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INCORPORATING FUNDING COSTS IN A STRESS TESTING FRAMEWORK

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Overview of Danmarks Nationalbank's stress test

- A *top-down* stress test
- Covers 16 banks
- 3 scenarios over 3 years: baseline, mild recession, adverse scenario
- Two thresholds: a) ”red”: total capital > 8 percent, b) ”yellow”: total capital > 8 percent + buffers
- Aggregate results published in Financial Stability report

Funding costs - the challenge

- Bank funding costs ought to rise as solvency deteriorates…
  - Q: by how much?
- Aymanns et al (2016), find that a 1 percentage point drop in capital ratio leads to
  - *2 bps* increase in average funding costs, *4 bps* increase in wholesale funding costs
  - Evidence of non-linearities
  - Magnitudes seem small relative to differences in funding costs between banks
- Identifying solvency-funding cost link is challenging for number of reasons. One example:
  - Riskier banks may choose to have more capital as precautionary measure – and risk weights may not fully reflect this. Therefore, riskier banks might have both higher capital ratios (see Flannery et al, 2017, for evidence of this in a stress test setting) and higher funding costs

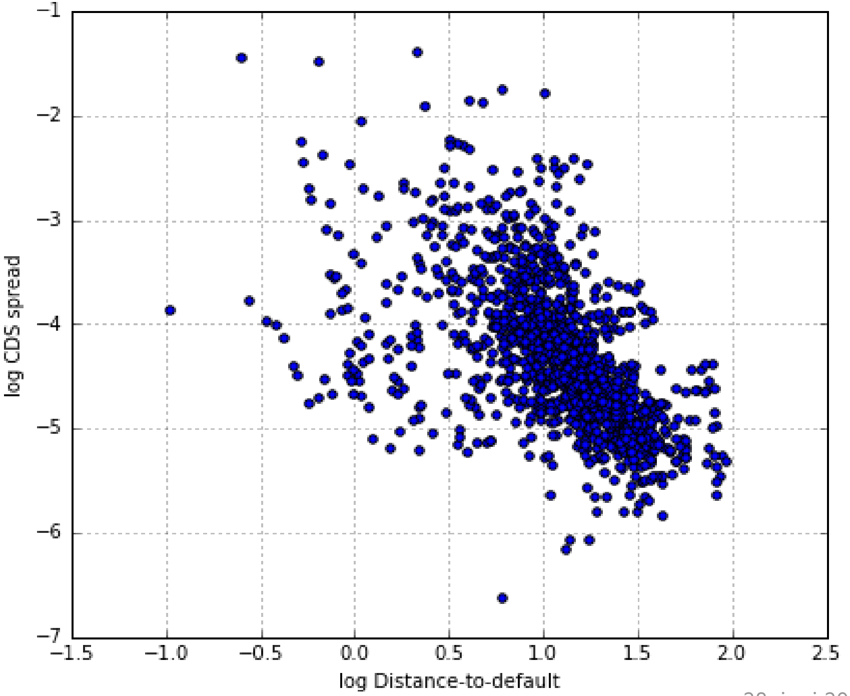
Funding costs – our approach

1) Start from market data: Clear relationship between standard risk measures and funding costs

2) Which risk measure to use? (next slides)

3) How to translate market data into stress test based on balance sheet data?

Relationship between CDS spreads and Distance-to-Default from standard Merton model – data for international sample of banks over period 2008-2016



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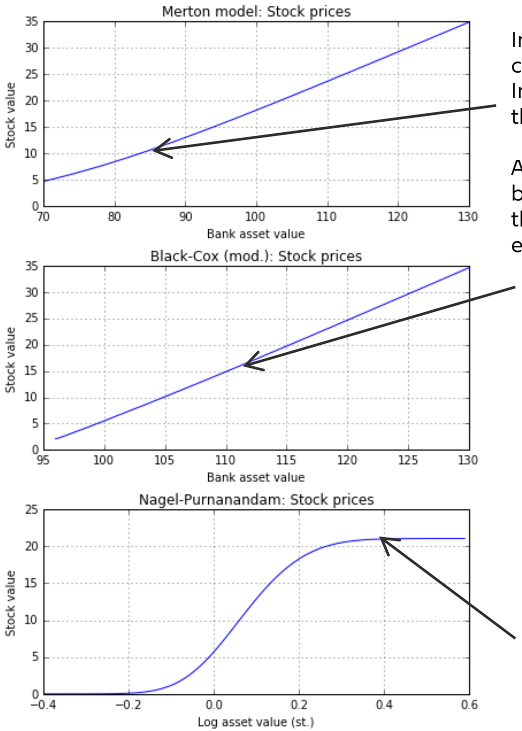
Risk measures [1]

- If one were to select a single covariate to predict default risk or funding costs, Merton's *distance-to-default* [DD] would be natural candidate
- Slightly simplified, $DD \approx \frac{Market\ value\ of\ equity}{Volatility\ of\ assets}$, i.e. # of standard deviations assets must fall in value for firm to be insolvent
- However, Merton model not adapted to banking – inspiration from other models:
    - Default barrier -> Black and Cox (1976)
    - Solvency regulation -> Chan-Lau and Sy (2006)
    - Special nature of bank assets -> Nagel and Purnanandam (2015)
    - […]

Examples of qualitative differences between models



In Merton model, value of assets can be less than debt (here, 100). In reality, banks are closed before then…

Also, non-linear relationship between asset and stock value in that region => numerically estimate asset vol

When introducing a default barrier, the relationship becomes more linear

=> $\sigma_V = \frac{E}{E+D}\sigma_E$ is good approximation of asset volatility

=> little need to use numerical schemes to infer asset vol

Bank loans like short position in put option: Limited upside.

Bank equity = option-on-options! Quite different payoff profile…

Tendency to underestimate asset vol in "good" times

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Risk measures [2]

The table shows the beta-coefficients from regressions of the form: log(CDS) = c + β * log(Distance measure), where the distance measure is akin to a distance-to-default

Distance measure	β	R^2	β	R^2
1. Merton	-0.39	0.29	-0.30	0.47
2. - w. solvency adjustment	-0.41	0.29	-0.34	0.52
3. - w. default barrier	-0.36	0.34	-0.28	0.50
4. Option-on-options	-0.39	0.26	-0.30	0.45
5. Inverse volatility	-0.84	0.38	-0.59	0.59
6. Market solvency	-0.55	0.24	-0.72	0.66
7. Naive measure	-0.76	0.35	-0.83	0.68
Country fixed effects	No		Yes	

Our risk measure does as good a job of explaining CDS-premia as other measures in "horse races"

Two key ideas in constructing "adapted" distance-to-default:

1. Incorporate qualitative features from other models
2. Simplify
   1. Avoids numerical estimation of asset values and volatilities -
   2. "Naive" versions of distance measures as good at explaining funding costs as actual measures (e.g. Bharath and Shumway, 2008)

Constructing "naive" measure

1. Start from intuitive defn. of $DD = \frac{E}{\sigma_V V}$
2. Use book value of debt to approx. $V \approx E + D_{book}$
3. Barrier models tell us $\frac{\partial S}{\partial V} \approx 1$, first set $\sigma_V = \frac{E}{V}\sigma_E$
4. Opt.-on-options model tell us we risk underestimating $\sigma_V \Rightarrow$ use "smoothed" measure (simple avg. of prior for σ_V and $\frac{E}{V}\sigma_E$)
5. (optional: One can also make correction to E to reflect solvency reg., but doesn't seem to improve explanatory power)

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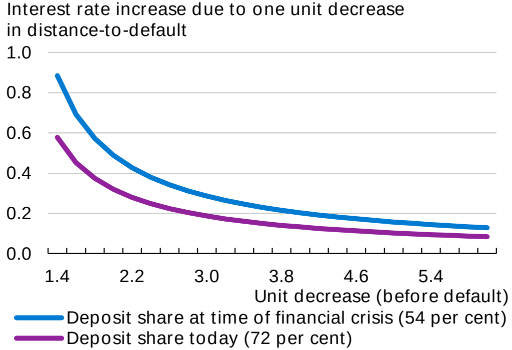
Using the measure in practice [1]

Estimate relationship between average funding costs and our DD-measure, also taking into account the role of deposits



Funding costs as a function of distance-to-default (DD) and deposit share

Model	Parameter estimates		
	β_1	β_2	R^2
1: $interest\ rate = \beta_0 + \beta_1 DD$	-0.23	-	0.26
2: $interest\ rate = \beta_0 + \beta_1 DD + \beta_2 (deposit\ share \times DD)$	-0.56	0.54	0.33
3: $interest\ rate = \beta_0 + \beta_1 \log(DD) + \beta_2 (deposit\ share \times \log(DD))$	-1.44	1.36	0.35

Source: Danmarks Nationalbank, Bloomberg and own calculations.

Using the measure in practice [2]

Key issue: How to combine market data with balance sheet data

Step 1: Calculate (adapted) DD from market data

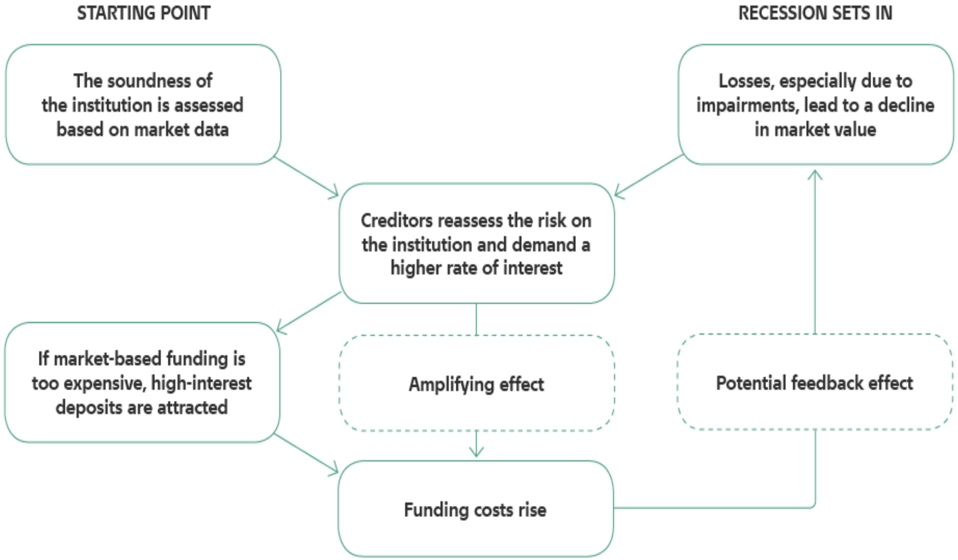
Step 2: Run stress test without funding cost increases

Step 3: Calculate difference in cumulative discounted profits in baseline and stress scenarios: *Measure of loss in market value*

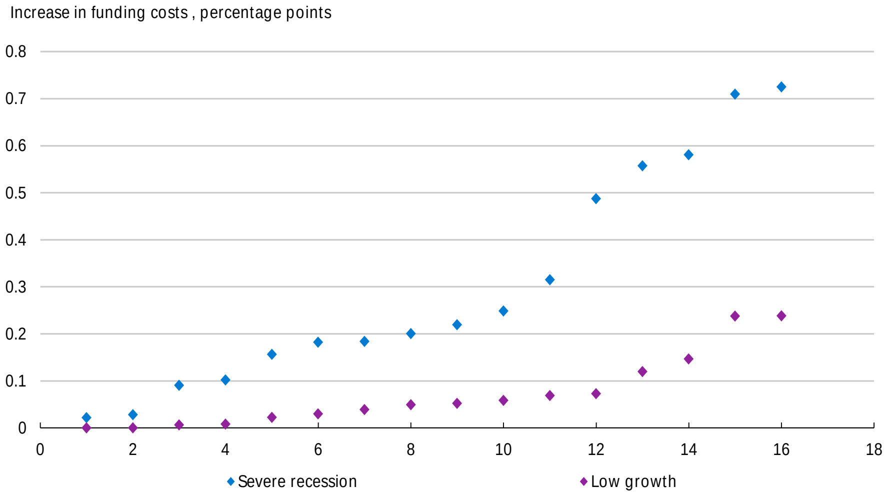
Step 4: Calculated updated DD based on loss in market value

Step 5: Calculate *change* in funding costs based on estimated relationships between DD and funding costs

(**Step 6:** optionally, calculate 2nd-, 3rd-, … -effects)



Effects in stress test [1]



Introducing funding stress has an *amplifying effect*.

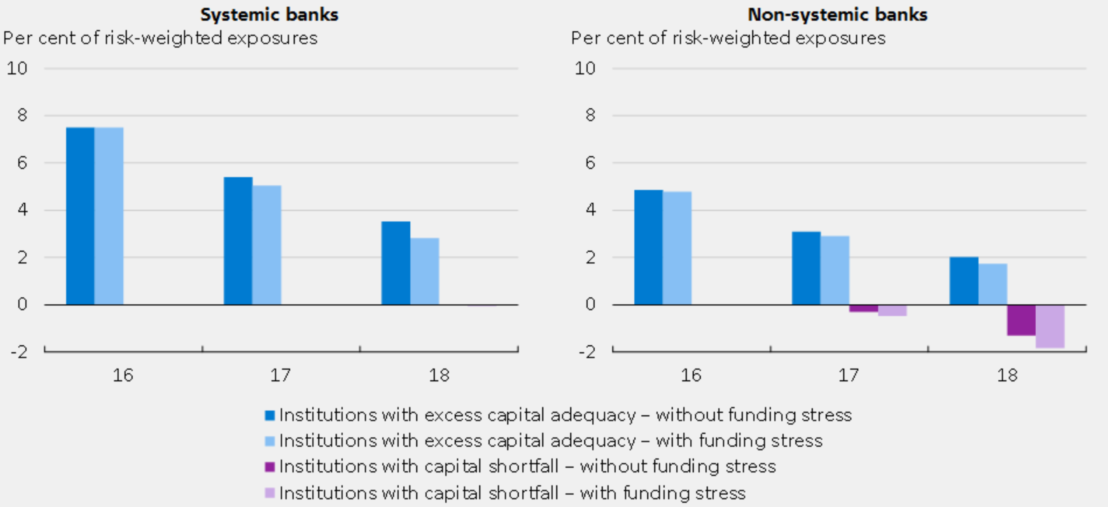
Those banks already hit by large losses experience further losses due to higher funding costs.

Effects vary considerably across banks.

Effects in stress test [2]

Institutions' excess capital adequacy or capital shortfall with and without stress on funding costs in severe recession scenario

Chart 3.6



Note: The chart shows the institutions' excess capital adequacy or capital shortfall as percentages of the total risk-weighted exposures of the systemic and non-systemic banks, respectively, in the severe recession scenario. The stress test is based on financial statements from the 1st half of 2016.

Source: Danish Financial Supervisory Authority and own calculations.

Conclusions - and a caveat

- We have introducing funding cost increases into our stress test
  - Using estimated relationships based on market data
  - Using stress test losses to update a market-based risk measure
  - Calculating funding cost increase based on the change in that risk measure

- Important caveat: A *solvency* stress test, ignores *liquidity* – implicit assumption that banks can get funding in time

For further details, see forthcoming WP (Korsgaard, 2017)