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The decline of solvency contagion risk

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Info

- Any views expressed are solely those of author(s) and so cannot be taken to represent those of the Bank of England or to state Bank of England policy.
- The Bank of England Staff Working Paper will be out soon: http://www.bankofengland.co.uk/research/pages/workingpapers
- Run solvency contagion on your own data! https://github.com/marcobardoscia/neva

Motivation

- One of the channels through which systemic risk spreads
- Classic critique: there have been few cascades of default
- Defaulting is not the only thing that matters: pre-default losses are important.
- "Roughly two thirds of the losses attributed to counterparty credit risk were due to CVA losses and only about one third were due to actual default."[1]

[1]Basel Committee, 2011. http://www.bis.org/press/p110601.htm

Short review

- Most empirical papers[1] are based on a simple mechanism: when a bank defaults its creditors lose the full amount of their exposures towards the defaulted bank, recovery rate is zero.
- Eisenberg and Noe[2]: recovery rate to claims towards defaulted banks is endogenously determined, and in general larger than zero.
- EN has been used in some empirical papers[3].
- Some pre-crisis empirical papers[4] look at the UK.

[1]Furfine, JBCM 2003; Upper and Worms, EER 2004; Wells, BoE SWP 2004; Degryse et al, IJCB 2007; Cont et al, 2010; Mistrulli, JBF 2011.
[2]Eisenberg and Noe, MS 2001.
[3]Elsinger et al, MS 2006; Elsinger et al, IJCB 2006.
[4]Wells, BoE SWP 2004; Elsinger et al, IJCB 2006.

Short review

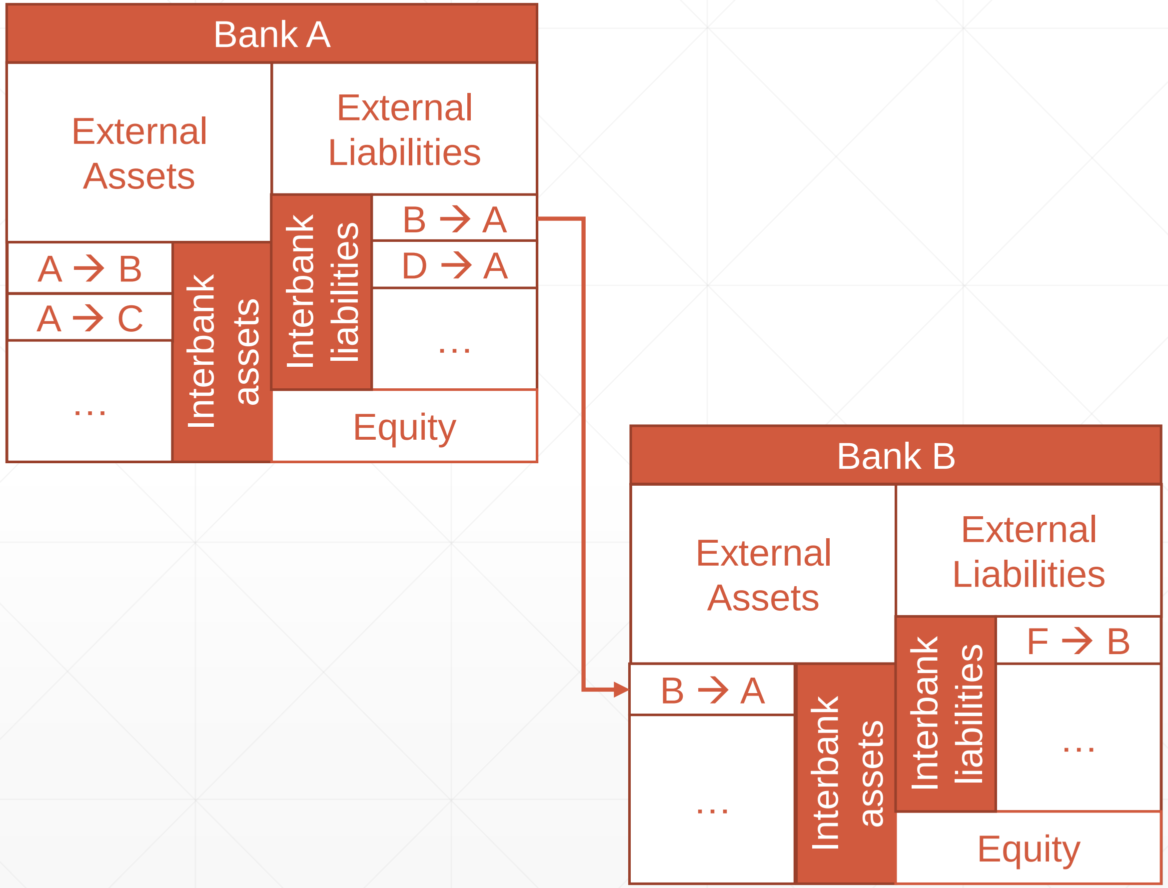
- Pre-default contagion can be though as an extension of structural credit models[1] to the case in which banks are tangled in complex network of contracts.
- There are two possible approaches:
  - Monte Carlo[2]
  - Neva[3]: Valuation functions
- We do not discuss the (much-debated) role of the topology of the underlying network[4].

[1]Merton, JF 1974; Black and Cox, JF 1976.
[2]Elsinger et al, MS 2006; Elsinger et al, IJCB 2006.
[3]Barucca et al, SSRN 2016.
[4]Acemoglu et al, AER 2015; Amini et al, Math. Fin. 2013; Bardoscia et al, Nature Comm. 2017.

Model

- Asset side:
  - External assets (e.g. loans)
  - Interbank assets
- Liability side:
  - External liabilities (e.g. deposits)
  - Interbank liabilities
  - Equity
- Balance sheet identity:

$$A_i^e + \sum_{j=1}^{n} A_{ij} = L_i^e + \sum_{j=1}^{n} L_{ij} + E_i$$



Valuation functions: Intuition

- We take assets at their market value, while liabilities do not change:

$$E_i(T) = A_i^e(T) + \sum_{j=1}^{n} A_{ij}\mathbb{V}_{ij}(E_j(T);\ldots) - L_i^e - \sum_{j=1}^{n} L_{ij}$$

- The valuation function can be interpreted as a discount factor: if equal to one the asset is worth its face value; if equal to zero the asset is worth nothing. It will depend on the creditworthiness of the counterparty.

$$\mathbb{V}_{ij}(E_j(T);\ldots) = \begin{cases} 1 & \text{for } E_j(T) > 0 \\ r_j(E_j(T);\ldots) & \text{for } E_j(T) \leq 0 \end{cases}$$

- The recovery rate *r* is chosen to be consistent with the Eisenberg and Noe model.

Valuation functions: Intuition

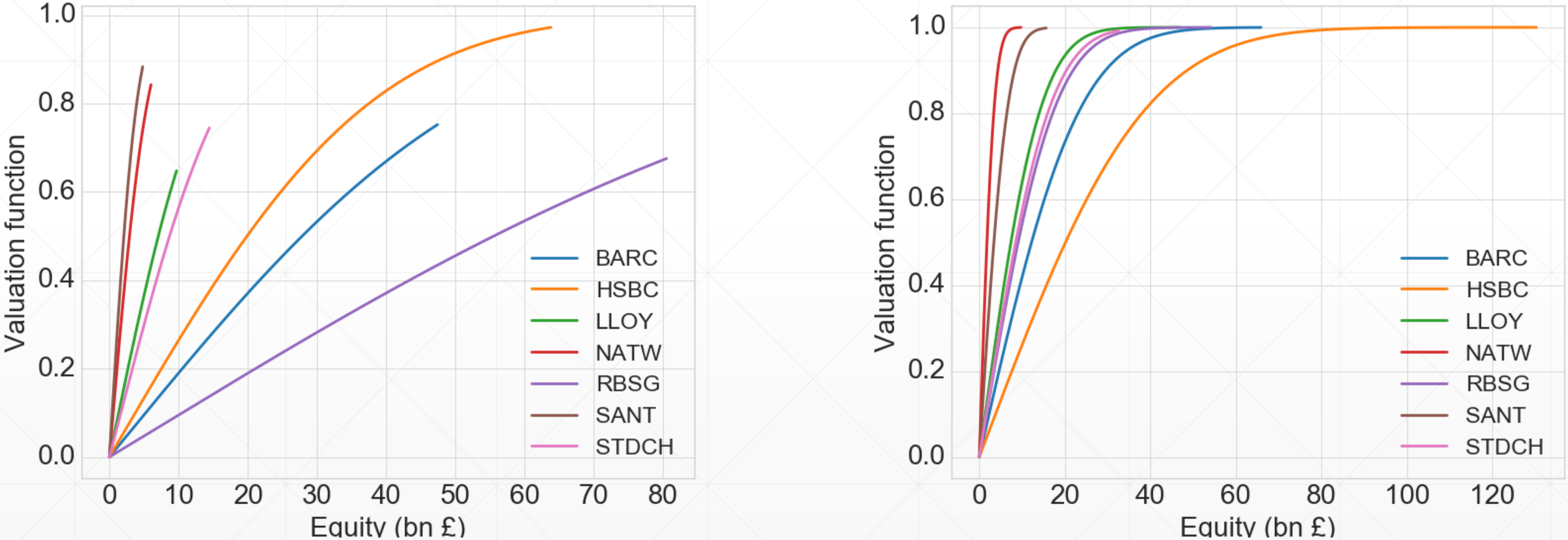
- We now perform the valuation at time $t < T$. The arbitrage-free price of the assets is computed as an average over the risk-neutral measure:

$$E_i(t) = A_i^e(t) + \sum_{j=1}^{n} A_{ij}\mathbb{E}^{\mathbb{Q}}\left[\mathbb{V}_{ij}(E_j(T);\ldots)|\mathbf{A}^e(t)\right] - L_i^e - \sum_{j=1}^{n} L_{ij}$$

- In our model banks can default at any time t before the maturity T, meaning that the average is made a la Black and Cox:

$$\mathbb{E}^{\mathbb{Q}}\left[\mathbb{V}_{ij}(E_j(T);\ldots)|\mathbf{A}^e(t)\right] = 1 - p_j^D(E_j(t)) + \rho\, p_j^D(E_j(t))$$

Valuation functions: Calibration



2008 (left) and 2015 (right), recovery rate = 0

Valuation functions: Results

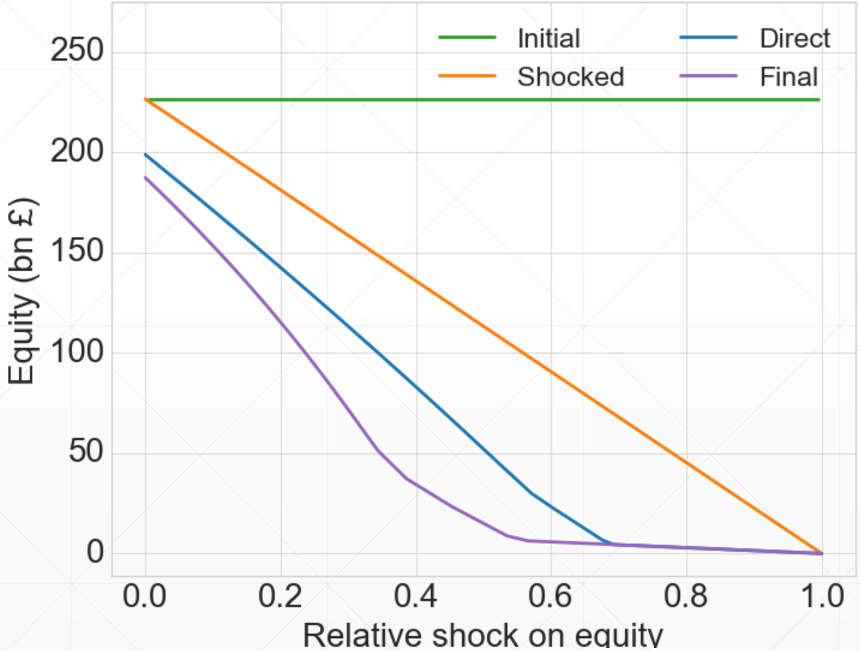
- In Barucca et al. (2016) (under mild assumptions) it is shown that the equations to compute the equities have a greatest solution, i.e. a solution that is simultaneously optimal for all banks.
- In order to compute the greatest solution one simply has to iterate the equations for equities using the book value of equities as a starting point.
- Computing the losses due to a shock amounts to:
  1. Using the post-shock equities as a starting point
  2. Finding the fixed-point of the equations for equities

Data

- We use real interbank exposures between banks part of the Bank of England's annual concurrent stress test:
  - 7 banks, which account for 80% of the regulated UK lending
  - 2008 – 2013: exposures larger than 10% of equity
  - 2014 – 2015: no threshold, more granular data
- When possible (2013 – 2015) we interpret the equity of our model as CET1, otherwise we use shareholders' equity for consistency.
- Volatilities are estimated from returns of banks' stock prices.

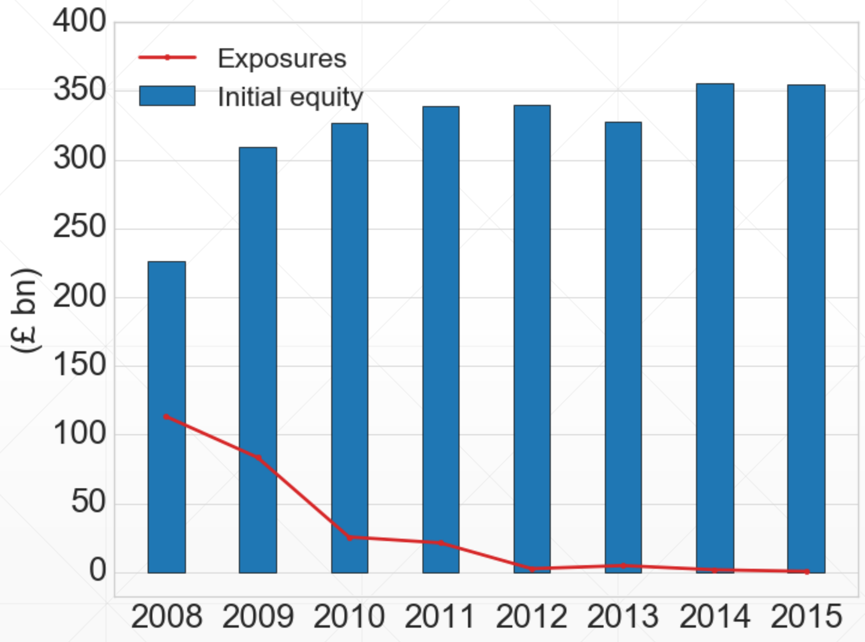
Simplified stress tests

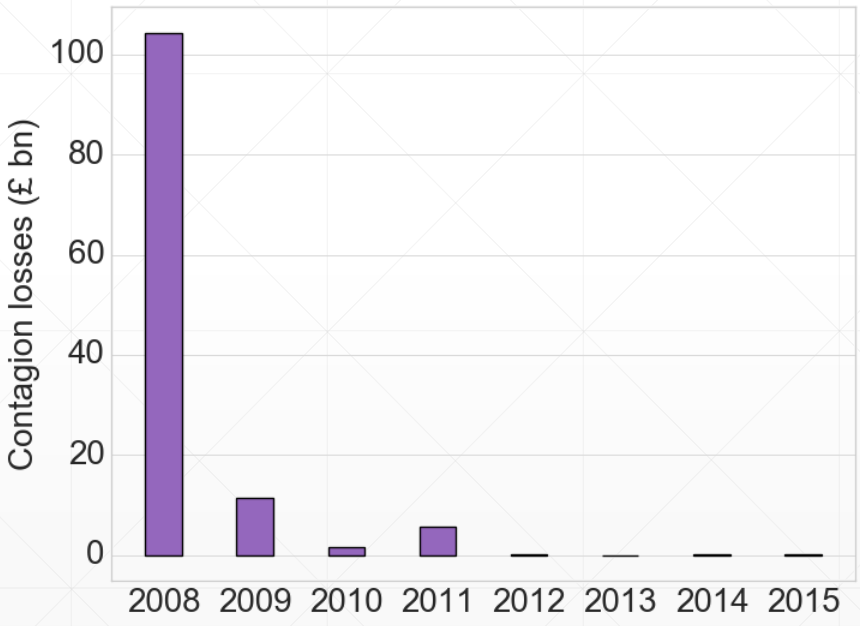
- We run simplified stress tests. In the first “scenario” all banks suffer a homogeneous (relative) shock to their equity.
- Losses due to contagion (orange to purple) can be as large as the exogenous shock.
- Losses caused by direct exposures (orange to blue) can be a large as those caused by indirect exposures (blue to purple).



2008, recovery rate = 0

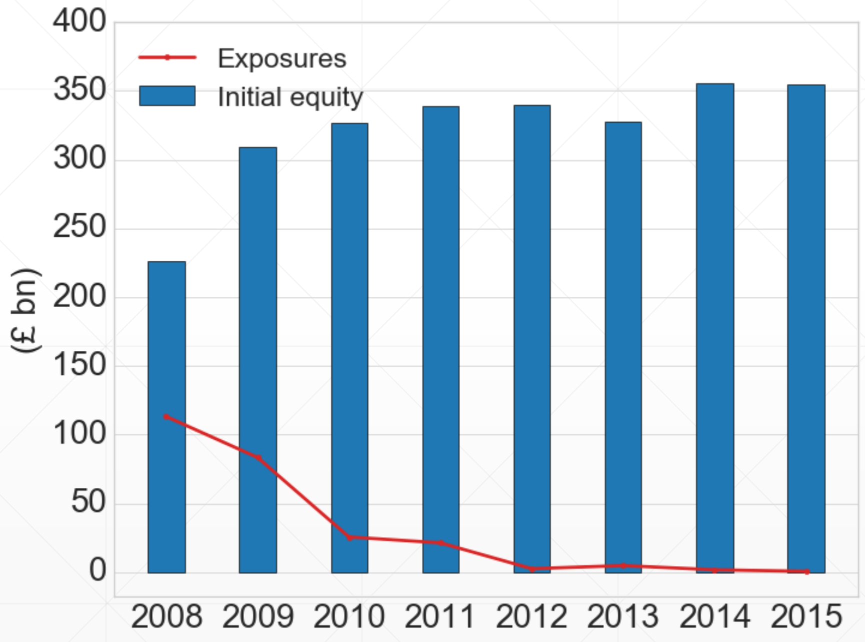
Contagion losses decline





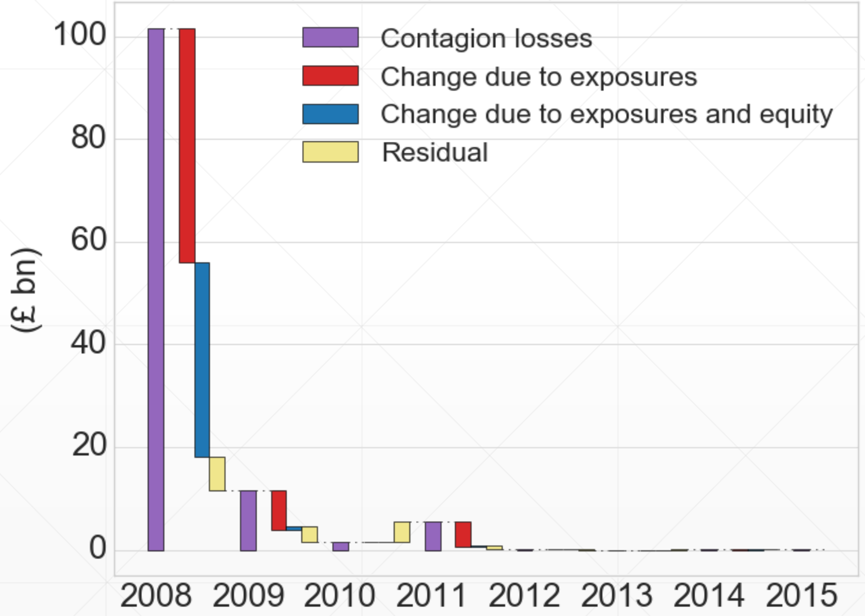
Shock on equity = 40%, recovery rate = 0

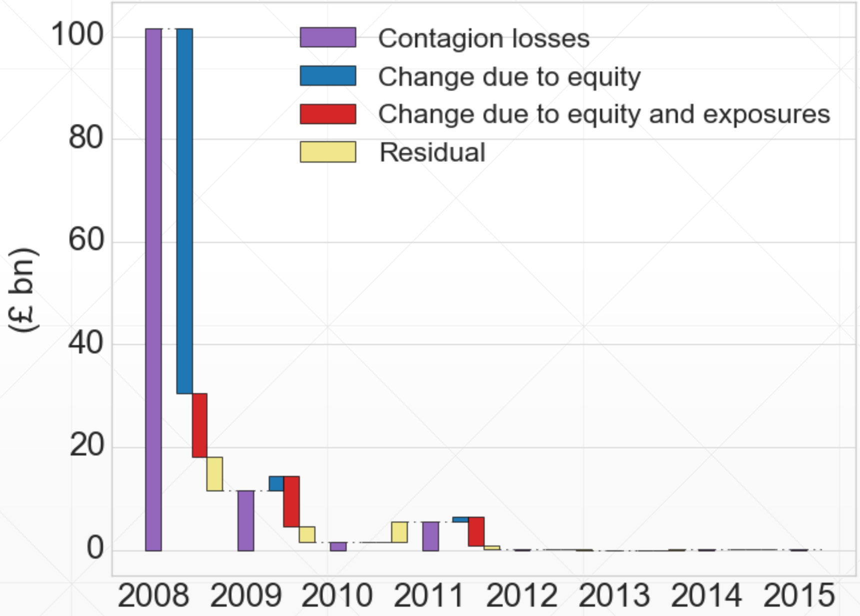
Decomposing the fall



- In order to isolate the effect in changes of equity and exposures we build synthetic balance sheets:
  1. 2008 balance sheets with 2009 exposures,
  2. 2008 balance sheets with 2009 exposures and equity,
  3. Vice versa
- If results are consistent than we can be confident of the decomposition.

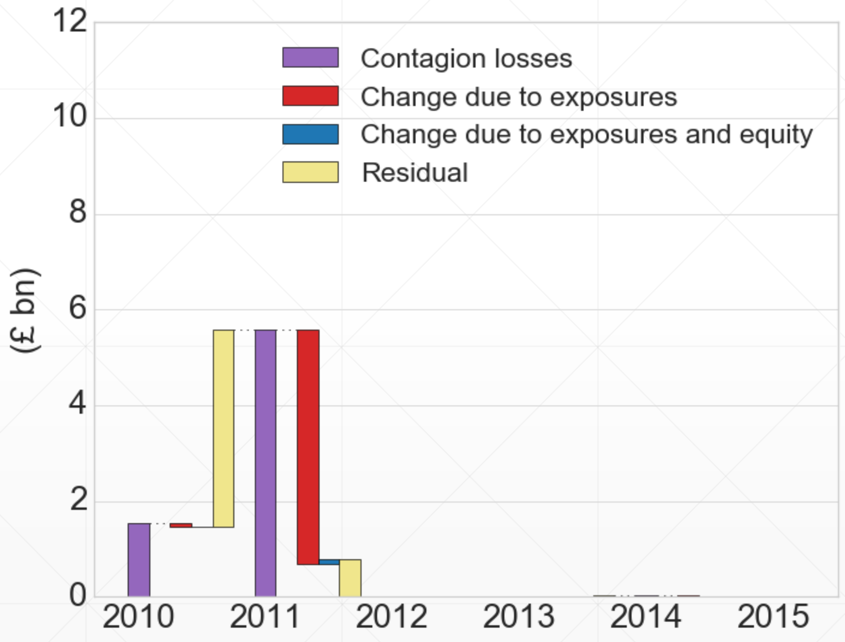
Decomposing the fall

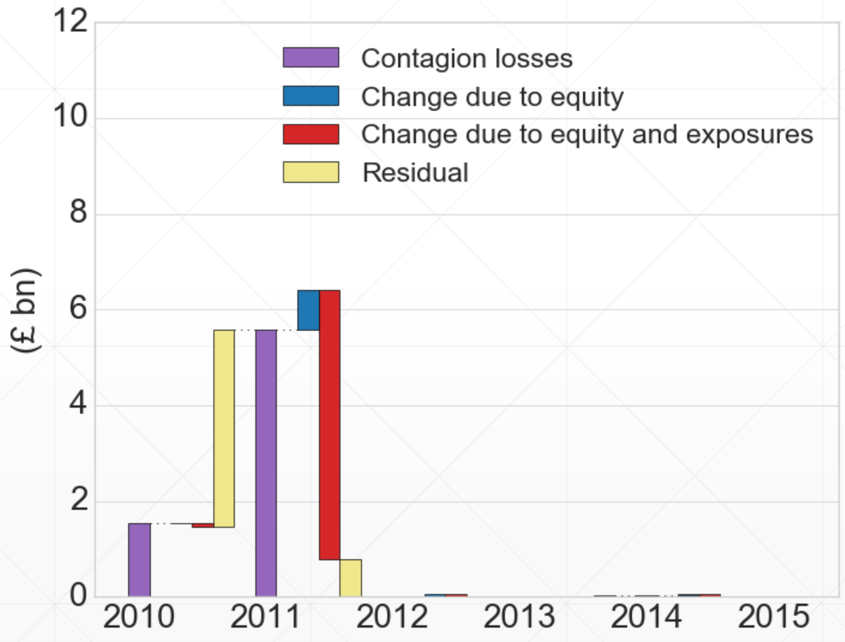




Shock on equity = 40%, recovery rate = 0

Decomposing the fall: Zooming in





Shock on equity = 40%, recovery rate = 0

A more realistic scenario

- We also run a more realistic “scenario” in which our model is used as a macro-prudential “overlay” to the Bank of England’s annual concurrent stress test.
- In 2014, 2015, and 2016 we take the CET1 at the point in time in which banks are most vulnerable (in terms of the CET1 to risk-weighted assets ratio) as the post-shock equity of our model.
- By setting the recovery rate equal to zero we get the following contagion losses:
  - 2013: £0bn
  - 2014: £0.2bn
  - 2015: £0.02bn

Conclusions

- The risk related to solvency contagion has shapely decreased from the peak of the crisis to today.
- We decompose the fall into two main drivers, equity and exposures.
- The distribution of equity matters: the contribution to contagion losses due to equity increases, even when capital in aggregate increases or stays constant.