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Monetary Policy and Stock Market Valuation

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Abstract

This paper estimates the effect of monetary policy on the term structure of stock market risk premia. Stock market risk premia are solved using analysts' dividend forecasts and dividend future prices. Although risk-free rates have decreased after the global financial crisis, the results indicate that the expected long-term average stock market return has remained quite stable at around 9 percent. This implies that the average stock market risk premium has increased since the financial crisis. The prices of dividend futures suggest that the rise is related to changes in the term structure of risk premia. The effect of monetary policy on risk premia is analysed using VAR models and local projection methods. According to the results, monetary policy easing raises the average risk premium. The effect is driven by a rise in long-horizon risk premia.

Keywords: Monetary policy, Stock market, Equity premium

JEL codes: E52, G12

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1. Introduction

The notion that the value of a stock is the present value of its expected future dividends goes back at least to Williams (1938). Hence, the changes in stock prices must be explained by either changes in dividend expectations or changes in discount rates. The discount rate, or (approximately) expected rate of return, can be thought of as a sum of a risk-free rate and a risk premium. Hence, monetary policy should have an effect on stock prices through the risk-free rates which it partly controls. Further, monetary policy may also affect dividend expectations, for example, through the output of firms (e.g. Galí and Gambetti, 2015). Its effect on the risk premium (not to mention the term structure of risk premia), however, is less clear.

In this paper, I analyse the effect of monetary policy on the term structure of equity premia in order to better understand developments in stock market valuation after the global financial crisis and during the era of unconventional monetary policy measures. First, as a preliminary analysis, I solve for the implied risk premium using a dividend discount model and analysts' forecasts for the future dividends of the major eurozone stocks that are included in the Eurostoxx 50 index.[1] This approach yields an approximation of the time-variation of the average long-term equity premium. Second, I move to the main topic of this paper – the term structure of equity premia. I combine the prices of Eurostoxx 50 dividend futures with the analysts' dividend forecasts to calculate horizon-specific risk premia using the framework of Binsbergen, Hueskes, Koijen and Vrugt (2013).[2] I then analyse the impact of monetary policy on the term structure of equity premia. To the best of my knowledge, this approach of using dividend futures together with dividend forecasts to solve for the term structure of stock market

[1] A kindred approach has been used by e.g. Claus and Thomas (2001), Gebhardt, Lee and Swaminathan (2001) and Damodaran (2020). None of these studies, however, provides empirical analysis of the impact of monetary policy on the risk premium.

[2] Dividend futures have been used recently in many other applications as well. See for example the paper by Gormsen and Koijen (2020). In this paper, I focus on the euro area, because the available time series regarding the prices of dividend futures in the USA is very short. When it comes to estimation of horizon-specific premia, alternative approach that applies credit default swap spreads is proposed by Berg (2010) and Berg and Kaserer (2013).

risk premia, and studying the impact of monetary policy on the term structure have not been dealt with in the earlier literature.

The effect of monetary policy on the risk premium is interesting as it may give information about the effect on investors' perception of risk. Thus, the issue is highly relevant for the risk-taking channel of monetary policy.[3] On the other hand, the effect on the implied risk premium may give information about the effect of monetary policy on stock market "bubbles" or mispricing. The reason for this is that the premium captures also the potential bubble component.[4] Therefore, the paper also contributes to the literature studying the effect of monetary policy on stock market bubbles (e.g. Galí, 2014; Galí and Gambetti, 2015). However, in the current paper, I do not attempt to distinguish whether the variation in the implied premium is due to mispricing or variation in the rational risk premium.

I analyse the effects of monetary policy with two methods. First, I study the effects in a VAR model in which monetary policy stance is measured using the shadow (policy) rate, taking account of the zero lower bound of the policy rate.[5] The monetary policy shock is identified using sign restrictions. In the second approach, I study the effects using local projections, where changes in the overnight indexed swap (OIS) rates around ECB Governing Council announcements are used as a proxy for monetary policy shocks.[6]

The results show that the average risk premium has increased considerably since the global financial crisis. This change is driven by the change in long-horizon premia. The VAR results show that monetary policy easing has had a positive impact on the average risk premium. Specifically, a negative shock to the shadow rate is estimated to increase average premium

[3] See, for example, the paper by Borio and Zhu (2012) about the risk-taking channel of monetary policy.
[4] The variation in the implied premium means that stocks are sometimes too expensive or too cheap for an investor whose required premium over the risk-free rate is constant over time (or whose required premium varies less than the implied premium).
[5] The concept of shasow rate was first introduced by Black (1995).
[6] Intraday OIS-rate changes are obtained from the EA-MPD: https://www.ecb.europa.eu/pub/pdf/annex/Dataset_EA-MPD.xlsx? afecc88fe2e29c7abcdee5670b6d0f68. See the paper by Altavilla, Brugnolini, Gürkaynak, Motto and Ragusa (2019).

persistently. Further, the results show that monetary policy easing temporarily decreases short-horizon risk premia. This implies that expansionary monetary policy steepens the slope of the term structure of risk premia. I obtain similar results with the local projection method.

The results also comport with the findings of Bernanke and Kuttner (2005), who note that expansionary monetary policy generates an immediate rise in equity prices followed by a period of lower-than-normal excess returns. This is in line with my results concerning the effect on short-horizon ex-ante risk premia. However, Bernanke and Kuttner (2005) do not study the effect on the long-run excess returns.[7] My results suggest that the effect of monetary policy on long-horizon risk premia has a different sign. This effect seems to more than offset the effect on short-horizon premia.

As to the policy implications, “leaning against the wind” policies appear to be ineffective when it comes to the stock market. Contractionary monetary policy increases the short-term premia temporarily but decreases long-horizon premia persistently. The effect on average risk premium is negative. Thus, monetary policy tightening actually makes stocks “expensive” in relation to the expected stream of dividends and the level of risk-free rates. The results provide no evidence that expansionary monetary policy causes stock market bubbles. Instead, the results support earlier findings that portfolio rebalancing to equities has not been a strong monetary policy channel in the euro area (see Koijen, Koulischer, Nguyen and Yogo, 2017).

The remainder of the paper is as follows. Section 2 explains the theoretical framework and empirical strategy. It is divided into three subsections. The first presents the general theoretical model, the second the empirical strategy and the third briefly reviews the main results of the previous literature. Section 3 presents the data and explains the econometric methods. It is also divided into three subsections, where the first focuses on the time-variation of risk-premia and

[7] Bernanke and Kuttner (2005) report the response of excess returns in Figure 6 of their paper. They study the effect roughly two years after the shock.

two latter explain the econometric methods to analyse how monetary policy has affected the risk premia. Section 4 shows the VAR and local projection results. Section 5 provides some additional results. Section 6 concludes.

2. Monetary policy and equity premia

2.1 Theoretical framework

The value of a stock at time 0 can be expressed as:

$$P_0 = E_0\left[\sum_{t=1}^{n} m_{0,t} D_t + m_{0,n} P_n\right], \tag{1}$$

where $m_{0,t}$ is the stochastic discount factor and D_t is the expected dividend. The specific form of the $m_{0,t}$ depends on the assumptions regarding the investors' preferences. An alternative expression for the stochastic discount factor is $m_{0,t} = \prod_{i=1}^{t} \frac{1}{(1+r_i)}$, where r_i is the required rate of return.[8] Risk premium is the difference between the required rate of return and the risk-free rate: $r_i^{excess} = r_i - r_i^{risk-free}$.

2.2 Solving for the implied risk premia

I use two approaches to solve for the implied risk premia. The first one gives an approximation of the long-run average premium (see e.g. Fama and French, 2015). The second one allows me to solve for the horizon specific premia.

For the first approach, I assume that expected dividends, D_t, grow at constant rate, g, after the period n, and that the discount rate, r, is the same for all the horizons. This r approximates the (time-varying) long-run average risk premium. With these assumptions, equation (1) simplifies to:

$$P_0 = E_0\left[\frac{D_1}{1+r} + \frac{D_2}{(1+r)^2} + \cdots + \frac{D_n}{(1+r)^n} + \frac{\frac{D_{n+1}}{r-g}}{(1+r)^n}\right]. \tag{2}$$

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[8] This expression follows from the definition of return: $r_1 = \frac{P_1 - P_0 + D_1}{P_0}$. This can be rearranged as: $P_0 = \frac{D_1 + P_1}{1+r_1}$. Using rational expectations one can solve this forward: $P_0 = E_0\left[\frac{D_1}{1+r_1} + \frac{D_2 + P_2}{(1+r_1)(1+r_2)}\right]$. Here, for example, $\frac{1}{(1+r_1)(1+r_2)} = m_{0,2}$.

If the market price of the share and the dividend expectations are known, r can be solved numerically period after period. This gives an approximation how the expected long-run average return varies over time. Subtracting some proxy for the risk-free rate gives an estimate for the risk premium

The second approach relates dividend expectations to the prices of dividend future contracts. Dividend futures are contracts that allow one to buy the dividends of a specific year.[9] The cash flows are paid at the end of the year. Assuming no-arbitrage, the price of the dividend future at time 0 that matures after h years is given by[10]:

$$F_{0,h}^{DivFut} = e^{-\sum_{i=1}^{h} r_i^{excess}} E_0[D_h]. \tag{3}$$

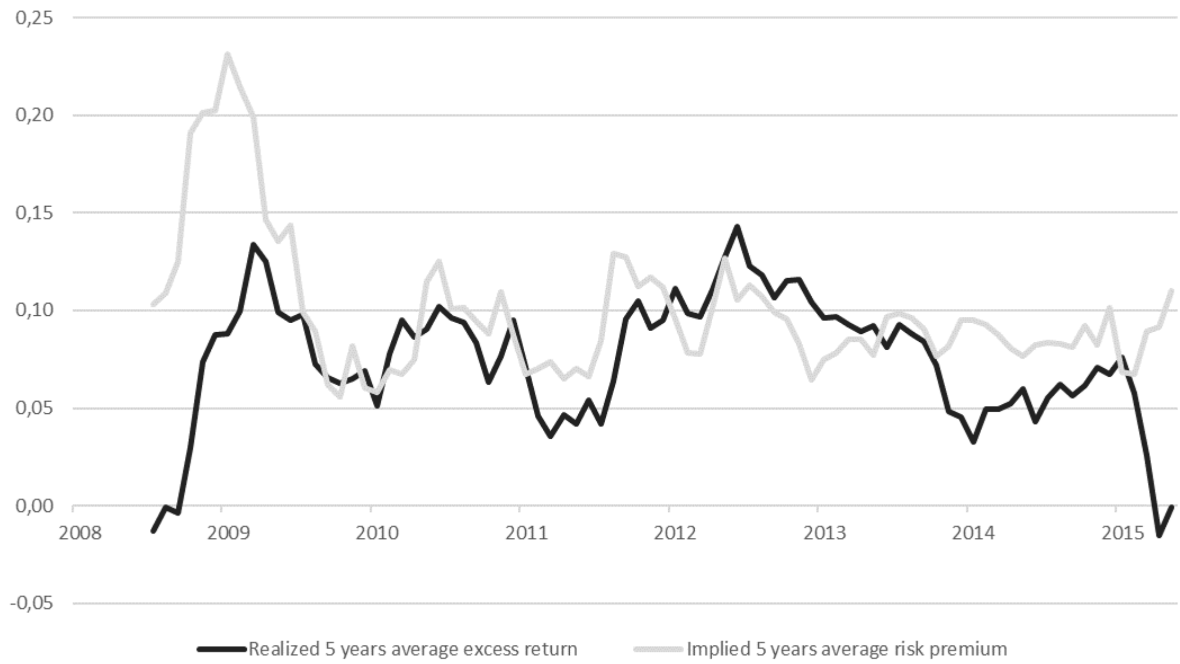
The discount rate is equal to the premium, r_i^{excess}, because the cash flows are paid at the maturity.[11] This means that the future contract does not tie up money. Thus, the buyer of the future receives the risk-free return in excess to the return of the future contract. The price of the dividend future, considering the dividends of the next 12 months, is $F_{0,1}^{DivFut} = e^{-r_1^{excess}} E_0[D_1]$. Accordingly, the price of the future considering the dividends 12 to 24 months ahead is $F_{0,2}^{DivFut} = e^{-(r_1^{excess}+r_2^{excess})} E_0[D_2]$ and so forth. Therefore, knowing the prices and the dividend expectations, one can solve horizon-specific expected premia beginning from r_1^{excess}.

2.3 The role of monetary policy

The previous literature considering the effects of monetary policy on stock market risk premia is actually analysed the effects on realized excess returns (e.g. Bernanke and Kuttner, 2005). Ex-ante risk premia and realized excess returns are related, but the two may sometimes differ

[9] Wilkens and Wimschulte (2010) and Lamponi and Latto (2017) provide a good overview of these instruments and their pricing.
[10] See Binsbergen et al. (2013) for details.
[11] For example, the future or forward price (the price one observes) of a dividend future contract maturing after one year is: $F_{0,1}^{DivFut} = e^{-(r_1^{risk-free}+r_1^{excess})} E_0[D_1] e^{r_1^{risk-free}} = e^{-r_1^{excess}} E_0[D_1]$. See also Binsbergen et al. (2013, p. 504-505).

Figure 1. *Expected and realized stock market premia of Eurostoxx 50 index. The expected premia are based on analysts' dividend forecasts, Eurostoxx 50 dividend futures and application of equation (3). More details are given in Section 3. The realized return is calculated from log-differences of Eurostoxx 50 gross return index, which takes into account paid dividends. The German 1-year yield is used as the risk-free rate measure.*



considerably. Figure 1 shows the development of implied 5-year average stock market risk premium based on equation (3) together with the realized stock market excess return.[12] For example, during the financial crisis of 2008 investors were pricing a roughly 20 percent risk premium. Yet, the actual realized excess returns were much lower. Thus, realized excess returns after the financial crisis tell little about stock market valuation during the financial crisis.

The variation in implied premia has roughly speaking two alternative interpretations. Consumption-based models suggest that the risk premium should be determined by investors' risk aversion and the covariance between premium and consumption growth (e.g. Cochrane, 2011). On the other hand, if investors were risk-neutral, any implied premium would mean mispricing. For example, Galí (2014) and Galí and Gambetti (2015) use the risk-neutrality assumption and interpret all deviations from risk-free return as a bubble.

[12] Details about empirical implementation are given in Section 3.

When it comes to the effect of monetary policy on stock prices, there are many empirical papers documenting that expansionary monetary policy increases the prices of stocks (e.g. Patelis, 1997; Bernanke and Kuttner, 2005). Theoretically, this is not entirely clear. Monetary policy can affect equity prices through the dividend expectations, expected risk-free rates or risk premia. The effect of expansionary monetary policy on the dividend expectations is probably positive, because expansionary monetary policy can be expected to increase output and firms' earnings. Expansionary policy probably lowers the risk-free rates, but it is also possible that the effect is different. Central bank's rate cut can increase risk-free rates, if people think that the rate cut eventually increases inflation. As for the expected premium, the sign of the effect is unclear.

Gust and López-Salido (2014) show theoretically that expansionary monetary policy lowers the premium in a DSGE model where asset and goods markets are segmented. When it comes to quantitative easing, one channel through which it could affect the expected premium is portfolio balance channel (Tobin, 1958; Tobin, 1969). Investors who have sold their assets to the central bank rebalance their portfolios into riskier assets, which lowers their expected returns. The evidence for such portfolio rebalancing to equities is not very supportive.[13]

Theoretically, it is also possible to argue that monetary policy easing actually increases the risk premia implied by equation (2) an (3). If one assumes that there exists mispricing like Galí (2014) and Galí and Gambetti (2015), then the sign of the response is ambiguous. Galí and Gambetti (2015) provide some evidence that expansionary monetary policy may actually decrease the potential stock market bubble. This means that monetary policy easing increases the risk premium implied by dividend discount model (see Galí and Gambetti, 2015, p. 250-252).

[13] Joyce, Liu and Tonks (2017) find that the quantitative easing in the United Kingdom has not led to portfolio rebalancing to equities. Koijen et al. (2017) find similar results for the euro area.

3. Data and empirical methods

3.1 Risk premia

To solve the implied risk premia, I use equations (2) and (3). First, I apply equation (2) to the Eurostoxx 50 stock market index and analysts' consensus forecasts for future dividends. Given the stock market index and aggregated dividend forecasts, I solve the expected annual rate of return, r. Further, the variation in expected return can be divided into variation in risk-free rate and stock market risk premium using some proxy for the risk-free rate. As a proxy for the risk-free rate, I use Germany's 10-year government bond yield following Claus and Thomas (2001), Gebhardt et al. (2001) and Damodaran (2020). The reason for using a long rather than a short rate is that the rate should represent the average expected risk-free rate.[14] All these data are from Bloomberg and cover the period from 06/2006 to 04/2020.

From Bloomberg, I obtain year-specific dividend forecasts. I calculate the 12- and 24-month-forward dividend expectations (D_1 and D_2) as a weighted average of year-specific forecasts.[15] Additionally, analysts' forecast average earnings per share growth rate after 3–5 years. I assume that dividend payout ratio remains constant meaning that earnings per share growth rate can be used to calculate dividends: D_3, D_4, D_5 and D_{5+1}.[16] I assume that the expected long-run dividend growth rate, g, equals the historical average of the analysts' expected earnings per share growth rate in the sample (4.5 percent).[17]

[14] Alternatively, one could use different interest rates for different horizons. However, Claus and Thomas (2001) conclude that the results are almost identical. Therefore, for the sake of transparency, I use one interest rate.
[15] For example, I calculate the 12-months-ahead dividend forecast in April 2020 as follows: $(8 * Dividend\ forecast\ for\ the\ year\ 2020 + 4 * Dividend\ forecast\ for\ the\ year\ 2021)/12$.
[16] As the data about the average future earnings per share growth rate are rather noisy, I use a 12-month moving average to smooth the series. In addition, I remove clearly unrealistic extreme values (values below -30 percent and greater than 30 percent).
[17] This assumption affects mainly the level of risk premium, but not so much the variation of premium. It is also possible that there has been variation in the expected long-run growth. This issue is assessed in Appendix C. The results show that the long-rung growth rate expectation should have declined more than 4 percentage points after the financial crisis to affect the conclusions of this paper.

Figure 2. *Solved expected rate of return and expected premium. The variables are solved applying equation (2) to Eurostoxx 50 stock market index and analysts' consensus forecasts in the period from 06/2006 to 04/2020.*

With these assumptions, the only unknown variable in equation (2) is r. This variable can be solved for every month in the sample. Subtracting Germany's 10-year government bond yield, I get an estimate for the expected average annual stock market premium in each month. The developments of the expected rate of return and expected premium are presented in Figure 2.

In the sample, the average expected premium, r^{excess}, is 7.3 percent and the average expected return, r, is 9.0 percent. These results are in line with the previous estimates based on a similar methodology.[18] Notably, the expected rate of return for equities has remained rather stable since the 2008 financial crisis, even as risk-free rates have declined substantially. This means that the expected premium over the risk-free rates has increased considerably since the crisis.[19]

[18] Claus and Thomas (2001) and Gebhardt et al. (2001) find that the average expected premium has been around 3 percent. However, recent estimates by Damodaran (2020) for the S&P 500 are quite similar to my results. The estimates for the S&P 500 suggest that the expected premium can deviate from its long-run average for many years. The expected premium in the United States was quite high during the 1970s and quite low during the 1990s (consistently with the results of Claus and Thomas (2001) and Gebhardt et al. (2001)). After the financial crisis, the expected premium has been very high in the United States and has exhibited an upward trend like in Europe.

[19] One potential explanation for this is that the long-run expected dividend growth rate, g, which is assumed constant, has declined. Appendix C studies this potential explanation. The results show that it is unlikely that the

Figure 3*. Year-specific expected premia implied by Eurostoxx 50 dividend futures and analysts' dividend forecast from 7/2008 to 4/2020.*

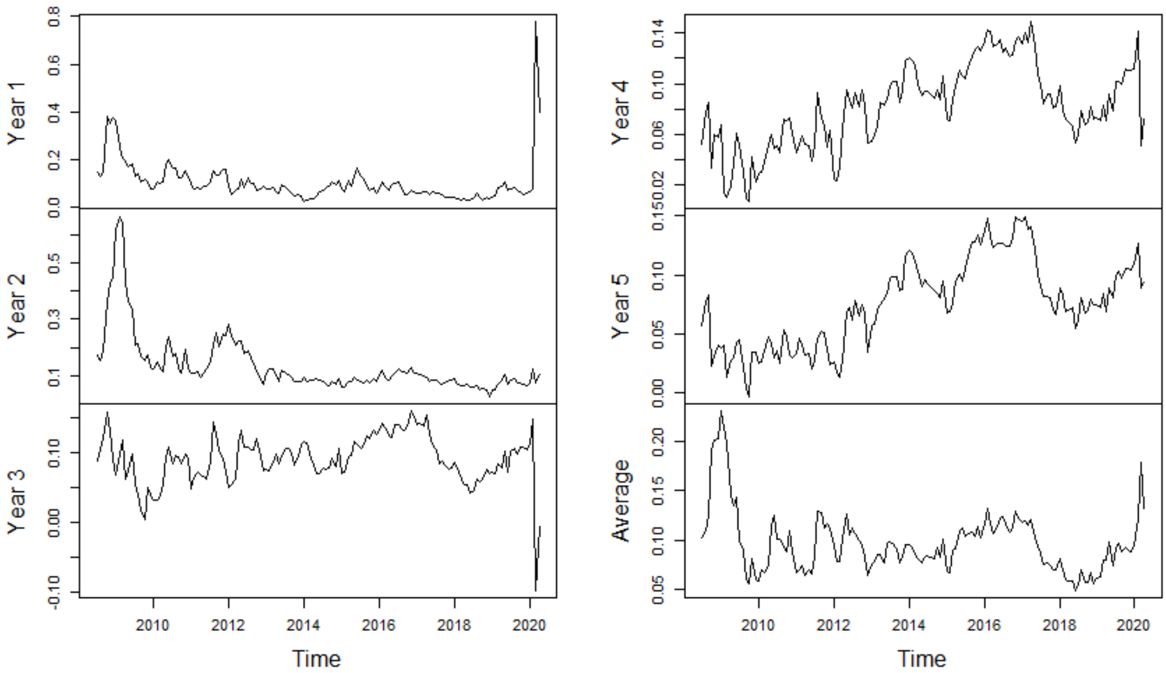


Table 1. *Summary statistics of the year-specific expected premia implied by Eurostoxx 50 dividend futures and analysts' dividend forecast. The observation period runs from 7/2008 to 4/2020.*

	Year 1	Year 2	Year 3	Year 4	Year 5
Mean	0.10	0.14	0.09	0.08	0.08
Median	0.08	0.10	0.09	0.08	0.08
SD	0.09	0.11	0.04	0.03	0.04

As was discussed earlier, expected returns differ across discounting horizons. To solve the horizon-specific risk premia, I apply equation (3) to the prices of Eurostoxx 50 dividend futures and analysts' dividend forecasts. A bit similar approach is used by Binsbergen et al. (2013).[20] I calculate the prices of 1, 2, 3, 4 and 5 years ahead dividend futures by taking the weighted average of the observed future prices.[21] Then, I calculate the implied expected premia for every

decline in very long-run expectations would explain the result. If one argues that the equity premium has not risen, it would mean that the long-run expected growth rate should have declined more than 4 percentage points.

[20] The key difference between this paper and the paper by Binsbergen et al. (2013) is that Binsbergen et al. (2013) use regression-based dividend forecasts instead of analysts' forecasts.

[21] For example, I calculate the price of the 1-year-ahead dividend future in April 2020 as follows: $(8 * Price\ of\ the\ future\ maturing\ in\ 2020 + 4 * Price\ of\ the\ future\ maturing\ in\ 2021)/12$.

horizon beginning from the 12-month discounting horizon. The data about the dividend futures are from 7/2008 to 4/2020 and have been collected from Bloomberg. The solved expected premia are shown in Figure 3. Key summary statistics appear in Table 1.

The results support the findings of Binsbergen, Brandt and Koijen (2012), Binsbergen et al. (2013) and Binsbergen and Koijen (2017). The variation in the expected premium is related mostly to the near future. The standard deviation of the year 1 premium is 0.09 and the standard deviation of the year 5 premium is 0.04. Year 1 premia on average are also higher than year 5 premia. The slope of the premium curve seems to be pro-cyclical as well. The premium for the year 2 has been the highest and the most volatile in this sample. This result is largely driven by the financial crisis, during which the year 2 premium reacted most strongly. This situation has been quite different during the covid-19 crisis. In March 2020, the year 1 premium climbed to about 80 percent, even as the year 2 premium remained at 8 percent.

One can also see that the premia of the years 4 and 5 exhibit similar upward trend as the premium implied by equation (2). Thus, these results are in line with the earlier conclusion that the average risk premium has increased after the financial crisis. Further, the results suggest that the rise in average premium is mainly driven by long-horizon expected premia.

3.2 VAR model

I start with an analysis of the effects of monetary policy using VAR models. A VAR model can be written in reduced-form as:

$$y_t = c + A(L)y_{t-1} + \mathrm{u}_t, \tag{4}$$

where y_t is $n\ x$ 1 vector of endogenous variables, c is $n\ x$ 1 vector of constants, $A(L)$ is $n\ x\ n$ matrix of lag polynomials and $\mathrm{u}_t = B\varepsilon_t$ is $n\ x$ 1 vector of error terms. B is $n\ x\ n$ matrix that relates error terms to structural shocks, ε_t, which are of interest.

In the baseline model, the stance of monetary policy is measured using the shadow rate proposed by Kortela (2016). The shadow rate permits analysis of the overall effect of monetary policy during a time when policy rates have been close to their effective lower bound. The use of shadow rates has been standard approach in recent macroeconomic literature (e.g. Wu and Xia, 2016). In the baseline model, y_t includes year-over-year changes in $\log(Industrial\ production)$ and $\log(Harmonised\ Index\ of\ Consumer\ Prices)$, the level of equity premium and the shadow rate. Industrial production and inflation are included as the monetary policy decisions are affected by the changes in real activity and price stability. The baseline model includes two lags. Many other model specifications are considered in Appendix A. As an estimate for risk premium, I consider the premium implied by equation (2) and the horizon-specific premia implied by dividend futures and equation (3). The data about industrial production and consumer prices are from Eurostat. The data cover the period from 06/2006 to 04/2020 except for horizon-specific premia that are not available before 7/2008.

I identify monetary policy shock using sign restrictions and standard rejection method of Rubio-Ramirez, Waggoner and Zha (2010).[22] I assume that negative monetary policy shock increases the growth in industrial production and consumer prices. These sign restrictions are assumed to hold the first nine months. The effect on shadow rate itself is also restricted negative for the first nine months. These restrictions are consistent with for example the results by Bernanke, Boivin, and Eliasz (2005) and Wu and Xia (2016). Alternative restrictions are considered in Appendix A.

3.3 Local projections

Second, I use intraday OIS-rate changes around the time of ECB Governing Council announcements as a proxy for monetary policy shocks. These OIS-rate changes are obtained

[22] The basic idea in sign restrictions is to randomly generate impulse response functions and store the impulse responses that are in line with sign restrictions. To implement the method, I use the MATLAB toolbox by Ferroni and Canova (2020). The documentation of the toolbox explains the practical implementation of the method in more detail.

from EA-MPD (see Altavilla et al., 2019).[23] I use change in the median quote from the 13:25-13:35 window before the press release to the median quote in the 15:40-15:50 window after the press conference. Assuming these changes represent exogenous variation in the ECB's monetary policy, one can assess the effect of monetary policy on different premia by estimating the following model for different horizons using OLS:

$$r_{t+h}^{excess} = \alpha_h + \gamma_h(L) r_{t-1}^{excess} + \beta_h Surprise_t + \epsilon_{t+h} \quad (5)$$

In the model, α_h is a constant, $\gamma_h(L)$ is a lag-polynomial, ϵ_{t+h} is an error term and $Surprise_t$ is the OIS-rate change. EA-MPD covers surprise changes in many different maturities. In this paper, the aim is not to distinguish between conventional and unconventional policies. Therefore, I use the average of available intraday OIS-rate changes as the monetary policy shock.[24]

4. Results

4.1 VAR results

Figures 4, 5 and 6 show the impulse responses to a negative shadow rate shock in three models with different expected premia.[25] In Figure 4, the premium is the one implied by equation (2). In Figure 5, the premium is the premium for the year 1 implied by dividend futures and equation (3). In Figure 6, the premium is for the year 5.

The responses of industrial production and consumer prices comport with the literature (e.g. Bernanke et al., 2005). The effects on growth rates are first positive, and then negative after about 20 months. The effects of the shock disappear after about five years. The responses of short-term and long-term premia have opposite signs. Expansionary monetary policy lowers

[23] I assume that the value of the shock was zero if there was no announcement during the month. If there were two announcements, I calculate the average of the two.
[24] I use OIS_1W, OIS_1M, OIS_3M, OIS_6M, OIS_1Y, OIS_2Y, OIS_3Y because those are available for the whole period (06/2006–04/2020).
[25] Multiple robustness checks are provided in Appendix A.

the short-term expected premium temporarily (Figure 5), while the responses of long-run average expected premium and year 5 premia are positive and persistent (Figure 6). The response of average premium is positive, indicating long-horizon premia drive the response (Figure 4).

The response of the year 1 premium is consistent with the evidence based on realized returns presented in Bernanke and Kuttner (2005). Notably, the effect on discounting dividends in the remote future suggests that expansionary monetary policy makes the long-run dividend stream riskier or reduces the size of the stock market bubble in line with the results of Galí (2014) and Galí and Gambetti (2015). One explanation for the results is also that analysts' dividend expectations, and thus, implied expected premia are not rational (Greenwood and Shleifer, 2014). It is also possible that monetary policy affects long-run expected premium somehow through expected inflation (e.g. Modigliani and Cohn, 1979; Schotman and Schweitzer, 2000).

Whatever the theoretical explanation is, the empirical results are robust (see Appendix A). The results do not depend on the model specification or on the used sign restrictions. The chosen shadow rate estimate is not crucial to the results. The results remain the same even though one uses the shadow rate by Krippner (2015) or Wu and Xia (2016). A possible delay in the update of analysts' expectation does not seem to drive the results either. The effects seem not to vary over time.

Figure 4. *The impulse response functions to a one standard deviation negative shock to the shadow rate in the model in which the premium is the long-run average expected premium implied by equation (2). Sign restrictions are imposed on DlogIP, DlogHICP and SR for the periods 1-9. The shaded area represents the 68 % confidence interval. The number of lags is 2.*

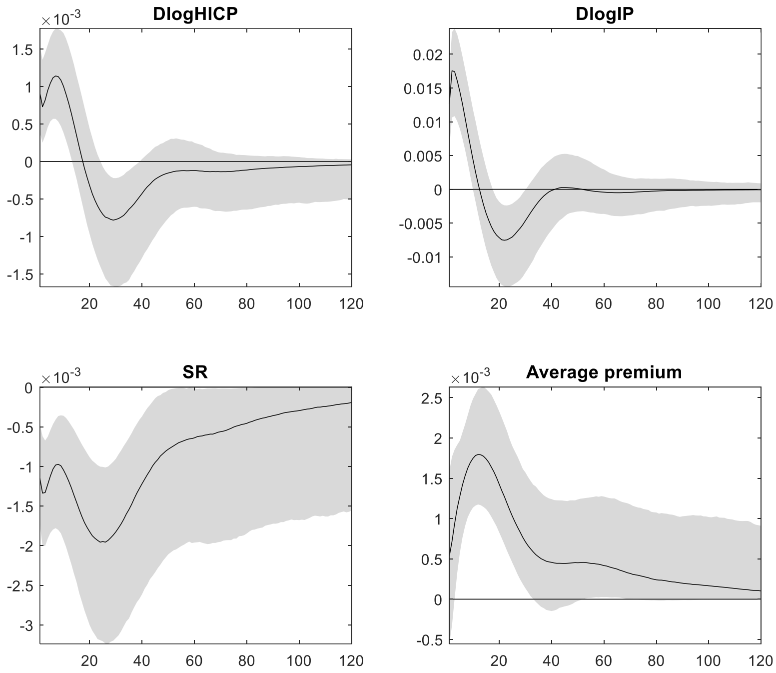


Figure 5*. The impulse response functions to a one standard deviation negative shock to the shadow rate in the model in which the premium is the year 1 premium implied by equation (3) and dividend futures. Sign restrictions are imposed on DlogIP, DlogHICP and SR for the periods 1-9. The shaded area represents the 68 % confidence interval. The number of lags is 2.*

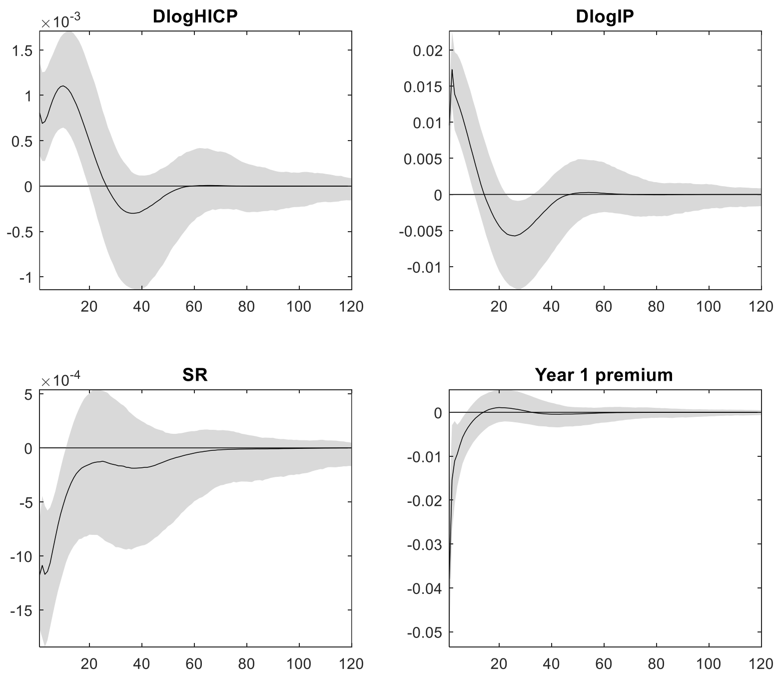


Figure 6*. The impulse response functions to a one standard deviation negative shock to the shadow rate in the model in which the premium is the year 5 premium implied by equation (3) and dividend futures. Sign restrictions are imposed to DlogIP, DlogHICP and SR for the periods 1-9. The shaded area represents the 68 % confidence interval. The number of lags is 2.*

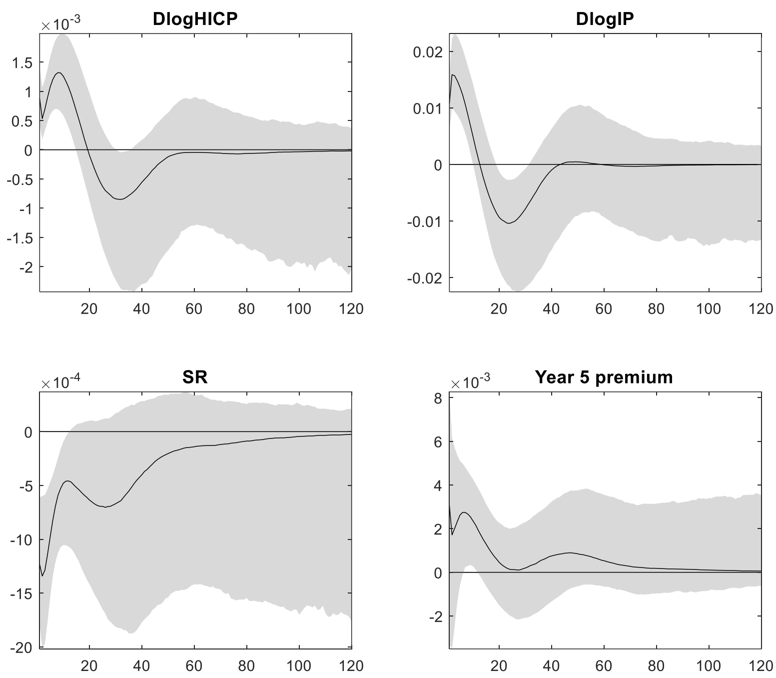


Figure 7*. The local-projection-based impulse response function of the long-run average expected premium implied by equation (2). The number of lags in the model is 3.*

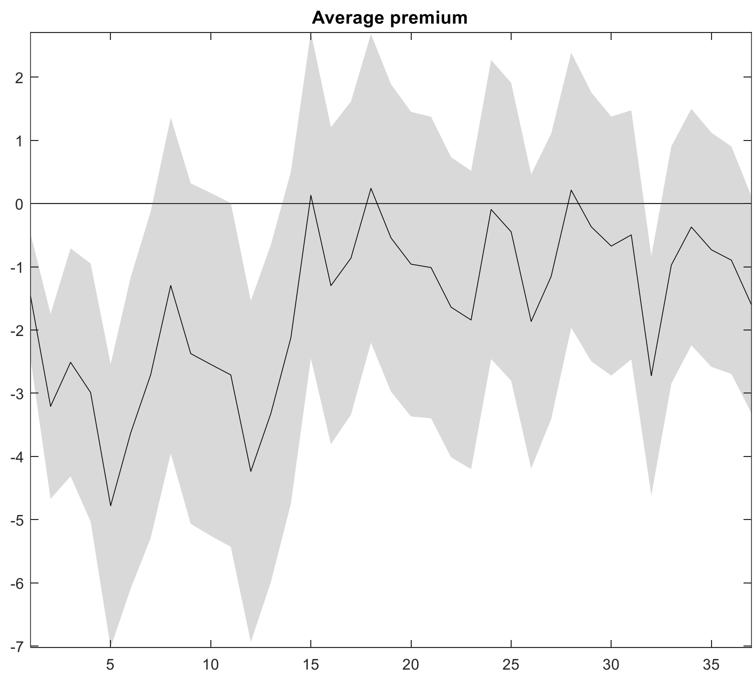


Figure 8*. The local-projection-based impulse response function of the expected year 1 premium implied by equation (3). The number of lags in the model is 3.*

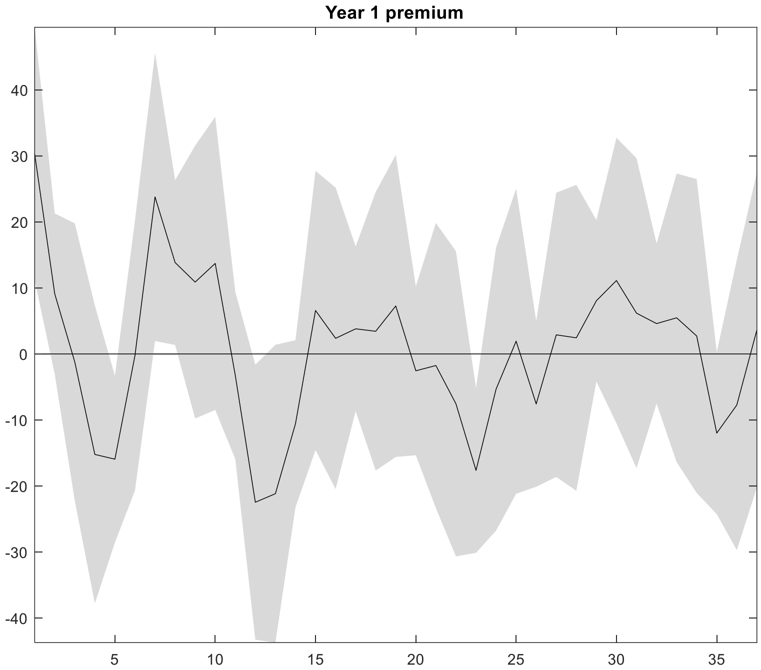
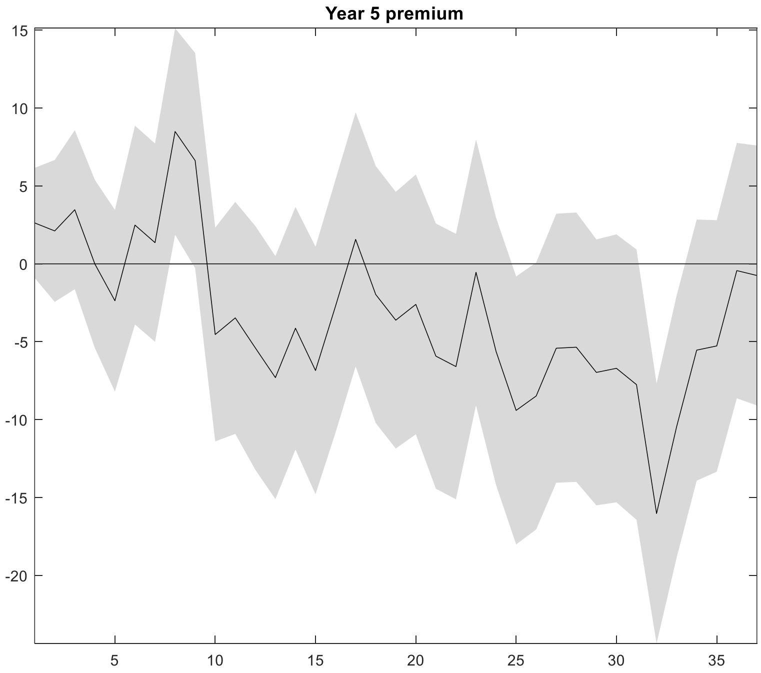


Figure 9. *The local-projection-based impulse response function of the expected year 5 premium implied by equation (3). The number of lags in the model is 3.*



4.2 Local projection results

Figure 7 shows the estimated response of expected long-run average premium implied by equation (2) to monetary policy tightening.[26] The sign of the response agrees with the VAR results. A rate hike seems to make stocks expensive in comparison to the expected stream of dividends. Figures 8 and 9 report the estimated responses of the year 1 and the year 5 premia. As in the previous section, the year 1 premium reacts immediately, but the effect is short-lived. The response of the year 5 premium is also in line with the earlier VAR results.

5. Some additional evidence using long-run data

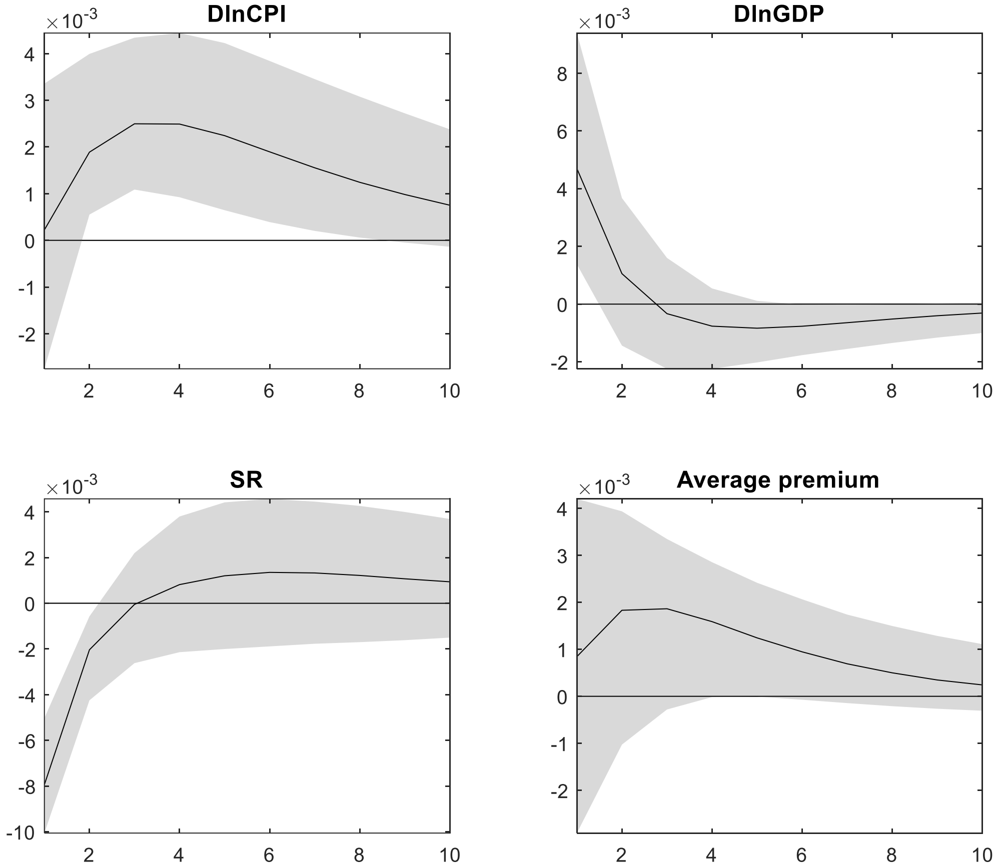
One may suspect that the results shown in the previous section depend on some specific choices made in the calculation of implied premia. The analysed time period is also limited, and the analysis has focused on the euro area. To show that these possible doubts are not justified, I run the following additional exercise.

Damodaran provides a dataset that includes equity premium estimate for the United States from 1961 to 2019 at the annual level.[27] The method used for the calculation of implied premium is described by Damodaran (2020). Basically, the method is very similar to my approach, in which I apply equation (2). The premium can be interpreted as an expected long-run average premium. I include this variable into a VAR model together with the measure of monetary policy and the changes in logarithms of CPI and GDP. As a measure of monetary policy, I use the shadow rate by Krippner (2015). In practice, this variable is equal to the effective fed funds rate most of the time. The model includes 1 lag and a constant. I identify the monetary policy shock using sign restrictions. I assume that a negative monetary policy shock has a positive effect on CPI and

[26] Some robustness checks are provided in Appendix B.

[27] http://pages.stern.nyu.edu/~adamodar/.

Figure 10. The impulse response functions to a one standard deviation negative shock to the shadow rate in the model in which the premium is the long-run average expected premium by Damodaran (2020). Sign restrictions are imposed on DlogIP, DlogHICP and SR for the first period. The shaded area represents the 68 % confidence interval. The number of lags is 1. The data are from 1961 to 2019 and from the United States.



GDP one period after the shock. The sign restriction to the shadow rate is imposed only to the first period.

The results are shown in Figure 10. The impulse response function of the premium is very similar to the impulse response function in Figure 4. The response is positive, and it lasts about a decade.

6. Conclusions

Interest rates have declined considerably since the global financial crisis, yet the expected average stock market return has remained quite stable at around 9 percent. This implies that expected average stock market premium has increased remarkably. This rise is mainly driven by the premia over a discounting horizon of four years.

These results may seem unintuitive as the prices of stocks have risen, and ratios like price-to-earnings have been historically high. However, high price-to-earnings ratios or low dividend yields do not necessarily mean that stocks are expensive, because the value of a stock is the present value of its *future dividends*.

When it comes to the role of monetary policy, the results show that monetary policy easing decreases short-horizon required premia, but increases longer-horizon premia. The effect on expected average premium is positive, i.e. expansionary monetary policy makes the prices of stocks cheap in comparison to the expected dividend stream and risk-free rates.

These results may raise more questions than provide answers. They underline the fact that the effect of monetary policy on stock market valuation is a puzzle that has not been solved yet.

References

Altavilla, C., Brugnolini, L., Gürkaynak, R. S., Motto, R., & Ragusa, G. (2019). Measuring euro area monetary policy. *Journal of Monetary Economics*, 108, 162-179.

Berg, T. (2010). The Term Structure of Risk Premia: New Evidence from the Financial Crisis. *European Central Banking Working Paper,* No. 1165.

Berg, T. and C. Kaserer (2013). Extracting the Equity Premium from CDS Spreads. *Journal of Derivatives*, 21(1), 8-26.

Bernanke, B.S., Boivin, J. and Eliasz, P. (2005). Measuring the effects of monetary policy: a factor-augmented vector autoregressive (FAVAR) approach. *Quarterly Journal of Economics*, 120(1), 387-422.

Bernanke, B.S. Kuttner, K.N. (2005). What explains the stock market's reaction to Federal Reserve policy? *Journal of Finance*, 60(3), 1221-1257.

Binsbergen, J., Brandt, M. and Koijen, R. (2012). On the timing and pricing of dividends. *American Economic Review*, 102(4), 1596-1618.

Binsbergen, J., Hueskes, W., Koijen, R. and Vrugt, E. (2013). Equity yields. *Journal of Financial Economics*, 110(3), 503-519.

Binsbergen, J.H. and Koijen, R.S. (2017). The term structure of returns: Facts and theory. *Journal of Financial Economics,* 124(1), 1-21.

Black, F. (1995). Interest rates as options. *Journal of Finance*, 50(5), 1371-1376.

Borio, C. and Zhu, H. (2012). Capital regulation, risk-taking and monetary policy: a missing link in the transmission mechanism? *Journal of Financial stability,* 8(4), 236-251.

Claus, J. and Thomas, J. (2001). Equity premia as low as three percent? Evidence from analysts' earnings forecasts for domestic and international stock markets. *Journal of Finance*, 56(5), 1629-1666.

Cochrane, J.H. (2011). Presidential address: Discount rates. *Journal of Finance*, 66(4), 1047-1108.

Damodaran, A. (2020). *Equity Risk Premiums: Determinants, Estimation and Implications – The 2020 Edition*. NYU Stern School of Business.

Fama, E. F., & French, K. R. (2015). A five-factor asset pricing model. *Journal of financial economics*, 116(1), 1-22.

Ferroni, F., Canova, F. (2020). A hitchhiker guide to empirical macro models. Mimeo, working paper.

Galí, J. (2014). Monetary policy and rational asset price bubbles. *American Economic Review,* 104(3), 721-52.

Galí, J. and Gambetti, L. (2015). The effects of monetary policy on stock market bubbles: Some evidence. *American Economic Journal: Macroeconomics*, 7(1), 233-57.

Gebhardt, W.R., Lee, C.M. and Swaminathan, B. (2001). Toward an implied cost of capital. *Journal of Accounting Research,* 39(1), 135-176.

Greenwood, R., and Shleifer, A. (2014). Expectations of returns and expected returns. *The Review of Financial Studies*, 27(3), 714-746.

Gormsen, N. J., and Koijen, R. S. (2020). Coronavirus: Impact on stock prices and growth expectations. University of Chicago, *Becker Friedman Institute for Economics Working Paper*, (2020-22).

Gust, C. and López-Salido, D. (2014). Monetary policy and the cyclicality of risk. *Journal of Monetary Economics*, 62, 59-75.

Joyce, M.A., Liu, Z. and Tonks, I. (2017). Institutional investors and the QE portfolio balance channel. *Journal of Money, Credit and Banking*, 49(6), 1225-1246.

Koijen, R.S., Koulischer, F., Nguyen, B. and Yogo, M. (2017). Euro-area quantitative easing and portfolio rebalancing. *American Economic Review*, 107(5), 621-27.

Kortela, T. (2016). A shadow rate model with time-varying lower bound of interest rates. *Bank of Finland Research Discussion Paper* 19/2016.

Krippner, L. (2015). Zero lower bound term structure modeling: A practitioner's guide. Springer.

Laine, O. (2020). The effect of the ECB's conventional monetary policy on the real economy: FAVAR-approach. *Empirical Economics*, 59(6), 2899–2924.

Lamponi, D., & Latto, D. (2017). The Life Cycle of Dividend Futures and the Dividend Risk Premium: A Practitioner's Perspective. *The Journal of Wealth Management*, 20(2), 67-75.

Modigliani, F. and Cohn, R.A. (1979). Inflation, rational valuation and the market. *Financial Analysts Journal*, 35(2), 24-44.

Patelis, A.D. (1997). Stock return predictability and the role of monetary policy. *Journal of Finance*, 52(5), 1951-1972.

Rubio-Ramirez, J., Waggoner, D.F. and Zha, T. (2010). Structural vector autoregressions: Theory of identification and algorithms for inference, *Review of Economic Studies*, 77, 665-696.

Schotman, P.C. and Schweitzer, M. (2000). Horizon sensitivity of the inflation hedge of stocks. *Journal of Empirical Finance*, 7(3-4), 301-315.

Tobin, J. (1958). Liquidity preference as behavior towards risk. *Review of Economic Studies*, 25(2), 65-86.

Tobin, J. (1969). A general equilibrium approach to monetary theory. *Journal of Money, Credit and Banking,* 1(1), 15-29.

Wilkens, S., and Wimschulte, J. (2010). The pricing of dividend futures in the European market: A first empirical analysis. *Journal of Derivatives & Hedge Funds*, 16(2), 136-143.

Williams, J.B. (1938). *The Theory of Investment Value.* Cambridge, MA, Harvard University Press.

Wu, J.C. and Xia, F.D. (2016). Measuring the macroeconomic impact of monetary policy at the zero lower bound. *Journal of Money, Credit and Banking*, 48(2-3), 253-291.

Appendix A

Figure A1 shows the results after increasing the number of lags to 4. Otherwise, the model is as in the baseline analysis. The results remain almost the same.

Figure A2 shows the results, when HICP and industrial production are in log-levels. The signs restrictions are still imposed for periods 1 to 9. The results are robust to using levels instead of differences.

One concern is that even though the data about analysts' expectations are available in rather high frequency, in practice the analysts do not update their expectations that often or there is some delay. To consider this issue, in the model of Figure A3, it is assumed that the analysts' expectations actually represent the expectations of the previous month. This does not seem to affect the results.

There are many other shadow rate estimates than the one proposed by Kortela (2016). In Figures A4 and A5, the shadow rate by Krippner (2015) and Wu and Xia (2016) are used. The results remain about the same.

Figure A6 shows that the results do not change even though one imposes the sign restriction only for the first 3 periods. The results also remain the same even though one uses recursive identification instead of sign restrictions (Figures A7 and A8).

One could also ask, what happens if I include multiple premia in the model. The results remain the same as shown in Figure A9.

There are multiple empirical papers documenting that stock prices react positively to monetary policy easing. Assuming that this really is the case, Figure A10 reports the results when the change in log ($Eurostoxx\ 50$) is included to the model and assumed to respond positively the first 2 periods after the shock. The result regarding the effect on long-run risk premium is unaffected.

Finally, there is some evidence that the effects of monetary policy may vary over time (e.g. Laine, 2020). To study this issue, I conduct a simple rolling window analysis, in which the model includes only the shadow rate and the premium implied by equation (2) in this order. Monetary policy shock is identified recursively. The length of the window is 120 months, and the window is moved 6 months at the time. The first estimation window ends in July 2016. The results are shown in Figure A11. The effect on long-run average expected premium seems not to vary over time.

Figure A1. *The impulse response functions to a one standard deviation negative shock to the shadow rate in the model in which the premium is the long-run average expected premium implied by equation (2). Sign restrictions are imposed on DlogIP, DlogHICP and SR for the periods 1-9. The shaded area represents the 68 % confidence interval. The number of lags is 4.*

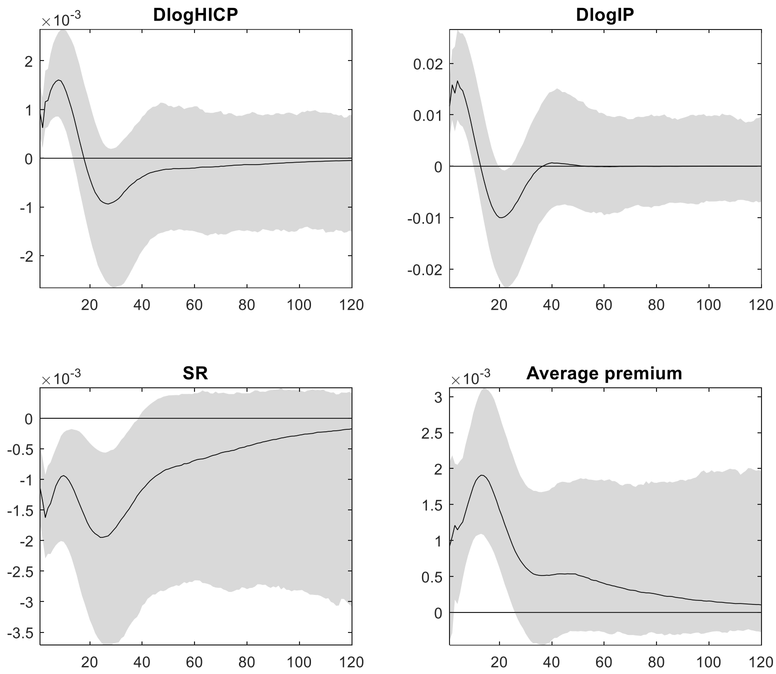


Figure A2. *The impulse response functions to a one standard deviation negative shock to the shadow rate in the model in which the premium is the long-run average expected premium implied by equation (2). Sign restrictions are imposed on logIP, logHICP and SR for the periods 1-9. The shaded area represents the 68 % confidence interval. The number of lags is 3.*

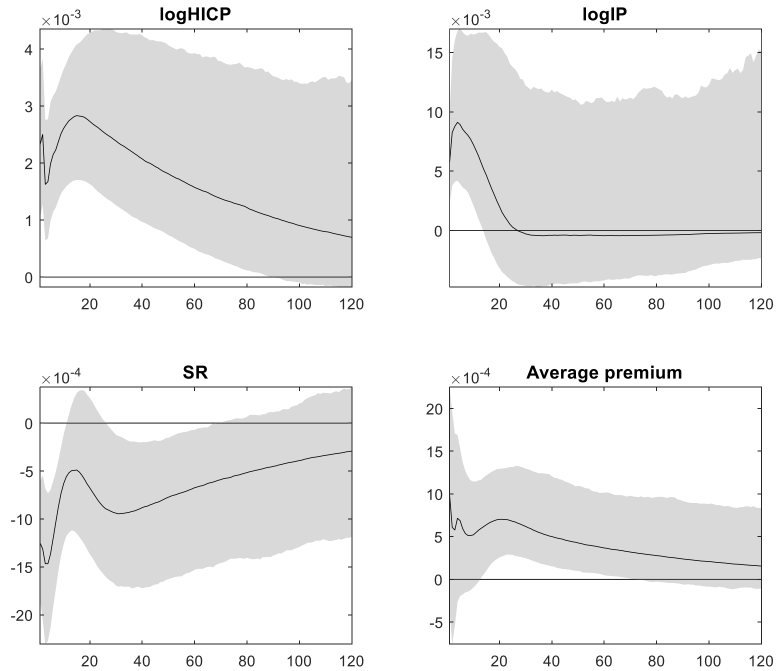


Figure A3. The impulse response functions to a one standard deviation negative shock to the shadow rate in the model in which the premium is the long-run average expected premium implied by equation (2). The analysts' dividend expectations are assumed to be updated with a lag of one month. Sign restrictions are imposed on DlogIP, DlogHICP and SR for the periods 1-9. The shaded area represents the 68 % confidence interval. The number of lags is 2.

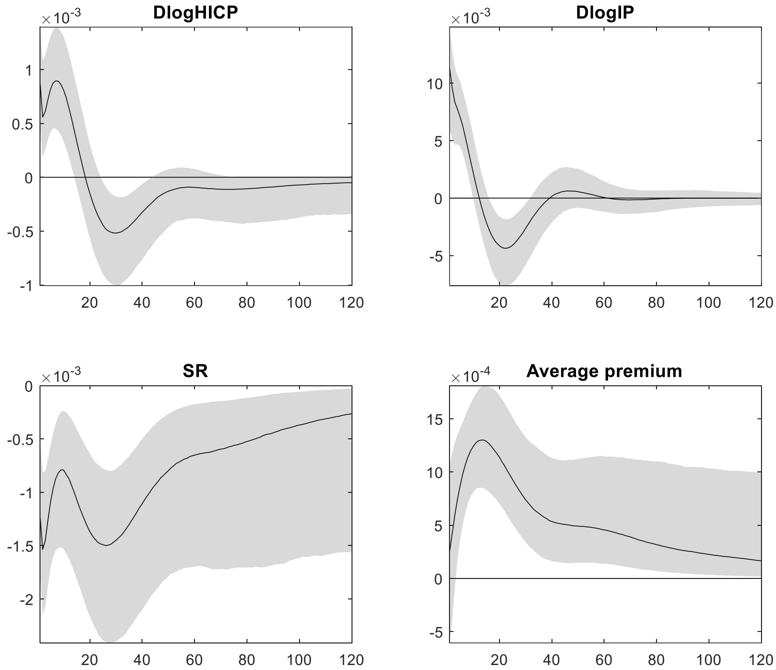


Figure A4. The impulse response functions to a one standard deviation negative shock to the shadow rate in the model in which the premium is the long-run average expected premium implied by equation (2). The shadow rate by Kortela (2016) is replaced by the shadow rate by Krippner (2015). Sign restrictions are imposed on DlogIP, DlogHICP and SR for the periods 1-9. The shaded area represents the 68 % confidence interval. The number of lags is 2.

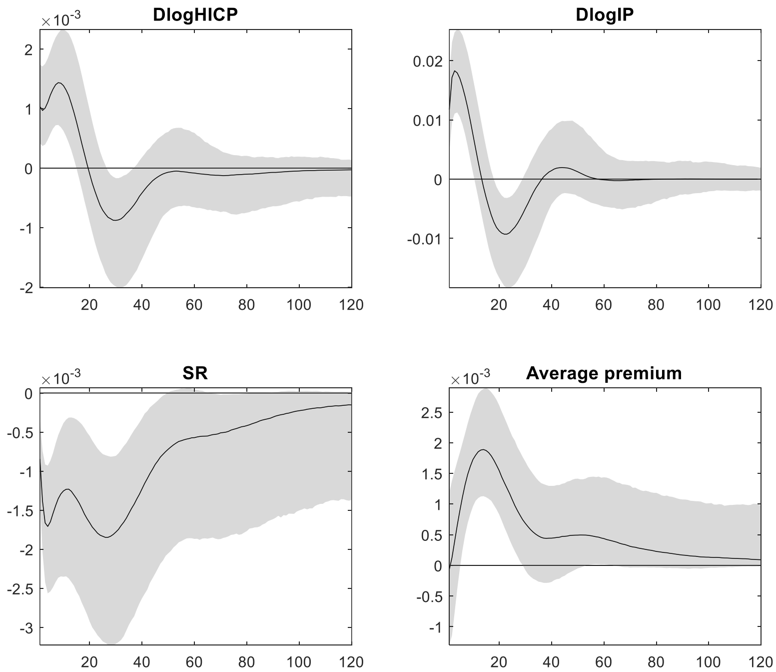


***Figure A5**. The impulse response functions to a one standard deviation negative shock to the shadow rate in the model in which the premium is the long-run average expected premium implied by equation (2). The shadow rate by Kortela (2016) is replaced by the shadow rate by Wu and Xia (2016). Sign restrictions are imposed on DlogIP, DlogHICP and SR for the periods 1-9. The shaded area represents the 68 % confidence interval. The number of lags is 2.*

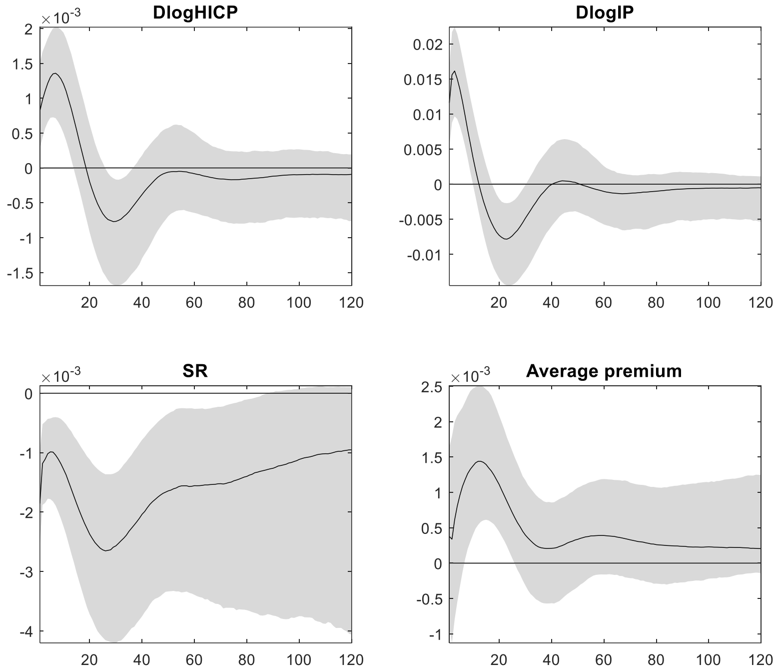


***Figure A6**. The impulse response functions to a one standard deviation negative shock to the shadow rate in the model in which the premium is the long-run average expected premium implied by equation (2). Sign restrictions are imposed on DlogIP, DlogHICP and SR. The sign restrictions are now set to hold only the first 3 periods. The shaded area represents the 68 % confidence interval. The number of lags is 2.*

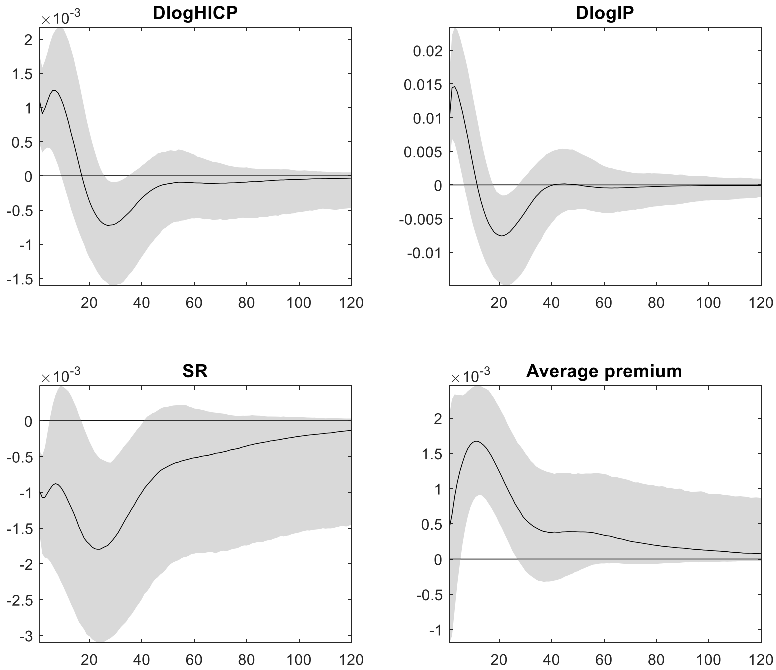


Figure A7*. The impulse response functions to a one standard deviation positive shock to the shadow rate in the model in which the premium is the long-run average expected premium implied by equation (2). The structural model is identified recursively. Average premium is ordered after the shadow rate. The shaded area represents the 68 % confidence interval. Model includes 2 lags.*

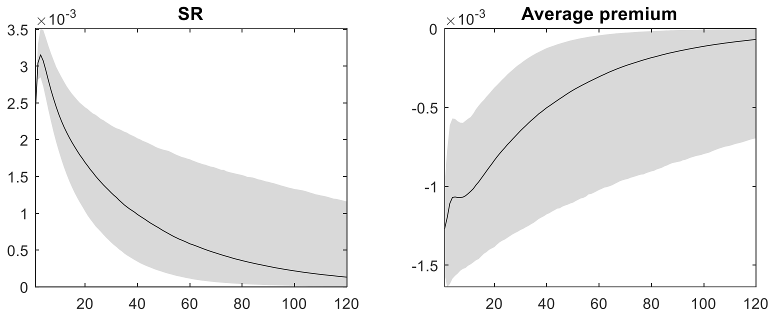


Figure A8*. The impulse response functions to a one standard deviation positive shock to the shadow rate in the model in which the premium is the long-run average expected premium implied by equation (2). The structural model is identified recursively. Average premium is ordered after the shadow rate. The shaded area represents the 68 % confidence interval. Model includes 12 lags.*

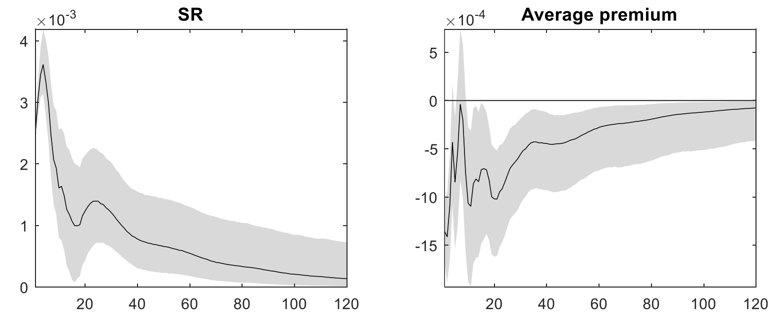


Figure A9. *The impulse response functions to a one standard deviation negative shock to the shadow rate in the model in which the premia are the long-run average expected premium implied by equation (2) and year 1 and year 5 premia implied by equation (2). Sign restrictions are imposed on DlogIP, DlogHICP and SR for the periods 1-9. The shaded area represents the 68 % confidence interval. The number of lags is 2.*

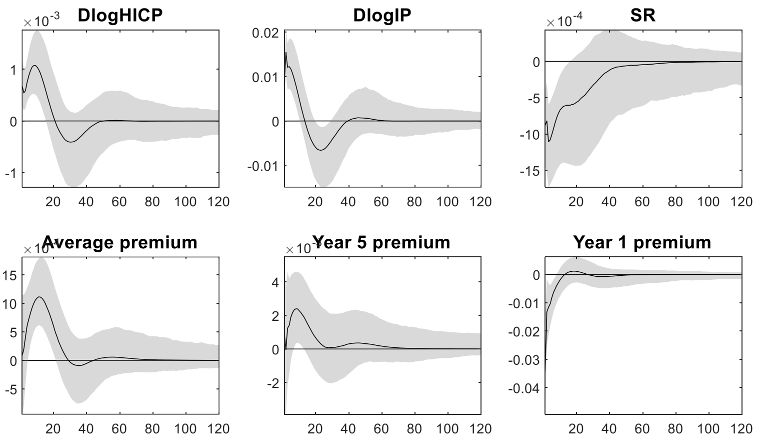


Figure A10*. The impulse response functions to a one standard deviation negative shock to the shadow rate in the model in which the premium is the long-run average expected premium implied by equation (2). The change in log(Eurostoxx 50) is included into the model. Sign restrictions are imposed on DlogIP, DlogHICP, SR for the periods 1-9 and on DlogStockPrice for the periods 1-2. The shaded area represents the 68 % confidence interval. The number of lags is 2.*

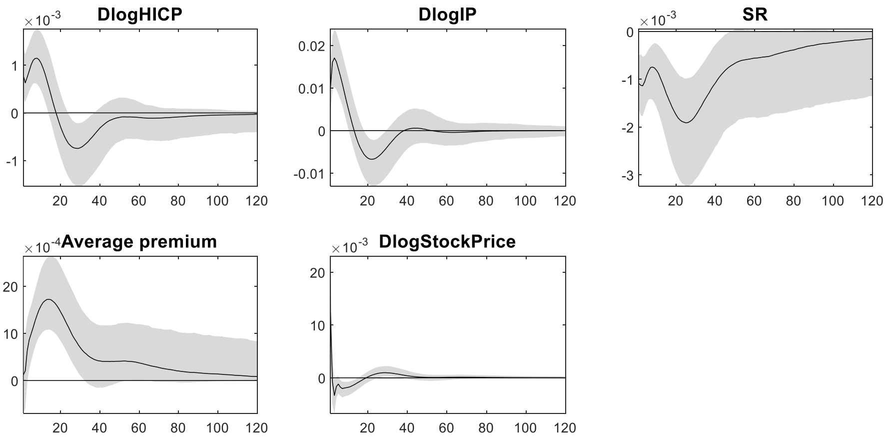
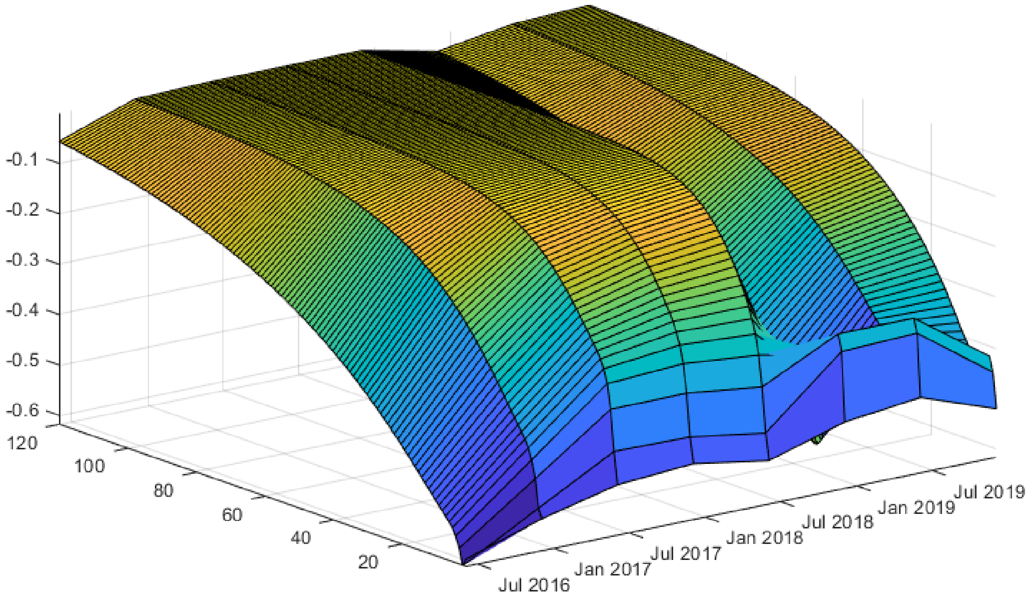


Figure A11. The time variation of the impulse response functions of the long-run average expected premium implied by equation (2) to one standard deviation positive shock to the shadow rate. The model includes SR and the premium in this order. The shock is identified recursively, and the size of the shock is normalized to 1 percent. The model has 2 lags. The dates on the axis tell the last period included in the estimation window.



Appendix B

Figures B1 and B2 show how adding more lags of the endogenous variable in equation (3) affects the results. In Figure B1, the number of lags is 6, and in Figure B2, it is 9. The results remain qualitatively the same.

***Figure B1**. The local-projection-based impulse response function of the long-run average expected premium implied by equation (2). The number of lags in the model is 6.*

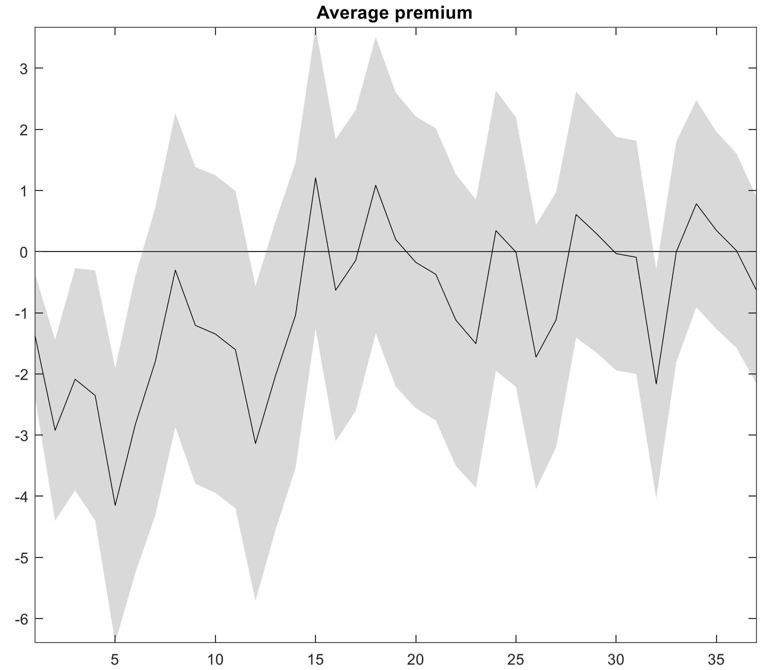
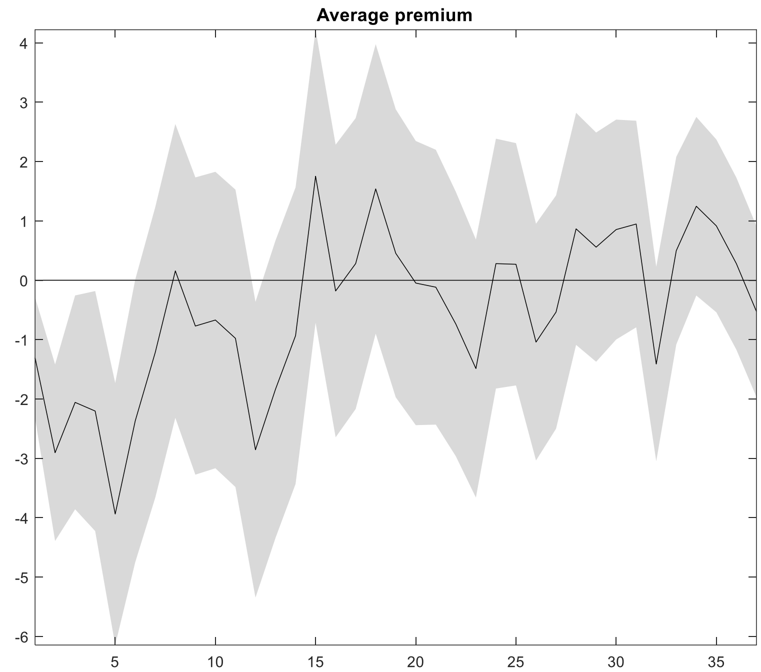


***Figure B2**. The local-projection-based impulse response function of the long-run average expected premium implied by equation (2). The number of lags in the model is 9.*



Appendix C

Figure C1 shows the development of risk premium and rate of return, when the long-run dividend growth rate, g, is assumed to have declined linearly from 4.5 percent to 0.5 percent during the period. Even in this case the risk premium seems to exhibit small upward trend. It does not seem very likely that the long-run expected growth rate would have declined more than 4 percentage points.

***Figure C1**. Solved expected rate of return and expected premium, when g is assumed to have declined from 4.5 percent to 0.5 percent. The variables are solved applying equation (2) to Eurostoxx 50 stock market index and analysts' consensus forecasts in the period from 06/2006 to 04/2020.*

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