

Berg, Jesper; Bækmand Nielsen, Morten; Vickery, James

Working Paper

Peas in a pod? Comparing the U.S. and Danish mortgage finance systems

Staff Report, No. 848

Provided in Cooperation with:
Federal Reserve Bank of New York

Suggested Citation: Berg, Jesper; Bækmand Nielsen, Morten; Vickery, James (2018) : Peas in a pod? Comparing the U.S. and Danish mortgage finance systems, Staff Report, No. 848, Federal Reserve Bank of New York, New York, NY

This Version is available at:
<https://hdl.handle.net/10419/210700>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

Federal Reserve Bank of New York
Staff Reports

Peas in a Pod? Comparing the U.S. and Danish Mortgage Finance Systems

Jesper Berg
Morten Bækmand Nielsen
James Vickery

Staff Report No. 848
May 2018



This paper presents preliminary findings and is being distributed to economists and other interested readers solely to stimulate discussion and elicit comments. The views expressed in this paper are those of the authors and do not necessarily reflect the position of the Federal Reserve Bank of New York or the Federal Reserve System. Any errors or omissions are the responsibility of the authors.

Peas in a Pod? Comparing the U.S. and Danish Mortgage Finance Systems

Jesper Berg, Morten Bækmand Nielsen, and James Vickery

Federal Reserve Bank of New York Staff Reports, no. 848

May 2018

JEL classification: G15, G18, G21, G23, G28

Abstract

Like the United States, Denmark relies heavily on capital markets for funding residential mortgages, and the Danish covered bond market bears a number of similarities to U.S. agency securitization. In this paper we describe the key features of the Danish mortgage finance system and compare and contrast it to the U.S. system. We also note characteristics of the Danish model that may be of interest as the United States considers further mortgage finance reform. In particular, the Danish system includes features that mitigate refinancing frictions during periods of falling home prices, and offers borrowers the option to repurchase their mortgage at the market price, mitigating “lock-in” effects. Danish mortgage intermediaries also have high capital ratios relative to their risk exposures, contributing to the stability of the Danish market.

Key words: mortgage, covered bond, securitization, Denmark, United States

Vickery: Federal Reserve Bank of New York (email: james.vickery@ny.frb.org). Berg: Danish Financial Supervisory Authority (email: jb@ftnet.dk). Nielsen: Nykredit (email: mobn@nykredit.dk). The authors thank Scott Frame for helpful comments. The views expressed in this paper are those of the authors and do not necessarily reflect the position of the Danish Financial Supervisory Authority, Nykredit, the Federal Reserve Bank of New York, or the Federal Reserve System.

To view the authors’ disclosure statements, visit
https://www.newyorkfed.org/research/staff_reports/sr848.html.

1. Introduction

The way mortgages are financed, designed, and regulated varies strikingly across countries.¹ Although this variation reflects adaptation to international differences in social, economic, and legal conditions, it is also likely in part due to historical accidents and path dependence. As the U.S. considers further reform of its mortgage finance system, it is natural to consider what can be learned from the experiences of other countries, and whether any international practices could be usefully adapted to improve the institutional design of the U.S. mortgage market.

With this goal in mind, this paper compares and contrasts the U.S. system to that of Denmark. The Danish mortgage finance system is a salient reference point because in several respects it is the international model most similar to the United States. In particular, Denmark relies very heavily on capital markets for funding residential mortgages, transferring interest rate risk and prepayment risk to fixed income investors in a similar way to U.S. mortgage securitization. Unlike the U.S., however, the Danish mortgage finance system remained stable and solvent during the 2007-09 financial crisis, and did not require government funding or capital injections, despite experiencing a fall in home prices during this period of similar magnitude to the United States.

In the Danish model, mortgages are financed through the issuance of covered bonds by a small number of specialized mortgage banks. The system relies on the “balance principle” – the covered bonds match the maturity and cash flows of the underlying pool of mortgages funded by the bond, and payments by mortgage borrowers are passed directly through to covered bond investors. Thus, interest rate risk and prepayment risk are borne by investors rather than the mortgage bank that issues the covered bond. However, ownership of the mortgages is retained by the mortgage bank throughout its life, which bears any credit losses on the mortgages.

This approach shares many similarities to the structure of the agency mortgage backed securities (MBS) market in the U.S., where mortgage bonds carry a credit guarantee from Fannie Mae, Freddie Mac or Ginnie Mae. Like the Danish system, agency mortgages are funded by capital market investors, who bear prepayment risk and interest rate risk but are not exposed to credit risk. Agency MBS and Danish covered bonds are widely held and traded, and in both countries these bonds remained liquid through the 2007-09 crisis period and other market downturns (see Section 3 for more details).

¹ See Campbell (2013), Lea (2010) and Green and Wachter (2005) for surveys and discussion of international variation in mortgage market design.

Reflecting this shared funding model, Denmark is also to our knowledge the only country aside from the U.S. where long-term (e.g., 30 year) prepayable fixed rate mortgages (FRMs) are widely available to homeowners. Capital market financing is important for the availability of such loans, because they embed significant interest rate and prepayment risk which is not a natural match for short-term bank deposit finance. Given the popularity and familiarity of FRMs in the U.S., Denmark provides a useful case study, because Danish homeowners² have historically shared this same preference for FRMs. The Danish model may suggest ways to improve the efficiency of the U.S. mortgage finance system without restricting the space of contracts available to borrowers.

As we discuss, the Danish system includes several features which mitigate frictions in mortgage financing and could potentially be usefully adapted in some form in the U.S. Prominent among these, Danish homeowners have the option to repurchase their own mortgage from the covered bond pool at the current market price. Mortgages are also assumable, meaning that homeowners can transfer their mortgage to a buyer as part of a property sale. These features are useful in a rising interest rate environment, since they reduce the propensity for the homeowner to become “locked in” to a mortgage with a below-market interest rate. Such lock-in can have some perverse effects—for instance it can discourage the homeowner from selling their home. The Danish system also allows homeowners to refinance easily at par with the same mortgage bank even if their home equity has declined due to a fall in home prices. Historically this has not generally been the case in the U.S., blunting the transmission of lower long-term interest rates to households during the recent recession (Beraja et al., 2017). Recent policy changes are likely to make the U.S. system more similar to Denmark in the future, however.³

Although our main focus is on mortgage funding, we also compare mortgage primary markets between Denmark and the U.S. Here, the two systems are less similar. For instance, mortgages in Denmark generally have much less credit risk, and experienced only a mild increase in credit losses during the financial crisis, despite a sustained fall in home prices. This reflects tighter underwriting standards (e.g., minimum down payments of at least 20% are required on first lien mortgages⁴), as well as a creditor-

² In this article we generally restrict attention to the residential mortgage market and refer to Danish borrowers as homeowners, even though Danish mortgage banks also finance commercial real estate and farms along the same principles as described here.

³ The Home Affordable Refinancing Program (HARP) was introduced in the U.S. in the wake of the financial crisis to facilitate refinancing for borrowers with little or no remaining home equity. HARP is scheduled to expire at the end of 2018, but will be replaced by permanent high-LTV streamlined refinancing programs offered by Fannie Mae and Freddie Mac. See section 4 for more detailed discussion.

⁴ Danish commercial banks are willing to finance up to 15 of the remaining 20 percent, but this financing takes place outside the covered bond system. By comparison in the U.S., Federal Housing Administration (FHA) loans can

friendly legal system in which foreclosure is uniformly quick, and lenders have full recourse against the borrower's assets and future income. In that sense, Danish mortgages embed less implicit insurance than U.S. mortgages, although that is partly made possible by the extensive social safety net offered in Denmark.

After comparing the Danish and U.S. systems, we highlight some lessons from the Danish experience which may be of interest in thinking about the future of U.S. housing finance. Among these: (1) The Danish experience suggests that returning to a balance-sheet funding model is not necessary to ensure stability of the U.S. mortgage finance system. Denmark has a capital-markets centric system which to date has been stable and robust, without reliance on government support or bailouts; (2) it is possible within a framework similar to agency securitization to offer innovations that mitigate frictions in mortgage refinancing; (3) Capital adequacy is critical for system stability. A key reason why Danish mortgage banks did not require government assistance during the financial crisis, unlike Fannie Mae and Freddie Mac, is that they were significantly better capitalized relative to the level of risk they assumed.

This paper is related to a number of studies which discuss key features of the Danish mortgage finance system (see Berg and Nielsen, 2014; Campbell, 2013; Green and Wachter, 2005; and Frankel et al., 2004). Besides some differences in emphasis, our main contribution relative to this previous work is to present an up-to-date comparative analysis of the Danish and U.S. systems, taking into account the experiences of both countries during and since the financial crisis.

Section 2 of this paper provides a history and overview of the Danish model of mortgage finance. In section 3, we compare the two systems side-by-side, both in terms of the way mortgages are funded, and then in terms of the features of mortgage primary markets. Section 4 discusses possible lessons from the Danish experience for the path of future U.S. housing finance reform. Section 5 concludes.

2. Overview of the Danish approach to mortgage finance

In Denmark, mortgage lending has long been dominated by specialized mortgage banks. The first mortgage bank was established in 1797 and Nykredit, the largest mortgage bank today traces its origins to 1851 (Moller and Nielsen, 1997). Originally, these firms were set up as mutual mortgage credit

have downpayments as low as 3.5%. Fannie Mae and Freddie Mac also purchase loans with low downpayments, although third party credit enhancement is required for loans with loan-to-value ratios exceeding 80%.

associations with a local focus. But several waves of mergers – some encouraged or even prescribed by their then-regulator⁵ – has led to the formation of a handful of large mortgage banks that today dominate mortgage lending in Denmark.

As the original mortgage credit associations were founded by borrowers, lending terms were to a large extent designed to reflect borrowers' objectives and interests. At the same time, the associations needed to build trust amongst the investors in the covered bonds and this led to a business model aiming at balancing borrower and investor interests (Moller and Nielsen, 1997):

- The mortgage lender could not call for early redemption of the loan unless the borrower became delinquent.
- The investors could not call the covered bonds.
- The homeowner had a right to prepay the mortgage loan at par on any payment day without penalties.
- The homeowners were personally liable for the mortgage debt.
- The homeowners were jointly and severally liable for the covered bonds issued by the mortgage credit association.
- Mortgage margins can be increased for the entire stock of mortgage loans, e.g. if needed in order to increase capitalization or cover loan losses.
- Strict lending guidelines which are regulated by law (maximum loan-to-value (LTV), maximum maturity etc.)⁶

With the exception of joint and several liability, these principles still apply to mortgage banks today.⁷ There has however been a shift in organizational form from mutual associations to limited liability

⁵ Mortgage banks were originally regulated and supervised by the Ministry of Housing. Today, the Ministry of Industry, Business and Financial Affairs is the mortgage bank regulator, and the Danish Financial Supervisory Authority is the supervisor.

⁶ Specifically, legislation in Denmark titled "Law on Mortgage Lending and Mortgage Bonds" includes restrictions such as 80% maximum LTV, 30 year maximum maturity, full amortization with a maximum initial interest only period of 10 years, legal documentation, principles for the assessment of the value of a property and a number of other aspects of mortgage underwriting.

⁷ Although borrowers are no longer personally liable for the covered bonds, mortgage banks can still elect to increase margins on existing borrowers if needed to increase capitalization or cover loan losses. This option to adjust margins arises out of the original mutual structure of the mortgage banks. This feature implies that, unlike the United States, small interest rate changes are possible even for a fixed rate mortgage. In practice, raising margins impacts the lender's reputation and competitiveness, and since mortgage borrowers can easily move from

corporations, which began in the mid-1990s. The mortgage credit associations were first converted into limited liability companies owned by mutual associations, and later many were merged with banks to form financial conglomerates⁸.

Capital market funding has been a mainstay of the Danish mortgage financing system since the beginning in 1797 (Moller and Nielsen, 1997). Inspired by the German and Austrian models, Denmark enacted its first Mortgage Credit Act in 1850 requiring the specialized mortgage credit associations to issue covered bonds to fund all mortgage lending and prohibiting them from taking deposits. The ban on deposits was due to a desire by regulators to eliminate any run risk on the lenders, who carried only long term and illiquid mortgage assets on the balance sheet.

The specialized nature of mortgage bank assets, and their reliance on covered bonds rather than deposits, remain the key distinguishing features of Danish mortgage banks today. Danish mortgage banks can be viewed as a form of “narrow banking” – they do not engage in maturity transformation, since payments to covered bond investors match the cash flows of the underlying mortgages. Because they do not rely on deposits for funding, mortgage banks do not benefit from any implicit subsidies due to deposit guarantees and structural subordination (the latter could be the case in a situation where deposit-taking banks issue covered bonds).

The covered bond structure provides a funding instrument with very low credit risk to investors, facilitating efficient funding of low risk financial assets such as residential mortgages. For more background on covered bonds, see Box I.

Box I: The basics of covered bonds⁹

Covered bonds are debt instruments issued by credit institutions financing a pool of ring-fenced assets. There are several different legal models for covered bonds in Europe. In Denmark most covered bonds

one bank to another, the scope to raise margins is limited, unless there is a general increase in credit losses or funding costs which affects all banks at the same time. As a result, margins tend to fluctuate little, and often remain constant for several years at a time. Over the past 10 years average mortgage margins have increased from approximately 50bps to just over 80bps.

⁸ When Denmark implemented the Capital Requirement Directive in 2007, it was decided to also allow deposit taking banks to issued covered bonds. So far only one bank has opted to issue covered bonds.

⁹ For more information on covered bonds see ECBC: <https://hypo.org/ecbc/covered-bonds/#introducing-covered-bonds>.

are issued by specialist mortgage bank that keep the mortgages on their balance sheet. Covered bonds issued in the European Union comply with special legislation from the European Union as well as national covered bond legislation.

Covered bonds primarily fund mortgage lending but there are also covered bonds funding other types of assets (e.g., public sector lending, ships, infrastructure). These are outside the scope of this article.

Unlike balance sheet securitization, covered bonds offer the investor double recourse; the investor has exclusive recourse to the segregated pool of assets on the issuer's balance sheet, and then furthermore has recourse to the overall assets of the issuer. In order to assure a high quality cover pool, mortgage loans in the pool must comply with several requirements regulated by law such as property types, maximum LTV ratios, substitute assets and transparency.

The distinguishing feature of Danish covered bonds is that interest rate risk and prepayment risk are fully passed through to capital market investors under the balance principle. In other European Union countries, these risks are at least partially retained by the covered bond issuer.

The three largest covered bond markets in the world are Denmark, Germany and France, as shown in Figure 1. The US does not have a significant covered bond market, in part due to the fact that lenders have access to funding collateralized by mortgages through the Federal Home Loan Bank system (Bernanke, 2009)¹⁰.

[Insert Figure 1]

2.1 The mortgage origination process

Like the United States, the traditional mortgage contract in Denmark is a fixed rate mortgage which fully amortizes over 30 years and may be prepaid at any time without penalty. A number of new types of loans have been introduced over the past two decades, the most popular of which are adjustable-rate

¹⁰ See Ashcraft, Bech and Frame (2009) for more detail on the structure of the Federal Home Loan Bank (FHLB) system and the role of FHLB advances as a stable source of funding during the 2007-09 financial crisis. Like Fannie Mae and Freddie Mac, the FHLBs are government sponsored enterprises created by an act of Congress. See Meuli, Nellen and Nitschka (2017) for a discussion of the Swiss Pfandbrief covered bond instrument, which shares a number of similarities with the FHLB system.

mortgages (ARMs) and interest-only loans¹¹. The growth in alternative mortgages has however stopped short of the riskiest contract features seen in the United States prior to the financial crisis (e.g., there are no negative amortization mortgages or no-documentation loans).

The homeowner's interest rate is directly linked to the lender's cost of funds. Specifically it is equal to the current market yield of the on-the-run covered bond in the capital market, plus a margin set by the lender. The bank simply acts as an intermediary between the borrower and the capital market. In principle, when a homeowner enters into a new mortgage, the mortgage bank provides her with covered bonds matching the principal amount being borrowed, which the borrower then can sell on the bond market. In practice, the mortgage bank will generally handle the sale of the bonds for a fee, and simply transfers the net proceeds of the bond sale to the homeowner's bank account. The mortgage bank pools thousands of loans with similar coupons and maturity to allow the build-up of large and liquid covered bond issues.

Danish mortgage banks have a vertically integrated business model – the same bank originates and owns the mortgages, funds them in the covered bond market, services the mortgages, and undertakes foreclosure proceedings if needed. In the U.S., these different roles are often played by different financial institutions (e.g., mortgages are often sold after origination, and many loans are serviced by a third party servicer).

2.2. Covered bond design and the balance principle

Covered bonds are issued at 50 basis point coupon rate increments, and each covered bond security is generally “on the run” for three years. This means that mortgages are progressively added to the cover pool for the bond over a three year period, before the pool is closed. Because the market price of the bond fluctuates daily during the three year on-the-run period, the homeowner's interest rate is set in a manner similar to the system known in the US of paying points (see Box II for more details of the mechanics).

¹¹ Unlike the US where ARMs typically switch to a floating interest rate after an initial fixed rate period, ARMs in Denmark consist of a number of equally spaced fixed-rate periods -- most commonly either three years or five years. The borrower however has the option to change the length of the fixed rate period on each reset date. On each reset date, the new mortgage interest rate is based on bond market yields at the time the rate is fixed, removing any basis risk for the bond issuer. For interest only mortgages, the initial interest-only period cannot exceed 10 years.

The funds received by the homeowner match the net amount raised from selling the corresponding covered bonds in the capital markets. Furthermore, on a flow basis, the cash flows received by covered bond investors exactly match the cash flows from the underlying pool of mortgages (except for a margin which is retained by the lender). Hence if a mortgage has a refinancing option, the bond has a similar option. As already mentioned, this complete pass through funding model is known as the “balance principle”.

Box II: The Mechanics of Issuing Bonds under the Balance Principle

Mortgage banks keep bond series (each with a specific ISIN security identifier) on the run for three years and tap them on a daily basis to fund new lending. When a new bond series is started, it has 33 years to maturity. This allows the bank to fund loans with the maximum legal loan term of 30 until the bond goes off-the-run. No loan in the cover pool backing the bond series will have a maturity in excess of 30 years, but since the loan portfolio is constructed over time, the amortization profile of the bond will reflect the gradual build-up of the underlying cover pool. The long three-year on-the-run period makes it possible to build up large and liquid series of covered bonds.

Under the balance principal, the amount lent to the homeowner exactly matches the net amount raised by selling covered bonds in the capital market. Bond market funding for each loan is obtained on the day the loan is disbursed thus avoiding any pipeline risk for the bank.

The effective mortgage rate paid by the borrower will reflect the yield on the corresponding covered bond. Since bond prices fluctuate over time, different homeowners will not have the same yield-to-maturity despite being funded in the same bond series with the same coupon. Mechanically, this is achieved by adjusting the principal on the mortgage in a manner analogous to the U.S. practice of paying mortgage points. The simple example below illustrates the mechanics (for the sake of simplicity we exclude all fees etc.):

*A homeowner needs 1 million DKK to purchase a house. The on-the-run 2% 30 year FRM-bond trades at 99.00. The bank will then make a loan offer with a principal of $1/0.99 = 1.01$ million DKK. The homeowner is liable for the bond amount issued and will receive the proceeds of 1 million DKK. The quarterly interest payment will be $2\%/4 * 1.01$ million DKK and hence the homeowner's effective loan rate will be slightly above the 2% coupon of the bond, reflecting the fact that the 2% bond is trading at a*

discount. Another homeowner taking out a loan the following day when the same bond series trades at 99.25 will be liable for a slightly smaller bond principal and pay a marginally lower effective interest rate.

Coupon rates are set at 50 basis point increments. At time of writing the Danish mortgage banks have bonds open for issuance with final maturity 1 October 2050 with coupons of 1.5%, 2.0% and 2.5%. Each homeowner will have her loan funded in the bond trading closest to par, thereby minimizing the number of points paid. If long-term interest rates for instance increased, mortgage banks will open new on-the-run bonds with higher coupons and start tapping them instead of the bonds with coupons below market rates. The end-date for the on-the-run period will be the same for all bonds of the same “vintage” irrespective of when in the 3 year period they begin to be on-the-run.

The homeowner’s quarterly mortgage payment equals the cash flow on the bonds issued to fund this customer’s loan plus a fixed margin to the mortgage bank. Thus, there is virtually no market risk to the mortgage bank. However, the mortgage bank lender is exposed to credit risk, since the loan remains on the lender’s balance sheet until maturity. If the borrower becomes delinquent, the mortgage bank will use its capital buffers to repay the holders of covered bonds and will start foreclosure procedures against the homeowner. In practice however, mortgage credit losses in Denmark have historically been low, even during significant housing market downturns (see section 2.4 for a more detailed discussion).

Relative to an “originate to distribute” model, the retention of credit risk by the originator creates skin in the game and reduces information asymmetries, which may contribute to the low mortgage default rates observed in Denmark.¹² The market risk is less subject to asymmetric information and therefore easier to distribute to capital market investors.

This allocation of market and credit risk means that the mortgage bank has an incentive to refinance the loans of existing borrowers. Refinancing a mortgage at par to a lower interest rate reduces credit risk, because it lowers the borrower’s interest payments; while there is a loss in the market value of the loan because of the refinancing at par, this loss is borne by the covered bond investor due to the balance principle. Since the original lender is responsible for loan servicing, there is also no disincentive to refinance associated with a loss of servicing fees.

¹² In the agency mortgage market in the U.S., Fannie Mae and Freddie Mac retain mortgage credit risk in the same way as Danish mortgage banks, but do not originate mortgages. Demiroglu and James (2012) finds evidence that securitized mortgage losses in the U.S. were lower for securities where the issuer was also the mortgage originator. See Willen (2014) for the case against mandatory mortgage risk retention.

2.3. Refinancing and prepayment

Mortgage refinancing is an integrated process in which a borrower simultaneously takes out a new loan and uses the process to repay the old loan. If the interest rate on the new mortgage is below the original loan rate, the repayment of the loan is at par. The homeowner will call the mortgage, and the mortgage bank will call a corresponding amount of the outstanding bonds at par at the same time. The mortgage bank will only call bonds corresponding to the actual mortgages that are being prepaid, and thus does not take on any interest rate risk or prepayment risk.

In contrast, if the market interest rate exceeds the original loan rate, it is possible to prepay the loan below par. In this case, the mortgage bank will repurchase the bonds backed by the homeowner's mortgage in the market, at the current market price, and then retire them. These bonds will be trading at a discount, given that market interest rates have increased since the old mortgage was originated. Thus, when the homeowner refinances, their new mortgage will have a smaller principal (as the old loan was redeemed at below par value) but a higher loan rate. These two effects will generally roughly offset each other, implying little net change in the borrower's mortgage payments¹³. Danish mortgages are also assumable, which means it is possible for homeowners to transfer their mortgage to a buyer as part of a property sale. This in effect is an alternative way for a homeowner to "buy back" their mortgage.

This ability of Danish borrowers to repurchase their own loan at the market price has potentially important advantages in a rising interest rate environment (as emphasized by Campbell, 2013). In the U.S. system, where FRM prepayment only occurs at par and the mortgage is generally due on sale, homeowners with a below-market mortgage interest rate face a "lock-in" effect; they are disincentived from moving to a new home or from changing their loan terms (e.g., from an FRM to an ARM, or to a loan with a different maturity), because doing so means they will have to retire their below-market-rate mortgage and take out a new loan at the higher current rate. This lock-in effect could generate allocative inefficiencies—e.g., it may reduce housing market turnover, and limit homeowners' ability to adjust their consumption of housing services in response to changes in economic circumstances. This

¹³ For example, if mortgage rates increase by 200 basis points, our homeowner from the example in Box II will now see the bonds issued to fund her loan trading at say 85 cents to the dollar. Assuming a new mortgage loan with a coupon of 4% could be disbursed at par value, the homeowner will need a new mortgage of just over 0.85 million DKK to redeem his old loan. The homeowner will thus realize a capital gain of 0.15 million DKK. Her annual mortgage payment including amortization will remain broadly unchanged at approx. 38,000 DKK after tax (taking into account a 32% tax rate deduction for interest payments), however, because the lower principal will be offset by a higher interest rate on the new loan.

lock-in effect is not present in Denmark, given that the cost of refinancing to a new higher interest rate is offset by the capital gain due to repurchasing the old mortgage below par.

An additional implication of borrowers' ability to repurchase their loans from the cover pool is that homeowners can act as a source of liquidity in the covered bond market. When interest rates increase and liquidity in the market for existing bonds typically suffers, refinancing activity adds to the demand for bonds for redemption. Homeowners can also act as a "buyer of last resort" in situations where covered bond prices become too low relative to fundamentals.

Streamlined mortgage refinancing is available to Danish homeowners who refinance their mortgage with the same lender, as long as the homeowner does not want to extend their loan term or extract equity from the home by increasing the mortgage principal amount.¹⁴ A property appraisal is not needed and the borrower is not required to provide updated documentation of income or assets. Streamlined refinancing is permitted even if home prices have fallen and the homeowner's updated loan-to-value ratio now exceeds the statutory maximum of 80% for purchase mortgages.¹⁵ As already discussed, the logic behind this "no questions asked" approach is that re-underwriting the loan is not necessary because the lender already bears the credit risk on the mortgage. In fact, allowing the borrower to refinance to a lower market interest rate actually reduces the lender's credit risk exposure, because it reduces the homeowner's debt payments.

The availability of streamlined refinancing makes it easier for borrowers to refinance during periods of depressed home prices. This contract feature could have been of significant value in the United States in the wake of the 2008 financial crisis (see section 3.3 for further discussion).

2.4 Credit risk and foreclosure

Realized mortgage credit losses in Denmark have been low over a long period of time. Historical credit loss rates on mortgages and other loans back to the early 20th century are plotted in Figure 2. Over that period, credit losses for Danish mortgage banks have averaged about 10 basis points per annum, and have consistently been much lower and less volatile than losses on non-mortgage loans held by deposit-

¹⁴ The homeowner is however allowed to roll refinancing costs (e.g., origination fees) into the refinancing, in which case the new principal will be slightly higher than the old principal.

¹⁵ The updated LTV is estimated based on an automated valuation of the property taking into account price appreciation or depreciation in the local geographic area. For homeowners with an updated LTV exceeding 80 percent, there are some restrictions in taking out an interest-only mortgage. Specifically, the lender must record a credit impairment charge if the borrower refinances to an interest-only loan. For this reason, some lenders will require that the homeowner refinances to an amortizing loan, even if the old mortgage is interest only.

taking banks. Even during the 2007-08 financial crisis, the mortgage credit loss rate peaked at only around 20 basis points. The peak mortgage credit loss rate was realized during the Scandinavian banking crisis in the early 1990s, although this peak is in part due to a change in accounting standards to a more forward-looking method for calculating provisions.

[Insert Figure 2]

The low credit losses experienced by Danish mortgage banks are not simply due to a lack of economic volatility. The drop in Danish house prices during the financial crisis was on par with the fall in US house prices (Berg and Nielsen, 2014), and in an International Monetary Fund study (IMF, 2000), the Danish housing market was characterized as the most volatile in the western world over the post Bretton Woods era.¹⁶ Denmark has also experienced significant business cycle fluctuations, as reflected in the high and variable loss rates on non-mortgage loans in Figure 2.¹⁷

Instead, low mortgage credit loss rates instead primarily reflect limits on up front loan-to-value, as well as strong creditor protection in Denmark, as in other countries with a German or Scandinavian legal tradition (Djankov, McLeish and Shleifer, 2007). Most importantly, the homeowner is personally liable for her mortgage loan; thus, the lender is protected both by the value of the collateral as well as the payment capacity of the homeowner. Control rights are also strongly enforceable; in Denmark a foreclosure is completed typically 6-9 months from the time the homeowner misses a payment. Even after a foreclosure is completed, the borrower remains liable for any debt that remains unpaid. These factors discourage mortgage delinquency and typically ensure that loss-given-default is low.

The creditor-friendliness of the Danish system in turn means that relatively more price risk is borne by the homeowner. This risk is however offset by an extensive social safety net, including a city obligation to provide rental housing to homeowners displaced by foreclosure. In this sense, some features of the Danish mortgage system reflect broader societal choices about social insurance and the role of government. Although these choices differ between Denmark and the U.S., mortgage funding arrangements have a number of close parallels between the two countries, as we now discuss.

¹⁶ One reason for this volatility is the pegging of the Danish currency to that of Germany and subsequently the Eurozone. As a result, for the past 30 years Danish monetary policy has focused on maintaining a fixed exchange rate rather than stabilizing the domestic economy.

¹⁷ In recent decades, Denmark has experienced negative or zero annual GDP growth in 1974-75, 1980-81, 1988, 1991, 2008 and 2009.

3. Comparing the Danish model to the U.S.

Table 1 compares the key features of the Danish mortgage finance system to the U.S., focusing on mortgage secondary markets. Although nearly all Danish mortgages are financed through covered bonds, the U.S. has a more heterogeneous system which makes use of a mix of three main funding sources:

- (i) **Agency securitization**, in which the resulting mortgage-backed securities (MBS) have a credit guarantee from one of the housing government-sponsored enterprises (GSEs) Fannie Mae or Freddie Mac, or from the government agency Ginnie Mae,
- (ii) **Nonagency securitization** of MBS by an investment bank or other private-sector firm, or
- (iii) **Balance sheet lending**, in which the mortgage is kept in portfolio as a whole loan by the originator, or sometimes another investor (e.g., a large bank, who purchases the loan from a correspondent lender, or a real estate investment trust). Most balance sheet loans are owned by commercial banks and funded by a mix of deposits and advances from the Federal Home Loan Bank (FHLB) system.

[Insert Table 1]

Of these three approaches, agency mortgage securitization is most similar to the Danish covered bond model. In both cases, mortgages are ultimately financed by the issuance of mortgage bonds which transfer interest rate risk and prepayment risk to capital market investors, but not credit risk. In Denmark, credit risk is borne by the covered bond issuer who retains ownership of the mortgages; this guarantee is credible because mortgages themselves have low credit risk and because mortgage banks are well capitalized. In the U.S., a credit guarantee is provided to MBS investors by Fannie Mae, Freddie Mac, or Ginnie Mae. These guarantees are credible because Ginnie Mae is a government agency and Fannie Mae and Freddie Mac are viewed as being backed by an implicit Federal government guarantee.

Like the Danish mortgage banks, Fannie Mae and Freddie Mac are specialized financial institutions focused on the mortgage market. Unlike Danish mortgage banks, however, Fannie Mae and Freddie Mac are not mortgage lenders; they operate only in the secondary mortgage market, purchasing loans from

banks and other mortgage originators and assembling them into MBS pools. Thus, the intermediation chain is at least one step longer in the U.S. agency mortgage market than in Denmark.¹⁸

The Danish model has less in common with nonagency securitization and balance sheet lending. Unlike covered bonds or agency MBS, nonagency MBS investors are directly exposed to credit risk. Subordination and other forms of credit enhancement are used to mitigate this risk and tranche it across investors. The nonagency MBS market is also traditionally less standardized than the agency market, with a much larger number of issuers and greater variation in security design. Nonagency securitization, while very popular in the period before the 2007-09 financial crisis, has not been a major source of mortgage funding since the crisis. Even so, nonagency securitization still represents the use of capital markets to fund residential mortgages, in common with the Danish model.

In the case of balance sheet lending, however, the lender does not make use of capital markets; instead the mortgage is retained in portfolio of a financial intermediary, usually a commercial bank. The marginal source of financing for such loans includes deposits and Federal Home Loan Bank advances. This more traditional approach aligns incentives but does not allow for the transfer of any of the major types of risks associated with mortgage lending.

3.1 Mortgage bond secondary market liquidity

As we have discussed, a key feature shared by the U.S. agency MBS market and Danish covered bond market is that mortgage bonds have little or no credit risk to the investor. Figure 3 illustrates that this feature allowed both markets to remain active through and after the period of the financial crisis. Although spreads on Danish mortgage bonds were elevated during the crisis, the market continued to operate and to intermediate mortgage credit. Similarly, primary market issuance and secondary market trading remained robust for agency MBS, despite the collapse in home prices and financial distress experienced by Fannie Mae and Freddie Mac. In contrast, the U.S. non-agency MBS market was not robust during the crisis period – issuance froze in the second half of 2007 and the market was closed as a source of funding for mortgage originators throughout the crisis period.

[Insert Figure 3]

¹⁸ The U.S. primary mortgage market is much more fragmented than in Denmark, including thousands of individual small lenders, many of which are nonbanks. In practice a Danish style system where all mortgage bonds are issued by the original lender does not seem possible under the current market structure in the U.S.

In our view, the presence of a credible issuer credit guarantee is a key reason why both the agency MBS market and Danish covered bond market remained relatively liquid and well-functioning during the crisis. The lack of credit risk on these instruments greatly reduces adverse selection due to asymmetric information about mortgage credit risk, a factor which likely contributed to the freeze in non-agency MBS issuance in 2007. The credit guarantee also helps standardize mortgage bonds, and is an important factor underlying the operation of the to-be-announced or “TBA” market in the United States, where most secondary market trading of U.S. agency MBS occurs (Vickery and Wright, 2013).

3.2 Mortgage contract design

Table 2 presents a comparison of mortgage contract design and other aspects of mortgage primary markets. As discussed by Green and Wachter (2005) and others, a notable implication of the capital-market centric mortgage systems of the U.S. and Denmark is that in both countries, mortgage intermediaries are willing to originate long-term fixed rate mortgages (with a fixed rate for as long as 30 years), and to offer borrowers the option to freely prepay such mortgages at par.

Long-term prepayable FRMs are not generally available outside of Denmark and the U.S. (Green and Wachter, 2005; Campbell, 2013). This is likely due at least in part to the duration mismatch between these instruments and deposit finance and other shorter-duration liabilities which are the usual sources of bank funding. Capital markets funding allows the interest rate risk and prepayment risk of FRMs to be shared with other types of fixed income investors (e.g., pension funds, life insurers, sovereign wealth funds) which have lower leverage, long investment horizons, or a less concentrated exposure to mortgages (e.g., pension funds, life insurance companies and other asset managers). Fuster and Vickery (2015) present empirical evidence that the availability of liquid securitization markets facilitates the availability of long-term prepayable fixed rate mortgages in the U.S.¹⁹

[Insert Table 2]

In both countries, mortgages with variable interest rates are also available. Most popular in the U.S. are hybrid adjustable-rate mortgages (ARMs) where the rate is fixed for an initial time period (e.g., five years) and thereafter is a floating rate which adjusts periodically based on movements in market interest rates. In Denmark, as we have discussed in section 2, adjustable rate mortgages consist of a

¹⁹ Fuster and Vickery find that the share of FRMs is significantly lower when mortgages are difficult to securitize, using shocks to MBS liquidity and cutoff rules governing which loans are eligible for agency purchase as sources of variation in the ease of securitization.

number of equally spaced shorter fixed-rate periods (usually either three years or five years), between which the interest rate resets.

3.3 Prepayment and refinancing

Although the U.S. and Denmark both rely heavily on long-term FRMs, there are some significant differences between the two countries in the ability of borrowers to easily refinance or repurchase their mortgages. Notably, although both countries allow mortgages to be prepaid freely at par, unlike Denmark, the U.S. does not allow homeowners to redeem their mortgages at the current market price by purchasing mortgage bonds and surrendering them to the lender (as described in section 2.3). Furthermore, mortgages in the U.S. are usually not assumable, meaning that a homeowner cannot “sell” their mortgage to the buyer as part of a property sale.²⁰ In Denmark, however, mortgages can uniformly be assumed as part of a property sale, on approval of the lender, and it is common to do so.

As we have discussed, an implication of these features is that, in a rising rate environment, U.S. fixed-rate mortgage borrowers may find themselves locked in to a loan with an interest rate below current market rates. Such borrowers would have a disincentive to sell their home and move, even if their current dwelling no longer best fits their economic circumstances. Borrowers also have a disincentive to refinance to a mortgage with different contract features or a higher principal balance, because doing so would require them to prepay their below-market-rate loan and take out a new loan at the higher current rate.

In addition, refinancing an existing mortgage at par has historically been more streamlined in Denmark than in the U.S. As discussed in section 2.3, refinancing with the same mortgage bank in Denmark does not require a new credit check, proof of employment, or home appraisal, and homeowners can still freely refinance even if their home value has fallen and they have little or no remaining equity. A similar structure in the U.S. would have likely helped stabilize economic conditions during the Great Recession, when many borrowers could not refinance to take advantage of lower interest rates, because of falling home prices and tighter underwriting standards. Beraja et al. (2017) find evidence that these refinancing frictions blunted the transmission of lower interest rates to the real economy in regions most hard-hit by the housing market decline. The Home Affordable Refinancing Program (HARP) was eventually introduced to facilitate refinancing for borrowers with little or no remaining home equity. Researchers

²⁰ In general, conventional U.S. mortgages have a due on sale clause and are not assumable except in the case of the death of the borrower. FHA and VA mortgages may be assumed, subject to lender approval (see e.g., Guttentag, 2010, for more details).

have found that HARP significantly increased mortgage refinancing, leading to higher durable-goods consumption and reducing foreclosure rates (Agarwal et al., 2017).

Although HARP is scheduled to expire at the end of 2018, permanent post-crisis changes in refinancing rules should bring the U.S. system significantly closer to Denmark in terms of facilitating mortgage refinancing during periods of falling home prices. Specifically, Fannie Mae and Freddie Mac will introduce permanent high-LTV streamlined refinancing programs in 2019 which will allow borrowers with a high loan-to-value due to falling property prices to refinance using an automated appraisal and with no minimum credit score (Federal Housing Financing Agency, 2017; Freddie Mac, 2017).²¹ Some restrictions apply as to which types of borrowers will be able to participate.²² Prior research has noted that limited competition and other frictions reduced the effectiveness of the HARP program to some extent (Agarwal et al., 2017; Amromin and Kearns, 2014). It will be interesting to assess the new streamlined refinancing programs in the wake of any future regional or national housing market downturns to confirm their effectiveness.

3.4 Other features of mortgage primary markets

Table 2 also highlights a number of starker differences in the structure of mortgage primary markets between the two countries. As we have discussed, Danish mortgage contracts are very creditor-friendly and foreclosure is quick; this is not generally the case in the U.S., although there is significant cross-state variation in creditor rights (Ghent and Kudlyak, 2011). The U.S. mortgage market is much less concentrated, including several thousand originators (compared to only four in Denmark), and features competition between banks and nonbanks, with a current nonbank market share of about half. This dynamic of competition between banks and nonbanks may be one reason why U.S. lending standards have fluctuated over time. The U.S. is also of course a much larger market, given its greater population.

4. What can the U.S. learn from the Danish experience?

²¹ The Federal Housing Administration and Veterans Administration already offer streamlined refinancing programs which waive the requirement for an appraisal and require less or verification of income, assets or credit when refinancing to a lower interest rate.

²² For example the homeowner must be performing on their existing mortgage, their loan must be at least fifteen months old, and their loan-to-value must exceed a minimum threshold (this minimum is 95% for a single-family owner-occupied home). See Freddie Mac (2017) for more details.

The Danish experience offers a number of lessons which may be of interest for U.S. policymakers in considering the path of housing finance reform. We summarize these lessons below.

- i. **Capital-markets centric system doesn't necessarily imply instability.** Criticism of the U.S. mortgage finance system often focuses on securitization and the system's reliance on capital markets. But the experience of Denmark suggests that a stable and robust mortgage finance system *is* possible even with a capital-markets centric funding model, and without requiring a large role for government. Return to a bank deposit-based funding model isn't necessary to achieve stability of the U.S. mortgage finance system. To the contrary, in our view there are significant systemic risk benefits from using capital markets to broaden the mortgage investor base and diversify the market risk of long-term fixed rate mortgages.²³

- ii. **Mortgage intermediaries should be well-capitalized.** Danish mortgage banks remained solvent through the financial crisis in part because they retain relatively little risk (credit risk is low, and Danish mortgage banks transfer essentially all market risk to investors under the balance principle). But Danish banks are also well-capitalized, with a risk based capital ratio that has not fallen below 10 percent in the period since 2001 , and a leverage ratio of about 5 percent (see Figure 4). In contrast, Fannie Mae and Freddie Mac retained large portfolios of mortgage assets prior to their conservatorships, and held only a thin layer of capital for their guarantee mortgage portfolio (the required capital ratio for securitized agency mortgages was only 0.45 percent).²⁴ In any future reform of mortgage finance, limiting the role of implicit government guarantees in the mortgage finance system will only be possible if systemically important private-sector mortgage intermediaries are financed with sufficient capital relative to their risks.

[Insert Figure 4]

- iii. **Mortgage system design can help facilitate more efficient refinancing.** As we have discussed, the Danish system includes features which help facilitate efficient mortgage prepayment and

²³ The savings and loan crisis of the 1980s is a case study of the problems that can arise from funding long-term fixed rate mortgages using bank deposits. See Kane (1989) and Barth (1991) for a detailed discussion of the crisis.

²⁴ Significant progress has been made since the financial crisis to reduce the risk footprint of the GSEs, for example by shrinking the size of the two firms' retained portfolios of mortgage assets, and by using credit risk transfer instruments to hedge mortgage credit risk (see Finkelstein, Strzodka and Vickery, this volume, for an overview of the credit risk transfer programs). However the two GSEs today operate with essentially no equity capital, and thus are entirely reliant on government support to cover any losses.

refinancing.²⁵ Danish homeowners are able to repurchase their mortgage out of a covered bond at the prevailing market price, and to transfer a mortgage as part of a property sale. These features reduce mortgage “lock in” effects during rising rate environments. Danish lenders also offer streamlined refinancing to homeowners even if home prices have fallen and the borrower’s equity has declined or disappeared.

The centralized structure of the U.S. agency MBS market may offer opportunities to introduce these features in some form, or to introduce other changes which could improve the efficiency of mortgage refinancing and facilitate interest-rate passthrough.²⁶ Indeed, the permanent high-LTV refinancing programs being implemented by Fannie Mae and Freddie Mac are a step in this direction. Changes in *ex ante* mortgage design reduce the need for *ex post* government programs during periods of stress; such programs are difficult to design and scale up “on the fly”, and take time to be implemented.

- iv. **Credit guarantees on mortgage bonds support market functioning.** The Danish covered bond market continued to operate and to intermediate mortgage credit during the 2007-09 financial crisis period, similar to the experience of the agency MBS market in U.S. but unlike the U.S. non-agency market, which froze in 2007. The presence of a credible credit guarantee on the mortgage bonds was a key feature supporting market functioning in both the agency MBS market and Danish covered bond market during this period. This guarantee adverse selection due to asymmetric information about mortgage credit risk, a factor which likely contributed to the freeze in non-agency MBS issuance in 2007, and helps standardize mortgage bonds, thereby supporting the operation of the to-be-announced or “TBA” market in the United States, where

²⁵ It should be noted that such features are not a free lunch, in the sense that facilitating easier refinancing *ex post* will be “priced in” by MBS investors and therefore affect mortgage interest rates at origination. However, reducing these frictions would likely reduce distortions in other economic decisions (e.g., decisions to move by otherwise locked-in borrowers) and could enhance the passthrough of monetary policy.

²⁶ For instance, Eberly and Krishnamurthy (2014) propose an “automatic stabilizer” mortgage which would convert into a lower adjustable interest rate during housing downturns. The GSEs could require that agency-eligible fixed-rate mortgages contain such a feature. More ambitious proposals to reduce refinancing frictions and transaction costs include fixed rate mortgages with a “ratchet” feature, under which the interest rate adjusts downwards automatically if market interest rates fall (Kalotay, 2015). This type of automatic refinancing mortgage would address the issue that many mortgage borrowers do not refinance optimally, as shown by Keys, Pope and Pope (2016) in the case of the U.S., and by Andersen et al. (2017) for Denmark. These issues were discussed in detail in a 2015 conference on “Mortgage Contract Design: Implications for Households, Financial Stability and Monetary Policy” held at the Federal Reserve Bank of New York. Conference agenda and presentation slides are available at: https://www.newyorkfed.org/research/conference/2015/mortgage_design.html.

most secondary market MBS trading occurs (Vickery and Wright, 2013). In short, both the Danish and U.S. experience suggests that a credible credit guarantee on mortgage bonds helps stabilize the supply of mortgage finance over the cycle and supports secondary market liquidity.

- v. **Government can play a smaller role.** Government plays a much smaller role in the Danish mortgage finance system than in the United States. For instance, Denmark does not have government mortgage insurance programs or hybrid private-public mortgage entities like the U.S. GSEs. This fact is particularly striking given that Denmark overall has a larger public sector and greater role for government in economic life. Entanglements between the private and public sector played a significant role in the instability of the U.S. mortgage market leading up to and during the financial crisis—for example, implicit government guarantees of the liabilities of Fannie Mae and Freddie Mac allowed these firms to issue debt more cheaply than other private firms, fueling the growth in their balance sheets and exacerbating their exposure to the housing downturn (Passmore, 2005; Frame et al., 2015).

Given the size and systemic importance of housing and mortgage markets, the government is always likely to bear some tail risk exposure to the mortgage finance system. Even so, the Danish example shows that a system similar to the U.S. agency MBS market can operate with a significantly smaller role for government than is the case in the U.S. A range of GSE reform proposals offer approaches to reduce the role of government in mortgage finance. For example, the credit risk transfer programs introduced by the GSEs provide a mechanism to shift mortgage credit risk to the private sector.

The five discussion points highlighted above focus on mortgage secondary markets and funding arrangements, the areas where the Danish and U.S. mortgage systems are most similar. Other features of the mortgage market differ more starkly, in part due to broader differences in the design of social insurance and the role of government in the two countries. Denmark has a more extensive social safety net than the U.S., although debt markets in the U.S. have more “insurance-like” features, providing for non-repayment in response to negative shocks, through personal bankruptcy law and limits on mortgage recourse. An evaluation of the broader tradeoffs between these and other forms of private and social insurance is beyond the scope of this paper, but is studied in the public economics literature (e.g., Hsu, Matsa and Meltzer, 2017; White, 2007; Brown and Finkelstein, 2008).

5. Conclusion

We have highlighted a number of similarities between the U.S. and Danish mortgage finance systems, and offered a number of potential lessons from the Danish experience which may be of interest for U.S. policymakers in charting the course of mortgage finance reform. The Danish example shows that a capital-market-centric model of mortgage finance does not necessarily imply structural instability or require a large role for government. The Danish model also offers a number of design features which could mitigate refinancing frictions and facilitate monetary policy transmission through the mortgage market during housing downturns.

References

- Agarwal, Sumit, Gene Amromin, Souphala Chomsisengphet, Tim Landvoigt, Tomasz Piskorski, Amit Seru and Vincent Yao. 2017. "Mortgage Refinancing, Consumer Spending, and Competition: Evidence from the Home Affordable Refinancing Program." NBER Working Paper No. 21512.
- Amromin, Gene and Caitlin Kearns. 2014. "Access to Refinancing and Mortgage Interest Rates: HARPing on the Importance of Competition." Federal Reserve Bank of Chicago Working Paper, No. 2014-25, December 2014.
- Andersen, Steffen, John Campbell, Kasper Nielsen and Tarun Ramadorai. 2017. "Inattention and Inertia in Household Finance: Evidence from the Danish Mortgage Market". Working Paper.
https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2463575
- Ashcraft, Adam, Morten Bech and Scott Frame. 2010. "The Federal Home Loan Bank System: The Lender of Next-to-Last Resort?" *Journal of Money, Credit and Banking*, 42: 551–583. doi:10.1111/j.1538-4616.2010.00299.x
- Barth, James R. 1991. "The Great Savings and Loan Debacle." American Enterprise Institute Press.
- Beraja, Martin, Andreas Fuster, Erik Hurst, and Joseph Vavra. 2017. "Regional Heterogeneity and Monetary Policy". Federal Reserve Bank of New York Staff Reports, no. 731, August.
https://www.newyorkfed.org/medialibrary/media/research/staff_reports/sr731.pdf
- Berg, Jesper and Morten Baekmand Nielsen. 2014. A New Housing Finance System for the US? Lessons from the Danish Model. In: Colombano J., Shah A. (eds) *Learning from the World*. Palgrave Macmillan, London.
- Bernanke, Ben. (2009). "The Future of Mortgage Finance in the United States." *The B.E. Journal of Economic Analysis & Policy*, 9(3), Symposium, Article 2. doi:10.2202/1935-1682.2225

Brown, Jeffrey R., and Amy Finkelstein. 2008. "The Interaction of Public and Private Insurance: Medicaid and the Long-Term Care Insurance Market." *American Economic Review*, 98(3): 1083-1102. DOI: 10.1257/aer.98.3.1083

Campbell, John. 2013. "Mortgage Market Design." *Review of Finance*. 17 (1): 1-33.

Demiroglu, Cem and Christopher James. 2012. "How Important is Having Skin in the Game? Originator-Sponsor Affiliation and Losses on Mortgage-backed Securities." *Review of Financial Studies*, Volume 25, Issue 11, 1 November 2012, Pages 3217-3258.

Djankov, Simeon, Caralee McLiesh, and Andrei Shleifer. 2007. "Private Credit in 129 Countries." *Journal of Financial Economics* 12 (2): 77-99.

Eberly, Janice and Arvind Krishnamurthy. 2014. "Efficient Credit Policies in a Housing Debt Crisis", *Brookings Papers on Economic Activity*, Fall. https://www.brookings.edu/wp-content/uploads/2016/07/Fall2014BPEA_Eberly_Krishnamurthy.pdf

Federal Housing Finance Agency. 2017. "FHFA Announces Modifications to High LTV Streamlined Refinance Program and Extension of HARP Through December 2018." Press Release, August 17.

Finkelstein, David, Andreas Strzodka and James Vickery. "Credit Risk Transfer and De Facto GSE reform". This volume.

Frame, W. Scott, Andreas Fuster, Joseph Tracy, and James Vickery. 2015. "The Rescue of Fannie Mae and Freddie Mac." *Journal of Economic Perspectives*, 29(2): 25-52. <https://doi.org/10.1257/jep.29.2.25>

Freddie Mac. 2017. "Relief Refinance". Bulletin to Freddie Mac Loan Sellers. September 8. <http://www.freddiemac.com/singlefamily/guide/bulletins/pdf/bl1717.pdf>

Frankel, Gyntelberg, Kjeldsen and Persson: The Danish mortgage market. *BIS Quarterly Review*, March 2004.

Fuster, Andreas and James Vickery. 2015. "Securitization and the Fixed-Rate Mortgage." *Review of Financial Studies*, 28(1): 176-211.

Ghent, Andra C. and Marianna Kudlyak. 2011. "Recourse and Residential Mortgage Default: Evidence from US States", *The Review of Financial Studies*, 24(9): 3139-3186, <https://doi.org/10.1093/rfs/hhr055>.

Green, Richard, K., and Susan M. Wachter. 2005. "The American Mortgage in Historical and International Context." *Journal of Economic Perspectives*, 19(4): 93-114.

Guttentag, Jack. 2010. "Are Mortgage Assumptions a Good Deal?" Mortgage Professor blog post, July 12 2010. https://www.mtgprofessor.com/A%20-%20Options/are_assumptions_a_good_deal.htm

Hsu, Joanne W. and Matsa, David A. and Melzer, Brian. 2017. "Unemployment Insurance as a Housing Market Stabilizer." *American Economic Review*, Forthcoming. Available at SSRN: <https://ssrn.com/abstract=2185198> or <http://dx.doi.org/10.2139/ssrn.2185198>

International Monetary Fund. 2000. "Asset prices and the business cycles", *IMF World Economic Outlook*, May.

Kalotay, Andrew. 2015. "The Case for the Ratchet Mortgage". Presentation at the Federal Reserve Bank of New York conference on Mortgage Contract Design: Implications for Households, Financial Stability and Monetary Policy, May 20-21. Presentation slides available at: https://www.newyorkfed.org/medialibrary/media/research/conference/2015/mortgage_design/kalotay.pdf

Kane, Edward J. 1989. "The S&L Insurance Mess: How Did it Happen?" Urban Institute Press.

Keys, Benjamin, Devin G. Pope and Jaren C. Pope. 2016. "Failure to Refinance", *Journal of Financial Economics*, 122(3): 482-499.

Lea, Michael. 2010. "International Comparison of Mortgage Product Offerings". Research Institute for Housing America White Paper.

Meuli, Jonas, Thomas Nellen and Thomas Nitschka. 2017. "Securitization, Loan Growth and Bank Funding: The Swiss Experience Since 1932." Working Paper, Swiss National Bank.

Møller, Michael and Niels Christian Nielsen. 1997. "Dansk realkredit gennem 200 år" (translation: Danish mortgage financing through 200 years). BRFKredit.

Passmore, Wayne. 2005. "The GSE Implicit Subsidy and the Value of Government Ambiguity." *Real Estate Economics*, 33: 465-486. doi:10.1111/j.1540-6229.2005.00126.x

Vickery, James, and Joshua Wright. 2013. "TBA Trading and Liquidity in the Agency MBS Market." *Federal Reserve Bank of New York Economic Policy Review* 19:1-18.

White, Michelle, J. 2007. "Bankruptcy Reform and Credit Cards." *Journal of Economic Perspectives*, 21(4): 175-200.

Willen, Paul. 2014. "Mandated Risk Retention in Mortgage Securitization: An Economist's View." *American Economic Review*, 104(5): 82-87. DOI: 10.1257/aer.104.5.82

Figure 1: Outstanding covered bonds, 2016, EUR bn

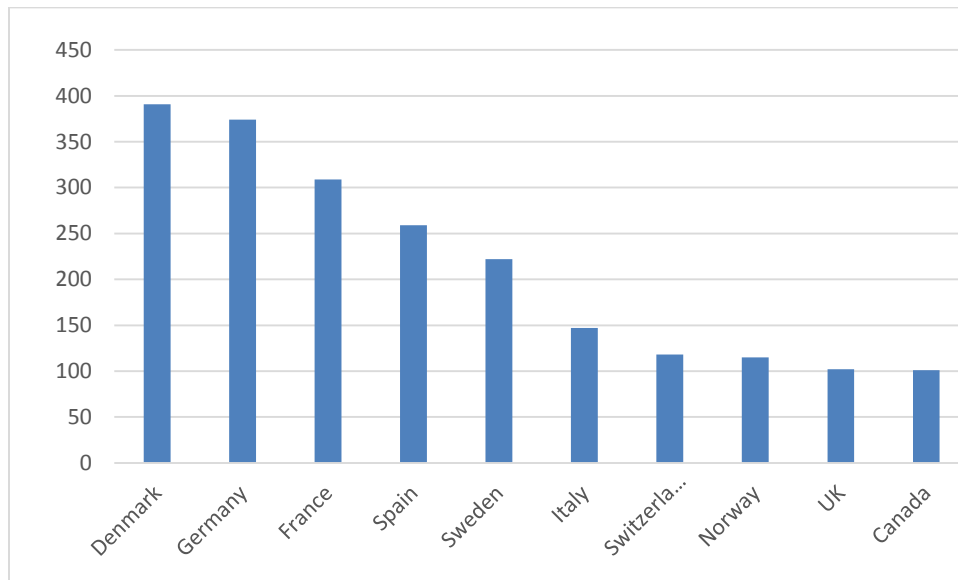
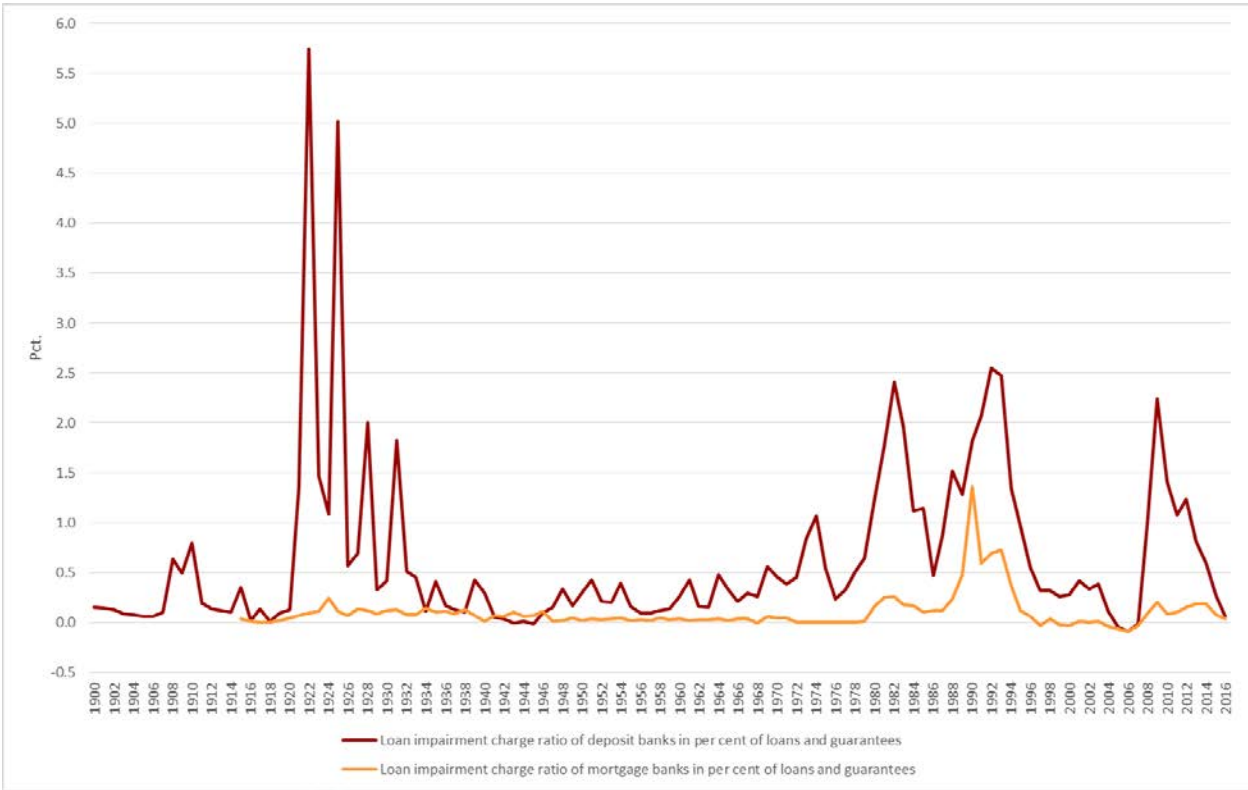


Figure note: Statistics in the graph cover all types of covered bonds backed by mortgages or public sector assets, for major European markets and Canada. Data is as of year-end 2016.

Source: ECBC Factbook, 2017.

Figure 2: Credit loss rates on Danish covered bond assets and bank loans

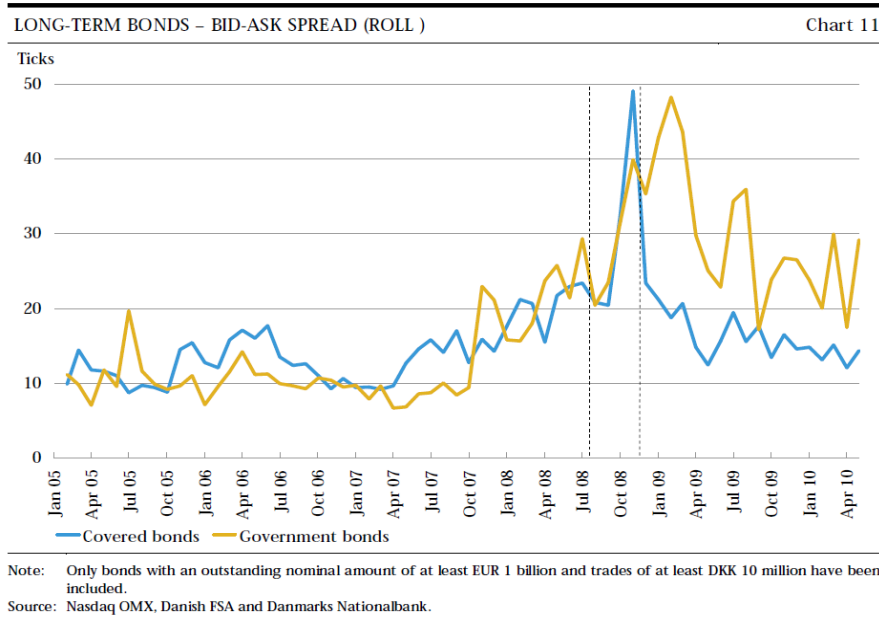


Notes: Figure shows annual credit loss rates for mortgage banks and deposit banks.

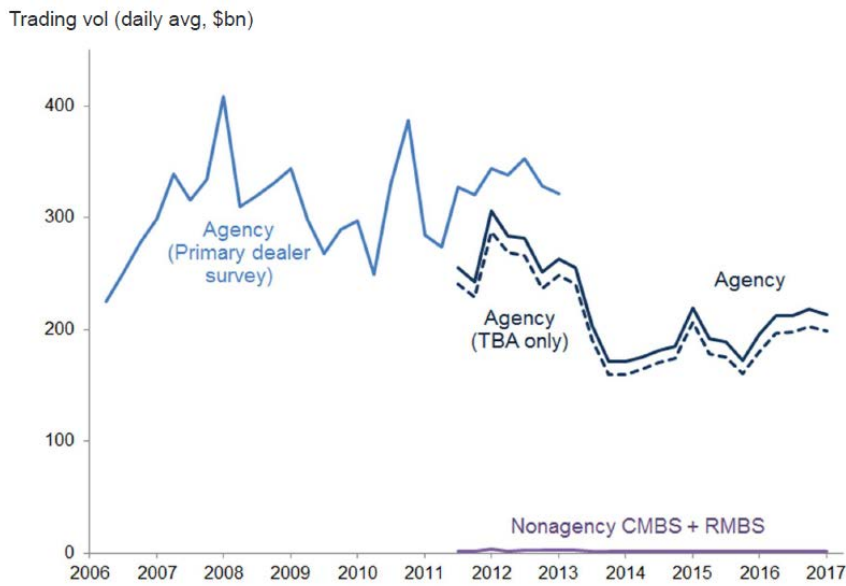
Source: Danmarks Nationalbank.

Figure 3: Mortgage bond liquidity during the crisis

A. Bid-ask spread in Denmark



B. U.S. MBS trading volume



Source: SIFMA

Figure 4: Danish mortgage credit institutions capital ratios, 2001-2016



Notes: Figure based on Basel I regulation 2001-2007; Basel II regulation 2008-2013; Basel III regulation 2014-. Basel standards are transformed into European regulation and directives (CRR/CRD). Data is reported by institutions at a consolidated level.

Source: Firm filings to the Danish FSA.

Table 1: Mortgage funding in Denmark and the US

	Denmark	United States		
		Agency securitization	Nonagency securitization	Balance sheet lending
How are loans funded?	Capital markets	Capital markets	Capital markets	Deposits or FHLB advances
Capital markets instrument	Covered bonds	Agency MBS	Nonagency MBS	n/a
Originator retains the credit risk?	Yes	No	No	Usually
Borrower can repurchase mortgage from secondary market pool?	Yes	No	No	n/a
Who bears:				
Interest rate risk?	Investor	Investor	Investor	Bank
Prepayment risk?	Investor	Investor	Investor	Bank
Credit risk?	Mortgage bank	Fannie Mae, Freddie Mac or U.S. government	Investor	Bank

Table 2: Primary mortgage markets in Denmark and the U.S.

	Denmark	U.S.
<i>Mortgage contract design</i>		
Long-term fixed rate mortgages available?	Yes	Yes
Maximum fixed rate term?	30 years	30 years
Mortgages prepayable on demand?	Yes	Yes
Mortgage is assumable in a property sale?	Yes	Usually not
Refinancing requires underwriting?	Not with same lender	Usually
Other mortgage types available?	ARMs Floating rate Capped floating rate	Hybrid ARMs, reverse mortgages, HELOCs
<i>Default and underwriting standards</i>		
Recourse in case of default?	Full	Limited
Maximum first-lien mortgage loan-to-value?	80%	97-100%
<i>Role of government</i>		
Government provides mortgage insurance?	No	Yes
Mortgage interest is tax deductible?	Yes	Yes
<i>Market size and structure</i>		
Mortgage debt outstanding (\$bn)	470	10,600
Concentration: Market share of four largest mortgage lenders	100%	18%

Notes: Data sources for market size and structure: Financial Accounts of the United States, Bloomberg, Home Mortgage Disclosure Act data.