

Written Exam Economics Summer 2020

**AØKK08397U Macroprudential policy and systemic financial risks (F)**

## **Suggested Answers**

June 17, 2020 from 10 AM to 10 PM

This exam question consists of 5 pages in total

Answers only in English.

**A take-home exam paper cannot exceed 10 pages – and one page is defined as 2400 keystrokes**

***The paper must be uploaded as one PDF document. The PDF document must be named with exam number only (e.g. '127.pdf') and uploaded to Digital Exam.***

### **Be careful not to cheat at exams!**

Exam cheating is for example if you:

Copy other people's texts without making use of quotation marks and source referencing, so that it may appear to be your own text

Use the ideas or thoughts of others without making use of source referencing, so it may appear to be your own idea or your thoughts

Reuse parts of a written paper that you have previously submitted and for which you have received a pass grade without making use of quotation marks or source references (self-plagiarism)

Receive help from others in contrary to the rules laid down in part 4.12 of the Faculty of Social Science's common part of the curriculum on cooperation/sparring

You can read more about the rules on exam cheating on your Study Site and in part 4.12 of the Faculty of Social Science's common part of the curriculum.

**Exam cheating is always sanctioned by a written warning and expulsion from the exam in question. In most cases, the student will also be expelled from the University for one semester.**

Please read the following carefully and answer **all** the questions.

## Part 1

1. According to Modigliani and Miller, it doesn't matter whether a business finances its operations using debt or equity. Nonetheless, banks tend to finance their operations in distinctly different ways to most other businesses. In what ways are banks' financing of their own operations different to most other businesses and why do they choose to finance their operations in this way? Why does this diverge from the conclusions of Modigliani and Miller?

*Suggested Answers:*

*The answer should explain that banks tend to finance their own operations using less equity and more debt than other businesses. The answer should explain at least one deviation from Modigliani and Miller. In the course we have discussed that there is a premium on short-term bank debt in the money market as it is useful as a transactions medium. A premium not related to its riskiness. Modigliani and Miller do not consider the non-risk-based premium on short-term bank debt and so this diverges from the conclusions of Modigliani and Miller. Therefore, it costs banks more to finance their operations using equity than debt. It is good if the answer also discuss the "competition hypothesis" of Hanson, Kashyap & Stein (2011). That is, even though the difference in financing costs might be small, banks compete almost solely on price and so higher financing costs are more damaging to them than other businesses.*

2. Most macroprudential regulators would want banks to finance their own operations in ways different to how banks, if left to their own devices, would choose to finance their own operations. How would macroprudential regulators prefer banks to finance their operations, and why would they want banks to finance their operations in this way. Further why are regulators more focused on the way in which banks finance their own operations and less focused on other industries?

*Suggested Answers:*

*The answer should explain that regulators would prefer banks finance their operations with greater equity than banks do. They want this because equity is loss-absorbing and so banks are less likely to fail if they have more equity (for a given shock). Furthermore, banks create externalities through their operations and so regulators would like them to internalize some of the costs associated with externalities through having greater equity. It is good if the answer discuss one or more of the externalities discussed in the course. The answer should explain that regulators are more focused on banks because banks perform functions that are not readily replicable by other agents in the economy. It is good if the answer also contains a discussion of the role of banks in society.*

3. A large shock hits the economy. As a result, a large highly-connected bank realizes that more of its customers will not be able to repay their loans than the bank had previously calculated. How would this affect the banks' balance sheet? What might the bank do in response to this change in its balance sheet? How might these actions affect other banks? What could macroprudential authorities have done prior to the shock to reduce the likelihood of these aftershocks occurring?

*Suggested Answers:*

*The answer should explain that the increase in bad loans would shrink the asset side of the balance sheet as the expected value of these assets would now be less. On the liabilities side, the equity would fall by a similar amount. This would reduce the solvency/increase the leverage of the bank and so the bank might sell assets to pay down some debt and restore its solvency/leverage.*

*This should lead into a discussion of fire sales (cf. Greenwood et.al. (2015)) and how other banks are affected by the bank's sales and how the value of assets will fall further, especially if other banks take the same action in response to this shock. The macroprudential authorities could have tried to build up the equity of the banks through use of capital buffers that can be used when a large shock hits the economy to reduce the likelihood of the banks being forced to enter into fire sales.*

*Alternatively to a discussion of fire sales, answers could discuss direct connectedness and how a fall in the value of assets, and associated increases in leverage, makes a bank more likely to fail. Therefore, the probability of default on any debts they owe other banks increase, which should decrease the expected value of those debts, reducing the value of the other banks' assets. This can then set off a chain of contagion through the inter-bank market. Again the use of capital buffers by macroprudential authorities could reduce the extent of these shocks as the banks will be further from default after the initial shock if they have a larger equity buffer.*

## Part 2

Assume that you are working as an economist at Danmarks Nationalbank. Your boss has recently read an article in the Financial Times, which states that market participants in Europe and the US are worried about an ensuing economic recession because the yield curve has been inverted. You are asked to estimate a measure of financial conditions in Denmark and use both financial and economic conditions to examine the distribution of the future unemployment rate in Denmark. Your results will provide basis for a discussion of whether it is necessary to activate macroprudential policies in Denmark or not.

**1. Selecting indicators for the financial conditions index.** To construct your financial conditions index (FCI), you first have to decide, which indicators to base your index on. Below is a list of seven financial indicators for Denmark. The indicators are listed with their AUROC (area under receiver operating curve)-measures, which have been calculated by investigating the indicators' ability to predict a binary systemic banking crisis indicator that takes a value of one if a crisis is going on two years ahead.

- 1) Credit growth, AUROC: 0.76
- 2) Excess capital adequacy, AUROC: 0.28
- 3) Property price growth, AUROC: 0.61
- 4) Ratio of deposits to loans, AUROC: 0.33
- 5) Stock price returns, AUROC: 0.65
- 6) Interest rate margin, AUROC: 0.47
- 7) Return on equity, AUROC: 0.32

- a) Using economic intuition, briefly explain why excessive credit growth can be a predictor of systemic banking crises.

*Suggested Answers:*

*The answer should explain that during episodes of excessive credit growth, banks may be easing their credit standards and providing cheap loans to firms and households with a low ability to repay. This enhances credit risk in the financial sector and makes the sector vulnerable to adverse real or financial shocks that can make borrowers default on their loans. Hence, high credit growth can result in elevated financial vulnerabilities that make systemic banking crises more probable.*

- b) Using AUROC as the performance metric, select the three variables with the highest predictive power and interpret the AUROC values.

*Suggested Answers:*

*Top 3 rank (in descending order of predictive power):*

- *Credit growth*
- *Stock price returns*
- *Property price growth*

*The AUROC-measure varies between 0 and 1. AUROC gives a measure of separability, i.e. how good is the indicator at predicting future episodes of crisis as crisis and non-crisis as non-crisis. The higher the AUROC-measure, the higher the predictive power of the indicator. Hence, an AUROC-measure of 0.76 for credit growth shows that it has superior forecasting power of the systemic banking crisis indicator as compared to excess capital adequacy.*

**2. Estimate a financial conditions index.** Combined with evidence from other EU-countries, you have decided to use 1) credit growth, 2) property price growth and 3) stock price returns as the input variables into your financial conditions index. In the Excel spreadsheet ExamData\_Question2\_June.xlsx, you can find indexes for credit growth (label Credit\_Growth), property price growth (label Property\_Growth) and stock returns (label Stock\_Returns). The indexes are positively correlated with their underlying variables; i.e. as Property\_Growth increases, so will property prices in Denmark. All data is fictive.

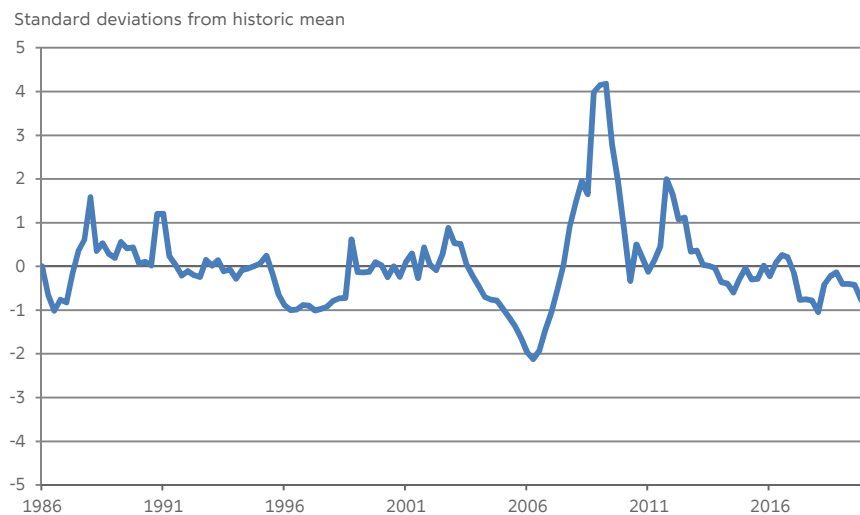
- a) Use a principal component analysis (PCA) to calculate a measure of financial conditions. If necessary, multiply the index by -1 such that it is positive when financial conditions are tight

(e.g. end-2008). Present the resulting index and the steps you have gone through. Note: 1) Remember to standardize the indexes prior to PCA and standardize the FCI after PCA, 2) You do not need to test for stationarity.

*Suggested Answers:*

The students will need to load the data into Stata and standardize the three indexes. The indexes do not have the same variance (on purpose), which should be accounted for by standardization prior to PCA. Subsequently, the students should run the principal component analysis and extract the first principal component, which will be their financial conditions index. They will then need to standardize the principal component such that it has mean zero and variance 1. Some students may need to multiply their index by -1 such that it is positive when financial conditions are tight as instructed in the text. The resulting index from following these steps is presented in figure 1.

**Figure 1: Financial conditions index for Denmark**



b) Interpret the movement of the financial conditions index in recent quarters.

*Suggested Answers:*

The answer should explain that in recent quarters, there has been a loosening of financial conditions relative to the historical average. Financial conditions are almost as loose as they were in the mid-1990s. It is good if the answer adds that the loosening is brought about by increases in the indexes for property price growth and credit growth, while index for stock returns has been neutral.

c) Briefly discuss limitations to using a principal component approach when estimating indexes for financial conditions.

*Suggested Answers:*

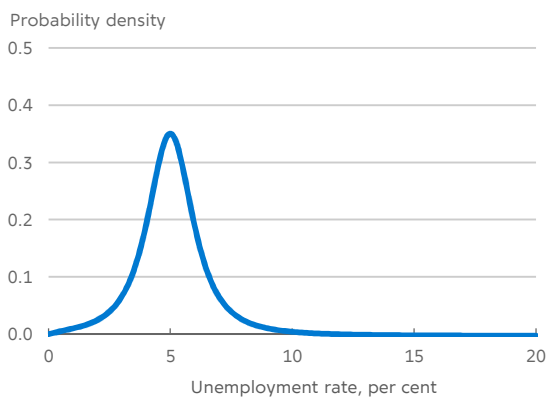
As compared to the SVAR-approach, which has also been presented in the course, the students may list some of the following disadvantages.

- It can be difficult to interpret the index as financial conditions are measured relative to their historical average.
- One principal component may not be sufficient to summarize the variation of the financial variables depending on the eigenvalue-threshold. Thus, more indexes are needed.
- The FCI does not account for endogeneity of the financial variables and activity in the real economy. One way of dealing with this endogeneity problem is regressing financial variables on current and lagged inflation and activity in the real economy and use the residuals from those regressions in a principal component analysis as explained in Hatzius et al (2010). Another way of dealing with this endogeneity problem is to estimate a structural VAR model as Jensen and Pedersen (2019).

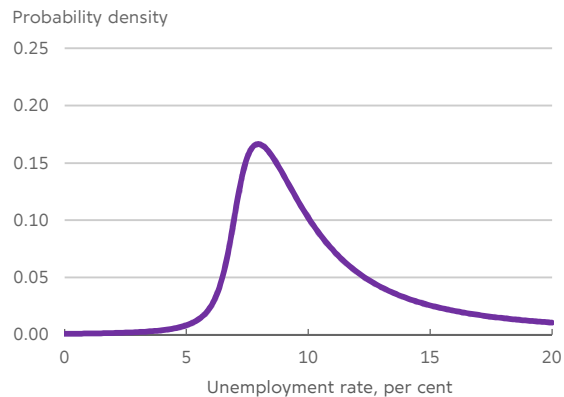
The list above is not exhaustive.

**3. Examine risks to developments in the real economy.** Your colleague has used your financial conditions index and current real GDP growth in Denmark to empirically estimate the conditional distribution of the unemployment rate in Denmark eight quarters ahead. The distribution of the future unemployment rate responds non-linearly to a change in financial conditions with the upper quantiles reacting strongly to a changing of financial conditions and the lower quantiles reacting very little. Figure 1 and 2 show the conditional distribution of the unemployment rate eight quarters ahead based on data from December 2018 and December 2019 (latest), respectively.

**Figure 1:** Distribution based on data from December 2018



**Figure 2:** Distribution based on data from December 2019



- a) Discuss how the distribution of the future unemployment rate (cf. figures 1 and 2) has changed over the considered months with a particular focus on the left and right tails of the distribution.

*Suggested Answers:*

The answer should discuss that there has been a significant change in the conditional distribution of the future unemployment rate in Denmark over the considered time period. Figure 1 shows a distribution that is fairly concentrated around the median with an equal balance between downside and upside risks. On the other hand, the distribution presented in figure 2 is more variable and has a more prominent right tail, which suggests that future scenarios with a high unemployment rate are (*ceteris paribus*) more probable.

- b) Discuss using economic intuition how a tighter LTV (loan to value)-limit will impact the financial conditions index and, in turn, the conditional distribution of the future unemployment rate in Denmark?

*Suggested Answers:*

*The answer should discuss that a tighter LTV-limit means that the maximum size of a loan relative to the value of the property decreases. In other words, a tighter LTV-limit means that a larger share of the property has to be financed with savings. A tighter LTV limit may lower credit growth because certain households may not have the means to finance property under these new lending restrictions. Moreover, it may also dampen property prices as the demand for property from these households is lowered. The good answer may also point out that it is not only credit growth that is important from a financial stability perspective, but also credit quality. The tighter LTV limit will ensure lending with lower credit risk, which is a positive effect of the policy measure not captured by the FCI.*

*Since both high credit growth and high property prices have a negative loading on the financial conditions index, their fall will drag the index up. Based on the text in the assignment, the students will know that the upper quantiles of the conditional distribution respond more strongly to changing financial conditions as compared to the lower quantiles. Moreover, the students should be able to see that looser financial conditions will result in a higher 95 per cent quantile. Thus, the increase in the financial conditions index should decrease the 95 per cent quantile and thereby lower downside risks to the future unemployment rate.*

## Part 3

1. Briefly describe the purpose of the Countercyclical Capital Buffer (CCyB) and discuss the difference between the CCyB and structural buffers.

*Suggested Answers:*

*The answer should explain that the CCyB is an instrument to strengthen the resilience of the credit institutions by increasing the capital requirement when risks in the financial system build up. The purpose is to limit negative effects on the real economy in a period of stress in the financial system or financial crisis. The good answer also notes that while the CCyB addresses cyclical systemic risks it is not a tool to manage the business cycle. The buffer must be released if there is a risk of severe tightening of lending to households and firms, and not necessarily in an economic slowdown. When addressing differences between the CCyB and structural buffers, the answer should point out that the CCyB is increased when risks build-up and relate it to the financial cycle. The answer should highlight that CCyB addresses cyclical risks contrary to structural buffers focusing on non-cyclical risks, such as the O-SII buffer and the systemic risk buffer. The good answer briefly points out that the O-SII buffer addresses risks related to systemically important financial institutions and the systemic risk buffer can be used in a more flexible way to addresses structural risks related to country-specific characteristics. The answer needs to point out that the CCyB can be released whereas structural buffers are supposed*

to be static. Here, the outstanding answer would be able to highlight that some countries have released structural buffer during the Covid-19 crisis.

2. Discuss advantages and disadvantages of using the credit-to-gdp gap to set the CCyB rate.

*Suggested Answers:*

*The answer should explain that the advantages of the credit-to-gdp gap is that the indicator is simple and easily maps into a buffer guide with simple thresholds for activation and setting the CCyB rate in the interval between 0 and 2.5 per cent. The good answer points out how the indicator was a decent indicator pre-financial crisis across countries, as e.g. analyzed by the ESRB. The disadvantages that the answer needs to address, is how the indicator is sensitive in its conclusions depending on how the credit-to-gdp gap is specified. For instance, using other definitions of credit can change the values markedly. The answer should also point out the end-point problems related to the HP-filter and how the trend estimation can differ markedly depending on choice of lambda. The good answer points out how the indicator does not work well for smaller open economies. The good answer also highlights how the strong credit-growth in many countries leading up to the financial crisis and the very smooth trend given the high lambda means that several countries (such as Denmark) currently has a negative credit-to-gdp gap which is in contrasts to many other indicators pointing to build-up of risks.*

3. The following question makes use of the excel bank in sub-questions a), b) and d). The excel bank is provided as part of the exam set. It starts out from a situation where the Countercyclical Capital Buffer is 0% in all countries. Please explain any calculations you make. Also, remember to think critically about the effects of any changes to cells that you make (e.g. whether you are making changes to the correct input cells).

a) The management of the bank is concerned about credit risk. What level of loan losses (on non-mortgage loans; assume a zero loan loss rate on mortgages) can the bank sustain before breaching its buffer requirements (i.e. the total capital requirement of 14.5%)?

*Answer:*

*The bank breaches its total buffer requirement at a loan loss rate of about 5.8%. (This can be seen by varying the loan loss rate in the sheet "StressValues")*

b) If the Countercyclical Capital Buffer (CCyB) had been 2.5 per cent instead of 0.0 per cent in all countries, how much additional capital would the bank need to maintain the same capital surplus relative to its total capital requirement?

*Answer:*

*Initially, the surplus is 2.16. This decreases to 1.49. The bank must raise an additional 0.663 units of capital.*

c) If the CCyB is increased, how do you think the bank would respond?



*Suggested Answers:*

*There is not a single "correct" answer to this question. A bank could respond in multiple ways. It might raise extra capital or, perhaps more realistically, retain more of its earnings going forward. It could also partially increase its capital levels, anticipating that the buffer might be released again in a time of crisis. Or it might already have increased its capital levels earlier in anticipation of an increase. Depending on the bank's circumstances, e.g. if it is already close to its requirements and finds it difficult to raise more capital, it might also chose to cut back on lending. However, since the CCyB is generally being raised in "good times" that probably isn't going to be the response of most banks.*

- d) Suppose the bank had increased its (CET1) capital by the amount found in question b), and that the CCyB was then subsequently released, i.e. set to zero. How would your answer to question a) then change, i.e. what is the maximal loan loss rate the bank can sustain before breaching its capital buffers (total capital requirement)?

*Answer:*

*To answer this question, the bank's capital level must be increased by 0.663 and the CCyB set back to 0.0. In that case the bank can sustain loan loss rates of up to 7.6 per cent before breaching the total capital requirement.*

4. What does a gradual phasing-in of the CCyB mean for the banks' adaption?

*Suggested Answers:*

*The answer should explain that if the CCyB is increased gradually, it will be easier for banks to adjust to the higher requirement. They can increase capital by retaining earnings over a period rather than issuing new equity, which is generally more expensive than retaining earnings. The good answer will point out how the gradual build-up then can limit the negative effect in the transmission mechanism when raising capital requirements.*

5. Read the attached recommendation from the Danish Systemic Risk Council from October 2019. Discuss the key arguments and indicators the Council use to support the recommendation to increase the buffer. Using your theoretical knowledge from the curriculum and the information in the recommendation, how would you argue against the recommended increase in the CCyB rate? (Do not consider information ex post, i.e. use only the information in the recommendation including its appendices from October 2019).

*Suggested Answers:*

*The answer will build on theoretical knowledge from the curriculum and information in the recommendation including its appendices. The answer should explain both the considerations the council makes on why it is important to build up the buffer and how the decision is based on an overall assessment. The answer should then explain which indicators are used to forming the overall assessment. The answer should highlight that the Council emphasize the importance of building up the buffer before financial imbalances "grow too large". In addition, the good answer will point out that the Council argues that the buffer must be of a certain size to make a difference. When discussing the key indicators used to argue for the increase, the answer should highlight the low risk perception, the indication of "search-for-yield", low interest rates, increases in property prices in recent years. The*

*answer should also point out the eased credit standards for a prolonged period and the indication of increased competition for customers. The good answer also highlights how the Council considers the current capital position of the banks, arguing that the banks are able to handle an increase in the CCyB.*

*The good answer is able to discuss indicators or other considerations that would argue against the recommended increase in October. It is important that the student does not consider ex-post information. Several arguments could be made against the increase. One is the low credit growth that was observed at the time of the recommendation. The low credit growth could indicate that the banks are not lending excessively at this time. The answer could also argue that there is no direct sign of the current credit growth being of low credit quality despite the increased competition. The answer could also argue that the property price growth was slowing at the time of the recommendation and thus indicating that the risk-buildup from this indicator was slowing down. The answer could also argue that the banks' leverage has been falling indicating that the banks were becoming less risky and thus less in need of further capital requirements. Finally, the answer could highlight the negative credit-to-gdp gap, but should demonstrate ability to not rely entirely on the credit-to-gdp indicator to argue against the recommended increase.*

6. How does implementing restrictions on borrowers' debt-to-income ratios (total debt divided by income, DTI) compare to activation of the CCyB? I.e. what is the effect on e.g. banks' balance sheets in terms of credit risk and equity?

*Suggested Answers:*

*Borrower-based measures like restrictions on borrowers' DTI does not have an immediate effect on banks' balance sheets as they work through the flow of new lending. In the longer run, credit risk on banks' balance sheets is likely to decrease as new lending become relatively less risky following a DTI initiative. If this translates into lower loss-rates, banks' capitalization will increase (provided banks can charge the same margins as before). The CCyB has no direct effect on credit risk but is likely to increase banks' capitalization (provided banks change their capitalization targets in response to a change in the CCyB-rate instead of just having a fixed internal capital target that assumes a permanent CCyB of 2.5 per cent)*

7. Many countries have implemented restrictions on borrowers' debt-service-to-income ratios, DSTI (i.e. the maximum share of the borrower's income that should be used to servicing debts, including principal repayments). Why are such restrictions problematic in countries where interest-only mortgages are widespread? And how is that related to the interest rate level?

*Suggested Answers:*

*Restrictions on borrowers' DSTI is problematic in these countries as principal repayments make up the majority of the debt-service-burden when interest rates are low. The lower the interest rate the higher the share of principal repayments in the annuity formula. If borrowers don't amortize and interest rates are close to zero, borrowers can in theory obtain extremely large loans relative to their incomes and still have very low DSTIs.*