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INCORPORATING FUNDING COSTS IN A TOP-DOWN STRESS TEST

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Background

- Danmarks Nationalbank's stress test
 - *A top-down* stress test
 - Covers 16 banks
 - 3 scenarios over 3 years: baseline, mild, adverse
 - Two thresholds: a) "red": total capital > 8 percent, b) "yellow": total capital > 8 percent + buffers
 - Aggregate results published in Financial Stability report
 - Until recently, no increase in funding costs as solvency deteriorated...

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

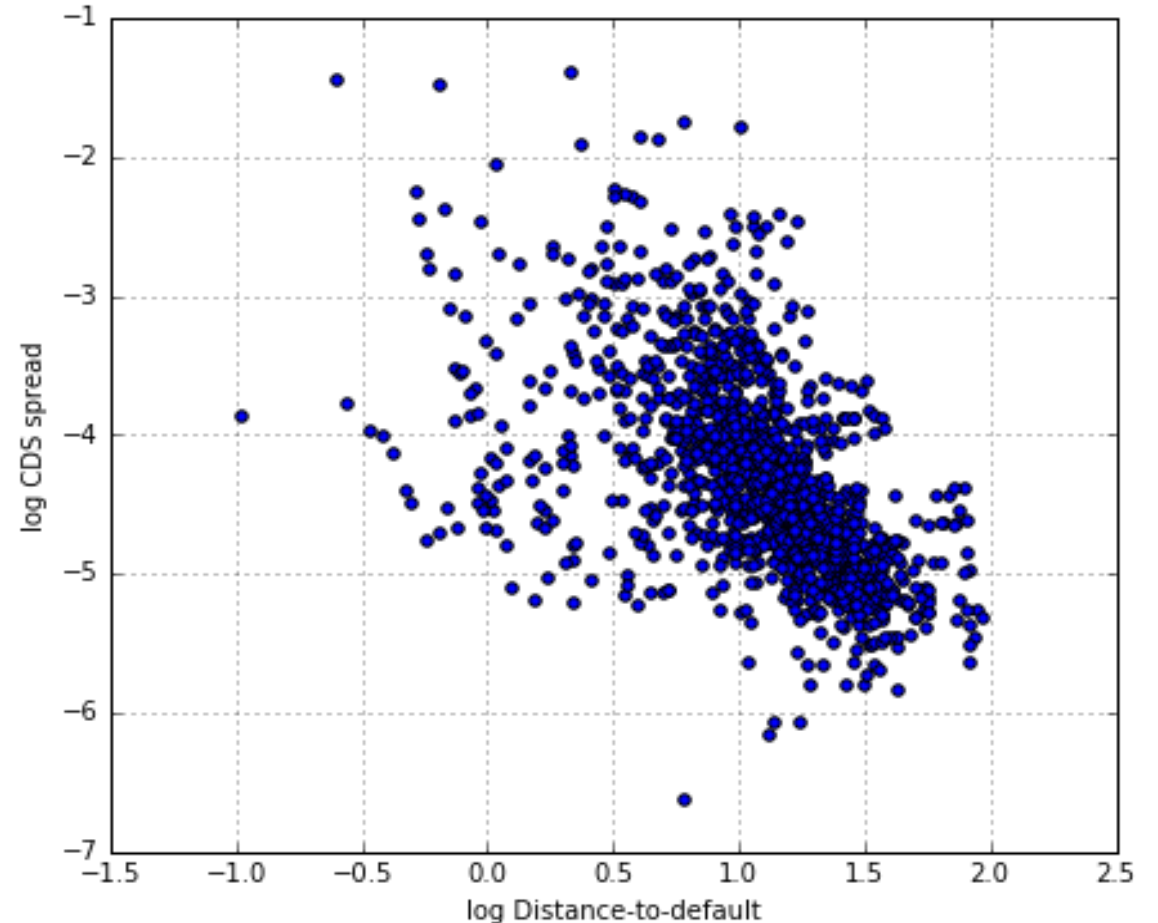
1) Start from market data: Clear(er) relationship between standard risk measures and funding costs

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

- I look at variations of Merton's model

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

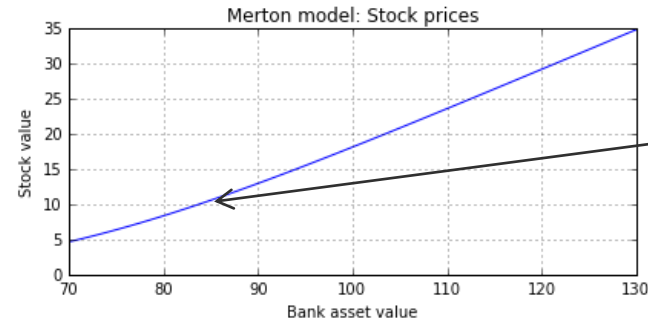
Relationship between CDS spreads and Distance-to-Default from standard Merton model – data for international sample of banks over period 2008-2016



Risk measures [1]

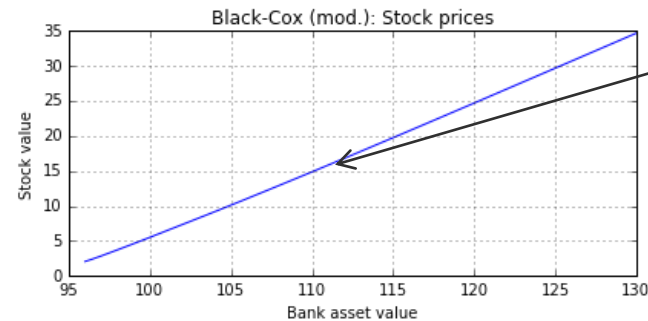
- If one were to select a single covariate to predict default risk or funding costs, Merton's *distance-to-default* [DD] would be natural candidate
- Slightly simplified, $DD \approx \frac{\text{Market value of equity}}{\text{Volatility of assets}}$, i.e. # of standard deviations assets must fall in 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...

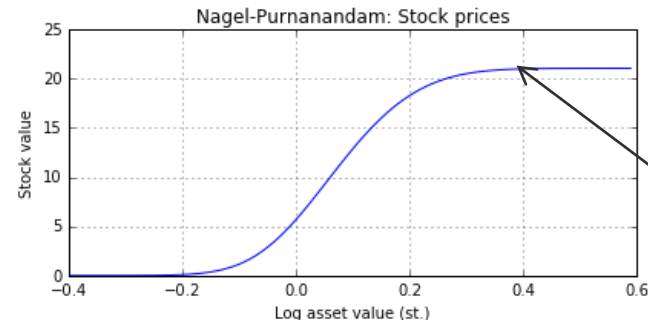
Also, non-linear relationship between asset and stock value in that region => numerically estimate asset vol



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

Risk measures [2]

The table shows the beta-coefficients from regressions of the form: $\log(\text{CDS}) = c + \beta * \log(\text{Distance measure})$, 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:

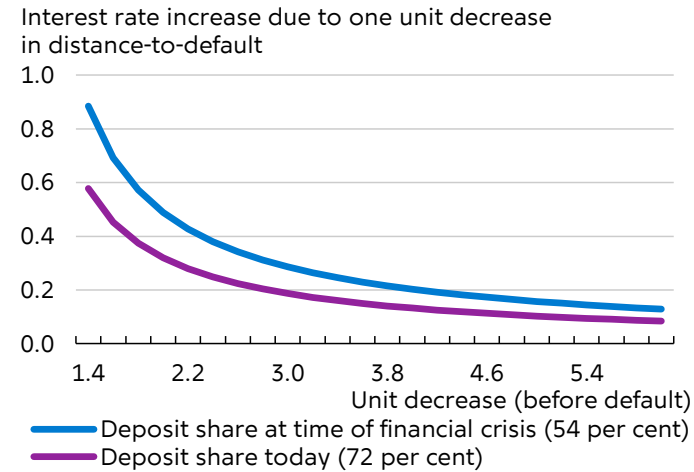
1. Incorporate *qualitative* features from other models
2. Simplify
 1. Avoids numerical estimation of asset values and volatilities -
 2. "Naive" versions of distance measures as good at explaining funding costs as actual measures (e.g. Bharath and Shumway, 2008)

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)

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

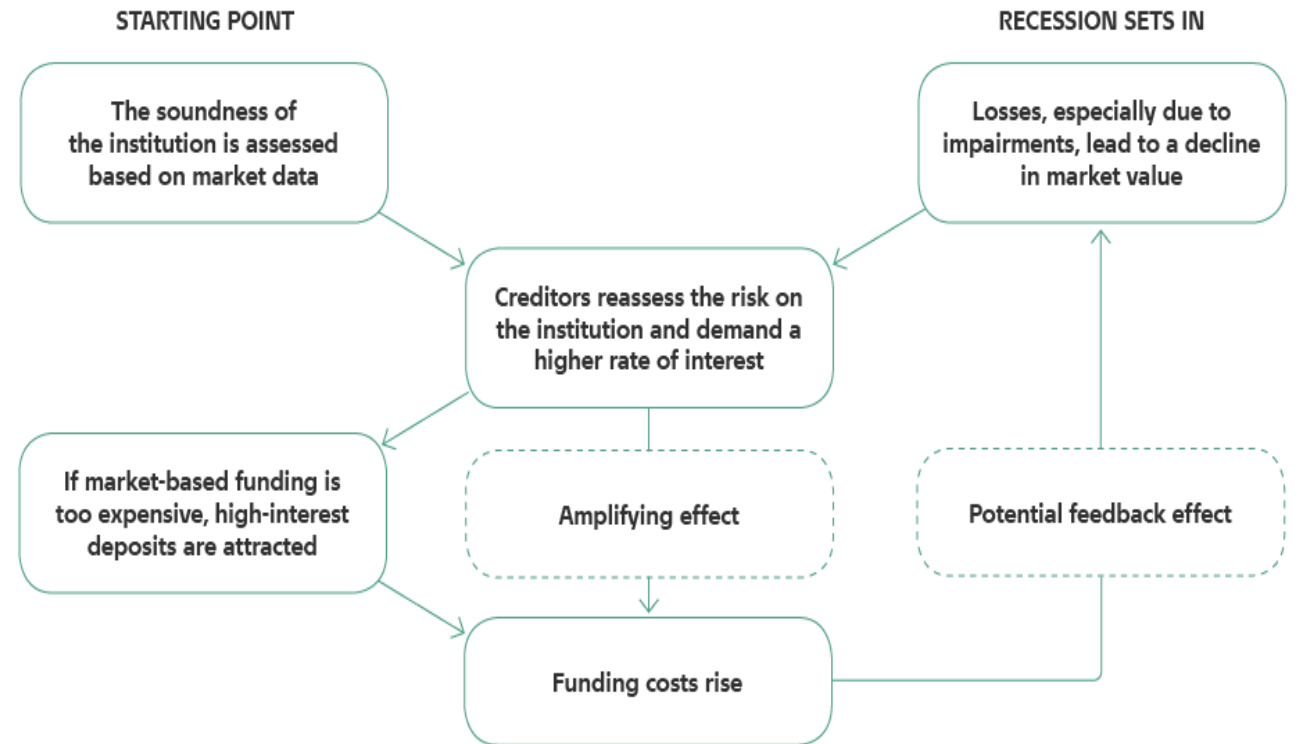
Step 2: Run stress test without funding cost increases

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)

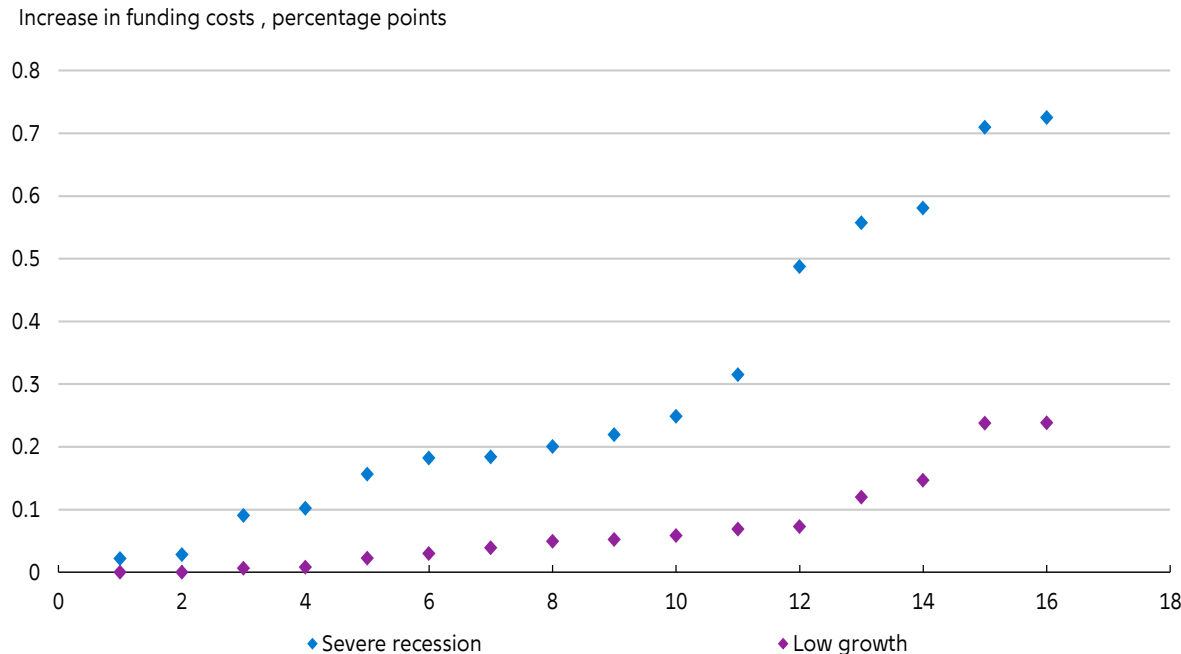


Other issues / comments

- Special handling of non-traded banks
- When does funding cost increases kick in?

- Advantages of method:
 - “Low cost”: Easy to implement, requires few data
 - Incorporates market information
 - Flexible and can easily be extended

Effects in stress test [1]



Introducing funding stress has an *amplifying effect*.

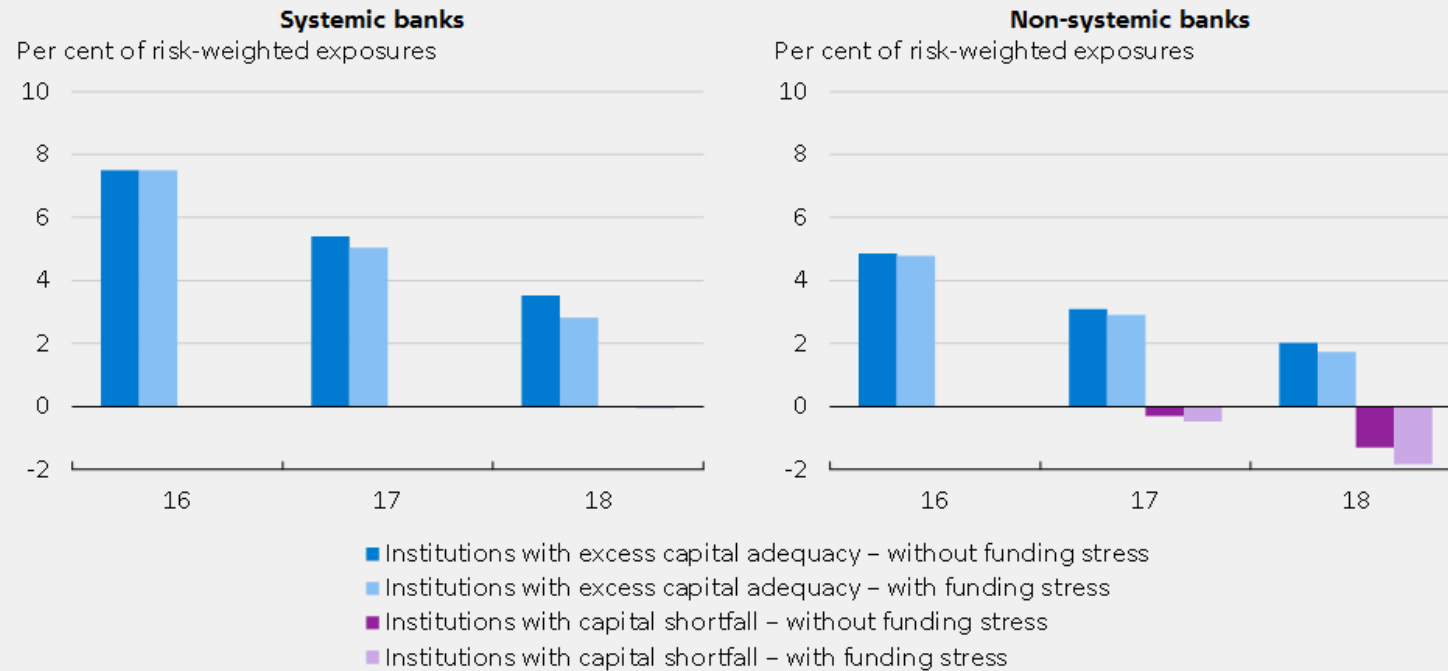
Those banks already hit by large losses experience further losses due to higher funding costs.

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 introduced 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 Korsgaard (2017)