The Role of Uncertainty in the Scandinavian Banking Sector

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Abstract

In this thesis we analyse the impact of uncertainty shocks in the Scandinavian banking sector. We apply the spillover approach developed by Diebold and Yilmaz (2009; 2012; 2014), followed by network analysis. Furthermore, the dynamics of uncertainty shocks are examined by applying a quantile regression approach. We study the effects of financial uncertainty, economic policy uncertainty, geopolitical risk and housing market uncertainty on the seven banks Swedbank, Nordea, SEB, Svenska Handelsbanken, DNB, Danske Bank and Jyske Bank. We study these uncertainties on global, regional and local level between 2005 and 2018. We find that the Swedish banks are greater emitters of contagion, compared to the Norwegian and Danish banks, where SEB and Nordea are the banks emitting and receiving the most spillovers. Moreover, the connectedness within the banking sector tend to increase in times of heightened uncertainty, such as during the Global Financial Crisis and the European Sovereign Debt Crisis. Global financial uncertainty is shown to affect the Scandinavian banks the most, followed by regional and local financial uncertainty. The same pattern can be seen for economic policy uncertainty, although at lower levels of spillovers. Reversely, housing market uncertainty is seen to increase going from global, regional to local, where the impact of local housing market uncertainty has a considerable amount of spillovers to the Scandinavian banks. Geopolitical risk is shown to have limited spillovers to the Scandinavian banks. The result of the quantile regressions suggests that financial uncertainty is affecting the banks’ returns negatively during bearish market conditions, whilst the relationship is positive during bullish market conditions. Moreover, we find that financial uncertainty is a quicker transmitter of spillovers than housing market uncertainty. Finally, we conclude that uncertainty shocks affecting the Scandinavian banks negatively tend to take effect instantaneously, while the effects of positive shocks are delayed.

Keywords: Scandinavian banking sector; Uncertainty; Spillovers; Contagion; Connectedness; Network analysis; Quantile regression
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1. Introduction

In 2008, the contagion of the subprime crisis had started to reach financial markets outside the US. Financial institutions held mortgage-backed securities in their equity portfolios, which exposed them to the US subprime market. The result was the greatest recession since the 1930s, with negative spillover effects spreading globally through financial markets. The banking system has a crucial role in providing liquidity to the market, which in turn promotes economic growth. Possible shocks that harm the function of the banks are therefore of societal importance (Levine, 1999). The Scandinavian banking system has in recent years become more interconnected than ever, there are few participants on the market and the major seven banks Swedbank, Nordea, SEB, Svenska Handelsbanken, DNB, Danske Bank and Jyske Bank together own 95.7% of the total market share. Due to the Scandinavian banks applying the same diversification tools, business models and wholesale funding models, they are susceptible to local contagion effects as a result of interconnectedness (IMF, 2017). Because of the market's interconnectedness, uncertainty shocks are likely to spread across the countries in Scandinavia, where Sweden is the most likely emitter of negative spillover effects (IMF, 2013). The problem of Scandinavia’s potential spillover effects from uncertainty shocks has previously been brought up by the IMF (2013), as well as by the Swedish Riksbank (2018). However, an accurate examination of the effects of shocks has thus far not been done. Therefore, the purpose of this study is to investigate the spillover effects of uncertainty shocks in the Scandinavian banking sector.

There is no established definition of spillovers or contagion, in this paper we choose to define them both as transmissions of shocks in one financial market to another. However, like Rigobon (2016), we make a distinction between the two phenomena as spillover always being present, regardless of good or bad markets, while contagion has a more negative connotation. There are a variety of different ways of measuring uncertainty, which has been proven to have an economic impact (Baker et al, 2016; Uribe et al., 2017; Caldara and Iacoviello, 2018). Increased uncertainty worries investors, who in turn require higher returns and when prices of assets and products become too uncertain, investors are more likely to step back and invest at a later time (Bloom, 2009). Therefore, uncertainty could have an increasing effect in a downward spiral such as the financial crisis of 2008 when people are too afraid to invest, which incites further downturn in the economy. Such a shock to the Scandinavian banking system is expected to have spillover effects between the countries due to their interconnectedness. One of the major risks and sources of uncertainty are the household's indebtedness and the increasing number of covered bonds outstanding from the Scandinavian banks. The risk of the covered bonds has been brought up by international organisations such as OECD, the European Commission, the European Systemic Risk Board (ESRB) and the IMF (Riksbanken, 2018).

An element worth considering is the global, regional and local aspect of uncertainty. Is global uncertainty more likely to explain the changes in the Scandinavian market, if so, what would the possible policy implication be? By analysing the spillover effects of the banks in the Scandinavian banking sector, as well as different types of uncertainties, we believe that we can contribute to an increased understanding of contagion within the sector. This is of importance since the banks are interconnected in the market, but also due to the banks being of systemic importance within Scandinavia and Europe. As of 2018 the European Banking Authority (EBA) ranks Nordea, SEB, Svenska Handelsbanken, Swedbank, DNB and Danske Bank as Scandinavian banks that are large
institutions with a leverage exposure above 200 billion EUR (EBA, 2018). Nordea has until 2018 been categorized as a global systemically important bank (G-SIB) by the Financial Stability Board. Not only are the effects from the banks important for investors in the banking sectors or the sector itself, but they also have implications for policymakers and the effectiveness to prevent contagion.

Diebold and Yilmaz (2009; 2012; 2014) have developed a methodology to calculate spillover effects in order to study financial connectedness. Following vector autoregressive (VAR) modelling with generalized variance decomposition, the methodology makes it possible to analyse shocks in one variable and examine what variance that is due to shocks in itself and what is due to shocks in other variables. Diebold and Yilmaz (2012) find that, during the global financial crisis, the volatility spillovers from the stock market increased. Furthermore, Baker et al. (2016) have introduced a new way of measuring uncertainty. By collecting data from different newspapers, they analyse certain words associated with uncertainty and create several uncertainty indices, such as economic policy uncertainty and geopolitical risk. Fig. 1 shows the evolution of global economic policy uncertainty from 2005 to 2018 and highlights several important events that caused shocks in uncertainty. Studying equity market uncertainty, Uribe et al. (2017) find that uncertainty is positively associated with systemic bank risk. Moreover, Betz et al. (2016) conclude that systemic risk is positively correlated with interconnectedness, size and leverage.

Our purpose is to investigate the spillover effects of uncertainty shocks in the Scandinavian banking sector. We do this by examining the uncertainties economic policy uncertainty, geopolitical risk, financial uncertainty and housing market uncertainty. Previous literature has studied the effects of spillovers, but rarely, if ever, in regard to specific uncertainty measurements. Neither has, to our
knowledge, any similar studies been done focusing on the Scandinavian banking sector and uncertainty. Households’ indebtedness has become a topic of discussion because of the low interest rates and its ramification on the banks’ asset portfolios, which further raises its importance. It is essential to note that different shocks to the system are not likely to cause the same spillovers, for this reason it is relevant to study different types of uncertainty. We have specified our study to the Scandinavian market, which includes Sweden, Denmark and Norway. For this market the seven major banks we study are Swedbank, Nordea, SEB, Svenska Handelsbanken, DNB, Danske Banks and Jyske Bank. Studying the Scandinavian banking sector is important for two reasons. Firstly, the countries handled the financial crisis better than most. Secondly, the banking sector is very concentrated to a few actors in the entire market. For these reasons we believe lessons can be learned by studying this specific market and it can also help understanding the global banking market better. We further increase our applicability by looking at different geographical aspects of uncertainty, namely global, regional and local. Diverse effects would imply the need for policy makers and investors to account for not only different types of shocks, but also their location.

To answer our purpose, we will focus on the following research questions:

i. Which Scandinavian banks are the largest transmitters and receivers of shocks?

ii. Which types of uncertainty are of importance to the Scandinavian banking sector?

iii. How is uncertainty affecting the Scandinavian banks during different market conditions?

To measure the connectedness within the banking sector and evaluate the effect of uncertainty shocks, we apply the methodology of Diebold and Yilmaz (2009; 2012; 2014). We identify VAR models by applying generalized variance decomposition with a forecast horizon of three months. Following this methodology, we are able to examine what variance in one variable that is due to shocks in itself and due to shocks in other variables. At last, in order to analyse the impact of uncertainty in different market conditions, we apply the quantile regression approach of Koenker and Basset (1978).

We find that global uncertainty has the largest impact on the Scandinavian banking sector in terms of financial and economic policy uncertainty. However, studying the spillover effects from shocks in housing market uncertainty, we find that local uncertainty is of greater importance than regional and global. Furthermore, uncertainty in terms of geopolitical risk has shown to have a limited impact on the Scandinavian banking sector. We also find that financial uncertainty is a quicker transmitter of spillovers than housing market uncertainty. Moreover, uncertainty affecting the banks negatively tend to have an instantaneous impact on the return, while positive shocks are delayed.

Our main contribution to the literature of spillover effects is that we look at the spillovers within the Scandinavian banking sector. Secondly, we include several uncertainty measurements in the paper. Thirdly, we apply different geographical version of our indices in order to identify differences in global, regional and local uncertainty. To our knowledge none of these research topics have been addressed before in the context of spillover analysis. The policy implications of our contributions are that global uncertainty is of greater importance, implying that the Scandinavian banking sector is driven by global factors, rather than regional and local. The exception to this is the housing market, where local is of greatest importance. Sweden can also be
described as the major force within Scandinavia, as the Swedish banks are the largest transmitters of spillovers to the Norwegian and Danish banks. We also find significant lagged effects of spillover for positive shocks, implying that uncertainty can be used in predicting future return of the Scandinavian banks.

We proceed as follows. In section 2 we briefly describe the Scandinavian banking sector and present some stylized facts. Section 3 outlines previous literature in our field of study, followed by section 4, consisting of the theoretical framework. Section 5 describes our methodology and in section 6 we describe and discuss our data. We present the empirical results and discussion in section 7 and finish with conclusions and policy implications in section 8.
2. The Scandinavian banking sector

To understand the Scandinavian banking sector, it is important to look at the stylized facts of the Scandinavian banks. Because of this, we briefly summarise the most important characteristics that make the Scandinavian banking sector unique and interesting to study.

Compiling the total assets of the Scandinavian banks from 2005 to 2017 gives us a comprehensive view of the state of the market. Fig. 2 shows that the Swedish banking sector is the largest among the Scandinavian countries, amounting to about three fifths of the market shares throughout the period of 2005-2017.

![Size of the Scandinavian banking sector 2005-2017](image)

**Fig. 2.** Size of the Scandinavian banking sector 2005-2017. Notes: Sum of total assets of all listed banks in each country from 2005 to 2017 in USDm. Definition of bank: ICB 8300 from Nasdaq for Sweden and Denmark; In Norway: GICS 401010 from Oslo stock exchange. Arion Bank, which is listed on NASDAQ Stockholm, is excluded since it is operating on the Icelandic market only. Source: Thomson Reuters Datastream.

Table 1 shows that as of 2017, the seven largest banks hold 95.74% of the total market share, continuing in line with the conclusion of IMF (2013) stating that the six largest banks had 90% of the market shares in 2013. Nordea’s market share is one quarter of the Scandinavian total, while Danske Bank’s equals one fifth and the third largest bank is the Norwegian DNB amounting to 12.71%. Considering that there are six Swedish banks, seven Norwegian and 23 Danish banks, the Swedish and Norwegian banking sectors are more concentrated than the Danish.
Table 1
Each bank’s market share in terms of total assets 2017.

<table>
<thead>
<tr>
<th></th>
<th>Total Assets (USDm)</th>
<th>Share of total domestic</th>
<th>Share of total Scandinavian</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sweden</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Swedbank</td>
<td>243,539</td>
<td>16.64%</td>
<td>9.88%</td>
</tr>
<tr>
<td>Nordea</td>
<td>629,554</td>
<td>43.02%</td>
<td>25.54%</td>
</tr>
<tr>
<td>SEB</td>
<td>281,722</td>
<td>19.25%</td>
<td>11.43%</td>
</tr>
<tr>
<td>Svenska Handelsbanken</td>
<td>304,534</td>
<td>20.81%</td>
<td>12.36%</td>
</tr>
<tr>
<td>Others SE(2)</td>
<td>3,995</td>
<td>0.27%</td>
<td>0.16%</td>
</tr>
<tr>
<td><strong>Norway</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DNB</td>
<td>313,382</td>
<td>88.02%</td>
<td>12.71%</td>
</tr>
<tr>
<td>Others NO(6)</td>
<td>42,654</td>
<td>11.98%</td>
<td>1.73%</td>
</tr>
<tr>
<td><strong>Denmark</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Danske Bank</td>
<td>502,028</td>
<td>77.80%</td>
<td>20.37%</td>
</tr>
<tr>
<td>Jyske Bank</td>
<td>84,748</td>
<td>13.13%</td>
<td>3.44%</td>
</tr>
<tr>
<td>Others DK(21)</td>
<td>58,536</td>
<td>9.07%</td>
<td>2.37%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>2,464,692</td>
<td>100.00%</td>
<td></td>
</tr>
</tbody>
</table>

Notes: Number of other banks are written in parenthesis. Source: Thomson Reuters Datastream.

Fig. 3 shows the trading volume of the Scandinavian banks’ stocks. During times of uncertainty, such as the global financial crisis and the European sovereign debt crisis, there are higher trading volumes, indicating that economic turmoil increases the activity on the stock market. The Swedish banks are traded the most followed by the Norwegian bank DNB. The Danish banks are traded the least and Jyske Bank’s stock is traded in significantly lower volumes. It is noteworthy that Danske bank, which is the second largest bank in the Scandinavian banking sector, is traded second least. The higher trading volumes of Swedish banks could indicate a stock market with more accurate pricing, compared to the Norwegian and Danish markets.

![Trading Volume Graph](image)

**Fig. 3.** Trading volume. Notes: Trading volume January 2005 – November 2018. Source: Thomson Reuters Datastream.
Loan-to-deposit (LTD) ratio is a way of measuring liquidity, describing how much of a bank’s loans that are funded through deposits. If the LTD ratio exceeds 100, that is, the bank’s loans are larger than the deposits, the bank has to fund the loans through financial markets. This is usually done by issuing covered bonds to investors and other banks, where the covered bonds are collateralised against a pool of assets, commonly known as a cover pool. The cover pools mainly consist of mortgage loans and hence, the value of the cover pools is largely determined by the value of the mortgages, i.e. the house prices. Moreover, if the dependence of the financial markets increases, it could mean greater uncertainty and expenses (Van den End, 2016). ECB (2012) claims that an LTD ratio of 80 implies a reduced ability of financial intermediation and a ratio of 120 or higher could be an indicator of a banking crisis. Table 2 shows that, on average, the Scandinavian banks have larger LTD ratios than the banks in the Euro area consistently from 2009 to 2018.

Table 2
Loan-to-deposit ratio.

<table>
<thead>
<tr>
<th></th>
<th>Q1 2009</th>
<th>Q1 2012</th>
<th>Q1 2015</th>
<th>Q1 2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swedbank</td>
<td>296.41</td>
<td>215.81</td>
<td>194.88</td>
<td>167.63</td>
</tr>
<tr>
<td>Nordea</td>
<td>197.12</td>
<td>198.73</td>
<td>161.17</td>
<td>184.66</td>
</tr>
<tr>
<td>SEB</td>
<td>192.30</td>
<td>187.82</td>
<td>151.38</td>
<td>151.26</td>
</tr>
<tr>
<td>Svenska Handelsbanken</td>
<td>303.95</td>
<td>260.78</td>
<td>178.62</td>
<td>213.35</td>
</tr>
<tr>
<td>DNB</td>
<td>211.15</td>
<td>165.21</td>
<td>175.44</td>
<td>180.67</td>
</tr>
<tr>
<td>Danske bank</td>
<td>259.07</td>
<td>255.46</td>
<td>199.67</td>
<td>240.77</td>
</tr>
<tr>
<td>Jyske bank</td>
<td>131.86</td>
<td>125.04</td>
<td>272.47</td>
<td>309.74</td>
</tr>
<tr>
<td>Euro Area</td>
<td>137.04</td>
<td>127.45</td>
<td>112.60</td>
<td>105.11</td>
</tr>
</tbody>
</table>

Notes: Loan-to-deposit ratios of the seven largest banks in Scandinavia and an average of the banks in the Euro Area. Source: FactSet Fundamentals & ECB.

Fig. 4 presents the household debt in the Scandinavian countries. Denmark has the highest degree of household debt compared to Sweden and Norway. However, the Danish indebtedness seems to be in a declining trend, whereas the Swedish and Norwegian is rising. Comparing the Scandinavian household debt with, for instance, the US or Euro area, the Scandinavian indebtedness is greater. As of 2017, the household debt as percentage of disposable income in the
US and Euro area were 109 and 113, respectively (OECD, 2019). As a result, the Scandinavian households are more vulnerable to increases in the interest rate and adverse shocks in the economy.

![Graph showing Scandinavian household debt](image)

**Fig. 4.** Scandinavian household debt. Notes: Household debt as a percentage of net disposable income 2005-2017. Source: OECD (2019).

Not only do the banks have large market shares, they are also interconnected with each other within the Scandinavian countries. According to the Swedish Riksbank (2018), the four Swedish banks are closely interconnected, as they have exposure to one another in the form of covered bonds, which they issue and purchase from each other. The same complication arises within the Scandinavian market as both Danish and Norwegian banks also issue covered bonds. The banks’ assets are therefore heterogeneous, with exposure to the housing market and commercial property market. As there are only a handful of large banks in Scandinavia, there are fewer possible counterparties in the interbanking market (Blåvarg and Nimander, 2002). Few banks in a system is problematic since it increases the risk of financial problems spreading to other systems. Spillovers to the Scandinavian market are mostly from the other countries within the Nordics, but also from other advanced economies. According to the IMF (2013), the largest spillover emitter to the countries in the Nordics is Sweden due to its size and importance to the economy in the region.
3. Literature review

In the field of our paper explaining how the Scandinavian banking system is affected by different types of uncertainty such as economic policy, financial, geopolitical and housing market, we have assembled relevant literature on the topic. The literature review is composed by the types of uncertainties we chose to study, the importance of systemic risk and how it is measured, the markets interconnectedness and spillover effects.

3.1 Economic policy uncertainty and Geopolitical risk

Recently, different measures of uncertainty have gained increased interest, for example the Economic Policy Uncertainty index (EPU) developed by Baker et al. (2016). By collecting data from eleven US newspapers, EPU has made it possible to empirically connect heightened levels of uncertainty to negative economic effects. Following the paper of Baker et al. (2016), one study using the same methodology is Caldara and Iacoviello (2018) who study geopolitical risk (GPR). They conclude that an increase in geopolitical risk is followed by a decrease in economic activity, stock return and capital flows. Both EPU and GPR have proven useful for policymakers and investors as uncertainty has an impact on the real economy. Market uncertainty is the focus of a study by Uribe et al. (2017), who find a relationship between share prices and equity market uncertainty by applying a dynamic factor model with quantile regression on 222 financial institutions. The key finding of their study is that equity market uncertainty has a positive impact on the systemic bank risk. In order to investigate the public responses to new economic information, Soroka (2006) studies peoples’ reactions to positive and negative media coverage applying an OLS approach. The author finds that the responses are asymmetric as the public responses to negative economic information are much greater than the responses to positive information.

3.2 Economic risk and measurements

After the financial crisis, researches have been developing models to measure systemic risk. Brownless and Engle (2012) propose SRISK1 as a measurement for possible capital shortage given a firm’s degree of leverage. Their study shows that several US financial firms were in a risk zone prior to the financial crisis, with several of the troubled institutions during the crisis being detected by the SRISK model. Using the same methodology studying 196 European financial firms, it was concluded that the systematic risk borne by European institutions was larger than the equivalent for the US (Engle et al., 2014). Engle et al. (2014) find that among the European institutions being considered “too big to be saved”, were the Scandinavian banks Nordea and Danske Bank. Another possible measurement is Tail-Event driven NETwork (TENET) by Härdle et al. (2016). The measure is a continuation of the CoVaR model of Adrian and Brunnermeir (2008), where a semiparametric quantile regression framework, that also considers non-linearity and variable selection is modelled. As Adrian and Brunnermeir’s (2008) model only is built for bivariate analysis, a more complete model is needed. Thus, the TENET model is created to be able to consider more variables. As measured with the TENET model, when both uncertainty and financial stress increase, the level of interconnectedness increases (Härdle et al., 2016; Wang et al., 2018). Moreover, by measuring social connections for close to 100 banks, Houston et al. (2018) conclude that higher connectedness can lead to better information flows, but at the same time it can

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1 Defined as expected capital shortfall during a prolonged market downturn.
contribute to increased systemic risk. Increases in the level of interconnectedness lead to increased systemic risk since connected banks are more likely to operate similarly and partner together for syndicated loans\(^2\). These studies show that when diversity is needed the most, markets tend to converge and become more connected.

As one would expect, global financial crises increase the systemic bank risks (Black et al., 2016; Rivera-Castro et al., 2018). A reason for this can be asymmetric effects, which has been studied by Choudhry and Jayasekera (2012; 2014a; 2014b). Using a Generalized Autoregressive Conditional Heteroskedasticity (GARCH) approach, they find that during the recent global financial crisis, the beta of the banks’ stocks rose and spillovers in terms of return and volatility between countries increased. However, studying capital mobility within and outside the European union, Choudhry et al. (2014) apply the Feldstein-Horioka\(^3\) coefficient and show that the capital mobility decreased entering the crisis. This contradicts research finding that financial crises in general increase the level of integration on the financial market.

**3.3 Interconnectedness and interbanking**

To study the effect of interconnectedness, researchers have started to use interbanking and other form of asset similarities as explanatory factors when measuring risk. Calomiris and Carlson (2017) show that the interbank market is beneficial for the included parties in good times, while in bad times, it creates a way of transmitting instability. By studying European banks with network analysis Gabrieli and Salakhova (2019) conclude that when banks reduce their interbank positions, the contagion losses decrease. Tonzer (2015) studies cross-border interbanking and finds that foreign exposure could decrease risk if linked to a stable counterparty, and reversely, being linked to a more unstable banking system could worsen the stability in the home country. Moreover, an increased exposure in foreign banking systems increases the risk of contagion losses. Studying the relationship between banking crisis and financial integration, Caballero (2015) use syndicated loans of 8,525 banks to measure connectedness and thereafter applies a generalized linear model. The paper finds that the level of financial connectedness between banks is positively associated with systemic banking crises. Positively, a higher level of interbanking can spread economic booms and welfare between geographical locations. However, negative contagion effects such as economic crises are more likely to spread faster and more extensively. In case of a default, the greater importance of the bank, the greater systemic loss. Betz et al. (2016) study the factors contributing to increased systemic risks and find that systemic importance is positively associated with size, leverage and interconnectedness. Kosmidou et al. (2017) study information asymmetry factors and network characteristics and their importance in prediction of idiosyncratic bank risks. They find that centrality in a network is negatively associated with risk, while information asymmetry\(^4\) is positively related to idiosyncratic bank risk.

Furthermore, Diebold and Yilmaz (2009; 2012) have developed a measurement for estimating return and volatility spillovers, that has been widely used in the contagion literature (see, among others, Diebold & Yilmaz, 2014, Barunik et al., 2016 and Zhang, 2017). In their initial paper, Diebold and Yilmaz (2009) introduce a method to calculate return and volatility spillovers. This is

\(^2\) A syndicated loan is a loan offered by a group of lenders to a single borrower.

\(^3\) A methodology used to study the relationship between domestic savings and domestic investments. A higher correlation between I and S implies less financial integration. See Feldstein and Horioka (1980).

\(^4\) Proxied by opacity (financial transparency).
done by VAR modelling and with focus on variance decomposition of the forecast errors. The variance decomposition makes it possible to examine what error variance in forecasting one variable is due to shocks in itself and due to shocks in other variables. Studying volatility spillovers in the US stock, bond, commodity and FX market between 1999 and 2010, the authors find that the largest aggregated directional spillovers are from the bond market. However, Diebold and Yilmaz (2012) conclude that, during the financial crisis, the significantly largest directional volatility spillovers are from the stock market.
4. Theoretical framework

4.1 Transmission of shocks

The theory of spillovers and previous research that has been done on the subject of financial connectedness and contagion, outline several mechanisms that explain the phenomena of shocks transmitting from one market to another. Longstaff (2010) identify three different theoretical explanations in terms of contagion. The first one is that contagion is equated with the transmission of bad economic news. When negative shocks hit one market, agents on other markets interpret this as new economic information, which in turn affect those other markets. This transmission mechanism theory implies that the market initially afflicted by the shocks, is the one with a more rapid price discovery process. The second theoretical explanation focuses on liquidity constraints and the occurrence of flight to quality. It states that when investors experience losses in their portfolios, their capability of acquiring new capital is reduced. This can in turn lead to an illiquidity shock in all markets due to investors shifting their capital towards safer investments, i.e. flight to quality. The last theoretical approach identified by Longstaff (2010) describes contagion as change in risk premium. This theory suggests that in case of negative shocks in one market, investors acting on other markets will require higher risk premiums and the returns will decline. One could argue that the two latter theoretical explanations complement each other. As the risk premium increase, meaning that investors are becoming more risk averse, the demand for less riskier assets will increase and the flight to quality emerges.

To explain the impact of liquidity shocks, Allen and Gale (2000) develop a microeconomic model to examine the presence of financial contagion. An assumption in the model is that there are three types of liquid assets, namely short assets, interregional holdings and long assets. When banks face increasing liquidity demands they will first sell off short assets, followed by interregional holdings and lastly, sell off long assets and accumulate losses. For example, if region A has met the consumers demand for liquidity, region A will lend liquidity to region B who might have higher demand. In the next time period, the demand for liquidity could change and the previous lender A requires more liquidity and borrower B requires less. Accordingly, the regions are willing to reverse their holdings as their preferences changed. There can only be a certain amount of liquidity in the market and as long as everyone’s liquidity needs are met the system works well. If consumers’ demand for liquidity is higher than the aggregated liquidity, the only way for regions to acquire liquidity is by liquidating their long assets, which is costly. If the region instead has interregional holdings, they can choose to liquidate those. However, this does not increase the total liquidity in the market, it just withdraws liquidity from one region to another, which can lead to bankruptcy. Therefore, the model shows that a small shock to liquidity preferences in one region has the possibility to transfer to other regions through contagion as regions liquidate long assets as a last resort.

4.2 Economic uncertainty

Knight (1921) makes a distinction between risk and uncertainty. He believes that a risk can be given a quantifiable probability while uncertainty is our incapability of predicting events. Almost a century later, Bloom (2009) finds that economic and political uncertainty shocks are highly associated with stock market volatility. Selecting 17 economic and political shocks between 1962 and 2008, the

---

5 Among others, JFK assassination, Black Monday and 9/11.
paper demonstrates that during these events, the stock market volatility is increasing. Using the stock market volatility as proxy for uncertainty, Bloom (2009) finds that an uncertainty shock is followed by drop and rebound in economic activity in the following six months and thereafter a milder long run overshoot. The author argues that the decline in economic activity arise because when an uncertainty shock occurs, employers delay their hiring processes and investors pause their investments.

Ilut and Schneider (2014) propose a theoretical explanation to why investments and employments decline during times of uncertainty. The paper argue that uncertainty makes agents on the market lose confidence and the ability to shape an appropriate probability distribution. The lack of confidence makes the agents pessimistic about the future and they start assuming the worse, putting a stop on hiring and investing. Bansal and Yaron (2004) present a model where uncertainty is associated with a decline in consumption due to an increase in precautionary savings. In the short run, this mechanism leads to a decrease in growth rate. However, since the savings increase, the boost in investments can result in an increased growth rate in the long run. Be that as it may, Fernández-Villaverde et al. (2011) argue that, in small open economies, the increase in uncertainty results in a higher share of investments flowing abroad. In such case, the long run effect of an increase in investments is limited.

4.3 Portfolio theory

Markowitz (1952) was the first to establish the concept of portfolio diversification. The main principal of modern portfolio theory (MPT) is to maximize the potential return given a certain level of risk. By measuring variance and correlation, a portfolio can be constructed to achieve higher returns at a lower level of risk than individual assets. A combination of different asset classes is therefore more diversified than a portfolio containing one single asset class. The concept of MPT is important in the context of our paper, since investors that are looking for diversification possibilities need to be aware of the possibility of spillover effects. Idiosyncratic shocks to one bank stock within the sector are inevitably affecting the others in the system. Therefore, it is of importance for investors to be conscious of the spillovers of all other variables in the system to the stock of interest to attain the highest return to risk.
5. Methodology

In this chapter we describe the methodology used to satisfy the objective of the thesis and answer our research questions. To summarise, we begin by applying several unit-root tests in order to conclude that all our variables are stationary and suitable for time series analysis. For a few of the uncertainty measurements, there are no suitable indices and for these we model GARCH processes and extract the residuals. We proceed with the spillover index of Diebold and Yilmaz (2009; 2012; 2014) by identifying the VAR(1) model and then apply the generalized variance decomposition method created by Koop et al. (1996) and Pesaran and Shin (1998) with a forecast horizon of three months. The results of the spillover analysis are summarised by the variance decomposition in pairwise connectedness in “To” and “From” format, where spillovers emitted and received are presented. We follow up the spillover index by applying ForceAtlas2 by Jacomy et al. (2014) in the visualisation software Gephi. This approach makes it possible to illustrate the connectedness within the system graphically. At last, we apply quantile regressions in order to investigate the dynamics of the relationship between uncertainty and the Scandinavian banks.

5.1 Stationarity

In time series econometrics, stationarity is a fundamental concept to produce models with robust result and to avoid spurious regression. To avoid the problem of spurious regression we apply an Augmented Dickey-Fuller test (ADF) and Philips-Perron test (P-P) to test the variables for the order of integration (Dickey and Fuller, 1979; Phillips and Perron, 1988). The ADF-test is shown in equation (1) with an intercept and in equation (2), using intercept and trend.

\[
\Delta y_t = \alpha + \delta y_{t-1} + \sum_{i=1}^{k} \theta \Delta y_{t-i} + \varepsilon_t
\]

\[
\Delta y_t = \alpha + \beta \bar{t} + \delta y_{t-1} + \sum_{i=1}^{k} \theta \Delta y_{t-i} + \varepsilon_t
\]

Where \( y_{t-1} \) is the lagged dependent variable, \( \Delta \) a first order operator, \( \alpha \) an intercept and \( \bar{t} \) is the deterministic trend. The null hypothesis of the tests is \( \delta = 0 \), that is, if \( \delta \neq 0 \) we can reject the null hypothesis and the series does not have a unit root. The Phillips-Perron’s test follows the same principal as the ADF-test, but instead uses a non-parametric adjustment of the t-statistic so it can be used in cases where the residuals are not white noise (Sjö, 2019). We also perform Zivot-Andrew (1992) unit root tests, which allows for a structural break in the intercept and trend.

5.2 Generalized autoregression conditional heteroskedasticity

One of our variables, financial uncertainty, is a volatility measurement usually based on the implied volatility of live listed options of a certain stock index. There is, however, no similar index for the Scandinavian market and because of this we must create our own. The same problem arises with the housing market indices. Given that the methodology to compute an index based on implied volatility is too time consuming, we calculate a Scandinavian volatility index by modelling a GARCH process and extracting the residuals. The two methodologies differ in their nature due to implied volatility index being a forward-looking measurement, whereas the GARCH process is backwards looking on a historical time series. We do, however, find that the GARCH process is an adequate uncertainty proxy for our needs.
The GARCH model was first introduced by Bollerslev (1986) as a generalized version of Engle (1982) Autoregressive Conditional Heteroskedasticity (ARCH) model. ARCH is a model that describes the variance of a time series that changes systematically. Since the ARCH model follows the Autoregressive Integrated Moving Average (ARIMA) process, a time period of high variance will be followed by periods of higher variance. Similarly, if the time period $t$ has low variance, the following period $t+1$ will also have low variance as it is based on the previous time period. Therefore, graphically an ARCH model will exhibit clustering periods of low and high volatility. As an example of this, our GARCH model of the local financial uncertainty shows signs of clusters of increased volatility after the financial crisis. The GARCH(1,1) process is described by equation (3) and (4).

$$\sigma_t^2 = \beta x_t + \varepsilon_t \sim D(0, h_t) \quad (3)$$

$$h_t = \omega + \alpha_1 \varepsilon_{t-1}^2 + \beta h_{t-1} \quad (4)$$

Where equation (3) is the mean equation and equation (4) is the variance equation. Together they form the GARCH model and must be estimated at the same time (Sjö, 2019). Importantly, the sum of $\alpha$ and $\beta$ must be $<1$ because of the condition of being mean reverting. To estimate our best fitting model, we also use the modified version of the ARCH, the GJR-GARCH by Glosten et al. (1993). This model considers the asymmetric impact of positive and negative shocks, where negative shocks have a larger impact. Equation (5) and (6) describes the GJR-GARCH(1,1) process,

$$\sigma_t^2 = \beta x_t + \varepsilon_t \sim D(0, h_t) \quad (5)$$

$$h_t = \omega + (\alpha_1 + \gamma_i I_{t-1}) \varepsilon_{t-1}^2 + \beta h_{t-1} \quad (6)$$

where $\gamma_i$ is included to account for the larger impact of negative shocks and where $I_{t-1}$ equals 0 for positive and 1 for negative shocks. Worth mentioning is that both local financial and housing uncertainty has GJR-GARCH(1,1) specifications. This implies that the best fitted GARCH models for these indices account for asymmetric volatility. Accordingly, for local financial and housing uncertainty, the effect of negative news has a larger impact than those that are positive.

5.3 Spillover methodology

To create the spillover index of Diebold and Yilmaz (2014) through variance decompositions it is necessary to first estimate a vector autoregressive (VAR) model. The VAR model, introduced by Sims (1980), is a stochastic process model which captures the dependence between time series. The VAR is built upon the univariate autoregressive moving average (ARMA) model but allows for multivariate models. The problem with a structural model is the requirement of assumptions of economic theory to create a good model, which makes a reduced form preferred. Therefore, from the structural model the reduced form of VAR can be calculated. An example of a reduced VAR(1) between the returns of Nordea and SEB can be defined as follows,

$$Nordea_t = \pi_{10} + \pi_{11}Nordea_{t-1} + \pi_{12}SEB_{t-1} + \varepsilon_{1t} \quad (7)$$

$$SEB_t = \pi_{20} + \pi_{21}Nordea_{t-1} + \pi_{22}SEB_{t-1} + \varepsilon_{2t} \quad (8)$$
where $\varepsilon_{1t}$ and $\varepsilon_{2t}$ are white noise processes and $\pi$ are parameters of the model (Sjö, 2019). In matrix form Equation 7 and 8 can be rewritten to Equation 9.

$$
\begin{bmatrix}
\text{Nordea} \\
\text{SEB}
\end{bmatrix} =
\begin{bmatrix}
\pi_{10} \\
\pi_{20}
\end{bmatrix} +
\begin{bmatrix}
\pi_{11} & \pi_{12,t-1} \\
\pi_{21} & \pi_{22,t-1}
\end{bmatrix} +
\begin{bmatrix}
\varepsilon_{1t} \\
\varepsilon_{2t}
\end{bmatrix}
$$

(9)

To simplify further, the above VAR(1) of Nordea and SEB can be rewritten as $x_t = \phi x_{t-1} + \varepsilon_t$, where $\phi$ is the $2 \times 2$ matrix. Following this, the prediction of the future value in $t+1$ for the VAR becomes

$$
x_{t+1,t} = \phi x_t
$$

(10)

The 1-step ahead error forecast is therefore simple to see, as it is the difference between the actual value $x_{t+1}$ and the prediction of the future value $x_{t+1,t}$.

$$
e_{t+1,t} = x_{t+1} - x_{t+1,t} = A_0 u_{t+1} =
\begin{bmatrix}
\pi_{11} & \pi_{12} \\
\pi_{21} & \pi_{22}
\end{bmatrix} u_{t+1}
$$

(11)

Equation 11 then has the covariance matrix,

$$
E(e_{t+1,t} e_{t+1,t}') = A_0 A_0'
$$

(12)

In the case of the VAR(1) of Nordea and SEB, the $A_0 A_0'$ matrix is

$$
A_0 A_0' =
\begin{bmatrix}
\pi_{11} & \pi_{12} \\
\pi_{21} & \pi_{22}
\end{bmatrix}
\begin{bmatrix}
\pi_{11} & \pi_{12} \\
\pi_{21} & \pi_{22}
\end{bmatrix} =
\begin{bmatrix}
\pi_{11}^2 + \pi_{12}^2 & \pi_{11} \pi_{21} + \pi_{12} \pi_{22} \\
\pi_{21} \pi_{11} + \pi_{22} \pi_{12} & \pi_{21}^2 + \pi_{22}^2
\end{bmatrix}
$$

(13)

The variance in the 1-step ahead variance is therefore the diagonal of the covariance matrix. Meaning that for Nordea, the 1-step ahead variance is $\pi_{11}^2 + \pi_{12}^2$ and for SEB $\pi_{21}^2 + \pi_{22}^2$. With the variance decomposition, we can see the amount of forecast error variance a specific shock to the system adds. To clarify what the 1-step ahead variance is we can go back to Equation 7 and 8. A shock to Nordea will have spillovers to SEB in the form of $\pi_{21}^2$ and a shock to SEB will transfer to Nordea from $\pi_{12}^2$. Therefore, the total amount of spillovers between the two banks in our example is $\pi_{12}^2 + \pi_{21}^2$. Together with the total forecast error variance, $\pi_{11}^2 + \pi_{12}^2 + \pi_{21}^2 + \pi_{22}^2$, we can create a spillover index as a percentage of the total forecast error variance. As an example, the spillovers between Nordea and SEB as a percentage of total forecast error variance becomes

$$
S = \frac{\pi_{12}^2 + \pi_{21}^2}{\pi_{11}^2 + \pi_{12}^2 + \pi_{21}^2 + \pi_{22}^2} * 100
$$

(14)

A general formula of Equation 14 can be written as,

$$
S = \frac{\sum_{h=1}^{H-1} \sum_{i,j=1}^{N} a_{h,i,j}^2}{\sum_{h=1}^{H-1} \text{trace}(A_h A'_h)} * 100
$$

(15)

where p-order VAR with N-variables, using h-step ahead forecasts and $\text{trace}(A_h A'_h)$ is the total forecast error variance.

In order to understand the origin of the shocks, the VAR model needs to be identified, otherwise it is impossible to separate shock coming from a specific variable. One way to achieve the identification is through the Cholesky decomposition, in which an upper diagonal triangular matrix is created with zeroes (Sims, 1980). Since consecutive shock in the systems do not affect each other,
the approach is sensitive to ordering. To analyse the spillover effects of different uncertainty shocks to the Scandinavian banking sector, we therefore apply the generalized variance decomposition (GVD) method of Diebold and Yilmaz (2014). The GVD approach was first introduced by Koop et al. (1996) and Pesaran and Shin (1998). As explained by Diebold and Yilmaz (2014) the GVD is indifferent of ordering, which in this case favours the use of the GVD approach over the Cholesky decomposition. The GVD approach works by introducing a similar shock to all variables in the system, therefore it works well with our goal to examine the effect of a shock from a specific uncertainty measurement to the banks. This will in turn give more robust results and it also removes the decision of ordering, while also making it possible to analyse the simultaneous interactions of the shocks as seen by Equation 16.

\[
d^{\text{gh}}_{ij} = \frac{\sigma_{jj}^{-1} \sum_{h=0}^{H-1} (e_i' \theta_h \sum e_i)^2}{\sum_{h=0}^{H-1} (e_i' \theta_h \sum e_i)^2} \tag{16}
\]

Where \( e_{ij} \) is the selection vector for the \( ij \)-th element, \( \theta \) is the coefficient matrix, \( \Sigma \) is the covariance matrix of the shock in the non-orthogonalized VAR and \( \sigma_{jj} \) is the \( jj \)-th element of \( \Sigma \). The GVD approach allows us to analyse the spillover from Nordea to SEB. As described by Diebold and Yilmaz (2014), the aforementioned pairwise spillover effect from Nordea to SEB is defined as \( C_{\text{nds-seb}} \). Further, the net spillover effects between two banks is defined by \( C_{h} = C_{i\rightarrow j} - C_{j\rightarrow i} \). The spillover effects from one bank to all others is defined as \( C_{\rightarrow *} \). Finally, the total net spillover effects between one bank and the rest of the market is defined as \( C_{h} = C_{i\rightarrow *} - C_{*\rightarrow i} \). This carries important information as we can identify the spillover effects of systemically important banks such as Nordea to other actors in the market, as well as from different uncertainty shocks.

A way to examine the change in connectedness within the sample over time is to include a rolling sample estimation. By tracking the most recent observations as a window with the parameter \( w \), we can see the real-time changes over time for the sample. As such, we are not looking at the entire sample, but a sub-sample within the sample, which is rolling over time.

In the model there are therefore three input parameters, firstly the \( h \)-step forecast, secondly the lag length \( p \) of the VAR model and thirdly, for the rolling sample, the rolling sample window \( w \) is included. The \( h \)-step forecast is set to three as it is likely to be a short to medium relationship, while the lag length of the VAR model is decided by the optimal lag length from the Akaike information criterion (AIC). However, we also conduct several robust tests where we change the \( h \)-step and lag length. For the rolling sample window \( w \), the parameter can be chosen arbitrarily, with restriction to the sample size due to the amount of degrees of freedom.

5.4 Network analysis

In our network analysis, we apply the ForceAtlas2 algorithm of Jacomy et al. (2014) in the visualisation software Gephi. By using the pairwise directional connectedness obtained from our spillover index created from the methodology of Diebold and Yilmaz (2014), we can visualise the connectedness within the system. This is done by calculating nodes and edges, describing the pairwise connectedness for our banks and uncertainty measurements. By including \( k \) number of variables, each variable will have \( k-1 \) edges. As such, for the entire system there will be \( k^2-k \) edges, since pairs to the own node are of no use. The level of one pairwise directional connectedness,
meaning the spillovers from one variable to another $C_{i\rightarrow j}$, is illustrated by edge size and edge colour. The node size is determined by the banks’ total assets and their colour represents the aggregated emitted spillovers, $C_{i\rightarrow*}$. As explained by Jacomy et al. (2014), a node’s position cannot be examined on its own, it has to be interpreted together with other nodes to understand its placement. As the algorithm is based on a continuous algorithm, the program runs indefinitely until the user cancels the program. As such, the nodes continue to repel from each other while the links attract the nodes. All the information seen in the network analysis is derived from the information of total assets and the variance decomposition, and do therefore not show any new information. It does, however, help to visualise the connectedness within the system in a comprehensive way.

5.5 Quantile regression

To further explore how uncertainty causes spillover effects to the Scandinavian banks, we apply panel quantile regression. The methodology of quantile regression was first introduced by Koenker and Basset (1978) and is used to split the dependent variables distributions into quantiles. We choose to apply it as it is of interest to our study to show how the relationship between return and uncertainty changes dependent on the distribution of the returns. This is important as a regular OLS regression only estimates the relationship based on the conditional mean and it may not necessarily tell the whole story. Applying the quantile approach after the Diebold Yilmaz (2014) methodology strengthens our ability to interpret the impact of uncertainty. From the Diebold Yilmaz (2014) approach, we know that uncertainty shocks transmit to the banking sector. However, we cannot declare whether the relationship is positive or negative and in which periods the spillovers actually appear. By applying quantile regressions, we can establish the relationship and if the impact of uncertainty on banks is greater in times of market upswings or downswings. The quantile regression can be defined as follows,

$$Y_{it}(\tau|Y_{i,t-1},UM_t,UM_{t-1},X_t,X_{t-1}) = a_0 + a_1 Return_{it-1} + a_2 UM_t + a_3 UM_{t-1} + a_4 X_t + a_5 X_{t-1} + a_6 u_{it}$$

where $Y_{it}$ is a panel of the returns of the Scandinavian banks, $\tau$ is the conditional quantiles, $UM_t$ is a vector of our uncertainty measurements, $X_t$ are different control variables for the regression and $u_{it}$ is a vector of the residual. We include lagged variables in the model and we estimate three models with local, regional and global uncertainty, respectively. Including lags in the regression provides more information and it is of interest to capture the dynamic of the impact of uncertainty on the banks.
6. Data and preliminary analysis

The data consists of two parts, firstly stock data of the major seven Scandinavian banks and secondly, uncertainty indices that are split into four categories. These categorizes are economic policy uncertainty, geopolitical uncertainty, financial uncertainty and housing market uncertainty. All indices that are denominated in a currency are transformed to US Dollar to make a comparison possible. The data consists of 167 monthly observations, covering the period January 2005 to November 2018. The main reason for the selection of time period is the housing market indices that do not go further back in time, which has limited our available data. However, with the chosen time period, we capture the spillovers during the global financial crisis and European sovereign debt crisis.

The Scandinavian banking stock data is collected from Thomson Reuters Datastream and the observations are the closing prices of the last day of the month. The banks included are the seven largest in terms of balance sheet, which are the Swedish banks Swedbank (SWD), Nordea (NDS), SEB and Svenska Handelsbanken (SHB), the Norwegian bank DNB and, the Danish banks, Danske Bank (DAB) and Jyske Bank (JYS).

Fig. 5 shows the evolution of the banks’ stock prices. Not surprisingly, there are steep declines during the global financial crisis and milder declines 2010-2012, which could be a result of the European sovereign debt crisis. Additionally, Svenska Handelsbanken appears to show lower volatility during the economic turmoil in 2007-2008 as well as during European sovereign debt crisis. This is also confirmed by Fig. 6 and the overall standard deviation presented in Table 3.

Fig. 5. Development of stock prices in US dollar 2005-2018.
Table 3 presents summary statistics and unit root tests of our data. From the stock return data, we can conclude that all the banks have positive returns during the time period, except Danske Bank, which could be attributed to the money laundering scandal in September 2018. The stock return series are leptokurtic and neither of our log returns are normally distributed, as confirmed by the Jarque-Bera tests. The leptokurtic distribution implies that the return data consists of outliers and is characterized by “fat tails”. Furthermore, the Augmented Dickey-Fuller (ADF) and Phillips-Perron (P-P) tests indicates that all returns are stationary. We also perform Zivot-Andrew unit root tests, which allows for a structural break in the intercept and trend. The result is consistent with the ADF and P-P and tests and the log returns remain stationary at the significant level of 1%.

As mentioned previously, we have four different types of uncertainty indices, economic policy uncertainty (EPU), geopolitical risk (GPR), financial uncertainty (VIX) and housing market uncertainty (HXV). Concerning economic policy uncertainty, we have a global one (EPUg) which is a GDP-weighted index based on 20 national EPU indices. A regional one (EPUe), which is a measure of the economic policy uncertainty in Europe based on 10 newspapers from Germany, United Kingdom, France, Italy and Spain. Lastly, a Swedish one (EPUs), which is used to represent the local economic policy uncertainty in Scandinavia based on four major newspapers. GPR measures geopolitical tensions from 11 major international newspapers (Caldara and Iacoviello, 2017). The EPU indices and GPR are created with the same methodology, developed by Baker et al. (2016) and are collected from their website http://www.policyuncertainty.com/. Regarding GPR, only a global index exists, which is why no regional or local GPR index is included.

Regarding financial uncertainty we follow the same structure as for the EPU indices, meaning that we aim to measure global, regional and local financial uncertainty. The CBOE VIX (VIXg) is a volatility index based on prices of options in the S&P 500 index and is therefore a measure of the
market's expectations of future volatility. VIXg is used to represent global financial uncertainty as the US can be viewed as the driving economy in the global market. The corresponding European VSTOXX (VIXe) is included to capture the uncertainty on the regional financial market. Both of these indices are collected from Thomson Reuters Datastream. To assess local financial uncertainty (VIXs), we use OMXSPI to calculate our own volatility index. OMXSPI is an index based on all stocks on Stockholm Stock Exchange and is also collected from Thomson Reuters Datastream. We use a Swedish one since Sweden can be seen as a proxy for the entire market as they are the largest net-transmitter of risk to other countries in the Nordic (IMF, 2013).

Housing market uncertainty includes a global, a regional and a local index. To assess the Global housing market, we use the US Housing price index S&P/Case-Shiller U.S. National Home Price Index. The British UK Nationwide Monthly Average House Price Index represents regional housing market. These two indices are collected from Thomson Reuters Datastream. Local housing market is proxied by the Swedish housing price index NASDAQ OMX Valueguard-KTH Housing Index Sweden, collected from Valueguard. Global (HXVg), regional (HXVe) and local (HXVs) housing market uncertainty is estimated by using the three aforementioned indices, applying GARCH processes.

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6 https://valueguard.se
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<th>Std.Dev</th>
<th>Skewness</th>
<th>Kurtosis</th>
<th>Jarque-Bera</th>
<th>ADF(c)</th>
<th>ADF(ct)</th>
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<th>P-P(ct)</th>
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<td>EPUs</td>
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<td>-0.323</td>
<td>2.687</td>
<td>3.482</td>
<td>-6.304(0)***</td>
<td>-8.545(0)***</td>
<td>-6.061***</td>
<td>-8.943(0)*** [Jun2011]</td>
<td></td>
</tr>
<tr>
<td>GPR</td>
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<td>0.414</td>
<td>0.622</td>
<td>2.680</td>
<td>11.456***</td>
<td>-5.174(0)***</td>
<td>-6.550(0)***</td>
<td>-4.814***</td>
<td>-6.476***</td>
<td>-8.919(0)*** [Mar2014]</td>
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<td>3.673</td>
<td>28.819***</td>
<td>-3.827(0)***</td>
<td>-3.962(0)***</td>
<td>-3.527***</td>
<td>-3.672**</td>
<td>-6.097(0)*** [May2009]</td>
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<td>-2.985(1)</td>
<td>-3.039**</td>
<td>-3.290*</td>
<td>-6.056(1)*** [Sep2008]</td>
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<td>HXVg</td>
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<td>-9.630***</td>
<td>-9.625***</td>
<td>-10.470(0)*** [Jan2009]</td>
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Notes: Number of lags are written in parenthesis and chosen with the Schwarz information criterion with the maximum of 13 lags. *, ** and *** represents significant level of 10%, 5% and 1%, respectively. Sources: SWD, NDS, SEB, SHB, DNB, DAB & JYS are collected from Thomson Reuters Datastream. EPUg, EPUe, EPUs & GPR are collected from http://www.policyuncertainty.com/. VIXg, VIXe & VIXs (OMXSPI) are collected from Thomson Reuters Datastream. HXVg (US Housing price index S&P/Case-Shiller U.S. National Home Price Index), HXVe (British UK Nationwide Monthly Average House Price Index) are collected from Thomson Reuters Datastream. HXVs (NASDAQ OMX Valueguard-KTH Housing Index Sweden) is collected from https://valueguard.se.
Fig. 7 shows graphs of the uncertainty indices. All data are in natural logarithms, except VIXs, HXVg, HXVe and HXVs, which are in log returns. Although there are different methodologies to the indices, we can see a spike in uncertainty for the economic policy uncertainty as well as financial uncertainty during the financial crisis of 2008. A spike can also be seen for the US credit rating drop of 2011 and the European sovereign debt crisis. Meanwhile, for the log return series VIXs, HXVg, HXVe and HXVs we can observe greater volatility during 2008. However, the volatility seems to be greater in the Swedish stock market than in the housing market, which is also confirmed by the larger standard deviations, presented in Table 3.

![Graphs of uncertainty indices](image)

**Fig. 7. Development of uncertainty indices.** Notes: EPUg, EPUe, EPUs, GPR, VIXg and VIXe are presented in their natural logarithm. VIXs, HXVg, HXVe and HXVs are presented in log returns.

As presented in Table 3, the skewness tests show varying results among the uncertainty indices. The kurtosis coefficients are 3 or above for VIXg and VIXs, as well as for HXVe and HXVs. This means that they are leptokurtic and the Jarque-Bera tests confirm that neither of the indices are normally distributed. The high kurtosis of VIXs can be explained by the fact that it is the log return of OMXSPI, and therefore comparable with the banks’ returns. Worth noting is the relatively high mean value of HXVs, 0.5%, indicating that the Swedish house prices have, on average, increased
with 6% each year from 2005 to 2018. The unit root tests show us that all uncertainty variables are stationary. However, the ADF test including only intercept gives us an inconclusive result regarding EPUe. By including trend in the ADF test we receive a significant result indicating that EPUe is stationary. It could be argued that inclusion of trend in the ADF test is the proper approach considering that uncertainty, as it is measured by the EPU indices, is likely to be trending. Even so, including only intercept in the P-P test, EPUe concludes to be stationary at level. This is also confirmed by allowing for breaks performing the Zivot-Andrew unit root test and by studying the partial autocorrelation function (PACF)\(^7\). The PACFs indicate that all our uncertainty measures are stationary since no first lags is significant and close to one (Sjö, 2019).

The four uncertainty indices, VIXs, HXVg, HXVe and HXVs, that are created by applying a GARCH-approach are presented in Fig. 8. There are smaller movements in these indices compared to VIXg and VIXe, which are instead based on implied volatility. However, like VIXg and VIXe, these indices show the fluctuations during the global financial crisis. The VIXs index and the HXV indices demonstrate the uncertainty that followed the European sovereign debt crisis. Furthermore, comparing the local indices VIXs and HXVs, HXVs is showing significantly larger increases in uncertainty after the global financial crisis.

Several interesting observations can be made by studying the correlation heatmap presented in Fig. 9. As one would expect, regarding the stock return data, there are higher correlations within the Swedish banking sector than between the Swedish banks and the Norwegian and Danish banks

\(^7\) See Appendix I, Fig. 18.
DNB, Danske Bank and Jyske Bank. Judging by the correlation matrix, Jyske Bank is slightly less correlated with the other Scandinavian banks. The reason for this could be that Jyske Bank operate on a smaller market, whereas the other banks operate in the entire Scandinavia. Moreover, regarding the correlation between the stock returns and the uncertainty variables, the correlation is negative or close to zero in all interrelations. This implies that as the uncertainty increases, the banks’ returns generally fall or remain the same.

Economic policy uncertainty and financial uncertainty have strong correlations between the local, regional and global level, which is to be expected. However, regarding the economic policy uncertainty and the financial uncertainty indices, the correlation between global and regional is stronger than between local and global. Moreover, geopolitical risk is shown to have a positive but low correlation with economic policy uncertainty and a negative correlation with financial uncertainty. Regarding housing market uncertainty, the regional and global is positively correlated, while local uncertainty has low correlation with HXVg and HXVe. A low correlation among the housing market uncertainty indices can be explained by the fact that we use national house market indices as proxy for the global, regional and local market. Considering that the housing market is not as globally integrated as the financial market due to its larger dependency on local idiosyncratic factors.

Fig. 9. Unconditional correlation in full data sample

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8 See Appendix I, Table 10.
7. Empirical results and discussion

In order to get an overview of the connectedness within the Scandinavian banking sector, we start by calculating the spillovers in a sample consisting of only the banks. Secondly, we expand our samples with global, regional and local uncertainty measurements. This is to test what types of uncertainties that are more likely to cause variance in the Scandinavian banks’ returns, followed by a visualisation using network analysis. At last, we include quantile regressions to further study the relationship of uncertainties during different market conditions.

7.1 Results and analysis of spillovers

Starting with Table 4, in which the spillovers within the Scandinavian banking sector is presented. The total connectedness across the banks are 77.08%, indicating that, on average, 77.08% of the variance in one bank’s return can be explained by the variance in the other banks. Moreover, we can conclude that the amount of total assets does not seem to have a role in determining the amount of spillovers from a bank. Given the “To” column of Table 4, SEB is seen to be the biggest emitter of spillover while only amounting to about 11% of the total assets. Nordea is the second largest transmitter of spillover effects, while being the bank with the largest balance sheet with 26% of the total assets. The Norwegian and Danish banks are also the banks with the least spillovers to others, while Danske Bank and DNB are the second and third largest. Furthermore, there are high fluctuations in the total amount of emitted spillovers, ranging from 56.82% for Jyske Bank to 94.47% from SEB. Studying the directional connectedness in the “From” column, we can see that it ranges between 73.95% to 78.68% with Jyske bank being the smallest and Nordea the largest receiver. The difference is, however, not large between all the banks and there is almost no difference between the Swedish banks. When studying the net pairwise spillover, SEB to Danske Bank has the highest net pairwise directional connectedness at 5.25%. Importantly SEB can be seen having a positive net spillover effect to all other banks, meaning that it has higher spillover effects pairwise to all other banks. Conversely, Jyske Bank has a negative pairwise spillover to all other banks. None of the Swedish banks have negative net transmissions, while the Norwegian bank DNB and both the Danish banks Jyske Bank and Danske Bank have negative net transmissions. SEB, with a total net spillover at 16%, has significantly higher total net spillover than all other banks.

\[ C_{\text{SEB} \rightarrow \text{DAB}} - C_{\text{DAB} \rightarrow \text{SEB}} \]
Table 4

<table>
<thead>
<tr>
<th></th>
<th>SWD</th>
<th>NDS</th>
<th>SEB</th>
<th>SHB</th>
<th>DNB</th>
<th>DAB</th>
<th>JYS</th>
<th>FROM</th>
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<td>-2.82</td>
<td>-17.04</td>
<td>-17.13</td>
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</tr>
</tbody>
</table>

Notes: Bank sample connectedness table. The sample ranges from January 2005 to November 2018, and the predictive horizon is 3 months with a VAR(1). The FROM column gives total directional connectedness from all others. The TO row gives total directional connectedness to all others. The NET gives net total directional connectedness (to-from) to others.

Unsurprisingly, when studying the Scandinavian banks in the connectedness table, a high degree of connectedness can be observed. The Swedish banks are also seen to be more connected within the country whereas the Norwegian and Danish banks receive less spillovers from Swedish banks. As only three of the seven banks in the sample are from Norway and Denmark it is difficult to conclude that there are country specific effects. There is, however, a higher degree of connectedness between the two Danish banks, similar to the higher connectedness between the Swedish banks. As explained by Calomiris and Carlson (2017), increased interconnectedness is of importance when looking at risk.

The result suggests that the spillovers from Swedish banks are larger than those from Danish and Norwegian. Our result can therefore be connected with Tonzer (2015), who shows that interbanking is positively associated with increasing spillovers between countries. Cross-border interbanking works as a transmitter of spillovers from Sweden to Denmark and Norway following an increase in financial uncertainty. For Sweden it could however be seen as a softening effect as the cross-border interbanking leads to spreading the risk to a larger market when uncertainty increases.

Spillovers can be interpreted as transmission of economic information and in such case, the largest emitters are the banks whose stocks have a more rapid price discovery process. One would expect that this refers to larger banks and stocks with higher trading volume. Nordea is the largest bank in our sample in terms of balance sheet and highest trading volume, but it is, however, the second largest emitter of spillovers. SEB is the fifth largest bank in regard to total assets and the second most traded. Therefore, it is remarkable that SEB is the largest emitter of spillovers within the Scandinavian banking sector. Furthermore, regarding trading volume, all Swedish banks have a greater trading volume compared to the Norwegian and Danish banks, and are also greater emitters of spillovers in all samples. Moreover, a systemically important bank could be described as a larger bank with great importance to the financial sector. Hence, a negative shock in a systemically important bank should have a bigger impact on the banking sector, in comparison to a negative shock in a less systemically important bank. It is therefore noteworthy that Danske Bank, which is the second largest bank in Scandinavia in terms of total assets, is a net receiver of spillovers. One explanation to this could be the money laundry scandal in 2018, which lead to a heavy decline in Danske Bank’s stock price. Since such event is associated with mainly operational factors, meaning
that it is not related to the overall market, it would be expected to result in a limited amount of contagion. These contagion effects can be explained by the theory of flight to quality. Investors in the Scandinavian banking sector could experience losses and since the market is highly connected, there could be difficulties in determining the best investments. Together with investors demanding higher risk premiums and flight to quality, the contagion effect could further increase as a response to the investors’ reactions.

Betz et al. (2016) argue that the level of systemic risk a bank induces is positively correlated with its size, leverage and interconnectedness. Regarding the banks’ leverage, the seven Scandinavian banks all have a high LTD-ratio, compared to the average ratio in the Euro area. Since Nordea and SEB are the largest emitters and receivers of spillovers, these two banks are the most interconnected within the Scandinavian banking sector. Moreover, Nordea is the largest bank in terms of total assets and is therefore, following Betz et al. (2016), of greatest systemic importance. While the findings of Betz et al. (2016) imply that Nordea and partially SEB induce more systemic risk than the other Scandinavian banks, Kosmidou et al. (2017) find that centrality in a banking network is negatively correlated with idiosyncratic bank risk. In spillover analysis, network centrality is positively associated with spillovers, emitted as well as received. Hence, ceteris paribus, our result suggests that the idiosyncratic risk of Nordea and SEB is lower compared to the other Scandinavian banks. Accordingly, the relationship between systemic risk and idiosyncratic risk is negative. An explanation for this can possibly be found in the “too big to fail” phenomena. Banks that are considered to be too big to fail are obviously of great systemic importance. Thus, the idiosyncratic risk of investing in these banks is lower compared to banks that are not too big to fail, as it is unlikely that the government will intervene and save banks whose potential failure are not a threat to the economy.

According to the IMF (2017), the Scandinavian banks in general and the Swedish in particular, act as potential contagion transmitters. As a result of the banks’ interconnectedness, paired with the similar business and funding model they are susceptible to the same uncertainty shocks. For instance, all the banks increase their liquidity by issuing covered bonds. If all the banks apply the same funding strategy, they become more interconnected and more vulnerable to the same shocks in the economy.

Studying the spillover effects between global uncertainty and the Scandinavian banks, the total connectedness amounts to 62.16%. As seen in Table 5, the spillovers from GPR to the Scandinavian banks is between 0.11% to 0.35%. Similar to GPR, HXVg has low impact on the returns of the Scandinavian banks, ranging from 0.00% to 0.82%. We can see that EPUg has small amounts of spillovers to the Scandinavian banks with the highest to Nordea at 1.82%. VIXg does however have reasonably high spillovers towards the banks with the highest of 4.89% to DNB. From the net pairwise spillovers the highest values come from the Scandinavian banks to EPUg and VIXg. A reason for this could be that the Scandinavian banks are connected to larger international banks, which are affecting global financial uncertainty directly. The largest net pairwise spillovers is from Nordea to EPUg at 8.21%.
Table 5

Global uncertainty spillovers

<table>
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<th>SWD</th>
<th>NDS</th>
<th>SEB</th>
<th>SHB</th>
<th>DNB</th>
<th>DAB</th>
<th>JYS</th>
<th>EPUg</th>
<th>GPR</th>
<th>VIXg</th>
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<td>4.08</td>
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Notes: Global sample connectedness table. The sample ranges from January 2005 to November 2018, and the predictive horizon is 3 months with a VAR(1). The FROM column gives total directional connectedness from all others. The TO row gives total directional connectedness to all others. The NET gives net total directional connectedness (to-from) to others.

In the perspective of portfolio management, financial uncertainty and housing market uncertainty are the two uncertainty measurements that correspond to markets, by which they can be used to achieve diversification benefits (Markowitz, 1952). The result presented in Table 5 suggests that the global financial market has larger impact on the Scandinavian banks than the global housing market, proxied by the US market. Hence, an agent investing in the Scandinavian banking sector seeking diversification opportunities on the global market could invest in the housing market rather than the financial market. On the one hand, this is to be expected since the Scandinavian banks are included in the financial market. On the other hand, the limited spillover effects of HXVg are a bit surprising considering the great importance of the housing market to the financial market, primarily observed in the subprime crisis in 2008.

Analysing the spillovers of the Scandinavian banks and regional uncertainty, the total connectedness amounts to 61.24%. As presented in Table 6, financial market uncertainty is the largest transmitter of spillovers to banks among the regional uncertainties. The largest transmissions of spillovers is from VIXe to DNB and Nordea at 4.16% and 3.36%, respectively. However, regional financial uncertainty is, as all four uncertainties, net receiver of spillovers in terms of both pairwise spillovers between itself and all banks and total net spillover. Meaning that variance in the banks’ returns explain the fluctuations in regional financial uncertainty more than variance in regional financial uncertainty explain fluctuations in the banks’ returns. Regional economic policy uncertainty is the second largest transmitter of spillovers to banks, housing market uncertainty the third largest and the geopolitical risk index continues to have limited effect on banks’ returns. Regarding regional economic policy uncertainty, it explains 1.58% on average of the variance in Nordea. This is significantly higher compared to its impact on the other banks’ returns and could emphasise the importance of Nordea within Europe.
Table 6
Regional uncertainty spillovers

<table>
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</thead>
<tbody>
<tr>
<td>SWD</td>
<td>21.46</td>
<td>14.10</td>
<td>17.50</td>
<td>14.17</td>
<td>11.06</td>
<td>9.10</td>
<td>8.01</td>
<td>0.93</td>
<td>0.24</td>
<td>2.46</td>
<td>0.97</td>
<td>78.54</td>
</tr>
<tr>
<td>NDS</td>
<td>13.45</td>
<td>19.98</td>
<td>15.70</td>
<td>15.47</td>
<td>12.02</td>
<td>9.49</td>
<td>8.56</td>
<td>1.58</td>
<td>0.18</td>
<td>3.36</td>
<td>0.22</td>
<td>80.02</td>
</tr>
<tr>
<td>SEB</td>
<td>15.38</td>
<td>15.08</td>
<td>20.01</td>
<td>15.09</td>
<td>11.70</td>
<td>9.33</td>
<td>9.04</td>
<td>0.86</td>
<td>0.29</td>
<td>2.05</td>
<td>1.16</td>
<td>79.99</td>
</tr>
<tr>
<td>SHB</td>
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<td>16.46</td>
<td>16.19</td>
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<td>11.11</td>
<td>8.34</td>
<td>8.17</td>
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<td>0.41</td>
<td>2.43</td>
<td>0.87</td>
<td>78.69</td>
</tr>
<tr>
<td>DNB</td>
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<td>14.01</td>
<td>14.22</td>
<td>11.97</td>
<td>22.33</td>
<td>9.78</td>
<td>9.90</td>
<td>0.92</td>
<td>0.14</td>
<td>4.16</td>
<td>0.23</td>
<td>77.67</td>
</tr>
<tr>
<td>DAB</td>
<td>11.95</td>
<td>12.55</td>
<td>13.73</td>
<td>11.25</td>
<td>11.64</td>
<td>21.23</td>
<td>13.30</td>
<td>0.92</td>
<td>0.17</td>
<td>2.59</td>
<td>0.67</td>
<td>78.77</td>
</tr>
<tr>
<td>JYS</td>
<td>10.32</td>
<td>11.17</td>
<td>12.82</td>
<td>10.46</td>
<td>11.63</td>
<td>14.58</td>
<td>24.08</td>
<td>1.16</td>
<td>0.45</td>
<td>2.77</td>
<td>0.56</td>
<td>75.92</td>
</tr>
<tr>
<td>EPUe</td>
<td>4.33</td>
<td>7.56</td>
<td>4.53</td>
<td>4.43</td>
<td>3.78</td>
<td>4.17</td>
<td>61.70</td>
<td>1.21</td>
<td>4.14</td>
<td>0.18</td>
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<td>GPR</td>
<td>0.67</td>
<td>0.13</td>
<td>0.53</td>
<td>0.41</td>
<td>0.98</td>
<td>0.21</td>
<td>1.18</td>
<td>89.02</td>
<td>6.25</td>
<td>0.52</td>
<td>10.98</td>
<td></td>
</tr>
<tr>
<td>VIXe</td>
<td>7.75</td>
<td>7.69</td>
<td>6.49</td>
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<td>11.38</td>
<td>4.83</td>
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<td>2.03</td>
<td>47.94</td>
<td>1.10</td>
<td>52.06</td>
</tr>
<tr>
<td>HXVe</td>
<td>3.22</td>
<td>2.01</td>
<td>2.70</td>
<td>2.06</td>
<td>3.19</td>
<td>3.03</td>
<td>2.00</td>
<td>0.90</td>
<td>0.21</td>
<td>3.36</td>
<td>77.32</td>
<td>22.68</td>
</tr>
</tbody>
</table>

Notes: Regional sample connectedness table. The sample ranges from January 2005 to November 2018, and the predictive horizon is 3 months with a VAR(1). The FROM column gives total directional connectedness from all others. The TO row gives total directional connectedness to all others. The NET gives net total directional connectedness (to-from) to others.

Interestingly, in our sample of regional uncertainty, the spillovers from VIXe to the Norwegian and Danish banks are higher than to the Swedish banks except Nordea. A possible explanation for this could be that the integration between Norway, Denmark, and the European market is higher than between Europe and Sweden. The reason for Nordea’s high level of received spillovers could be that it is a relatively large bank in the European market. A contradictory fact is that DNB is receiving the highest amount of spillovers, while Norway is the only country not part of the European Union.

In the sample with local uncertainty and the Scandinavian banks, the total connectedness amounts to 61.96%. In Table 7 it can be noted that GPR and EPUs are fairly weak transmitters of spillovers. At the same time, we can see that VIXs and HXVs are giving a moderate amount of spillovers to the Scandinavian banks. Interestingly, Swedish housing market uncertainty emits more spillovers to the Swedish banks than VIXs, while VIXs is a larger emitter to the Danish and Norwegian banks. Calomiris and Carlson (2017) find that interbanking increases contagion effects and according to the IMF (2017) and Riksbanken (2018), there are high contagion effects from the Swedish housing market to the other Scandinavian countries. Hence, uncertainty shocks that are not originated in Norway and Denmark can be transmitted by Swedish banks from the housing market through interbanking. A reason for the comparably larger amounts of spillovers from local financial uncertainty to Norway and Denmark, could be that the Swedish economy is driving the rest of the Scandinavian countries’ markets. Our conclusion is therefore in line with IMF (2017), where they emphasize that Sweden is the most important financial system in the Nordic-Baltic region due to the size of Sweden’s financial market. Regarding spillovers from the Scandinavian banks to VIXs and HXVs, the net pairwise spillovers run from the banks to the uncertainty variables, implying that the banks have larger impact on the uncertainty measurements rather than vice versa. It is quite expected that the net spillovers run form the banks to the financial uncertainty since the banks are included in the underlying index of VIXs.
Table 7
Local uncertainty spillovers

<table>
<thead>
<tr>
<th></th>
<th>SWD</th>
<th>NDS</th>
<th>SEB</th>
<th>SHB</th>
<th>DNB</th>
<th>DAB</th>
<th>JYS</th>
<th>EPU</th>
<th>GPR</th>
<th>VIX</th>
<th>HXV</th>
<th>FROM</th>
</tr>
</thead>
<tbody>
<tr>
<td>SWD</td>
<td>21.76</td>
<td>14.43</td>
<td>17.99</td>
<td>14.90</td>
<td>11.49</td>
<td>8.31</td>
<td>7.70</td>
<td>0.14</td>
<td>0.13</td>
<td>1.07</td>
<td>2.08</td>
<td>78.24</td>
</tr>
<tr>
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<td>9.29</td>
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<td>0.20</td>
<td>1.05</td>
<td>1.89</td>
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</tr>
<tr>
<td>SEB</td>
<td>15.91</td>
<td>15.16</td>
<td>20.60</td>
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<td>11.75</td>
<td>8.30</td>
<td>8.61</td>
<td>0.30</td>
<td>0.11</td>
<td>1.40</td>
<td>2.12</td>
<td>79.40</td>
</tr>
<tr>
<td>SHB</td>
<td>14.70</td>
<td>16.90</td>
<td>16.93</td>
<td>22.03</td>
<td>11.61</td>
<td>7.69</td>
<td>7.82</td>
<td>0.29</td>
<td>0.39</td>
<td>0.38</td>
<td>1.26</td>
<td>77.97</td>
</tr>
<tr>
<td>DNB</td>
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<td>14.67</td>
<td>14.40</td>
<td>12.64</td>
<td>23.28</td>
<td>9.74</td>
<td>9.33</td>
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<td>0.19</td>
<td>1.76</td>
<td>0.50</td>
<td>76.72</td>
</tr>
<tr>
<td>DAB</td>
<td>12.15</td>
<td>12.83</td>
<td>13.52</td>
<td>11.32</td>
<td>11.99</td>
<td>21.82</td>
<td>13.83</td>
<td>0.27</td>
<td>0.15</td>
<td>1.50</td>
<td>0.61</td>
<td>78.18</td>
</tr>
<tr>
<td>JYS</td>
<td>10.44</td>
<td>11.06</td>
<td>12.73</td>
<td>10.25</td>
<td>11.07</td>
<td>14.90</td>
<td>24.39</td>
<td>0.82</td>
<td>0.22</td>
<td>3.04</td>
<td>1.07</td>
<td>75.61</td>
</tr>
<tr>
<td>EPU</td>
<td>3.02</td>
<td>5.91</td>
<td>3.98</td>
<td>4.33</td>
<td>4.55</td>
<td>1.65</td>
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<td>66.06</td>
<td>2.91</td>
<td>2.52</td>
<td>0.64</td>
<td>33.94</td>
</tr>
<tr>
<td>GPR</td>
<td>0.98</td>
<td>0.12</td>
<td>0.93</td>
<td>0.34</td>
<td>0.66</td>
<td>0.14</td>
<td>0.18</td>
<td>1.49</td>
<td>91.24</td>
<td>2.83</td>
<td>1.09</td>
<td>8.76</td>
</tr>
<tr>
<td>VIX</td>
<td>7.36</td>
<td>4.57</td>
<td>6.56</td>
<td>2.66</td>
<td>9.53</td>
<td>3.72</td>
<td>4.53</td>
<td>2.66</td>
<td>2.45</td>
<td>51.36</td>
<td>4.59</td>
<td>48.64</td>
</tr>
<tr>
<td>HXV</td>
<td>8.94</td>
<td>6.77</td>
<td>8.05</td>
<td>4.28</td>
<td>4.47</td>
<td>2.06</td>
<td>3.17</td>
<td>0.29</td>
<td>0.07</td>
<td>6.49</td>
<td>55.40</td>
<td>44.60</td>
</tr>
<tr>
<td><strong>TO</strong></td>
<td>100.56</td>
<td>102.41</td>
<td>110.59</td>
<td>92.30</td>
<td>89.60</td>
<td>65.79</td>
<td>68.04</td>
<td>7.18</td>
<td>6.81</td>
<td>22.05</td>
<td>15.85</td>
<td>61.96</td>
</tr>
</tbody>
</table>

Notes: Local sample connectedness table. The sample ranges from January 2005 to November 2018, and the predictive horizon is 3 months with a VAR(1). The FROM column gives total directional connectedness from all others. The TO row gives total directional connectedness to all others. The NET gives net total directional connectedness (from-to) to others.

A pattern in terms of which banks emits and receives the most spillovers can be seen between the different samples. The following order of the banks being the one who emits the most spillovers; SEB, Nordea, Swedbank, Svenska Handelsbanken, DNB, Danske Bank and Jyske Bank. Only for the sample with local uncertainty is there a change from this pattern, where Danske Bank and Jyske Bank switch places. To conclude the different uncertainties’ impact on the banks, the sum of all indices’ spillovers from the three different geographical samples is presented in Table 8.

Table 8
Aggregated spillovers from uncertainty shocks to the Scandinavian banks

<table>
<thead>
<tr>
<th></th>
<th>EPU</th>
<th>GPR</th>
<th>VIX</th>
<th>HXV</th>
<th>TOT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local</td>
<td>2.74</td>
<td>1.39</td>
<td>10.20</td>
<td>9.53</td>
<td>23.86</td>
</tr>
<tr>
<td>Regional</td>
<td>7.18</td>
<td>1.88</td>
<td>19.82</td>
<td>4.68</td>
<td>33.56</td>
</tr>
<tr>
<td>Global</td>
<td>8.39</td>
<td>1.28</td>
<td>28.52</td>
<td>1.50</td>
<td>39.69</td>
</tr>
</tbody>
</table>

Notes: The sample ranges from January 2005 to November 2018, and the predictive horizon is 3 months with a VAR(1). The table shows the aggregated spillovers from the uncertainty variables to the banks on global, regional & local level from Table 5, Table 6 and Table 7.

Initially, as presented in Table 8, we can conclude that global uncertainty has the greatest spillover effects on the Scandinavian banking sector. Financial uncertainty has the greatest spillover effects on all levels, i.e. local, regional and global. Global financial uncertainty is shown to have the largest effects compared to local and regional. Of the 39.69% in total global uncertainty spillover, VIXg amounts to 28.52 p.p. This follows Demirer et al. (2016) who find that Sweden is the country with the highest connectedness to the American banks within the Northern European countries. Therefore, it is not unreasonable for us to see a high degree of connectedness to VIXg. One possible interpretation of this result is the importance of the US stock market for the Scandinavian stock market. The Scandinavian countries are in comparison small open economies which in the world economy are going to be receivers of spillovers. Further, it could possibly be explained by a higher degree of integration of financial markets between the US and Scandinavia compared to Europe and Scandinavia. This is clear as our result shows that the Scandinavian banking sector is
more vulnerable to global financial shocks than to regional and local. In the study of Hardouvelis et al. (2006) they find that the UK did not show an increased level of integration with members of the EMU after its implementation. The countries within the EMU did, however, gain an increase in integration with the other union members. Like the UK, the Scandinavian countries are not members of the EMU, which can be the reason for the lower levels of financial integration between the European financial market and the Scandinavian banks. This conclusion is supported by Pukthuanthong and Roll (2009), who state that the overall global financial integration has increased. A problem arises with VIXs as its methodology is different from VIXg and VIXe. However, our analysis of VIXs does nonetheless follow economic reasoning as to why the result is acceptable.

Global economic policy uncertainty has shown to have greater spillover effects on the Scandinavian banks than regional and local. Since EPU is based on how frequent the words economic, uncertainty and terms related to policy are used in leading newspapers, it essentially measures macroeconomic uncertainty. Such uncertainties could for example be associated with whether a central bank will change the repo rate or doubt about the current position in the business cycle. Thus, our result suggests that macroeconomic factors have bigger impact on the Scandinavian banking sector on a global level than local and regional. Therefore, it is of greater importance for investors that are about to invest in Scandinavian banks to study the global macroeconomic conditions rather than local. Considering that EPUg is a GDP-weighted index, meaning that the EPU in larger economies are given more weight, the uncertainty in e.g. the US is of great importance.

GPR is shown to have a low impact on the Scandinavian banking sector. Studying Fig. 7, GPR has no increased uncertainty during the global financial crisis, compared to EPU that sees major spikes in uncertainty. Another possible explanation is the fundamental methodology behind GPR. GPR is comprised of 11 international and American newspapers, none of which are a major newspaper in Scandinavia. Also, the Scandinavian countries are rarely subjected to terrorism attacks and war, therefore, it is unlikely that GPR would have a significant impact. One aspect that GPR could be able to detect is the increasing money laundering scandals connected to Scandinavian banks as could have ties to terrorism. The recent money laundering scandals are, however, outside of our sample, except for the Danske Bank scandal.

Regarding housing market uncertainty, there are a large variety of the spillover effects between global, regional and local. The spillover effects of regional HXV, proxied by the UK housing market, has shown to have more spillover effects on the Scandinavian banks than HXVg, which is captured by the US housing market. However, on a local level, housing market uncertainty has a comparably large spillover effect on the Scandinavian banking sector. HXVs’ aggregated spillover effects towards the Scandinavian banks amounts to 9.53%, which is circa two fifths of the total spillovers of local uncertainty. That is, comparing the different geographical levels, the effects of housing market uncertainty are the reverse of financial and economic policy uncertainty.

The reason why the Scandinavian banks are affected by the local housing market is clear. The housing market is dependent on local macroeconomic factors, such as the development of wage level and interest rate. Furthermore, the banks are dependent on the housing market as a consequence of the risks derived from the household mortgages in their credit portfolios. This is

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10 These terms are e.g. for US EPU, among others, “federal reserve” and “white house” and for Swedish, among others, “riksbank” and “regering”.

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particularly of interest due to the high indebtedness of the Scandinavian households. When the households acquire more debt, they become more vulnerable to shocks in macroeconomic fundamentals, which impacts the house prices. Increases in interest rate and unemployment rate result in worsen solvency of the households and the risk of default in the outstanding mortgage loans enlarges. Obviously, increasing defaults of outstanding mortgage loans have a negative effect on the banks since it affects the banks’ assets as well as interest incomes.

Concerning shocks in the local housing market, they mainly affect the Scandinavian banks in two ways. Firstly, increases in housing market uncertainty will lower the demand on houses, which decreases the banks’ lending and hence their incomes. Secondly, if a negative shock occurs in the housing market, meaning that the house prices fall, the value of the banks’ cover pools will decrease. Given that a bank does not have a high level of overcollateralization and since the value of the cover pool must match the covered bonds, a heavy decrease in the value of the bank’s cover pool will leave the bank with two options. The bank can either increase the amount of assets in the cover pool or decrease its stock of issued covered bonds by buying them back. In both cases, the bank will need liquidity and its liquidity preferences are thus changed. Allen and Gale (2000) argue that shocks in liquidity preferences in one region can transmit to other regions through interregional banking. We believe the same argument could be made for banks, as they are connected to a larger market, where changes of liquidity preferences in one bank will affect other banks in the system. In the case of changes in liquidity preferences due to shocks in the housing market, banks will try to liquidate their interregional assets, which covered bonds arguably are. The long assets are in this case the assets of which the cover pool comprises of, i.e. mainly mortgage loans. From Allen and Gale (2000) we know that the banks rather not liquidate their long assets as it is costly. Moreover, if a bank suffers from a mismatch between the cover pool and outstanding covered bonds, selling of assets in the cover pool will expand the mismatch. The first banks to sell their interbank holdings create a chain reaction to other banks who do the same. However, this does not create any additional liquidity in the market, it merely transfers it between banks. The most troubled banks, those who initially have a shortage of liquidity, are heavily indebted with outstanding covered bonds and long assets, which due to the housing market shock have dropped in value. Moreover, in the long run, one would expect such circumstances to damage the confidence in the banking sector. The greatest benefit of covered bonds is that they are considered as safe, which makes it easy for the banks to issue them. However, a damaged confidence in these types of securities would increase the risk premium and the banks’ cost of capital would thus increase.

Spillover effects from regional and global housing market uncertainty are, however, more difficult to explain. One explanation could be that e.g. the US housing market are affecting banks operating in the United States, which in turn emits spillovers to the Scandinavian banks. A second reason could be that the Scandinavian banks are operating globally and are therefore directly affected by the housing market uncertainty. A third explanation is that there are underlying macroeconomic fundamental factors that affect the US housing market and which are later transmitted to Scandinavia due to the high level of integration. Such macroeconomic factors could be changes in the business cycle or changes in the interest rate. As our result suggest, the Scandinavian banks are more affected by regional housing market uncertainty than global. Since our result also suggests that the Scandinavian banking sector is more connected to the global financial market, in terms of VIXg, it is more likely that the Scandinavian banks are affected directly by the regional housing market, rather than due to changes in macroeconomic factors.
7.2 Rolling total connectedness

In Fig. 10 we plot the result of the rolling total connectedness for global, regional and local samples, with the rolling sample window \( w = 24 \). As our sample starts January 2005, the first observation in the rolling total connectedness is January 2007. Although there are differences between the global, regional and local samples, the major trend stays the same through the geographical levels. Moreover, connectedness is good in a booming economy and reversely, a way of transmitting contagion in recessions. In Fig. 10 we can see that the overall connectedness increased during the global financial crisis and remains somewhat high for the time period. This asymmetric behaviour of connectedness is of course unwanted, in bad times the contagion will increase and the emitted risk will spread. A possible way to soften the contagion could be to minimize the interbanking as explained by Gabrieli and Salakhova (2019). The counter cyclical buffer as proposed by the amendment of Basel II is therefore a good response to decrease contagion effects, which could be further explored with larger restrictions.

Moreover, we can see an increase in connectedness in the end of 2011, which could be a consequence of the European sovereign debt crisis. After 2012 it dropped somewhat steadily until the beginning of 2016 where it started to increase again. The increase in connectedness during 2016 could in turn be a consequence of the Brexit referendum. In line with Choudhry and Jayasekera’s (2012; 2014a; 2014b) findings, that return spillovers between countries increased during the global financial crisis using a GARCH methodology, we find that the spillovers between banks increased during the global financial crisis and other times of uncertainty. Similarly, the TENET model applied by Härdle et al. (2016) and Wang et al. (2018) also show that when uncertainty rise, the level of interconnectedness increases. The same pattern from previous studies is identified applying the Diebold and Yilmaz (2014) method in our study.
As previously argued, the Scandinavian countries can be small open economies. Following Fernández-Villaverde’s et al. (2011) reasoning, investments in the Scandinavian economies could decline during times of greater uncertainty, since investors are seeking investment opportunities in larger and more stable economies. This is also in line with the theory flight to quality, which also suggests that the impact of uncertainty should be greater in smaller economies. That is, spillover effects of uncertainty shocks are expected to increase in the Scandinavian banking sector during uncertain periods, such as the global financial crisis.

7.3 Network analysis

To follow our results from the connectedness tables we show the result of the network analyses (Fig. 11, Fig. 12 and Fig. 13). It is interpreted in four ways, which are all derived from the connectedness tables and total assets. The size of the nodes for the Scandinavian banks are all connected to their total assets, showing Nordea as the largest bank and Jyske Bank as the smallest. The uncertainty measurements have been standardized, meaning that no conclusion from the size of the nodes can be drawn. The colour of the arrows and their size represents the directional connectedness from one node to another, thin green being the smallest and thick black being the largest. The total connectedness from a node can be seen from the colour following the same principle. Distance is a part of the algorithm but does not necessarily reflect the connectedness as other measures are valued higher.

While all the network analyses show a cluster for the Scandinavian banks, some differences can be found. The network analysis of the global sample show VIXg being redder to the banks, implying that the spillovers from VIXg is greater than from the other uncertainties. The colour of the financial uncertainty can be seen becoming greener as we go from global to regional to local. It is difficult to make assumptions from the locations of each node as the simulation is dependent on the starting point and there exist no unique arrangement of the system Jacomy et al. (2014). As the algorithm favours larger connections, it is likely that the banks are placed first and then dictates where the uncertainty measurements are placed. Therefore, the location of the uncertainty measurements will not necessarily match with what they are more connected to. However, we can conclude that housing market uncertainty is attracted closer to the cluster of the banks as we go from a more global level to local. At the same time EPUg is shown to be less influential than EPUg and EPUe.
Fig. 11. Global network analysis

Fig. 12. Regional network analysis

Fig. 13. Local network analysis
7.4 Robustness check of spillovers

In order to control that our results are stable with different model specifications, we change the forecast horizon, h to 1, 3, 6 and 9 months. We can also change the VAR model specification to check if our result remains stable to different lag structures. As explained by Diebold and Yilmaz (2014), the total connectedness should increase with increasing forecast horizon h-values, as there is more time for connectedness to appear in the result. As seen in Fig. 14, Fig. 15 and Fig. 16, there appears to only be small differences between the changes in the input parameters of the model. The VAR(2) seems to result in more spillovers, but the VAR(1) used in our paper is the model with the lowest AIC-value. We therefore conclude that our results are stable given the different h and p parameters. An issue worth mentioning, is that due to the number of variables in the samples and our data ranging from January 2005 to November 2018, we can only test for p = 1 and p = 2. This is because we do not have a sample big enough to run the total connectedness across the time period with our value of window width for the rolling sample due to the loss of degrees of freedom. As such there is a difference in the rolling sample window between the total connectedness in Chapter 7.6 and the robustness check. For the robustness check we have used the rolling sample window w = 60.

![Fig. 14. Global robust check, different h (forecast horizon) and p (VAR-lag)](image)

![Fig. 15. Regional robust check, different h (forecast horizon) and p (VAR-lag)](image)
Fig. 16. Local robust check, different $h$ (forecast horizon) and $p$ (VAR-lag)
7.5 Quantile Regressions

GPR has from our previous results shown limited spillovers to the banks’ returns and therefore, we chose not to include it in the quantile regressions. Table 9 summarises the results of the quantile regressions presented in Appendix II. Global, regional as well as local financial uncertainty is proven to have significant effects on the Scandinavian banks’ returns in both the lower and higher quantiles. Moreover, the relationship between financial uncertainty and the banks is negative in the lower quantiles and positive in the higher quantiles. That is, during periods of which the banks are experiencing falling stock prices, financial uncertainty has a negative impact on the banks’ returns. Reversely, in bull market periods, greater fluctuations on the stock market have a positive effect. Obviously, this result is to be expected since financial uncertainty is to be associated with fluctuations on the stock market. Hence, in good periods, the fluctuations are positive meaning that prices on the stock market are increasing, which has a positive effect on the Scandinavian banks. However, it is interesting to study the dynamics in the relationship between global financial uncertainty and the Scandinavian banks. The negative effect in the lower quantiles occurs in the current period, while the positive effect in the higher quantiles is of the lagged variable. An interpretation of this result is that negative shocks to the financial market affects the Scandinavian banks instantaneously, while the effect of positive shocks is delayed. Applying the theory of Longstaff (2010), one could say that transmission of negative economic information travels at a greater speed than positive economic information. This is also in line with the research of Soroka (2006), which state that the public responses to negative economic information is greater than to positive.

Table 9
Quantile Regressions

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<td>M</td>
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<tr>
<td>HXV(-1)</td>
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</table>

Notes: The table reports a summary of the quantile regressions presented in Appendix II. Low(L) is the quantiles 5, 10 and 25, M(Median) is the 50th quantile and H(High) is the quantiles 75, 90 and 95. If a minimum of 2 quantiles per category (L and H) is significant on 10% level and have the same relation, the cell is given “+” if positive and “-” if negative. Otherwise, if the aforementioned criterions are not met, the cell is given the sign “\".

Regarding regional and local financial uncertainty, the dynamics are not the same as in the quantile regressions with global financial uncertainty. Regional financial uncertainty has only a significant effect in the current period, since the lagged variable is insignificant in all quantiles. Concerning local financial uncertainty, the relationship with the banks’ returns is negative in bearish and normal market conditions in the current period. In bullish market conditions, local financial uncertainty has a positive impact on the Scandinavian banks in the current period as well as in the lagged period. Although the dynamics in the different samples vary a bit, the negative effect of financial uncertainty is in all samples occurring in the current period. Moreover, the significant and positive relationship between the banks’ returns and global and local financial uncertainty in the higher quantiles implies that during bullish market periods, these measurements can be used to predict the banks’ returns and are therefore of value to investors.
Concerning economic policy uncertainty, there are only two scenarios where there are significant results. Firstly, for bullish market conditions on global level there is a negative relation to the returns. Secondly, on normal market conditions for our regional sample, we can see that there is instead a positive relation to the return in the same time period. The lagged version of economic policy uncertainty can be seen having no significant result on the return of the Scandinavian banks, meaning that economic policy uncertainty cannot be used to predict the future value of the banks.

In the matter of housing market uncertainty, the results of the global regressions are a bit surprising. The quantile regressions demonstrate that in the current period, global housing market uncertainty has a negative effect on the Scandinavian banks in bullish market conditions. Moreover, for the lagged global housing market uncertainty, both the lower quantiles and the median show a significant positive relationship. This result is difficult to explain, one would expect that it instead would have a negative relationship. However, we do find a significant negative relationship for the lagged regional housing market uncertainty in the lower quantiles. Regarding local housing market uncertainty, we find, similarly to regional, that in bearish market conditions, fluctuations on the housing market in the previous period has a negative effect on the Scandinavian banks’ returns. Furthermore, the relationship between the banks’ returns and local housing market uncertainty in the current period is negative during normal market conditions. Moreover, we find that fluctuations on the local housing market in the previous period has a positive effect on the Scandinavian banks’ returns. The result of local housing market uncertainty shares the same pattern as financial uncertainty, meaning that during bearish periods, market fluctuations has a negative impact on the banks, while during bullish periods the fluctuations work in favour of the banks’ returns. However, financial uncertainty in the lower quantiles affect the banks in the current period, whereas the effect of local housing market uncertainty is delayed. The result implies that during worse market conditions, financial uncertainty affect the Scandinavian banks sooner than housing market uncertainty. Moreover, this indicates that, during a bearish market, shareholders investing in Scandinavian banks are acting quicker on emerged turmoil in the financial markets than in the housing market. Accordingly, there are benefits that can be utilised by investors, namely to use the housing market uncertainty in bearish market conditions to predict future values on the Scandinavian banks’ returns.
8. Conclusion and policy implications

Our main finding is that global uncertainty has the biggest impact in terms of spillovers to the Scandinavian banking sector. Scandinavian banks are therefore more likely to be affected by global uncertainty shocks than regional and local. Regarding the housing market, local uncertainty has instead proven to affect the Scandinavian banks the most. We also find that size and connectedness are not necessarily positively correlated, as seen by SEB, which is a smaller bank and still has the most emitted spillover effects. Meanwhile Danske Bank and DNB have small amount of spillovers considering their size. However, trading volume appears to be positively associated with connectedness within the Scandinavian banking sector, as seen by SEB and Nordea, which have the most frequently traded stocks. Applying quantile regressions, we find that financial uncertainty is a quicker transmitter of spillovers to the banks compared to housing market uncertainty.

To answer our research questions, (i) all Swedish banks emit more spillovers than the other Scandinavian banks in the sample, with SEB and Nordea emitting and receiving the most spillovers. (ii) Global financial uncertainty is the most important uncertainty in terms of the amount of emitted spillovers. Local housing market uncertainty is, however, the most influential uncertainty after the different geographical financial uncertainty indices. Global economic policy uncertainty affects the Scandinavian banking sector more than regional and local, implying that uncertainty concerning macroeconomic policies in larger economies are of higher importance to the Scandinavian banks. We also find that geopolitical risk has limited spillover effects on the Scandinavian banks. (iii) The quantile regressions show that financial uncertainty tends to have a negative impact on the banks’ returns in bearish and normal market conditions, while its impact is positive in bullish periods. Few conclusions can be drawn for economic policy uncertainty, where only a negative relation could be found for global uncertainty in bullish markets and a positive in normal markets for regional uncertainty. Regarding housing market uncertainty, we find different results for global compared to regional and local. Global housing market uncertainty show positive relationship in bearish and normal market conditions. However, the relationship between regional and local housing market uncertainty and the banks’ returns is negative in bearish market conditions and positive in bullish.

For both policy makers and investors, we can see that global uncertainty is of higher importance than regional and local. Because of the higher levels of spillovers from global uncertainty, Scandinavia is more likely to be driven by the world economy. Another implication of our result is that the Swedish economy is of importance to both Denmark and Norway. Spillovers from Sweden to the other countries are higher, which for Sweden could mean a softening effect where risk can be spread, but for Denmark and Norway, this is instead a source of risk. From the perspective of investors, we must recognize the possibility of diversification. We can clearly see that housing market uncertainty on a local level affects the Scandinavian banks, especially in Sweden. Accordingly, in terms of diversification opportunities, the local housing market is of importance together with the financial uncertainty. Considering that the spillover effects of uncertainty varies between the banks, there are diversification opportunities for investors who wish to avoid exposure to a specific uncertainty. We also find that financial uncertainty can be used to predict the Scandinavian banks’ returns in bullish market conditions.
References


Appendix I

Fig. 17. Raw uncertainty data

Fig. 18. PACFs of full sample
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### Appendix II

#### Table 11
Quantile Regressions - Global

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Notes: ***, **, and * indicate significant p values at the 1, 5, and 10% level, respectively. A lag of the banks’ returns as well as interest rate (INT) and unemployment rate (UNR) are included as control variables.
### Table 12
Quantile Regressions - Regional

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<td>-137.022***</td>
<td>-149.061***</td>
<td>-7.372</td>
<td>37.671</td>
<td>97.670</td>
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<td>0.023</td>
<td>-0.004</td>
<td>0.064</td>
<td>0.078***</td>
<td>0.052</td>
<td>0.097***</td>
<td>0.005</td>
<td>-0.076</td>
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<td>INT(-1)</td>
<td>0.011</td>
<td>0.068*</td>
<td>0.059</td>
<td>-0.024</td>
<td>0.010</td>
<td>-0.065</td>
<td>-0.077*</td>
<td>-0.039</td>
<td>1.458</td>
</tr>
<tr>
<td>UNR</td>
<td>0.008</td>
<td>0.042*</td>
<td>0.025</td>
<td>0.022*</td>
<td>-0.004</td>
<td>0.008</td>
<td>0.022</td>
<td>0.040*</td>
<td>1.226</td>
</tr>
<tr>
<td>UNR(-1)</td>
<td>-0.009</td>
<td>-0.012</td>
<td>-0.021</td>
<td>-0.015</td>
<td>-0.003</td>
<td>0.003</td>
<td>-0.022</td>
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<tr>
<td>Intercept</td>
<td>-0.097**</td>
<td>0.236***</td>
<td>0.162**</td>
<td>0.055</td>
<td>-0.037</td>
<td>-0.170***</td>
<td>-0.262***</td>
<td>-0.276***</td>
<td>NA</td>
</tr>
<tr>
<td>(Pseudo) R2</td>
<td>0.045</td>
<td>0.241</td>
<td>0.151</td>
<td>0.058</td>
<td>0.010</td>
<td>0.042</td>
<td>0.133</td>
<td>0.240</td>
<td></td>
</tr>
</tbody>
</table>

Notes: ***, **, and * indicate significant p values at the 1, 5, and 10% level, respectively. A lag of the banks’ returns as well as interest rate (INT) and unemployment rate (UNR) are included as control variables.
### Table 13
Quantile Regressions - Local

<table>
<thead>
<tr>
<th></th>
<th>OLS</th>
<th>τ=0.05</th>
<th>τ=0.10</th>
<th>τ=0.25</th>
<th>τ=0.50</th>
<th>τ=0.75</th>
<th>τ=0.90</th>
<th>τ=0.95</th>
<th>VIF</th>
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<td>RET(-1)</td>
<td>0.120***</td>
<td>0.046</td>
<td>0.037</td>
<td>0.003</td>
<td>0.015</td>
<td>0.065*</td>
<td>0.157***</td>
<td>0.177***</td>
<td>1.187</td>
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<td>VIXs(-1)</td>
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<td>0.679</td>
<td>-0.367</td>
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<td>0.478</td>
<td>0.547</td>
<td>1.667*</td>
<td>1.383**</td>
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<td>EPUs</td>
<td>-0.007</td>
<td>-0.002</td>
<td>0.013</td>
<td>0.005</td>
<td>-0.020</td>
<td>-0.020</td>
<td>-0.008</td>
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<tr>
<td>EPUs(-1)</td>
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<td>-0.037</td>
<td>-0.006</td>
<td>0.008</td>
<td>0.016</td>
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<td>-49.901**</td>
<td>-9.211</td>
<td>1.763</td>
<td>11.231*</td>
<td>15.755**</td>
<td>14.724**</td>
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<td>0.022</td>
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<td>0.025</td>
<td>0.036</td>
<td>0.061***</td>
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<td>-0.027</td>
<td>1.364</td>
</tr>
<tr>
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<td>0.016</td>
<td>0.105***</td>
<td>0.088***</td>
<td>0.047</td>
<td>0.015</td>
<td>-0.048</td>
<td>-0.101**</td>
<td>-0.097*</td>
<td>1.264</td>
</tr>
<tr>
<td>UNR</td>
<td>0.012</td>
<td>0.042**</td>
<td>0.017</td>
<td>0.010</td>
<td>0.004</td>
<td>0.003</td>
<td>0.011</td>
<td>0.048**</td>
<td>1.266</td>
</tr>
<tr>
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<td>0.018</td>
<td>-0.004</td>
<td>0.011</td>
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<td>0.012</td>
<td>0.010</td>
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<td>-0.093</td>
<td>-0.087</td>
<td>0.028</td>
<td>0.051</td>
<td>0.081</td>
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<td>(Pseudo) R2</td>
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<td>0.273</td>
<td>0.132</td>
<td>0.033</td>
<td>0.061</td>
<td>0.183</td>
<td>0.262</td>
<td></td>
</tr>
</tbody>
</table>

Notes: ***, **, and * indicate significant p values at the 1, 5, and 10% level, respectively. A lag of the banks' returns as well as interest rate (INT) and unemployment rate (UNR) are included as control variables.