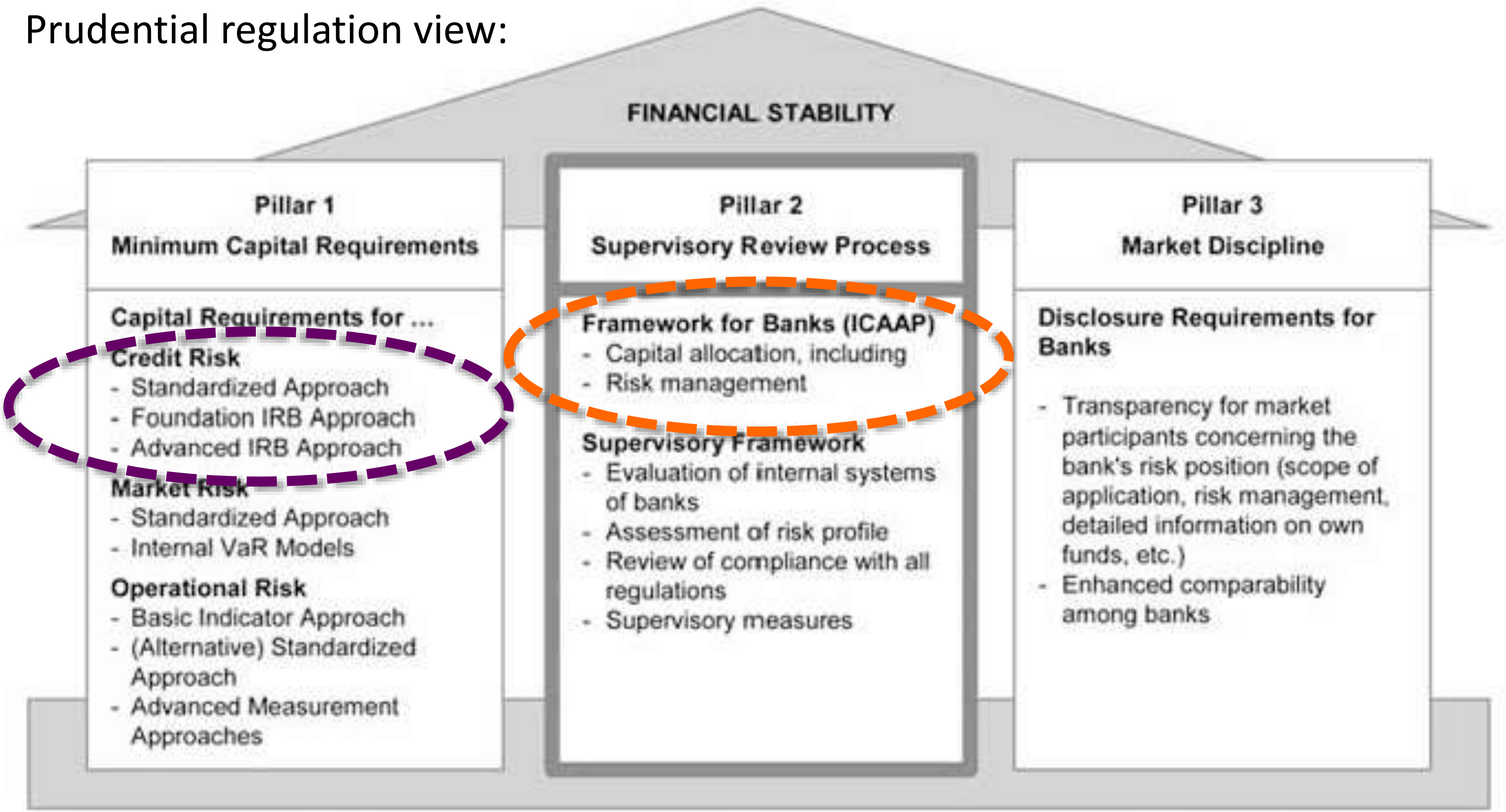
- **In this study we analyze** the interrelation between interest rate risk (IRR) and credit risk (CR) present in banking books of financial institutions exposed to EM sovereign debt, **contributing both:**
  - to the **empirical evidence** on the mutual attenuation effects between IRR and CR resulting in inter-risk diversification benefits;
  - to the **understanding of the nature** of automatic stabilizer-type behavior between these risks.

- **We try to answer the question**: whether the integrated treatment of IRR and CR is a robust, accurate, and advisable approach to quantifying economic capital (ECAP) requirements for banking books under the internal capital adequacy assessment process known as ICAAP. And our answer is yes.

- We develop a **derivative-based integrated framework** for assessing ECAP requirements. Our approach is based on historic time series of credit default swap (**CDS**) spreads and interest rate swap (**IRS**) rates. We apply it to analyze risk dynamics of **debt of 30 developing countries**.

## Basel III Financial Stability Framework: our research concerns Pillar 1 and Pillar 2

Prudential regulation view:

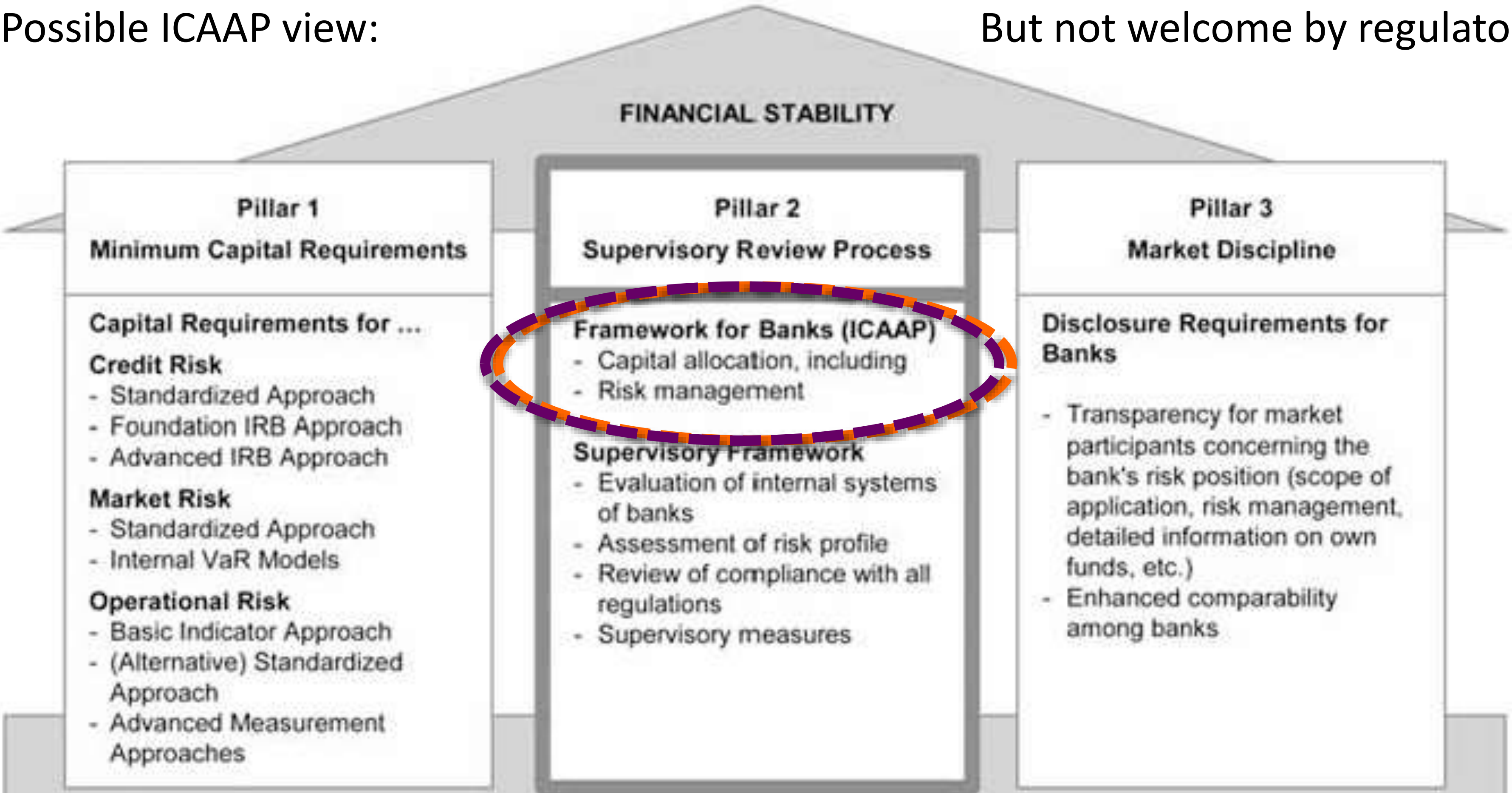



**Credit Risk in the Banking Book** **IRR in the Banking Book (IRRBB)**

## Basel III Financial Stability Framework: our research concerns Pillar 1 and Pillar 2

Possible ICAAP view:

But not welcome by regulators




**Credit Risk in the Banking Book**

**IRR in the Banking Book (IRRBB)**

## Theoretical justification of a split of liquidity, credit and interest rate risk

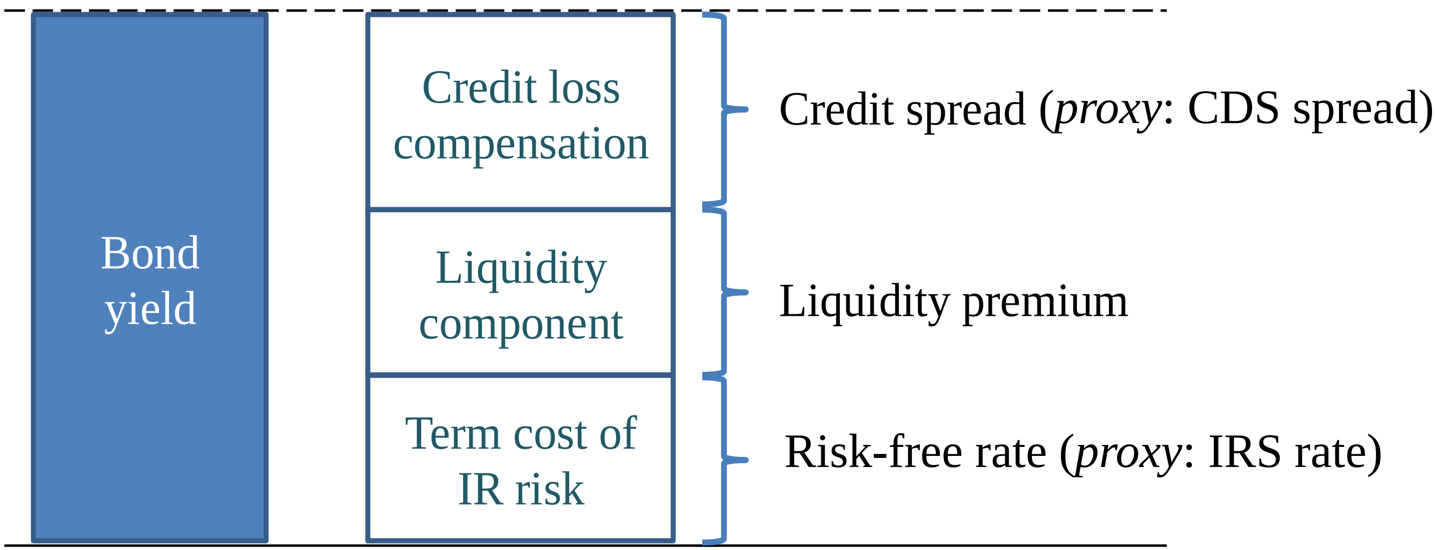
A theoretical justification of an yield split into liquidity, credit and interest rate risk descends from Black´s* (1970) economic thinking:

**“…a long term corporate bond could actually be sold to three separate persons. One would supply the money for the bond; one would bear the interest rate risk, and one would bear the risk of default. The last two would not have to put up any capital for the bond, though they might have to post some sort of collateral”.**

Thus, Black (1970) anticipated two derivative instruments: interest rate swaps (IRS) and credit default swaps (CDS).

** Black, F. 1970. Fundamentals of Liquidity. Internal Memo, Graduated School of Business, University of Chicago. https://speculativematerialism.files.wordpress.com/2013/07/fischer-black-fundamentals-of-liquidity-1970.pdf*

## Components of a bond yield



## State of the Art: Theoretical Bases and Inputs

- ***Integrating credit and interest rate risk in the banking book***

  - Alessandri, P., & Drehmann, M. (2010). An economic capital model integrating credit and interest rate risk in the banking book. *Journal of Banking and Finance*, 34(4), 730-742.

  **Assumption:** IRR and CR amplify one another.

- ***Interrelation between CR and IRR based on non-derivative instruments***

  - Boulkeroua, M., & Stark, A. (2013). On the determinants of the sensitivity of the yield spread of corporate bonds to changes in the level and slope of the yield curve. In: N. Apergis (Ed.), Proceedings of the IV World Finance Conference (pp. 118/167).
  - Dupoyet B., Jiang X, & Zhang Q. (2016). A new take on the relationship between Interest rates and credit Spreads. Working paper. Retrieved from https://openconf.s3.amazonaws.com/MFA2016/papers/120.pdf

## State of the Art: Theoretical Bases and Inputs

- ***Interrelation between CR and IRR based on derivative instruments***


  - Jermann, U. & Yue, V. (2013). Interest rate swaps and corporate default. Working Paper, Wharton School, University of Pennsylvania.
  - Chen, R., Cheng, X., & Wu, L. (2013). Dynamic interactions between interest-rate and credit risk: theory and evidence on the credit default swap term structure. *Review of Finance*, 17(1), 403-441.
  - Neal, R., Rolph, D., Dupoyet, B., & Jiang, X. (2015). Interest rates and credit spread dynamics. *The Journal of Derivatives*, 23(1), pp. 25-39.


- ***Downside risk management and flight-to-quality phenomena***


  - Gubareva, M. & Borges, M. (2016). Typology for flight-to-quality episodes and downside risk measurement. *Applied Economics* 48(10), 835 – 853. doi: 10.1080/00036846.2015.1088143.

## Main Objectives

- Study **interrelation between IRR and CR**, using CDS spreads and IRS rates as proxies for the respective risks and historical Value-at-Risk approach;
- Analyze a cross-elasticity of IRR and CR impacts through the prism of ECAP quantification, i.e. analyze **capital-wise cross-elasticity of IRR and CR**;
- Assess potential **hedge strategies against downside risk** from the point of view of historical cross-elasticity between IRR and CR;
- **Benchmarking derivative-based model** for ECAP **against the regulatory Basel II/III formula** for quantifying credit risk capital under the internal ratings based (IRB) Foundation approach;
- Initiate the **discussion supporting the use of integrated approach** to joint IRR an CR assessment potentially allowing **to unleash bank´s capital**.

## Compositions of the investigated equally weighted *EM* portfolios:

| **AEM** (**A**dvanced **EM**) | **SEM** (**S**econdary **EM**) | **FEM** (**F**rontier **EM**) |
|---|---|---|
| Brazil | Chile | Bahrain |
| Czech Republic | China | Cyprus |
| Hungary | Colombia | Estonia |
| Malaysia | Dubai | Lithuania |
| Mexico | Egypt | Morocco |
| Poland | Indonesia | Romania |
| South Africa | Pakistan | Serbia |
| Thailand | Peru | Slovakia |
| Turkey | Philippines | Slovenia |
| - | Russia | Tunisia |
| - | - | Vietnam |

We align our selection with the
**FTSE Global Equity Index Series Country Classification, as of September 2014**,
available at the beginning of our analyses (FTSE International Limited, 2014)

## General considerations:

- Focus on 5-year (5Y) point in the credit spread term structures, as this is the most tradable and the most liquid term;
- CDS spread quotes for USD denominated instruments;
  - ✓ such instruments are much more liquid than CDS denominated in other currencies, and,
  - ✓ our choice facilitates comparison of credit risks data and results across diverse geographies as the spreads are quoted on the same USD denominated basis.
- As a proxy for the USD denominated risk-free interest rate we use a fixed IRS rate at 5Y point (Bloomberg ticker: USSW5).

**Historical Value-at-Risk (VaR) approach:**

- VaR describes the maximum loss, which is not exceeded in a given time period, called holding period, with a given quite elevated probability, denominated confidence level.

- Historical VaR is calculated as a percentile of the distribution of the incurred losses.

- Targeting different aspects of financial management, VaR can be calculated for:

  - different holding periods**, in our case 260 banking days, i.e. 1 year**

  **-** different confidence levels, **in our case 99,9% corresponding to IG rating**

  **-** different lengths of historic data series, **we consider both 5Y and 7Y arrays.**

Already in place in many institutions:



**ECAP for IRR under segregated risk treatment based IRS fixed rate quotes:**

$$\Delta Value_{260d_{IR}}(t) = \left\{ \frac{[1 + yield\ (t)]^5}{[1 + yield\ (t) + \ \Delta USSW5_{260d}(t)\ ]^5} - 1 \right\} \times Nominal$$

$$ECAP_{\ IRR} = Percentile_{99.9\%} \{ Array[ -\Delta Value_{260d\_IR}(t)] \}$$

**ECAP for CR under segregated risk treatment based on CDS spread quotes:**

$$\Delta Value_{260d\_Spread}(t) = \left\{ \frac{[1 + yield\ (t)]^5}{[1 + yield\ (t) + \ \Delta Spread_{260d}(t)\ ]^5} - 1 \right\} \times Nominal$$

$$ECAP_{\ CR} = Percentile_{99.9\%} \{ Array[ -\Delta Value_{260d\_Spread}(t)] \}$$

**Compounded ECAP calculation:**

$$ECAP_{\ Compounded} = ECAP_{IRR} + ECAP_{\ CR}$$

Developed and studied in this research:



## Derivative-based risk assessment for integrated ECAP calculation :

$$\Delta Value_{260d_{Integrated}}(t) = \left\{ \frac{[1 + yield\ (t)]^5}{[1 + yield\ (t) + \Delta Spread_{260d}(t) + \Delta USSW5_{260d}(t)\ ]^5} - 1 \right\} \times Nominal$$

$$ECAP_{\ Integrated} = Percentile_{99.9\%}\ \{\ Array[\ -\Delta Value_{\ 260d\_Integrated}\ (t)]\ \}$$

**ECAP-wise elasticity of IRR and CR modeled for the pair of instruments: bond + IRS**

$$\Delta Value_{260d\_Hedge\_Pair}(t) = \Delta Value_{260d\_IR}(t) \times Hedge\_Coefficient + \Delta Value_{260d\_Integrated}(t)$$

$$ECAP_{Hedge\_Pair} = Percentile_{99.9\%}\{ Array[ -\Delta Value_{260d\_Hedge\_Pair}(t)] \}$$

Defined in this manner $ECAP_{Hedge\_Pair}$ depends on *Hedge_Coefficient.*
Thus, varying *Hedge_Coefficient* we solve the ECAP minimization problem:

$$ECAP_{Minimum\_Hedge\_Pair} = MINIMUM_{Hedge\_Coefficient}\{ (ECAP_{Hedge\_Pair}[ Hedge\_Coefficient] \}$$

- The value of the **hedge coefficient**, which corresponds to the **minimum possible ECAP**, defines a **possible downside risk hedge strategy from ECAP optimization point of view**.
- In other words, the value of the hedge coefficient characterizes **the cross-elasticity of IRR and CR** as seen from the point of view of ECAP optimization.

## Benchmarking integrated derivative-based model :

## Unexpected Loss quantified by Internal Ratings-based (IRB) Foundation approach

*Regulation (EU) No 575/2013 of the European Parliament, Article 153*

$$ECAP = exposure\ value \times \left[LGD \times N\left(\frac{1}{\sqrt{1-R}} \times G(PD) + \sqrt{\frac{R}{1-R}} \times G(0.999)\right) - LGD \times PD\right] \times$$

$$\times \frac{1+(M-2.5)b}{1-1.5b} \times 1.06$$

where *N(x)* is the cumulative distribution function for a standard normal random variable (i.e. the probability that a normal random variable with mean zero and variance of one is less than or equal to x); *G(Z)* denotes the inverse cumulative distribution function for a standard normal random variable (i.e. the value *x* such that *N(x) = z*); *R* denotes the coefficient of correlation, is defined as:

$$R = 0.12 \times \frac{1-e^{-50 \times PD}}{1-e^{-50}} + 0.24 \times \left(1 - \frac{1-e^{-50 \times PD}}{1-e^{-50}}\right)$$

and *b* stands for the maturity adjustment factor: $b = (0.11852 - 0.05478 \times \ln(PD))^2$.

## **Segregated versus Integrated approach to risk assessment: ECAP for EM portfolios** as of Dec-2014

| **5Y-long VaR history** 99,9% confidence interval | | **Portfolios** | | |
|---|---|---|---|---|
| | | **AEM** | **SEM** | **FEM** |
| CR ECAP, % | ( A ) | 6,33 | 5,82 | 11,00 |
| IRR ECAP, % | ( B ) | 5,28 | 5,22 | 5,16 |
| Compounded ECAP, % | ( C = A + B ) | 11,65 | 11,04 | 16,16 |
| Integrated ECAP, % | ( D ) | 6,23 | 6,40 | 10,02 |
| Disposable ECAP, % | ( E = C - D ) | 5,42 | 4,64 | 6,14 |

| **7Y-long VaR history** 99,9% confidence interval | | **Portfolios** | | |
|---|---|---|---|---|
| | | **AEM** | **SEM** | **FEM** |
| CR ECAP, % | ( A ) | 13,01 | 14,83 | 17,09 |
| IRR ECAP, % | ( B ) | 5,27 | 5,21 | 5,20 |
| Compounded ECAP, % | ( C = A + B ) | 18,28 | 20,04 | 22,29 |
| Integrated ECAP, % | ( D ) | 8,93 | 10,98 | 13,52 |
| Disposable ECAP, % | ( E = C - D ) | 9,35 | 9,06 | 8,77 |

**The interest rate downtrend dynamics mitigates the credit spread widening.**

- The ECAP under the integrated approach is significantly lower than the compounded ECAP following the segregated approach.
- The less advanced markets are, the greater are ECAP requirements under the integrated approach.
- For 7Y-long data series, the ECAP requirements under both integrated and segregated (compounded) approaches are higher than for the respective 5Y-long VaR sample that does not capture the entire history of the crisis development.

# ECAP for pre-crisis and post-crisis phases

## pre-crisis 2004-2008

| Country/ Portfolio | CR ECAP, % | IRR ECAP, % | Compounded ECAP, % | Integrated ECAP, % | Disposable ECAP, % |
|---|---|---|---|---|---|
| | ( A ) | ( B ) | ( C = A + B ) | ( D ) | ( E = C - D ) |
| Brazil (AEM) | 20,38 | 7,42 | 27,80 | 16,72 | 11,08 |
| Chile (SEM) | 12,99 | 7,80 | 20,79 | 8,80 | 11,99 |
| China (SEM) | 11,20 | 7,80 | 19,00 | 7,54 | 11,46 |
| Colombia (SEM) | 19,36 | 7,54 | 26,90 | 15,65 | 11,25 |
| Hungary (AEM) | 22,86 | 7,81 | 30,67 | 19,31 | 11,36 |
| Malaysia (AEM) | 18,34 | 7,79 | 26,13 | 14,47 | 11,66 |
| Mexico (AEM) | 21,93 | 7,75 | 29,68 | 18,33 | 11,35 |
| Peru (SEM) | 19,85 | 7,55 | 27,40 | 16,06 | 11,34 |
| Philippines (SEM) | 25,93 | 7,46 | 33,39 | 22,59 | 10,80 |
| Poland (AEM) | 11,51 | 7,80 | 19,31 | 8,20 | 11,11 |
| Romania (FEM) | 25,80 | 7,70 | 33,50 | 20,54 | 12,96 |
| Russia (SEM) | 36,69 | 7,69 | 44,38 | 33,92 | 10,46 |
| Slovakia (FEM) | 9,79 | 7,81 | 17,60 | 7,45 | 10,15 |
| South Africa (AEM) | 23,73 | 7,75 | 31,48 | 20,17 | 11,31 |
| Thailand (AEM) | 17,57 | 7,80 | 25,37 | 13,75 | 11,62 |
| Turkey (AEM) | 24,99 | 7,56 | 32,55 | 21,62 | 10,93 |
| **Average** | **19,85** | **7,69** | **27,54** | **16,08** | **11,46** |

# ECAP for pre-crisis and post-crisis phases

## post-crisis 2009-2013

| Country/ Portfolio | CR ECAP, % | IRR ECAP, % | Compounded ECAP, % | Integrated ECAP, % | Disposable ECAP, % |
|---|---|---|---|---|---|
| | ( A ) | ( B ) | ( C = A + B ) | ( D ) | ( E = C - D ) |
| Brazil (AEM) | 4,95 | 5,29 | 10,24 | 8,84 | 1,40 |
| Chile (SEM) | 4,08 | 5,31 | 9,39 | 5,76 | 3,63 |
| China (SEM) | 6,00 | 5,31 | 11,31 | 6,35 | 4,96 |
| Colombia (SEM) | 4,67 | 5,30 | 9,97 | 6,62 | 3,35 |
| Hungary (AEM) | 16,17 | 5,16 | 21,33 | 12,86 | 8,47 |
| Malaysia (AEM) | 5,91 | 5,30 | 11,21 | 7,08 | 4,13 |
| Mexico (AEM) | 4,57 | 5,30 | 9,87 | 6,45 | 3,42 |
| Peru (SEM) | 4,86 | 5,30 | 10,16 | 6,89 | 3,27 |
| Philippines (SEM) | 5,88 | 5,29 | 11,17 | 5,14 | 6,03 |
| Poland (AEM) | 8,53 | 5,29 | 13,82 | 7,31 | 6,51 |
| Romania (FEM) | 11,08 | 5,18 | 16,26 | 7,52 | 8,74 |
| Russia (SEM) | 7,56 | 5,28 | 12,84 | 7,60 | 5,24 |
| Slovakia (FEM) | 11,79 | 5,28 | 17,07 | 9,21 | 7,86 |
| South Africa (AEM) | 5,25 | 5,29 | 10,54 | 9,60 | 0,94 |
| Thailand (AEM) | 6,60 | 5,29 | 11,89 | 6,30 | 5,59 |
| Turkey (AEM) | 8,94 | 5,27 | 14,21 | 9,64 | 4,57 |
| **Average** | **6,26** | **5,28** | **11,54** | **5,66** | **5,88** |

## ECAP for expansion and contraction phases of business cycle

- Even though, as absolute values of the CR and IRR requirements for the period before the apogee of the crisis are superior to the CR and IRR requirements for the period after the apogee of the crisis, the diversification benefits of the integrated treatment of this pair of risks are bigger for the 2004 – 2008 period.

- But still, taking into consideration the absolute values of the CR and IRR requirements we observe that the proposed herein derivative-based integrated approach accounts correctly for the higher riskiness of the 2004 – 2008 period.

- On the other hand, one could infer that if exposure to the IRR in the pre-crisis/crisis period (2004 – 2008) would be bigger, the inter-risk diversification benefits could be also greater, reducing in this manner the ECAP requirements under the integrated approach.

# Economic capital-wise cross-elasticity of IRR and CR for Advanced EM

| Optimal hedge coefficients minimizing ECAP as per year ends | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 31/12/07 | 31/12/08 | 31/12/09 | 31/12/10 | 31/12/11 | 31/12/12 | 31/12/13 | 31/12/14 |
| Brazil | -0,89 | 1,27 | 1,27 | 2,39 | 2,39 | 0,92 | -0,96 | -0,96 |
| Hungary | -0,95 | 0,78 | 0,78 | 2,40 | 1,39 | 0,84 | 0,21 | 0,21 |
| Malasia | -0,82 | 0,51 | 0,51 | 1,74 | 1,63 | 0,41 | -0,34 | -0,34 |
| Mexico | -1,00 | 0,83 | 0,89 | 2,49 | 2,49 | 1,91 | -0,53 | -0,53 |
| Poland | -0,96 | -0,10 | 0,19 | 1,28 | 0,72 | 0,72 | 0,03 | 0,03 |
| South Africa | -0,89 | 0,86 | 0,86 | 2,45 | 2,73 | 1,36 | -0,98 | -0,98 |
| Thailand | -0,82 | 0,44 | 0,44 | 1,59 | 1,72 | 0,01 | -0,23 | -0,32 |
| Turkey | -0,87 | 0,99 | 0,99 | 2,98 | 2,93 | 0,52 | -0,48 | -0,56 |
| ***Average*** | ***-0,90*** | ***0,70*** | ***0,74*** | ***2,17*** | ***2,00*** | ***0,84*** | ***-0,41*** | ***-0,43*** |

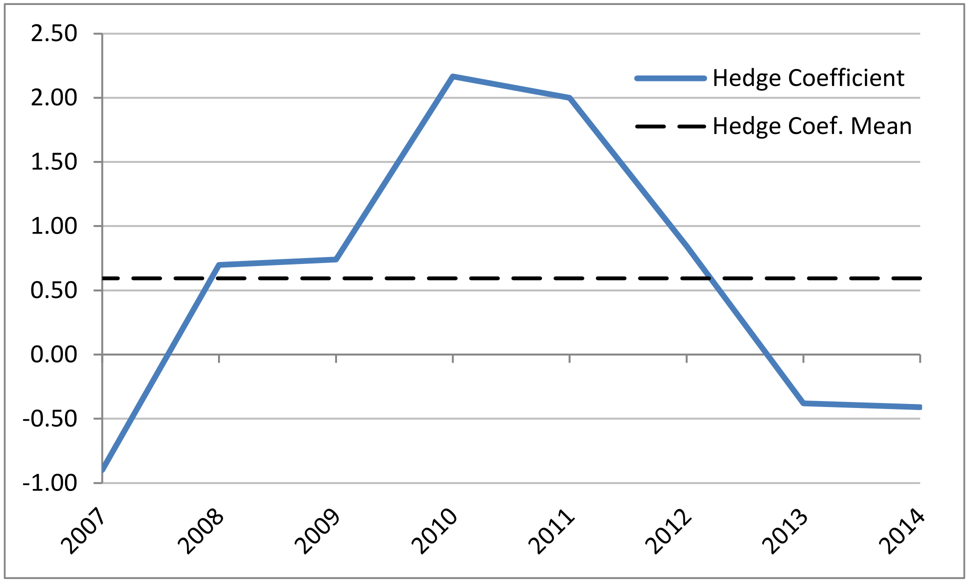
We observe that the ECAP-minimizing hedge coefficient is a function of the considered time windows. **For the pre-crisis period 2003 – 2007** for all the considered countries the ECAP minimizing hedge coefficient on average is closed to –0.9. It means that in order to diminish exposure to downside risk during the economy expansion phase of business cycle, **we may need to diminish exposure to the IRR by <u>contracting pay-fixed receive-float IRS</u> with notional roughly equal to 0.9 times Nominal of an analyzed Advanced EM bond.**

# Economic capital-wise cross-elasticity of IRR and CR for Advanced EM (cont.)

| Optimal hedge coefficients minimizing ECAP as per year ends | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 31/12/07 | 31/12/08 | 31/12/09 | 31/12/10 | 31/12/11 | 31/12/12 | 31/12/13 | 31/12/14 |
| Brazil | -0,89 | 1,27 | 1,27 | 2,39 | 2,39 | 0,92 | -0,96 | -0,96 |
| Hungary | -0,95 | 0,78 | 0,78 | 2,40 | 1,39 | 0,84 | 0,21 | 0,21 |
| Malasia | -0,82 | 0,51 | 0,51 | 1,74 | 1,63 | 0,41 | -0,34 | -0,34 |
| Mexico | -1,00 | 0,83 | 0,89 | 2,49 | 2,49 | 1,91 | -0,53 | -0,53 |
| Poland | -0,96 | -0,10 | 0,19 | 1,28 | 0,72 | 0,72 | 0,03 | 0,03 |
| South Africa | -0,89 | 0,86 | 0,86 | 2,45 | 2,73 | 1,36 | -0,98 | -0,98 |
| Thailand | -0,82 | 0,44 | 0,44 | 1,59 | 1,72 | 0,01 | -0,23 | -0,32 |
| Turkey | -0,87 | 0,99 | 0,99 | 2,98 | 2,93 | 0,52 | -0,48 | -0,56 |
| ***Average*** | ***-0,90*** | ***0,70*** | ***0,74*** | ***2,17*** | ***2,00*** | ***0,84*** | ***-0,41*** | ***-0,43*** |

As the 5Y-long VaR data history starts to overlap the apogee of the global financial crisis which took place in 2008, **since the 2004 – 2008 time window to the 2008 – 2012**, we see at the aggregate portfolio level that the ECAP-minimizing hedge coefficients begin to assume positive values, meaning that augmenting exposure to IRR was capable of canceling out the negative impacts of the widening credit spreads. Under these circumstances, **in order to diminish exposure to downside risk we may need to augment exposure to the IRR by contracting pay-float receive-fixed IRS with notional, equal to bond´s Nominal times hedge coefficient.**

# ECAP-minimizing downside hedge coefficient for the AEM portfolio, 2007-2014



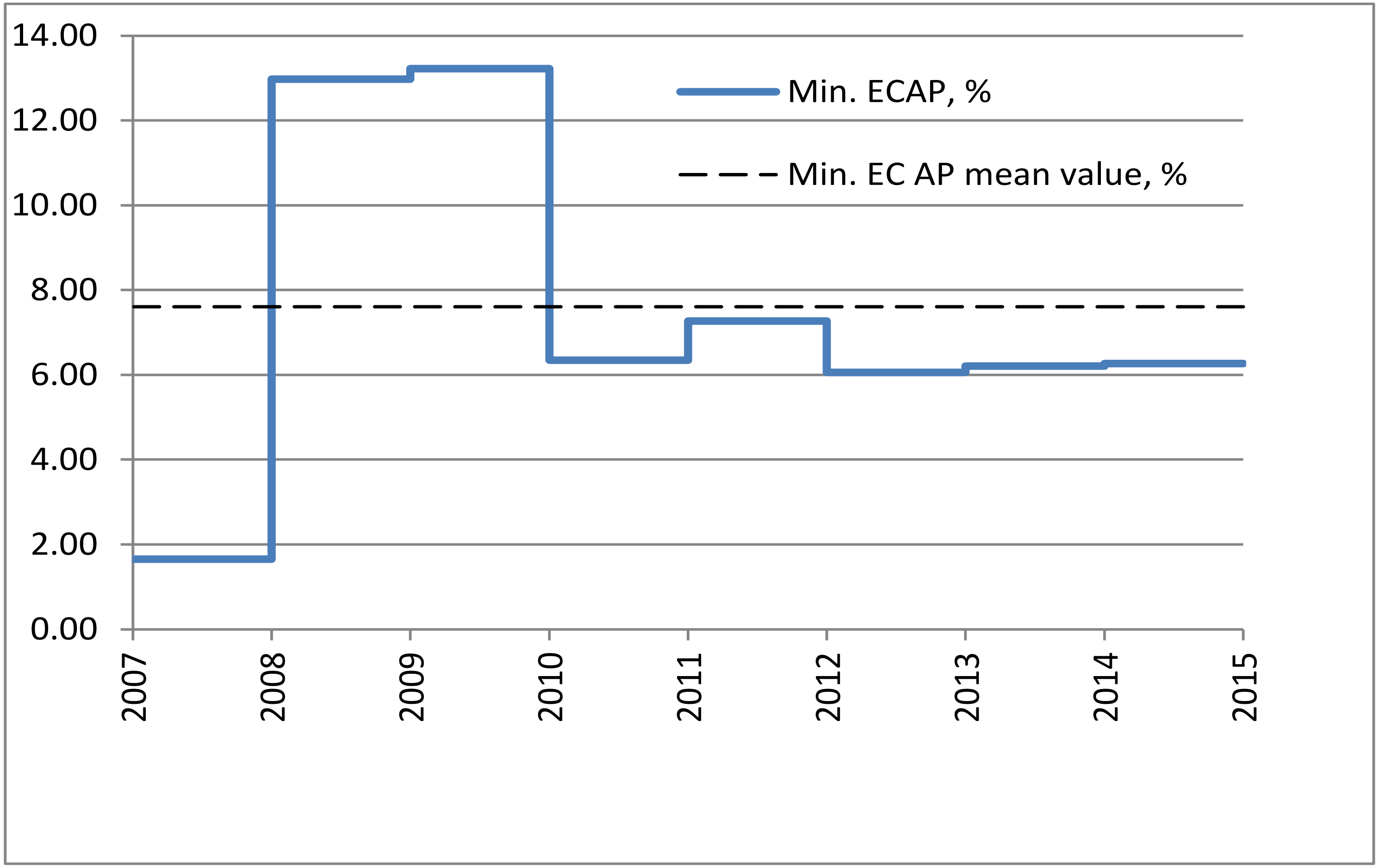

This chart indicates that the ECAP-minimizing downside hedge coefficient on average exhibits positive values for the year-ends since 2008 until 2012, i.e. when 5Y long VaR series include the crisis apogee year of 2008. Thus, during this period the augmenting exposure to IRR would be benefic in the sense of the ECAP optimization. The stronger affirmation is also correct: over all the considered data history, from 2003 until 2014 the mean value of the hedge coefficient is about 0.6. Thus, **constantly maintaining the exposure to the IRR augmented by 60% would make us better off in terms of capital allocation.**

# ECAP estimates for non-hedged bonds and the ECAP minima for the optimally IRS-hedged bonds.

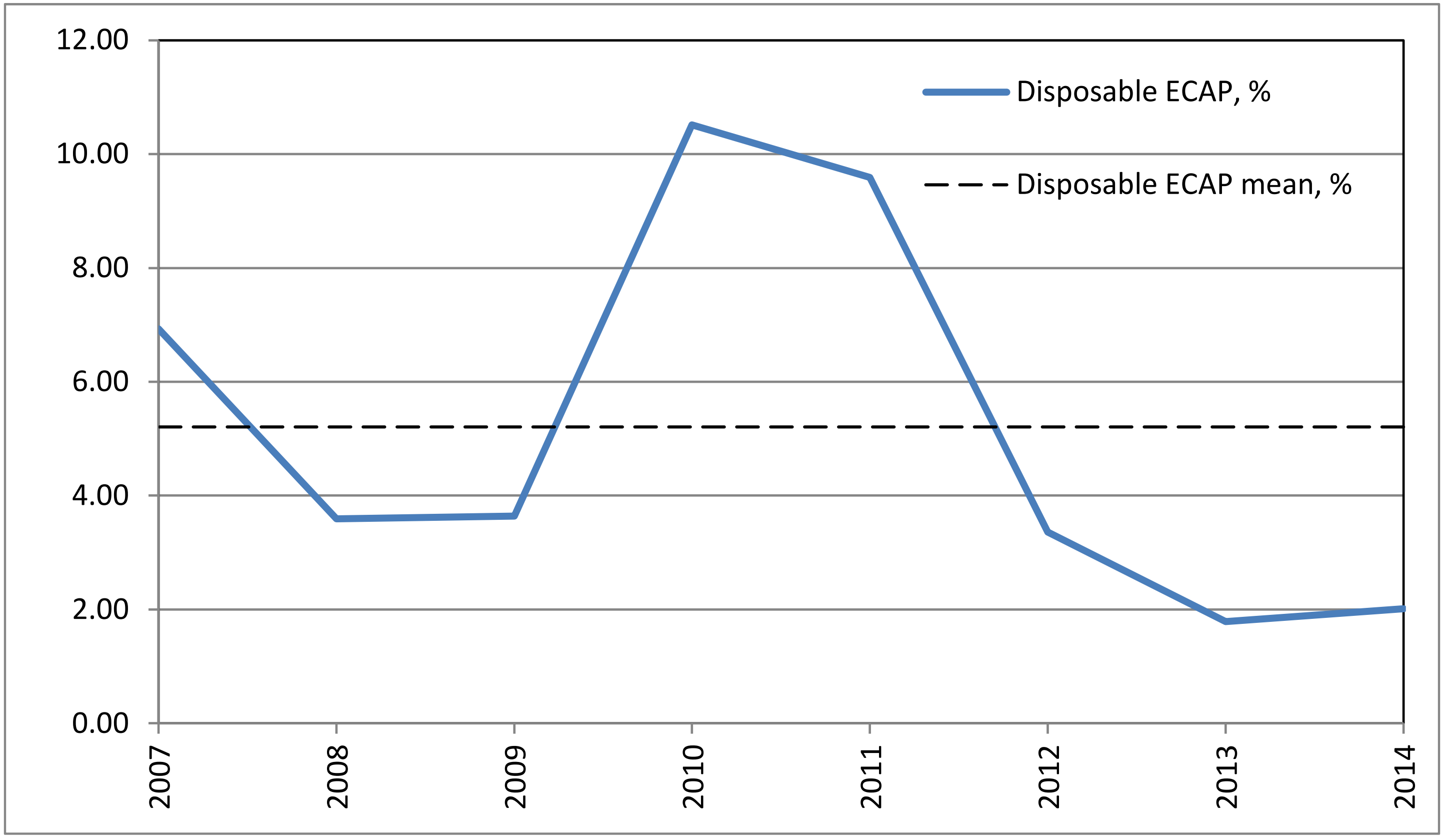
| ECAPs for non-hedged bonds and achievable minima of ECAPs under the optimal hedge, % of nominal | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 31/12/07 | | 31/12/08 | | 31/12/09 | | 31/12/10 | | 31/12/11 | | 31/12/12 | | 31/12/13 | | 31/12/14 | |
| | ECAP | Min. ECAP | ECAP | Min. ECAP | ECAP | Min. ECAP | ECAP | Min. ECAP | ECAP | Min. ECAP | ECAP | Min. ECAP | ECAP | Min. ECAP | ECAP | Min. ECAP |
| Brazil | 7,35 | **1,24** | 16,72 | **10,59** | 16,72 | **10,59** | 16,72 | **5,21** | 16,72 | **5,21** | 8,23 | **4,38** | 8,84 | **4,88** | 8,84 | **4,88** |
| Hungary | 9,14 | **1,62** | 19,3 | **15,4** | 19,3 | **15,4** | 19,3 | **7,37** | 19,3 | **12,7** | 16 | **12,4** | 12,9 | **12,1** | 12,9 | **12,1** |
| Malasia | 7,74 | **1,33** | 14,5 | **11,8** | 14,5 | **11,8** | 14,5 | **5,55** | 14,5 | **6,13** | 6,73 | **5,41** | 7,08 | **5,35** | 7,08 | **5,35** |
| Mexico | 8,90 | **1,76** | 18,33 | **14,38** | 18,33 | **14,09** | 18,33 | **6,58** | 18,33 | **6,58** | 11,77 | **4,53** | 6,45 | **3,91** | 6,45 | **3,91** |
| Poland | 8,71 | **0,77** | 8,20 | **7,48** | 10,50 | **9,71** | 10,50 | **4,69** | 10,50 | **7,45** | 10,50 | **7,45** | 7,31 | **7,29** | 7,31 | **7,29** |
| S. Africa | 8,86 | **1,70** | 20,17 | **15,72** | 20,17 | **15,72** | 20,17 | **7,48** | 20,17 | **6,23** | 9,45 | **3,46** | 9,60 | **5,10** | 9,60 | **5,10** |
| Thailand | 8,55 | **1,59** | 13,75 | **11,54** | 13,75 | **11,54** | 13,75 | **5,68** | 13,75 | **6,23** | 5,97 | **5,93** | 6,30 | **6,01** | 7,29 | **6,05** |
| Turkey | 9,46 | **3,25** | 21,61 | **16,92** | 21,61 | **16,92** | 21,61 | **8,22** | 21,61 | **7,65** | 7,84 | **6,48** | 9,64 | **7,69** | 10,20 | **7,99** |
| ***Average*** | *8,59* | ***1,66*** | *16,57* | ***12,98*** | *16,86* | ***13,22*** | *16,86* | ***6,35*** | *16,86* | ***7,27*** | *9,56* | ***6,25*** | *8,51* | ***6,54*** | *8,70* | ***6,59*** |

This table clearly evidences that downside risk hedging makes possible the diminishing of the ECAP requirements for all the considered herein reference dates and for all the selected developing geographies.

## Minimum ECAP requirements achievable for the Advanced EM bond portfolio.



**Potentially disposable stock of ECAP for the bond portfolio of the Advanced EM countries hedged against the downside risk by optimized IRS contracts.**




Of course many other aspects, such as profit targets and regulatory limits of exposure to IRR need to be taken into account while evaluating a necessity of IRS-based hedging strategy.

## CR requirements for the Advanced EM: Basel III Foundation vs. CDS-based segregated approach as of Dec-2014.

| Country | Moody's Foreign Currency LT Debt Rating | S&P's Foreign Currency LT Debt Rating | Basel Rating in S&P Notation | Basel III Foundation Regulatory CR Requirements, % | CDS-based CR Requirements, % |
|---|---|---|---|---|---|
| Brazil | Baa2 | BBB- | BBB- | 4.52 | 4.95 |
| Czech Republik | A1 | AA- | A+ | 2.09 | 5.13 |
| Hungary | Ba1 | BB | BB | 6.89 | 16.17 |
| Malaysia | A3 | A- | A- | 2.04 | 5.91 |
| Mexico | A3 | BBB+ | BBB+ | 3.15 | 4.57 |
| Poland | A2 | A- | A- | 2.04 | 8.52 |
| South Africa | Baa2 | BBB- | BBB- | 4.52 | 5.25 |
| Thailand | Baa1 | BBB+ | BBB+ | 3.15 | 6.60 |
| Turkey | Baa3 | BB+ | BB+ | 6.17 | 8.94 |

Comparing the last two columns of the table above one could observe that the capital requirements for the CR computed according to the regulatory formula are well below the CDS-based estimates for the ECAP regarding CR.

## Basel III Foundation CR plus the IRS-based historic VaR IRR requirements vs. ECAP requirements calculated according to the historic VaR derivative-based risk-integrating approach. Advanced EM, as of Dec-2014.

| Country | IRS-based IRR ECAP requirements, % | Basel III Foundation Regulatory CR Requirements, % | Total Compounded Pillar 1 CR + Pillar 2 IRR ECAP, % | Derivative-based risk-intergrating approach ECAP, % | Delta, % |
|---|---|---|---|---|---|
| | A | B | C = A + B | D | E = C - D |
| Brazil | 5.29 | 4.52 | 9.81 | 8.84 | 0.97 |
| Czech Republic | 5.30 | 2.09 | 7.39 | 4.86 | 2.53 |
| Hungary | 5.16 | 6.89 | 12.05 | 12.86 | -0.81 |
| Malaysia | 5.30 | 2.04 | 7.34 | 7.08 | 0.26 |
| Mexico | 5.30 | 3.15 | 8.45 | 6.45 | 2.00 |
| Poland | 5.29 | 2.04 | 7.33 | 7.31 | 0.02 |
| South Africa | 5.29 | 4.52 | 9.81 | 9.60 | 0.21 |
| Thailand | 5.29 | 3.15 | 8.44 | 7.29 | 1.15 |
| Turkey | 5.27 | 6.17 | 11.44 | 10.2 | 1.24 |

It is empirically demonstrated that the results of the proposed derivative-based integrated approach to the risk assessment are consistent with the Basel III IRB Foundation approach.

## ECAP modeling for Advanced EM following the integrated derivative-based approach

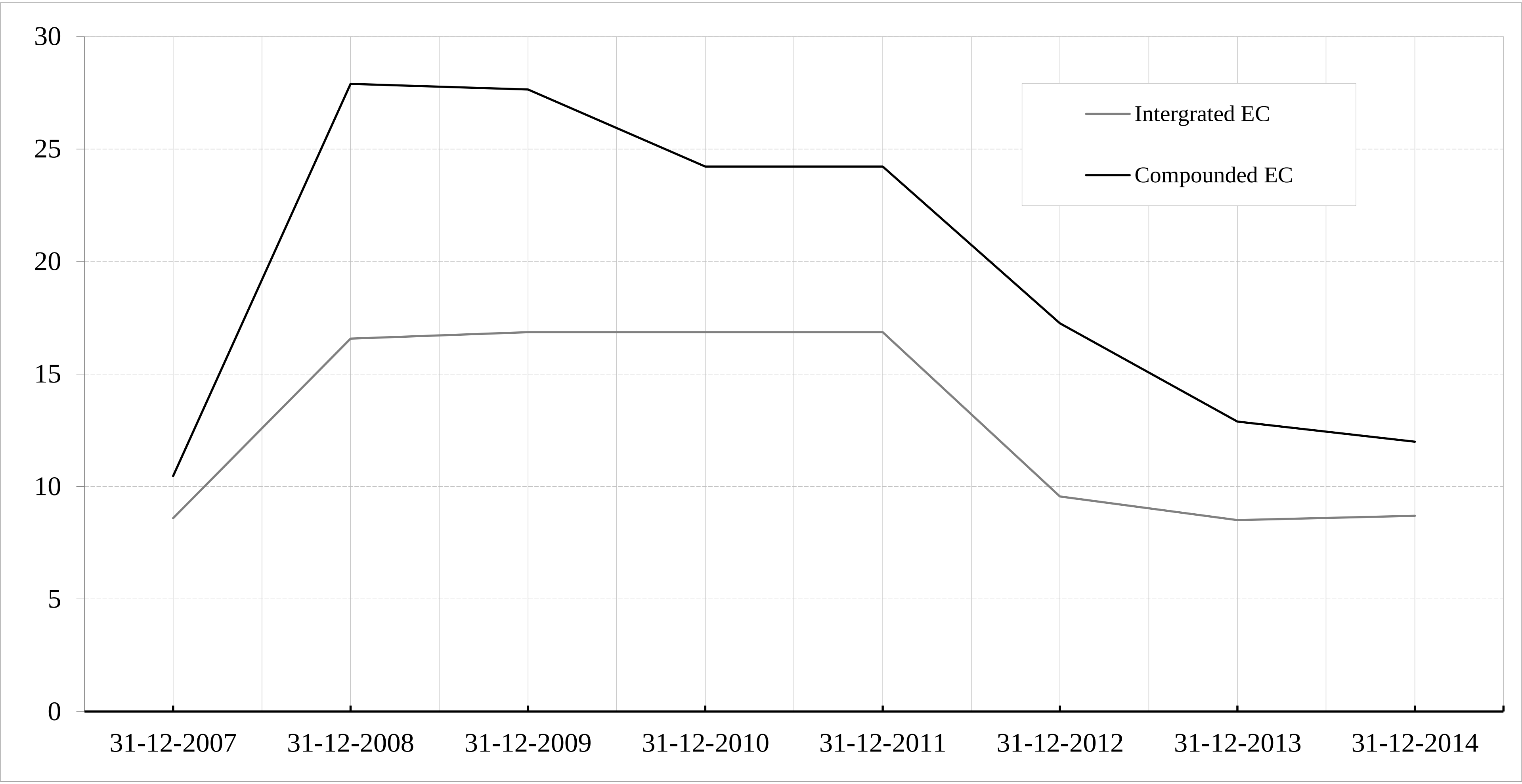



Figure above evidences that the integrated approach to risk assessment permits optimizing the ECAP.

- This research addresses a **regulatory perspective of the IRR and CR integration**.
- Analyzing risk integration results this study represents a long needed attempt to define a **common basis for discussion between banking industry and financial regulators**.
- **Examining rules for asset sensitivity or non-sensitivity to interest rate changes and providing an integrated treatment of the IRR and CR potentially allows for optimizing ECAP of banks and financial institutions**.
- We find that the ECAP requirements under the integrated approach are consistently lower than the capital requirements quantified following the segregated approach to CR assessment only. **This suggests that the hedging of downside risk could be based on augmenting exposure to the IRR**.
- We demonstrate that the ECAP-wise elasticity is a function of the considered **phase of a business cycle.**
- Our approach potentially allows for disentangling **liquidity components** in yields.
- We benchmark the proposed derivative-based integrated approach against the Basel III regulation and show that **our approach is consistent with the benchmark**.

Thank you !

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