BBVA | RESEARCH

Flows & Assets Report

"Global Reallocation fueled by growth concerns and China"

Second Quarter 2015

BBVA Research

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Sonsoles Castillo & Cristina Varela **(Financial Scenarios)**
Julián Cubero & Sara Baliña **(Economic Scenarios)**

Updated 31 July 2015

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2. **Portfolio Flows & Asset Prices: stylized facts, drivers and now-casts**
3. **Scenarios: Macroeconomic and Monetary Policy and Flows Scenarios**
4. **Hot Topic:**
   - Analysing Exposure Risk to China using Network Theory
5. **Useful Information: Methodological Appendix**

Key Messages

- **Main drivers**
  - Global growth concerns intensified led by China slowdown, weighing on commodities and a challenging EM cycle
  - Divergences between central banks policies remain but not intensify: Fed points for a gradual interest rate hikes. ECB commits to QE until Sep16
  - Contained financial tensions and market volatility ahead Fed's first-hike amid low liquidity in bond markets
- **Capital flows**
  - The risk-on mood from the beginning of Q2 halted in line with the growth concerns, Fed's lift-off and Grexit fears
  - Portfolio rotation from DM bonds to DM Equity funds. Aggregate contraction of EM flows dominated by local factors. Retail investors responsible for the downsizing in flow dynamics; Institutional remained resilient
  - Strong but short-lived outflows from European bond markets in a temporary flight to quality (valuation adjustment and Grexit). European equity flows also moderated
- **Asset prices**
  - Global Dollar appreciation remained but with less intensity (Fed wording gradualism)
  - DM Equity valuations remain tight (despite price correction). Growth will weigh on EM equity performance
  - Risk premia evolved selectively the local shocks akin. Grexit moderately spilled-over into EZ periphery markets
- **Forecasts & Analysis**
  - Global Reallocation from EM to DM now fueled by growth concerns and Chinese woes
  - Risks to EM flows tilted to the downside if global recovery looses steam and/or the Chinese relapse spills-over
  - Global Exposure Risk to Chinese financial impairment only relevant in the Banking system but not systemic

Capital flows

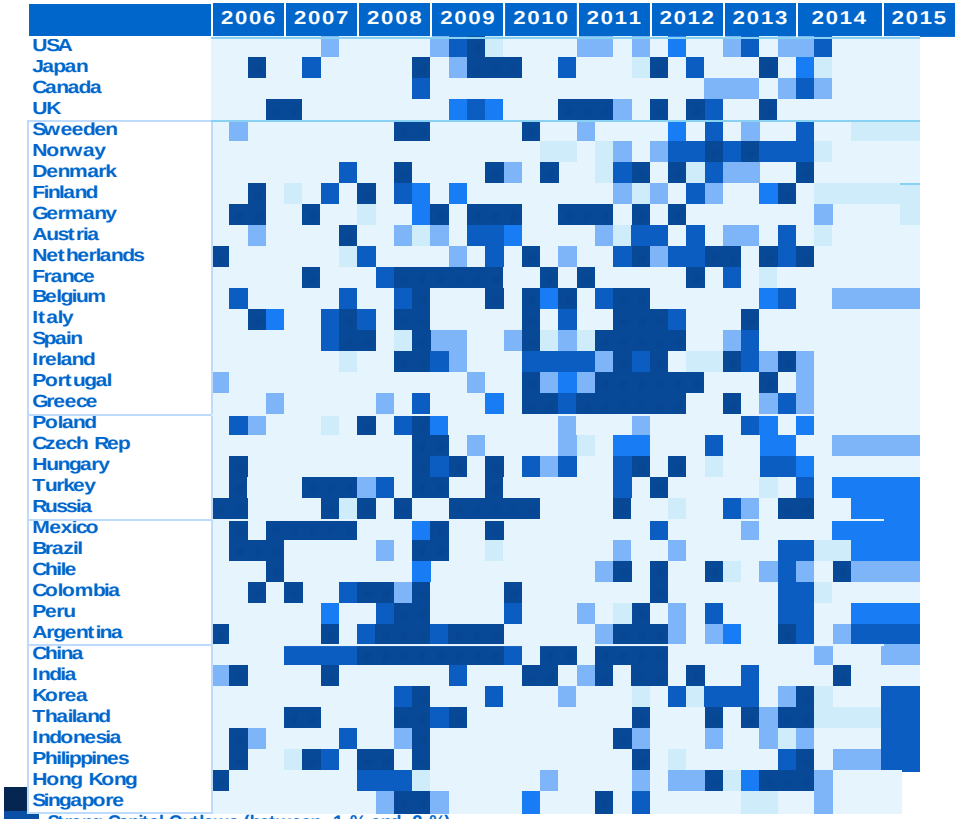
Quarterly assessment

The reallocation changed gear. Chinese growth and valuation concerns weight on EM flows

BBVA Balance of Payments Portfolio Update

(Official Balance of Payments data, QoQ % change)

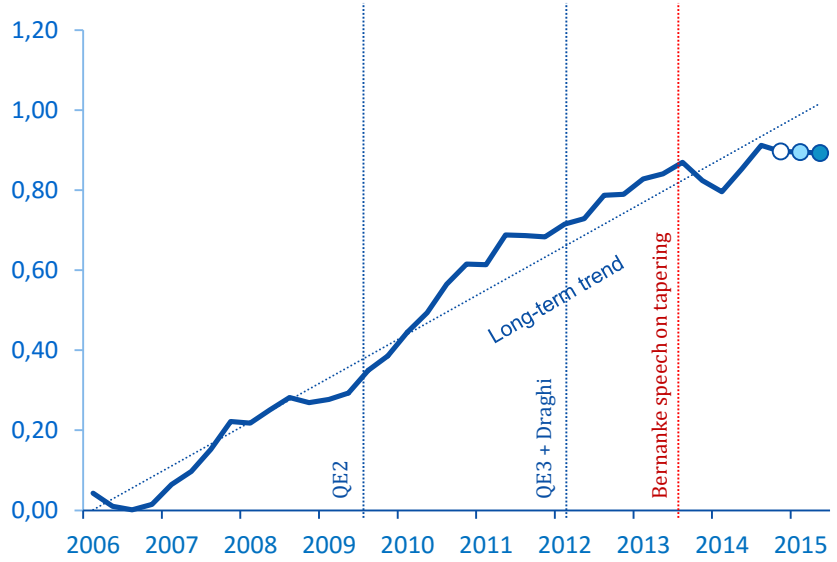
Update 10 July 2015, Source: BBVA Research



Update* of accumulated flows to Emerging Markets

(Official Balance of Payments data, in USD trn)

Update 27 Feb. 2015, Source: BBVA Research



Official Data Imbalance Assessment

(BOP official data deviations from long-term trend in USD bn)

Official BoP data in Q4 2014 (est.)

EM flows adjustment still at play (est.)

The adjustment will continue in 2Q15 (now-cast)

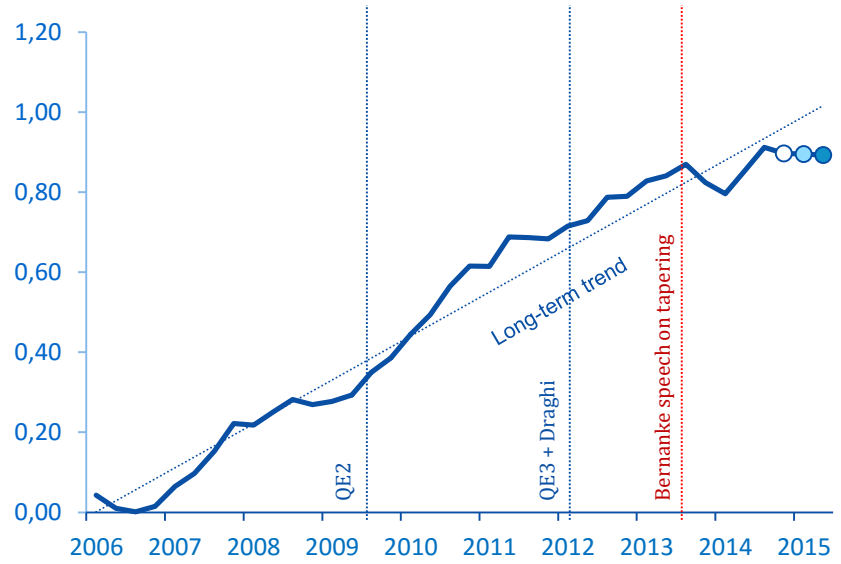
The reallocation changed gear. Chinese growth and valuation concerns weight on EM flows

EM Flows adjustment still at play, yet this time on a different nature

Fears on China & the commodity exporting countries growth offset the effect on flows of likely milder monetary policy normalization in the US

The EM flows cumulate 80 Bn. USD below long run trend in Q2 2015.

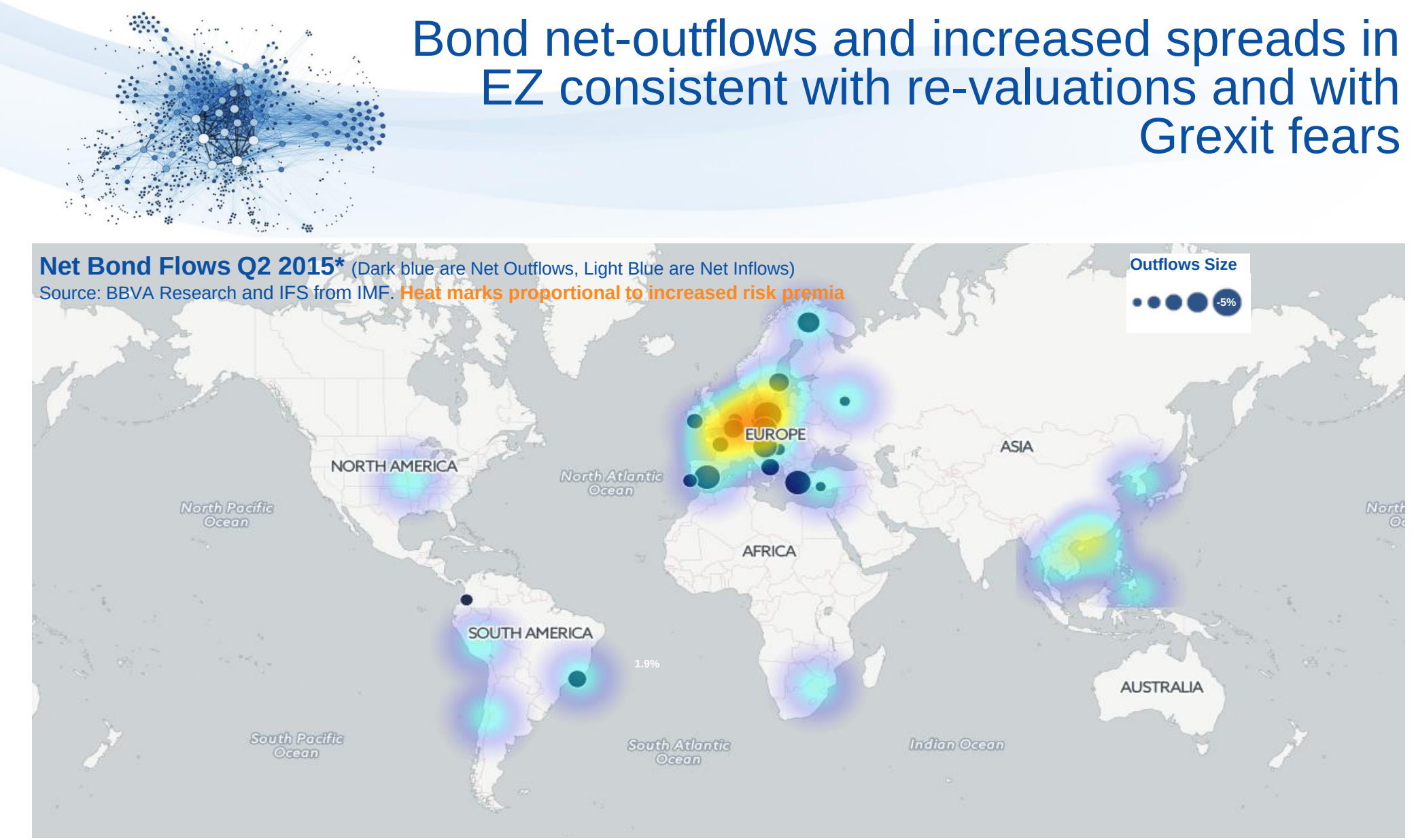
Update* of accumulated flows to Emerging Markets
(Official Balance of Payments data, in USD trn)
Update 27 Feb. 2015, Source: BBVA Research



Official Data Imbalance Assessment
(BOP official data deviations from long-term trend in USD bn)

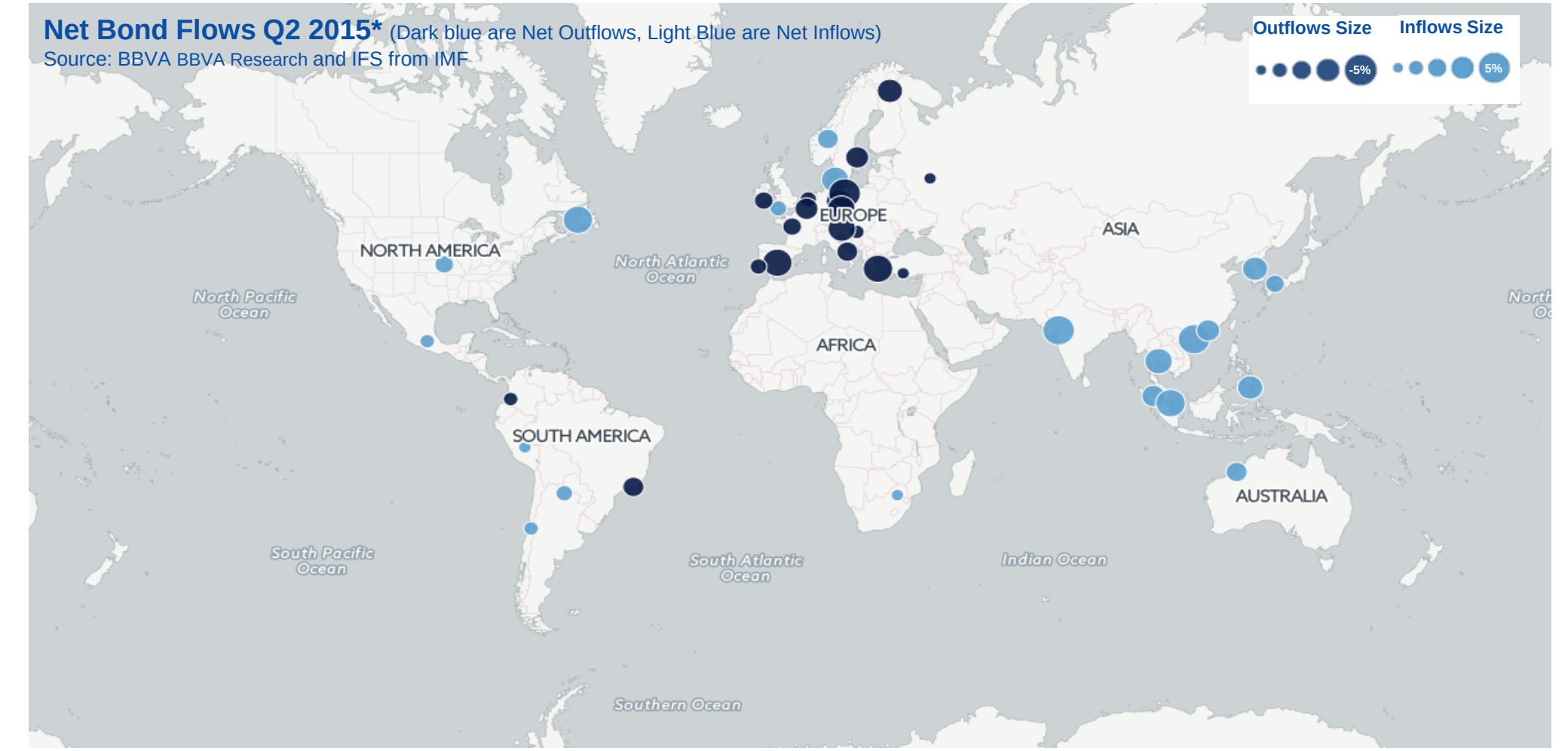
Official BoP data in Q4 2014 (est.)
EM flows adjustment still at play (est.)
The adjustment will continue in 2Q15 (now-cast)

Bond net-outflows and increased spreads in EZ consistent with re-valuations and with Grexit fears



Net flows to DM-funds halted in 2Q15. On the bond side due to Grexit and Fed's delay concerns, bringing only a modest rotation into **DM equity flows** limited by valuation and growth concerns in both the US and EZ. **The recess did not revamped EM flows** due to increasing concerns on China (growth and valuations). The result was a net neutral change on average growth of flows globally

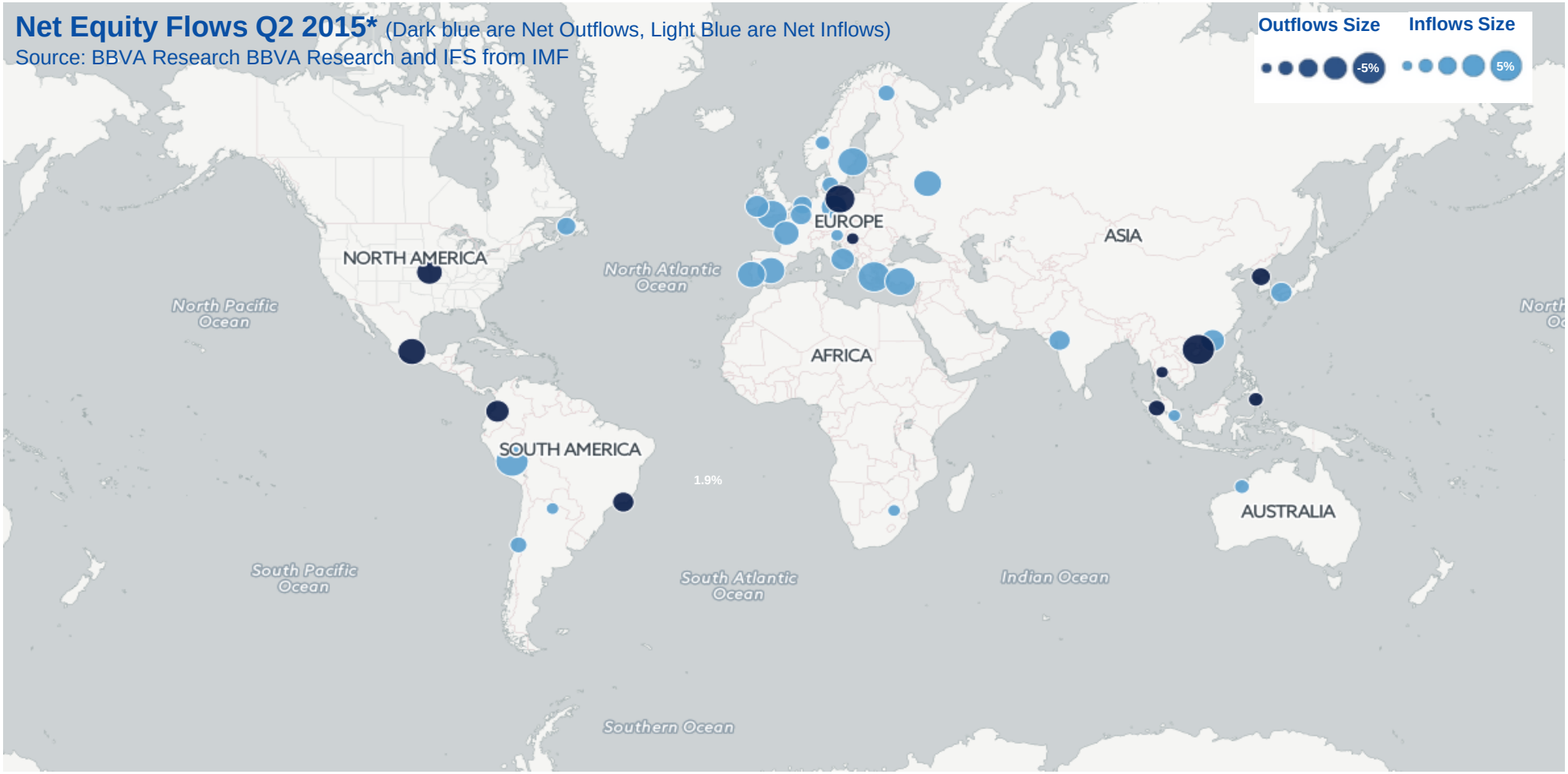
Bringing a reallocation into the rest of DM bond Markets and Asia.



(*) Flows are % quarterly change in each country's net liabilities (Equity and Bond) measured as the ratio of net portfolio flows in (q) to total liabilities accrued until (q-1).

A strong rotation into EZ equity positions was also observed

Net Equity Flows Q2 2015* (Dark blue are Net Outflows, Light Blue are Net Inflows)
Source: BBVA Research BBVA Research and IFS from IMF

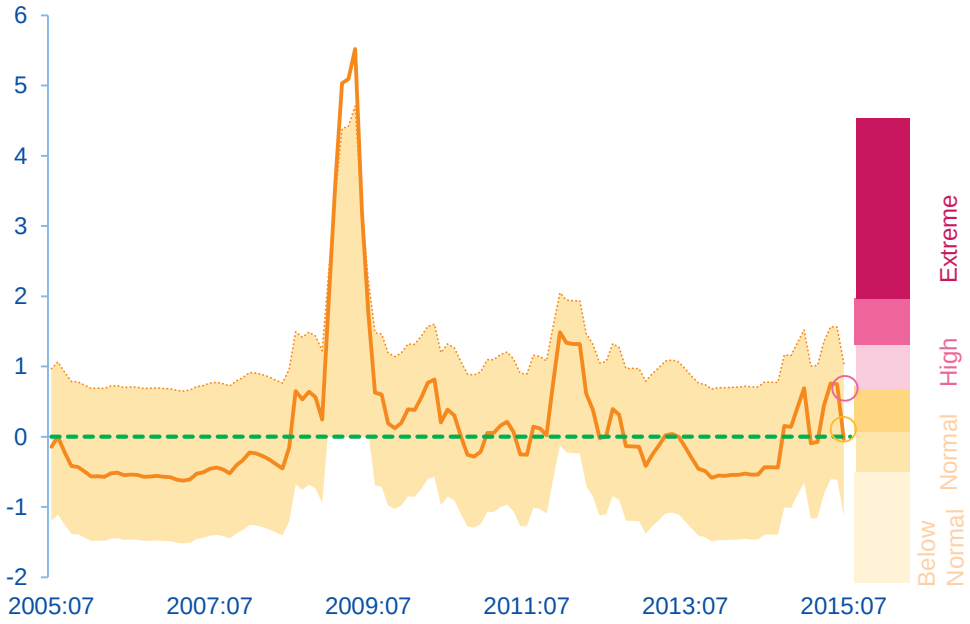


(*) Flows are % quarterly change in each country's net liabilities (Equity and Bond) measured as the ratio of net portfolio flows in (q) to total liabilities accrued until (q-1).

Flight to quality so far contained. Volatility could be back on Fed's lift-off and Chinese woes

BBVA Research Safe Haven Indicator

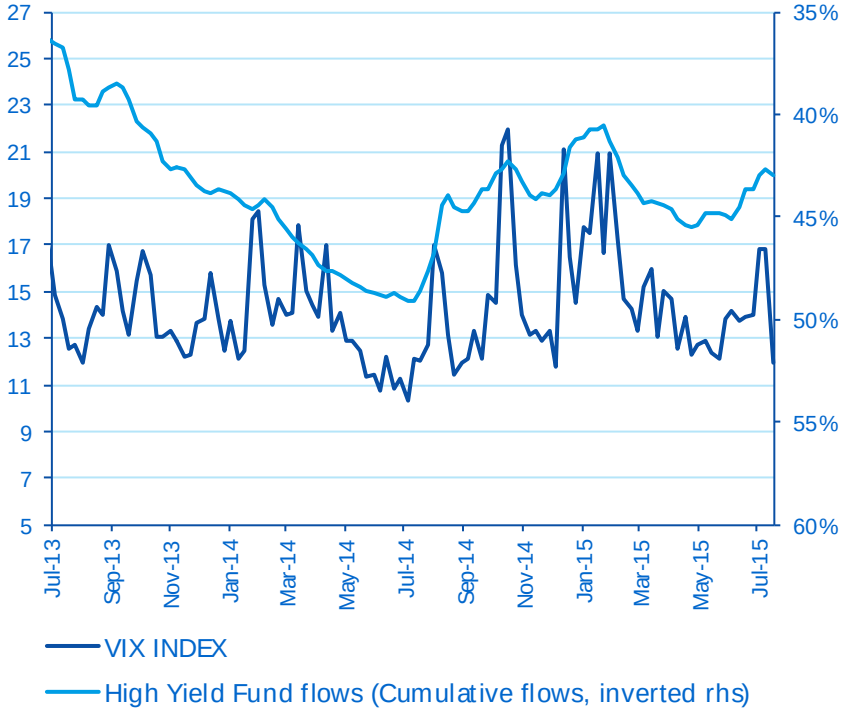
(Median Safe Haven Factor from flows and asset prices data using the BBVA DFM/FAVAR Model) Source: BBVA Research



BBVA Safe Haven Indicator
Represents the median of the selected Safe Haven Components in Portfolio Flows, Risk Preimia and FX data

High-yield bond funds vs. volatility

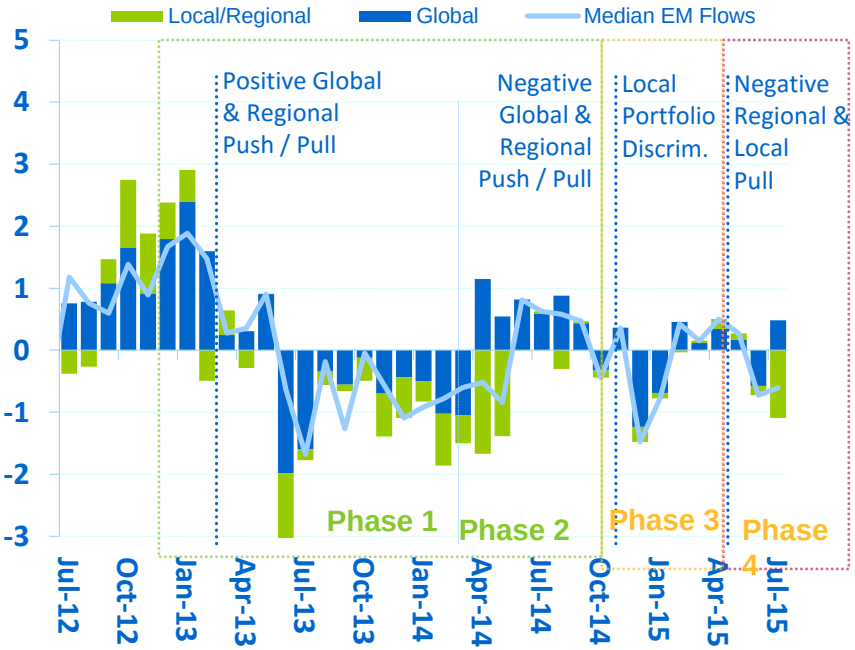
Four-week cumulative flows over Total Assets)
Source: BBVA Research and EPFR



Global factors (mainly Fed's stance) do not explain Q2 EM flow correction. Local and regional Factors promote discrimination

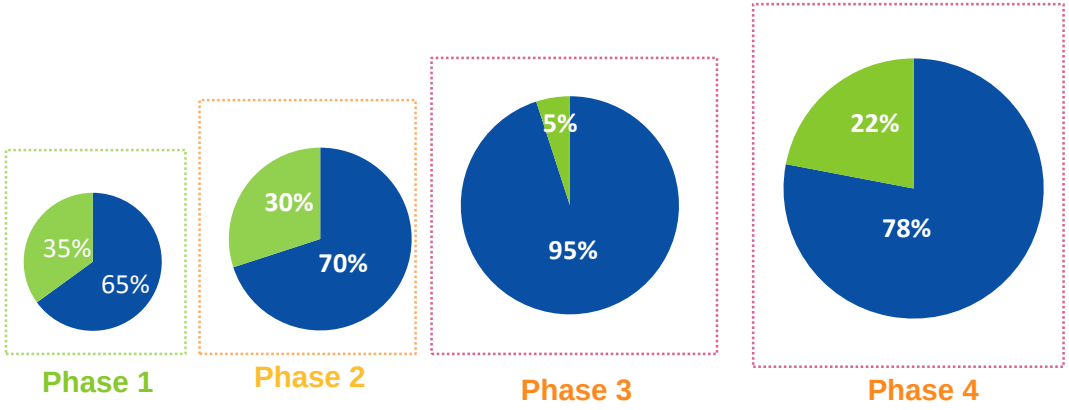
Emerging Markets Flows

(Median Emerging Market Portfolio Flow Decomposition, monthly change in %) Source: BBVA Research and IFS from IMF



Emerging Markets Flows Drivers

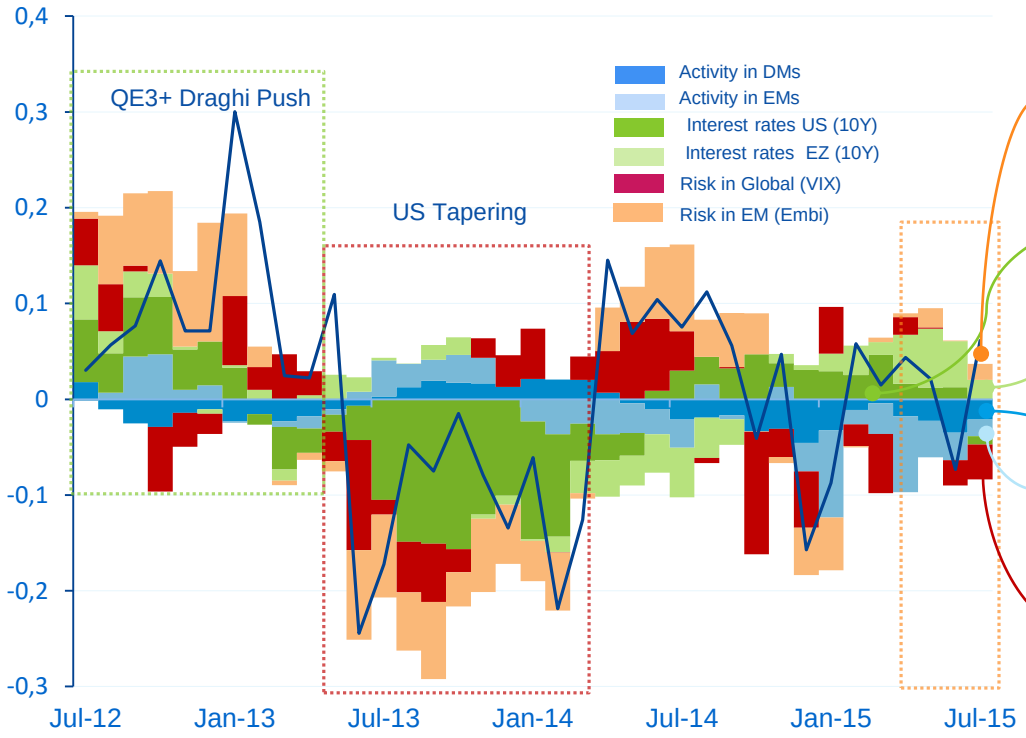
(Median Emerging Market Portfolio Flow Decomposition, in % change m/m)
Source: BBVA Research and IFS from IMF



Lose monetary conditions partially offset the impact of activity relapse on global flows

BBVA Global Factor of Portfolio Flows

(First Factor from Flows using BBVA's DFM/FAVAR Model represents the main driver of flows) Source: BBVA Research



Limited risk perception on EM bonds

Expectations on a gradual Fed lift off mantain anchored long term rates

ECB commitment to QE

Transitory slowdown in US growth

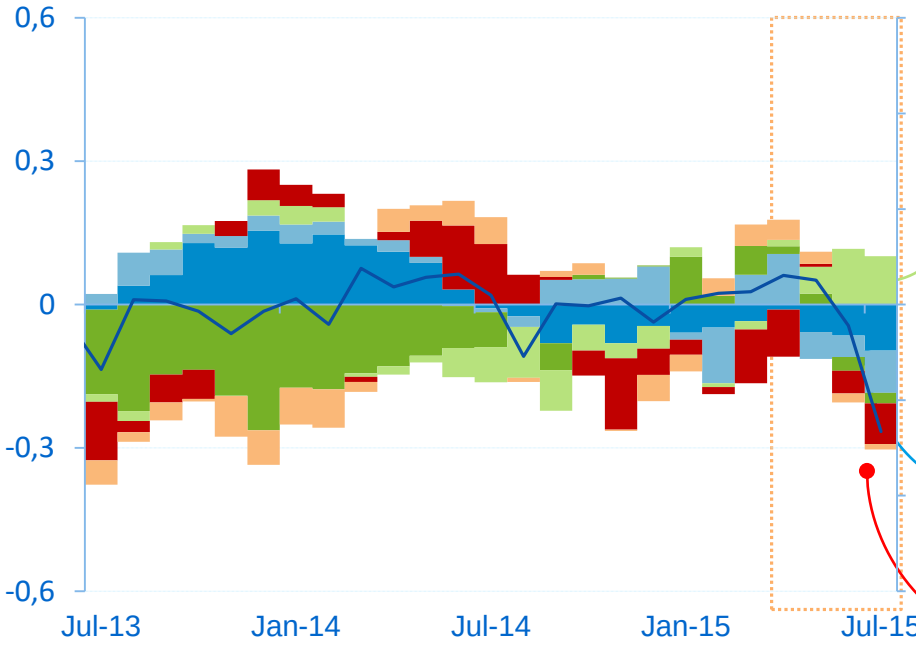
Worsening EM growth outlook

Global Risk Aversion rebound

Growth and risk aversion concerns shove EM factor to the downside.

BBVA Emerging Market Factor of Portfolio Flows

Third Factor from flows using BBVA's DFM/FAVAR Model represents the main driver of flows) Source: BBVA Research



ECB QE supportive for EM flows

Raising US long-term rates start weighting on EM investment positions

A worsening in EM and DM Growth outlook drains EM inflows

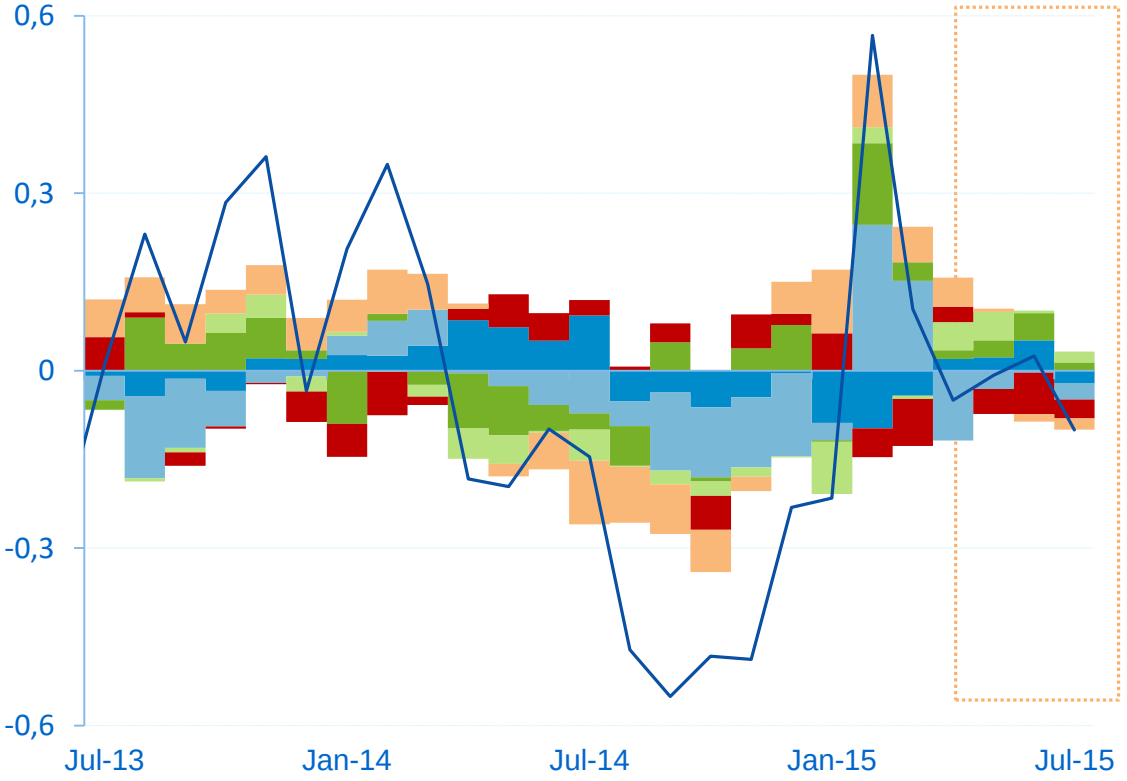
Risk aversion punish EM flows

- Activity in Developed Markets
- Activity in Emerging Markets
- Interest rates in US (10 Yr)
- Interest rates in the EZ (10 yr Bund)
- Risk in Global (VIX)
- Risk in EM (Embi)

Risk aversion skewed DM factor contribution into negative territory

BBVA Developed Market Factor of Portfolio Flows

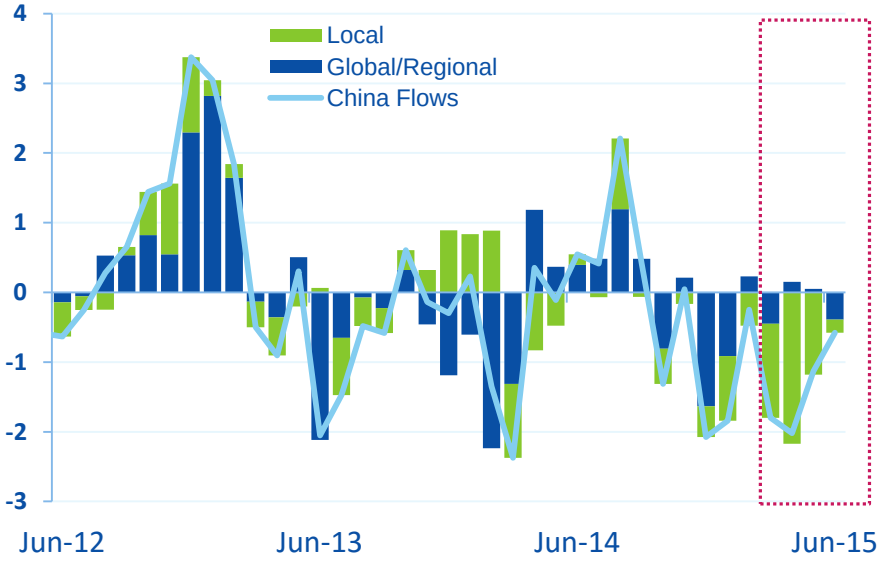
Third Factor from flows using BBVA's DFM/FAVAR Model represents the main driver of flows) Source: BBVA Research



Local factors behind the strong shortfall in equity flows (recent equity slump). The bond market so far isolated

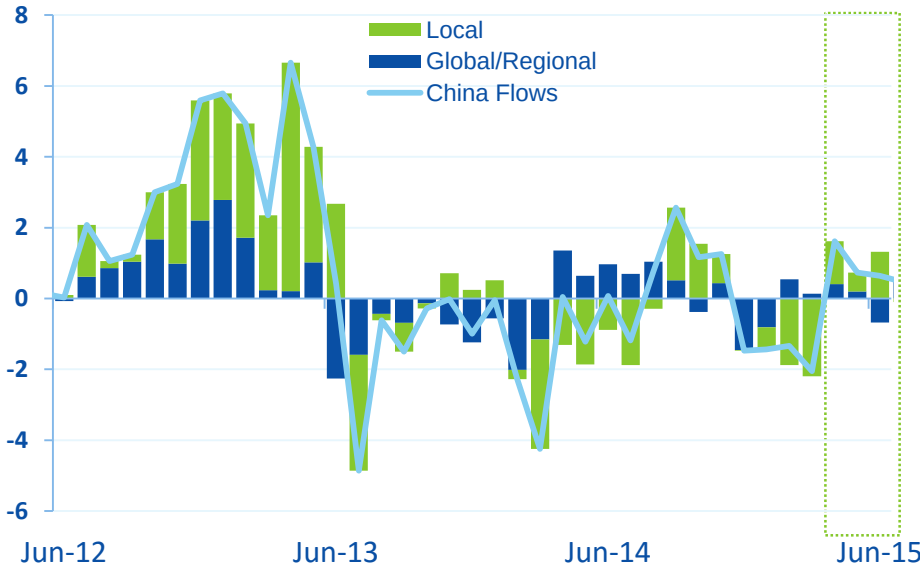
China Equity Flows

(Bond Portfolio Flow Decomposition, monthly change in %)
Source: BBVA Research and IFS from IMF



China Bond Flows

(Bond Portfolio Flow Decomposition, monthly change in %)
Source: BBVA Research BBVA Research and IFS from IMF



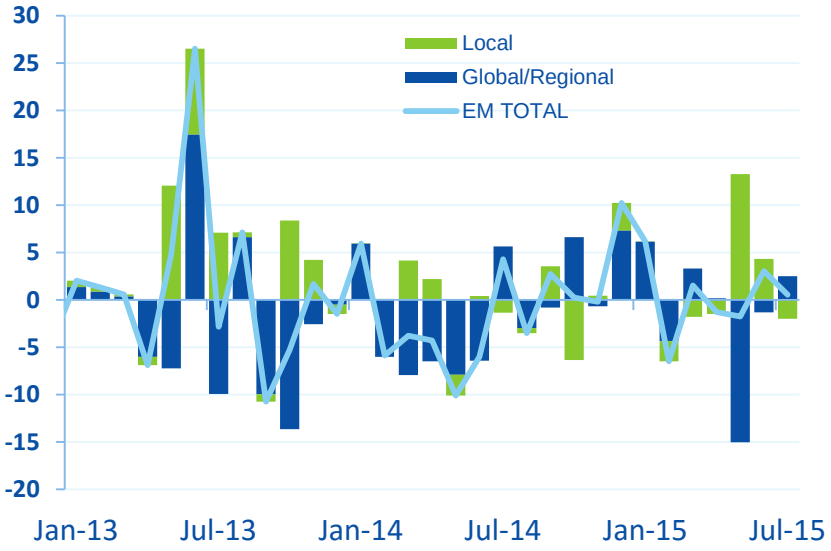
Financial variables

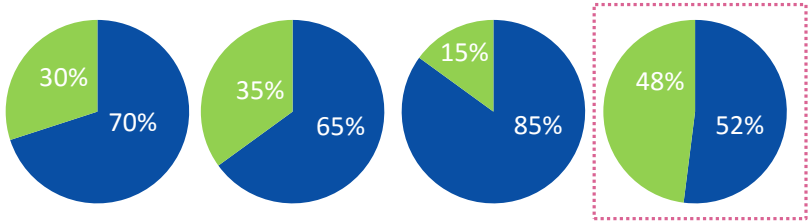
Quarterly assessment

Risk aversion was not globally fueled but followed local strains. The flight to quality was short lived

EMs change in risk premia

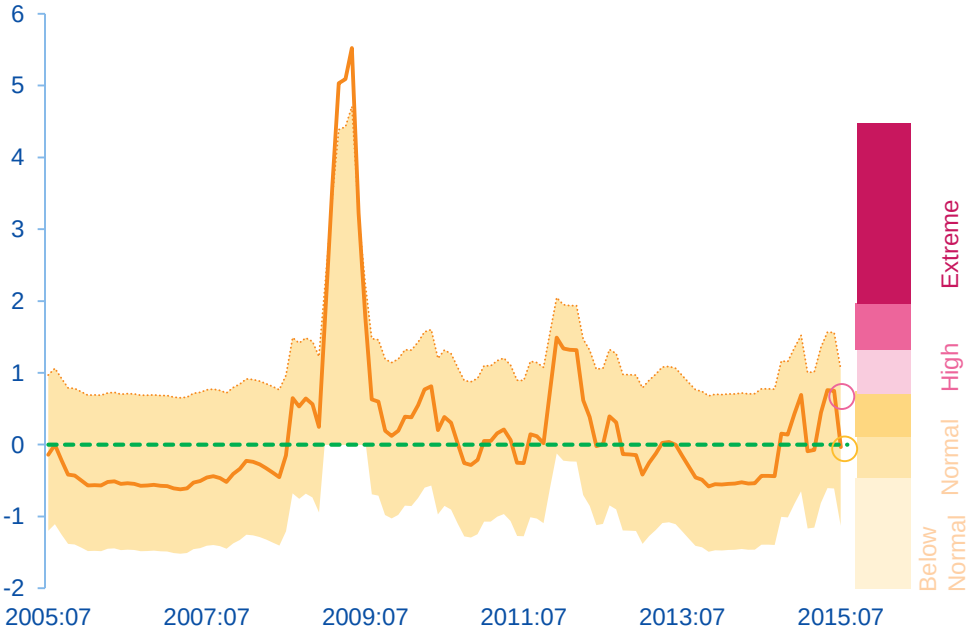
(Median EM 5Y CDS MoM % change)
Source: BBVA Research





BBVA Research Safe Haven Indicator

(Median Safe Haven Factor (2nd) from flows and asset prices data using the BBVA DFM/FAVAR Model) Source: BBVA Research

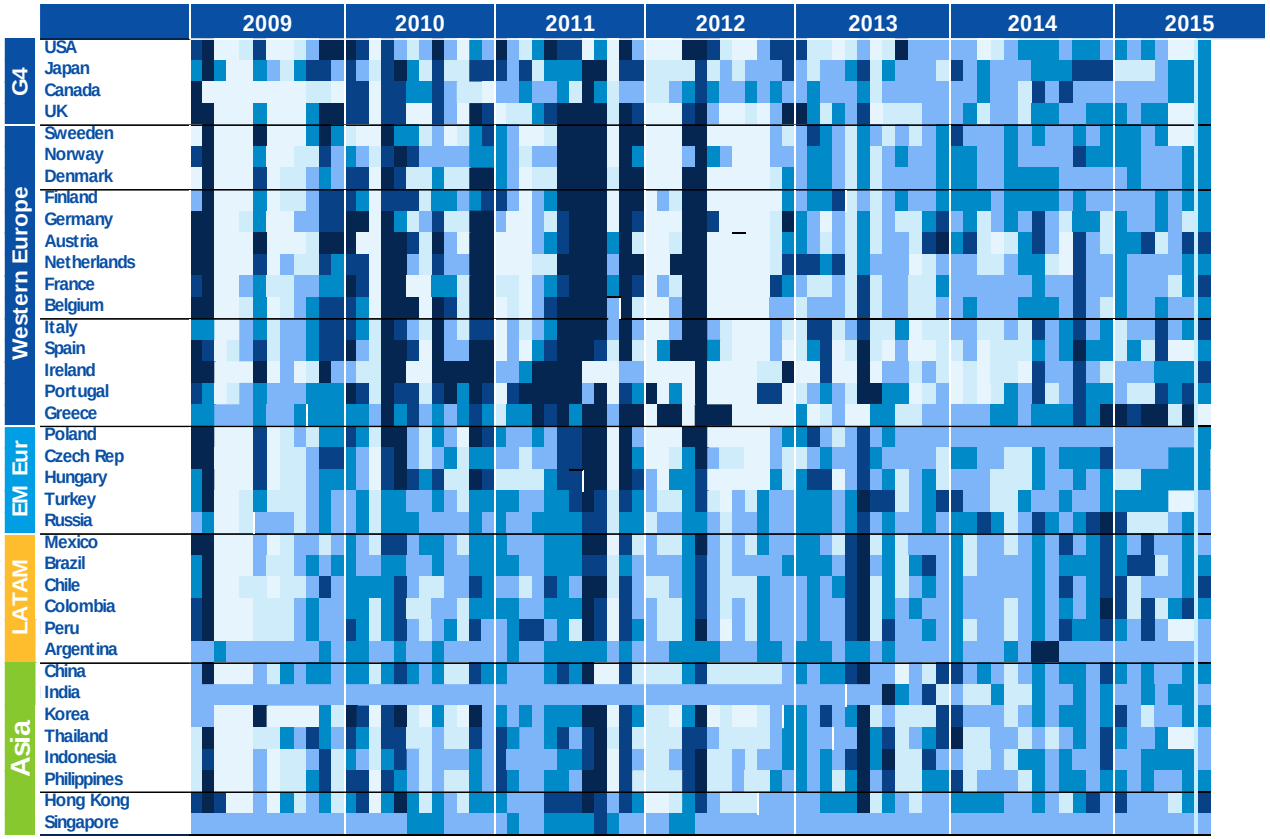


BBVA Safe Haven Indicator
Represents the median of the selected safe haven components in portfolio flows, risk premia and FX data

Risk premia evolved selectively on local shocks. Grexit tensions moderately spilled-over into EZ periphery markets

BBVA Risk Premia Change Map

(as % MoM change in 5Y CDS. Darker color stand for positive or higher risk premia
Source: BBVA Research)



Increase — Decrease

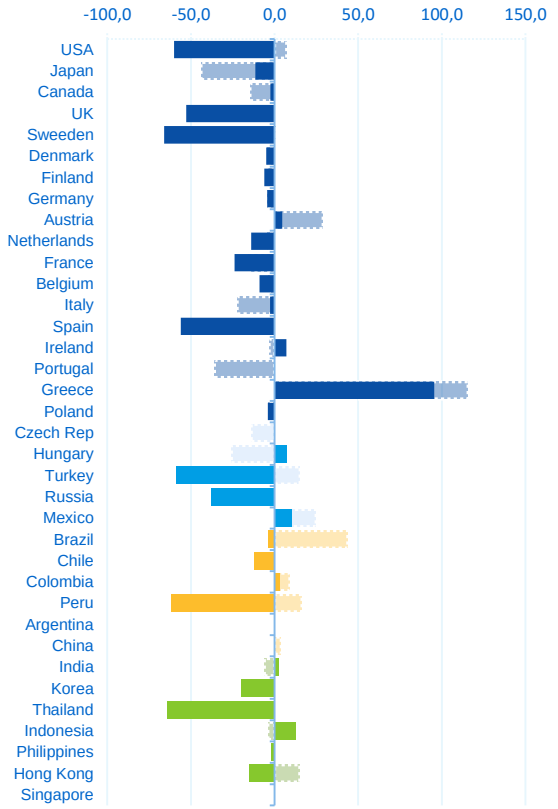
<+25% 0% -25%>

BBVA Research Risk Premia Map*

The Credit Risk Map show the monthly change in % of 5yr. CD Swaps
Darker / lighter colors mean sharper increases / decreases of CDS

2Q15 Change Credit Default Swaps

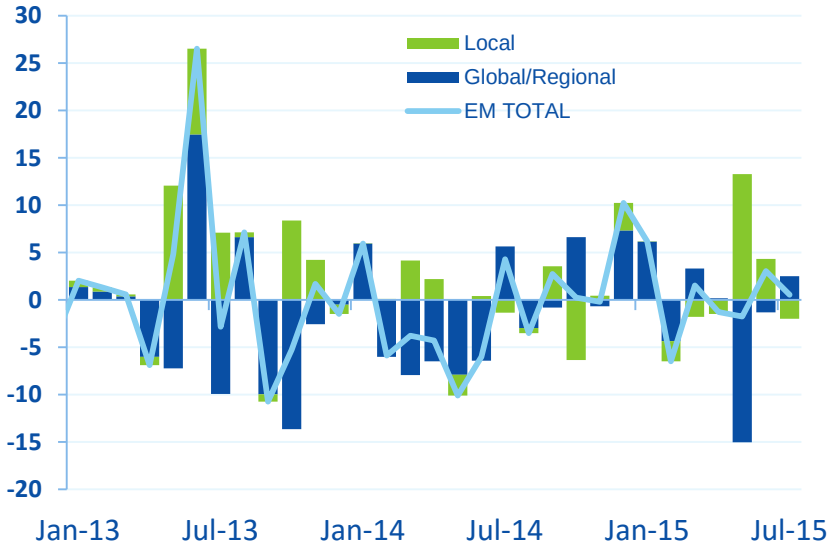
(% change in risk premia, shades represent last quarter change)
Source: BBVA Research)

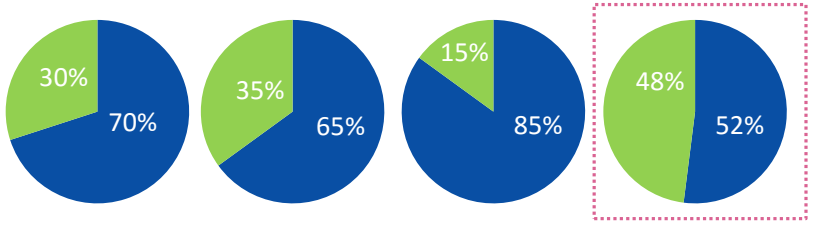


Global and local forces behind EM risk are -on average- equilibrated, but this conceals a great degree of differentiation

EMs change in risk premia

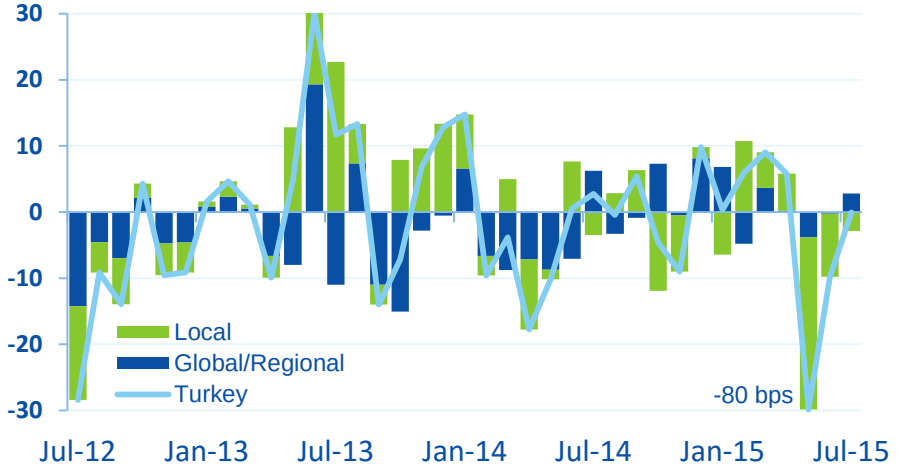
(Median EM 5Y CDS MoM % change)
Source: BBVA Research





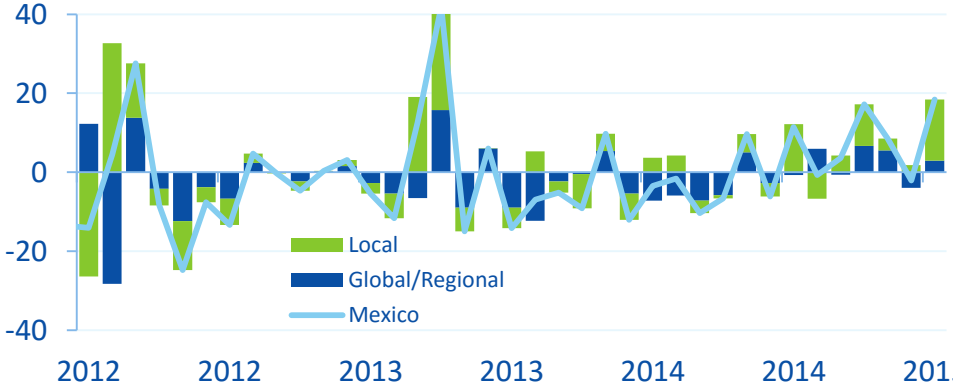
Risk Premium Change in Turkey and Factors

Source: BBVA Research



Risk Premium Change in Mexico and Factors

Source: BBVA Research

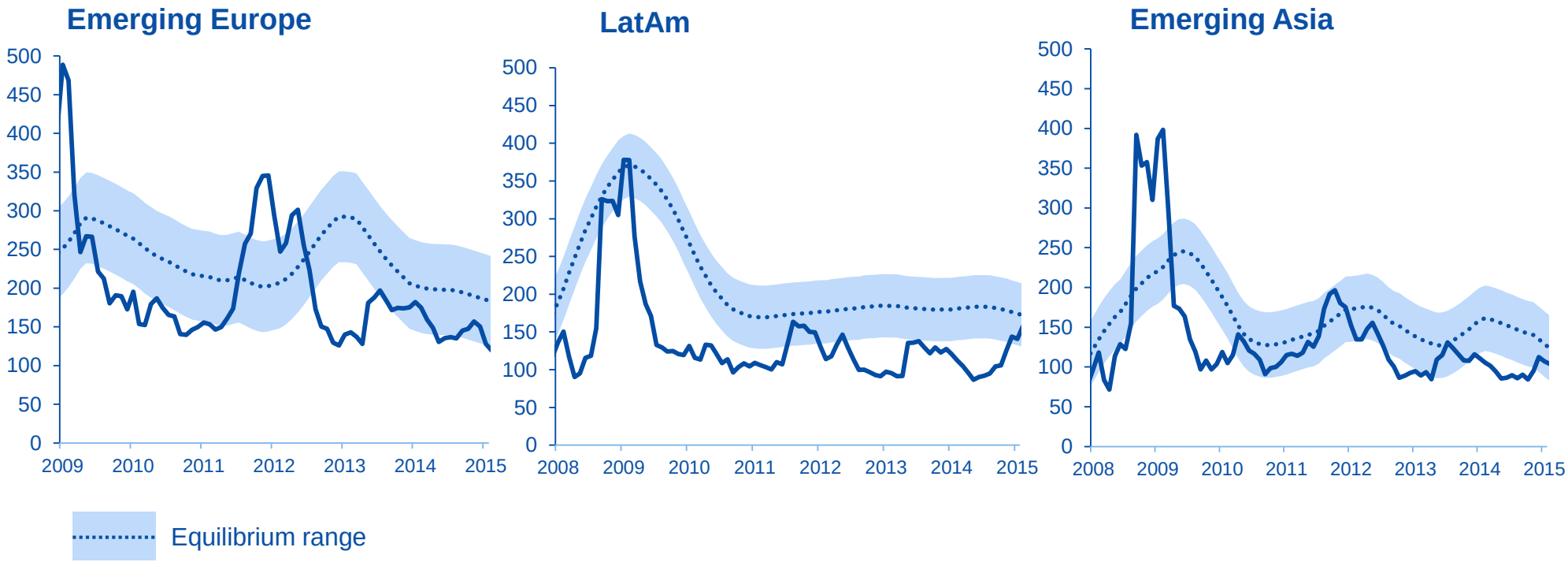


There is room for further downside correction in EM as risk premia hover below equilibrium levels

S&P just revised Brazil's outlook to the downside

CDS and equilibrium risk premium

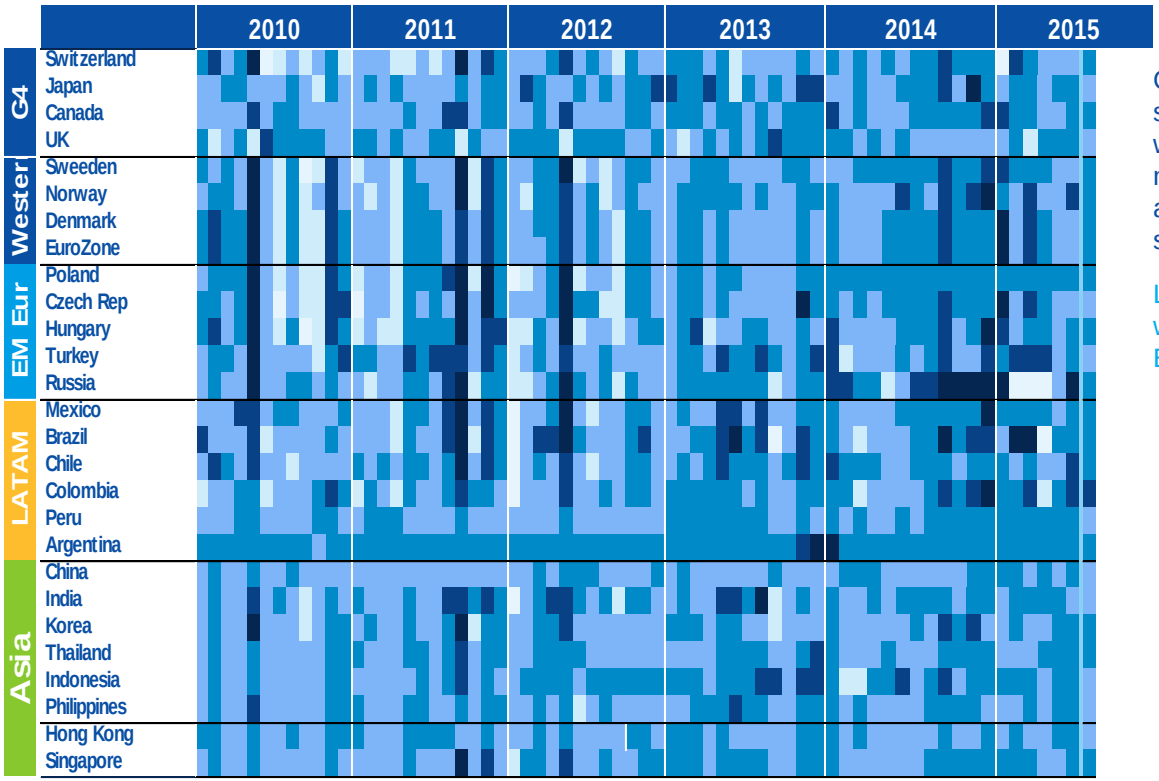
(Source: BBVA Research, Equilibrium: average of four alternative models + 0.5 standard deviation)



Global Dollar appreciation remained but with less intensity due to Fed wording gradualism

BBVA Exchange Rate Map

(Monthly variation of exchange rates vs. USD in %. Darker is depreciation)



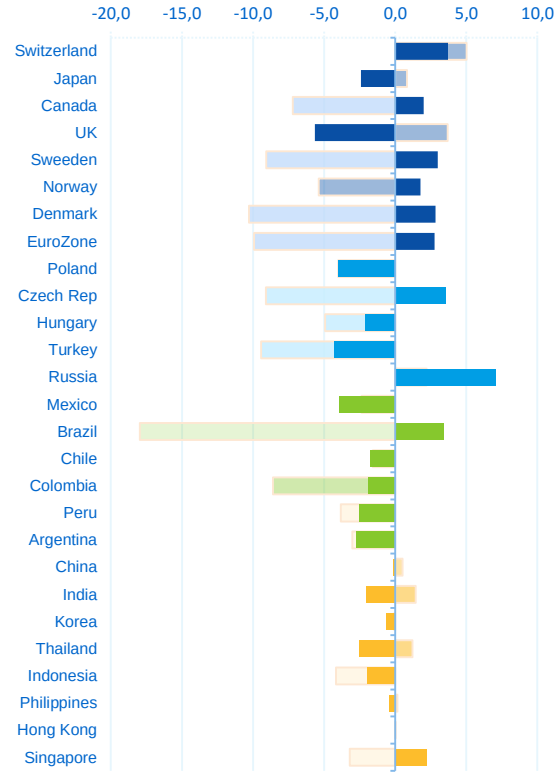
Grexit did no weigh significantly on FX, while the ECB did not show concerns about interest rate spike

Local factors weighed in EM European FX

Weak domestic cycle and, recently commodity prices sill weighed on EM Latam FX

FX 2Q15 average change in %

(shades are last quarter's average FX change)



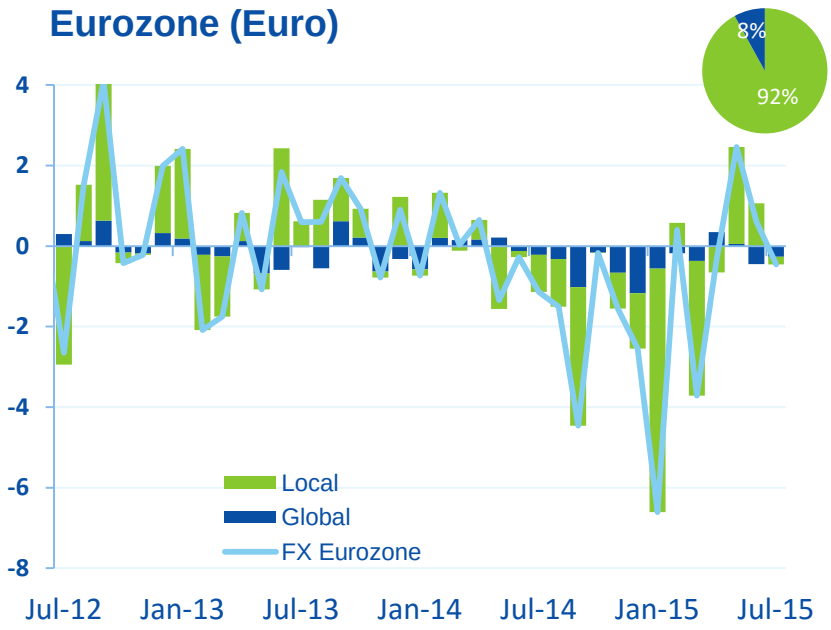
Sharp Currency Depreciation (below -6 %)
Strong Currency Depreciation (between -3 % and -6 %)
Moderate Currency Depreciation (between 0 and -3 %)
ModerateCurrency Apreciation (between 0 and 3 %)
Strong Currency Apreciation (between 3 % and 6 %)
Sharp Currency Apreciation (greater than 6 %)

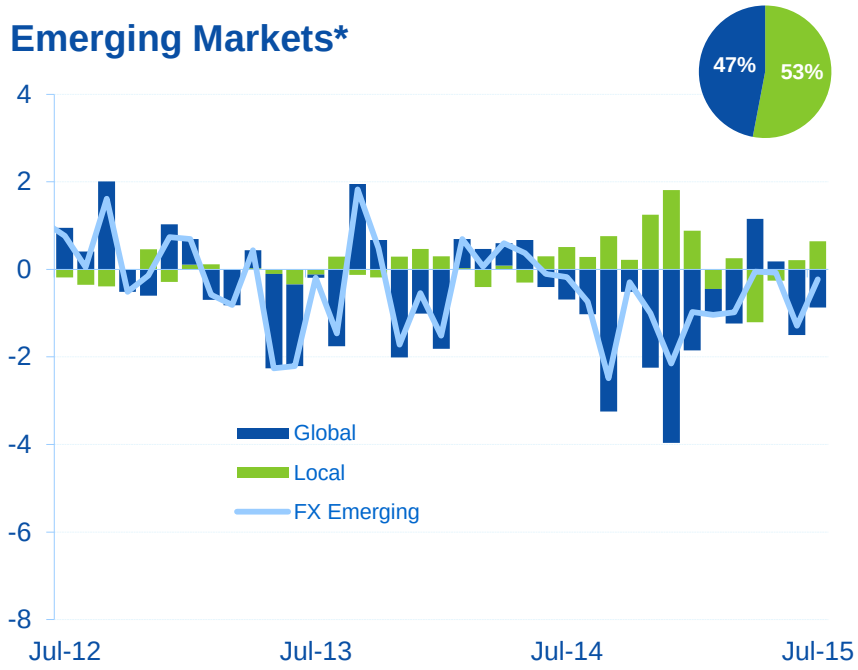
BBVA Research Exchange Rate Map

(Darker Zones are negative variations but here it means depreciations)

Local factors led movements in the Euro: as ECB shows less activism in QE than expected (it seems comfortable with 2Q15 volatility)

FX Change Decomposition in Developed and Emerging Markets
(in % MoM change, negative are depreciations)
Source: BBVA Research



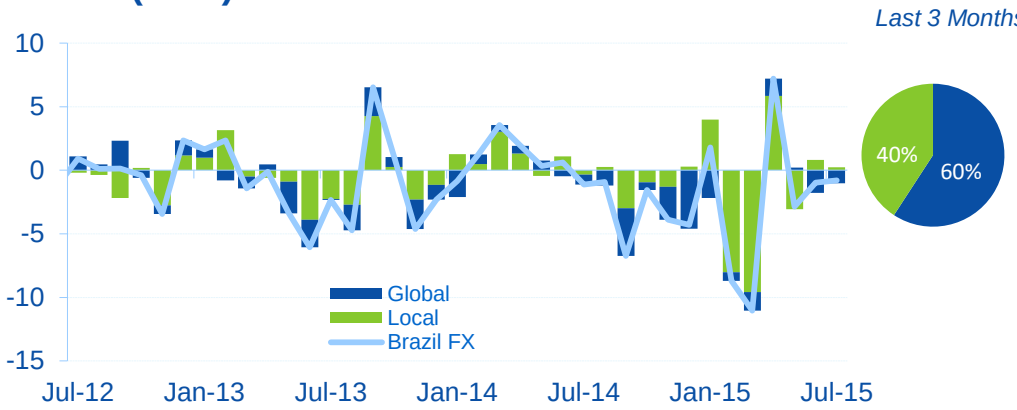


(*) Measured as median % MoM change from the following Emerging Economies; Turkey, Poland Czech. Rep., Hungary, Russia South Africa, Mexico, Brazil, Chile, Colombia, Argentina, Peru, China, Korea, Thailand, India, Indonesia, Philippines, Hong Kong, Singapore

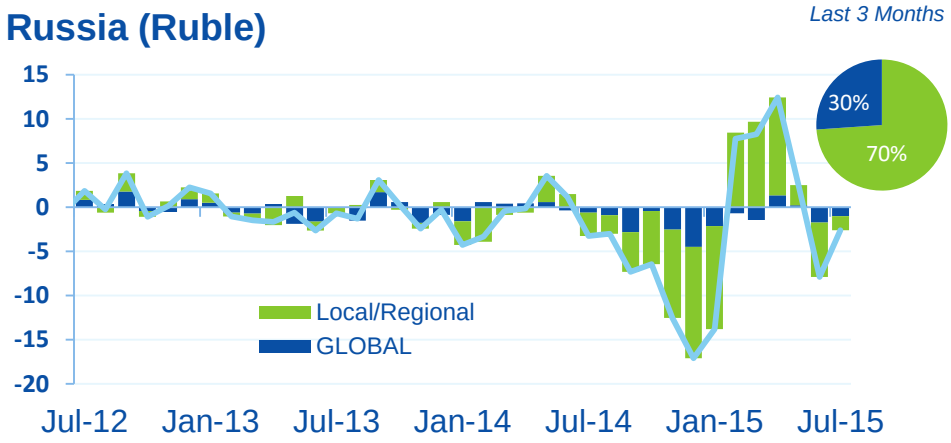
Global factors (Fed & growth) weigh on Latam. Local factors (FX intervention and election results) weigh on Russia and Turkey

FX Change Decomposition in Developed and Big Emerging Markets
(negative are depreciations) Source: BBVA Research

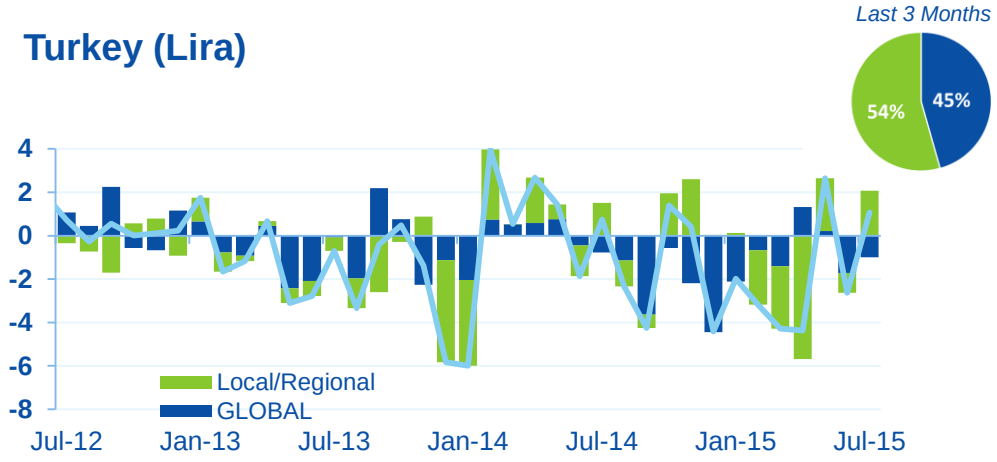
Brazil (Real)



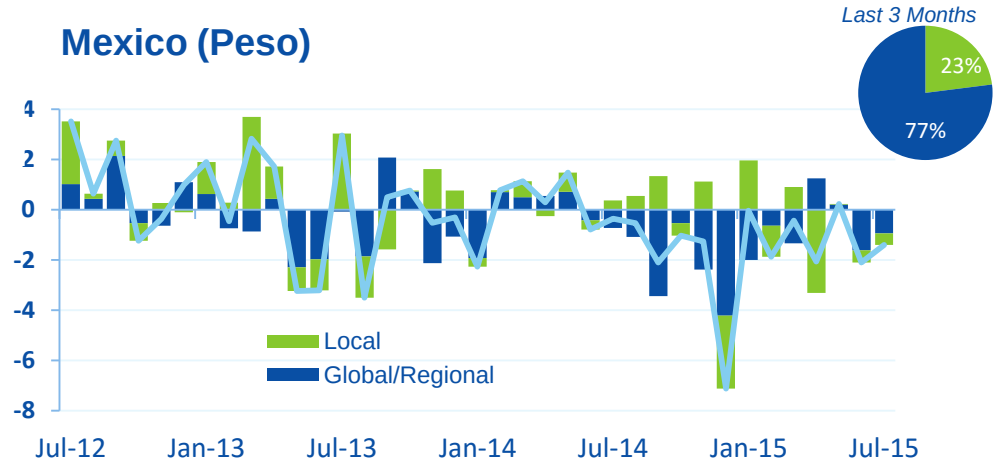
Russia (Ruble)



Turkey (Lira)



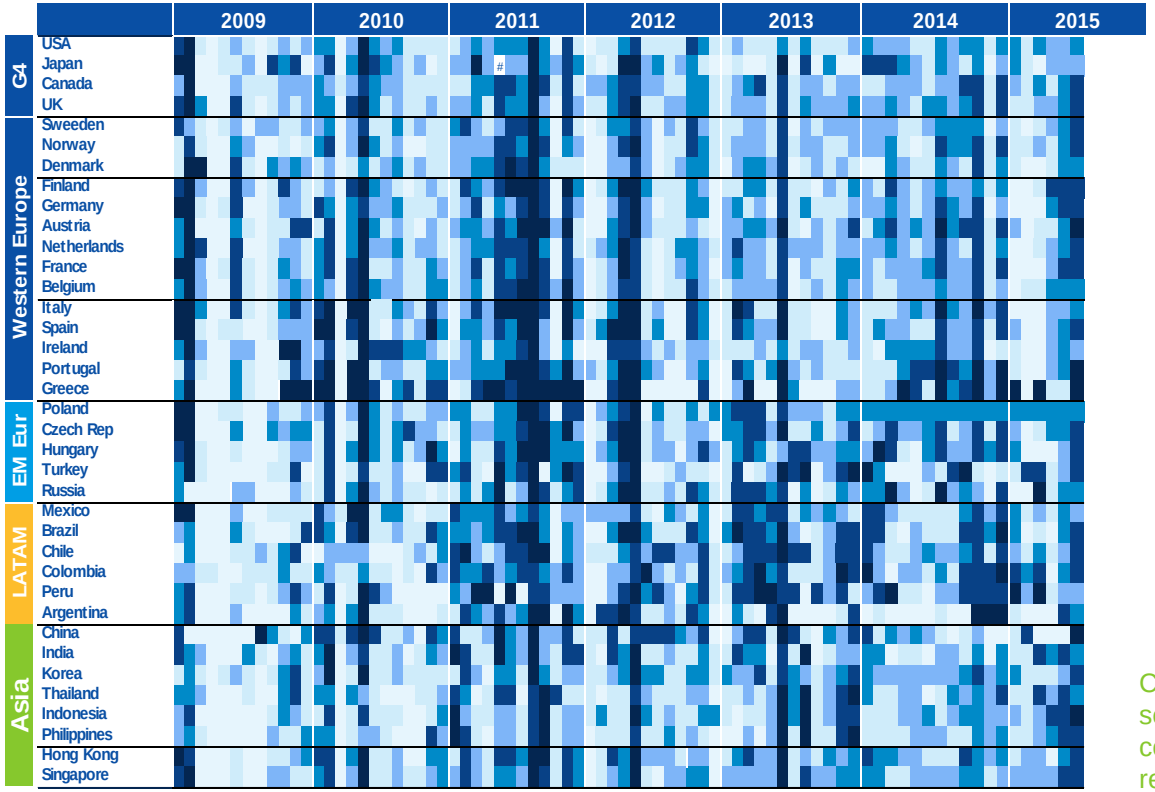
Mexico (Peso)



Raise in long-term interest rates sparks equity markets corrections amid global growth and Grexit concerns

BBVA Equity Price Map

(Monthly Variation of Equity Price Indexes in %)



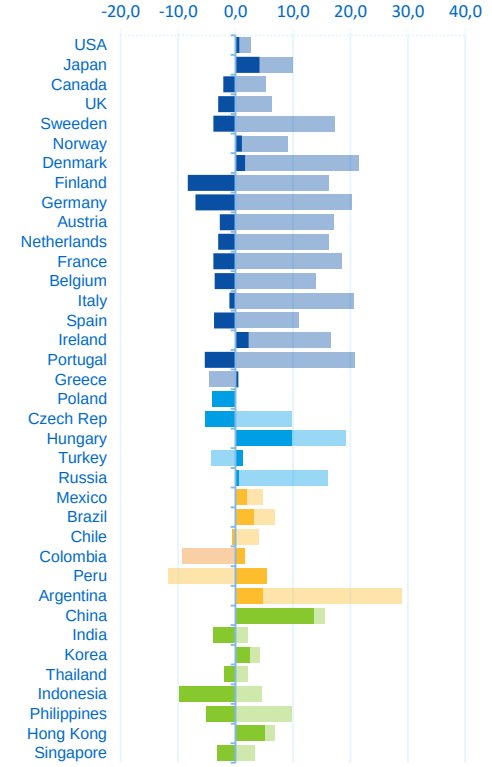
Sharp Equity Price Contraction (below -6 %)
Strong Equity Price Contraction (between -3 % and -6 %)
Moderate Equity Price Contraction (between 0 and -3 %)
Moderate Equity Price Expansion (between 0 and 3 %)
Strong Equity Price Expansion (between 3 % and 6 %)
Booming Equity Price Expansion (greater than 6 %)

Global bond sell-off, couple with expectations for a lower euro depreciation levels and risk of Grexit weigh on Eurozone Equity markets

Chinese equity sell-off prompted correction in the region indices

Q2 2015 Equity price changes (% QoQ)

(shades are last quarters QoQ change)

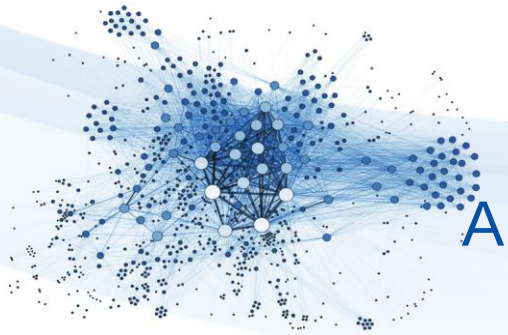


Expectations on EM economic cycle will weight on expected corporate profits, favoring discrimination for DM equity markets

BBVA Assessing Equity Market Misalignment Composite Indicator (Weighted average, of PER 12Forward, PER12T and P/B Ratios) updated July 16th

Scenarios

Simulation analysis



Recent events on activity and global risk aversion reshape our set of plausible portfolio flow scenarios

A global failed recovery and a China activity shock as main drivers likely to produce an EM portfolio readjustment

(1) Baseline Market & macro scenario
Source: BBVA Research –FAVAR Model

Global growth
Gradual global recovery led by DM

Global monetary policy
Monetary conditions temporary lose at the global level. DM policy divergences remain (interest rate hikes in US vs. QE in EMU)

Global risk aversion
Contained below the recent past levels

(2) Global Failed Recovery
Source: BBVA Research –FAVAR Model

Global growth
Sluggish growth at the global level (-0.4 pp. bellow baseline in 2015 –16 avg.)

Global monetary policy
Delayed MP normalization in DM and maintenance of supportive policies in EM

Global risk aversion
Contained in DM due to central bank support but higher risk perception in EM

(2) China activity contraction
Source: BBVA Research –FAVAR Model

Global growth
China triggers a correction of EM growth (a shortfall of -1pp. less growth in China brings -0.6 pp. less growth in EM along 2015-16 avg.)

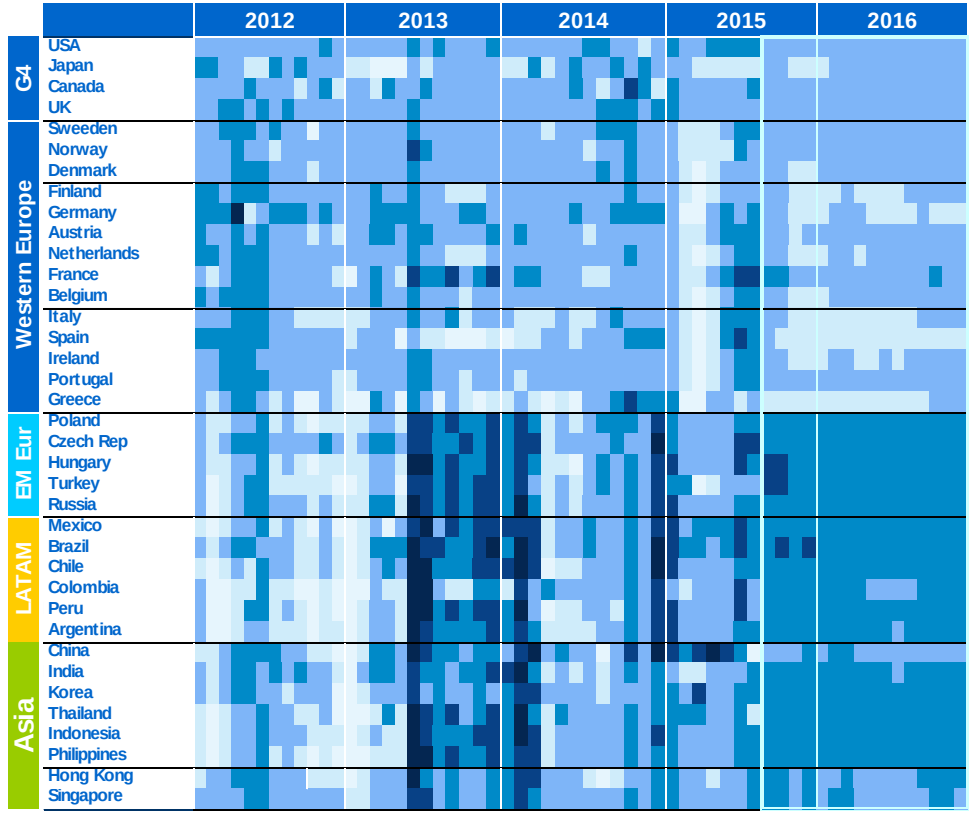
Global monetary policy
Reinforced easing in DM but less room to maneuver in EM to support the cycle preventing capital outflows

Global risk aversion
Heightened risk aversion globally (in particular in EM)

Baseline: Global portfolio retrenchment, in particular on EM due to growth concerns

BBVA Baseline Scenario of Portfolio Flows

(% monthly change in net liabilities measured as net flows to total assets under management) Source: BBVA Research and EPFR



BBVA Research Portfolio Flows Map*

The Flows Map show the monthly evolution of net inflows with Darker blue colors representing sharp net outflows and lighter colors standing for net Inflows

Baseline Market & Macro Scenario

Source: BBVA Research –FAVAR Model

Global Growth

+3.6 pp in 2015-16 avg.
+2.3 pp DM
+4.5 pp EM

Global Monetary Policy

Tepid raise in long term rates
2.72 pp 10y T-note 2016 EoP
1.30 pp 10y Bund 2016 EoP

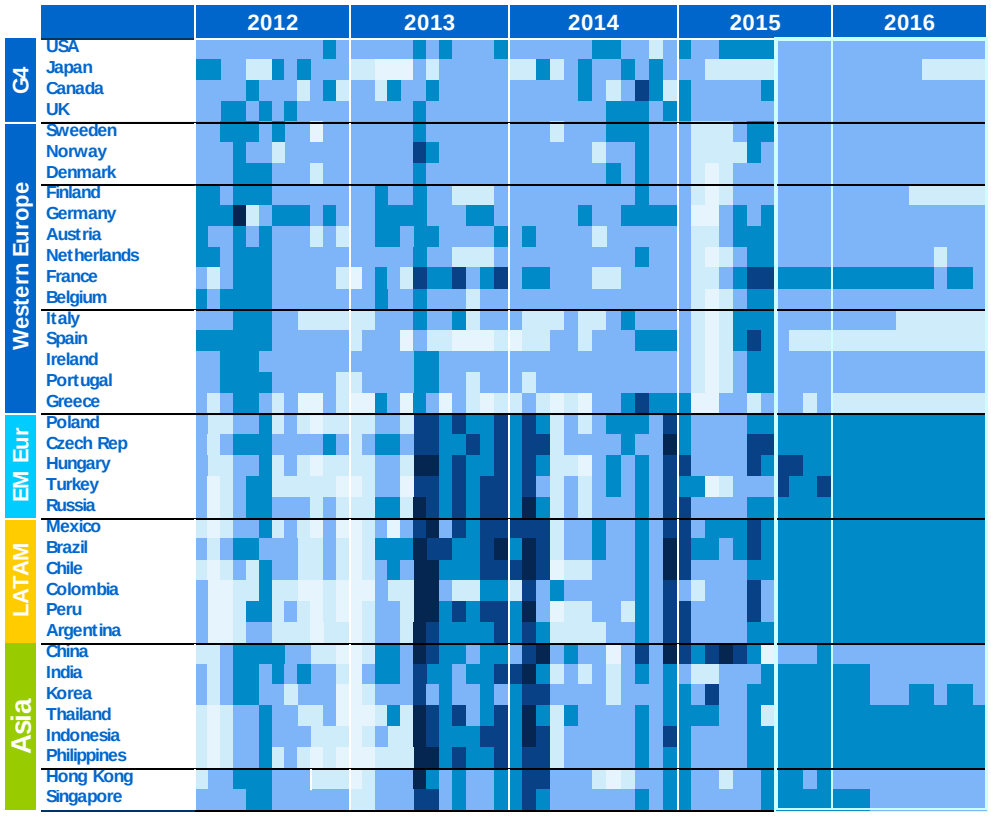
Global Risk Aversion

Stable VIX at 15 points in 2016 EoP
EMBI slightly moderates to 4 pp in 2016 EoP

Global Failed Recovery: global net outflows intensify with respect to the Base scenario in both DM and EM but differentially more in the latter

BBVA Global Failed Recovery & Portfolio Flows

(% monthly change in net liabilities measured as net flows to total assets under management) Source: BBVA Research and EPFR



BBVA Research Portfolio Flows Map*

The Flows Map show the monthly evolution of net inflows with Darker blue colors representing sharp net outflows and lighter colors standing for net Inflows

BBVA Global Failed Recovery & Portfolio Flows

Source: BBVA Research –FAVAR Model

Global Growth

+3.3 pp in 2015-16 avg. (-0.3 pp below base scenario)
+1.9 pp DM (-0.4)
+4.3 pp EM (-0.3)

Global Monetary Policy

Flattening in long term rates
2.20 pp 10y T-note 2016 EoP (-50 pbs)
0.30 pp 10y Bund 2016 EoP (-100 pbs)

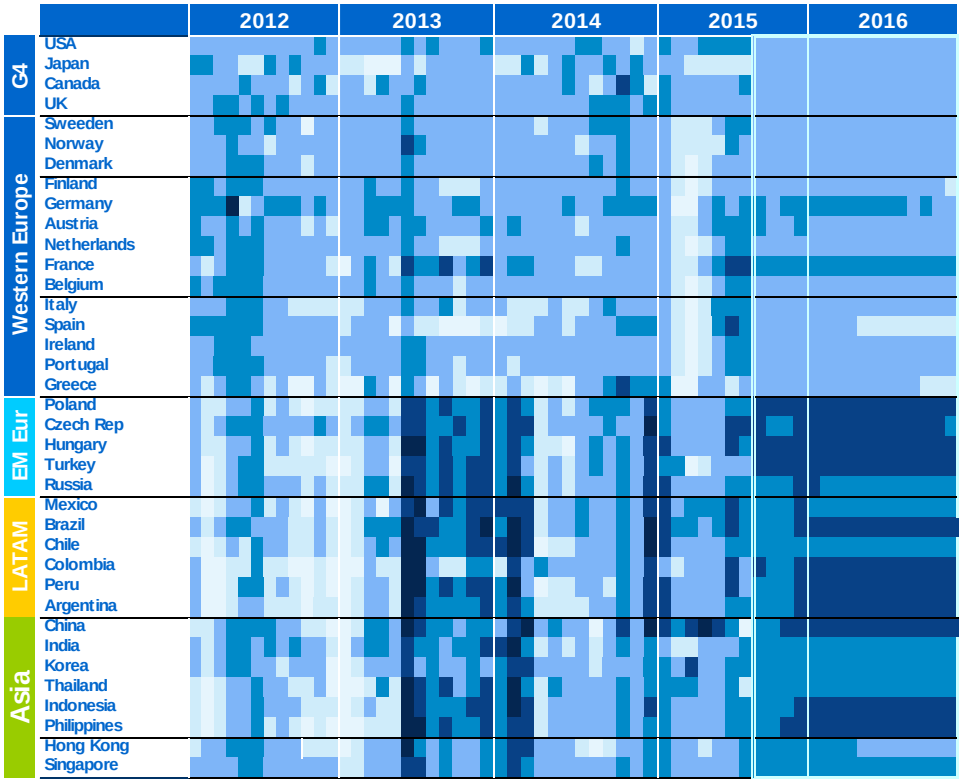
Global Risk Aversion

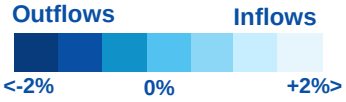
Stable VIX at 15 points in 2016 EoP
EMBI increases to 4.7 pp in 2016 EoP

China activity contraction: Chinese shock relates only to the real side. Portfolio flows will contract strongly in EM

BBVA China Activity Contraction & Portfolio Flows

(% monthly change in net liabilities measured as net flows to total assets under management) Source: BBVA Research and EPFR





BBVA Research Portfolio Flows Map*

The Flows Map show the monthly evolution of net inflows with Darker blue colors representing sharp net outflows and lighter colors standing for net Inflows

China Activity Contraction & Macro Scenario

Source: BBVA Research –FAVAR Model

Global Growth

China -5.4 pp in 2015-16 avg.(-1.0 pp below base scenario)
+4.1 pp EM (-0.6)

Global Monetary Policy

1.80 pp 10y T-note 2016 EoP (-90 pbs)
0.10 pp 10y Bund 2016 EoP (-120 pbs)

Global Risk Aversion

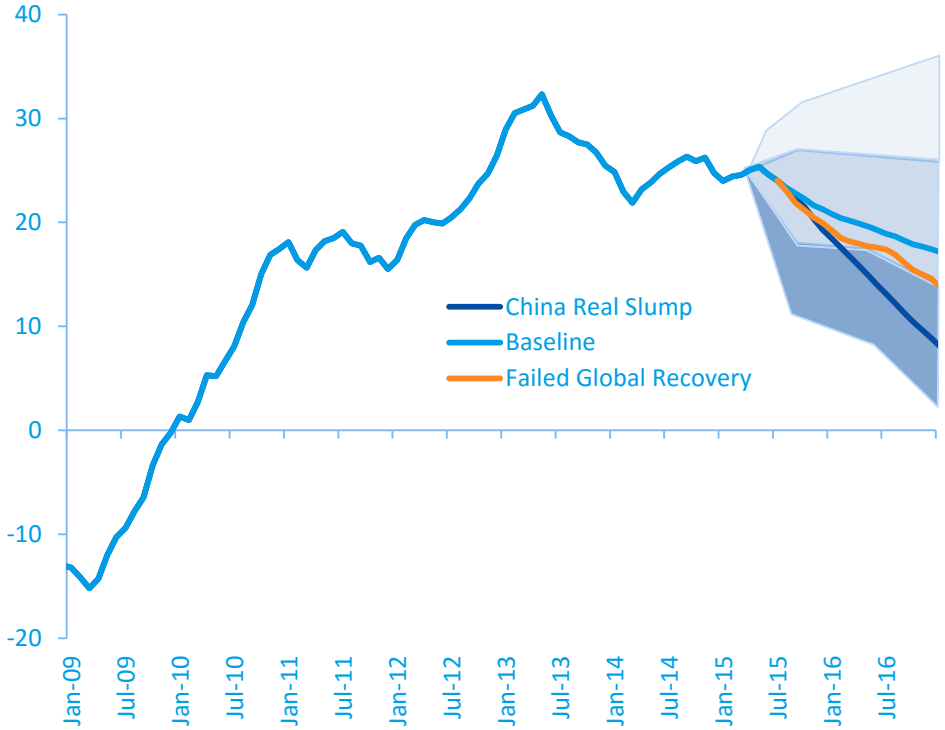
VIX Increases at 20 points in 2016 EoP
EMBI rebounds to 5.5 pp in 2016 EoP

In any case portfolio flows reallocation will continue now fueled on uneven growth risks between EMs and DMs

Scenario Conditional Flow Paths for EMs

(Baseline and alternative scenarios)

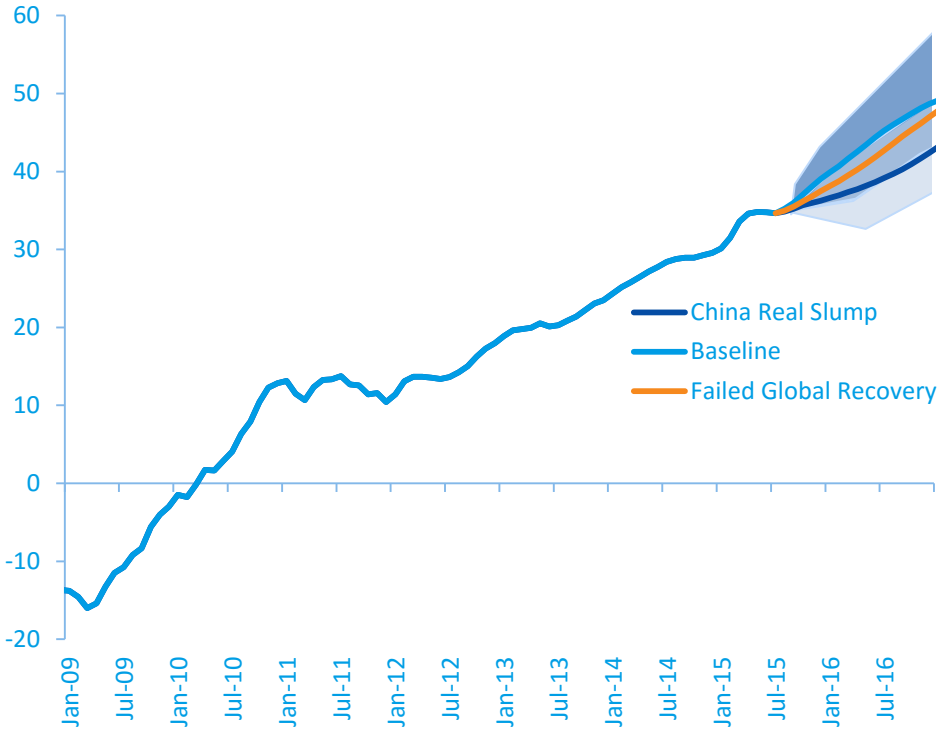
Cumulative % variation of MEDIAN portfolio Flows, forecast made as July 2015) Source: BBVA Research



Scenario Conditional Flow Paths for DMs

(Baseline and alternative scenarios)

Cumulative % variation of MEDIAN portfolio Flows, forecast made as July 2015) Source: BBVA Research



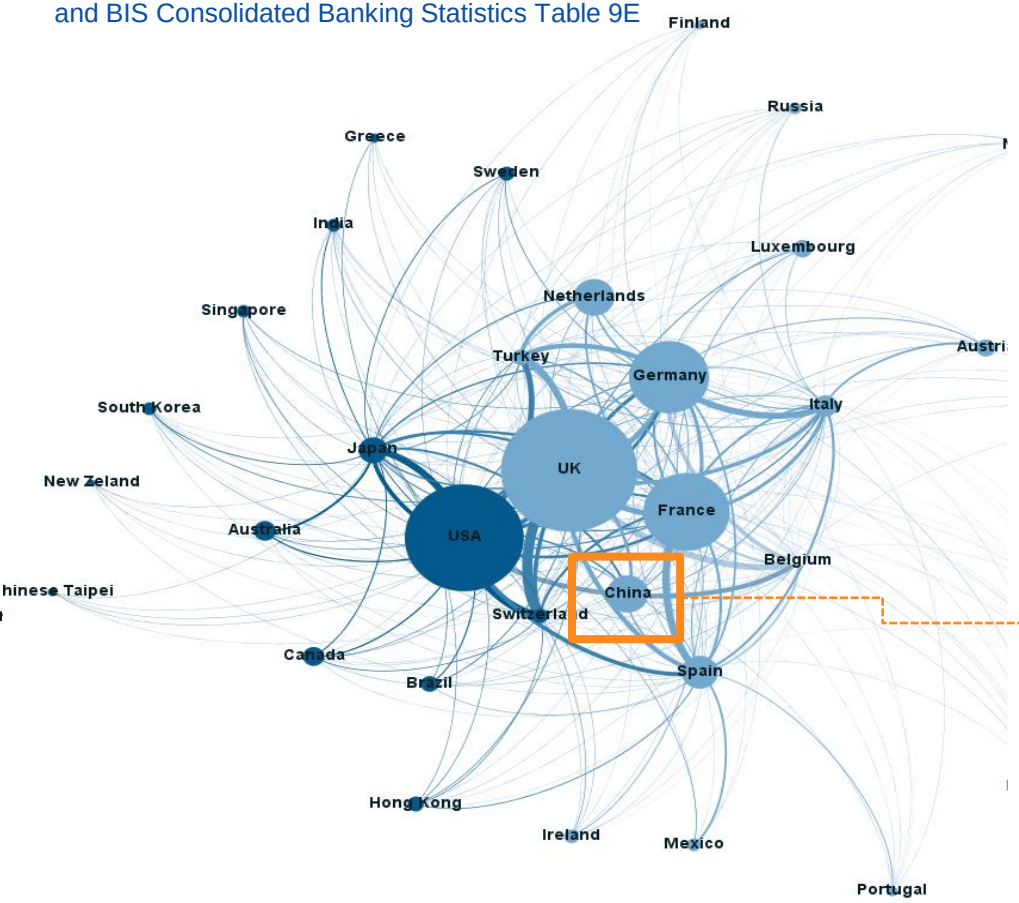
Hot Topics

Exposure risk to Chinese Banking distress

The expected cost of a Chinese banking impairment would be high but not systemic. Financial integration (connectivity) and exposure (share of liabilities) are far from the top banking systems.

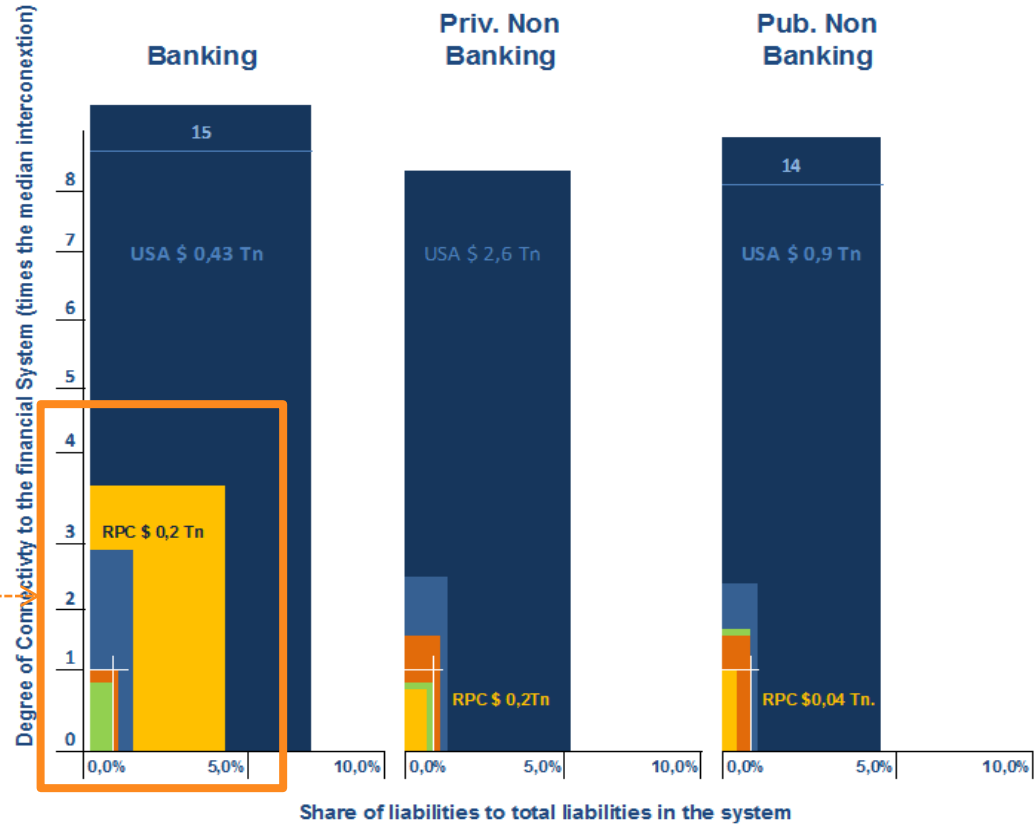
Banking Exposure Network

(Banking Exposures and Interconnectivity Q4 2014 node size is the share of liabilities to the total, links are proportional to the claim) Source: BBVA Research and BIS Consolidated Banking Statistics Table 9E



Financial System Exposure & Interconnectedness

Source: BBVA Research and BIS CBS Table 9E



Useful Information

Methodology and Interpreting the Results

A Dynamic Factor Model / Factor Augmented VAR to analyze and forecast flows and asset prices

Our framework is based on the belief that there are unobservable factors or channels that act at the global (GLOBAL), regional (Developed (DM), Emerging (EM) and Safe Havens (SH) and idiosyncratic (I) transmitting from the global macro economy to flows or asset prices. The origin of these shocks can be created due to monetary policy in DMs, expected growth differentials between DMs and EMs and the differential risk aversion levels arising between the latter two.

To model the behavior between flows and asset prices and these global shocks via the described channels we use a two step approach based on a Dynamic Factor Model (DFM) and its interaction to a Factor Augmented Vector Autorregresion (FAVAR)

In the first part of the model, the “Dynamic Factor Model of Portfolio Flows and Asset Prices”, we use a version of a Dynamic Factor Model. Our set-up comprises a measurement equation block (1) and a state equation block (2). Both blocks together build the so called State Space Model. In this, the measurement equation block relates each observable portfolio flow in the (Y) matrix to several unobservable “states” or latent factors (F) with varying intensities according to the estimated parameters of each flow.

In the second part of the model the “Factor Augmented VAR (FAVAR) model“ we state the relation of the extracted factors with a set of macroeconomic variables in the form of a VAR structure allowing time dynamics between the three elements of the analysis: factors, macro and flows/assets.

We have chosen a set of macro variables so that the extracted factors carry strong statistical relations to the global financial cycle represented here with the EUR and US long-term rates that proxy the term premium. Also, factors and these latter variables carry strong links to the Global Risk Aversion and the Differential Risk Aversion to Emerging Markets (here gathered with the VIX and the EMBI respectively as in Rey 2012). Lastly we have analysed the relation of these variables and variables that proxy growth and growth differentials between developed and emerging markets (here as the G7 and great -EM median GDP Q/Q growth rates).

The model is estimated by means of maximum likelihood with Bayesian techniques and a prior that leverages more in the recent past in order to gauge the recent events.

Factors are forecasted conditional to the evolution of macro economic variables following the scenarios described bellow and flows are recovered back from the forecasted factors by means of the estimated measurement equation block (1) described above.

The BBVA_PM: a two step DFM/FAVAR model

(1) The Dynamic Factor Model (DFM) to extract flows (and asset prices) factors

1 Measurement Block Relates Factors (Ft) and Flows (Xt)

$$x_t = \mu + \Lambda f_t + \xi_t$$

2) Transition Block allows for flows (Ft) dynamics as AR

$$f_t = \Phi_1 f_{t-1} + \ldots + \Phi_p f_{t-p} + \varepsilon_t$$

The **Noise to Signal Ratio** is maximized, errors are iid.

The process is estimated using a Kalman Filter

……

Flows assumed to conceal a structure of **latent factors** (Λ) (**Global, Regional and Idiosyncratic**), Each factor is **orthogonal** and follows an **AR(p)** process (ϕ(L)).

PF(t)i=β1i∗Global(t)+β2i∗EME(t) +βi∗IDIO(t)i+U(t) *(emerging)*

PF(t)j=β1j∗Global(t)+β4i∗DME(t) +βi∗IDIO(t)i+U(t) *(developed)*

PF(t)j=β1j∗Global(t)+ β4i∗DME(t) ++β5i∗SH(t) + βi∗IDIO(t)i+U(t) *(SH)*

* See Doz, Giannone, Reichlin (2006), Watson, Reis (2010), Agrippino and Rey, H. (2013) Fratzscher 2013, Rey (2012), Puy (2013) among others

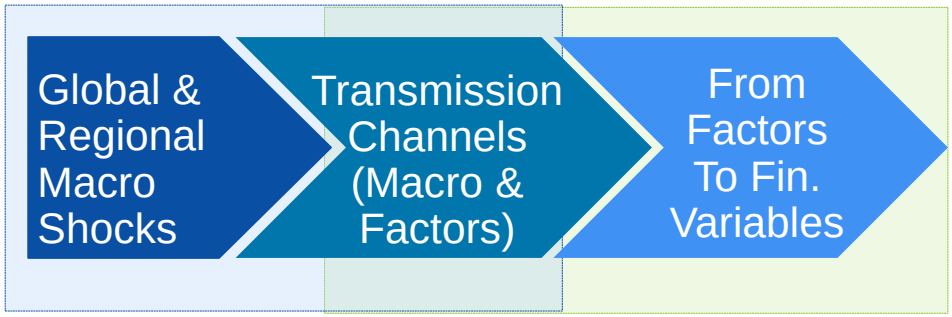
(2) Factor Augmented Model (FAVAR) to combine Macroeconomic variables and factors and Variables

$$\begin{bmatrix} Y_t \\ F_t \end{bmatrix} = A(L) \begin{bmatrix} Y_{t-1} \\ F_{t-1} \end{bmatrix} + \eta_t$$

$$F = \{ F^{SF}, F^{DM}, F^{EM}, F^{G} \}$$

$$Y = \{ y^{DM}, y^{EM}, i^{US}, i^{EZ}, VIX, i^{EMbi} \}$$

Exploiting time relations between the extracted latent factors and a set of selected global macro variables (2) and recovering flows by means of the measurement equation block in the DFM.



SHOCK
- Risk Aversion (VIX /EMBI)
- Monetary Policy (Fed, ECB rates)
- Growth differentials

TRANSMISSION
- To Global the Global factor
- To Specific Markets (DM,EM, SH)

REACTION
- Retrenchment
- Reallocation
- Flight to Quality
- etc.

Technical Appendix
Centrality measures

In graph theory and network analysis, indicators of centrality identify the most important vertices within a graph. We have chosen four measures to explain the centrality: **In-Degree**, **Out-Degree, Eigenvector Centrality** and **Betweenness**.

A node may have a different number of outgoing and incoming ties, and therefore, degree is split into **In-Degree** and **Out-Degree**. Accordingly, **In-Degree** is a count of the number of ties directed to the node and **Out-Degree** is the number of ties that the node directs to others. The node with the highest degree is most important. It is an index of exposure to whatever is flowing through the network.

However, the degree is in many applications a very crude measure. Usually not all neighbors (nodes close to each other) are equally important and, therefore, the number of neighbors alone is not enough to assess centrality. This idea leads to several more advanced centrality measures.

Eigenvector Centrality assigns relative scores to all nodes in the graph based on the principle that connections to nodes having a high score contribute more to the score of the node in question than equal connections to low-scoring nodes. It is a measure of the influence of a node in a network. Eigenvector is a measure that makes the centrality proportional to the sum of its neighbors' centrality.

The **Betweenness** is an indicator equal to the number of shortest paths from all vertices to all others that pass through that node. A node with high betweenness centrality has a large influence on the transfer of items through the network, under the assumption that item transfer follows the shortest paths. It quantifies the control of a node on the communication between other nodes. It shows which nodes are more likely to be in communication paths between other nodes. The intuition behind betweenness is that a node is important if it is involved in a large number of paths compared to the total set of paths in the network.

How centrality measures are calculated

1. In and Out Degree

The degree centrality of a vertex v, for a given graph $G = (V, E)$ with $|V|$ vertices and $|E|$ edges, is defined as:

$$\deg(v) = [\{(u, v) \in E : u \in V\}] \text{ and } C_D(v) = \deg(v)$$

Let v^*be the node with highest degree centrality in G. Correspondingly, the degree centralization of the graph is:

$$C_D(G) = \sum_{i=1}^{|V|} [\, C_D(v^*) - C_D(v_i)] \,/\, H$$

Where H is $(n-1)$

2. Eigenvector Centrality

Let $A = (a_{v,t})$ be the adjacency matrix.
i.e.$a_{v,t} = 1$, if vertex v is linked to vertex t, and $a_{v,t} = 0$ otherwise. The centrality score of vertex v can be defined as:

$$x_v = \frac{1}{\lambda} \sum_{t \in M(v)} ; \; x_t = \frac{1}{\lambda} \sum_{t \in G} a_{v,t} x_t$$

Where $M(v)$ is a set of the neighbors of v and λ is a constant. With a small rearrangement this can be rewritten in vector notation as the eigenvector equation: $Ax = \lambda x$

In general, there will be many different eigenvalues λ for which an eigenvector solution exists.

3. Betweenness

Formally, betweenness is a metric defined as:

$$g(v) = \sum_{s \neq v \neq t} \frac{\sigma_{st}(v)}{\sigma_{st}}$$

Where σ_{st} is the total number of shortest paths from node s to node t and $\sigma_{st}(v)$ is the number of those paths that pass through v.

Note that the betweenness centrality of a node scales with the number of pairs of nodes as implied by the summation indices. Therefore the calculation may be rescaled by dividing through by the number of pairs of nodes not including v, so that $g \in [0,1]$. The division is done by $(N-1)(N-2)$, where N is the number of nodes in the giant component.

This scales for the highest possible value, where one node is crossed by every single shortest path. This is not the case, and a normalization can be performed without a loss of precision:

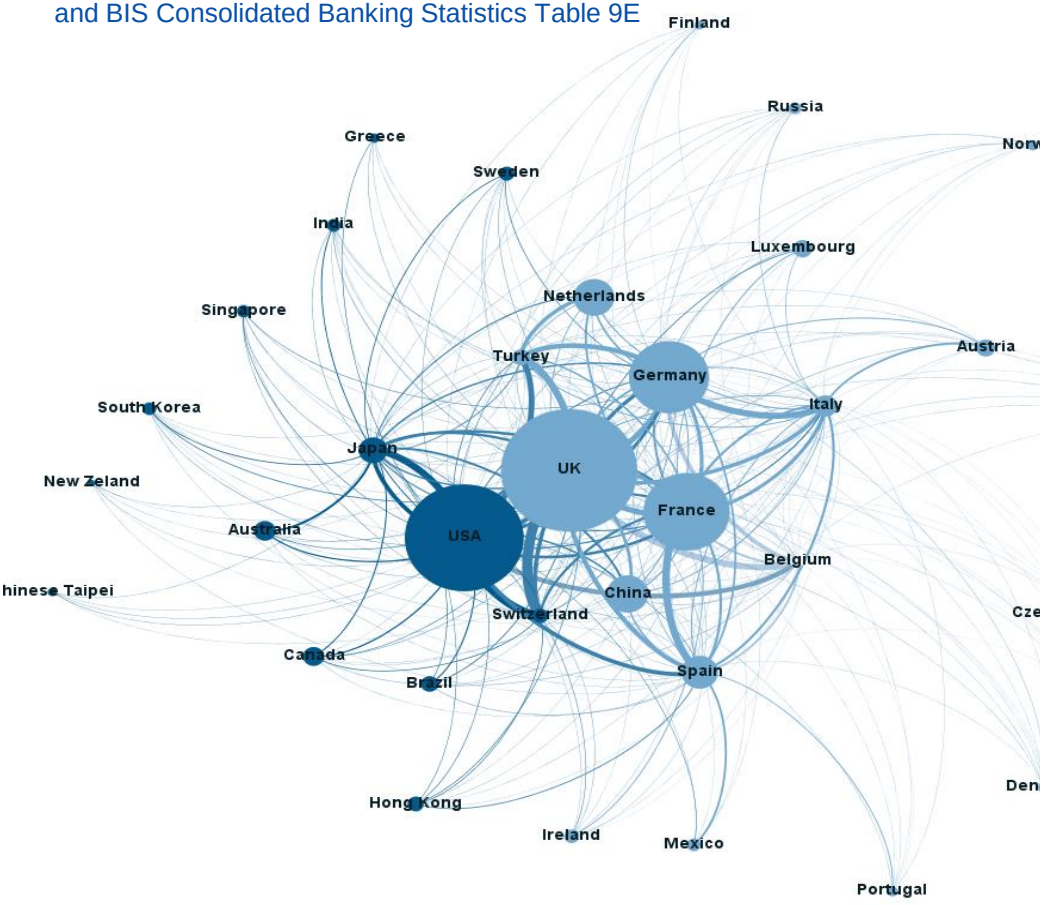
$$\text{normal}\,(\text{g(v)}) = \frac{g(v) - \min(g)}{\max(g) - \min(g)};$$

Which results in: $\max(normal) = 1; \min(normal) = 0$

Reading an Exposure Network for China (Capadia & Gai 2011).

Banking Exposure Network

(Banking Exposures and Interconnectivity Q4 2014 node size is the share of liabilities to the total, links are proportional to the claim) Source: BBVA Research and BIS Consolidated Banking Statistics Table 9E



Blue color tones determine the **financial clusters** found by means of Page-Rank maximization algorithms (those whose interconnectivity is maximized vs. a null Random model). Financial clusters are made on behalf of the strength of the relations from both the liability and the asset side as reported by the BIS. The two financial clusters found could be summarized as those with **strongest ties in America/Pacific (dark blue) and Europe/Eurasia (light blue) The size of each node relates to the share of the global liabilities** that it entails. Un-surprisingly **UK, USA and EU5 are the biggest** nodes while **China is the biggest of the Emerging Markets** but its size is not bigger than that of Spain in terms of liabilities. The size of these nodes gives an intuition of the **stake at odds in case of banking impairment**. The amount of strides "in" and "out" each node or country are the amount of asset and liability lines to other countries, the thicker the links the larger the proportion of liabilities a country has to another. Every liability is an asset for someone else so the color of the liability signifies to whom is the money owed. For instance, the Switzerland claims a very important part of its assets on the UK but owes a large extent of its claims to the US. The **weighted centrality degree** used above is a combination of both measures IN/OUT degrees while the Eigenvector Centrality Measure, **considers the degree of relation of a node to the most relevant clusters or financial integration**. Needless to say that the UK-US-EU systems are the key relevant clusters and that links to these from other countries deem the systemic nature they have. **IN/OUT and Eigenvector Measures give a sense of the centrality of a financial system within the global environment**. We use the first criteria as connectivity and the second as integration. **China has a moderate number of weighted ties to the global system but is relatively close to both financial clusters found**; hence its centrality (in terms of connectivity and integration) **is fairly high** (though not as high as that of the UK for example). In an Exposure Network, the location of the nodes is relative to the combined centrality measure. **China is just inside the orbit of systemic countries from this point of view** (size and connectivity). Despite that it has increased the integration to the banking system in 60% since 2010 it represents < ¼ of the centrality achieved by the biggest interconnected banking systems (truly systemic ones)

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