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HOUSING RETURNS AND RISK PROXIES

EVIDENCE FROM THE UNITED STATES AND ITS NINE CENSUS DIVISIONS

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ABSTRACT:

This thesis adopts the commonly known asset pricing models and investigates the relationship between housing price returns, financial risk proxies and rents in the United States and its nine Census Divisions. Analysis of the thesis consists of two parts. The first part measures the Census Divisions' systematic risk and abnormal returns. The second part investigates the relationship between housing excess returns, financial risk proxies and rents and tests the CAPM capability to price financial risk proxy variables and rents. Financial risk proxy variables used in the analysis are VIX, TYVIX and Ted Spread. Abnormal returns are measured by utilizing CAPM excess return modification model's residual values.

Sample period is from January 2008 to December 2019 and observations are monthly. Methodology in the first part of the analysis is two variable OLS regression model and in the following part multi variable OLS regression models.

Results from the first part of the analysis provides that market models tend to generate mostly negative abnormal returns in housing markets. Results also show that the strength of systematic risks varies between the Census Division indices. The second part of the analysis show that financial risk proxies' impact is mostly insignificant, with few exceptions. On the other hand, abnormal return estimation results also suggests that CAPM significantly misprices financial risk proxies, since TYVIX and VIX show significant coefficients in four Divisions. Results from the direct effect estimations show that financial risk proxies are not correlated with country level excess returns and the level of significance decreases when the model does not include market variable. In turn, the rent variable turns out to be positive and significant factor without the market variable.

All in all, the study provides evidence about the importance of asset pricing research in housing markets, since CAPM tend to generate negative abnormal returns in housing markets and shows significant mispricing effects in four Divisions. This study provides also evidence about the low and insignificant relationships between housing price returns and financial risk factors which supports the theory that house investments may provide good options for investment diversification purposes.

KEY WORDS: Housing, Housing Price Returns, Financial Risk Proxy, TYVIX, VIX, TED Spread, Rents

VAASAN YLIOPISTO**Laskentatoimen ja rahoituksen akateeminen yksikkö**

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TIIVISTELMÄ:

Tämä Pro Gradu tutkielma hyödyntää yleisesti käytössä olevia sijoitushyödykkeiden hinnoittelumalleja ja tutkii asuntojen hintatuottojen, rahoitusmarkkinariskien ja vuokraindexin korrelaatioita Yhdysvalloissa ja Yhdysvaltojen yhdeksässä divisioonassa. Tutkielman empiiriset analyysit koostuvat kahdesta osiosta. Ensimmäinen osio tutkii divisioonien asuntohintaindeksituottojen systemaattista riskiä ja epänormaaleita tuottoja. Toinen osio puolestaan tutkii asuntohintaindeksien riskikorjatuiden tuottojen yhteyttä rahoitusmarkkinariskeihin sekä vuokratasoihin. Toinen osio mittaa myös CAP-mallin hinnoittelukyvykkyyttä hinnoitella rahoitusmarkkinariskit ja vuokramuutokset. Tutkielmassa käytettävät rahoitusmarkkinariskit ovat VIX, TYVIX ja Ted Spread.

Tutkielman analyyseissä käytetyt data aikasarjat on kerätty tammikuun 2008 ja joulukuun 2019 välillä. Tutkielman ensimmäisessä analyysissä hyödynnetään kahden muuttujan – ja toisessa osiossa usean muuttujan regressio analyysejä. Tutkielman kaikissa regressioissa on hyödynnetty pienimmän neliösumman menetelmää.

Ensimmäisen empiirisen osion tulokset osoittavat, että markkinamallit tuottavat keskimääräisesti negatiivisia epänormaaleita tuottoja asuntomarkkinoilla. Tulokset osoittavat myös eroavaisuuksia Divisioonaindeksien systemaattisten riskifaktoreiden välillä. Toisen osion tulokset osoittavat, että rahoitusriski faktoreiden vaikutukset eivät ole suurimmaksi osaksi tilastollisesti merkitseviä. Toisaalta epänormaaleiden tuottojen jäännösarvo mallinukset osoittavat, että CAP-malli ei kykene hinnoittelemaan kaikkia tutkielmassa käytettäviä rahoitusmarkkinariskejä, sillä faktorit VIX ja TYVIX osoittavat tilastollisesti merkitseviä vaikutuksia neljässä divisioonassa. Suorien vaikutusten tulokset puolestaan osoittavat, että tutkielmassa käytettävät rahoitusmarkkinariskit eivät ole tilastollisesti merkitseviä faktoreita selittämään maanlaajuisia asuntojen tuottoja ja rahoitusmarkkinariski faktoreiden tilastollinen merkitsevyys jopa laskee, kun mallista poistetaan markkinamuuttuja selittävänä muuttujana. Sen sijaan vuokra faktori osoittaa positiivisia ja tilastollisesti merkitseviä kertoimia, kun markkinamuuttuja ei sisälly malliin.

Yhteenvedona voidaan todeta, että tämä tutkielman tulokset tarjoavat evidenssiä hinnoittelumalleihin liittyvien tutkimusten tärkeydestä asuntomarkkinoilla, sillä CAP-mallilla estimoidut epänormaalit tuotot ovat enimmäkseen negatiivisia ja epänormaaleihin tuottoihin vaikuttavia tekijöitä löytyy myös rahoitusmarkkinariskien joukosta. Tutkielma tarjoaa myös tuloksia matalasta- ja tilastollisesti merkityksettömästä yhteydestä asuntojen hintatuottojen ja rahoitusmarkkinariskien välillä, mikä tukee aikaisempia teorioita siitä, että asuntosijoittaminen voi tarjota sijoittajille hajautushyötyjä.

KEY WORDS: Housing, Housing Price Returns, Financial Risk Proxy, TYVIX, VIX, TED Spread, Rents

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Abbreviations

ENC	East North Central
ESC	East South Central
MA	Middle Atlantic
MOUNT	Mountain
NE	New England
PAC	Pacific
SA	South Atlantic
WSC	West South Central
WNC	West North Central

1 INTRODUCTION

Recently prevailed low interest rate levels, increase in stock market, and financial crisis, in which housing prices and mortgage backed securities were the biggest reason for crisis, makes the relationship between housing price returns and market risks an interesting research topic. In 2008 financial crisis, consumers ability to pay their loans led to collapse of housing prices which led to collapse of value of the mortgage backed securities, better known as subprime loans. This Master's Thesis provide evidence about the relationship between systematic market risk, stock market risk, interest rate risk, credit risk, rent levels and housing price returns.

Housing prices and price returns are interesting research topic in several reasons. Firstly, houses can be considered to be both, consuming goods and investment goods. For example, house buyers can utilize house investment for consuming purposes by living in the property or dwellings can be rented, when investors earn rental income from the tenants. Secondly, according to Glickman (2014) residential property market is the biggest real estate market in the United States, which is approximately worth of 16 trillion dollars and about 85% of multifamily houses are owned by investors. Thirdly, house is usually one of the biggest investments for families and housing prices are one of the key economic indicators.

Real Estate investing have similar characteristics than investing in other asset classes as well. For example, house provides rental income and price increase such as stocks provide dividends and increase in value. Unlike stocks, house investments are usually less volatile than investing in stock market but more volatile than investing in bond market, which means that house investments are usually less risky investments than stock market investments but riskier than bond market investments. Volatility of single house investments are approximately 12% which is equivalent than investing in portfolio that includes 50% stocks and 50% bonds (Blanchett 2017: 8). According to Glickman (2013)

real estate investments have historically generated inflation adjusted returns for homeowners and investors. Also, correlations between real estate investments and other asset classes are usually relatively low.

In investment perspective, house investments provide many benefits for investors. For example, rents have increased in the United States faster than inflation and wages, which supports Glickman's (2014) argument about inflation adjusted returns as well (Rose & Zhu 2020: 133). Also, investors can diversify their investments by investing in real estate assets, which usually produce stable cash flows and value growth. For example, Webb, Curcio & Rubens (1988) and Firstenberg, Ross & Zisler (1988) argue that real estate assets are important characteristics in investment diversification. Rental housing has also grown popularity among consumers. US homeownership rate has recently been the lowest level in decades, recording 65,1% in 2019. Homeownership rate is still 3,8% lower than before the financial crisis (Rose & Zhu 2020: 133; Statista 2020). Also, rental occupied housing has increased approximately 13,8% since 2010 while owner occupied housing has increased only 6,2% at the same time-period (Statista 2020). One reason for popularity of rental housing and low homeownership rate is urbanization, which is a global phenomenon.

Even if real estate investments are always local it does not mean that the business and investors are domestic. For example, Glickman (2014), Devaneid, Scofield & Zhang (2018), McAllister & Nanda (2016) and Oikarinen & Falkenbach (2017) argue that real estate investments are becoming more global all the time as well as other investment classes. Internationalization and global financial market increases competition and might cause relation between housing price returns and financial market risks. For example, Cannon, Miller & Pandher (2006) and Bekiros, Dahlström, Uddin, Ege & Jayasekera (2020) argue that stock market risk have an impact on housing returns. Levin & Pryce (2009) and Nissim (2013) found evidence about the negative correlation between house prices and interest rates. Credit risk's role on housing returns and prices includes only minor evidence but for example Akash & Malhorta (2016) found evidence about the impact of

credit risk to housing prices. Also, Bian, Lin & Liu (2018) argues that credit supply and demand which is linked to market credit risk is one of the key characteristics which explains housing prices and price returns.

1.1. Purpose of the study and research hypotheses

Since asset pricing models are commonly known and highly used in finance research the real estate research includes only few studies from asset pricing subject of field. This study utilizes asset pricing techniques from previous studies on real estate asset pricing subject of field, such as Bekiros et al. (2020), Cannon et al. (2019), Beracha & Skiba (2016) and Domian, Wolf & Yang (2015). Purpose of the thesis is to investigate the relationship between housing price returns, systematic risk, selected financial market risk proxies and rent levels in the United States and its nine Census Divisions. Nine Census Divisions which are used as a separate housing price indices of the analysis are East North Central, East South Central, Middle Atlantic, Mountain, New England, Pacific, South Atlantic, West North Central and West South Central.

Empirical investigation of this thesis consists of two parts. The first part includes analysis of the systematic risk, co-movement of housing returns and identifications of the possible abnormal. Second part investigates the financial market risk proxies and rents capability to explain housing returns and abnormal housing returns. Second part includes analysis of the direct effect of selected financial risk proxies and rents impact on housing price returns as well.

1.1.1 Research hypotheses

Research hypothesis of this Master's thesis are as well based on the results of previous studies of the field of subject. As mentioned in the previous paragraph, empirical analysis of this study are consisted of two parts. The first part investigates the systematic risk factor which also describes the co-movement of the US nine Census Divisions housing

prices returns and measures the abnormal returns which are generated from the market models. According to Markovitz (1952) portfolio theory market return is commonly capable to explain one asset or portfolio's returns. Thus, the first hypothesis of this study is formed as follows:

H1: Housing market index return is capable to explain housing price movement in all of the Census Divisions and betas are positive.

Domian et. al (2015) found that housing tend to generate negative abnormal returns. Thus, the second hypothesis is formed as follows:

H2: Census Divisions' abnormal housing returns are on average negative during the research period.

Second part of the empirical analysis investigates whether the changes in TYVIX, VIX, TED Spread and rent indices are capable to explain the housing returns of Census Divisions' housing prices. According to portfolio theory, the market risk should include all of the risk variables, which cannot be diversified. Interest rate risk, stock market risk, credit spread and national rent levels are assumed to be market factors which are already included in to the systematic risk. Following that all of the b hypotheses which are expectations about the power of explanation of abnormal returns are formed similarly being insignificant, since significant factors would indicate that market model do not capture all of the systematic housing returns, similarly as Beracha & Skiba (2013). However, the b hypotheses are developed separately for all variables in case that the results vary between variables.

Levin & Pryce (2009) and Nissim (2013) found negative relationship between interest rates and housing prices which indicates that housing returns are negatively correlated with the interest rate uncertainty as well. Therefore, the next hypotheses are formed as follows:

H3a: TYVIX has a negative impact on the housing returns

H3b: TYVIX impact on abnormal housing returns is insignificant

Previous literature, including for example Bekiros et. al (2020) and Cannon et. al (2006), suggest that stock market risk and housing returns are correlated. Bekiros et. al (2020) found evidence that VIX index has a significant and negative impact on housing returns, which leads to fourth hypothesis:

H4a: VIX has a negative impact on housing returns

H4b: VIX impact on abnormal housing returns is insignificant

Previous literature includes only minor evidence about the impact of credit risk on housing markets. Since one of the biggest reasons for the financial crisis was the housing price boom and for example Bian et al. (2018) found evidence that high LTV ratios are significant determinants for housing prices and returns and Akash & Malhorta (2016) found evidence about the correlation between TED Spread and housing prices, the anticipation of this thesis is that correlations between TED Spread and housing returns are negative. Also, increasing uncertainty on credit markets can be assumed to have an impact on housing prices returns. Therefore, the next hypotheses are formed as followings:

H5a: TED Spread has a negative impact on housing returns

H5b: TED Spread's impact on abnormal housing returns is insignificant

Previous literature, for example Cannon et. al (2006), includes evidence about the importance of rents in housing returns. Rents are the cash flows when the house is bought for investment purposes and a key determinant in housing valuation models which are introduced later on this study. Therefore, the last hypotheses of this study are formed as follows:

H6a: Rents' have a positive impact on housing returns

H6b: Rents' impact on abnormal housing returns is insignificant.

1.2. Structure of the paper

This master's thesis consists of five parts. The first part introduces the theoretical background of the thesis including commonly known theories about market efficiency and asset pricing models.

Second and third part of this thesis are focusing on the definition of risk proxies and housing markets, which are the variables used in empirical analysis. Second part introduces selected financial market risk proxies, including stock market risk, interest rate risk and credit risk. Factors which are used to measure the risks are VIX, which measures the stock market risk, TYVIX, which measures interest rate risk and TED Spread, which measures the credit risk. Third part includes basic valuation models and description of the United States' housing market development.

Fourth and fifth part of this thesis are focusing on the empirical evidence and analysis of the results. Fourth part introduces the data and methodology which are used in this thesis' analysis while fifth part includes empirical analysis and conclusions.

1.3. Contribution

The main contribution of this thesis is to show the market model capability to explain housing market returns and measure whether the selected financial proxies are capable to explain housing returns and unexplained abnormal housing returns on asset pricing perspective. As the commonly known financial uncertainty indices and asset pricing methodologies are not extremely used in real estate research, this thesis provides new evidence about the relationships between selected financial risk proxies, and capability

of market model of explaining housing returns on the United States' Census Division level. This thesis also uses monthly data series while real estate research is commonly based on quarterly and annual data series.

2 THEORETICAL BACKGROUND

This paper utilizes commonly known asset pricing models. Purpose of this chapter is to introduce theoretical background which supports the empirical analysis of this paper. Theoretical background includes basic theorems of market efficiency and introduction of common asset pricing models.

2.1. Efficient Market Theorem

This paper adopts Fama's (1970) assumptions of efficient markets. Efficient market theorem and efficient market hypothesis are developed for stock prices, but the main points of these theorems can be adopted to housing markets as well. One example for modifying efficient market theorem to house investing could be: If investor has an opportunity to buy a cheaper house which provides exactly the same rental income than the other one which is more expensive, investor should sell the more expensive asset and buy the cheaper one instead.

Basic forms of efficient market theorem are that market returns follow a random walk and they cannot be predicted from historical prices. Kendall (1953) was the first one who introduced the theorem about the random walk and future returns interdependence about the past information. Kendall's observations are based on stock prices and he bases his argument for the fact that stocks do not have a memory so future price cannot be influenced about the past information.

Assumptions of Fama's (1970) efficient market hypothesis are that one investor can occasionally receive excess returns but it is constantly impossible, transactions do not cause transaction costs or taxes, information is available and it is costless, market participants behave rationally and investors' expectations are homogenous.

Fama (1970) assumes that asset prices react to available information quickly. According to Fama (1970), only future information is significant and historical information should not matter in asset pricing. Fama (1970) argue that asset's price should be its fundamental value which is also known as a net present value of an asset. He argues that net present value is based on future free cashflows which are consequence of future information which means that past information should not affect to future cashflows.

Fama (1970) divides asset pricing theorem in three forms. First form is weak form where asset price includes all historically available information. Second form is semi-strong form which also considers that asset price includes all publicly available information. Third and last form is strong form and it considers that asset price is a result of historical –, publicly available – and non-publicly available information.

Also, Modiglian and Miller (1961) assumes that market participants are rational, and they make decisions for maximizing profits. Based on the rationality of investors they assume that one investor cannot manipulate market prices and taxation is the only characteristic which should affect to investors' investment decisions.

Theories about the market efficiency have received a lot of critic and housing market is one of the best examples of inefficient markets. If markets would be efficient, market bubbles would be impossible. Financial crisis 2008 resulted from the commonly known housing bubble and burst of the bubble caused uncertainty to every other financial market as well. In reality, market participants have different information and prices do not always follow the latest information immediately. Also, transactions are not cost free and market participants may receive different transaction costs as well. House buyers do not always be rational, and they may receive benefits from other things than maximizing the future value of their apartment or receiving the highest possible rental income from their investment. House buyers neither have a homogenous expectation about the markets and some buyers prefer different things than others.

2.2. CAPM

Capital Asset Pricing Model, CAPM, was introduced by Markowitz (1952) in his portfolio theory. Also, for example, Lintner (1965) and Sharpe (1964) utilizes CAPM model in their researches about asset pricing and valuation. Purpose of the CAPM is to determine the theoretical expected rate of return for one asset or portfolio by measuring asset or portfolio's unsystematic risk. Markowitz's (1952) portfolio theory is based on the assumption that investors cannot manage systematic market risk by diversifying their investments, but unsystematic risk can be eliminated by diversifying investments. In other words, CAPM assumes that price of the one asset or portfolio is related to lowest possible return from market and price depends on the market movements. CAPM model assumption is that markets are efficient. Formula of the CAPM is presented below.

$$E(r_i) = r_f + \beta[r_m - r_f] \quad (1)$$

$E(r_i)$ represents asset or portfolio i 's expected rate of return. r_m is market index return and r_f represents risk free interest rate. r_f is theoretical factor, but usually government bonds or treasury bills are considered to be risk free investments. β is a measure for asset or portfolio's systematic risk which can be theoretically eliminated by diversifying investments. Factor $[r_m - r_f]$ represents the market risk premium.

CAPM is usually used for testing stock prices but the model is capable to price all kind of assets. CAPM is highly used in finance research and it is basic model in finance theorem even if it has received a lot of critic. For example, Roll (1977) argues that testing CAPM is impossible because market portfolio which includes all possible assets does not exist, but it is a theoretical assumption. CAPM can be criticized also because it is obvious that all investors do not have similar and optimal market portfolio and, for example, institutional investors have more options to diversify their investments because they have more capital.

2.3. Jensen's Alpha

Jensen introduced (1967) a methodology which measures abnormal returns. Jensen's alpha is a modification of CAPM, and purpose of the model is to measure received over – or underperformance of asset or portfolio's returns. CAPM assumes that asset returns are risk adjusted and riskier asset should have higher returns. Jensen (1967) developed Jensen's alpha methodology to measure returns which CAPM do not explain. According to Jensen, these returns are abnormal, either higher or – lower returns than market expected to receive. The formula of Jensen's alpha is presented below.

$$(2) \alpha_i = r_i - [r_f + \beta[r_m - r_f]] \quad (2)$$

Where,

α_i is the received abnormal return,

r_i is received return of asset or portfolio i and

$[r_f + \beta[r_m - r_f]]$ represents CAPM estimated returns.

Model has been widely used for measuring especially stock portfolios' performance. Model do not only consider asset or portfolio's overall return, but it also takes into account risk adjusted returns and measures if the asset or portfolio has received excess returns when compared to market portfolio.

2.4. Arbitrage Pricing Theory

Ross (1976) created other model for estimating upcoming asset prices. As well as CAPM, APT estimates future returns by measuring asset's risk but while CAPM assumes that markets are perfect, APT does not. CAPM also assumes that only risk factor which affects to asset's expected return is systematic risk but APT takes into account several factors which are not specified.

APT consist of three assumptions which are: Perfect market competition, asset returns are explained by systematic risk factors, and investors can eliminate specific risks by diversifying their investments. APT assumes also that assets which have same sensitivity to same factors should receive same results from the model. The formula of APT is presented below.

$$E(r_i) = r_f + \beta_1 f_1 + \beta_2 f_2 + \dots + \beta_n f_n \quad (3)$$

Where, $E(r_i)$ represents asset or portfolio's i expected return, r_f is risk free interest rate, betas are asset's sensitivity to factor f and f_s' are risk factors.

3 DEFINITION OF RISK PROXIES

Purpose of this chapter is to shortly introduce the selected risk factors which impact on housing prices are investigated in this Master's thesis analysis chapter. Risk factors are classified in three factors which are stock market risk, interest rate risk and credit risk. Stock market risk and interest rate risk are measured as implied volatility indices while the measurement of credit risk is TED spread, which is considered to be a reliable predictor of financial crisis in economy (Cheung, Fung & Tsai 2010: 86).

3.1. Definition of volatility and implied volatility

Volatility is defined as the standard deviation of specific variable returns, such as equity and commodity prices and interest rates. Volatility is usually provided by the variable of time and it is usually annualized. Assumption of volatility calculations is that variable returns are continuously compounding. Volatility is generally defined as a measurement of risk because it describes the standard fluctuations of asset returns. (Hull 2018: 213, 239.)

This Master's thesis uses implied volatilities instead of historical volatilities. Implied volatilities are forward looking market participants' expectations while historical volatilities are results of past price movements. Implied volatilities are derived from option prices and thus they describe the uncertainty of the future variable returns. Implied volatilities used in this Master's thesis are VIX, which is implied volatility index of US stock market S&P500 and TVIX which is implied volatility of US interest rate markets. (Dumas, Fleming & Whaley 1998; Canina & Figlewski 1993.)

3.2. VIX

VIX was founded by CBOE (Chicago Board Options Exchange) and it measures the 30 days put and call option based implied volatility of S&P500 index stocks. In other words, VIX measures the market participants' expectations of the fluctuations in S&P500 index. VIX has usually considered to be the fear indicator of stock markets. Higher values of VIX indicates the increase of uncertainty in stock markets. (Whaley 2013.). The graph of daily closing prices of VIX between 2004-2019 is presented below.

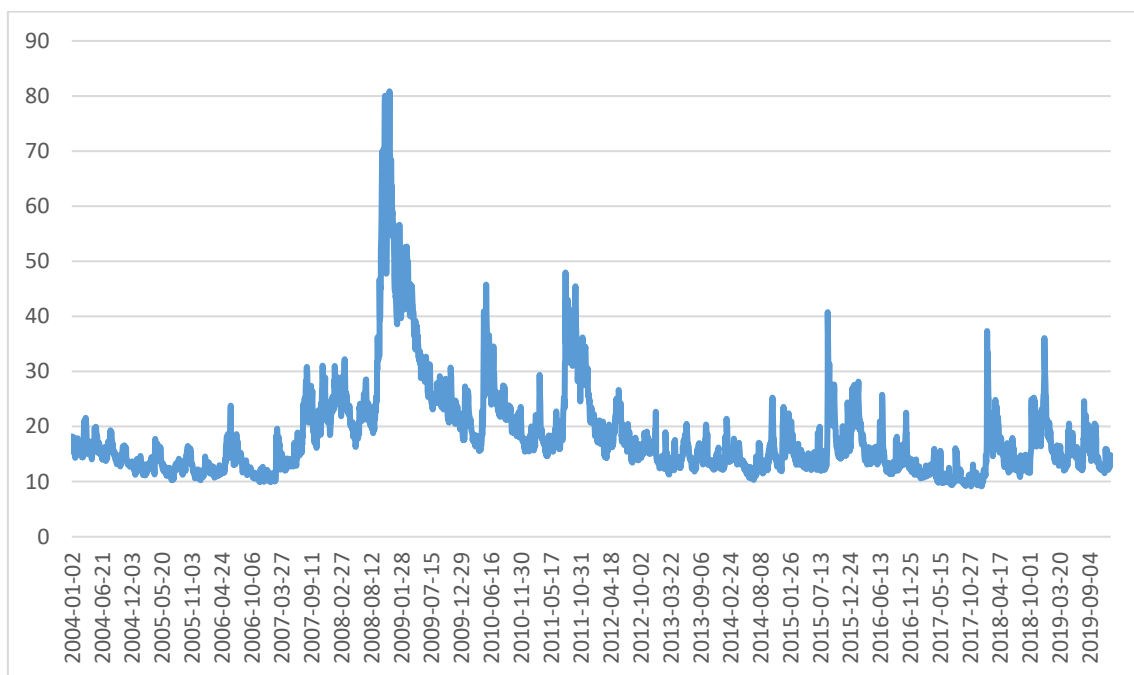


Figure 1. Daily closing values of VIX between 2004-2019 (CBOE 2020).

Figure 1 shows how uncertainty on stock market increased during the financial crisis 2008, which is still the highest value of VIX. This relationship makes the correlation between VIX and housing prices an interesting research issue. Another example about the increase of market uncertainty is in February 2016, when VIX resulted the highest spike in years because investors were waiting the increase in interest rate levels after the stock market boom and accelerated inflation. VIX index is used as a measurement of stock market risk in analysis of this thesis.

3.3. Definition of interest rate risk

Interest rate risk is a consequence of changes in interest rates, which means that characteristics which affect to interest rate risk cause changes in interest rates. According to Modiglian and Miller's (1958) basic theorem of finance, the starting point of perfect market theory is the situation where risk free rate can be defined. However, many previous studies show that markets are not perfect. Markets include imperfections, such as asymmetric information, which may cause changes in interest rates. Usually, government bonds' interest rates are used as a risk-free rate in finance, which are result of central banks' decisions and countries' credit ratings. Other benchmarks for risk-free rates in finance are benchmark rates which are interest rate criterions for other interest rates. Institutional investors as well as private market house buyers have to take into account their interest rate criterion for debt and maturity of the loan, when searching a credit financing for their investments. Usually, the optimal choice is to search short term debt which is linked to short time interest rate criterion for minimizing the cost of debt. Short interest rate period may affect huge changes to cost of debt in case of shocks and in this way, it significantly increases investor's cost of debt. On the other hand, long maturity loan and long interest rate period may affect significantly to the value of the loan as well as the value of the assets. (Kasanen, Lundström, Puttonen & Veijola 1997: 193.)

Interest rate risk can be viewed in interest rate sensitivity of financial items and interest rate sensitivity of cash flow point of views. According to Horcher (2005), key characteristics of managing interest rate risk are managing assets and liabilities, which in this case means managing the leverage of house investments. Characteristics which affect to assets and liabilities sensitivity of interest rate fluctuations are usually shared for two main categories which are benchmark interest rate, such as risk-free interest rate and the maturity of interest rate.

Interest rate risk can be classified in two main components which are interest rate flow risk and price risk (Knüpfer & Puttonen 2017: 221). According to Modiglian and Miller's

(1958) basic theorem of finance, companies and institutions should use only debt financing for financing their practices, which minimizes the cost of capital, because investors required rate of return is higher than lenders required rate of return. This theorem works only in perfect market conditions, because in reality too big leverage increases interest rate costs because it increases lender's credit risk. Also, the fluctuations of market interest rates would cause a significant risk for companies and investors if all of their practises would be financed by using debt financing. (Knüpfer & Puttonen 2017: 189–197.)

Interest rate fluctuations are usually a consequence of macroeconomic shocks, such as financial crisis, actions of central banks and governments' political decisions. For example, asymmetric information between central banks and market participants is key characteristic for fluctuations in interest rates. Market participants do not have information about the future development of the markets which causes fluctuations even in long interest rates before central banks announcements. (Romer & Romer 2000: 455.)

Also, market's pricing risk, duration, is one of the characteristics which causes fluctuations on interest rates of investors' loans. Duration means loan portfolio's sensitivity to fluctuations of interest rates. Loan portfolio's sensitivity for fluctuations in interest rates is related to the amount the loans are fixed – or floating rate loans. Duration measures cash flow weighted payback time of the loan. In other words, how long bullet loan has the same value as the coupon rate loan. Variables which affect to duration are maturity of interest rate, change in coupon rate, and change in investor's required rate of return. The model calculates the effect of percentual change in investor's required rate of return, which explains the loan portfolio sensitivity to interest rate fluctuations. (Kasanen et. al. 1997: 235 – 238.)

Interest rates of countries' bonds are usually used as a risk-free rate in finance. Increase in the risk premium of risk-free rates decreases values of assets through discount rates which cause fluctuations in asset prices as well. Discount rate can be considered as a required rate for return for investment, which is based on the base interest rate and risk

premium. For example, asset's value increases when market interest rates decrease and value decreases if market interest rates increase. (Knüpfer & Puttonen 2017: 109–110, 221.)

3.3.1. TYVIX

TYVIX, which is used as a measurement of interest rate risk in this thesis, is similar implied volatility index provided by CBOE. Similarly, like VIX, TYVIX measures the expected 30-day volatility of 10-year US treasury notes by utilizing range of put and call options. The underlying asset for TYVIX are 10-year US Treasury futures. Treasury futures have the highest trading volume of US Treasury futures and the volatility of futures is similar with other fixed income assets, including mortgage-backed securities. Figure 2 below shows the daily closing prices from TYVIX between years 2008-2019. (CBOE 2015: 2–3.)

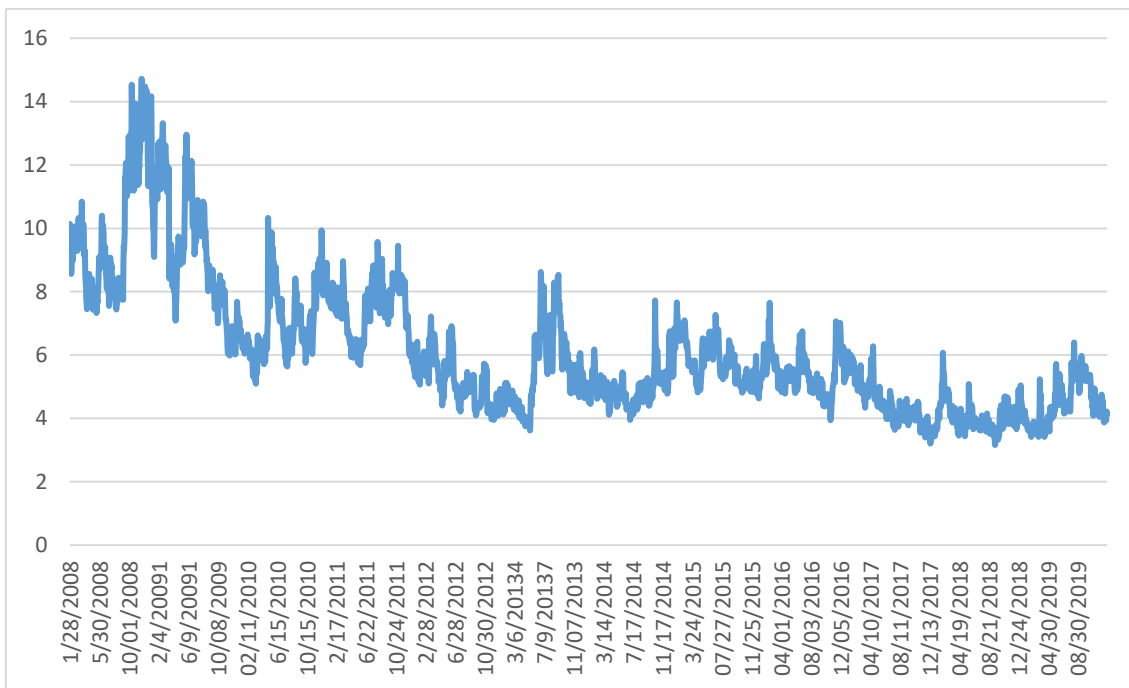


Figure 2. TYVIX daily closing prices between 2008-2019 (CBOE 2020).

Figure 2 shows that market expectations about the interest rates have not been as volatile as in stock markets but also TYVIX has received its highest spikes during financial crisis between years 2008-2009.

3.4. Definition of credit risk

Another significant characteristic which is related to interest rate flow risk is credit risk. Credit risk is related to the leverage of investments because credit ratings are usually based on the capital structure of investments. Lending risk premiums increase when the leverage of investments increase. For example, the financial crisis and especially the collapse of Lehman Brothers in 2008 increased the credit risk between bank markets. Bad debts and uncertainty about the banks which were holding junk bonds led to the situation in which banks were not willing to lend to other banks. This situation decreased the market liquidity and increased risk premiums. (Hristov, Hülsewig & Wollmershäuser 2014: 104–105.)

According to Alessandri and Drehman (2010), credit risk and interest rate risk are usually measured as a separate entity in banking sector, even if credit risk and interest rate risk are usually connected to each other. Interest rates or interest rate spreads are usually used as a measurement of credit risk and characteristics of credit risk and interest rate risk are different, which is the reason why they are used separately in this thesis.

3.4.1. TED Spread

TED Spread is calculated as the difference between 3-month T-bill rate and 3-month London InterBank Offered Rate (LIBOR) (Cheung et. All 2010: 88). T-bill rates and LIBOR rates are used on the global interbank markets. In other words, they are used as a benchmark rates on interbank markets which makes them the least risky rates of the market. TED Spread explains especially the credit risk between interbank markets, which explains why it is a good measurement for credit risk in economy. Figure 3 on the next page shows the rates in 3-month T-bill rate, 3-month LIBOR rate and TED spread.

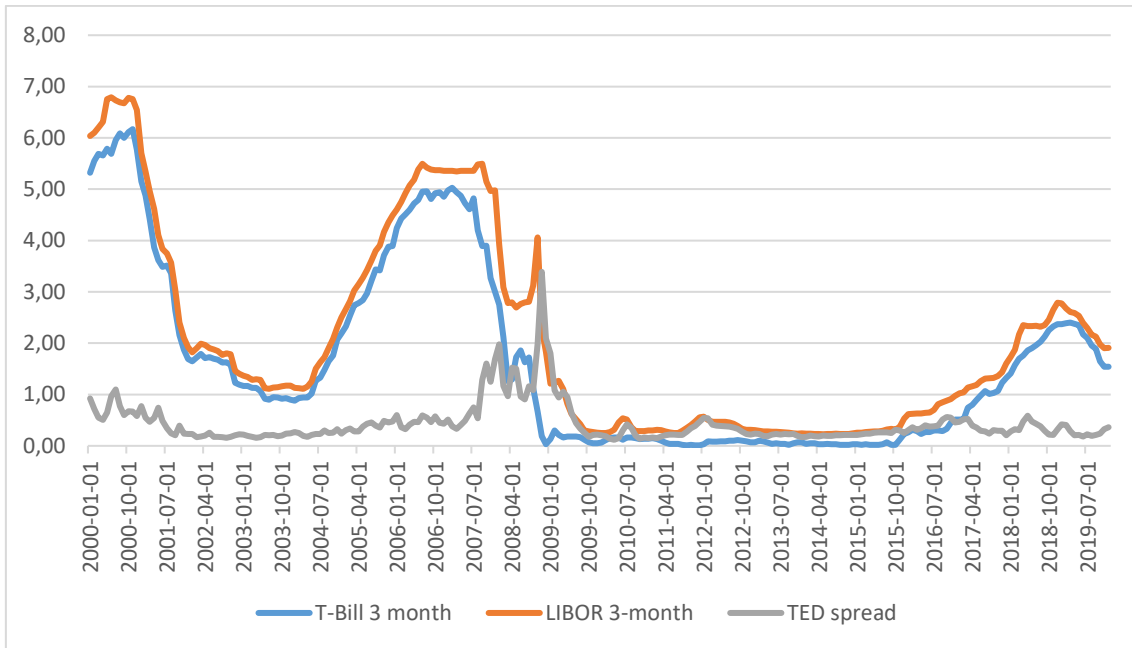


Figure 3. Monthly indices for 3-month T-Bill rate, 3-month LIBOR rate and TED Spread (FRED 2020).

Figure 3 shows that markets' least risky rates were on high levels in early 2000 and they were increasing again before the collapse of housing market between years 2003-2007. TED spread has typically been relatively low-level recording under 1% spread between LIBOR and T-bill rates but during the financial crisis TED spread spiked over 3% spread between these two rates. Spike in TED spread supports the idea about the TED spread's goodness for predicting the perceived credit risk in economy.

4 HOUSING MARKET

Purpose of this chapter is to introduce the theory and models behind the property valuation and US housing market. The first part of the chapter includes generally used valuation methods and it also provides why the financial market risks introduced in previous chapters may have relation to housing prices through the valuation models. Second part of this chapter provides description about the US housing market and development of US housing market.

4.1. Property Valuation

Property valuation methods and especially the factors which are used in valuation methods are reason why it is interesting to investigate the linkage between market risk factors and housing prices. Property valuation is similar with other asset class valuation and generally the factors are same even if the names of the factors might be different. This chapter introduces three commonly used valuation methods which are sales comparable method, capitalized NOI method and discounted cash flow method.

4.1.1 Sales Comparable Method

Sales comparable method is the simplest method for valuating housing prices. It is especially commonly used among consumers who are interested to buy house for consumption purposes, but it supports results of the other valuation methods as well. Method is based on the assumption that similar apartments from similar areas should have the same price per unit area. (Glickman 2014: 141–142.)

The biggest weakness of sales comparable method is that it is impossible to find exactly same apartment. Conditions and building years vary between houses and volumes are relatively small when compared for example to stock markets. Other example which affect to single house price is the location of the house. For example, distance from public

transport, distance from services and environment attractiveness are key determinants for housing prices (Glickman 2014: 142).

4.1.2 Capitalized NOI Method

As an investment perspective, capitalized NOI method is the most commonly used valuation method for real estate assets. NOI is abbreviation of the words Net Operating Income and it is generally annualized. NOI is the difference between gross rent and operational expenses (OPEX). OPEXes generally include administration, cleaning, heating, electricity, waste management, insurance, property tax, usage and maintenance costs. NOI is usually stabilized because it may vary over different years. Stabilized NOI describes asset's expected long-term income. Formula of the capitalized NOI method is presented below. (Glickman 2014: 129–130.)

$$\text{Property Value} = \frac{\text{Stabilized NOI}}{\text{Cap Rate}} \quad (4)$$

Cap rate used in capitalized NOI method is similar with required rate of return measurement in stock market valuation. It includes in addition to benchmark interest rate a risk premium. Cap rates vary over market areas and they are generally lower on better market conditions and in more competitive areas. (Glickman 2014: 129–130.)

4.1.3 Discounted Cash Flow Method

Discounted cash flow model (DCF) is commonly used valuation technique in finance. Model sums present values of expected future cash flows and asset's terminal value, also known as residual value of asset. DCF model takes into account yearly cash flows during investment period, which makes it more accurate, but also more sensitive model than capitalized NOI method. Yearly cash flows allow to take into account also capital expenditures, which include for example renovation costs of property and it decreases the specific year's NOI. Formula of the DCF model is presented on the next page.

$$\text{Property Value} = \sum_{i=1}^N \frac{NOI_i}{(1+r)^i} + TV \quad (5)$$

Where,

$$TV = \frac{\frac{NOI_N}{\text{Exit Cap Rate}}}{(1+r)^N} \quad (6)$$

NOI_i is the NOI in year i

r is discount rate.

Terminal value of the asset, also known as residual value of the asset, is the largest cash flow of the model which makes it particularly sensitive factor for the result of the DCF model. Generally terminal value is calculated by capitalizing the stabilized NOI at the end of the investment period by using exit cap rate. Exit cap rate and discount rates are generally the same and as well as mentioned in capitalized NOI chapter, all of these rates vary over time periods and market areas, because of the changes in market conditions, changes in risk free rates and changes in risk premiums. (Glickman 2014: 136–141.)

4.2. US Housing Market Development

As well as other asset markets, normal market dynamics apply also in housing markets. Economic growth and supply and demand atmosphere have an influence on housing markets among other markets as well. Also, even if real properties cannot be physically moved their prices are results of global and local characteristics. (Glickman 2014: 25–26.)

As mentioned before, house can be an investment good as well as consumption good. Housing includes a lot of different data which is useful for both purposes. The next few paragraphs introduce analysis, key figures, and ratios of few key factors which benefits investment decisions as well as consumer house buyers. These include housing price figures, building permit figures, occupancy ratios and comparisons between housing price -, rent- and inflation ratios.

Price development has not been equal in every Census Division. Mountain has received the highest price increase recording 76% growth between 2010-2019. The lowest increase has been in Middle Atlantic with 24% growth in housing prices, which is still about 5% higher than consumer price index in US during 2010-2019. Housing price development in US and in nine census divisions are presented in figure 4 below.

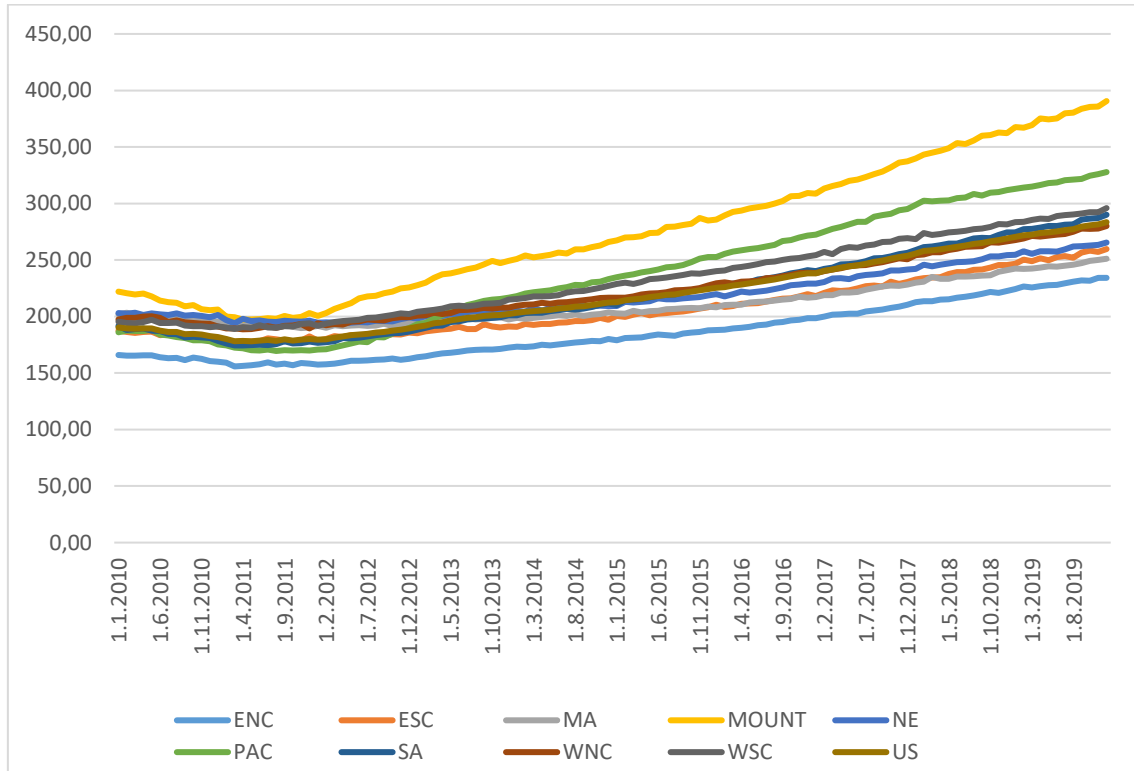


Figure 4. Housing price indices in US and Central divisions between 2010-2019 (FRED 2020).

Figure 4 supports Hou, Long & Li's (2019) investigation about the co-movement of housing prices of nine census divisions. Housing prices in US have increased even more than rents recording 49% increase during 2010-2019 period while rents have increased only 35%. Even if the housing price drop was significant in 2008, prices are recovered afterwards, and all of the indices are nowadays significantly upper levels than before the crisis period in 2007, which can be considered to be a good capability to recover after the shock (FRED 2020). In 2019 price-to-rent ratio, which measures is it cheaper rent or buy an apartment, was 109,5% in US, which is also 9,5% increase to 2015's base index value.

Even if the housing price index in US has increased 49% since 2010, the average sales price of new apartments has increased only 40% during the same time-period. On the other hand, private housing permits have increased over 145% between years 2010-2019, which explains that new development apartments are generally smaller than older ones. This development might also be a consequence of popularity of multifamily housing and urbanization, which is a global phenomenon. Figure 5 shows the yearly average sales prices in thousands of dollars and Figure 6 shows the yearly private house building permits in US between 2010-2019. (Statista 2020; FRED 2020.)

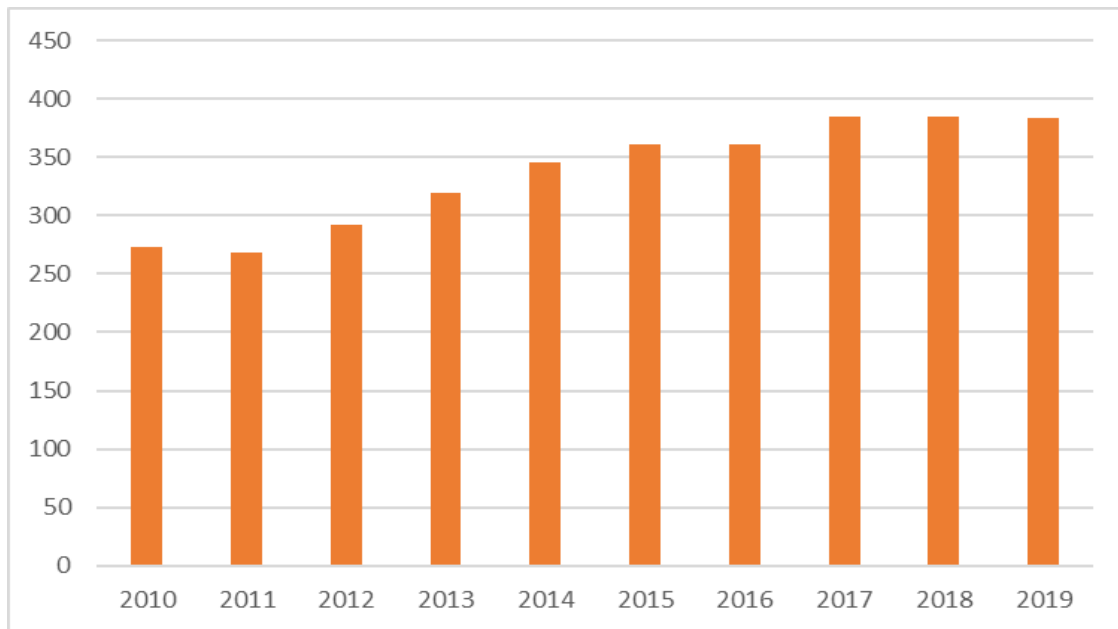


Figure 5. Average sales price of housing unit in US between 2010-2019 (Statista 2020).

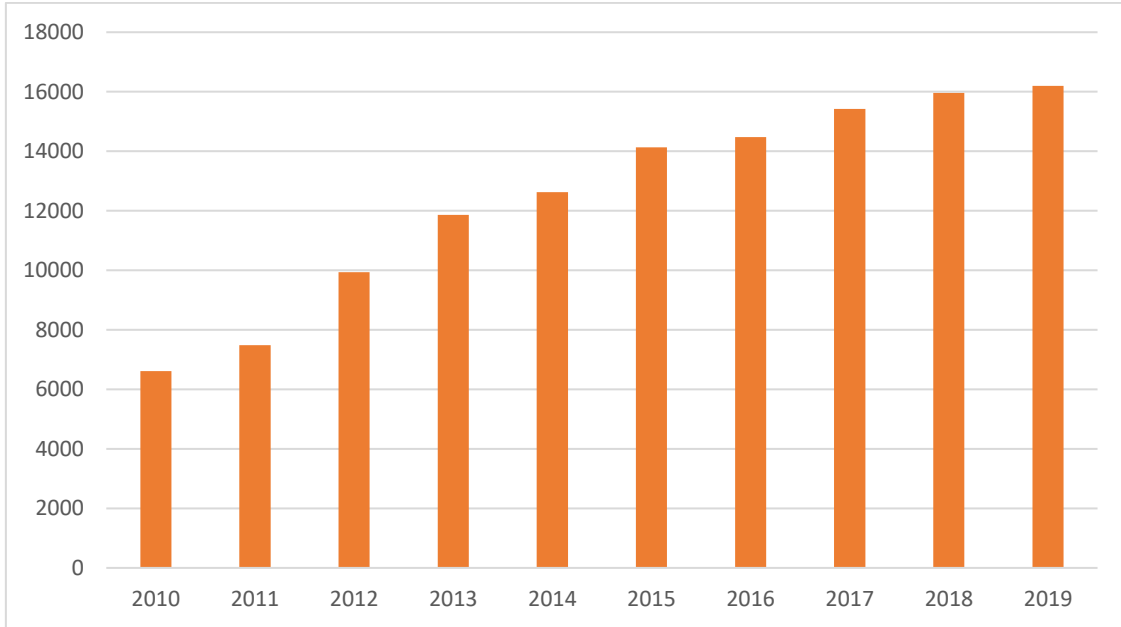


Figure 6. Building permits in thousands of units (FRED 2020).

Figure 7 presents homeownership rates in US between 2010-2019. Home ownership rate is a measurement which is a ratio of owner-occupied housing unit part of total residential units. Homeownership rate received its highest value in 2004 when 69,2% of all residential units were owner-occupied (Statista 2020).

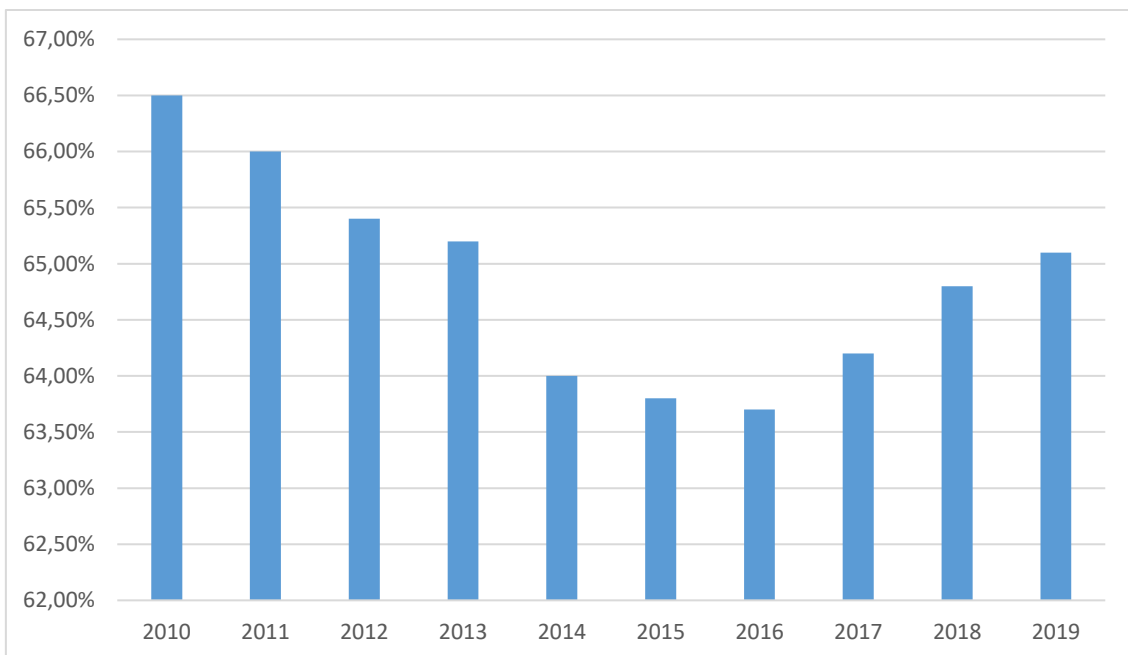


Figure 7. Homeownership rates in US between years 2010-2019 (Statista 2020).

Figure 7 shows that popularity of owning an apartment were significantly decreasing from 2010 to 2016, until in 2017 the popularity started to increase again. However, homeownership rate in US is still significantly lower than before the financial crisis, which is a result of abandon of the sub-prime loans and regulation of banks. Both of these characteristics affects to consumers' credit availability. (Statista 2020.)

Unlike homeownership rate, figure 8 shows that number of housing transactions have increased almost every year since 2010, even if homeownership rate systematically decreased until it started to increase again after 2016. Increase of transaction volumes and building permits are signs of the good economic condition's effect on housing market. (Census Bureau 2020.)

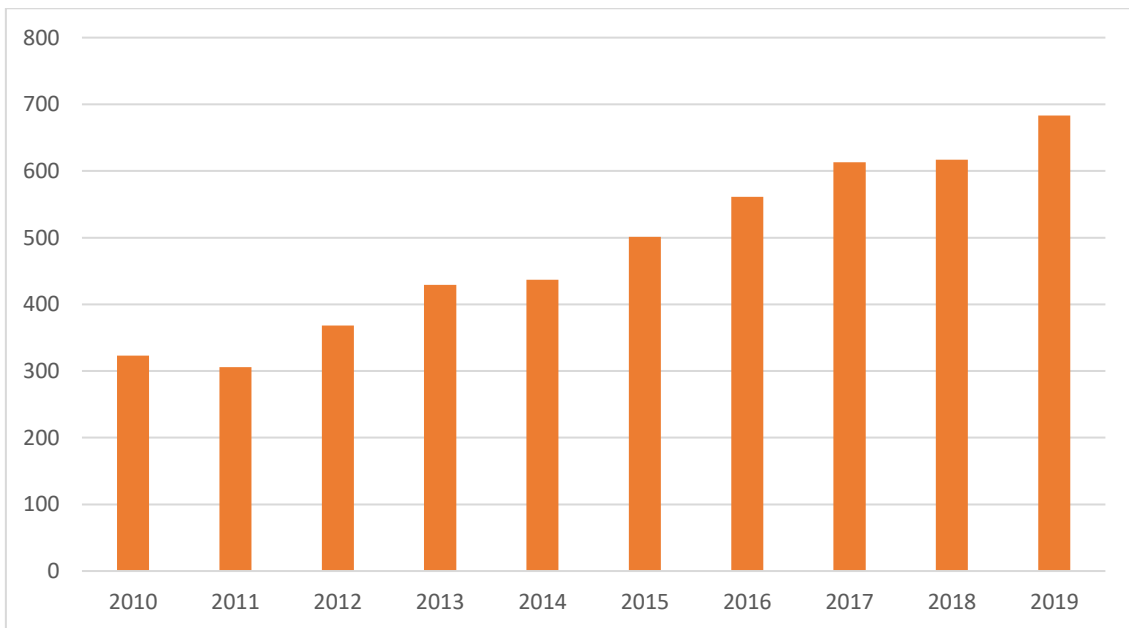


Figure 8. Number of houses sold in thousands in US between 2010-2019 (United States Census Bureau 2020).

Figures 7 and 8 provides evidence that housing as well as other asset transactions generally increase during the good economic conditions. Also, interest rates have been relatively low levels during the same time-period, which decreases loan costs for consumers and makes owning an apartment more attractive than living on a rental apartment.

Lower costs also make houses more attractive investment targets, because house investments generally require a lot of capital and most of the transactions are generally financed by using credit financing (Hou et. Al. 2019: 298).

Figure 9 presents the figures of owner occupied and renter occupied housing units in millions between 2010-2019. Figure shows that especially after 2016 owning an apartment have become more attractive for consumers. The absolute increase of owner-occupied housing is during the time-period is 4,69 million units while it is 5,26 million units of renter occupied housing. Relatively changes have been approximately 6% increase for owner-occupied housing and 14% increase for renter occupied housing. (Statista 2020.)

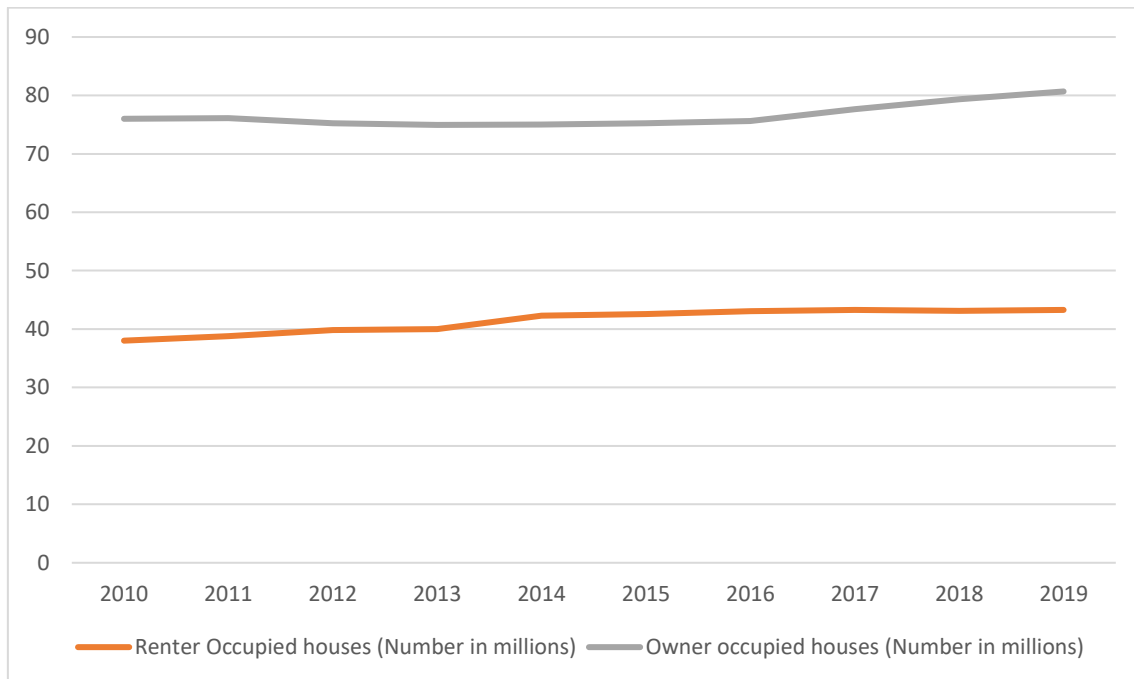


Figure 9. Owner occupied, and Renter occupied houses in millions between 2010-2019 in US (Statista 2020).

Figure 9 together with homeownership rate and transaction volumes signs that before 2016 investors were investing on the housing market and popularity of living on a rent increased faster than owner occupied housing. In turn, during recent years, popularity of owning a house has increased faster than renter occupied housing.

As well as housing prices, also gross rents have increased faster than inflation during the same 10-year period. Gross rent increase in US has been 35% which is 16% higher than inflation during the same period, which is in line with Rose & Zhu (2020) findings. Figure 10 below presents the development of gross rents and CPI in US between years 2010-2019.

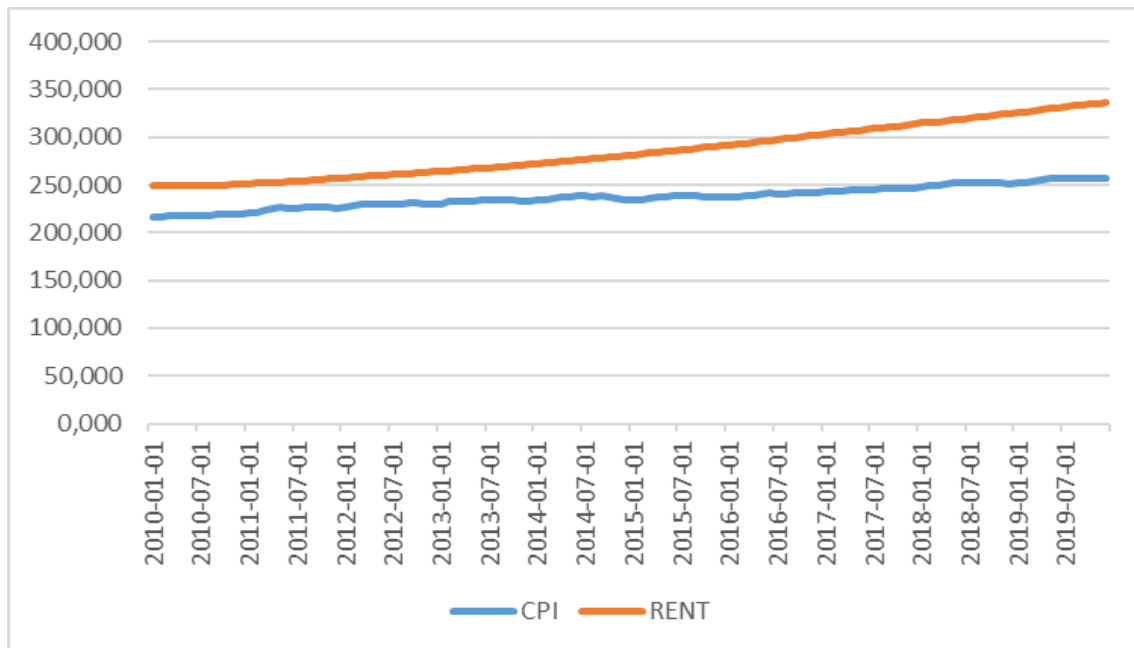


Figure 10. Rent index and CPI index in US between 2010-2019 (FRED 2020).

Investing in housing market have been a good investment when considered that both, housing prices and gross rent levels have increased faster than inflation after the financial crisis period. This also supports Glickman's (2014) arguments and common understanding about the inflation adjusted returns and house as a storage of value.

5 LITERATURE PREVIEW

Purpose of this chapter is to introduce previous studies which are related to the research problem of this Master's thesis. Asset pricing models are generally highly used in finance research even if the models are not yet highly adopted to real estate research. The most of the previous studies focus on the return correlations between housing and other asset markets but the volatility atmosphere is not used as much in real estate research. Studies cover the whole research area including studies which investigates stock market, interest rates, credit risk and rents' relationship on housing prices and housing returns, and real estate asset pricing literature.

5.1. Stock Markets and Housing Prices

Many of the previous studies about stock markets and real estate markets focuses on the correlations between asset returns while the relationship between stock market uncertainty and housing returns has received less attention. However, for example Bekiros et. al (2020) takes into account the relationship of the VIX and housing returns in their quantile regression analysis. They conclude that clear VIX index is a reliable predictor of housing returns especially during bearing market conditions. Also, Cannon et. al (2006) found evidence about the stock market risks impact on housing returns, but unlike Bekiros et. al. (2020), they measure the impact through the housing market returns sensitivity to stock market returns.

Most of the studies argue that real estate asset returns and stock market returns have weak correlations which makes real estate investments good for diversifying purposes. For example, Fogler (1984) and Ibbotson & Siegel (1984) argues that real estate asset returns, and stock market returns might have even negative correlations. According to these studies, negative correlation is stronger in high inflation circumstances and correlation becomes weaker when the inflation decreases. Quan & Titman (1997) investigates

correlations between real estate asset returns and stock market returns on international perspective. Their main finding is that correlations vary over countries and continents, being stronger in small countries and weaker in larger countries.

Also, some of the 21st century studies have found relationship between housing markets and stock markets. For example, Toyoshima (2018) investigates the relationship between housing markets and stock markets in UK through causality-in-mean and variance methodology. His main finding is two-way causal relationship between housing markets and stock markets. According to Toyoshima (2018), this finding is in line with the theory about wealth effect and credit price effect existence between stock and housing markets. Lin & Fuerst (2014) investigates cointegration between direct real estate investments and stock market in nine Asian countries. They found linear cointegration in Taiwan and fractional cointegration in Singapore while their results did not show any cointegration in other market areas. This finding concludes that real estate assets and stock market assets are substitutable goods, which supports the theory of real estate investments diversification benefits.

Some previous papers suggest that stock markets might also have indirect relation to housing market. For example, Upadhyaya, Dhakal & Mixon Jr (2017) argues that the most of US aggregate output is explained by stock returns while housing prices and Treasury yields are able to explain only 3% together of the aggregate output. This finding supports the theory of indirect stock market effects on housing prices.

5.2. Interest rates and Housing Prices

Many of the papers including the research of the relationship between interest rates and housing prices conclude that interest rates are negatively correlated with housing prices. For example, Nissim (2013) finds negative correlation between corporate bond yields and housing prices in the US market, which means that housing investments can be con-

sidered to be alternative investments with bonds. Also, Levin & Pryce (2009) found similar results from UK market during the housing price boom between 1996-2007. They argue that decrease of interest rates during this time-period was one of the key factors for housing price increase. In turn, Zhu, Li & Guo (2018) argued that for example real estate constructors, investors and house buyers requires debt financing for finance their operations and transactions, but their results of the quantile regression analysis confirmed that interest rates impact on housing prices are low or impact is insignificant in China.

On the other hand, some studies have found evidence about the effect of financial conditions on relationship between interest rates and housing prices. For example, Wong, Hui & Seabrooke (2003) argues that interest rates had significant negative effect on housing prices during deflationary period and positive during inflationary period in Hong Kong between years 1981-2001. They conclude that during high inflation circumstances, correlation between interest rates and housing prices are not necessarily negative.

Some papers argue that monetary policy is one of the key characteristics on interest rates and housing prices relationship. Tse, Rodgers & Niklewski (2014) concludes that interest rate based monetary policy has a significant effect on housing prices. They argue that 2007 financial crisis changed the relationship between mortgage interest rates and housing prices in UK market. Their analysis provide evidence about positive correlations between mortgage interest rates and housing prices as a consequence of the financial crisis. Also, Bårdsen & Eitrheim (2006) conclude that monetary policy effects on interest rate rules usually outperforms housing prices.

5.3. Credit Risk and Housing Prices

The relationship between TED spread and housing prices is not highly investigated field of subject but for example Akash & Malhotra (2016) found evidence about the significant impact of TED spread on home prices. Instead credit risks' relationship on housing prices

are investigated through credit supply and demand and LTV (loan-to-value) ratio. Some of the previous studies provide analysis about the importance of credit supply and leverage on housing prices. For example, Bian, Lin & Liu (2018) argues that high LTV ratio increases credit supply which increases housing prices as well. Also, Geanakoplos et. al. (2012) provides evidence about the importance of leverage in housing price boom before the 2007 housing bubble collapse. They argue that instead of low interest rate levels, financial leverage on housing investments was the key determinant of the increase of housing prices before 2007 financial crisis.

On the other hand, housing prices are also related to credit risk. For example, mortgages are usually tied to the price of the house, which means that the value of mortgages decrease if the housing prices decrease. Mortgages are one of the key credit classes banks offer to customers which means that the decrease of housing prices and value of mortgages cause increase in credit risk between bank markets. According to Benbouzid, Mallick & Pilbeam (2018), housing prices are meaningful factors for determining banks' CDS premiums as well.

5.4. Rents and Housing Prices

As introduced before in this Master's thesis, housing valuation is based on the net rental income in investment purposes, which is one of the field of subject of this thesis. Many previous studies provide evidence about the relationship of the rents and housing prices. For example, Kim & Chung (2014) adopted logarithmic model to investigate the house prices sensitivity to rent movements in the US market. They conclude that rent movements are significant factors for house prices and house prices are sensitive to changes on rent levels. Also, Hargreaves (2008) argues that rents are useful indicator for housing prices even if rent increase was not as fast as housing price increase in New Zealand between 1992-2005. According to Hargreaves (2008), the spread between rent increase and housing price increase was a consequence of required rate of return levels which were decreasing even if the rent levels did not follow the increase of housing prices.

On the other hand, sometimes rents cannot explain the increase of housing prices. For example, some areas are more attractive than others for consumers and they are ready to pay more for the house than the estimation based on net rental income provides. Bram (2012) argues that rents are not every time the driven factor for housing prices because house investments are sometimes driven by speculative purposes. He concludes that supply and demand matter more in some areas than rents and mortgage rates. Bram (2012) bases his findings on the housing price increase in New York, Manhattan. On the other hand, Bram (2012) do not take into account the required rate of return in his research, which means that results could be different if the rate of returns have decreased in the area as well.

5.5. Real Estate Asset Pricing

Beracha & Skiba (2013) created a modification of commonly known asset pricing model by adding economic, geographic and psychologic factors to the asset pricing model. Their model includes, in addition to market factor, income growth, land supply elasticity and momentum factor. They conclude that model is capable to explain the market risks and their findings suggests that local risk factors, which are previously considered to be part of the market risks, are capable to explain the risk reward relation. Also, Cannon et. al (2006) utilizes asset pricing approach. They find positive correlation between housing returns and volatility. Their results provide that rents are capable to explain housing returns as well.

Domian et al. (2015) uses two CAPM based simple models for measuring housing market systematic risk and abnormal returns. They find that housing returns have underperformed in the US between time period 1987-2011, since the market models generate negative abnormal returns. Kuosmanen (2002) investigates the CAPM ability to price systematic risk of housing stocks in Finland. He concludes that his empirical analysis provides supportive results for CAPM ability to price systematic risk of housing stocks even

if stock market related studies about the CAPM ability of pricing systematic risk have been opposite.

5.6. Other Relative Studies

Especially in bigger countries the housing prices may not be similar in every area. For example, some areas might face migration loss to bigger cities which decreases the local housing prices. Also, in some countries, states have administrative freedoms which have different consequences on housing prices in different areas. Hou, Long & Li (2019) investigates the co-movement of housing prices in nine US census divisions. They use quartile dataset and the observation period is 1975-2016. They conclude that regional housing prices have become more integrated since 1980s. They also argue that macroeconomic situation and monetary policy have an influence on regional housing prices.

Kallber, Liu & Pasquariello (2014) also investigates the price co-movement in the United States. Instead of division level, they use data from 14 biggest metropolitan areas in US from 1992-2008. They conclude that integration between house prices have strengthened during the investigation period and strengthened integration is mostly a consequence of systematic real and financial factors.

6 DATA AND METHODOLOGY

Purpose of this chapter is to introduce data and methodology which are used in the empirical analysis of this thesis. The first part includes data collection and data description. The second part includes methods and formulas which are used in analysis of the collected data.

6.1. Data Collection

This Master's Thesis analysis data consist of housing prices indices, previously introduced financial risk proxy indices and rent index. House price indices are similar with the Hou et. Al (2019) with the exception that they used quarterly time series. Housing price indices are collected from Federal Reserve Economic data (FRED) public database. Abbreviations used in the following analysis about each of the Census Divisions and the States of each division are presented on table 1 below.

Table 1. Abbreviations and states of the nine Census Divisions (Census Bureau 2010).

Abbreviation	Name	States
ENC	East North Central	Indiana, Illinois, Michigan, Ohio, and Wisconsin
ESC	East South Central	Alabama, Kentucky, Mississippi, and Tennessee
MA	Middle Atlantic	New Jersey, New York, and Pennsylvania
MOUNT	Mountain	Arizona, Colorado, Idaho, New Mexico, Montana, Utah, Nevada, and Wyoming
NE	New England	Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont
PAC	Pacific	Alaska, California, Hawaii, Oregon, and Washington
SA	South Atlantic	Delaware, District of Columbia, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, and West Virginia
WSC	West South Central	Arkansas, Louisiana, Oklahoma and Texas
WNC	West North Central	Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota and South Dakota

All of the time series are monthly average indices and time period of the analysis is from the beginning of the 2008 to the end of 2019, including total of 144 observations from each index. Volatility indices, TYVIX and VIX are provided by Chicago Board Option Exchange (CBOE), which is the leading option exchange of the world. TED Spread is calculated from the difference of the LIBOR 3-month monthly average rate and 3-month T-Bill monthly average rate. Data for the TED Spread and rent indices are collected as well from the FRED public databases.

6.2. Data Description

Housing returns are used in analysis in excess return format, with the exception of the first model, where the returns are not corrected by the risk-free rate. Risk free rate in the excess return calculations is 3-month T-Bill interest rate. Formula for the excess return modifications is presented below:

$$Excess Ri = R_i - Rf \quad (7)$$

Where,

R_i is the monthly return of housing price index i , and

Rf is the 3-month T-bill rate which is considered to be the risk free rate.

Financial risk proxy and rent variable data sets of the empirical analysis are transferred to delta formats, similarly as Daigler, Hibbert & Pavlova (2014). Delta format measures the monthly changes of each indices. Deltas are calculated as the differences of period t and $t-1$. Formula of the delta calculations is presented below.

$$\Delta f_i = f_{it} - f_{i(t-1)} \quad (8)$$

Where,

f_{it} is the index value of factor i at time t ,

$f_{i(t-1)}$ is the index value of factor i at previous month $t-1$, and

Δf_i is the monthly percentage point change of the factor index f .

Table 2 below presents the summary statistics of housing price excess returns. Results of table 2 shows the expected result and indicates that the Census Divisions' housing returns are similar with the market returns, since all of the excess returns are positive. However, the excess returns still vary between the Census Divisions, since the market excess return during the sample period is approximately 20% since the Census Divisions sample period returns are approximately between 8%-33%. Pacific has the highest standard deviation while Middle Atlantic has the lowest standard deviation of the Census Divisions' excess returns. Middle Atlantic has received also the lowest mean returns of the housing price indices while West South Central has the highest mean. Almost all of the indices are negatively Skewed and have a positive Kurtosis, with the exception of Middle Atlantic, which have a negative Kurtosis.

Table 2. Descriptive statistics of excess returns on housing price indices.

	US	ENC	ESC	MA	MOUNT	NE	PAC	SA	WNC	WSC
Mean	0.0014	0.0012	0.0014	0.0006	0.0020	0.0007	0.0016	0.0011	0.0015	0.0023
Standard Error	0.0005	0.0006	0.0007	0.0005	0.0008	0.0006	0.0008	0.0007	0.0005	0.0005
Median	0.0031	0.0025	0.0015	0.0017	0.0039	0.0017	0.0038	0.0027	0.0020	0.0031
Standard Deviation	0.0056	0.0067	0.0082	0.0060	0.0100	0.0076	0.0101	0.0087	0.0065	0.0061
Sample Variance	0.0000	0.0000	0.0001	0.0000	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000
Kurtosis	1.0196	0.7734	0.2647	-0.0694	0.9585	0.8839	1.4000	1.1753	1.800	0.5827
Skewness	-1.2866	-0.6832	-0.1170	-0.3232	-0.9512	-0.3425	-0.9923	-0.8119	-0.5953	-0.4786
Range	0.0278	0.0402	0.0466	0.0333	0.0501	0.0429	0.0595	0.0539	0.0440	0.0331
Minimum	-0.0181	-0.0204	-0.0242	-0.0166	-0.0306	-0.0221	-0.0327	-0.0282	-0.0201	-0.0141
Maximum	0.0097	0.0198	0.0223	0.0167	0.0195	0.0208	0.0268	0.0257	0.0238	0.0190
Sum	0.1994	0.1707	0.1963	0.0796	0.2810	0.1072	0.2313	0.1627	0.2135	0.3331
Count	144	144	144	144	144	144	144	144	144	144

Table 3 on the next page shows that abnormal excess housing returns are mostly negative with exceptions of East South Central, West North Central and Pacific. Abnormal returns are residual values of the estimated expected excess returns. Negative abnormal returns are in line with Domian et. al (2015) findings. Abnormal returns are surprisingly

strong and positive in the West South Central, since the index records over 20% abnormal returns during the sample period. Standard deviations of abnormal excess returns are relatively low. All of the abnormal excess returns have positive Kurtosis while the sign of the Skewness varies between the Census Divisions. Skewness is positive in East North Central, New England, South Atlantic and West North Central and negative in the other Census Divisions.

Table 3. Descriptive statistics of abnormal excess returns on housing price indices.

	α ENC	α ESC	α MA	α MOUNT	α NE	α PAC	α SA	α WNC	α WSC
Mean	-0.0001	0.0004	-0.0001	0.0000	-0.0003	-0.0004	-0.0007	0.0005	0.0014
Standard Error	0.0003	0.0006	0.0004	0.0005	0.0005	0.0005	0.0004	0.0004	0.0004
Median	-0.0001	0.0005	0.0003	0.0001	-0.0003	-0.0004	-0.0012	0.0006	0.0010
Standard Deviation	0.0040	0.0072	0.0053	0.0059	0.0063	0.0059	0.0047	0.0053	0.0049
Sample Variance	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Kurtosis	0.6245	0.3747	0.2184	0.0510	0.8441	2.8180	1.1257	4.8001	0.7075
Skewness	0.0509	-0.0255	-0.1646	-0.1801	0.2596	-0.4881	0.3041	0.1142	-0.0145
Range	0.0233	0.0380	0.0317	0.0301	0.0365	0.0445	0.0284	0.0477	0.0289
Minimum	-0.0108	-0.0189	-0.0154	-0.0163	-0.0170	-0.0262	-0.0145	-0.0220	-0.0116
Maximum	0.0126	0.0191	0.0163	0.0137	0.0195	0.0184	0.0139	0.0258	0.0172
Sum	-0.0198	0.0547	-0.0168	-0.0055	-0.0471	-0.0625	-0.0999	0.0772	0.2061
Count	144	144	144	144	144	144	144	144	144

In turn, table 4 on the next page presents descriptive statistics of TYVIX, VIX, TED Spread and Rent delta indices. Financial proxy indices have low mean changes while mean monthly changes of rents is significantly higher than financial risk proxies' mean. VIX has the highest standard deviation of risk proxy indices which indicates as expected that implied volatility on stock markets is stronger than in interest rate implied volatility or changes on interest rate spreads. TYVIX, VIX and TED Spread are positively skewed, and they have strong and positive Kurtosis while the Skewness and Kurtosis are negative and low for rent changes.

Table 4. Descriptive statistics of TYVIX, VIX, TED Spread and Rent change indices.

	$\Delta TYVIX$	ΔVIX	ΔTED	$\Delta RENT$
Mean	-0,028	-0,061	-0,007	0,678
Standard Error	0,084	0,412	0,021	0,030
Median	-0,075	-0,410	-0,019	0,730
Standard Deviation	1,007	4,950	0,256	0,364
Sample Variance	1,014	24,499	0,066	0,132
Kurtosis	4,323	3,817	11,405	-0,402
Skewness	0,819	0,836	0,416	-0,372
Range	8,330	35,780	2,696	1,565
Minimum	-3,32	-15,28	-1,299	-0,127
Maximum	5,01	20,5	1,397	1,438
Sum	-4,0705	-8,72	-1,040	97,687
Count	144	144	144	144

6.3. Correlation Matrix

Table 5 below presents the results of the correlation matrix. Purpose of the correlation matrix is to test if the explanatory variables are correlated, which may cause multicollinearity problem in the regression analysis.

Table 5. Correlation matrix of independent variable indices and market return.

	US	$\Delta TYVIX$	ΔVIX	ΔTED	$\Delta RENT$
US	1.000				
$\Delta TYVIX$	-0.022	1.000			
ΔVIX	0.035	0.269	1.000		
ΔTED	-0.062	0.015	0.401	1.000	
$\Delta RENT$	0.297	0.033	0.056	0.094	1.000

Table 5 shows that most of the financial risk proxy estimates have a linear correlation with each other but the correlations seem to be relatively weak. The linear correlations are weak among US housing market excess returns and financial risk proxies and stronger between US housing market excess returns and rents. The strongest correlation exists

between US housing market excess returns and changes in rent index. However, the correlation matrix suggests that further analysis about the possible multicollinearity among independent variables are needed, since the correlations between rents and the US housing market returns have correlation of 0.297 and TYVIX and VIX have correlation of 0.269. Results of the further multicollinearity analysis are presented together with the regression results in chapter 7.

6.4. Methodology

This Master's thesis methodology is motivated and followed by Ross (1976) arbitrage pricing theory and previous research papers, which are related to return-volatility correlation or real estate asset pricing, such as Bekiros et. al (2020), Domian et. al (2015), Zheng et al. (2015), Beracha & Skiba (2013) and Cannon et. al (2006). Analysis include two variable regression analysis and multiple variable regression analysis. Both of the methodologies are based on the Ordinary Least Squares (OLS) method and standard errors of the results are adjusted with Huber-White modification. All in all, the empirical analysis consists of six different analysis. The first two analysis includes estimations of market risk to all nine Census Divisions. The difference between the two analyses of the first part is that the first one includes market model without risk adjustments and the second one uses market model with risk adjusted returns. Purpose for these two models is to investigate if the abnormal returns and betas differs when the returns are in excess return format.

Purpose of the second part is to investigate TYVIX, VIX, TED Spread and rent's impact on excess returns and abnormal excess returns of Census Division housing prices. The models test whether the financial risk proxies and rents have an impact on housing returns and tests does the market model price these variables by using abnormal return estimations.

6.4.1. Two-variable OLS regression

In analysis, first two models are made by utilizing simple linear regression method, following (Domian et. al (2015) and Cannon et. al (2006). Purpose of the first models is to estimate the systematic risk factors and measure the possible abnormal returns which are not explained by market models. Methodology of the first analysis is presented below.

$$(M1) R_i = \alpha_i + \beta_i R_m + \varepsilon_i \quad (9)$$

Where,

R_i is the return of the Census Division i ,

α_i is constant and denotes the abnormal return,

β_1 is R_i 's sensitivity to market index returns,

R_m is market index return, and

ε_i is error term.

The second model utilizes Jensen's alpha model which is presented previously in chapter two. The original formula of Jensen's alpha does not consider excess returns, which means that the formula needs to be modified. Thus, the modified formula for the Jensen's alpha is following Domian et. al (2015):

$$(M2) R_i - R_f = \alpha_i + \beta_i(R_m - R_f) + \varepsilon_i \quad (10)$$

Where,

$R_i - R_f$ is the excess return of the Census Division i

α_i is Jensen's alpha,

β_1 is R_i 's sensitivity to market index returns,

R_m is market index return,

R_f is the 3-month treasury bill return, and

ε_i is error term.

6.4.2. OLS regression with multiple explanatory variables

The second part utilizes multiple variable OLS methodology. Methodology behind the models are similar with Bekiros et al. (2020) and Beracha & Skiba (2013) while the variables are different. Multiple variable part of the empirical analysis consists of three different sections. The first model is multifactor market model and it includes all explanatory variables including market variable as an explanatory variable. The model investigates the factors impact on excess housing returns. Second section investigates the financial risk proxies and rents' impact on abnormal excess returns and the third section investigates the direct impact of financial risk proxies and rents' on housing excess returns when the market variable is omitted from the model. The last section includes also analysis of only financial risk proxies' impact on excess housing returns.

Purpose of the first model in the second part of the empirical analysis is to investigate the financial risk proxies and rent fluctuations' impact on the Census Divisions' excess housing returns, when the model includes also market variable as an explanatory variable. Similarly as the first part of the analysis, 3-month T-Bill rate is used as risk free rate in the excess return modifications. Model for the section is following:

$$(M3) R_i = \alpha_i + US + \beta_1 \Delta TYVIX + \beta_2 \Delta VIX + \beta_3 \Delta TED + \beta_4 \Delta RENT + \varepsilon_i \quad (11)$$

Where,

R_i is the excess return of index i ,

α_i is the abnormal excess return,

$\Delta TYVIX, \Delta VIX, \Delta TED$ and $\Delta RENT$ are index changes

US denotes the US housing market return R_m , and

ε_i is the error term.

The next section of empirical analysis investigates the market risk factors and rents effect on abnormal returns of Census Divisions' housing prices. Abnormal returns are in excess

return format and abnormal returns are estimated as a difference between received return and estimated expected return. Expected returns are estimated for each month by utilizing excess return CAPM modification, similarly as presented in model 2. 3-month T-Bill rates are used as risk free rates in the abnormal return estimations. Formula of the abnormal return regressions is following:

$$(M4) \quad \alpha R_i = \gamma + \beta_1 \Delta TYVIX + \beta_2 \Delta VIX + \beta_3 \Delta TED + \beta_4 \Delta RENT + \varepsilon_i \quad (12)$$

Where,

αR_i is Census Division i excess return market model residual value and considered to be abnormal excess return of the Census Division i's housing price index,

γ is constant,

$\Delta TYVIX, \Delta VIX, \Delta TED$ and $\Delta RENT$ are index changes, and

ε_i is the error term.

Last part of the analysis investigates the results without the market variable as an explanatory variable in the model. The first model includes rent variable while purpose of the last model is to investigate only financial risk proxy factors direct impact on housing returns. Models for the last part are followings:

$$(M5) \quad R_i = \alpha_i + \beta_1 \Delta TYVIX + \beta_2 \Delta VIX + \beta_3 \Delta TED + \beta_4 \Delta RENT + \varepsilon_i \quad (13)$$

$$(M6) \quad R_i = \alpha_i + \beta_1 \Delta TYVIX + \beta_2 \Delta VIX + \beta_3 \Delta TED + \varepsilon_i \quad (14)$$

7 EMPIRICAL RESULTS

Purpose of this chapter is to present the results of this Master's thesis empirical analysis. Part 1 presents the results of market models and regressions are made by utilizing two variable regression model. Second part presents the results of multi variable OLS models and it takes into account the financial risk variables and rents' effect on housing price excess returns and abnormal excess returns.

7.1. Market Models

Table 6 below presents simple linear regression model results for systematic risk estimates on each of the Census Divisions. Model presents the market index return impact on the Census Division's housing price index returns. Standard errors are in parenthesis and *, ** and *** denote significance levels at 10%, 5% and 1%, respectively.

Table 6. Results from the market model (M1).

	ENC	ESC	MA	MOUNT	NE	PAC	SA	WNC	WSC
α	-0.000 (0.000)	0.001 (0.001)	0.000 (0.000)	-0.000 (0.001)	-0.000 (0.001)	-0.001 (0.001)	-0.001** (0.000)	0.001 (0.000)	0.002*** (0.000)
Rm	0.963*** (0.062)	0.721*** (0.110)	0.492*** (0.082)	1.445*** (0.090)	0.781*** (0.095)	1.443*** (0.092)	1.319*** (0.071)	0.686*** (0.080)	0.633*** (0.075)
R^2	0.632	0.233	0.203	0.643	0.321	0.636	0.709	0.339	0.335
Adj. R^2	0.629	0.228	0.198	0.641	0.316	0.633	0.707	0.334	0.331
Std. E	0.004	0.007	0.005	0.006	0.006	0.006	0.005	0.005	0.005

Notes: This table presents the results of market model (M1). Rm is the US housing price index return which is not adjusted by risk free rate and Intercept represents the abnormal returns.

Table 6 shows that the US housing return market estimator is capable to explain the Census Divisions' housing price returns and all of the betas are positive, which are in line

with the first hypothesis of this thesis. Market estimator is highly significant for all Census Divisions. Positive betas indicate about the co-movement of housing returns in all of the Census Divisions, similarly as Hou et. al (2019) and Kallberg et. al (2014). However, the simple market model results that the Census Divisions sensitivities to the US housing market returns differ from each other. Betas are lower than one in East North Central, East South Central, Middle Atlantic, New England, West North Central and West South Central. In turn, betas are higher than one in Mountain, Pacific and South Atlantic. Mountain has the highest beta with a beta factor of 1.445 while Middle Atlantic has the lowest beta with 0.492 beta factor.

On the other hand, adjusted coefficient of determinations are relatively low, which indicates that the simple market model can easily misprice returns. All in all, the simple market model explains under 50% of the returns in five of the nine Census Divisions. Middle Atlantic has the lowest adjusted coefficient of determination with the explanation power of 19,8% and South Atlantic has the highest adjusted coefficient of determination of 70,7%.

Table 7 on the next page shows the results of excess return market model. Model presents the US housing market excess return impact on housing price index excess returns in the Census Divisions and the average abnormal excess returns of the Census Divisions' housing price indices. Standard errors are in parenthesis and *,** and *** denote significance levels at 10%, 5% and 1%, respectively.

Table 7. Results from the excess return estimates and Jensen's alpha (M2).

	ENC	ESC	MA	MOUNT	NE	PAC	SA	WNC	WSC
α	-0.000 (0.000)	0.000 (0.001)	-0.000 (0.000)	-0.000 (0.001)	-0.000 (0.001)	-0.000 (0.001)	-0.001* (0.000)	0.001 (0.000)	0.001*** (0.000)
Rm-Rf	0.955*** (0.061)	0.710*** (0.108)	0.483*** (0.080)	1.436*** (0.090)	0.774*** (0.094)	1.473*** (0.090)	1.317*** (0.070)	0.683*** (0.080)	0.637*** (0.074)
R^2	0.633	0.232	0.203	0.644	0.321	0.656	0.712	0.342	0.342
Adj. R^2	0.630	0.227	0.197	0.641	0.317	0.653	0.71	0.337	0.337
Std. E	0.004	0.007	0.005	0.006	0.006	0.006	0.005	0.005	0.005

Notes: This table presents the results of excess return Jensen's alpha model (M2). Rm-Rf is the US housing price index excess return and depended variables are also in excess return format. Alpha is Jensen's alpha.

Results on the table 7 are similar with table 6, which is in line with Domian et. al. (2015) finding and indicates that the results do not differ significantly when the returns are risk adjusted. However, as presented in summary statistics in table 3, table 7 also presents that most of the abnormal excess returns are on average negative, which is as well in line with Domian et. al (2015) finding. However, the results still suggest that the H2 cannot be fully accepted, since the abnormal returns have been positive in East North Central, West North Central and West South Central.

Table 8 on the next page shows the yearly distribution of Jensen's alpha abnormal excess returns. Distribution shows that the signs of the abnormal returns have distributed separately between the Census Divisions and the trend line in which years the abnormal returns have been negative or positive in every Division is not identifiable.

Table 8. Jensen's alpha abnormal yearly excess returns of every division housing returns.

	ENC	ESC	MA	MOUNT	NE	PAC	SA	WNC	WSC
2008	0.02	0.03	-0.02	0.02	0.01	-0.07	-0.02	0.02	0.04
2009	0.00	0.00	0.00	-0.05	0.01	0.01	0.00	0.00	0.02
2010	0.00	-0.02	-0.01	-0.01	0.00	0.01	0.01	0.00	0.00
2011	0.00	0.03	-0.02	0.01	0.00	-0.02	0.00	-0.01	0.03
2012	-0.02	-0.02	-0.01	0.04	-0.02	0.04	-0.02	0.02	0.01
2013	0.00	-0.02	-0.01	0.00	-0.03	0.04	-0.01	0.00	0.02
2014	0.00	0.00	0.01	-0.01	-0.01	0.00	-0.01	0.01	0.02
2015	-0.01	0.02	0.00	-0.01	0.00	0.00	-0.01	0.01	0.02
2016	0.00	0.01	0.01	0.00	0.00	-0.01	-0.01	0.01	0.02
2017	0.00	0.00	0.02	0.00	0.00	-0.01	-0.02	0.00	0.02
2018	0.00	0.02	0.02	0.00	0.00	-0.02	0.00	0.02	0.00
2019	0.00	0.01	0.00	0.01	0.00	-0.02	-0.01	0.01	0.01
Total	-0.02	0.05	-0.02	-0.01	-0.05	-0.06	-0.10	0.08	0.21

7.2. Variance inflation factors

As discussed previously in correlation matrix table 4, explanatory variables showed low correlation between each other's. Table 9 below shows the results of variance inflation factors for the explanatory variables which are used in the analysis of the second part of this thesis.

Table 9. Variance inflation factors for independent variables.

	US	ΔTYVIX	ΔVIX	ΔTED	ΔRENT
US		1.617	1.425	2.151	1.026
ΔTYVIX	1.029		1.013	1.297	1.054
ΔVIX	1.760	1.053		1.301	1.401
ΔTED	1.750	1.313	1.029		1.340
ΔRENT	1.020	1.340	1.406	2.118	

Generally, the VIF values over 5 are considered to cause multicollinearity for the model (Bekiros et al. 2020: 9). Table 9 shows that all of the VIF values are below 2.16 which indicates that the models are not influenced by multicollinearity problem.

7.3. Results of the Multiple Variable Regressions

The second part of the analysis includes results of the multifactor regression models. The first section presents results of the multifactor market models, second section includes results of the multifactor abnormal return model and the last section presents the variables direct impact on housing return when the model does not include independent market variable. Returns of the models are excess returns, similarly as in table 7 in the first part of empirical analysis.

7.3.1. Multifactor Market Model

Table 10 below reports the results of the multifactor market models (M3). US is the country level housing market excess return and intercept represents the abnormal return. Standard errors are adjusted by using Huber-White estimation. Results of the VIF values are presented in Appendix 1. Standard errors are in parenthesis and *,** and *** denote significance levels at 10%, 5% and 1%, respectively.

Table 10. Results from the multifactor market model (M3).

Variable	ENC	ESC	MA	MOUNT	NE	PAC	SA	WNC	WSC
Inter.	0.000 (0.001)	-0.001 (0.001)	0.000 (0.001)	-0.001 (0.001)	-0.000 (0.001)	0.001 (0.001)	-0.002 (0.001)	0.001 (0.001)	0.002* (0.001)
US	0.957*** (0.062)	0.667*** (0.099)	0.487*** (0.077)	1.416*** (0.102)	0.769*** (0.095)	1.525*** (0.109)	1.285*** (0.068)	0.688*** (0.085)	0.659*** (0.081)
ΔTYVIX	-0.000 (0.000)	-0.000 (0.001)	-0.000 (0.001)	0.000 (0.001)	0.000 (0.001)	0.001 (0.001)	-0.001** (0.000)	0.001* (0.001)	0.001*** (0.000)
ΔVIX	0.000 (0.001)	0.000 (0.001)	0.000 (0.001)	-0.001** (0.001)	0.000 (0.001)	-0.000 (0.001)	0.000 (0.001)	0.000 (0.001)	0.000 (0.001)
ΔTED	-0.001 (0.002)	-0.003 (0.002)	-0.001 (0.003)	-0.002 (0.003)	-0.001 (0.002)	0.002 (0.004)	0.001 (0.002)	0.001 (0.003)	0.001 (0.002)
ΔRENT	-0.000 (0.001)	0.002 (0.002)	-0.000 (0.001)	0.001 (0.001)	-0.000 (0.002)	-0.002 (0.001)	0.001 (0.001)	-0.000 (0.001)	-0.001 (0.001)
R²	0.634	0.243	0.207	0.665	0.332	0.668	0.738	0.377	0.389
Adj. R²	0.621	0.215	0.178	0.653	0.307	0.656	0.729	0.354	0.367
Std. E.	0.004	0.007	0.005	0.006	0.006	0.006	0.005	0.005	0.005
F-stat.	47.856	8.844	7.205	54.713	13.691	55.570	77.873	16.682	17.581
VIF	<1.95	<1.83	<1.19	<1.42	<4.08	<2.44	<1.21	<1.18	<1.18

(M3) results on table 10 shows that financial risk proxy variables are insignificant in most of the Census Divisions, when the market variable is included in the model. Coefficient for TYVIX are significant in South Atlantic, West North Central and West South Central while VIX is only significant and shows negative correlation with Mountain's returns. Sign of the TYVIX significant coefficients vary between the Census Divisions, since the correlation is negative in South Atlantic and positive in West North Central and West South Central. In turn, Ted Spread and rent is insignificant in every Census Division. However, the impact of significant coefficients is relatively small, since TYVIX shows approximately 0,1% monthly impact and VIX shows under 0,1% monthly impact on excess returns.

Abnormal returns of the (M4) estimations are all close to 0, similarly as in table 7. In turn, the sign of the abnormal returns varies more when more factors are added to the models. Table 10 shows positive sign abnormal returns in five of the Census Divisions while the the Jensen's alpha estimated abnormal returns are positive for only three of the Census Divisions.

7.3.2. Multifactor Abnormal Return Model

Table 11 on the next page shows the results from the multifactor abnormal return estimations (M5). Abnormal returns are depended variables of the model and calculated as monthly residual values of excess return market model (M2). Standard errors are adjusted by using Huber-White estimation. Results of the VIF values are presented in Appendix 2. Standard errors are in parenthesis and *,** an *** denote significance levels at 10%, 5% and 1%, respectively.

Table 11. Results from the multifactor abnormal return model (M4).

Variable	α_{ENC}	α_{ESC}	α_{MA}	α_{MOUNT}	α_{NE}	α_{PAC}	α_{SA}	α_{WNC}	α_{WSC}
Inter.	0.000 (0.001)	-0.001 (0.001)	0.000 (0.001)	-0.001 (0.001)	-0.000 (0.001)	0.001 (0.001)	-0.002 (0.001)	0.001 (0.001)	0.002** (0.001)
$\Delta TYVIX$	-0.000 (0.000)	-0.000 (0.001)	-0.000 (0.001)	-0.000 (0.001)	0.000 (0.001)	0.001 (0.001)	-0.001*** (0.000)	0.001* (0.001)	0.001*** (0.000)
ΔVIX	0.000 (0.000)	0.000 (0.000)	-0.000 (0.000)	-0.000** (0.000)	0.000 (0.000)	-0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	-0.000 (0.000)
ΔTED	-0.001 (0.002)	0.000 (0.002)	-0.001 (0.003)	-0.003 (0.003)	0.000 (0.002)	0.003 (0.004)	-0.001 (0.002)	0.002 (0.003)	0.002 (0.002)
$\Delta RENT$	-0.000 (0.001)	0.001 (0.002)	-0.000 (0.001)	0.001 (0.001)	-0.000 (0.001)	-0.002 (0.001)	0.001 (0.001)	-0.000 (0.001)	-0.001 (0.001)
R^2	0.005	0.008	0.004	0.068	0.014	0.038	0.089	0.056	0.075
Adj. R^2	-0.024	-0.021	-0.025	0.041	-0.014	0.011	0.063	0.029	0.048
Std. E.	0.004	0.007	0.005	0.006	0.006	0.006	0.005	0.005	0.005
F-stat.	0.165	0.280	0.135	2.532	0.500	1.380	3.414	2.057	2.799
VIF	<1.57	<1.76	<1.23	<1.38	<1.37	<3.61	<2.24	<1.27	<1.12

Notes: VIX impact in Mountain is approximately -0.02%.

Results in table 11 are similar with table 10, since the significant coefficients of TYVIX and VIX are same as in table 10. This finding provides evidence about the significant mispricing of CAPM even if the impact of significant coefficients is relatively low. However, the results suggest that hypotheses H3b, H4b and H5b cannot be fully rejected while the hypothesis H6b will be accepted.

7.3.3. Direct Effect models

As the financial risk proxy and rents' correlations are mostly insignificant in both of the previous estimations, the impact of these variables are tested further to provide certainty of rejection of the hypotheses H3a, H4a, H5a and H6a by testing the impact of these variables without the market factor. Tables 12 and 13 on the next page presents the results of the direct effect estimations (M5) and (M6). Table 12 includes results with the rent variable and table 13 includes only financial risk proxies' impact. Dependent variables are excess returns of each housing price index. Standard errors are adjusted by using Huber-White estimation. Results of the VIF values are presented in Appendix 3.

Standard errors are in parenthesis and *, ** and *** denote significance levels at 10%, 5% and 1%, respectively.

Table 12. Results without the market variable (M5).

Variable	US	ENC	ESC	MA	MOUNT	NE	PAC	SA	WNC	WSC
Inter.	-0.002** (0.001)	-0.002 (0.001)	-0.002 (0.002)	-0.001 (0.001)	-0.003* (0.002)	-0.002 (0.001)	-0.002 (0.002)	-0.004** (0.002)	-0.001 (0.001)	0.001 (0.001)
ΔTYVIX	-0.000 (0.001)	-0.000 (0.001)	-0.001 (0.001)	-0.000 (0.001)	-0.000 (0.001)	-0.000 (0.001)	0.000 (0.001)	-0.002 (0.001)	0.001 (0.001)	0.001** (0.001)
ΔVIX	0.000 (0.001)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	-0.000 (0.000)	0.000* (0.000)	-0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
ΔTED	-0.003 (0.006)	-0.004 (0.006)	-0.005 (0.004)	-0.003 (0.003)	-0.006 (0.008)	-0.003 (0.005)	-0.003 (0.009)	-0.003 (0.008)	-0.001 (0.006)	-0.001 (0.005)
ΔRENT	0.005*** (0.001)	0.004*** (0.001)	0.005** (0.002)	0.002 (0.001)	0.008*** (0.002)	0.004** (0.002)	0.005** (0.002)	0.007*** (0.002)	0.003** (0.001)	0.002* (0.001)
R²	0.103	0.065	0.059	0.022	0.103	0.047	0.037	0.130	0.066	0.060
Adj. R²	0.077	0.038	0.032	-0.006	0.078	0.019	0.010	0.105	0.039	0.033
Std. E.	0.005	0.007	0.008	0.006	0.010	0.008	0.010	0.008	0.006	0.006
F-stat.	3.973	2.409	2.186	0.774	4.004	1.709	1.352	5.196	2.437	2.232
VIF	<1.76	<1.54	<1.51	<1.52	<1.47	<1.50	<1.43	<1.47	<1.33	<1.41

Table 13. Results from the financial risk proxy model (M6).

Variable	US	ENC	ESC	MA	MOUNT	NE	PAC	SA	WNC	WSC
Inter.	0.001*** (0.000)	0.001** (0.001)	0.001** (0.001)	0.001 (0.000)	0.002** (0.001)	0.001 (0.001)	0.002* (0.001)	0.001 (0.001)	0.002*** (0.001)	0.002*** (0.001)
ΔTYVIX	-0.000 (0.001)	-0.000 (0.001)	-0.001 (0.001)	-0.000 (0.001)	-0.000 (0.001)	0.000 (0.001)	0.000 (0.001)	-0.002 (0.001)	0.001 (0.001)	0.001* (0.000)
ΔVIX	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	-0.000 (0.000)	0.000* (0.000)	-0.000 (0.000)	-0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
ΔTED	-0.002 (0.005)	-0.003 (0.006)	-0.004 (0.004)	-0.003 (0.003)	-0.005 (0.007)	-0.003 (0.005)	-0.002 (0.009)	-0.002 (0.008)	-0.001 (0.006)	-0.001 (0.005)
R²	0.018	0.013	0.015	0.009	0.022	0.018	0.004	0.037	0.035	0.040
Adj. R²	-0.003	-0.008	-0.006	-0.012	0.001	-0.003	-0.018	0.017	0.014	0.019
Std. E.	0.008	0.007	0.008	0.006	0.010	0.008	0.010	0.009	0.006	0.006
F-stat.	0.874	0.615	0.731	0.426	1.027	0.874	0.172	1.810	1.677	1.944
VIF	<1.31	<1.46	<1.46	<1.55	<1.28	<1.45	<1.38	<1.40	<1.23	<1.38

Notes: VIX impact in New England is approximately 0.02%.

Table 12 shows that rent variable becomes significant in most of the Divisions when the market variable is omitted from the model. All of the rent coefficients are positive and supports Hargreaves (2008) and Kim & Chung (2014) conclusions. This finding suggests that rents are important characteristics for determining housing prices, but the impact of rents includes in the systematic risks.

Financial risk proxies' impacts are similar in both of the tables. Results show even less significancy for the risk proxy coefficients when the model does not include market variable. The financial proxy correlations are tested also separately, but the results were similar, which means that TYVIX provides significant correlations only in West South Central and VIX only in New England. This finding is against for example Bekiros et al. (2020) finding about the significant and negative impact of VIX on housing returns, which might be a consequence of the different VIX measurement methods, since Bekiros et. al (2020) used the VIX index without the change impact. However, this result leads to the rejection of the hypotheses H3a, H4a and H5a and acceptance of H6a.

In summary, the financial risk factors effect on housing prices in the United States and in the Census Divisions seems to be relatively low and mostly insignificant. In turn, the results show significant mispricing of CAPM, since the abnormal return estimations provided significant coefficients for risk proxies in few of the Census Divisions. However, these results suggest that even if the housing markets are becoming more global all the time, the factors which affects to housing returns comes mostly outside of the financial risk proxies. This finding differs from Bekiros et. al (2020). In turn, results also suggest that CAPM is capable to price rents impact since rent fluctuations showed insignificant correlations together with the market variable and for the abnormal returns.

8. CONCLUSIONS

This study investigates the relationship between housing returns, systematic risk, financial risk proxies and rents in the United States and its nine Census Divisions. Housing price returns are calculated from the housing price indices. Financial risk proxies used in analysis of this study are TYVIX, VIX and TED Spread. These indices are transferred to delta formats. TYVIX is used to measure the interest rate risk, VIX is used to measure the stock market risk and Ted Spread is used to measure the credit risk. Sample is collected between years 2008 and 2019.

Analysis consists of two parts. The first part measures the systematic risk and abnormal returns by utilizing commonly known market model and Jensen's alpha excess return modification, following Domian et. al. (2015). The second part utilizes multi variable regression models and tests the impact of financial risk proxies and rent fluctuations on the housing excess returns and tests the CAPM capability to price financial risk proxies and rent fluctuations. All of the regression models used in analysis of this thesis are OLS regression models.

Results of the first part suggests that the market models tend to generate mostly negative abnormal price returns in housing market. This finding is similar with Domian et. al (2015). Results of the first part suggests also that market variable is highly significant and positive for all of the variables, which indicates about the co-movement of housing prices. This finding is in line with Hou et. al (2019) and Kallber et. al (2014) results.

Results of the first section of the second part shows that when the market return variable is included in the model, the impact of financial risk proxies' is mostly insignificant. On the other hand, the results also show significant coefficients for VIX and TYVIX in few Divisions which indicated about the possibility of market model mispricing. However, the impacts of the significant coefficients are relatively low. In turn, rent variable is insignificant in every Division together with market variable.

The second section of the multi variable analysis measures the financial risk proxies and rents' correlations between market model residual value abnormal returns. Results suggest significant mispricing of CAPM since the results show significant coefficients for VIX in Mountain and for TYVIX in South Atlantic, West North Central and West South Central. However, similarly as in the first multivariable analysis, the impact of these variables remains relatively low. In turn, results also suggests that CAPM is capable to price rent fluctuations since the coefficients for rent remained insignificant, similarly as with the market variable.

Results from the last section show that rent variable turns out to be significant and positive at country level as well as in most of the Divisions when the market variable is omitted from the model. This finding is in line with Hargreaves (2008) and Kim and Chung (2014) and indicates about the importance of the relationship between rents and housing prices. In turn, the direct effect estimations show also that the correlations between financial risk proxies and housing excess returns are insignificant at country level and also significance of financial risk proxies decreases when the market variable is omitted from the model.

All in all, the findings of this study show that the relationship between housing price returns and financial risk proxies is minor, which supports the theory that house investments may be good options for diversification purposes. This study suggests further research from the same subject of field in several reasons. At first, commonly known asset pricing models are not yet highly adopted for the real estate research. Secondly, OLS methodology's ability to explain relationship between risk and return is minor when the model includes volatility indices, which leaves room for alternative research models. Investigation period of this thesis is relatively short and do not include the housing market crash, which leaves probability to different results if the time-period would be longer.

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APPENDICES

APPENDIX 1. VIF values for (M3).

	ENC	ESC	MA	MOUNT	NE	PAC	SA	WNC	WSC
US	1.283	1.121	1.151	1.083	1.093	1.081	1.170	1.207	1.174
ΔTYVIX	1.420	1.059	1.180	1.082	1.419	1.689	1.636	1.066	1.087
ΔVIX	1.489	1.859	1.224	1.185	1.395	4.076	2.422	1.160	1.058
ΔTED	1.296	1.739	1.011	1.160	1.215	3.262	2.432	1.192	1.109
ΔRENT	1.194	1.148	1.082	1.041	1.085	1.091	1.072	1.188	1.162

APPENDIX 2. VIF values for (M4).

	ENC	ESC	MA	MOUNT	NE	PAC	SA	WNC	WSC
ΔTYVIX	1.560	1.067	1.215	1.263	1.329	1.759	1.425	1.155	1.107
ΔVIX	1.391	1.746	1.199	1.156	1.365	3.597	2.234	1.124	1.018
ΔTED	1.243	1.634	1.037	1.374	1.107	3.098	1.906	1.263	1.088
ΔRENT	1.055	1.043	1.004	1.010	1.029	1.057	1.052	1.055	1.020

APPENDIX 3. VIF values for (M5).

	US	ENC	ESC	MA	MOUNT	NE	PAC	SA	WNC	WSC
ΔTYVIX	1.175	1.048	1.105	1.510	1.467	1.122	1.049	1.196	1.006	1.348
ΔVIX	1.311	1.465	1.496	1.424	1.271	1.448	1.394	1.465	1.268	1.247
ΔTED	1.485	1.527	1.404	1.075	1.355	1.495	1.428	1.391	1.322	1.404
ΔRENT	1.193	1.103	1.078	1.003	1.149	1.093	1.077	1.101	1.144	1.089

APPENDIX 4. VIF values for (M6).

	US	ENC	ESC	MA	MOUNT	NE	PAC	SA	WNC	WSC
ΔTYVIX	1.112	1.052	1.113	1.545	1.272	1.087	1.045	1.115	1.007	1.334
ΔVIX	1.275	1.456	1.457	1.449	1.163	1.446	1.371	1.392	1.221	1.264
ΔTED	1.303	1.417	1.343	1.080	1.247	1.422	1.337	1.288	1.223	1.371