The Danish and the American mortgage system

A comparative analysis of two mortgage systems

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Executive Summary

The Danish and the US mortgage models have often been portrayed as similar, as they both provide homeowners with access to long-term housing financing. In an attempt to clarify the similarities and differences between the two models, this thesis seeks to *'Illustrate the differences between the Danish and the US mortgage system, and analyze if the Danish mortgage model provides borrowers with a more optimal system'*. A theoretical framework is presented in order to clarify the fundamentals behind a mortgage system and the factors that make the two mortgage systems successful. The theoretical framework is based on theories on efficient markets, liquidity and interest rate determination. A historical introduction the Danish and the US mortgage market is provided and the current mortgage market model for both systems is presented. In the comparative analysis of the two models, it is found that the largest differences lie in the prepayment options, the securitization model, the standardized loan terms, and the balance principle. Through the theoretical framework, it is argued that the Danish model provides the highest level of operational, and informational efficiency, while the US model has the highest degree of market liquidity. The theory on interest rates is used to assess the future development in interest rates between the two nations. It is found that inflation is expected to increase in Denmark over time, relative to the US. Further, it is found through an analysis of the spread between the 30-year FRM and the 10-year government bond that the US spread has decreased to such an extent that the premium on US mortgage almost exclusively consists of a prepayment premium. The analysis states that the narrowing of the spread is partly due to the large-asset purchase program conducted by the Federal Reserve System of the United States. The discussion addresses the idea of implementing the buy-back prepayment option of the Danish mortgage model into the US mortgage model. Further, the current state of liquidity on the Danish mortgage market is discussed. It is concluded that despite the higher level of liquidity of the US mortgage model and the narrower spread between the 30-year fixed-rate mortgage bonds and the 10-year government bond, the Danish model still provides the optimal system for mortgage borrowers. This conclusion is based upon the structural simplicity, the higher level of safety, the balance principle and the buy-back options that

all together provide the Danish borrowers with a more optimal mortgage system compared to the US equivalent.

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Table of abbreviations

ABS	Asset backed securities
APR	Annual percentage rate
ARM	Adjustable-rate mortgages
B&L	Building and Loan
CIBOR	Copenhagen Interbank Offered Rate
CIP	Covered Interest Parity
CITA	Copenhagen Interbank Tomorrow/Next Average
CLL	Conforming Loans Limit
CMT	Constant Maturity Treasury
ECB	European Central Bank
EMH	Efficient Market Hypothesis
FHA	Federal Housing Administration
FINRA	Financial Industry Regulatory Authority
FIRREA	Financial Institutions Reform Recovery and Enforcement Act
FRM	Fixed rate mortgage
HOLC	Home Owners' Loan Corporations
HUD	Housing and Urban Development
IO	Interest rate only
IRP	Interest Rate Parity
LIBOR	London Interbank Offered Rate
LTV	Loan-to-value
MBS	Mortgage-backed security
OTC	Over-the-counter
PMI	Private mortgage insurance
PPP	Purchasing Power Parity
QE	Quantitative easing
S&L	Saving and Loan
SDO	Særlig Dækkede Obligationer
SIFMA	Securities Industry and Financial Market Association
SPV	Special purpose vehicle

TBA	To be announced
TRACE	Trade Reporting and Compliance Engine
UIP	Uncovered Interest Rate Parity

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Introduction

The Danish mortgage model has it roots in 1795 with the Great Fire of Copenhagen, and played a vital role in the reconstruction of Copenhagen. The first law on the Danish mortgage model was passed in 1850 and established the regulatory framework of the underlying security of the issued instrument of debt. In the late 1800s the Danish mortgage model allowed farmers to transit from plant-based agricultural production to an animal-based agricultural production, and facilitated the industrial revolution by providing loan possibilities in Copenhagen and other large cities in Denmark (Østrup, 2011). Today, more than 165 years after the first law on the Danish mortgage model was passed, the model has changed significantly, most recently with the division of the balance principle. However, the Danish mortgage model has been and still is a fundamental part of the efficient and stable housing market and Danish economy.

Similar to the creation of the Danish mortgage model, the American mortgage model as we know it today, was created in the wake of an economic disaster. The Great Depression during the 1930s in the US caused a dramatic decline in property value, and as borrowers were unable to repay or refinance their mortgages, a wave of defaults and foreclosures brought the housing market to its feet. In an attempt to stabilize the housing finance market, the US government created the Home Owner's Loan Corporation, The Federal Housing Administration, and The Federal National Mortgage Association (Fannie Mae). Fannie Mae's main objective was to increase funding of mortgage loans by creating a secondary market. In 1970, The Federal Home Loan Mortgage Corporation (Freddie Mac) was established and the following 30 years were characterized by market dominance and expansion. When the financial crisis of 2007-2008 hit, the US mortgage market suffered as both Fannie Mae and Freddie Mac had taken massive risks in the years leading to the financial crisis. Both ended up being nationalized and delisted from the stock exchange. The US mortgage market survived the crisis with the help of government backing and large-asset purchase programs, which allowed the market to function to this day.

In relation to past and current information on the Danish and the US mortgage model, this thesis examines the two markets individually and seeks to clarify the differences between the Danish and the US mortgage market. Theories on efficient markets, liquidity and interest rate determination are reviewed in order to establish the fundamentals behind the mortgage markets. A historical perspective is used to provide the reader with an understanding of the development and the current structure of the Danish and the US markets. The theoretical framework is used in the analysis to answer the questions raised in the problem statement. The inclusion of a discussion is made in order to discuss the current and future challenges faced by the two models.

Problem statement

In relation to the above, the aim of this thesis is to:

Illustrate the differences between the Danish and the US mortgage system, and analyze if the Danish mortgage model provides borrowers with a more optimal system.

Methodology

The following sections presents the structure of the thesis and its key components.

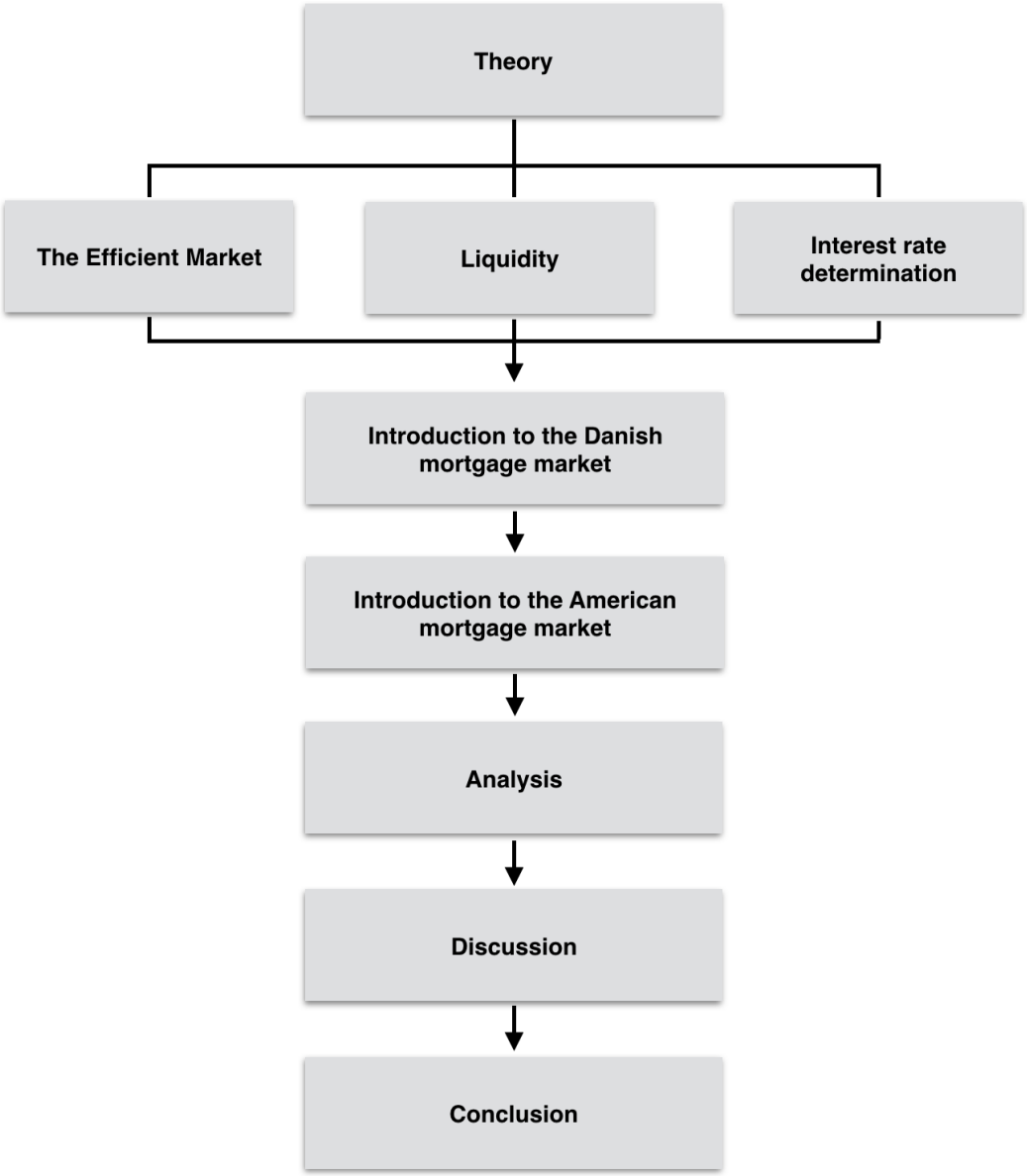

Figure 1. Thesis composition, own work.

As visible in Figure 1, this thesis is divided into four main elements. The introduction of the Danish and the US market is done through a historical perspective, presenting factors that have shaped the two systems, to provide an understanding of the current structure of the mortgage market in Denmark and in the US.

The theoretical section introduces theory on the efficient market, liquidity, and interest rate determination. The third section, the analysis, draws on knowledge introduced in the previous sections and seeks to answer the questions raised in the problem statement. The fourth sections provides a discussion of the findings in the analysis, and lastly the thesis is summed up in a conclusion.

Deductive Method

The deductive approach is used to analyze the quantitative data in this thesis. It will allow the thesis to establish a cause-and-effect relationship between the chosen parameters. The deductive approach has proved its validity by being the dominant research approach in natural sciences, connecting research and theory. The approach allows the thesis to deduct a hypothesis, which is subject to the collected empirical data, allowing the findings to either reject or confirm the proposed hypothesis.

Limitations

The focus of this thesis will primarily be the Danish and the US mortgage system and the 30-year fixed-rate mortgage (FRM) bonds. Both Danish and American government bonds will be introduced in the analysis, but a comprehensive review of government bonds and their structure will not be introduced. Theory on pricing and pricing analysis of US and Danish mortgage bonds will not be introduced as it reaches beyond the intended purpose of this thesis. It addresses the differences between the Danish and US mortgage market and examines the two systems from a borrower's point of view; therefore, introduction of subjects that concerns portfolio theory and asset pricing models has been omitted.

Data Analysis

This thesis introduces a data analysis that seeks to provide better information and understanding of the aspects in the Danish and American mortgage model. The data analysis is based on information from public and non-public available distributors. Public information is primarily available through the National Bank of Denmark, the Federal Reserve, Securities Industry and Financial Market Association (SIFMA), and Nasdaq OMX.

The non-public data is primarily made available through sources as Datastream, Nordea Analytics, and Bloomberg Terminal. I characterize the above sources as highly reliable.

Datastream

Datastream is used as a reliable source of information for this thesis. The service holds an impressive amount of data on both American and Danish bonds and is provided by Reuters, a company generally known for their reliability.

According to their own website, Datastream holds the great benefit of owning more of the important data sources than any of their competitors[1]. Further, Datastream provides easy access to a large amount of predefined bond categories combined with the ability for customization, both in terms of choosing the desired security or securities as well as defining the historical data. Datastream is available through CBS' Learning Resource Center at Solbjerg Plads.

Nordea Analytics (a part of Nordea e-Markets)

Nordea Analytics is a service provided by the Nordic bank Nordea. This service is commonly used by bond analysts in Denmark as it holds a large amount of data on Danish mortgage bonds. Through Nordea Analytics it is possible to obtain information on yields, macro overviews and historical data.

The National Bank of Denmark and NASDAQ OMX

A large amount of data on the Danish mortgage market used in this thesis is made available through the National Bank of Denmark, 'Statistikbanken' and NASDAQ OMX. 'Statistikbanken' or StatBank is a gathering of financial statistics concerning interest rates, mortgage banks, and security trading among other things. The database is free of charge for all users. Nasdaq OMX was formerly known as 'Fondsbørsen' but a grouping of

[1] http://financial.thomsonreuters.com/en/products/tools-applications/trading-investment-tools/datastream-macroeconomic-analysis.html

the Nordic exchanges has brought all information under one roof, in theory making it easier to gather information.

The Federal Reserve, SIFMA and FINRA

As with the National Bank of Denmark, the Federal Reserve (FED) provides a StatBank holding data on the financial accounts and outstanding mortgage debts in the US. The StatBank is free to use, however, the available data is not as detailed as the data provided by the National Bank of Denmark.

SIFMA is an industry trade group, which represents a large amount of the American Financial sector. SIFMA provides data on the American mortgage market but the free access is highly limited as they also provide a paid service.

The Financial Industry Regulatory Authority (FINRA) is a non-governmental and not-for-profit organization, which, in their own words, provides protection for the American investors. Their Trade Reporting and Compliance Engine (TRACE) holds a large amount of historical data on both public trades and over-the-counter (OTC) trading in the American mortgage market.

THEORY

Literature review on efficiency and liquidity

Different studies have been conducted on the efficiency of the different securities markets around the world. To give the reader a better understanding of these previous studies, the following sections introduce studies of efficiency and liquidity on both the Danish and the American securities markets.

Early theories on the Efficient Market Hypothesis (EMH) stated that in an efficient capital market all available information has already been incorporated in security prices. In 1970, Eugene Fama introduced the groundbreaking theory that the efficient capital market could exist in three forms (Fama, 1970). Following Fama's famous article on EMH, Steven Katz decided to test the hypothesis of semi-strong efficiency on the

American bond market (Katz, 1974). Katz studied the price adjustments following changes in bond ratings and his empirical data suggests a lag in price adjustments following a public announcement of changes in rating. The data further suggests that no anticipation is registered prior to announcements. On this basis, he concludes that the bond market might be inefficient.

In 1990, Finn Østrup wrote the article 'Pricing of small bond series' (Østrup, 1990) in which it is argued that in a market with effective arbitrage, a large number of bond series should not affect the pricing of bonds, as the effective arbitrage would offset yield differentials between the individual bond series. The article describes, based on market observations, that on the Danish market, there are large differences between the individual bond series' turnover rates, which affects pricing. It is therefore concluded that the Danish mortgage market is not arbitrage effective.

Delvin D. Hawley and Mark M. Walker investigated efficiency in the high-yield debt market (Hawley & Walker, 1992). Their findings show that it is possible to achieve abnormal returns when choosing better-rated bonds compared to lower rated bonds in the high-yield market.

In relation to the Maastrichts agreement in December 1991, Østrup wrote an article on the consequences of a European Monetary Union for the financial markets (Østrup, 1992). Among other things, the article states that pricing of floating-rate and index-linked bonds were inefficient due to analysts' ignorance on pricing of these bonds on the Danish market.

Henrik D. Sørensen examined the liquidity on the Danish bond market between 1985 - 1992 (H. Sørensen, D, 1993). He found that less than five percent of the Danish bonds are traded daily, and more than eighty percent of the bonds have a very poor turnover rate - especially mortgage bonds holds a low turnover rate. He concludes that the poor liquidity is mainly due to the vast amount of rarely traded mortgage bond series.

In 1995, Bjarne G. Sørensen published an empirical study on the Danish bond market. The study focused on three bonds series and tested whether or not there was efficient pricing in the market (B. Sørensen, G., 1995). Through the examination period from

1988-1992, the study showed systematic imbalances in the pricing of the three series. As of this, Sørensen concluded the Danish bond market to be inefficient.

An Examination of the US Treasury market, through analysis of intraday bid and ask spreads (Balduzzi, Elton, & Green, 2001) found that several news announcements significantly affect the price of securities, and that the effect differs when looking at maturity. However, they found that bid-ask spreads revert quickly to normal levels, indicating that public information is quickly incorporated in prices.

In 2012, Friewald, Jankowitsch and Subrahmanyam examined the liquidity of the fixed income market in the US. They compared the liquidity of different fixed income products with the information available and found that fixed income products issued by federal agencies tend to have a higher level of liquidity (Friewald, Jankowitsch, & Subrahmanyam, 2012).

Examining the 'to be announced' (TBA) market of US mortgage bonds, Vickery and Wright found that the availability of the TBA market increases mortgage-backed security (MBS) prices and lowers the mortgage interest rates, as a consequence of the increased liquidity associated with the TBA market (Vickery & Wright, 2013).

In an attempt to clarify the current status of liquidity on the Danish mortgage bond market, the National Bank of Denmark published a quantitative study on liquidity in the Danish market. They concluded that the liquidity still existed but the volatility of the liquidity had increased. They further concluded that the market maker approach was of great importance for the liquidity level (National Bank of Denmark, 2015). In a response to the study by the National Bank of Denmark, 'Børsmæglerforeningen' published a qualitative study. This study argued that liquidity on the Danish market has been steadily declining because of the vast amount of bond series, regulations for the EU, and the market makers unwillingness to take positions on their balances to the same extent as before (Børsmæglerforeningen, 2016).

The Efficient Market Hypothesis

In order to understand the theory of efficient markets, this section will seek to enlighten the different types of efficiency. The most known definition of the efficient market was

proposed by Eugene Fama in the paper ‘Random Walks in Stock Market Prices’ (Fama, 1965). The early theory stated that in an efficient capital market, all available information has already been incorporated in security prices (Elton, Brown, Gruber, & Goetzmann, 2011). Fama defined the efficient capital market as:

> “An ‘efficient’ market is defined as a market where there are large numbers of rational, profit-maximizers actively competing, with each trying to predict future market values of individual securities, and where important current information is almost freely available to all participants” (Fama, 1965).

In 1970 Fama defined the three forms or states in which the efficient capital market can exist (Fama, 1970); i) weak-form, ii) semi-strong-form iii) strong-form. The three forms are used to grade the efficiency in the capital market.

In the weak-form, investors cannot create above-normal returns with the use of the financial analysis method called “technical analysis”. Technical analysis is set out to give investors guidance and advice based on historical information on prices and returns (Copeland, Shastri, & Weston, 2014). In the weak-form this information is already incorporated in security prices, making it impossible to act on it. Looking at historical yield spreads and prices therefore will not help the agent in creating above-normal returns (M. Christensen, 2014).

In the semi-strong-form, all public available information in addition to all historical information is reflected in prices. Public available information like annual reports or investment advisory data (Copeland et al., 2014) is already incorporated in prices, making impossible to make above-normal returns. Categorizing bonds as cheap or expensive will therefore have only symbolic value and is not an accurate term. The price of the bond or any other asset is the best estimate of the value of the given bond (Malkiel, 2003).

In the strong-form of efficiency, all historical, all public and all non-public information is incorporated in the prices of any asset. The all non-public information also includes insider information, meaning that prices reflect all existing information (Ackert & Deaves, 2010). As such, the EMH is concerned with, under which circumstances it is impossible for investors to make above-normal returns on their investments (Elton et al., 2011).

In accordance with Fama's definition of the different forms of efficient capital markets, a perfect capital market exists when prices of assets reflect all information (M. Christensen, 2005), i.e. the market is informationally efficient (Copeland et al., 2014). Michael Jensen supported Fama's view on information and claimed it was impossible to make economic profits by trading on information (Jensen, 1978). Jensen further argued that the EMH was the most well documented hypothesis in terms of empirical evidence.

However, the perfect capital market can only exist under the assumption that the following criteria are present; i) informationally efficient – as mentioned above, ii) frictionless markets (operational efficiency), iii) perfect competition in securities markets (allocational efficiency), iv) all individuals must be rational (Copeland et al., 2014). The terms allocational and operational efficiency are described below.

Allocational efficiency

The phrase allocational efficiency refers to a market in which prices are determined in such a way that the marginal rate of return, adjusted for risk, is equal for all producers and savers (Copeland et al., 2014). Further, savings or resources are allocated in such a way that it benefits the whole, thereby creating greatest possible value for the whole (Copeland et al., 2014). With the above in mind, the market for mortgage financing through bond investments, creates the possibility for placement of capital in assets, which benefits the whole.

Operational efficiency

Operational efficiency refers to the cost of fund transferring. In a perfect capital market, the costs would be equal to zero and the market would be perfectly liquid. However, even with the conditions mentioned above in place, the market would not be perfect as the cost of transferring also include risks, making it near impossible to achieve a perfect capital market (Copeland et al., 2014).

In the real market or the imperfect capital market, the actions of fund transferring comes at a cost, therefore, minimizing cost and keeping the market liquid is of great

importance. Keeping cost low and the bond market liquid are main components in markets that allow the issuance of mortgage and investment in mortgage.

Information efficiency and value

The cost of acquiring information in the perfect efficient market should be equal to zero. However, in the efficient capital market this is not necessarily the case. A model proposed by Cornell and Roll in the article 'Strategies for Pairwise Competitions in Markets and Organizations' (Cornell & Roll, 1981) shows that the average investor using costly information in their analysis of investments will outperform, those who seek and make use of lesser information. However, this only applies to gross return, the net return will be equivalent for both (Copeland et al., 2014). The fact that the net return stays the same for investors regardless of their use of costly information argues that the efficient capital market can exist despite existence of costly information.

The inefficient market – barriers for the EMH

In the article 'On the Impossibility of Informationally Efficient Markets', Grossman and Stiglitz argues that if the perfect efficient market should exist, then there would be no incentive to collect information. For a market to be perfectly informationally efficient, information would have, as mentioned above, to come at zero cost. But if all information was available at zero cost, then spending time and costs on analyzing and obtaining information would award investors with no premium, making it undesirable to gather information (Grossman & Stiglitz, 1980). Following the trail of thoughts from Grossman and Stiglitz about the inefficient market, Fischer Black argues that investors are not fully rational. In fact, investors act on irrelevant information and Black labels this irrelevant information as 'noise' (Black, 1986). The noise causes investors to sell winning stocks and hold loosing stocks. They actively trade stocks and follow popular models, making them in fact irrational (Shleifer, 2000). Further, prices on assets are affected by noise, meaning that asset prices both reflect information and noise. This noise will according to Black make it more profitable for the informed investors to trade solely based on information (Black, 1986). Noise gives the informed investor the

opportunity to make above-normal returns, as price of a given asset does not reflect its fair value. As an argument against noise, EMH proposes that if arbitrage possibilities are created, these will quickly be adjusted such that investors cannot achieve abnormal returns.

The efficient capital market

The efficient market can still exist even if the market is not entirely frictionless. Financial systems are constructed in such a way that brokerage fees and similar transaction costs exist, factors that create friction. Therefore, the requirement of a frictionless financial system cannot maintain its validity. However, even with frictions in the market, prices will still fully reflect all available information (Copeland et al., 2014).

If imperfect competition occurs, the efficient capital market can still be justified. If imperfect competition exists in the form of biasing, favoring companies over others or monopoly, the market will be able to incorporate this information of imperfect competition into prices.

The efficient capital market is dependent on a level of operational efficiency and allocational efficiency. The allocational efficiency is needed in order to secure that assets prices reflect all relevant information; this enables assets to flow and maximize returns. Further, the operational efficiency secures that the cost of asset flowing from savers to investors is kept at minimum cost (Copeland et al., 2014).

Liquidity

In continuation of the EMH, it would be obvious to examine the theory of liquidity on securities markets. The existence of liquidity in the market often entails efficiency in the market and vice versa. Liquidity refers to the ease of which large quantitates of securities can be realized i.e. traded, in relation to both speed and cost (Chordia, Sarkar, & Subrahmanyam, 2005; International Monetary Fund, 2015). A market where products are not easily realized will therefore, in theory, be categorized as illiquid.

Liquidity of a bond market can be determined in a number of different ways; realized trades, bid-ask spread, turnover rate, alongside transaction cost are among the key indicators.

When analyzing a market's liquidity, tightness, depth in the market, immediacy, and resilience, are often used indicators. The following section will review these four indicators (International Monetary Fund, 2006). i) Tightness refers to the bid-ask spread, a key indicator of liquidity on securities markets. The narrower the spread, the greater the liquidity and vice versa (Amihud & Mendelson, 1986). Both the bid and the ask quotes reflect a premium for the service of an immediate transaction, therefore, the narrower the spread the smaller the premium required to facilitating the transaction (Amihud & Mendelson, 1986). ii) Market depth refers to the ability of which the given market is able to realize large trade volumes without moving market prices significantly. Market depth is often measured by turnover ratio, with a higher turnover ratio indicating a more liquid market and vice versa. iii) Immediacy is the speed at which trades can be realized. The speed or the efficiency depends at large on the efficiency of clearing and settlement systems. iv) Resilience refers to the correction time of price movements and order imbalances. Resilience is measured by the Hui-Heubel ratio, which is the relation between volumes of trades relative to the percentage price change. A lower value indicates a larger amount of resilience i.e. a more liquid market (International Monetary Fund, 2006).

Interest rates

The interest rate is among the most influential economic indicators and it is a very strong tool for central banks to keep the economy stable. Fear of low or high inflation is as key concern for central banks around the world, and changes in the interest rates is a preferred tool when it comes to controlling inflation. The interest rate or the market rate is further a large influencer on the coupon of bonds and the interest payed on mortgages.

The interest rate is the price of money i.e. the premium, lenders receive for lending their capital and thereby decrease their liquid assets. The willingness to lend is in large

affected by the premium lenders receive; this is described in detail in the section ‘liquidity preference’. It is the price borrowers pay to take out a mortgage or any other loan (Clacher, Hillier, Jordon, & Westerfield, 2011).

The premium is determined by demand and supply; if the supply is large e.g. credit institutions and banks are willing to lend out capital, then the interest rate will decrease and vice versa. The demand for money is affected heavily by the current investment climate and expectations for the future. Uncertainty about international and national policy tends to stagnate the demand for money.

Globalization has brought many changes to the modern world, such as the free movement of capital, which allows investors to invest in foreign economies at a higher level than previously. The possibility to lend or borrow across borders, as well as buying and selling of securities and foreign currency, has created a closer relation between developed countries’ interest rates. Differences in countries’ interest rates can be explained by the inflation premium, the default risk premium, the liquidity premium, and the maturity premium. If interest rates around the world were not affected by these premium, large arbitrage possibilities would exist in the world of international speculation. The premiums of the interest rate are described in detail in the section below. The process of international interest rate determination will also be described in greater detail through the theories on Purchase Power Parity, Covered and Uncovered Interest Rate Parity and the International Fisher Effect.

The Components of the Interest Rate

To give a better understanding of the components of the interest rate or to understand the risk premium that investors demand for holding a given security, the following section highlights the five components of the interest rate. These components are referred to as the real risk-free interest rate and the four risk premiums; i) the inflation premium, ii) the default risk premium, iii) the default risk premium and iv) the maturity premium. The real risk-free interest rate is the single period interest rate of a risk-free security, often in the form of short-term government bonds. i) The inflation premium is the compensation that investors demand for the expected future inflation. As described

in detail in the section of Purchase Power Parity, inflation decreases the purchasing power of a unit of currency. The nominal interest rate is the real rate plus the inflation premium. ii) The default risk premium is, as the name implies, the premium that compensates investors for the risk of borrower default. iii) The liquidity premium is the compensation investors demand for the risk of loss when a given security has to be transformed into cash. If large quantities of a security can be traded without affecting the price, the liquidity premium will decrease, and vice versa. The liquidity premium is elaborated in the section on Liquidity Preference. iv) The maturity premium is the premium that investors demand for uncertainty about future changes in the market interest rate. Longer maturity increases the sensitivity of the market value of debt-securities to a change in market interest rates, meaning that the maturity premium is positively correlated with maturity (DeFusco, McLeavey, Pinto, & Runkle, 2016).

The Effect of Liquidity

The term ‘liquidity effect’ describes the relationship between changes in the money supply and the nominal interest rate. The ‘liquidity effect’ is present when an increase in the money supply forces nominal interest rates to depreciate for a short period. Described in greater detail later, Friedman argues that an increase in the money supply would cause inflation to increase, leading to a decrease in nominal interest rates. Milton Friedman argues that an increase in money supply, would cause the nominal rate to decrease, causing inflation to increase and thereby decreasing real interest rates (Edmond & Weil, 2005; Friedman, 1968; Grossman & Weiss, 1983).

A change in money supply is labeled as monetary policy and is exercised by monetary authorities e.g. the FED and the National Bank of Denmark. Monetary authorities can among other things increase or decrease the money supply in an open economy by buying or selling government bonds. This intervention in markets by national banks and central banks is called ‘open market operations’. Buying bonds in the market will increase the available liquidity in the market i.e. the money supply (Hamilton, 1997).

Credit Risk

As information about future income and wealth is very hard to obtain, it is only possible for the originator of a loan to justify the loan based on current income and wealth. Future events are unpredictable, and therefore uncertainty about future installments on the mortgage arises. This uncertainty is called the credit risk and by providing collateral in the form of property, the lender is able to reduce the potential credit risk.

Through times, housing prices have fluctuated meaning that the value of the provided collateral changes. In order to reduce the risk factor of fluctuating housing prices, some loans ascribe the originator to maintain a certain loan-to-value ratio by providing ongoing collateral.

Monetary Policy - Central Banks

The National Bank of Denmark is responsible for the monetary policy in Denmark. As a consequence of the European Union, the National Bank of Denmark has to a large extent followed the monetary policy of the European Central Bank (ECB). The Danish yield curve is closely related to the European yield curve, in large due to the fact that Denmark conducts a fixed exchange-rate policy against the euro. Though the Danish krone has a fixed exchange-rate policy towards the euro, the krone is allowed to fluctuate around +/-2.25 pct. against the euro (National Bank of Denmark, 2016). The fixed exchange-rate of the Danish krone against the euro means that the short-term bond yields in Denmark are affected by the monetary policy of the ECB. As the krone is pegged to the euro, the main objective of the National Bank of Denmark is to ensure stable prices and low inflation; this is achieved through changes in the exchange rate policy and in the monetary policy interest rates. When foreign exchange markets are relatively stable, the National Bank of Denmark follows the monetary policy interest rates of the ECB (National Bank of Denmark, 2016). However, in cases of large inflows or outflows of capital, downward or upward pressure on the krone, the National Bank of Denmark is able to deviate from ECBs monetary policy in order to maintain the fixed exchange-rate policy.

The American FED has a greater variety of options and tools to pursue an independent monetary policy. The FED is responsible for open market operations (OMO), the discount rate, and reserve requirements. Using these three tools the FED is able to alter the depository rate also called the federal fund rate. Alterations in the federal fund rate affects the short-term interest rates and foreign exchange rates among other things (The Federal Reserve, 2016). A target for the FEDs fund rate is set eight times a year by The Federal Open Market Committee. The rate is essentially determined by the market, but the FED influences the rate through open market operations in order to reach the predefined target.

In both the Danish and American economies, changes in short-term overnight funding rates affect the mortgage rates. Mortgage rates are often long-term interest rates, and as these are affected by changes in the short-term interest rates, they reflect the current and expected future value of short-term rates (The Federal Reserve, 2016).

In an attempt to influence long-term rates, both the FED and the ECB has since 2008 pursued quantitative-easing programs (QE). Essentially, these programs are purchase programs which by buying longer-term MBS and government bonds aim at driving the long-term interest rates down, in an attempt to stimulate inflation and growth in both Europe and the US (The Federal Reserve, 2016).

Existing literature on interest rate determination

In 1963, Arthur Okun studied the correlation between changes in supply of government securities and yields. The aim was to establish whether changes in maturity composition on government debt would have an effect on yields. He concluded that the effect was in fact very little (Okun, 1963).

With the empirical study ‘The Sensitivity of Interest Rates to Changes in Money and Income’ from 1968, Gibson and Kaufman found that the monetary policies in the US had little effect on Bill rates, as the interest rate was instead affected by consumption, employment, investments, prices and wages which they labeled ‘the real sector’ (Gibson & Kaufman, 1968).

Another empirical study from 1969 concluded that the findings of Gibson and Kaufman were inadequate, and monetary policies have an effect on US Bill rates (Hamburger & Silber, 1969).

In 1989 Anders Møller Christensen and Dan Knudsen examined the changes in interest rates in Denmark in the years 1975-1988 (A. Christensen, M. & Knudsen, 1989). They found that the Danish bond rate was closely linked to the German bond rate and the expected change in exchange rates.

An empirical study from 2001 on the differences in interest rates between conforming and jumbo mortgage in the US, concluded that other financial markets have a large impact on the spread between the two loan types. The jumbo market is less liquid and carries a larger credit risk, which in economic slowdowns leads to a widening of the spreads between conforming and jumbo mortgage rates (Torregrosa, 2001).

A US study from 2015 examined the consequences of FEDs large-scale asset purchases program. It found that the first quantitative easing (QE1) put downward pressure on the yields and lowered longer-term interest rates, thereby lowering mortgage rates and helped support the US mortgage market (Hancook & Passmore, 2015).

External factors

International trade has opened national economies to international financial markets, this development has left national monetary policies much more affected by external factors such as QE's, interest rate adjustments by central banks, and large in- or outflow of capital. A recent example of large capital inflows was experienced in 2015 when Denmark experienced a speculative attack when large international investors put upward pressure on the EURDKK peg. The large inflows of capital caused the EURDKK exchange rate to fluctuate as the National Bank of Denmark defended the DKK with interest rate cuts, a suspension of government bond issuing, and amassment of foreign reserves (Skovgaard, 2015).

The integration of markets

Trading across borders has raised questions on the integration of market for tradable goods and services. In modern economic theory, the perfect integrations of goods across countries is present when, i) there is full information concerning market conditions, and, ii) when there are not obstacles for trade, and transportation cost is equal to zero. This implies that a tradable good can be sold or purchased at the same price on different markets, if the exchange rate is taken into account. This will cause goods to be trade across borders, when the smallest arbitrage possibility is present (Østrup, 2009).

Purchasing Power Parity

The Purchasing Power Parity (PPP), states that price levels are identical on all markets, when the exchange rate is taken into account (Patterson & Lygnerud, 1999). The PPP can be expressed as:

$$P_t = S_t P_t *$$

P denotes the price level of domestic good, S denotes the nominal exchange rate, and P* the foreign price level. As mentioned above, PPP holds when all goods are tradable and there is a perfect integration of the goods market. This concept of *'Law of one price'* is also known as the 'absolute' PPP, meaning that a good will sell at the same price on all markets, if prices are expressed in the same currency.

Relative PPP, states that the change in exchange rate between the foreign and the domestic countries' currency is determined by the difference between the foreign and domestic inflation rate, expressed as:

$$\%\Delta S_{f/d} \cong \pi_f - \pi_d$$

(DeFusco et al., 2016)

Where $\%\Delta S_{f/d}$ denotes the percentage change of foreign and domestics exchange rate, and π_d denotes the inflation rate in the domestic country and π_f denotes the inflation in the foreign country. Absolute PPP examines the current relationship, while relative PPP examines the changes over a period of time (Moffett, Stonehill, & Eiteman, 2011).

Uncovered interest rate parity

The Uncovered Interest Rate Parity (UIP) originates from the Interest Rate Parity (IRP). The IRP assumes an equilibrium state in which there exists a no-arbitrage condition, meaning that it is impossible for investors to arbitrage, as returns on interest-bearing securities will be unified through adjustments in the exchange rate (Copeland et al., 2014). The UIP assumes that a risk neutral investor should receive the same expected return on investments in both domestic and foreign countries. In addition to the IRP, the UIP assumes that investors are exposed to foreign exchange risk.

The UIP expresses the condition in which the differences in interest rates between two nations are equal to the expected changes in exchange rates between those nations' currencies. In other words the UIP states that the domestic interest rate should be equal to the foreign interest rate when adjusted for the expected exchange rate (Moffett et al., 2011). The UIP is expressed as:

$$i \approx i^* + E(\Delta v | t)$$

where i denotes the domestic interest rate, i^* denotes the foreign interest rate, and $E(\Delta v | t)$ denotes the expected change in the exchange rate (Andersen & Sørensen, 1993). The difference between the UIP and the Covered Interest Parity (CIP), is that the CIP is covered by forward contracts eliminating the future risks of fluctuations in exchange rates i.e. the forward rate (Foy, 2005).

In terms of making investments in domestic and foreign securities, the UIP expresses that the expected return on foreign and domestic securities are equalized. This means that investors should expect to receive the same real return whether they have invested in foreign or domestic financial assets, however, the theory only holds when there is zero cost related to the placement in different securities (Østrup, 2009).

The Fisher Effect

Interest rates are expressed as the relationship between demand and supply for loans. In theory, the equilibrium between supply and demand should determine the interest rate. In macroeconomic terms, interest rates are high in periods with shortage in money supply and low in periods of excessive money supply. Irvin Fisher assumes in his work, 'The Theory of Interest' that the critical determinant for people's willingness to save, is whether they are compensated for the lost utility value during savings. If high enough, the interest rate compensates savers with a higher future value of their savings holding the utility value constant (Fisher, 1930).

The Fisher Effect interprets the nominal rate *i* as the sum of the real rate *r* and the expected inflation π, in other word the nominal interest rates in foreign and domestic country are equal to the required real rate of return plus compensation for expected inflation (Moffett et al., 2011). The Fisher Effect is stated as:

$$i = r + \pi$$

when the Fisher Effect holds, information on expected inflation is fully visible in financial assets, preserving the real rate of return (Levich, 2001). This means that the real rate remains unchanged and the entire inflation is visible in the nominal rate.

The International Fisher Effect states that the differences in nominal interest rates between two countries can describe the expected exchange rate between these countries. The International Fisher Effect is shown in the equation below where S_1 denotes the spot rate a t_o and S_2 the spot rate at t_1, i denotes interest rate in domestic country, while i^* denotes interest rate in foreign country (Moffett et al., 2011).

$$\frac{S_1 - S_2}{S_2} = i - i^*$$

In short, the International Fisher Effect implies that the spot exchange rate should change in an equal amount but in the opposite direction to the difference in the rates

between two countries (Moffett et al., 2011). Meaning that if the domestic interest rate is higher than the foreign interest rate, then the foreign currency must appreciate relative to the domestic currency over the period of the investment.

The Term Structure of Interest Rates

Term structure describes the relationship between duration and yield on default-free, pure discount bonds of all maturities (Lund, 2005). In other words, the term structure describes the value of money for different lengths of time (Clacher et al., 2011).

The term structure is determined by three fundamental components; the real rate of interest, the rate of inflation, and the interest rate risk. The real rate of interests is the premium demanded by investors for providing liquidity. The rate of inflation has a vast impact on the term structure of interest rates, as inflation erodes the future value of an investment. Investors pay close attention to the difference between the nominal and the real interest rate, the real interest being the nominal interest rate adjusted for inflation. The third and last component of the term structure of interest rates is the maturity risk. Longer-term bonds have a greater risk of default than shorter-term bonds. As investors recognize this risk, they demand a premium in the form of higher interest rates for bearing the increased risk. When speaking of the term structure of interest rates, it is important to mention the yield curve. The yield curve and the term structure of interest rates is in fact almost the same thing, their main difference being that the yield curve is not based on pure discount bonds but on coupon bond yields (Clacher et al., 2011). The yield curve is often constructed by plotting the interest rates on bonds with different maturity e.g. the 3-month and the 10-year US Treasury bond.

In order to elaborate on the term structure of interest rates, the following section will try to explain the sharpening of the yield curve.

The Expectation Theory

The Pure Expectation Theory states that long-term interest rates are a reflection of the expectations to the future short-term interest rates (Buse, 1970). In other words, an increasing yield curve should imply that future short-term interest rates would be higher

than their current level. This implies that the return on long-term bonds should be the same as the expected return on future short-term bonds (Russel, 1992).

Risk Premium Model

John Hicks' Risk Premium model assumes that longer-term bonds carries a larger uncertainty, since longer maturities comes a larger uncertainty of future events and future rates meaning that the return will be uncertain (Hicks, 1939). Short-term bonds on the other hand, have a more certain return as the principal is guaranteed. If it is assumed that the expected return on all bonds are the same, then investors would prefer short-term bonds. Therefore, if the market want to induce investors to hold longer-term bonds, the expected return on longer maturities must exceed the expected return on shorter-term bonds by the expected risk. This risk premium will cause the yield curve to be upward-sloping as the risk premium increases as maturity increases (Modigliani & Sutch, 1966).

Liquidity Preference Theory

In relation to Hicks' Risk Premium model John Keynes' book 'The General Theory of Employment, Interest and Money' (Keynes, 1954 (1936)) argues for the existence of three liquidity motives; i) the transaction purpose, refers to the liquidity needed for daily usage, ii) the precautionary purpose, the liquid position needed for not accounted for expenses, and iii) the speculative purpose, free liquid which can be invested or not for the purpose of gaining a positive rate of return (Keynes, 1954 (1936)). The amount of liquidity assigned for speculative purposes varies inversely with the rate of interest, meaning that if interest rates decrease investors will keep their capital liquid until interest rates increase. The 'Liquidity Preference Theory' gives an understanding of why investors are willing to tie up their liquid positions in assets like bonds.

In a world were risk is often correlated with return, investors seek to be compensated for the risk associated with carrying bonds for longer periods. Long-term issues should therefore, award investors with a higher premium than short-term issues as a way of compensating for the increased risk. Long-term issues like the typical 30-year mortgage

bonds are associated with greater price volatility than those of shorter maturity. In other words, investing in a less liquid asset, like a mortgage bond, should be rewarded with a premium (Keynes, 1954 (1936)). The market for government bonds and treasuries is often extremely liquid causing the premium for tying up capital to be smaller than for the market of mortgage bonds. This premium is visible in the yield spread between mortgage and government bonds. Trading in illiquid or less liquid bonds will increase the transactions costs, causing investors to demand higher premiums for holding the illiquid assets.

The Market Segmentation Theory

The theory on market segmentation is about the segmentation of investors' preferences in terms of maturity on bonds. Investors with a longer investment horizon, like pension funds, will prefer bonds with a longer-term maturity. While investors with a short-term investment horizon, like banks and typical private investors, will prefer investments in shorter-term bonds. The theory implies that investors do not see bonds with different maturities as substitutes, as they will be reluctant to change the maturity on their investments. Hence, the yield curve is determined through supply and demand, and expectations for future interest rates levels are not the decisive determinant.

Preferred Habitat theory

Unlike the market segmentation theory where investors are extremely committed to their investment horizon, the preferred habitat theory takes a more 'flexible' approach. The theory assumes that investors can change their predefined investment horizon, meaning their preferred habitat, if a change enables the investor to achieve a higher return. This altering of an investment strategy occurs when a change-compensation is present (Modigliani & Sutch, 1966).

Measures

Bid-ask spread

The bid-ask spread is among the most used financial indicators in terms of liquidity measurements. The spread is a quick measure of the difference between what a seller ask for a security and what a buyer bids for the same security. It is important to note that only the highest bid and lowest ask price is taking into account. The difference between the ask and bid price, i.e., the size of the spread, is believed to be assigned to the liquidity of the security (Fabozzi, 2007). The bid-ask spread is calculated as:

$$\text{Bid-Ask spread} = \textit{Ask price on bond X} - \textit{Bid price on bond X}$$

Yield spread

Yield spread is one of the most common ways to measure the premium of choosing a given asset over a given risk-free rate. For the sake of this thesis, the chosen asset will be mortgage bonds with a 30-year maturity and the risk-free rate will be a 10-year government bond from respectively Denmark and the US. This comparison is often made as government bonds typically are bullet loans causing a longer duration, while mortgage bonds often are annuity loans which causes a shorter duration. Yield spreads are often expressed in absolute terms and the difference is measured in basis point (Fabozzi, 2007). The yield spread is calculated as:

$$\textit{Yield spread} = \textit{Yield on bond X} - \textit{Yield on price on bond Y}$$

The Danish Mortgage Market

A historic introduction

The first Danish mortgage bank 'Kreditkassen for Husejerne i Kjøbenhavn' was established in 1797 as a consequence of the Great Fire of Copenhagen in 1795. It was created by wealthy citizens who financed the borrowing through the issuance of bonds.

The first law on Danish mortgage credit called 'Kreditforeningslov' was passed in 1850 and called for joint and several liability among associated borrowers for up to 60

percent of the property value. Loans were only granted against collateral in property and repayments had to account for an appropriate percentage of the loan, and they were made irredeemable from a lender's perspective. The 'bond' issuing was prohibited from exceeding the borrowings, and the assets of the mortgage bank belonged to the lenders (Realkreditrådet, 2012; Østrup, 2011).

In 1936, the 'Hypotekforeningslov' was created as a consequence of political skepticism about the survivability of the so-called 'Hypotekforeninger'. The 'Hypotekforeninger' were created in 1895 and they were associations that were able to complement the existing loan-to-value (LTV) limit of 60 percent with 15 percent in order to provide loans with up to a 75 percent LTV (Realkreditrådet, 2012).

In June 1970, significant changes faced the Danish mortgage market. Shorter repayment periods were introduced, reducing the maximum maturity from 60 years to 20-30 years (Østrup, 2011). The LTV ratio was lowered and the way mortgage loans could be used was confined. Further, the number of mortgage banks was reduced by mergers, in an attempt to create economies of scales advantages for borrowers and investors (Realkreditrådet, 2016b).

A new mortgage law passed in 1979, which allowed existing mortgage banks to convert from an association structure to a limited company structure and stated that all newly created mortgage bank should be created as limited companies (Realkreditrådet, 2016b).

In 2003, the option to issue and take out mortgage with interest-only periods was made possible. In 2007 the Danish mortgage system was reformed by two significant changes; the law on covered bonds, 'Lov om Særlig Dækkede Obligationer' (SDO), was passed and mortgage banks were given the possibility to deviate from the original balance principle for the first time ever. The law on covered bonds was created in order to fulfill the new EU Capital Adequacy Directive concerning covered bonds. With the new law, both mortgage banks and financial institutions were given authorization to issue covered bonds (Realkreditrådet, 2016b). A separation of the balance principle allowed mortgage banks to choose between what is known as the general ('overordnet') and the specific

('specifikt') balance principle. A more thorough description of both SDO and the division of the balance principle will be presented in the following section.

A regulatory change was passed in 2014 when the maturity extension law was introduced. It enables a maturity extension of mortgage bonds and covered bonds if the mortgage bank is unable to refinance at market condition or if the interest rate appreciates heavily.

Principles of the Danish mortgage market

With a nominal outstanding amount of approximately DKK 2,500 billion for all outstanding residential Danish mortgage in the first quarter of 2016 (Nasdaq OMX, 2016), the Danish mortgage market is among the largest in the world. The mortgage bond market in Denmark exceeds both the Danish government bond market and the Danish GDP. When looking abroad, the Danish mortgage market, is the largest mortgage bond market in Europe measured on outstanding mortgage bonds (Realkreditrådet, 2016c). Hence, the mortgage market is an important factor in the Danish economy.

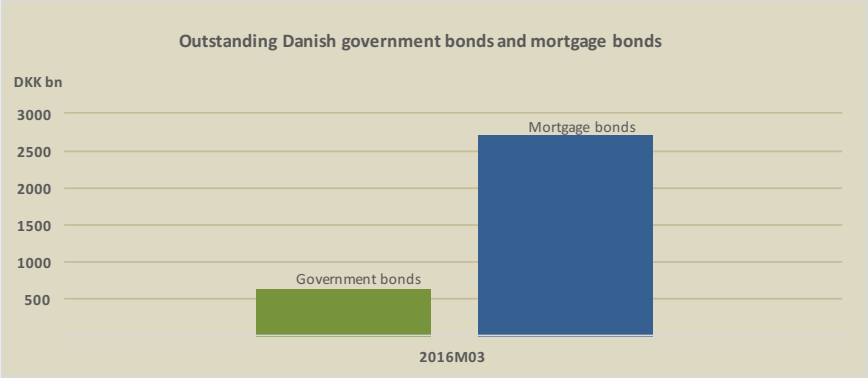

Figure 2: Outstanding amount of the Danish Government Bonds and Mortgage Bonds. Source: (National Bank of Denmark, 2016), own work.

In order to keep such a large market safe and to provide it with a basis for stability, Danish legislation defines Danish mortgage bonds as a high-grade investment with low risk, a so-called 'gilt-edged security'. International credit rating agencies rank Danish mortgage bonds among the highest rated mortgage bonds in the world, approaching government bonds in terms of rating. The high rating makes the mortgage bonds repo-

eligible with both the National Bank of Denmark and the European Central Bank, the latter, however, is only applicable to some EUR-denominated bonds.

The private Danish housing market is primarily financed through the Danish mortgage banks which consist of, Nordea Kredit (part of Nordea), BRF (part of Jyske Bank), TotaltKredit (part of Nykredit), and Realkredit Danmark. The basic principle of the Danish mortgage model is to provide a high level of security and liquidity of the issued bonds. In order to achieve this, the Danish mortgage credit model is built upon a statutory framework consisting of the following principles:

- Mortgage banks are only allowed to grant loans against a mortgage on real property within a fixed lending time and based on current LTV limits. However, public authorities or borrowers, who have obtained a public authority guarantee, can be granted loans without mortgage on real property.
- Valuation of real property and calculation of the loan amount is completed in compliance with rules laid down by The Financial Services Authority (FSA), 'Finanstilsynet'.
- The loan is and may solely be funded through the issuance of bonds. Therefore, raising of finance in the money market is not required to fund mortgage lending.
- Issuance of bonds by mortgage banks is subjected to the balance principle.
- In the event of bankruptcy of a mortgage bank, bondholders carry preferential status.

Especially the balance principle is a key stone in the Danish model. The model builds upon a balance between lending and funding. A close relationship between mortgage loans and the underlying bonds ensures that duration, payments, coupons, and repayment profiles are matching. This match-funding of mortgage loans and the underlying bonds allows borrowers to repay mortgage loans by buying the underlying bonds in the market.

The SDO legislation has made it possible for mortgage banks to bypass the balance principle as match-funding is not a requirement, however, no mortgage bank has chosen to do so. The SDO allows mortgage banks to choose between three types of bonds to

fund their loans, i) the traditional mortgage bond (RO), ii) the covered mortgage bond (SDRO), and iii) the covered bond. Essentially, the RO and SDRO can only be used by mortgage banks, while the SDO makes it possible for both mortgage banks and financial institutions to issue mortgage in Denmark. Further, a major change for the Danish mortgage banks was the introduction of ongoing collateral requirements. In essence, the ongoing collateral requirements to LTV requires the mortgage banks to provide additional security if falling housing prices cause a depreciation that results in the principal exceeding the LTV limit. Table 1 highlights the main structural differences between RO, SDRO, and SDO.

Criteria	RO	SDO/SDRO	SDO/SDRO
LTV	80 percent	80 percent	75 percent
Maximun maturity	30 years	30 years	No requirement
Ongoing collateral requirements to LTV	no	yes	yes
Maximum IO	10 years	10 years	No requirement

Table 1, Differences in RO, SDRO, and RO. (Realkreditrådet, 2016a), own work.

It should be noted that it is required that every single mortgage in an SDO/SDRO bond series is within the LTV limit, such that mortgage with lower LTVs cannot offset mortgage with a higher LTV (Realkreditrådet, 2012). The aim of the SDO/SDRO is to provide investors with an extra layer of security, which should entail better rates for borrowers. The continuous supervision of the LTV limits and the possible need of additional collateral have also increased costs for the Danish mortgage banks.

The balance principle was introduced in order to protect the mortgage banks against financial risks such as interest rate risk, currency risk and credit risk. Restrictions on interest rate means that it is not allowed to issue fixed rate bonds based on floating-rate bonds and vice versa. Currency risk is kept at a minimum by matching the currency of mortgage and the issued bond. Liquidity and credit risk is minimized by the match between the mortgage and the issued bond and a pass-through of payments of installments from borrowers to the bond investor.

The match-funding reduces the risk of mortgage banks not being able to pay investors in changing market conditions. With the law passed in 2007, a division of the balance principle made it possible for mortgage banks to choose between the specific balance principle and the newly created general balance principle. The specific balance principle is a continuation of the structural conformity rooted in the original balance principle. The specific balance principle reduces the financial risk mentioned in the section above through the match-funding principle. The general balance principle moves away from this structural conformity of loans and funding, and separates them instead. It allows the mortgage banks to offer a greater variety of loans, one of them being the priority loan (Prioritetslån), which is essentially an overdraft against property-loan. As the general balance principle provides mortgage banks with the opportunity to issue 'unbalanced' product (Bomgaard & Lausten, 2009) the unbalanced mortgage has to be hedged by either using derivatives or through refinancing of the mortgage. In order to reduce the creativity and to protect borrowers, the possibility of redemption at par is still possible for unbalanced mortgage issued using the general principle.

In practice, the Danish mortgage banks act as an intermediary between a borrower in the need for a loan to buy property, and the investor who provides funding for the required loans. This means that the mortgage banks issue bonds and sell these bonds to investors, funding the loans required to make a property purchase. During the maturity of the loan terms, the mortgage banks collect principal and interest rate payments from borrowers and transfers these payments to the investors. Floating loan rates, therefore, only affect borrowers and investors and not the mortgage banks, as they are only required to transfer the incoming payments. Instead, the mortgage banks charge a lending margin ('bidragssats') in order to cover their expenses and potential defaults from borrowers. The margin is calculated as a percentage of the outstanding debt and is paid by the borrower until the loan is redeemed.

The lending margin has through 2016 caused a bit of a controversy as Nykredit/Total Kredit raised their lending margins as a consequence of increased capital requirements. The lending margin was raised on both fixed-rate mortgage and floating/adjustable-rate mortgage loans with the least affected being the fixed rate loan (P. Christensen, O. & Rangvid, 2016).

The main mortgage loans types of the Danish model

In a direct link to the match-funding principle, the Danish mortgage market streamlines its mortgage loans by providing only standardized products. This provides the mortgage banks with economies of scales, makes the market more transparent, and provides the market with competition among the mortgage banks. No products are customized to the borrower's demand, however, there is a broad variety of standardized products, which makes is easy for the borrowers to find a loan satisfying their needs. These standardized products are grouped into three types of mortgage loans; i) fixed-rate loans, ii) adjustable-rate mortgages, and iii) floating-rate loans (with or without interest rate cap), all of which can have different structural setups. Further, all of the options listed above can be offered as interest rate only (IO) loans. The distribution of the different loan types is shown in the graph below:

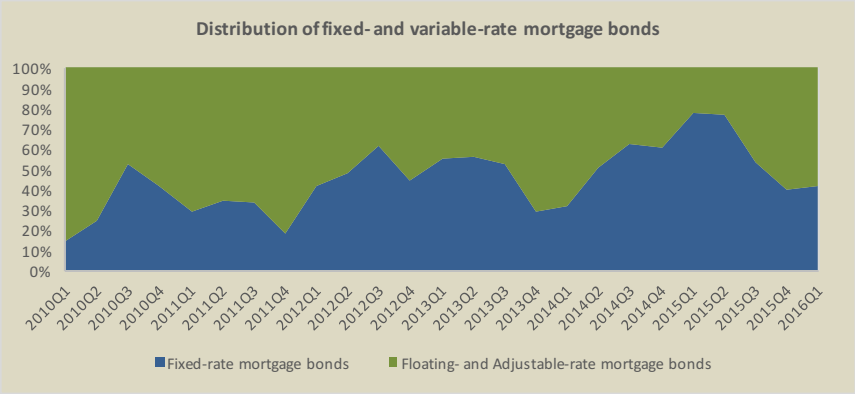

Figure 3: Distribution of fixed- and variable-rate mortgage bonds. Source: (National Bank of Denmark, 2016), own work

Fixed-rate loans

The 30-year long-term fixed-rate, callable loan is often characterized as the most traditional mortgage loan on the Danish market. This mortgage loan provides the borrower with certainty about future payments despite changes in the yield curve. Further, the callable option provides the borrower with the opportunity to redeem the loan in two ways; i) prepay the outstanding debt at par or ii) purchase the underlying bond in the market. In practice, the borrower instructs the mortgage banks to purchase the bonds in the market. In today's market it is required that all long-term fixed rate

loans can be redeemed at par. The callable option prevents the market price of the bond to rise high above par, a situation that could otherwise occur in a market with decreasing interest rates, due to the inverse relationship of bond prices and interest rates. Further, the option offers borrowers a high level of security against the 'lock-in effect' where borrowers become technically insolvent as the mortgage debt exceeds the value of their property (Realkreditrådet, 2012).

Adjustable-rate loans

Since its inception in 1996, the adjustable-rate mortgages (ARM) have gained widespread popularity. These loans typically offer a lower rate than the fixed-rate loans, but opposite of the fixed-rate loans, future payments beyond the fixing periods are unknown. Payments of interest will change until maturity or prepayment. Typically, the interest rate period is fixed for 1, 3, 5 or 10 years, this is commonly known as F1, F3, F5, and F10. By the end of a fixing period, the underlying bonds are replaced by new bonds and the yields on the newly issued bonds then determines the loan rate for the next fixing period.

As with fixed-rate loans, ARMs can be prepaid at par in correlation with the fixing period or the borrower can purchase the underlying bonds in the market as with fixed-rate loans (Realkreditrådet, 2012).

Floating-rate loans

For floating-rate loans, the frequency of interest rate fixing is very short often between three to six months. Further, the interest rate of floating-rate loans is correlated to a reference rate, e.g. London Interbank Offered Rate (LIBOR), EURIBOR, and the like. For bonds denominated in DKK, the reference rate is CIBOR (Copenhagen Interbank Offered Rate) or CITA (Copenhagen Interbank Tomorrow/Next Average). Bonds with a quarterly fixing rate are fixed to CIBOR on the fourth last banking day of December, March, June, and September, respectively. A small additional rate is added to the CIBOR or CITA rate (Østrup, 2010). Some floating-rates loans offer the so-called caps, i.e., capped floaters that prevent the rate from exceeding a predefined level. If the CIBOR or the CITA rates exceed the predefined level, the bond is treated as a fixed rate bond until the CITA or

CIBOR rate moves below the predefined level (Østrup, 2010). This enables borrowers to hedge against steep increases in yields. Floating-rate loans can, like the two other loans types, be prepaid in two ways; i) as ARMs at par when the underlying bonds are replaced by newly issued bonds, or ii) by buying the underlying bonds at market price.

Maturity and issuing

In general, the Danish mortgage bonds are issued with a maturity that correlates with the maturity of the underlying mortgage loan, i.e., the balance principle. In the case of ARM loans the maturity corresponds to the maturity until the next fixing period, e.g. for a F1 loan the maturity of the issued bond is one year and so on. Following the increased popularity of ARMs, the average maturity on the Danish mortgage marked has shifted downwards. In an attempt to prevent illiquidity in the Danish mortgage market, the issued bonds are gathered in bond series. The bonds series are kept open in periods of up to three years and a continuous issuing is made in this period. In contrary to the closed bond series, the open bond series are priced continuously, resulting in greater liquidity meaning that the open series are easier to sell and buy (Østrup, 2010).

Prepayment profile

The new SDO-regulation in 2007 made it possible for Danish borrowers to obtain loans with a greater IO-period than ten years. However, an IO-period of ten years that has been available since 2003 is still favored (Realkreditrådet, 2016a). IO-loans are a combination of bullet loans, accounting for the IO-period and annuity loans accounting for the remaining maturity. The borrower has four options in terms of the repayment profile when the IO-period is matured. i) To make the payments for the IO-period and thereafter resume the original annuity loan. ii) To make payments on a 30-year annuity loan with the remaining payments of the IO-period being made at maturity. iii) To repay payments equivalent to a 20-year annuity loan, which repays the principal at maturity of a 30-year period. iv) To refinance at maturity of the IO-period making it possible to achieve another IO-period (Østrup, 2010).

The annuity loan is the most common repayment profile for bonds with a long maturity in the Danish market. The loan has a fixed repayments profile during the maturity of the loan, and the percentage of which the interest rate accounts for is reduced during this period. The bullet loan option is primarily used for loans with a short maturity of up to 10 years.

From an investor's point of view, premature redemptions attribute to uncertainty about the repayment profile of the mortgage bonds. Both callable and noncallable bonds can be redeemed prematurely through purchases in the market. However, noncallable bonds, which are redeemed prematurely holds the risk of being redeemed above par, a risk the callable bonds do not hold. The callable factor should be incorporated into the price of the callable and noncallable bonds, meaning that the noncallable price should reflect a discount in price compared to the callable (Østrup, 2010).

A brief historic introduction - The American mortgage market

The earliest examples of mortgages in the US date back to 1766 when the first mortgage was issued in St. Louis (Green Richard, 2014). Around 1830, the first Building and Loan Associations (B&L) were created. The B&Ls were member-based associations, which provided their members with the possibility to eventually become homeowners. The members would commit to accumulate shares equal to the value of their potential housing purchase. The accumulation of shares was done via mandatory monthly payments, which constituted a certain percentage of the accumulated shares. The loans provided by the B&Ls were balloon loans, which do not amortize fully over its term and a 'balloon' payment is therefore needed at maturity in order to pay the remaining principal. To meet the large balloon payments at maturity, the creation of sinking funds was necessary (Green Richard, 2014). The B&Ls further required interest payment on the principal, since the full principal remained outstanding until the shares were matured and the loans were cancelled. Regulations concerning payment of dues were rigid, fining members for missed or late payments. Further, if members chose to withdraw prematurely, their accumulated dividends would be lost. As borrowers' sinking funds grew, they accumulated retained dividends, which in the end would cancel out some of

the interest payment. The rate at which the retained dividend could accumulate would be decisive of the maturity of the loan. In theory, the loan term could be indefinite but in practice, the loans typically matured with 11-12 years. The original B&Ls associations were terminated as shares reached maturity, known as terminating associations. By then each member would have accumulated sufficient funds in order to buy a house (Rose & Snowden, 2012). Around the 1860s, a new type of associations, the non-serial associations, was introduced. These associations put an end to the grouping of members into series, and instead each member was given an individual series, eluding the concern when all shares matured simultaneously (Rose & Snowden, 2012).

Around the 1850s, the B&Ls moved away from the terminating structure, as it limited the B&Ls to only serve a very small number of potential borrowers, and the structure failed to attract non-borrowing savers (investors). Further, the B&Ls had a hard time matching the rate of borrowing with the rate of the members' contributions. Instead, the B&Ls began issuing multiple series of shares with different maturities rather than issuing a series of shares at one time. With the creation of these serial associations, the demand that all members had to borrow was removed.

During the 1870s and 1880s, B&Ls located in Dayton, Ohio started to adopt the amortized loans, which had previously been limited to farm-lending. With the amortized loan option being available to private lenders, the Ohio B&Ls soon became national leaders in amortized lending. They further introduced optional shares thereby eluding the previously mandatory required payments for members of the B&Ls.

Driven by lower housing prices and significant unemployment, the mortgage crises caused one in three B&L associations to lose all of its borrowers' retained dividends, and many were forced to liquidate. From the beginning of the mortgage crisis in 1929, mortgage foreclosures occurred at an increasing frequency, and the foreclosures did not retract remarkably until the late 1930s. This caused a large section of the B&L industry to fall into deep financial distress during most of the 1930s. The transition towards direct reductions loans that requires the borrower to make payment on both interest and principal with each installment, quickly gained widespread popularity. This was mainly due to the lacking performance and risk of the share accumulation loans during the 1930s Great Depression. Further, the share accumulations loans had a significant risk

compared to the direct reduction loans, largely due to the fact the borrowers' sinking funds should remain invested in the equity of the B&L association(Rose & Snowden, 2012).

The New Deal Program, HOLC and FHA

As mentioned above many of the US mortgages experienced a difficult time during the Great Depression in the 1930s. The mortgage market was dominated by shorter-term mortgage, typically between 5-10 years, and as housing prices declined steeply, many borrowers refused or were simply not financially capable of refinancing their mortgages. As a result, delinquency rates skyrocketed and between 1931 to 1935 around 250,000 forecloses per year took place. In an attempt to secure their outstanding, financial institutions began selling repossessed houses, which caused the housing prices to decline further. Consequently, the Roosevelt administration created the Home Owners' Loan Corporations (HOLC). In brief, the HOLC bought defaulted mortgage from banks using US Treasury funds (Green Richard, 2014). The HOLC (1933-1952) bought the mortgages from the bank at a discount, enabling them to offer principal reductions to borrowers. More significantly the HOLC converted the by then standard short-term loans with large balloon payments into self-amortizing 15-year fixed payments mortgages (Green Richard, 2014). The Federal Housing Administration (FHA) was created in 1934 in response to lenders' reluctance to lend without having security in large down payments. Through collections of insurance premiums, the FHA (Emmons, 2008) put down a guarantee to ensure that lenders would not bear losses on defaulted loans, and the loans were backed be the government's credit. The FHA provided American citizens who were not able to make the large down payment with the opportunity to obtain loans with a low LTV of 75 percent allowing for a more stabilized American housing market (Green Richard, 2014).

Fannie Mae, Freddie Mac and non-agency lending

The Federal National Mortgage Association, Fannie Mae, was created in 1938 as a consequence of the new types of mortgage institutions mentioned above. It was created

as a government agency, with the objective to breed the grounds for a secondary market in FHA loans (Green Richard, 2014; Rose & Snowden, 2012). In 1968, Congress converted Fannie Mae from a government agency to a shareholder-owned company with government backing. This decision was solely made due to accounting reasons, as it removed Fannie Mae's debt from the balance of the federal government's books. In 1970, The Federal Home Loan Mortgage Corporation, or simply Freddie Mac, was created. As with Fannie Mae, Freddie Mac was established to create a secondary market, in this case for conventional mortgage loans. In the early 1970s, the role of the Government Sponsored Enterprises (GSE) was primarily to standardize the structure of origination and underwriting of mortgage loans. The process of underwriting and origination had previously been autonomous process for the individual mortgage originators. The standardization of closing, funding, and sale of mortgage loans enabled the GSEs to homogenize loans, which allowed for the process of pooling loans into the standardized product; the MBS (Green Richard, 2014). In the mid-to-late 1970s, the oil crisis hit in the US and as interest rates increased, Fannie Mae became technically insolvent. Fannie Mae had since its creation, retained large amounts of mortgage on its books, a lot of which were funded with short-term debt. With the increasing interest rates, Fannie Mae experienced a larger outflow of capital, and as the value of its liabilities rose above the value of its assets, it was only kept afloat by its strong ties to the US government (Barth, 2009). In 1982 Freddie Mac became a public traded, shareholder-owned corporation (DiVenti, 2009), while Fannie Mae became a public traded shareholder-owned corporation with the Financial Institutions Reform Recovery and Enforcement Act (FIRREA) of 1989. With the introduction of the FIRREA Fannie Mae and Freddie Mac became fundamentally identical. The construction as shareholder-owned and federally-chartered associations provided them with special government privileges and a public purpose (Barth, 2009). The government privilege provided the GSEs with a USD 2.5 billion line of credit with the US Treasury, and exemption from both state and local income tax. In the years following the FIRREA, the outstanding amount of MBSs issued by the GSEs grew from USD 610 billion in 1990 to USD 2.8 trillion in 2003, while Freddie Mac's and Fannies Mae's retained portfolios had an annual growth rate of approximately 21 and 17 percent, respectively. In 1996, the purpose of creating a standardized mortgage market culminated when Freddie Mac launched its credit score

standard for mortgage underwriting. The newly developed system called Automated Underwriting System, improved the originating process considerably, as it allowed for a faster and less expensive way of measuring borrowers' credibility (Barth, 2009).

The late 1990s and early 2000s were turbulent times for the GSEs as they faced a number of accounting scandals and increased their exposure to risk dramatically on their retained portfolios. Prior to 1997, the GSEs primarily invested in its own securities, but this changed after 1997 when the GSEs began investing and acquiring large quantities of non-agency asset-backed securities (ABS). Fannie Mae's retained portfolio holding of non-agency ABSs, including subprime and Alt-A loans, grew from zero to approximately 7 percent from 1998 through 2003, making the GSEs active investors in the subprime market. As the accounting scandals arose in 2003, Freddie Mac was accused of creative accounting, which allowed them to understate corporate earnings by approximately USD 5 billion. A year later, Fannie Mae was accused of overstating their earnings by USD 9 billion, and the accounting scandals let to a round of layoffs in senior management in both GSEs.

By 2004, the mortgage market moved away from Fannie Mae and Freddie Mac, as low interest rates and increasing housing prices paved the way for new mortgage products. Borrowers began to favor non-agency lending, using mortgage products as subprime loans and Alt-A loans. The non-agency lending gained widespread popularity and decreased the GSEs originations (Green Richard, 2014). It has later been argued that a large factor of the transition from agency to non-agency mortgage was the more relaxed underwriting standards. By late 2006, the growth rate of housing prices began to slow down and the delinquency rates on subprime mortgage began to rise. The increasing delinquency rates caused an increase in the number of agencies originating subprime mortgage to default. By early 2008, when the financial crisis hit, the market for subprime and Alt-A mortgage had eroded (Barth, 2009). The failure of the subprime market had tremendous impact on the GSEs, and the increased risk exposure towards the subprime market caused huge loses. In September 2008, both GSEs where taking under control by the US government, to prevent the entire mortgage market from eroding. By 2010, the GSEs were delisted from New York Stock Exchange (Adler, 2010) an both associations are today traded on the OTC market.

Principles of the American mortgage market

With a nominal outstanding amount as of first quarter 2016 of around USD 11,000 billion for all residential mortgage (Reserve, 2016), the American mortgage market is the largest mortgage market in the world. The GSEs account for 60 percent of the guaranteed originated mortgage while Ginnie Mae accounts for approximately 20 percent (Frame, Fuster, Tracy, & Vickery, 2015). The GSEs are prevented from issuing and originating straight mortgage bonds, however, they are obliged to provide financing to the less developed and rural areas of the US. Instead of issuing mortgage bonds, Fannie Mae and Freddie Mac purchase conforming mortgage bonds from lenders (Fannie Mae, 2013), and either keep them on their balance sheet, also known as the retained portfolio, or resell them in the market through securitization as MBS (Acharya, Richardson, van Nieuwerburgh, & White, 2011). Non-Agency securitization still exists despite its failure during the financial crisis, but the GSEs are by far the largest providers of securitization on the US mortgage market.

The credit score system is the key element of the US mortgage model, as the credit score, the point system, and the loan amount are the decisive factors of the interest rate, apart from the market interest rate, a borrower will be offered when applying for a loan.

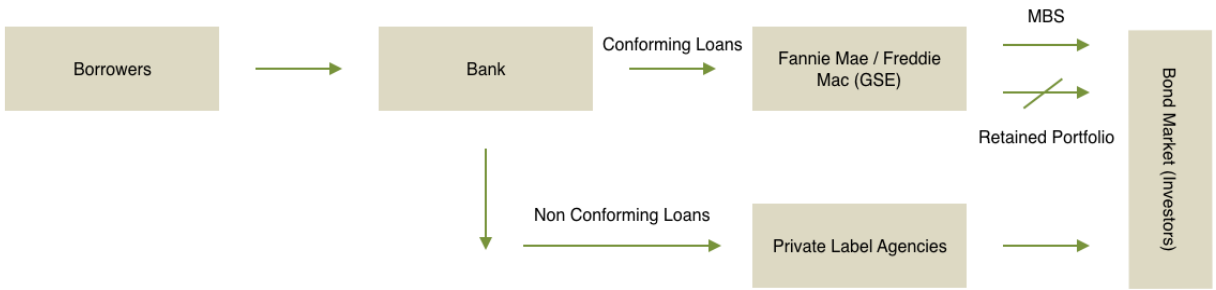

Figure 4: Simplified model of the American Mortgage Model. (Kjeldsen, 2004), own work

In Figure 4 it is illustrated how the process of conforming and non-conforming loans dictates how mortgage can be funded in the market.

A more thorough introduction to the key elements of the US mortgage model will be presented in the following sections.

The financing model

For many years the main part of the American mortgage loans were issued by Saving and Loan Associations (S&L), but through the 1970's this structure changed. The S&L originally originated, serviced, and held the outstanding mortgage loans in their own portfolio. The model was named the 'Originate-to-hold' model (Barth, 2009), named so as the institutions carried out all three functions. However, with the changes in the 1970's the functions became separated and securitization of residential mortgages became the dominant approach. This model, labeled the 'Originate-to-distribute' model, allows pools of individual loans to be re-packed into securities, these securities being backed by the individual mortgage loans (Barth, 2009). The new model passed through the monthly payments of interest and principal to the investors, which in practice reduced the importance of the S&Ls. Fannie Mae, Freddie Mac, and private-label securitizers e.g. Bank of America, became the dominant securitizers of mortgage (Barth, 2009). The invention of securitization, allowed the American lenders to widen their options in terms of mortgage funding. The division of mortgage funding into three separate categories, funding, origination, and servicing introduced new ways for borrowers to obtain their loans.

One way to obtain a loan in the US is through a mortgage broker who provides borrowers with information on loan possibilities and facilitates loans for the borrowers through their collaborators in the mortgage market (Green Richard, 2014). A second option is through mortgage bankers, who unlike the mortgage brokers have the necessary funds to originate loans. The necessary funding is raised in the capital market, and as a consequence the originated loans are sold to a "longer-term portfolio lender or in the secondary market"(Green Richard, 2014). A third option is through Correspondent Lenders, an odd mix between brokers and bankers. Like brokers they do not have the funds needed to provide loans, however, they are allowed to underwrite loans. The fourth and last option is through direct lenders (depositories), they use short-term funds in the form of deposits to fund the mortgages and they both originate, underwrite, and

fund the mortgages. As with the mortgage bankers, the direct lenders aim to sell their issued mortgage in the secondary market.

Prime and subprime loans

Loans, which are conformed to match the standards of Fannie Mae and Freddie Mac, are called conformed loans. This conformity allows the GSEs to securitize the loans. Non-conformed loans can be securitized by private-label securitizers or enter into a financial institution's portfolio. The conforming loans are divided into two sub-categories, these categories define the creditworthiness of the individual borrower. The first tier categories are prime loans, these loans are granted to borrowers with the highest credit score (Barth, 2009; Fabozzi, 2011). The second tier categories are Alt-A, subprime, and jumbo loans, the loans in the second tier categories are all non-conforming loans. The Alt-A loans are offered to borrowers who fall just outside of the creditworthiness needed to obtain a prime loan, or if the borrower is unable to account for income or wealth.

As prime loans requires the highest creditworthiness, they are only offered to borrowers who are able to meet the "28/36" credit rating principle. This principle states that no more the 28 percent of the monthly income may be used on mortgage payments and no more than 36 percent of the after tax income may be used on all obtained loans (Kjeldsen, 2004). Another factor is the LTV, which is not allowed to exceed 85 percent, and the borrower is obligated to provide evidence of income and the value of the property. A credit score above 680 is considered as prime.

Subprime loans are offered to borrowers with a lower creditworthiness, preventing borrowers from obtaining a prime loan. Another determining factor is LTV and the debt service-to-income, if levels exceed 85 percent and 55 percent respectively, the borrowers falls into the subprime category (Kiff & Mills, 2007). A credit score below 620 is considered to be subprime.

The most common form of loan structures on the American market includes fixed-rate long-term mortgages and the adjustable-rate long-term mortgages, both annuity loans. As with the Danish FRM, the American FRM is structured so that payments are made on both the principal and interests for the maturity of the bond.

The conforming loans are subject to the Conforming Loans Limit (CLL), which basically allows the loans to be securitized. The CLL is the loan limit, which agencies are allowed to securitize, and this loan limit varies from county to county depending on the current prices on real estate in the specific county. As an example, the CLL for a single-unit home unit in Napa county (California) is USD 625,500 while the limit in Fresno (California) USD 417,000, the latter is also the national average loan limit. As visible there is quite a difference between 'high-cost' areas and 'lower-cost' areas (Federal Housing Finance Agency, 2016). Conforming loans further require that the borrower is able to make a 20 percent down payment, if a borrower is not able to do so, the borrower is forced to take out a mortgage insurance. Mortgage insurance is an insurance for the lender that lowers the risk for the lender, but increases the monthly costs for the borrower (The Consumer Financial Protection Bureau, 2016).

The main mortgage loans types of the US model

Fixed-rate mortgage

The 30-year FRM is the most commonly used mortgage in the US (Urban Institue, 2016), the distribution of mortgage types are shown in Figure 5 below . Its fixed rate allows borrowers certainty on future payments, and decreases their sensitivity towards a steepening of the yield curve. Therefore, the FRM is generally considered the safe mortgage choice. US borrowers also have the opportunity to choose a shorter-term 15 year mortgage, a loan which most typically carries a lower mortgage rate (Fuster & Vickery, 2013). The FRM is offered both as a fully amortizing loan, or with IO-periods of typically 5-10 years (Bank of America, 2016).

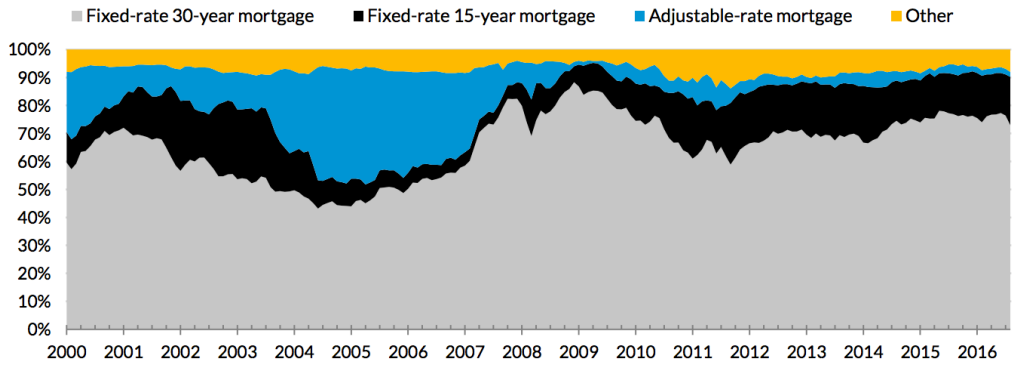

Figure 5, Source: (Housing Finance Policy Center, 2016)

ARM Hybrid

The US MBS ARMs use both the LIBOR and the 1-Year Constant Maturity Treasury index but the LIBOR index has become the most favored among many US institutions. The interest rate on the loans is often determined by adding a spread to the specified index or by adding a gross mortgage margin (Fannie Mae, 2013). ARM and hybrid loans feature an initial fixed rate period most commonly of 5, 7, or 10 years. When the fixed rate period expires, the mortgage rates become adjustable until maturity. A commonly used mortgage is the 5/1 ARM that carries an initial fixing period of five years in which the mortgage rate remains constant, often referred to as the introductory period. After the expiration of the five-year introductory period, the interest rate is adjusted once a year until maturity, which is indicated by the one in the name. Like the FRMs, the ARMs are offered either as fully amortizing loans or with an IO period of 5-10 years (Bank of America, 2016).

Mortgage options

A characteristic of the US mortgage market is the possibility for alternative mortgage options that are offered to borrowers who meet certain criteria. Generally speaking three types of mortgage options exist; i) conventional loans, ii) FHA loans, and finally iii) The Department of Veterans Affairs loans. i) Then conventional loan is a private sector loan, which means it is not insured by a government entity. They require a down payment of 20 percent or more, unless the borrower takes out a private mortgage insurance (PMI), which adds a fee to the monthly payments. As a consequence of the financial crisis, where some of the PMI institutions suffered significant loses, their requirements to borrowers' credit ratings are often rigid and require a credit rating above 640 in order to be approved for the PMI. ii) The second option is to apply for an FHA loan. These loans are insured by the federal government more precisely the Department of Housing and Urban Development, guaranteeing the lender in the event of borrower default. Unlike the conventional loans, the FHA loans provide the borrower with the opportunity to make a down payment as low as 3.5 percent of the housing price. Borrowers are obligated to pay for the insurance provided by the federal government, which increases monthly payments, but a recent analysis has shown that

costs associated with an FHA insurance are lower than the cost of an equivalent PMI (Housing Finance Policy Center, 2015). iii) The third option is limited to military personnel and family members. The arrangement is like the FHA guaranteed by the federal government. However, the Veteran Affairs (VA) loans allow a down payment of zero, meaning that borrowers can receive a 100 percent funding of the house value.

Securitization

As previously mentioned, the financial model of securitization was introduced to the American market in order to provide a larger base for mortgage funding. This section aims to broaden the understanding for securitization in the American mortgage market, as securitization has played a very important role in the American mortgage market. Put simply, securitization allows Fannie Mae and Freddie Mac to buy single conformed loans in the market for the purpose of transforming these individually relatively illiquid securities into a single liquid security. This process allows Fannie Mae and Freddie Mac to issue the MBS. The advantages of the MBSs are that they can be sold in the secondary market, which is very liquid. These MBS market pools are aggregations of a large number of mortgage loans who carries similar characteristics, but the loans are not identical. Loans that fall into the category of the CLL can be securitized by Fannie Mae and Freddie Mac. However, the non-conforming loans cannot as these can only be securitized by private-label agencies (Fabozzi, 2011). Securitization allows the created MBSs to be sold in the secondary market, and this facilitates the pass-through system as mentioned earlier. What makes the MBS issued by the two GSEs desirable is that they both guarantee payments of principal and of interests, in exchange for a so-called guarantee fee.

The first step of the securitization is the selection of assets, which are to be sold to the special purpose vehicle (SPV). The assets are classified into pools, which conform with the desired structure of the final ABS - the term MBS is used when the pool only consists of mortgage bonds. Once this process is completed, the assets are then audited by a rating agency and an underwriter. The process is completed for investors to obtain better knowledge about the risk of the underlying assets. The second step is to create the SPV, an entity which finances the purchase of the pooled loans through the issuance

of securities backed by the pool, i.e., MBS (Berger, Molyneux, Wilson, Casu, & Sarkisyan, 2014). Once the creation is completed, the pooled assets are sold to the SPV, the SPV then obtain full rights of the pooled assets. The process is further done for accounting purposes as it removes the assets from the banks' balance sheet and transfers it to the SPEs. The third step is the actual structuring of the assets in order to modify and conform risk and return, towards the desired of investors. This structuring is also called tranching, basically the tranching allows the ABS to be divided into different tranches with different credit risk categories i.e. reducing the credit risk for the top tranche, the tranches are prioritized following the junior/senior method, were the junior tranches are exposed to the highest credit risk, and senior are exposed to the lowest and therefore receives the highest rating (Berger et al., 2014).

The fourth step is the issuance of the ABS, the issuance is made by the SPE and the securities are divided into the tranches as mentioned above, duration, interest, and other structural characteristics. Finally, the fifth step is to pass-through the cash flows received from their underlying pool. In accordance with the tranche division, senior trance holder receive their payments and only after this pass-through has been successful does the junior tranche holders receives their payments (Berger et al., 2014).

A simplified model shows the securitization process is illustrated below:

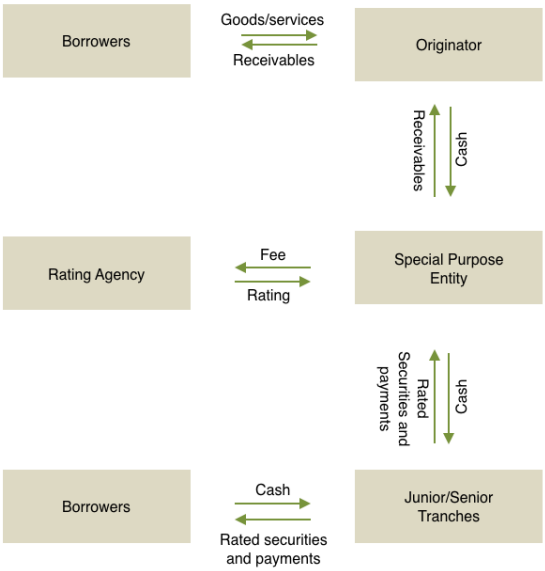

Figure 6. Showing a simplified model of the securitization process. Source: (Berger et al., 2014), own work.

The cash flows, which are transferred from the underlying pool are not equal to the cash flows, which security holders receive. Servicing fees and other administrative fees are deducted from the underlying pool cash flow which is passed through to investors. The servicing fee is related to the monthly collection of payments from borrowers', maintaining records of a borrowers outstanding principle, and so on. The coupon rate on a mortgage pass-through security is called the pass-through rate, as a consequence of the servicing fees, the pass-through rate is lower than the coupon on the underlying mortgage pool. When MBS are sold to investors, not all loans of the underlying pool will carry the same mortgage rate or even the same maturity. Therefore, the MBSs are sold with a weighted average coupon rate and a weighted average maturity meaning that the coupon rate of the MBS is not directly comparable with a single underlying mortgage rate (Fabozzi, 2016).

Prematurely redemptions

Similar to the Danish mortgage market, the American mortgage market is affected by premature redemptions, however, the American market differentiates itself in a number of ways. Prematurely redemptions through purchase of the borrowers underlying bond in the market is not possible, however, the borrower is allowed to exploit the callable option through a redemption at pair, or partial prepayments (Fabozzi, 2011), the lacking ability to buy bonds in the market prevents US borrowers from taking advantage of increasing yield which could enable them to buy back their outstanding mortgage debt at a reduced price, up-conversion, thereby reducing the principal. (Baun, Wagner, & Gyntelberg, 2000). Further, the American borrower is forced to redeem the mortgage loan in case of change of ownership e.g. if the borrower wishes to sell or buy a new house (Kjeldsen, 2004; Terkelsen & Hansen, 1990). Changes in the yield curve and sale of property increases the risk, from an investor's perspective, of premature redemption. For mortgage held in the retained portfolios of Fannie Mae and Freddie Mac, they alone carry the prepayment risk associated with investments in mortgage. The prepayment risk which Fannie Mae and Freddie Mac holds is hedged through derivatives and purchases and sales of US government bonds (Kjeldsen, 2004).

The MBS market

A key characteristic of the US market is the 'To Be announced Market' or simply TBA market which accounts for approximately 70 percent[2] of the agency MBS trading volume (Vickery & Wright, 2013). TBA is a forward market that in theory should help lenders manage their risks, as it allows them to sell not-yet-originated loans in the market to a predefined price. In practice the future is traded on six parameters, which characterize the future MBS, i) issuer, ii) weighted average maturity, iii) weighted average coupon, iv) par value, v) settlement date, and vi) price (Vickery & Wright, 2013). The weighted average coupon is based on the underlying MBSs and moves by 50 basis points. In addition to the TBA market, the 'Specified pool' market exists, and unlike the TBA market the exact characteristics of the specific security is known.

Analysis

Comparative Analysis of the US and Danish Mortgage Market

Despite similarities in the Danish and American mortgage market, the fundamentals of the loan structure are significantly different. During the financial crisis of 2007-2008, the Danish system proved sturdier and was less affected by the huge downward shocks on assets and credit. The following section will provide a comparative analysis of the Danish and the American mortgage market, and provide answers to the questions raised in the problem statement.

Unlike the American market, the Danish market is dominated by four mortgage banks, which fund their mortgage assets through the issuance of mortgage bonds, the balance principle. Danish originating-institutions are, contrary to their American counterparts, also the mortgage banks themselves, meaning that the asset will remain on the balance of the Danish mortgage banks. Investors in Danish mortgage bonds have a claim against the mortgage banks, and not the individual borrowers. In effect, this means that unlike American originators, it is the Danish mortgage banks that carry the credit risk. The fact the Danish mortgage banks are both in the role of the originator and carries the risk in

[2] Based on own calculations as of second quarter 2016, the calculation is based on daily MBS trading. Source: TRACE

the event of defaults, is intended to provide the Danish model with an extra level of safety. The separation in the US induced some originators, prior to the financial crisis, to provide lending with a very high credit risk.

Fannie Mae and Freddie Mac are government sponsored enterprises. Prior to the financial crisis, it was a general assumption that the GSEs had an implicit government guarantee providing investors with a safety net in the event of massive defaults. As the financial crisis hit, the implicit guarantee proved to be very explicit. Danish mortgage banks are not supported by the Danish government, and European law further prohibits the government from favoring business, as it will cause a biased competitive environment. However, as the financial crisis hit Denmark in the fall of 2008, the Danish banks were heavily affected, as were most other banks around the world. Since Danish banks were, and still are, the largest buyers of Danish mortgage bonds, the mortgage market was in fact kept stable by the government aid in form of Bank Package 1, especially the ARM bonds which require short-term funding (Østrup, 2011).

The American mortgage market is characterized by securitization, which allows mortgage originators to sell their loans into the secondary market. Mortgage which do not meet the conforming loan limit are sold as non-agency bonds, while mortgage which meets the conforming loan limit are sold as agency bonds. The GSEs are the primary sellers of agency MBS and as a consequence of the financial crisis, the FED has become major buyers of MBS (Hancook & Passmore, 2015). Reselling through securitization distributes the credit risk away from the originators of mortgage, and onto the GSEs.

The prepayment structures of the American and Danish markets are comparable, but an addition exists in the Danish model that helps borrowers in situations of increasing interest rates. Like the Danish model, the American model provides the borrower with the opportunity to redeem mortgage loans at par. However, American borrowers are forced to redeem their loan in the event of a house sale, while Danish borrowers are allowed to transfer their current mortgage loan onto their new housing purchase. Danish borrowers are allowed to redeem their mortgage loans at market price and this buy-back option is of great importance to the Danish borrower, in the event of increasing interest rates. As with bond prices, house prices tends to go down in the event of increasing interest rates. The buy-back options allows the Danish borrower to reduce the principal

of the mortgage by agreeing to pay a higher coupon, this is called an ‘up-conversion’. The buy-back option is one of the reasons why the default rate on mortgage loans in Denmark is very low compared to the US.

The low rates on delinquency became visible in the aftermath of the financial crisis, when US delinquency rates on single-family residential mortgage, at its highest rate, hit 11.26 percent in the first quarter of 2010 compared to the highest Danish rate of 0.59 percent, which occurred in the third quarter of 2009 (Realkreditrådet, 2016e; The Federal Reserve Bank of St. Louis, 2016). The difference in delinquency rates are also visible in the current market by the end of 2015 the annual delinquency rate on American Single-family residential mortgage averaged at 5.65 percent (The Federal Reserve Bank of St. Louis, 2016) compared to an average of 0.23 percent in 2015 in Denmark (Realkreditrådet, 2016d).

Both the American and the Danish lenders are subject to credit assessment. In the US, the lender has a credit score rating, while the Danish lender is assessed by their own bank and the mortgage bank. The big difference lies in both the differentiated mortgage rates experienced in the US, and the possibility for American borrowers to affect the mortgage rate provided by the lender. The Danish mortgage model leaves no room for altercation of the interest rate, this is a consequence of the balance principle as all mortgage issuing is based on mortgage rates, which are in alignment with the current market rate plus the lending margin and a liquidity premium. The mortgage rates are very closely related to the market rate, due to the effective bond trading market in Denmark. A bond series is ‘open’ in three years but can be opened or closed in accordance with the current market prices. Mortgage loans with rates that trade above par will be closed and opened again if prices move below par. The closing of one bond series allows for the opening of another bond series with a different coupon. This increases the Danish borrowers’ information and understanding of the current mortgage rate and its connection to market rates. The mortgage rate on American mortgages is more opaque, the pricing is less transparent and it is possible for lenders to ‘buy down the rate’ in the form of discount point. Further, borrowers are required to pay a mortgage insurance premium if they are unable to meet the 20 percent down payment.

There are no limitations on the principal on the mortgage in the Danish market, the limitation is instead determined by the LTV ratio, as this is not allowed to exceed 80 percent. In theory, this allows the borrower to obtain the same rate on the required loan amount regardless of whether it is USD 50,000 or USD 2,000,000, in comparison to the US market where the conforming loan limit of USD 417,000 applies limitations on the obtainable loan amount with the lowest possible rate. If borrowers wish to take out a loan greater than USD 417,000 they are able to get a separate loan of the amount exceeding USD 417,000. Loans exceeding USD 417,000 are characterized as non-conforming or jumbo loans.

Investing in Danish mortgage bonds is in terms of credit risk a much more straightforward process to understand. It has often been argued that there has never been a default in a mortgage bond series in the entire history of the Danish mortgage model, however, this is not the case. An expansionary lending policy through the 1850s by 'Den Jyske Købstad-Kreditforening, and a financial crisis in 1857, caused borrowers to pull out of the mortgage bank in an attempt to escape the joint and several liabilities. In 1861, the mortgage bank was trialled by the bankruptcy court. All creditors received full coverage but over a period of 20 years. In 1859 the 'Hypotekforeningen af Landejendomsbesiddere' defaulted and in 1931 'Jydsk Land-Hypotekforening' was put under administration (Østrup, 2011).

Today, in the event of default, the capital requirements, imposed by the EU in the form of Basel III, and the Danish Garantiformuen exist to cover the potential loses. The credit risk of investing in Danish mortgage is therefore only dependent on the credit worthiness of the issuing mortgage bank. This is in contrast to the American MBS where there is a huge dependency on rating agencies to rate the individual MBS in order to understand how large the risks associated with future cash flows are.

Loan information

The balance principle of the Danish model, makes the mortgage market transparent relative to the US model. The match-funding makes information easily available, such that borrowers have access to information on their current loan. This provides a

favorable situation for borrowers who wish to refinance their mortgage or simple get an understanding of the current market. Danish borrowers are able to observe the prices of the mortgage bonds which fund their loans; all quotes on Danish mortgage banks are available with a slight delay on Nasdaq Nordic OMX, and all post-trade information has to be reported to the Danish stock exchange, including OTC trades. Due to the securitization process in the US, it is difficult for lenders to obtain information on their loans, as individual private loans are sold as MBSs, which do not trade on a public available exchange.

The larger Danish mortgage banks provide, through their website, information on the current available market rate including monthly payments, and a detailed description of the fees involved when taking out a mortgage loan. The information available on American mortgage is less transparent compared to Danish standards, as no issued MBS directly matches their individual loan.

Like the Danish mortgage banks, the US website bankrate.com provides information on the current available mortgage rate that borrowers can get, based on their down payment. However, what differentiates the two systems is that borrowers are required to fill out their credit score, as the credit score is a determinant of the available rate, which is in contrast to Denmark were borrowers are only declared creditworthy or not. When the necessary forms are filled out, the website provides information on the given interest rate, the ARP, a fee, and the monthly payments. Below is re-written information from the respective websites:

Mortgage loan, Showing data provided by Bankrate and Realkredit Danmark		
	Danish mortgage	US Mortgage
Mortgage Type	30 -year fixed rate	30 -year fixed rate
Interest Rate	2.0	3.5
Currency	DKK	USD
1 year monthly payments (before tax)	10,652.32	1,679
- Of which repayments are	5,122.84	-
Bond Price	97.456	-
Principle	2,500,000	374,000
Lending margin	0.68	-
APR	3.1	3.513
- Of which fees	-	603
Effective interest rate	2.9477	-
Total costs	45,814.60	1%*
- Of which to the Mortgage Bank	6,654.60	-
- Of which to the registration in the land register	39,160.00	-

Table 2, Mortgage Rates for August, Maine, and 'average Denmark'. Source: https://rd.dk/da-dk/privat/Beregnere/Laaneberegner, http://www.bankrate.com, (own work)

It should be noted that the information on the Danish mortgage loans is transcribed but rearranged to simplify the available information. Table 2 shows the difference in available information on mortgages between the American and the Danish markets. It can be argued that there is a higher information efficiency in Denmark as the cost of gathering information on a fictional mortgage loan in Denmark is very close to zero.

As shown in Table 2, the 30-year mortgage rate in the US is 3.5 percent, with an annual percentage rate (APR) of 3.5 percent (BankRate, 2016). The rate is based on the median credit score, with a down payment of 20 percent, with zero discount points, and the state is listed as the state of Maine, as it is a good indicator of the national average rate on mortgages (Barchart, 2015). The total costs are defined as one percent of the loan amount. In Denmark, it is currently possible to take out a two percent 30-year fixed mortgage loan. As shown in Table 2, the loan is based on a down payment of 20 percent as the American mortgage loan. The APR is 3.1 percent, a relatively large increase from the 2 percent mortgage rate and coupon on the mortgage bond. The 3.1 percent APR can be explained by the 0.68 percent lending margin which is the annual payment made to the mortgage banks in order for the mortgage banks to meet their capital requirements. Comparing the two APRs, the Danish mortgage loan is around 41 basis point lower than the American, while the difference on the mortgage rate itself is 150 basis point.

Liquidity

The bid-ask spread is used to determine the liquidity of both the American and the Danish market. While it is relatively simple to obtain data on bid-ask offers on the Danish mortgage bond market, it has proved much harder on the American. FINRA, the American regulatory authority, provides information on OTC trades in both the MBS segment and the TBA segment, however, through their search engine, it is only possible to get the execution price and not the different bid-asks. A report by the Federal Reserve of New York has obtained information from the FINRA and TradeWeb, which is the leading platform for trading in the TBA-MBS segment. The graph provided in the report made by the Federal Reserve of New York, will be used as an indicator of the spread in the American TBA-MBS market.

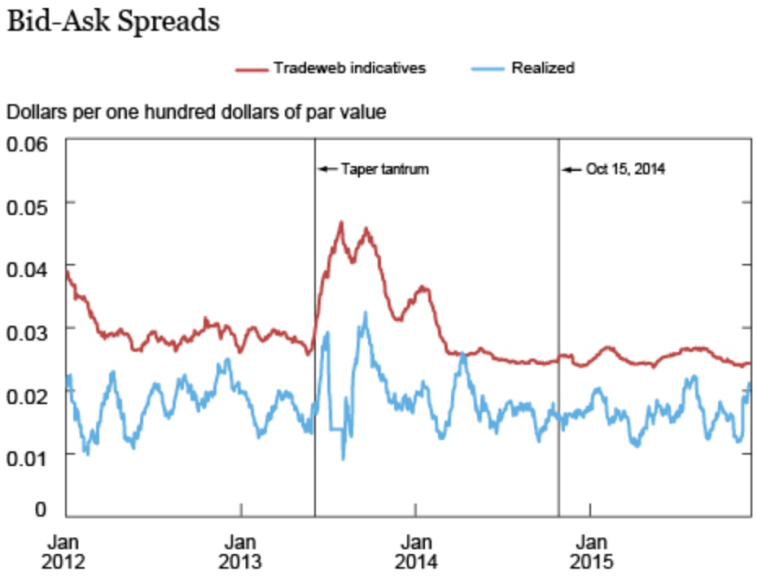

Figure 7. spread on US MBS-TBA, source: (Vickery & Wright, 2013)

The bid-ask spread in the American market is very low, also taking the exchange rate into account, which is a good indicator of the high level of liquidity. Analyzing the spread on the Danish mortgage bonds, it is clear that the spreads is wide out compared to the American.

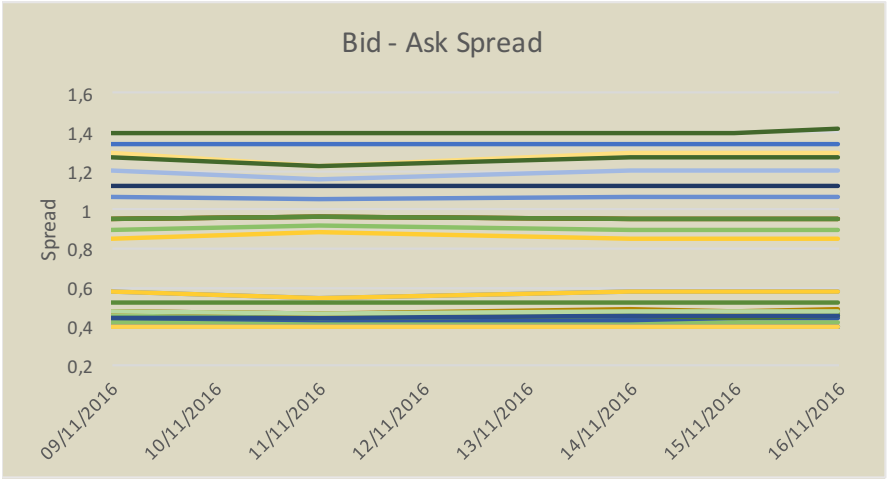

Figure 8, Bid-ask spread on Danish benchmark mortgage bonds, sample of 39 bond series, see appendix for list of bond sample source: Bloomberg, own work

The average spread on the Danish sample is 73 bps. The Danish mortgage bonds with a coupon between 0.5 - 3.0 percent have a spread of 61 bps while the mortgage bonds with a coupon between 3.5 - 4.0 percent have a spread of 90 bps in average. By looking at the bid-ask spreads isolated, it could be argued that the liquidity of the American MBS market is larger than the Danish. Investors demand a smaller premium, indicating lower transactions costs and a more efficient capital market. According to the theory of efficient capital market, a narrow bid-ask spread indicates tightness in the market. On the American market, it is simply less expensive to carry out a round-trip in the market than in the Danish. Investors have the possibility to sell the bond right after their purchase and buy it back again at a lower cost than what would be possible in the Danish market. In an interview study by the Danish 'Børsmæglerforeningen' with large professional institutional investors, the institutional investors expressed concerns about the reduced operational efficiency in the Danish market. Investors have been forced to recognize the increased operational risk of not being able to trade certain bond series due to low liquidity. This has caused the bid-ask spread to increase i.e. costs have increased for the general investor (Børsmæglerforeningen, 2016).

Looking at the bid-ask spread alone might be at bit too single minded, therefore the turnover rate on both markets are included in Table 3.

	Average daily turnover rate DK (%)	Average daily turnover rate US (%)
2011	1,11%	2,93%
2012	1,10%	3,45%
2013	0,55%	2,79%
2014	0,75%	2,24%
2015	0,73%	2,43%
2016 Q2	0,52%	2,55%

Table 3. Average daily turnover rate of Danish and American mortgage bonds, source Nasdaq OMX and SIFMA, own work

As visible in Table 3, the American market is significantly larger than the Danish market. Here, the turnover rate is calculated as the daily turnover relative to the circulating amount for both markets. The Danish turnover from 2011 to second quarter 2016 averaged a daily turnover of 0.79 percent while the American marked averaged a daily turnover of 2.73 percent, indicating that the American market is more liquid than the Danish market.

Further, it is worth noting that the average daily turnover rate on the Danish market is decreasing, in the last five years the turnover rate has more than halved. This decrease combined with the increased bid-ask spread, and the difficulties on trading larger quantities without affecting the market, all calls for a falling liquidity in the Danish mortgage bond market (Børsmæglerforeningen, 2016). It should be noted that the above analysis is not an attempt to neglect the liquidity of the Danish mortgage market it is merely an attempt to highlight the decrease in liquidity, which has taken place.

Daily trading in the American and Danish market is included in the analysis to highlight the fact that the Danish market is still highly active, relative to its size, despite the fall in liquidity.

The US daily average trading of MBS is around 10,800, with trades in the TBA market accounting for approximately 7,500 daily trades. As shown in Figure 9, the daily trading average is relatively stable, with especially 'normal' trading being very steady.

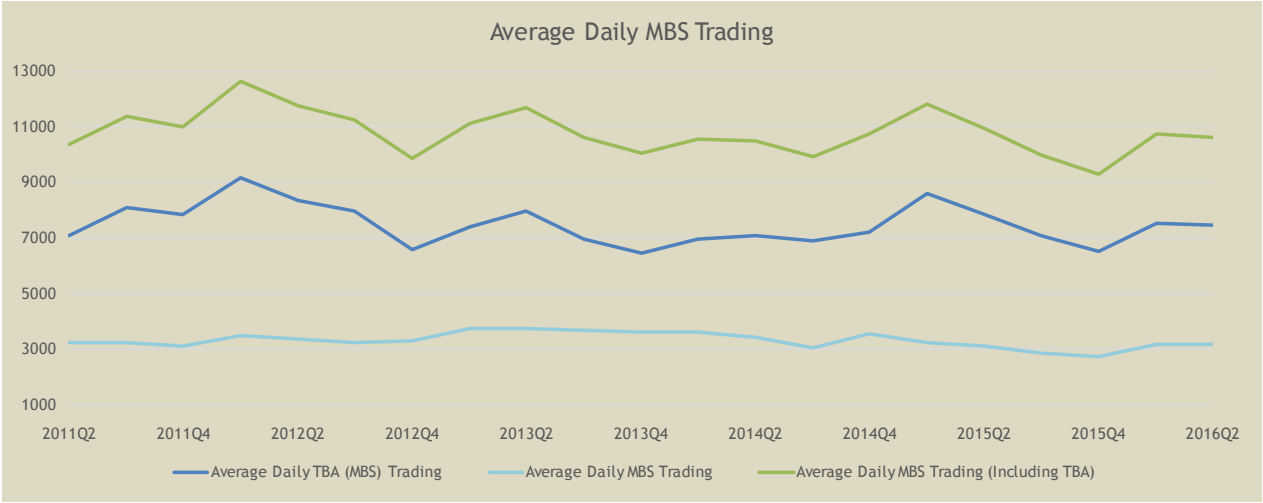

Figure 9. Average daily trades of MBS, including trades in the TBA market Source: TRACE, own work.

In comparison, the average daily trades on the Danish mortgage market is quite steady, fluctuating around 1,100 daily trades of Danish mortgage bonds, as visible in Figure 10.

What is noticeable, however, is the much larger trading in the TBA market in the US (Figure 9). As visible in Figure 9 the trading in the TBA accounts for around 70 percent of the daily average trading, making the TBA market far more liquid than the standard exchange market for MBS in the US

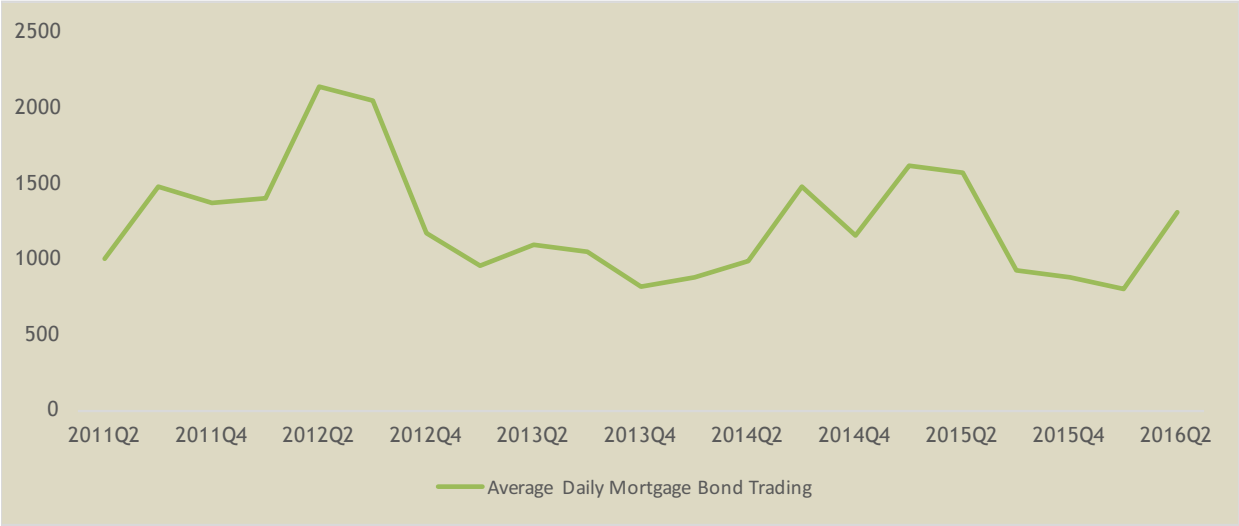

Figure 10. Average daily trading of Danish mortgage bonds

The difference in daily trading between the US and Denmark is expectable, as the American market is approximately five times larger than the Danish market.

Analysis of interest rates

As visible in Figure 11 below, the yield of the leading indicator, the 10-year government bond has been falling steadily over the last 20-years, hitting approximately zero in Denmark while hovering just around two percent in the US. Despite the ongoing fluctuations the trends seems to be downward sloping. The current yield spread between the Danish and American 10-year government bond is approximately 1.59 percentage-points, see Figure 11. This spread may indicate that investors perceive the American government bonds as more risky than the Danish, and they therefore demand a higher premium for placing their liquidity in American government bonds. Still, both the Danish and American government bonds carry a Moodys AAA rating. Further, American government bonds are perceived by many as being risk-free, and it is therefore highly unlikely that the spread can be justified by investors demanding such a high liquidity premium.

Figure 11. Yields on 10-year Government bonds in USA and Denmark. Source: Datastream, FED, and National Bank of Denmark own work

As the Danish 10-year government yield and the American Treasury yield are denoted in DKK and USD, respectively, examining the yield spread just by comparing rates will not give the correct image of the current situation. Instead, the spread should be examined with the help of the PPP, as the Danish and American inflation differs, currently the Danish inflation is zero percent while the American is 1.5 percent (OECD, 2016). Therefore, it would be interesting to examine the 5Y5Y inflation swap, as the inflation swap provides a market-based measure of the expected future inflation. Over a short period, exchange rates do not provide a very good explanatory power, but it is believed that the exchange rate over a longer period reflects the changes in inflation (Neely, 2014). As a 5Y5Y inflation swap does not exist on DKK but only on USD, the inflation indicator chosen will instead be the inflation forecast provided by OECD. The forecast runs until 2020 and expects the US inflation to be 2.02 while the Danish inflation is expected to be 1.48 (OECD, 2016). The lower inflation in Denmark suggests that the DKK is expected to appreciate by the difference in expected inflation, i.e., 0.54 percent annually against the USD. The expected inflation describes about one-third of the yield spread, but it is worth noting that the expected 2020 inflation forecast might be a too short-period indicator. Looking at the 5Y5Y US Inflation swap and 5Y5Y EUR inflation swap, could provide a longer-period estimate for the explanation of the yield spread. Looking at Figure 12 it is visible that the difference between FWIS US and the FWIS EU is approximately 0.87 percent points. Taking Denmark's fixed exchange-rate policy into

Figure 12. Forward 5Y on 5Y Inflation Swap for USD and EUR, source: Bloomberg

consideration, it will be safe to assume that the 5Y5Y DKK inflation rate should be in the area of the EUR. This would indicate that the DKK should appreciate approximately 0.87 percent annually against the dollar.

The current yield spread can be explained by the slower growing economy in EU and Denmark. As mentioned, earlier Danish inflation was in September 2016 0.0, while the American inflation was 1.5 (Trading Economies, 2016). If yields were equal in Denmark and the US with the current inflation rates, then investors would prefer Danish investments as these would not be eroded by inflation.

As the Danish yield on the 10-year government bond is lower than the comparable 10-year US Treasury, the DKK is expected to appreciate relative to the USD, according to the International Fisher Effect. By examining the 1-year forward exchange rate of USDDKK, the markets expectations to the future exchange rates becomes clear. Currently the USDDKK spot rate is 6.62 while the USDDKK FW 1Y[3] is 6.74 which equals:

$$\frac{USDDKK\ FW1Y - USDDKK\ \text{Spot rate}}{USDDKK\ FW1Y} = \frac{6.74 - 6.62}{6.74} = 1.81\ percent$$

which shows that the Danish interest rate should appreciate relative to the change in the USDDKK over a period of 1 year for the International Fisher Effect to hold.

As mentioned earlier, the IRP states that the difference in interest rates between two securities that are similar in terms of risk and maturity should be equal to the change in the forward rate. The Danish and the US government bond is assumed to be equal in terms of risk, and maturity, implying that the USDDKK should depreciate in order to even out the differences in interest rates, as the US interest is higher than the Danish. Further, the lower expected inflation rate in Denmark should cause the USDDKK to depreciate, as the expected value of the USD will be affected by inflation.

[3] Both the USDDKK Forward rate and the spot rate is of 9/11-2016, source Nordea Analytics

If the rates on 30-year FRM are included in Figure 11 for both Denmark and the US, it is visible that the Danish mortgage rate is very close to the 10-year US Treasury rate. What is more interesting is that the spread between the Danish 10-year government bond yield and the Danish 30-year mortgage is wide compared to the same US spread. This spread should in fact indicate that American investors demand a smaller liquidity premium for MBS compared to the Danish alternative. The spread will be examined further in the following section.

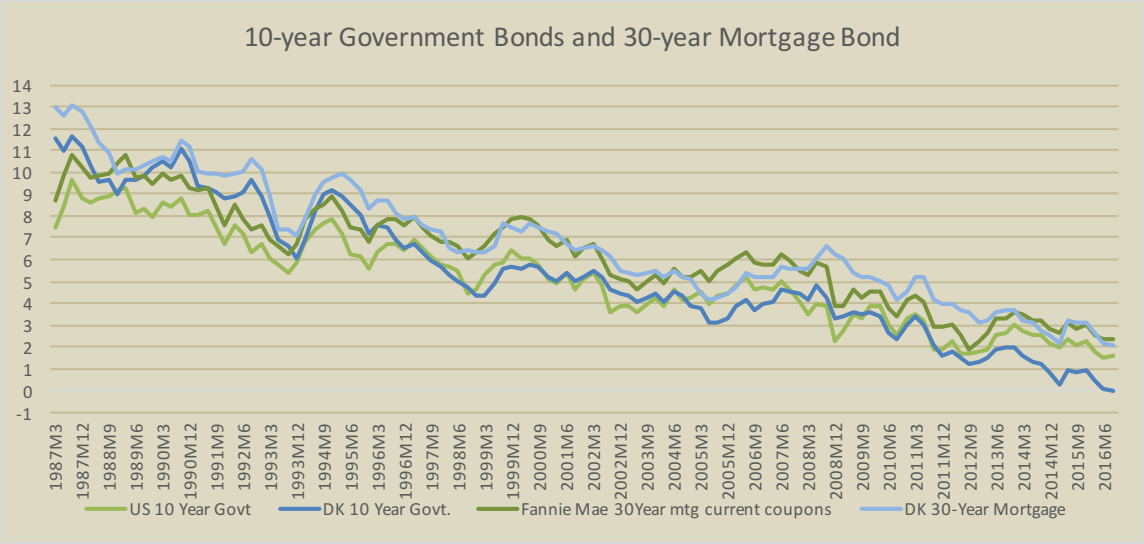

Figure 13. Yields on 10-year Government bonds in USA and Denmark vs. 30-year mortgage rates in Denmark and USA. Source: Datastream, FED, and National Bank of Denmark own work

Yield Spread on government and mortgage bonds

In an efficient market, the interest rate determination of mortgage bonds should be visible by analyzing the spread of the 30-year mortgage bond against the 10-year government bonds. The yield on mortgage bonds should be closely related to the yield of the government bond plus four premium factors; i) a credit risk premium with regards to default or misconduct by the issuer or mortgage bank, ii) a risk premium with concern to the risk of prematurely redemptions, iii) a premium as a consequence of the increased capital requirements of mortgage banks with positioning in mortgage compared to government bonds, and iv) a liquidity premium as the mortgage bond market is less liquid than the government bond market. The spread is visible through a comparison of a 30-year mortgage bond and a 'risk-free' 10-year government bond (Østrup, 2010). Examining the spread between the 10-year government bond and the 30-year mortgage

bond[4] in Figure 14,shows that since the late 1980s the Danish spread has generally been below the American spread.

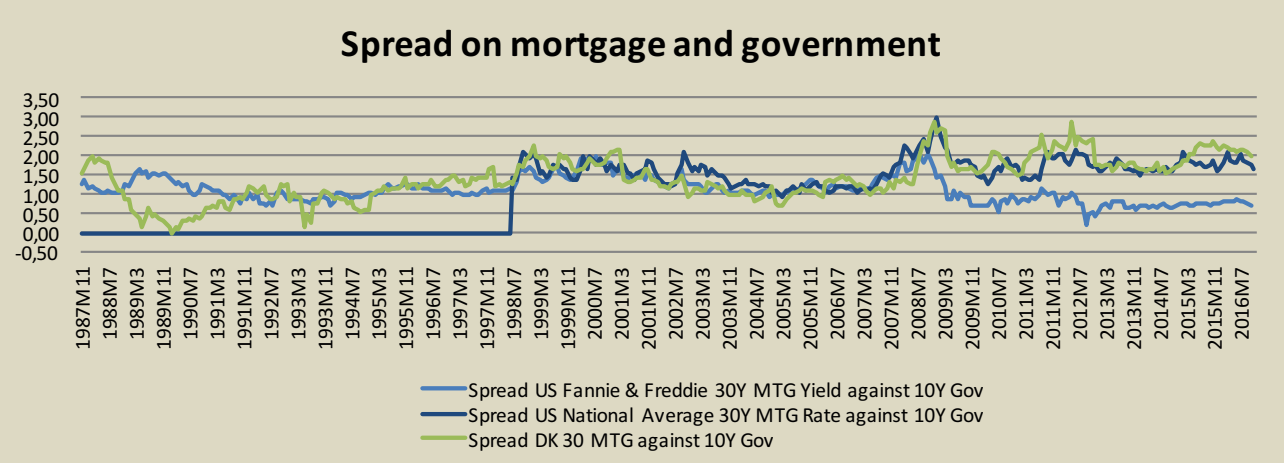

Figure 14: Yield spread between 30-year mortgage bond (annuity) and 10-year Government bonds. Source: DataStream, National Bank of Denmark, Nordea Analytics, Bloomberg, own work

With the dot-com bubble of the late 1990s and early 2000s the spread narrowed, but widened again up until the financial crisis of 2007-2008. With the financial crisis, the Danish spread moved from historically being below the US spread to being above. The American spread has had minor fluctuations compared the Danish, and it appears that the Danish spread has been steadily increasing for the last 30 years if compared to the relatively stable American spread. As visible in Table 4, the spread on the Fannie Mae and Freddie Mac current coupon has narrowed relative to both the 30-year fixed rate national average and the Danish spread over the last 10 years.

6 months moving average	2006M12	2007M6	2007M12	2008M6	2008M12	2009M6	2009M12	2010M6	2010M12	2011M6
US SPREAD - WA current copoun 30Y MTG	1,17	1,16	1,45	1,69	1,91	1,15	0,87	0,75	0,81	0,84
US SPREAD - Average 30Y MTG Rate	1,17	1,13	1,57	2,07	2,51	2,04	1,75	1,49	1,77	1,41
DK SPREAD - 30Y MTG	1,41	1,13	1,17	1,33	2,32	2,25	1,64	1,81	1,78	1,84
6 months moving average - Continued	2011M12	2012M6	2012M12	2013M6	2013M12	2014M6	2014M12	2015M6	2015M12	2016M6
US SPREAD - WA current copoun 30Y MTG	1,05	0,89	0,52	0,72	0,71	0,69	0,69	0,75	0,75	0,81
US SPREAD - Average 30Y MTG Rate	1,96	1,95	1,83	1,77	1,64	1,63	1,69	1,88	1,71	1,91
DK SPREAD - 30Y MTG	2,22	2,35	2,29	1,71	1,77	1,67	1,62	1,97	2,29	2,17

Table 4. Spread on US and DK fixed-rate mortgage against 10-year government yield. A 6 months moving average is used. Sources: Bloomberg, National Bank of Denmark, own work.

[4] For the Danish 30-year mortgage bond, a constant maturity index of 30-year mortgage bond yields is used. The index made available through Nordea Analytics. For the US National Average 30-year mortgage bond the 30-year fixed rate national average is used, this is made available through Federal Reserve Bank of St. Louis. For the US spread Fannie Mae and Freddie Mac the current coupon yield is used, this is made available through Bloomberg.

From 2003 to early 2008, the difference in spreads on the Fannie Mae and Freddie Mac current coupon, and the national average of the 30-year fixed mortgage rate was insignificant, but as the financial crisis hit the mortgage market, the difference in the two spreads increased. The Danish spread has increased quite significantly since the financial crisis; the latest increase is visible in early 2015 and has been credited to the attack of the DKK when the 10-year government yield decreased quite significantly as visible in Figure 11 and 13. It should be noted that the Danish 10-year government yield is in zero territory, a coupon rate very close to zero on a 30-year mortgage bond is hard to justify.

Examining the years following the financial crisis in the US, it becomes clear that the rate might have been affected by other forces than normal trading. As the US economy came to a halt and the mortgage marked froze, the FED announced in November 2008 its first quantitative easing program (QE1). The program aimed at improving liquidity in the financial market by buying bonds through OMO. The QE1 was launched in January 2009, and initiated large quantity purchases of agency MBSs, originally up to USD 500 billion in MBS and additionally USD 100 billion debt from the GSEs. In March 2009, the intended purchase of USD 500 billion was raised to USD 1,250 billion, and a year later in March 2010 the OMO was carried out (Acharya et al., 2011). In September 2013, the FED announced in QE3 that it would increase its agency MBS holdings by approximately USD 40 billion per month. The purchasing of additional agency MBSs came to a halt around August 2014 but the FEDs portfolio holding of MBSs has been kept relatively steady since then. As visible in Figure 15, the announcement and the purchase of large quantities of US MBSs by the FED, had significant impact on the spread. Spreads in the late 2007 and early 2008 were on level with the spread in the dot-com crisis, but as the QE increased the buying of MBSs, the spread decreased to a new low. With the QE announcement, the FED put an even stronger emphasis on the government guarantee, which has been a fundamental part of the MBS market since the creation of Fannie Mae and Freddie Mac.

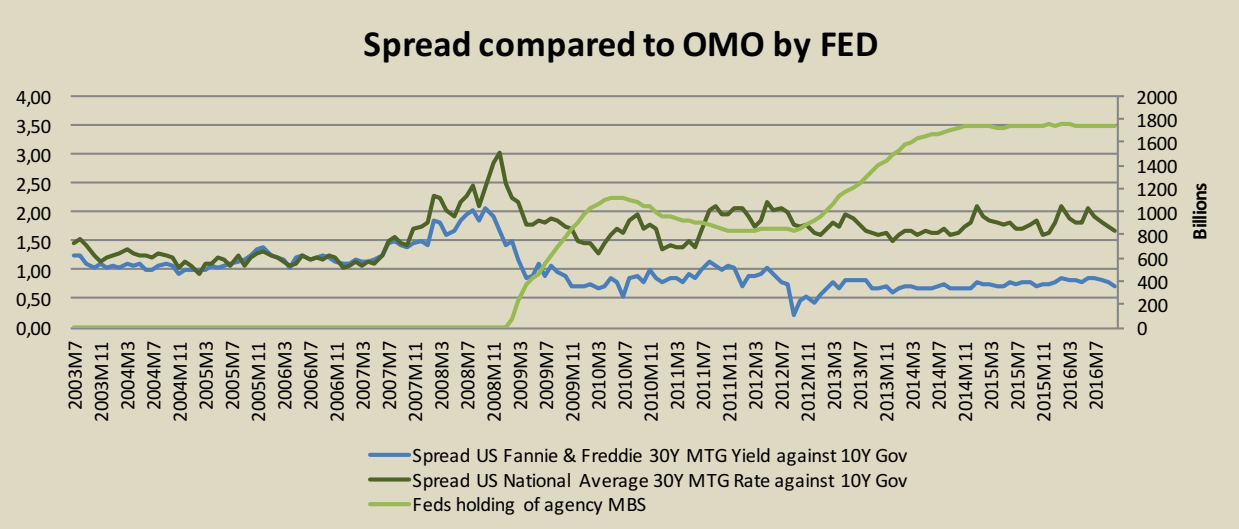

Figure 15: Spread on 30-year mortgage and 10-year Government (US) compared with The FEDs holding of MBS

Further, it is striking how small the premiums are on MBS relative to the 10-year government bond. Taking history into perspective, the most recent financial crisis proved that many US borrowers had to default on their mortgage. However, if the credit risk is assumed to be eliminated due to the mortgage insurance and the government guarantee, then the spread should exist as a combination of the liquidity premium and the prematurely redemption premium. With the large quantity purchases carried out by the FED, the market should be extremely liquid, implying that the majority of the spread is due to uncertainty about future cash flows, i.e., the prepayment option. As mentioned in the introduction to the US mortgage market, MBSs have an embedded prepayment option, which allows borrowers to redeem their loan at par, and this option creates uncertainty about future cash flows, which is not the case on treasury bonds.

From the US borrower's perspective it is noticeable that the spread on national average fixed 30-year mortgage rate is above pre-financial crisis levels, while the current coupon spread has moved below pre-financial crisis levels. As of 2013 the FED held about one-fifth of all outstanding agency MBSs, as a consequence prices have increased and yields have been driven down (Hancook & Passmore, 2015).

With the announcement from the FED that the QE *"action is being taken to reduce the cost and increase the availability of credit for the purchase of houses, which in turn should support housing markets and foster improved conditions in financial markets more generally"* (The Federal Reserve, 2008), it seems as if they have managed to keep

the marked liquid and provide funding for the US borrowers. The mortgage rate is lower than the pre-crisis levels supporting the statement of reducing costs of mortgage. Although, the large quantity purchases have only involved agency MBS, it seems as if the OMO has benefitted the jumbo loans as well. As visible in Figure 16, the spread increased slightly in the period leading to the presidential election of 2016 as investors might have moved away from the non-agency market and into more safe investments. As the presidential election did not cause a dramatic change in the financial markets, as otherwise expected, the spread has decreased again.

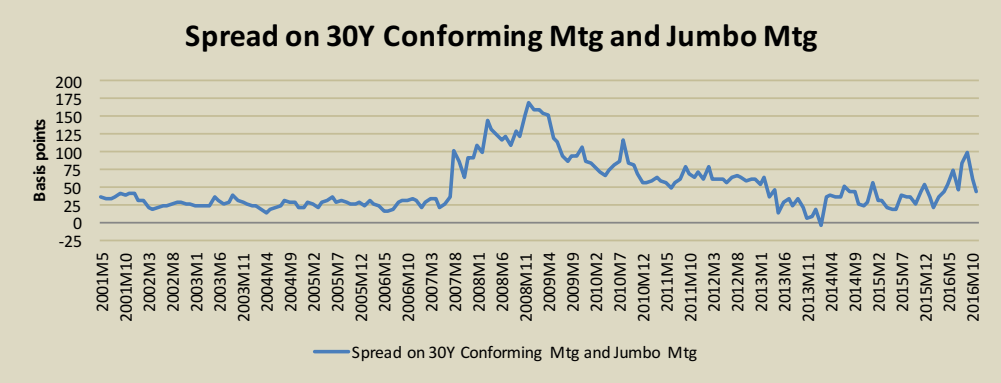

Figure 16. Spread on us 30 year fixed rate conforming and jumbo/non-conforming mortgage.

By comparing the US spread to the Danish spread on 30-year mortgage bonds to the 10-year government bond, it seems as if the liquidity premium and the prematurely redemption premiums are the largest attributes to the relatively large spread differential between US and Denmark. Thus, an increase in the Danish government yield could cause mortgage rates to move above the US mortgage rates. But with the current outlook the Danish borrowers receives favorable rates as it is possible to obtain a mortgage loan with a rate between 2 - 2.5 percent, compared to the US borrowers who receive a less favorable rates on mortgage between 3.5 - 4 percent, rates which seem highly dependent on the large holdings of MBSs by the FED.

Despite the analysis findings of lower liquidity in the Danish mortgage market and wider spread between the 10-year government bond and the 30-year mortgage bonds compared to the equivalent US model, the Danish borrowers are assessed to be better equipped for changes in interest rates due to the reduced information cost and the structural simplicity of the Danish model along with the option for market priced

repayments. The standardized mortgage loans in terms of structure and rate (Realkreditrådet, 2016b) simplifies the process of obtaining loans for Danish borrowers compared to US borrowers. The possibility to affect mortgage rates for US borrowers creates a disproportion among wealthy and less financially strong borrowers which conflicts with the original purpose of the US mortgage model.

Discussion

Through the analysis, information on structure, efficiency, liquidity, and interest rates spreads has been visualized. The following section includes the findings made in the analysis, which provide basis for further discussion of the research question.

A significant difference in structure between the Danish mortgage model and the US mortgage model is the extended prepayment option. As slow growing economies across Europe and the US have caused interest rates to decline, there has not been a large incentive to exercise the buy-back option among borrowers. However, both the Danish and American model provides borrowers with the opportunity to make prepayment at par, and mortgage markets therefore have experienced prematurely redemptions as borrowers have gained potential discounts on monthly payments by refinancing their mortgage with lower rates.

It is not unthinkable to assume that long-term interest rates will increase again in both Denmark and the US. The current and expected future increasing inflation suggests that long-term interest rates will start increasing on a continuous basis, at least in the US. A showstopper in both Europe and the US might be the ongoing QE programs, which still create downward pressure on interest rates. If long-term interest rates start to increase, the buy-back option of the Danish model will again become attractive, as it functions as a safety instrument by allowing Danish borrowers to ‘up-convert’, thereby reducing the possibility of technical insolvency. Such an addition to the US model has been argued to potentially improve homeownership rates for low-to-middle income families. As this income class is more exposed to insecure jobs, it would provide these borrowers to repay their mortgage at a fair price thereby lowering the default rate (Svenstrup & Willemann, 2006). Improving homeownership for low-to-middle income families is in the

current model heavily dependent on Fannie Mae and Freddie Mac's retained portfolios. Introducing the buy-back option in the US model, would require additional modifications apart from implementation of the buy-back option as the buy-back options relies on the fair price of the underlying mortgage (Svenstrup & Willemann, 2006). Since US borrowers only have the opportunity to redeem their mortgage at par, it will be interesting to see the effects on US mortgage when interest rates rise again.

The comparative shows that both the Danish and the US model have seen significant changes since their establishment. Since 1979, the Danish model has experienced altercations, which has changed the fundamental structure of the model. The deterioration of the balance principle and the passing of the SDO legislation has made the market less transparent and more complex than previously. Still, information on both prices and the current structure is more transparent compared to the US model. The variety of rates, which are available to borrowers and the different ways to affect these rates makes the model US quite complex. Further, the necessity to rate every single MBS, seems to increase information costs while decreasing stability and structural transparency.

The analysis of liquidity shows that while the FED keeps the US market for MBS extremely liquid, there has been a decrease in the liquidity of the Danish mortgage bond market. Assuming that the FED will not continue to hold a large proportion of the outstanding MBSs when the fiscal policy interactions comes to a halt, it will be interesting to see whether or not it is possible to maintain the current liquidity. The decrease in the Danish liquidity has to a large extent been ascribed to the EU and the market makers' reluctance to take on risk (Børsmæglerforeningen, 2016). Further, the decrease in liquidity has increased the operational cost for investors, a cost which will inevitably be transferred to borrowers if the trend continues. Hence, keeping a high level of liquidity in the Danish market should be of high priority if the reliance of fair value of mortgage bonds shall continue to maintain its central role. Suggestions have been made to reduce the number of Danish mortgage bonds series, by only allowing issuance of mortgage bonds in 100 basis points intervals, thereby creating an even more standardized market (Børsmæglerforeningen, 2016). Such a change would reduce the

number of bond series and create greater liquidity, but the consequences from a borrower's perspective are unknown.

The large decrease in spread between the US mortgage bonds and the 10-year treasury have undoubtedly been a consequence of the large-scale asset purchase program of the FED. It seems unlikely that the current liquidity premium can be maintained once the large-scale asset purchases will have to be reversed. Removing the federal guarantee of the GSEs will most likely put negative pressure on the US mortgage market, making it more difficult and more expensive to obtain mortgage loans. The GSEs should solely be concerned with providing a stable and reliant mortgage model for the US housing market, not creating high profits on their retained portfolios.

The Danish model should strive to reduce the current spread between 30-year mortgage and 10-year government bonds. As prepayment risk is hard to avoid, the spread can possibly be changed through improvement of liquidity as mentioned above. Attracting foreign investors could be an option, but this would require that foreign investors are better informed about the risk associated with the Danish mortgage market.

Conclusion

This thesis has examined the historical development of the Danish and the US mortgage model. The introduction to theories of efficient markets, liquidity and interest rate determination, has established the fundamentals for assessing the research question. The presentation of the current structure of both models shows the transformation that the Danish and the US mortgage models have experienced. The comparative analysis concludes that the key differences between the Danish mortgage model and they US mortgage model relate to the securitization process, the buy-back option, the structural simplicity, the balance principle and the ease at which information on the structure and loan conditions can be obtained.

The analysis further concludes that the yield differential between the Danish 10-year government bond and the US 10-year treasury is assessed to be largely explained by the greater inflation rates observed in the US. It is argued that the inflation rate in Denmark should increase over a longer period, and that the DKK should appreciate relative to the USD. Additionally, it is found that the while the liquidity on the Danish mortgage market

is still existent, the liquidity has seen a slight decrease over the last couple of years. On the contrary, the US mortgage market has proven extremely liquid, which in large can be ascribed to the large-scale asset purchase program that the FED has conducted since 2009. The large-scale asset purchase program has further reduced yields on MBSs securitized by the GSEs, and this has caused mortgage rates for conforming loans to decrease. While rates on non-conforming loans have decreased as well, they have not been able to decrease as much as the rates on the conforming loans. In addition to decreasing mortgage rates, the large-scale asset purchase program has also narrowed the spread of 30-year FRM against the 10-year treasury to historical low levels. This spread has previously been almost equal between Denmark and the US, but the Danish spread has been unable to follow suit of the US spread. The smaller spread in the US, implies that investors perceive the MBSs to carry a smaller risk premium than Danish mortgage bonds.

Despite fundamental changes to the balance principle and thereby the match-funding, the structure of the Danish models still seems to provide borrowers with the highest level of security. The match-funding principle allows borrowers to monitor price movements of the bond supporting their mortgage, providing them with the opportunity to exercise the buy-back option if they wish to repay their mortgage at market conditions. In the US, the borrowers are limited to make prepayments at par, which can cause a lock-in for US borrowers if the low interest rate environment, as currently experienced, is replaced by increasing long-term interest rates.

The structural simplicity of the Danish mortgage model compared to the US mortgage model, along with the ease at which borrowers can obtain information on their loans, provides the borrower a greater understanding of the mortgage system. The standardizations of loan structures in the Danish model allows investors to know the exact underlying mortgages of the bonds in which they choose to invest, in contrast to the US model of MBSs were a weighted average of both coupon and term are ascribed to a pool of mortgages. Therefore, despite the findings of higher liquidity and a narrower spread on 30-year FRM bonds against 10-year government bonds, it can be argued that of the Danish and the US mortgage model, the Danish mortgage model provides the best system for the borrower.

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Appendices

Appendix 1 - Data on outstanding of DK government bonds and mortgage bonds

Government bonds

Nominal value: 645.48 bn DKK

Market value: 806.07 bn DKK

Mortgage Bonds

Nominal Value: 2,705 bn DKK

Market value: 2753 bn DKK

Appendix 2 - Data on distribution of mortgage types DK

Distribution of Fixed rate and Variable rate mortgage in Denmark

Year and quarter	2010Q1	2010Q2	2010Q3	2010Q4	2011Q1	2011Q2	2011Q3	2011Q4	2012Q1
Fixed-rate mortgage bonds	26,90	37,20	111,20	96,90	33,10	36,40	38,20	39,70	109,00
Fixed-rate mortgage bonds	14,97%	24,65%	52,38%	41,45%	28,71%	34,57%	33,54%	18,41%	41,29%
Floating- and Adjustable-rate mortgage bonds	152,80	113,70	101,10	136,90	82,20	68,90	75,70	176,00	155,00
Floating- and Adjustable-rate mortgage bonds	85,03%	75,35%	47,62%	58,55%	71,29%	65,43%	66,46%	81,59%	58,71%
Total	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%

Year and quarter	2012Q2	2012Q3	2012Q4	2013Q1	2013Q2	2013Q3	2013Q4	2014Q1	2014Q2
Fixed-rate mortgage bonds	99,50	127,10	116,00	86,70	82,40	69,40	61,30	47,00	65,60
Fixed-rate mortgage bonds	48,21%	61,28%	44,48%	55,43%	56,32%	52,30%	29,30%	31,82%	50,97%
Floating- and Adjustable-rate mortgage bonds	106,90	80,30	144,80	69,70	63,90	63,30	#######	100,70	63,10
Floating- and Adjustable-rate mortgage bonds	51,79%	38,72%	55,52%	44,57%	43,68%	47,70%	70,70%	68,18%	49,03%
Total	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%

Year and quarter	2014Q3	2014Q4	2015Q1	2015Q2	2015Q3	2015Q4	2016Q1
Fixed-rate mortgage bonds	138,60	236,80	328,40	253,30	102,50	93,30	69,00
Fixed-rate mortgage bonds	62,66%	60,50%	77,54%	76,62%	53,03%	39,77%	41,95%
Floating- and Adjustable-rate mortgage bonds	82,60	154,60	95,10	77,30	90,80	141,30	95,50
Floating- and Adjustable-rate mortgage bonds	37,34%	39,50%	22,46%	23,38%	46,97%	60,23%	58,05%
Total	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%

Appendix 3 - Data on bid-ask spread, DK

	Spread	Spread	Spread	Spread	Spread	Average Spread
	09/11/2016	11/11/2016	14/11/2016	15/11/2016	16/11/2016	
0,5'27	0,395	0,45	0,46	0,46	0,47	0,45
1'27	0,478	0,47	0,48	0,48	0,48	0,48
1'32	0,48	0,47	0,48	0,48	0,48	0,48
1,5'24	1,4	1,40	1,40	1,40	1,41	1,40
1,5'27	0,45	0,45	0,45	0,45	0,45	0,45
1,5'32	0,462	0,45	ל,46	0,46	0,46	0,46
1,5'37	0,42	0,42	0,42	0,42	0,42	0,42
2'24	2,5		2,50	2,50	2,50	2,50
2'29	0,58	0,55	0,58	0,58	0,58	0,57
2'32	0,502	0,48	0,50	0,50	0,50	0,50
2'34	0,5225	0,52	0,53	0,53	0,52	0,52
2'37	0,442	0,43	0,44	0,44	0,44	0,44
2'47	0,4	0,40	0,40	0,40	0,40	0,40
2'47 IO	0,4	0,40	0,40	0,40	0,40	0,40
2,5'37	0,4	0,40	0,40	0,40	0,40	0,40
2,5'47	0,398	0,40	0,40	0,40	0,40	0,40
2,5'47 IO	0,4	0,40	0,40	0,40	0,40	0,40
3'29	1,125	1,13	1,13	1,13	1,13	1,13
3'34	0,475	0,46	0,48	0,48	0,48	0,47
3'44	0,4565	0,45	0,46	0,46	0,46	0,45
3'44 IO	0,4565	0,45	0,46	0,45	0,46	0,45
3'47	0,4	0,40	0,40	0,40	0,40	0,40
3'47 IO	0,3975	0,40	0,40	0,40	0,40	0,40
3,5'44	0,4475	0,44	0,45	0,45	0,45	0,45
3,5'44 IO	0,4475	0,44	0,45	0,45	0,45	0,45
3,5'47	0,4832	0,47	0,49	0,48	0,49	0,48
3,5'47 IO	0,479	0,47	0,48	0,48	0,48	0,48
4'25	1,2	1,16	1,20	1,20	1,20	1,19
4'28	1,2875	1,23	1,29	1,29	1,29	1,28
4'31	1,3375	1,34	1,34	1,34	1,34	1,34
4'35	0,95	0,96	0,95	0,95	0,95	0,95
4'35 IO	1,27	1,23	1,27	1,27	1,28	1,26
4'38	0,95	0,96	0,95	0,95	0,95	0,95
4'38 IO	0,95	0,96	0,95	0,95	0,95	0,95
4'41	0,9	0,92	0,90	0,90	0,90	0,90
4'41 IO10Y	1,0625	1,05	1,06	1,06	1,06	1,06
4'41 IO30Y	0,85	0,88	0,85	0,85	0,85	0,86
4'44	0,95	0,96	0,95	0,95	0,95	0,95
4'44 IO	0,875	0,90	0,88	0,88	0,88	0,88

Appendix 4 - Data on average daily trading of mortgage bonds DK

Average Daily Mortgage Bond Trading	
2011Q2	1.002
2011Q3	1.477
2011Q4	1.364
2012Q1	1.404
2012Q2	2.143
2012Q3	2.052
2012Q4	1.168
2013Q1	949
2013Q2	1.091
2013Q3	1.045
2013Q4	815
2014Q1	882
2014Q2	989
2014Q3	1.473
2014Q4	1.151
2015Q1	1.615
2015Q2	1.567
2015Q3	924
2015Q4	873
2016Q1	804
2016Q2	1.313

Appendix 5 - Data on average daily mortgage bond trading US

Average Daily MBS Trading	2011Q2	2011Q3	2011Q4	2012Q1	2012Q2	2012Q3	2012Q4	2013Q1	2013Q2	2013Q3	2013Q4	2014Q1	2014Q2	2014Q3
	3259	3258	3131	3487	3377	3255	3311	3736	3766	3679	3591	3607	3411	3034
Average Daily TBA (MBS) Trading	2011Q2	2011Q3	2011Q4	2012Q1	2012Q2	2012Q3	2012Q4	2013Q1	2013Q2	2013Q3	2013Q4	2014Q1	2014Q2	2014Q3
	7111	8088	7870	9159	8353	7981	6567	7414	7944	6932	6440	6973	7105	6923
Average Daily MBS Trading (Including TBA)	10370	11346	11001	12646	11730	11236	9878	11150	11710	10611	10031	10580	10516	9957

Average Daily MBS Trading	2014Q4	2015Q1	2015Q2	2015Q3	2015Q4	2016Q1	2016Q2
	3530	3272	3110	2861	2724	3195	3169
Average Daily TBA (MBS) Trading	2014Q4	2015Q1	2015Q2	2015Q3	2015Q4	2016Q1	2016Q2
	7205	8576	7844	7113	6551	7545	7478
Average Daily MBS Trading (Including TBA)	10735	11848	10954	9974	9275	10740	10647

Appendix 6 - Data on the 10-year treasury yield US

END OF MONTH - constant maturity
ALFRED St.Louis hhttps://fred.stlouisfed.org/series/DGS10#0

10-year Treasury yield (USA)

1987M1	7,18	**1996M12**	6,43	**2006M11**	4,46
1987M2	7,19	**1997M1**	6,53	**2006M12**	4,71
1987M3	7,51	**1997M2**	6,56	**2007M1**	4,83
1987M4	8,21	**1997M3**	6,92	**2007M2**	4,56
1987M5	8,49	**1997M4**	6,72	**2007M3**	4,65
1987M6	8,38	**1997M5**	6,67	**2007M4**	4,63
1987M7	8,66	**1997M6**	6,51	**2007M5**	4,90
1987M8	9,00	**1997M7**	6,02	**2007M6**	5,03
1987M9	9,63	**1997M8**	6,34	**2007M7**	4,78
1987M10	8,88	**1997M9**	6,12	**2007M8**	4,54
1987M11	8,99	**1997M10**	5,84	**2007M9**	4,59
1987M12	8,83	**1997M11**	5,86	**2007M10**	4,48
1988M1	8,26	**1997M12**	5,75	**2007M11**	3,97
1988M2	8,16	**1998M1**	5,53	**2007M12**	4,04
1988M3	8,57	**1998M2**	5,62	**2008M1**	3,67
1988M4	8,87	**1998M3**	5,67	**2008M2**	3,53
1988M5	9,20	**1998M4**	5,68	**2008M3**	3,45
1988M6	8,82	**1998M5**	5,56	**2008M4**	3,77
1988M7	9,12	**1998M6**	5,44	**2008M5**	4,06
1988M8	9,25	**1998M7**	5,50	**2008M6**	3,99
1988M9	8,87	**1998M8**	5,05	**2008M7**	3,99
1988M10	8,65	**1998M9**	4,44	**2008M8**	3,83
1988M11	9,06	**1998M10**	4,64	**2008M9**	3,85
1988M12	9,14	**1998M11**	4,74	**2008M10**	4,01
1989M1	9,01	**1998M12**	4,65	**2008M11**	2,93
1989M2	9,32	**1999M1**	4,66	**2008M12**	2,25
1989M3	9,30	**1999M2**	5,29	**2009M1**	2,87
1989M4	9,02	**1999M3**	5,25	**2009M2**	3,02
1989M5	8,60	**1999M4**	5,36	**2009M3**	2,71
1989M6	8,10	**1999M5**	5,64	**2009M4**	3,16
1989M7	7,82	**1999M6**	5,81	**2009M5**	3,47
1989M8	8,26	**1999M7**	5,92	**2009M6**	3,53
1989M9	8,31	**1999M8**	5,98	**2009M7**	3,52
1989M10	7,92	**1999M9**	5,90	**2009M8**	3,40
1989M11	7,84	**1999M10**	6,02	**2009M9**	3,31
1989M12	7,93	**1999M11**	6,18	**2009M10**	3,41
1990M1	8,43	**1999M12**	6,45	**2009M11**	3,21
1990M2	8,51	**2000M1**	6,68	**2009M12**	3,85
1990M3	8,65	**2000M2**	6,42	**2010M1**	3,63

1990M4	9,04	2000M3	6,03	2010M2	3,61
1990M5	8,60	2000M4	6,23	2010M3	3,84
1990M6	8,43	2000M5	6,29	2010M4	3,69
1990M7	8,36	2000M6	6,03	2010M5	3,31
1990M8	8,86	2000M7	6,04	2010M6	2,97
1990M9	8,82	2000M8	5,73	2010M7	2,94
1990M10	8,65	2000M9	5,80	2010M8	2,47
1990M11	8,26	2000M10	5,77	2010M9	2,53
1990M12	8,08	2000M11	5,48	2010M10	2,63
1991M1	8,03	2000M12	5,12	2010M11	2,81
1991M2	8,02	2001M1	5,19	2010M12	3,30
1991M3	8,05	2001M2	4,92	2011M1	3,42
1991M4	8,02	2001M3	4,93	2011M2	3,42
1991M5	8,06	2001M4	5,35	2011M3	3,47
1991M6	8,24	2001M5	5,43	2011M4	3,32
1991M7	8,20	2001M6	5,42	2011M5	3,05
1991M8	7,82	2001M7	5,07	2011M6	3,18
1991M9	7,47	2001M8	4,85	2011M7	2,82
1991M10	7,47	2001M9	4,60	2011M8	2,23
1991M11	7,38	2001M10	4,30	2011M9	1,92
1991M12	6,71	2001M11	4,78	2011M10	2,17
1992M1	7,31	2001M12	5,07	2011M11	2,08
1992M2	7,27	2002M1	5,07	2011M12	1,89
1992M3	7,54	2002M2	4,88	2012M1	1,83
1992M4	7,61	2002M3	5,42	2012M2	1,98
1992M5	7,33	2002M4	5,11	2012M3	2,23
1992M6	7,14	2002M5	5,08	2012M4	1,95
1992M7	6,72	2002M6	4,86	2012M5	1,59
1992M8	6,62	2002M7	4,51	2012M6	1,67
1992M9	6,37	2002M8	4,14	2012M7	1,51
1992M10	6,80	2002M9	3,63	2012M8	1,57
1992M11	6,95	2002M10	3,93	2012M9	1,65
1992M12	6,70	2002M11	4,22	2012M10	1,72
1993M1	6,39	2002M12	3,83	2012M11	1,62
1993M2	6,03	2003M1	4,00	2012M12	1,78
1993M3	6,03	2003M2	3,71	2013M1	2,02
1993M4	6,05	2003M3	3,83	2013M2	1,89
1993M5	6,16	2003M4	3,89	2013M3	1,87
1993M6	5,80	2003M5	3,37	2013M4	1,70
1993M7	5,83	2003M6	3,54	2013M5	2,16
1993M8	5,45	2003M7	4,49	2013M6	2,52
1993M9	5,40	2003M8	4,45	2013M7	2,60
1993M10	5,43	2003M9	3,96	2013M8	2,78
1993M11	5,83	2003M10	4,33	2013M9	2,64
1993M12	5,83	2003M11	4,34	2013M10	2,57

1994M1	5,70	2003M12	4,27	2013M11	2,75
1994M2	6,15	2004M1	4,16	2013M12	3,04
1994M3	6,77	2004M2	3,99	2014M1	2,67
1994M4	7,06	2004M3	3,86	2014M2	2,66
1994M5	7,17	2004M4	4,53	2014M3	2,73
1994M6	7,34	2004M5	4,66	2014M4	2,67
1994M7	7,12	2004M6	4,62	2014M5	2,48
1994M8	7,19	2004M7	4,50	2014M6	2,53
1994M9	7,62	2004M8	4,13	2014M7	2,58
1994M10	7,81	2004M9	4,14	2014M8	2,35
1994M11	7,91	2004M10	4,05	2014M9	2,52
1994M12	7,84	2004M11	4,36	2014M10	2,35
1995M1	7,60	2004M12	4,24	2014M11	2,18
1995M2	7,22	2005M1	4,14	2014M12	2,17
1995M3	7,20	2005M2	4,36	2015M1	1,68
1995M4	7,07	2005M3	4,50	2015M2	2,00
1995M5	6,30	2005M4	4,21	2015M3	1,94
1995M6	6,21	2005M5	4,00	2015M4	2,05
1995M7	6,45	2005M6	3,94	2015M5	2,12
1995M8	6,28	2005M7	4,28	2015M6	2,35
1995M9	6,17	2005M8	4,02	2015M7	2,20
1995M10	6,03	2005M9	4,34	2015M8	2,21
1995M11	5,76	2005M10	4,57	2015M9	2,06
1995M12	5,58	2005M11	4,49	2015M10	2,16
1996M1	5,60	2005M12	4,39	2015M11	2,21
1996M2	6,13	2006M1	4,53	2015M12	2,27
1996M3	6,34	2006M2	4,55	2016M1	1,94
1996M4	6,66	2006M3	4,86	2016M2	1,74
1996M5	6,85	2006M4	5,07	2016M3	1,78
1996M6	6,73	2006M5	5,12	2016M4	1,83
1996M7	6,80	2006M6	5,15	2016M5	1,84
1996M8	6,96	2006M7	4,99	2016M6	1,49
1996M9	6,72	2006M8	4,74	2016M7	1,46
1996M10	6,37	2006M9	4,64	2016M8	1,58
1996M11	6,06	2006M10	4,61	2016M9	1,60
				2016M10	1,84

Appendix 7 - Data on the 10-year government bond yield DK

END OF MONTH - constant maturity
NATIONALBANKEN, Datastream

	DK 10-year Government Bond yield				
1987M1	10,76	1997M12	5,63	2008M11	3,844
1987M2	12,1	1998M1	5,51	2008M12	3,307
1987M3	11,5	1998M2	5,33	2009M1	3,704
1987M4	11,22	1998M3	5,25	2009M2	3,46
1987M5	10,94	1998M4	5,35	2009M3	3,398
1987M6	10,94	1998M5	5,18	2009M4	3,464
1987M7	10,95	1998M6	5,05	2009M5	3,774
1987M8	10,82	1998M7	5,02	2009M6	3,617
1987M9	11,65	1998M8	4,93	2009M7	3,662
1987M10	11,93	1998M9	4,71	2009M8	3,539
1987M11	11,31	1998M10	4,8	2009M9	3,528
1987M12	11,15	1998M11	4,49	2009M10	3,646
1988M1	10,1	1998M12	4,35	2009M11	3,526
1988M2	9,86	1999M1	4,05	2009M12	3,618
1988M3	10,29	1999M2	4,42	2010M1	3,536
1988M4	10,66	1999M3	4,37	2010M2	3,415
1988M5	9,95	1999M4	4,25	2010M3	3,37
1988M6	9,56	1999M5	4,56	2010M4	3,208
1988M7	9,45	1999M6	4,93	2010M5	2,685
1988M8	9,87	1999M7	5,22	2010M6	2,675
1988M9	9,65	1999M8	5,41	2010M7	2,759
1988M10	9,44	1999M9	5,62	2010M8	2,164
1988M11	9,23	1999M10	5,63	2010M9	2,345
1988M12	9,03	1999M11	5,57	2010M10	2,613
1989M1	9,11	1999M12	5,64	2010M11	2,822
1989M2	9,69	2000M1	5,91	2010M12	2,981
1989M3	9,63	2000M2	5,82	2011M1	3,151
1989M4	9,69	2000M3	5,57	2011M2	3,173
1989M5	10,17	2000M4	5,68	2011M3	3,39
1989M6	9,64	2000M5	5,74	2011M4	3,27
1989M7	9,08	2000M6	5,73	2011M5	3,03
1989M8	9,56	2000M7	5,73	2011M6	2,98
1989M9	9,81	2000M8	5,69	2011M7	2,8
1989M10	10,29	2000M9	5,68	2011M8	2,35
1989M11	10,26	2000M10	5,58	2011M9	2,06
1989M12	10,26	2000M11	5,37	2011M10	2,33
1990M1	10,66	2000M12	5,2	2011M11	2,04
1990M2	11,48	2001M1	5,15	2011M12	1,58
1990M3	10,52	2001M2	5,06	2012M1	1,75
1990M4	10,54	2001M3	5,02	2012M2	1,78
1990M5	10,35	2001M4	5,31	2012M3	1,82

1990M6	10,21	2001M5	5,46	2012M4	1,63
1990M7	9,85	2001M6	5,36	2012M5	1,08
1990M8	10,59	2001M7	5,18	2012M6	1,46
1990M9	11,03	2001M8	5,06	2012M7	1,09
1990M10	10,68	2001M9	5,01	2012M8	1,11
1990M11	10,57	2001M10	4,65	2012M9	1,23
1990M12	10,5	2001M11	4,76	2012M10	1,23
1991M1	9,95	2001M12	5,15	2012M11	1,05
1991M2	9,31	2002M1	5,16	2012M12	1,35
1991M3	9,39	2002M2	5,17	2013M1	1,8
1991M4	9,15	2002M3	5,44	2013M2	1,59
1991M5	9,09	2002M4	5,36	2013M3	1,46
1991M6	9,27	2002M5	5,37	2013M4	1,32
1991M7	9,48	2002M6	5,19	2013M5	1,59
1991M8	9,24	2002M7	5,05	2013M6	1,88
1991M9	9,06	2002M8	4,91	2013M7	1,81
1991M10	8,94	2002M9	4,63	2013M8	2,05
1991M11	9,04	2002M10	4,86	2013M9	1,97
1991M12	8,76	2002M11	4,81	2013M10	1,77
1992M1	8,49	2002M12	4,45	2013M11	1,74
1992M2	8,5	2003M1	4,29	2013M12	1,99
1992M3	8,89	2003M2	4,17	2014M1	1,68
1992M4	8,82	2003M3	4,32	2014M2	1,64
1992M5	8,65	2003M4	4,37	2014M3	1,62
1992M6	9,07	2003M5	3,89	2014M4	1,54
1992M7	9,55	2003M6	4,03	2014M5	1,38
1992M8	9,75	2003M7	4,27	2014M6	1,29
1992M9	9,66	2003M8	4,39	2014M7	1,55
1992M10	8,95	2003M9	4,22	2014M8	1,19
1992M11	9,02	2003M10	4,51	2014M9	1,2
1992M12	8,91	2003M11	4,62	2014M10	1,1
1993M1	8,5	2003M12	4,46	2014M11	0,93
1993M2	8,59	2004M1	4,41	2014M12	0,83
1993M3	7,97	2004M2	4,22	2015M1	0,4
1993M4	7,71	2004M3	4,1	2015M2	0,28
1993M5	7,5	2004M4	4,38	2015M3	0,27
1993M6	6,87	2004M5	4,47	2015M4	0,46
1993M7	7,02	2004M6	4,51	2015M5	0,65
1993M8	6,58	2004M7	4,61	2015M6	0,97
1993M9	6,64	2004M8	4,41	2015M7	0,8
1993M10	6,37	2004M9	4,32	2015M8	0,92
1993M11	6,4	2004M10	4,18	2015M9	0,85
1993M12	6,09	2004M11	4,02	2015M10	0,83
1994M1	6	2004M12	3,87	2015M11	0,71
1994M2	6,58	2005M1	3,67	2015M12	0,92

1994M3	6,92	2005M2	3,77	2016M1	0,61
1994M4	7,11	2005M3	3,74	2016M2	0,43
1994M5	8,02	2005M4	3,45	2016M3	0,42
1994M6	8,18	2005M5	3,31	2016M4	0,52
1994M7	7,98	2005M6	3,12	2016M5	0,41
1994M8	8,8	2005M7	3,2	2016M6	0,08
1994M9	9,02	2005M8	3,08	2016M7	0,04
1994M10	8,92	2005M9	3,09	2016M8	0
1994M11	8,65	2005M10	3,39	2016M9	-0,03
1994M12	9,14	2005M11	3,43	2016M10	0,25
1995M1	8,96	2005M12	3,3		
1995M2	8,78	2006M1	3,45		
1995M3	8,86	2006M2	3,54		
1995M4	8,62	2006M3	3,84		
1995M5	8,03	2006M4	4,04		
1995M6	8,53	2006M5	3,987		
1995M7	8,27	2006M6	4,121		
1995M8	8,01	2006M7	3,97		
1995M9	8,02	2006M8	3,825		
1995M10	7,81	2006M9	3,672		
1995M11	7,33	2006M10	3,858		
1995M12	7,23	2006M11	3,744		
1996M1	7,06	2006M12	3,947		
1996M2	7,6	2007M1	4,064		
1996M3	7,53	2007M2	3,956		
1996M4	7,2	2007M3	4,05		
1996M5	7,45	2007M4	4,226		
1996M6	7,44	2007M5	4,491		
1996M7	7,34	2007M6	4,61		
1996M8	7,33	2007M7	4,418		
1996M9	6,94	2007M8	4,365		
1996M10	6,85	2007M9	4,506		
1996M11	6,62	2007M10	4,313		
1996M12	6,52	2007M11	4,184		
1997M1	6,48	2007M12	4,479		
1997M2	6,2	2008M1	4,084		
1997M3	6,69	2008M2	4,062		
1997M4	6,49	2008M3	4,191		
1997M5	6,6	2008M4	4,388		
1997M6	6,29	2008M5	4,673		
1997M7	5,97	2008M6	4,81		
1997M8	6,25	2008M7	4,7		
1997M9	5,99	2008M8	4,381		
1997M10	6,16	2008M9	4,286		
1997M11	5,93	2008M10	4,347		

Appendix 8 - Data on 30-year fixed-rate mortgage DK

END OF MONTH - constant maturity
Soruce National Bank of Denmark, Nordea Analytics
30-year Fixed Mortgage Rates (Denmark)

1987M1	11,96	1997M11	7,38	2008M9	6,662
1987M2	12,94	1997M12	7,28	2008M10	6,637
1987M3	12,94	1998M1	7,2	2008M11	6,436
1987M4	12,59	1998M2	6,51	2008M12	6,208
1987M5	12,42	1998M3	6,49	2009M1	6,314
1987M6	12,59	1998M4	6,56	2009M2	6,194
1987M7	12,59	1998M5	6,43	2009M3	6,052
1987M8	12,3	1998M6	6,36	2009M4	5,46
1987M9	13,09	1998M7	6,3	2009M5	5,499
1987M10	13,43	1998M8	6,46	2009M6	5,416
1987M11	12,84	1998M9	6,47	2009M7	5,283
1987M12	12,79	1998M10	6,51	2009M8	5,181
1988M1	12	1998M11	6,36	2009M9	5,19
1988M2	11,85	1998M12	6,34	2009M10	5,281
1988M3	12,13	1999M1	6,31	2009M11	5,208
1988M4	12,59	1999M2	6,41	2009M12	5,188
1988M5	11,82	1999M3	6,32	2010M1	5,104
1988M6	11,4	1999M4	6,23	2010M2	5,025
1988M7	11,25	1999M5	6,43	2010M3	5,012
1988M8	11,3	1999M6	6,63	2010M4	4,98
1988M9	10,88	1999M7	6,88	2010M5	4,811
1988M10	10,55	1999M8	7,12	2010M6	4,795
1988M11	10,32	1999M9	7,66	2010M7	4,791
1988M12	9,92	1999M10	7,57	2010M8	4,087
1989M1	9,98	1999M11	7,54	2010M9	4,147
1989M2	10,27	1999M12	7,45	2010M10	4,306
1989M3	10,12	2000M1	7,54	2010M11	4,472
1989M4	10,06	2000M2	7,41	2010M12	4,533
1989M5	10,32	2000M3	7,25	2011M1	4,646
1989M6	10,08	2000M4	7,35	2011M2	4,706
1989M7	9,7	2000M5	7,57	2011M3	5,23
1989M8	10	2000M6	7,64	2011M4	5,19
1989M9	10,29	2000M7	7,55	2011M5	5,11
1989M10	10,66	2000M8	7,48	2011M6	5,16
1989M11	10,59	2000M9	7,46	2011M7	5,04
1989M12	10,49	2000M10	7,41	2011M8	4,88
1990M1	10,79	2000M11	7,31	2011M9	4,15
1990M2	11,45	2000M12	7,3	2011M10	4,26
1990M3	10,68	2001M1	7,25	2011M11	4,21
1990M4	10,65	2001M2	7,19	2011M12	3,94
1990M5	10,65	2001M3	7,16	2012M1	4,01

1990M6	10,53	2001M4	6,7	2012M2	3,98
1990M7	10,22	2001M5	6,8	2012M3	3,96
1990M8	10,88	2001M6	6,69	2012M4	4
1990M9	11,44	2001M7	6,58	2012M5	3,96
1990M10	11,05	2001M8	6,49	2012M6	3,71
1990M11	11,02	2001M9	6,44	2012M7	3,57
1990M12	11,15	2001M10	6,31	2012M8	3,51
1991M1	10,58	2001M11	6,39	2012M9	3,57
1991M2	10,04	2001M12	6,55	2012M10	3,59
1991M3	10,04	2002M1	6,53	2012M11	3,46
1991M4	9,99	2002M2	6,51	2012M12	3,12
1991M5	9,88	2002M3	6,63	2013M1	3,58734011
1991M6	9,92	2002M4	6,57	2013M2	3,27392433
1991M7	10,09	2002M5	6,54	2013M3	3,19879592
1991M8	10,1	2002M6	6,45	2013M4	3,08779065
1991M9	9,93	2002M7	6,38	2013M5	3,16250468
1991M10	9,86	2002M8	6,25	2013M6	3,6128656
1991M11	9,92	2002M9	6,13	2013M7	3,61517479
1991M12	9,8	2002M10	6,17	2013M8	3,78816452
1992M1	9,72	2002M11	5,72	2013M9	3,70050371
1992M2	9,66	2002M12	5,47	2013M10	3,60292899
1992M3	9,91	2003M1	5,44	2013M11	3,55241241
1992M4	9,89	2003M2	5,32	2013M12	3,6886446
1992M5	9,83	2003M3	5,42	2014M1	3,3214583
1992M6	10,06	2003M4	5,46	2014M2	3,28480942
1992M7	10,42	2003M5	5,23	2014M3	3,23494832
1992M8	10,61	2003M6	5,29	2014M4	3,17461852
1992M9	10,6	2003M7	5,47	2014M5	3,06045636
1992M10	10,21	2003M8	5,56	2014M6	3,11899197
1992M11	10,2	2003M9	5,43	2014M7	3,12124714
1992M12	10,17	2003M10	5,58	2014M8	2,91787825
1993M1	9,3	2003M11	5,61	2014M9	2,71499115
1993M2	9,63	2003M12	5,45	2014M10	2,68287985
1993M3	8,88	2004M1	5,39	2014M11	2,58351364
1993M4	8,66	2004M2	5,23	2014M12	2,52351068
1993M5	7,62	2004M3	5,2	2015M1	2,15603356
1993M6	7,36	2004M4	5,35	2015M2	2,13563286
1993M7	7,26	2004M5	5,47	2015M3	2,14741946
1993M8	7,36	2004M6	5,49	2015M4	2,52916487
1993M9	7,4	2004M7	5,41	2015M5	2,70431202
1993M10	7,43	2004M8	5,28	2015M6	3,16138258
1993M11	7,49	2004M9	5,24	2015M7	3,14973473
1993M12	7,11	2004M10	5,21	2015M8	3,18193509
1994M1	6,96	2004M11	5,14	2015M9	3,11531653
1994M2	7,45	2004M12	5,07	2015M10	3,10594141

1994M3	7,82	2005M1	4,45	2015M11	3,07594413
1994M4	7,96	2005M2	4,47	2015M12	3,1244245
1994M5	8,87	2005M3	4,46	2016M1	2,74047934
1994M6	8,94	2005M4	4,34	2016M2	2,70106944
1994M7	8,78	2005M5	4,25	2016M3	2,63514833
1994M8	9,44	2005M6	4,18	2016M4	2,66347711
1994M9	9,6	2005M7	4,24	2016M5	2,58440435
1994M10	9,48	2005M8	4,18	2016M6	2,18314398
1994M11	9,26	2005M9	4,24	2016M7	2,17410469
1994M12	9,73	2005M10	4,46	2016M8	2,13393647
1995M1	9,97	2005M11	4,5	2016M9	2,07406751
1995M2	9,8	2005M12	4,39	2016M10	2,21464976
1995M3	9,95	2006M1	4,48		
1995M4	9,74	2006M2	4,54		
1995M5	9,22	2006M3	4,76		
1995M6	9,62	2006M4	5,351		
1995M7	9,4	2006M5	5,362		
1995M8	9,15	2006M6	5,425		
1995M9	9,16	2006M7	5,353		
1995M10	9,02	2006M8	5,27		
1995M11	8,74	2006M9	5,183		
1995M12	8,36	2006M10	5,223		
1996M1	8,33	2006M11	5,187		
1996M2	8,85	2006M12	5,24		
1996M3	8,69	2007M1	5,284		
1996M4	8,44	2007M2	5,231		
1996M5	8,69	2007M3	5,232		
1996M6	8,73	2007M4	5,325		
1996M7	8,69	2007M5	5,484		
1996M8	8,52	2007M6	5,628		
1996M9	8,17	2007M7	5,591		
1996M10	8,13	2007M8	5,535		
1996M11	7,98	2007M9	5,561		
1996M12	7,87	2007M10	5,479		
1997M1	7,97	2007M11	5,487		
1997M2	7,66	2007M12	5,607		
1997M3	7,99	2008M1	5,468		
1997M4	7,88	2008M2	5,38		
1997M5	7,78	2008M3	5,612		
1997M6	7,58	2008M4	5,712		
1997M7	7,4	2008M5	5,917		
1997M8	7,61	2008M6	6,084		
1997M9	7,42	2008M7	6,493		
1997M10	7,58	2008M8	6,375		

Appendix 9 - Data on 30-year fixed-rate mortgage national average USA

ALFRED St.Louis

https://alfred.stlouisfed.org/series?seid=MORTGAGE30US&utm_source=series_page&utm_

30-year Fixed Mortgage Rates (USA) - National Average 30-year fixed

1987M1	9,08	**1998M1**	7,12	**2009M1**	5,1
1987M2	9,07	**1998M2**	7,09	**2009M2**	5,07
1987M3	9,03	**1998M3**	7,08	**2009M3**	4,85
1987M4	10,37	**1998M4**	7,15	**2009M4**	4,78
1987M5	10,7	**1998M5**	7,07	**2009M5**	4,91
1987M6	10,35	**1998M6**	6,96	**2009M6**	5,42
1987M7	10,27	**1998M7**	6,97	**2009M7**	5,25
1987M8	10,33	**1998M8**	6,92	**2009M8**	5,14
1987M9	11,02	**1998M9**	6,64	**2009M9**	5,04
1987M10	10,97	**1998M10**	6,83	**2009M10**	5,03
1987M11	10,55	**1998M11**	6,78	**2009M11**	4,78
1987M12	10,61	**1998M12**	6,83	**2009M12**	5,14
1988M1	10,16	**1999M1**	6,74	**2010M1**	4,98
1988M2	9,87	**1999M2**	6,89	**2010M2**	5,05
1988M3	9,99	**1999M3**	6,98	**2010M3**	4,99
1988M4	10,28	**1999M4**	6,93	**2010M4**	5,06
1988M5	10,58	**1999M5**	7,23	**2010M5**	4,78
1988M6	10,4	**1999M6**	7,63	**2010M6**	4,69
1988M7	10,49	**1999M7**	7,7	**2010M7**	4,54
1988M8	10,67	**1999M8**	7,8	**2010M8**	4,36
1988M9	10,42	**1999M9**	7,76	**2010M9**	4,32
1988M10	10,22	**1999M10**	7,96	**2010M10**	4,23
1988M11	10,39	**1999M11**	7,75	**2010M11**	4,4
1988M12	10,77	**1999M12**	8,06	**2010M12**	4,86
1989M1	10,6	**2000M1**	8,25	**2011M1**	4,8
1989M2	10,78	**2000M2**	8,31	**2011M2**	4,95
1989M3	11,19	**2000M3**	8,23	**2011M3**	4,86
1989M4	11,03	**2000M4**	8,13	**2011M4**	4,78
1989M5	10,5	**2000M5**	8,62	**2011M5**	4,6
1989M6	10,07	**2000M6**	8,22	**2011M6**	4,51
1989M7	9,81	**2000M7**	8,13	**2011M7**	4,55
1989M8	10,21	**2000M8**	7,99	**2011M8**	4,22
1989M9	10,16	**2000M9**	7,88	**2011M9**	4,01
1989M10	9,82	**2000M10**	7,68	**2011M10**	4,1
1989M11	9,74	**2000M11**	7,73	**2011M11**	3,98
1989M12	9,78	**2000M12**	7,13	**2011M12**	3,95
1990M1	10,05	**2001M1**	7,15	**2012M1**	3,98
1990M2	10,31	**2001M2**	7,12	**2012M2**	3,95
1990M3	10,22	**2001M3**	6,91	**2012M3**	3,99
1990M4	10,56	**2001M4**	7,12	**2012M4**	3,88
1990M5	10,33	**2001M5**	7,2	**2012M5**	3,75
1990M6	10,15	**2001M6**	7,11	**2012M6**	3,66

1990M7	9,98	2001M7	7,03	2012M7	3,49
1990M8	10,24	2001M8	6,92	2012M8	3,59
1990M9	10,22	2001M9	6,72	2012M9	3,4
1990M10	10,17	2001M10	6,64	2012M10	3,41
1990M11	9,9	2001M11	7,02	2012M11	3,32
1990M12	9,68	2001M12	7,16	2012M12	3,35
1991M1	9,61	2002M1	6,96	2013M1	3,53
1991M2	9,29	2002M2	6,81	2013M2	3,51
1991M3	9,52	2002M3	7,18	2013M3	3,57
1991M4	9,53	2002M4	6,88	2013M4	3,4
1991M5	9,45	2002M5	6,76	2013M5	3,81
1991M6	9,67	2002M6	6,55	2013M6	4,46
1991M7	9,5	2002M7	6,34	2013M7	4,31
1991M8	9,15	2002M8	6,22	2013M8	4,51
1991M9	8,92	2002M9	5,99	2013M9	4,32
1991M10	8,91	2002M10	6,31	2013M10	4,1
1991M11	8,7	2002M11	6,13	2013M11	4,29
1991M12	8,35	2002M12	5,93	2013M12	4,48
1992M1	8,68	2003M1	5,9	2014M1	4,32
1992M2	8,83	2003M2	5,79	2014M2	4,37
1992M3	8,98	2003M3	5,91	2014M3	4,4
1992M4	8,85	2003M4	5,79	2014M4	4,33
1992M5	8,6	2003M5	5,31	2014M5	4,12
1992M6	8,43	2003M6	5,24	2014M6	4,14
1992M7	8,05	2003M7	5,94	2014M7	4,12
1992M8	8,01	2003M8	6,32	2014M8	4,1
1992M9	8,02	2003M9	5,98	2014M9	4,2
1992M10	8,21	2003M10	5,94	2014M10	3,98
1992M11	8,29	2003M11	5,89	2014M11	3,97
1992M12	8,14	2003M12	5,85	2014M12	3,87
1993M1	7,86	2004M1	5,68	2015M1	3,66
1993M2	7,53	2004M2	5,58	2015M2	3,8
1993M3	7,5	2004M3	5,4	2015M3	3,69
1993M4	7,43	2004M4	6,01	2015M4	3,68
1993M5	7,5	2004M5	6,32	2015M5	3,87
1993M6	7,34	2004M6	6,25	2015M6	4,02
1993M7	7,25	2004M7	6,08	2015M7	3,98
1993M8	6,97	2004M8	5,82	2015M8	3,84
1993M9	6,95	2004M9	5,72	2015M9	3,86
1993M10	6,86	2004M10	5,64	2015M10	3,76
1993M11	7,31	2004M11	5,72	2015M11	3,95
1993M12	7,13	2004M12	5,81	2015M12	4,01
1994M1	6,97	2005M1	5,66	2016M1	3,79
1994M2	7,32	2005M2	5,69	2016M2	3,62
1994M3	7,8	2005M3	6,04	2016M3	3,71

1994M4	8,32	2005M4	5,78	2016M4	3,66
1994M5	8,53	2005M5	5,65	2016M5	3,64
1994M6	8,46	2005M6	5,53	2016M6	3,48
1994M7	8,57	2005M7	5,77	2016M7	3,48
1994M8	8,56	2005M8	5,77	2016M8	3,43
1994M9	8,82	2005M9	5,91	2016M9	3,42
1994M10	9,03	2005M10	6,15	2016M10	3,47
1994M11	9,25	2005M11	6,28		
1994M12	9,18	2005M12	6,22		
1995M1	9,13	2006M1	6,12		
1995M2	8,73	2006M2	6,26		
1995M3	8,38	2006M3	6,35		
1995M4	8,26	2006M4	6,58		
1995M5	7,85	2006M5	6,62		
1995M6	7,53	2006M6	6,78		
1995M7	7,79	2006M7	6,72		
1995M8	7,88	2006M8	6,44		
1995M9	7,62	2006M9	6,31		
1995M10	7,45	2006M10	6,4		
1995M11	7,35	2006M11	6,14		
1995M12	7,11	2006M12	6,18		
1996M1	7	2007M1	6,25		
1996M2	7,32	2007M2	6,22		
1996M3	7,69	2007M3	6,16		
1996M4	7,92	2007M4	6,16		
1996M5	8,03	2007M5	6,42		
1996M6	8,29	2007M6	6,67		
1996M7	8,19	2007M7	6,69		
1996M8	8,09	2007M8	6,45		
1996M9	8,16	2007M9	6,42		
1996M10	7,86	2007M10	6,33		
1996M11	7,52	2007M11	6,1		
1996M12	7,64	2007M12	6,17		
1997M1	7,88	2008M1	5,68		
1997M2	7,65	2008M2	6,24		
1997M3	7,97	2008M3	5,85		
1997M4	8,08	2008M4	6,03		
1997M5	7,94	2008M5	6,08		
1997M6	7,58	2008M6	6,45		
1997M7	7,43	2008M7	6,52		
1997M8	7,58	2008M8	6,4		
1997M9	7,28	2008M9	6,09		
1997M10	7,21	2008M10	6,46		
1997M11	7,17	2008M11	5,97		
1997M12	6,99	2008M12	5,1		

Appendix 10 - Data on Fannie Mae and Freddie Mac 30-year current coupon yield

Weighted Average of current coupon Fannie and Freddie
Source: Bloomberg

Date	Mid Yield	Date	Mid Yield	Date	Mid Yield
1987M11	10,225	**1998M11**	6,33	**2009M11**	3,936
1987M12	10,196	**1998M12**	6,375	**2009M12**	4,5735
1988M1	9,409	**1999M1**	6,285	**2010M1**	4,3575
1988M2	9,371	**1999M2**	6,7	**2010M2**	4,339
1988M3	9,719	**1999M3**	6,63	**2010M3**	4,5215
1988M4	9,939	**1999M4**	6,66	**2010M4**	4,4175
1988M5	10,249	**1999M5**	7,01	**2010M5**	4,162
1988M6	9,862	**1999M6**	7,24	**2010M6**	3,764
1988M7	10,21	**1999M7**	7,55	**2010M7**	3,4625
1988M8	10,283	**1999M8**	7,71	**2010M8**	3,3115
1988M9	9,896	**1999M9**	7,44	**2010M9**	3,41
1988M10	9,676	**1999M10**	7,485	**2010M10**	3,3945
1988M11	10,148	**1999M11**	7,605	**2010M11**	3,802
1988M12	10,416	**1999M12**	7,82	**2010M12**	4,153
1989M1	10,225	**2000M1**	8,115	**2011M1**	4,192
1989M2	10,658	**2000M2**	8,01	**2011M2**	4,2655
1989M3	10,822	**2000M3**	7,955	**2011M3**	4,325
1989M4	10,668	**2000M4**	8,065	**2011M4**	4,1095
1989M5	10,143	**2000M5**	8,23	**2011M5**	3,9605
1989M6	9,719	**2000M6**	7,91	**2011M6**	4,036
1989M7	9,25	**2000M7**	7,915	**2011M7**	3,8265
1989M8	9,814	**2000M8**	7,72	**2011M8**	3,3815
1989M9	9,86	**2000M9**	7,575	**2011M9**	2,982
1989M10	9,42	**2000M10**	7,545	**2011M10**	3,1705
1989M11	9,39	**2000M11**	7,29	**2011M11**	3,1325
1989M12	9,46	**2000M12**	6,925	**2011M12**	2,9195
1990M1	9,85	**2001M1**	6,655	**2012M1**	2,5435
1990M2	9,88	**2001M2**	6,59	**2012M2**	2,882
1990M3	9,93	**2001M3**	6,59	**2012M3**	3,0995
1990M4	10,37	**2001M4**	6,81	**2012M4**	2,859
1990M5	9,83	**2001M5**	6,815	**2012M5**	2,621
1990M6	9,69	**2001M6**	6,93	**2012M6**	2,6025
1990M7	9,46	**2001M7**	6,54	**2012M7**	2,2775
1990M8	9,83	**2001M8**	6,415	**2012M8**	2,318
1990M9	9,82	**2001M9**	6,12	**2012M9**	1,8505
1990M10	9,74	**2001M10**	5,665	**2012M10**	2,196
1990M11	9,54	**2001M11**	6,295	**2012M11**	2,1365
1990M12	9,29	**2001M12**	6,53	**2012M12**	2,2165
1991M1	9,16	**2002M1**	6,465	**2013M1**	2,6
1991M2	9,11	**2002M2**	6,2	**2013M2**	2,578
1991M3	9,16	**2002M3**	6,69	**2013M3**	2,653
1991M4	9,09	**2002M4**	6,29	**2013M4**	2,3695

1991M5	9,04	**2002M5**	6,225	**2013M5**	2,9625
1991M6	9,25	**2002M6**	6,105	**2013M6**	3,338
1991M7	9,07	**2002M7**	5,855	**2013M7**	3,4245
1991M8	8,78	**2002M8**	5,55	**2013M8**	3,594
1991M9	8,42	**2002M9**	5,295	**2013M9**	3,314
1991M10	8,25	**2002M10**	5,331	**2013M10**	3,227
1991M11	8,285	**2002M11**	5,497	**2013M11**	3,4545
1991M12	7,57	**2002M12**	5,0975	**2013M12**	3,6325
1992M1	8,33	**2003M1**	5,248	**2014M1**	3,3555
1992M2	8,115	**2003M2**	4,9735	**2014M2**	3,367
1992M3	8,515	**2003M3**	5,026	**2014M3**	3,4535
1992M4	8,35	**2003M4**	4,9205	**2014M4**	3,3385
1992M5	8,115	**2003M5**	4,417	**2014M5**	3,1705
1992M6	7,86	**2003M6**	4,672	**2014M6**	3,1915
1992M7	7,52	**2003M7**	5,7375	**2014M7**	3,2935
1992M8	7,35	**2003M8**	5,696	**2014M8**	3,0925
1992M9	7,425	**2003M9**	5,045	**2014M9**	3,204
1992M10	7,88	**2003M10**	5,3635	**2014M10**	3,021
1992M11	8	**2003M11**	5,4345	**2014M11**	2,845
1992M12	7,575	**2003M12**	5,307	**2014M12**	2,8545
1993M1	7,24	**2004M1**	5,215	**2015M1**	2,448
1993M2	6,925	**2004M2**	5,016	**2015M2**	2,757
1993M3	6,915	**2004M3**	4,9475	**2015M3**	2,68
1993M4	6,91	**2004M4**	5,602	**2015M4**	2,7655
1993M5	6,975	**2004M5**	5,7615	**2015M5**	2,847
1993M6	6,605	**2004M6**	5,604	**2015M6**	3,118
1993M7	6,61	**2004M7**	5,494	**2015M7**	2,9325
1993M8	6,33	**2004M8**	5,1785	**2015M8**	2,9755
1993M9	6,27	**2004M9**	5,245	**2015M9**	2,832
1993M10	6,345	**2004M10**	5,1225	**2015M10**	2,866
1993M11	6,765	**2004M11**	5,272	**2015M11**	2,963
1993M12	6,69	**2004M12**	5,245	**2015M12**	3,0205
1994M1	6,39	**2005M1**	5,1205	**2016M1**	2,714
1994M2	6,975	**2005M2**	5,343	**2016M2**	2,5805
1994M3	7,82	**2005M3**	5,485	**2016M3**	2,5925
1994M4	8,08	**2005M4**	5,287	**2016M4**	2,629
1994M5	8,14	**2005M5**	5,037	**2016M5**	2,6305
1994M6	8,35	**2005M6**	5,02	**2016M6**	2,3385
1994M7	8,005	**2005M7**	5,378	**2016M7**	2,302
1994M8	8,13	**2005M8**	5,1675	**2016M8**	2,386
1994M9	8,555	**2005M9**	5,5235	**2016M9**	2,373
1994M10	8,73	**2005M10**	5,819	**2016M10**	2,534
1994M11	8,905	**2005M11**	5,853		
1994M12	8,895	**2005M12**	5,763		
1995M1	8,625	**2006M1**	5,769		

1995M2	8,18	**2006M2**	5,742
1995M3	8,235	**2006M3**	6,024
1995M4	8,105	**2006M4**	6,115
1995M5	7,45	**2006M5**	6,3105
1995M6	7,45	**2006M6**	6,3845
1995M7	7,585	**2006M7**	6,163
1995M8	7,455	**2006M8**	5,9485
1995M9	7,38	**2006M9**	5,8695
1995M10	7,255	**2006M10**	5,808
1995M11	7,035	**2006M11**	5,5945
1995M12	6,815	**2006M12**	5,806
1996M1	6,76	**2007M1**	5,9315
1996M2	7,27	**2007M2**	5,7425
1996M3	7,575	**2007M3**	5,7835
1996M4	7,81	**2007M4**	5,7745
1996M5	8,01	**2007M5**	6,0565
1996M6	7,875	**2007M6**	6,2685
1996M7	7,92	**2007M7**	6,226
1996M8	8,065	**2007M8**	6,025
1996M9	7,83	**2007M9**	5,996
1996M10	7,48	**2007M10**	5,8715
1996M11	7,21	**2007M11**	5,432
1996M12	7,545	**2007M12**	5,5415
1997M1	7,525	**2008M1**	5,0755
1997M2	7,58	**2008M2**	5,3635
1997M3	7,95	**2008M3**	5,2695
1997M4	7,715	**2008M4**	5,365
1997M5	7,63	**2008M5**	5,7185
1997M6	7,475	**2008M6**	5,847
1997M7	7,05	**2008M7**	5,9355
1997M8	7,305	**2008M8**	5,8535
1997M9	7,105	**2008M9**	5,699
1997M10	6,93	**2008M10**	6,0705
1997M11	6,985	**2008M11**	4,856
1997M12	6,815	**2008M12**	3,929
1998M1	6,62	**2009M1**	4,2755
1998M2	6,74	**2009M2**	4,496
1998M3	6,78	**2009M3**	3,8945
1998M4	6,75	**2009M4**	4,0245
1998M5	6,65	**2009M5**	4,358
1998M6	6,6	**2009M6**	4,6255
1998M7	6,615	**2009M7**	4,4165
1998M8	6,385	**2009M8**	4,4495
1998M9	6,035	**2009M9**	4,261
1998M10	6,305	**2009M10**	4,3105

Appendix 11 - Data on rates spread between conforming and non-conforming loans

Spread on conforming and non-conforming loans
Source: Bloomberg

Date	basis points	Date	basis points	Date	basis points
2001M5	36	2006M10	30	2012M3	60
2001M6	34	2006M11	34	2012M4	61
2001M7	34	2006M12	30	2012M5	60
2001M8	36	2007M1	21	2012M6	57
2001M9	42	2007M2	29	2012M7	63
2001M10	39	2007M3	34	2012M8	66
2001M11	42	2007M4	33	2012M9	64
2001M12	40	2007M5	21	2012M10	59
2002M1	31	2007M6	25	2012M11	61
2002M2	31	2007M7	35	2012M12	62
2002M3	20	2007M8	101	2013M1	54
2002M4	19	2007M9	86	2013M2	63
2002M5	20	2007M10	63	2013M3	36
2002M6	24	2007M11	91	2013M4	47
2002M7	23	2007M12	92	2013M5	13
2002M8	27	2008M1	109	2013M6	28
2002M9	28	2008M2	99	2013M7	34
2002M10	29	2008M3	144	2013M8	24
2002M11	27	2008M4	132	2013M9	33
2002M12	26	2008M5	124	2013M10	21
2003M1	23	2008M6	116	2013M11	6
2003M2	23	2008M7	121	2013M12	9
2003M3	23	2008M8	110	2014M1	19
2003M4	24	2008M9	130	2014M2	-3
2003M5	36	2008M10	122	2014M3	36
2003M6	31	2008M11	151	2014M4	38
2003M7	27	2008M12	170	2014M5	35
2003M8	29	2009M1	159	2014M6	35
2003M9	38	2009M2	158	2014M7	52
2003M10	31	2009M3	155	2014M8	43
2003M11	28	2009M4	151	2014M9	43
2003M12	25	2009M5	120	2014M10	27
2004M1	24	2009M6	114	2014M11	23
2004M2	23	2009M7	93	2014M12	29
2004M3	19	2009M8	86	2015M1	57
2004M4	14	2009M9	95	2015M2	31
2004M5	18	2009M10	94	2015M3	31
2004M6	20	2009M11	106	2015M4	20
2004M7	23	2009M12	87	2015M5	19
2004M8	30	2010M1	83	2015M6	18
2004M9	29	2010M2	80	2015M7	39
2004M10	28	2010M3	71	2015M8	37

2004M11	21	2010M4	67	2015M9	37		
2004M12	22	2010M5	74	2015M10	25		
2005M1	28	2010M6	82	2015M11	44		
2005M2	26	2010M7	86	2015M12	54		
2005M3	21	2010M8	116	2016M1	36		
2005M4	29	2010M9	84	2016M2	20		
2005M5	31	2010M10	81	2016M3	36		
2005M6	35	2010M11	68	2016M4	44		
2005M7	28	2010M12	55	2016M5	54		
2005M8	30	2011M1	57	2016M6	73		
2005M9	29	2011M2	59	2016M7	46		
2005M10	27	2011M3	65	2016M8	83		
2005M11	26	2011M4	59	2016M9	98		
2005M12	28	2011M5	56	2016M10	62		
2006M1	24	2011M6	49	2016M11	44		
2006M2	32	2011M7	56				
2006M3	25	2011M8	61				
2006M4	23	2011M9	80				
2006M5	17	2011M10	68				
2006M6	17	2011M11	63				
2006M7	19	2011M12	72				
2006M8	28	2012M1	60				
2006M9	31	2012M2	79				

Appendix 12 - Data on FED holdings of Agency MBS

Date	Billions	Date	Billions	Date	Billions	Date	Billions
2003M7	0	2007M3	0	2010M11	1037,803	2014M7	1674,363
2003M8	0	2007M4	0	2010M12	992,141	2014M8	1678,312
2003M9	0	2007M5	0	2011M1	965,077	2014M9	1706,282
2003M10	0	2007M6	0	2011M2	958,201	2014M10	1717,887
2003M11	0	2007M7	0	2011M3	937,155	2014M11	1729,79
2003M12	0	2007M8	0	2011M4	927,021	2014M12	1736,833
2004M1	0	2007M9	0	2011M5	917,856	2015M1	1738,672
2004M2	0	2007M10	0	2011M6	908,853	2015M2	1740,208
2004M3	0	2007M11	0	2011M7	897,285	2015M3	1731,909
2004M4	0	2007M12	0	2011M8	884,945	2015M4	1718,85
2004M5	0	2008M1	0	2011M9	870,883	2015M5	1722,434
2004M6	0	2008M2	0	2011M10	849,261	2015M6	1746,393
2004M7	0	2008M3	0	2011M11	827,052	2015M7	1734,834
2004M8	0	2008M4	0	2011M12	837,295	2015M8	1736,612
2004M9	0	2008M5	0	2012M1	835,624	2015M9	1741,233
2004M10	0	2008M6	0	2012M2	840,795	2015M10	1744,091
2004M11	0	2008M7	0	2012M3	836,786	2015M11	1744,789
2004M12	0	2008M8	0	2012M4	847,796	2015M12	1747,467
2005M1	0	2008M9	0	2012M5	851,75	2016M1	1744,179
2005M2	0	2008M10	0	2012M6	854,979	2016M2	1760,918
2005M3	0	2008M11	0	2012M7	853,362	2016M3	1753,082
2005M4	0	2008M12	0	2012M8	843,597	2016M4	1744,826
2005M5	0	2009M1	7,377	2012M9	834,979	2016M5	1743,074
2005M6	0	2009M2	68,745	2012M10	852,039	2016M6	1743,541
2005M7	0	2009M3	236,156	2012M11	883,539	2016M7	1741,091
2005M8	0	2009M4	366,153	2012M12	926,558	2016M8	1743,982
2005M9	0	2009M5	427,552	2013M1	965,784	2016M9	1736,875
2005M10	0	2009M6	467,226	2013M2	1015,914	2016M10	1735,841
2005M11	0	2009M7	542,888	2013M3	1070,932		
2005M12	0	2009M8	622,864	2013M4	1136,007		
2006M1	0	2009M9	692,365	2013M5	1164,934		
2006M2	0	2009M10	774,066	2013M6	1208,116		
2006M3	0	2009M11	852,124	2013M7	1246,964		
2006M4	0	2009M12	908,257	2013M8	1291,341		
2006M5	0	2010M1	969,728	2013M9	1342,004		
2006M6	0	2010M2	1032,56	2013M10	1393,687		
2006M7	0	2010M3	1068,7	2013M11	1439,854		
2006M8	0	2010M4	1096,42	2013M12	1496,943		
2006M9	0	2010M5	1112,91	2014M1	1532,224		
2006M10	0	2010M6	1118,13	2014M2	1570,067		
2006M11	0	2010M7	1117,47	2014M3	1603,104		
2006M12	0	2010M8	1103,17	2014M4	1631,875		
2007M1	0	2010M9	1078,54	2014M5	1647,982		
2007M2	0	2010M10	1051,04	2014M6	1663,897		