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Abstract

This paper sheds light on Swiss franc Libor futures, which are often used to measure interest rate expectations. We show that the differences between Libor futures and realized rates (excess returns) are, on average, positive over the last 25 years. Using interest rate surveys, we decompose excess returns into a (forward) term premium and forecast errors. The decomposition reveals that the bulk of excess returns arises from forecast errors, while the term premium is time varying but on average zero. We find that the term premium positively correlates with the business cycle, interest rate developments, and in absolute values increases with interest rate uncertainty. Our findings suggest that Libor futures should be adjusted by the term premium to extract risk-neutral interest rate expectations.

JEL Classification: E43, E44, E52

Keywords: Term premium, Libor futures, Swiss franc.

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1 Introduction

Predicting the future path of monetary policy is of great importance for financial market participants. To do so, interest rate futures are widely used by researchers, analysts, and central bankers to infer expectations of future interest rates (see, for instance, Bernanke and Kuttner (2005), European Central Bank (2005), and Jordan (2012)).¹

Literature has shown that differences between interest rate futures and realized rates at maturity of the future contract, so-called excess returns, are, on average, positive (see, e.g., Piazzesi and Swanson (2008)). Thus, interest rate futures are, on average, higher than effective realizations. Moreover, excess returns can be decomposed into a (forward) term premium and forecast errors (see, e.g. Friedman (1979)).² While forecast errors result from false expectations (i.e., unexpected interest rate changes), the term premium is the markup that market participants are willing to pay to hedge against interest rate risks or to speculate on interest rate movements. Hence, interest rate futures may deviate from risk-neutral interest rate expectations due to the term premium.

To empirically identify risk-neutral interest rate expectations, survey data on interest rates expectations (interest rate survey) can be used as a proxy. Surveys cannot be traded and hence are not influenced by any term premium (see, for instance, Froot (1989)). Consequently, the term premium can simply be identified as the difference between interest rate futures and interest rate expectations derived from surveys. This also implies that the term premium is known at any time, whereas forecast errors do only materialize ex-post using effective interest rate realizations.

In this paper, we estimate excess returns in Swiss franc (CHF) interest rate futures and decompose excess returns into its two components using interest rate surveys, an analysis that has not been undertaken yet. Moreover, we contribute to the literature by shedding light on the key determinants of the term premium. The analysis is of particular interest as interest rate futures are based on the three-month CHF London Interbank Offered Rate (Libor), which serves as the monetary policy target rate for the Swiss National Bank (SNB). Therefore, CHF Libor futures are often used as an indicator of market participants' expectations of SNB's future monetary policy and its "correct" interpretation is relevant for market participants and policy makers.

The key findings from our analysis are as follows. First, we show that excess returns in CHF Libor futures are, over the last 25 years, on average positive and statistically significant which is in line with the existing literature. Being more concrete, our analysis highlights that Libor futures with a maturity date in three (twelve) months contain an average excess return of 12 (63) basis points (bps). Therefore, interest rates implied by CHF Libor futures are in the long run significantly higher than realized rates. Second, we find that for CHF Libor futures the term premium is, on average, close to zero but time varying, while forecast errors are positive on average. Positive forecast errors result in our sample period as market participants have been surprised by unexpected economic downturns and corresponding interest rate declines. Third, we show that the term premium in CHF Libor futures has been persistently negative between 2010 and 2016. Thus, there is evidence that in a period with close to zero or negative interest rates, market participants pay a premium to insure themselves against interest rate cuts. Fourth, we

¹The Chicago Mercantile Exchange describes Eurodollar futures with the following words: "Eurodollar futures prices reflect market expectations for interest rates on three-month Eurodollar deposits for specific dates in the future.". See: www.cmegroup.com/trading/interest-rates/introduction-to-eurodollar-futures-and-options.html

²We use for simplicity the notion term premium instead of forward term premium, which would be more precise as we analyze standardized interest rate forward contracts. Note that the terminology used in the existing literature is not homogeneous. For example, the term premium is sometimes called "risk premium" (Ferrero and Nobili, 2009), "forward premium" (Gameiro, 2006), and "original survey-based premium" (Ichiue and Yuyama, 2009).

provide empirical evidence that the magnitude of the absolute term premium is affected by the degree of uncertainty about the future stance of monetary policy. In periods where interest rate uncertainty is high, the absolute term premium (i.e. irrespective whether the term premium is positive or negative) is large. Fifth, we show that the term premium is positively related with the Swiss business cycle. In an economic upturn (downturn) the term premium is positive (negative). Related to this point, we show that the time variation in the term premium is correlated with changes in short-term interest rates. In times of increasing (decreasing) interest rates, the term premium increases (decreases). This may imply that market participants pro-cyclically hedge interest rate risks or speculate on interest rate movements.

Our results are relevant in the following ways. First, the fact that the term premium is, on average, close to zero implies that CHF Libor futures do not under- or overestimate risk-neutral interest rate expectations, on average. Second, the time variation of the term premium implies that CHF Libor futures can significantly deviate from risk-neutral interest rate expectations. Our results show that these deviations are pro-cyclically related to economic variables and interest rate uncertainty. Thus, we argue that if CHF Libor futures are analyzed on a daily basis, they should be adjusted by the estimated term premium to extract risk-neutral interest rate expectations, especially during periods with elevated uncertainty about the future interest rate path. Third, we show that forecast errors are considerably larger for contracts with maturity dates further into the future. Thus, an implication could be to use interest rate futures and surveys only for the near future (next few quarters). Fourth, our results indicate that the term premium itself can be used as an indicator for market participants' hedging demand and speculative positioning.

The remainder of this paper is structured as follows: Section 2 gives an overview of the literature. Section 3 describes the institutional details of the Libor futures market and the SNB's monetary policy framework, while Section 4 introduces the notion of excess returns, term premium and forecast errors. Section 5 describes the dataset used and provides descriptive statistics. Section 6 presents the regressions analysis, while Section 7 provides robustness checks. Finally, Section 8 concludes.

2 Literature

Our paper is related to the literature on the expectation hypothesis of interest rates and the term premium. Starting with Fama and Bliss (1987), there is nowadays considerable empirical evidence challenging the expectation hypothesis and it is generally accepted that a long-term interest rate corresponds to expected average short-term interest rates over the according maturity as well as a term premium, which compensates investors for risks.

A non-zero term premium in long-term interest rates implies that forward interest rates do not correspond to the expected short-term interest rates (Kim and Orphanides, 2007). In this regard, several papers analyze the term premium in interest rate futures and forward contracts. Among the first papers highlighting that forward rates can contain a term premium were Friedman (1979) and Froot (1989). The authors highlight that the difference between forward rates and ex-post realizations (excess returns) is not only capturing the term premium but also tests rational expectations, i.e. whether forecast errors are zero on average. Subsequently, several contributions and extensions were provided. Peacock (2004) finds evidence for the existence of a term premium in forward rates using sterling short-term rates and interest rate surveys, while Gameiro (2006) provides similar evidence for German three-month interest rates. Piazzesi and Swanson (2008) show that excess returns in federal funds futures are positive on average

and predictable by macroeconomic and financial market variables. Ferrero and Nobili (2009) extend the analysis and show that excess returns in the Euro area have similar properties and highlight that excess returns in U.S. dollars and Euro result predominantly due to forecast errors. More recently, Ichiue and Yuyama (2009) show that, on average, positive excess returns mostly arise as market participants do not anticipate the declining trend in interest rates during the recent decades. Moreover, there is a recent strain of policy work explaining potential reasons for the differences between federal funds futures and the dot plots by Federal Open Market Committee members.³ Finally, Crump et al. (2016) use interest rate surveys as observable estimates of expected short-term interest rates and obtain thereby model-free estimates of the term premium for longer-term rates.

For CHF interest rates, Kugler (1996) provides evidence for a time-varying term premium. This result is confirmed by Gerlach-Kristen (2007) for long-term government bonds, while at the short-end of the yield curve the expectation hypothesis cannot be rejected. Moreover, Gerlach-Kristen (2007) analyzes the relationship between the term structure and macroeconomic variables and finds that a steepening of the interest rate curve predicts an increase in economic activity. Söderlind (2010) estimates an affine yield curve model using interest rate options and illustrates that a surprise increase in the SNB’s Libor target decreases the term premium in longer-term rates considerably. More recently, Christensen and Krogstrup (2015) document a reduction in the term premium for long-term government bonds following the SNB’s expansion of reserves in 2011 via temporary open market operations. Grisse and Schumacher (2017) do not specifically consider the term premium but analyze the transmission of changes in short-term to longer-term interest rates. They find an asymmetric relationship during the period when interest rates were at zero, while the asymmetry was reduced when interest rates were effectively negative.

3 Institutional background

3.1 Libor futures

Definition: Interest rate futures are standardized forward rate agreements. In an interest rate forward contract, counterparties agree today on the rate at which the buyer of the future (lender) places a deposit with the seller (borrower) at a specific maturity date in the future. In CHF Libor futures, the underlying rate is the CHF three-month Libor. Libor is a panel-based reference rate that provides an indication of the average rate at which Libor panel banks can obtain unsecured funding for a specific maturity and currency.⁴

Trading motivation: Libor futures can be used for hedging interest rate risks or to speculate on future interest rates (Veyrassat, 2004). The buyer (seller) of a Libor future profits if interest rates fall (rise), i.e., if the three-month Libor fixing at maturity of the future is below (above) the agreed rate in the Libor future. Hence, the price determining factors of an interest rate future are, on the one hand, the

³Among others, references are Kim and Tanaka (2016), Crump et al. (2014a), Crump et al. (2014b), Brodsky et al. (2016a), and Brodsky et al. (2016b).

⁴Libor rates may be associated with some issues: First, several banks were fined for misconduct relating to Libor, in particular seeking to influence Libor contributions. These manipulations should, however, have a limited effect on our analysis, as the manipulations distorted Libor fixings only to a rather small degree (see, e.g., Abrantes-Metz et al. (2012)). Second, in the recent years the activity in the unsecured interbank market has declined substantially and e.g. CHF Libor rates are nowadays based on very few transactions (Moser, 2015). Third, the future of Libor is uncertain. End of July 2017 the Financial Conduct Authority announced that it would no longer be in a position to guarantee that banks submit contributions to Libor beyond the year 2021 (Bailey, 2017).

risk-neutral expectations regarding the underlying interest rate evolution and, on the other hand, the premium market participants are willing to pay for hedging interest rate risks or taking speculative positions.

Conventions:⁵ CHF Libor futures are traded on an electronic and anonymous trading platform offered by the Intercontinental Exchange (ICE). Trades can be initiated by entering a quote into the central order book and are concluded via an automatic matching algorithm. The official trading hours are from 7:30 a.m. to 6:00 p.m. London time. The quotation on the trading platform is 100.00 minus the forward interest rate. Thus, for example, a Libor future contract with a price of 99.50 implies a forward interest rate of 0.50%.

Libor futures are traded with different pre-defined settlement dates. Settlement dates are International Monetary Market (IMM) dates: the third Wednesday of March, June, September, and December of each year. The last trading day for a specific Libor future is two business days prior to its settlement date (i.e. IMM date). Libor futures are based on a CHF 1 million notional. Contracts are cash settled and the settlement price is the three-month Libor at the last trading date. Trades are cleared through ICE Clear Europe. ICE Clear Europe acts as a central counterparty and guarantees the settlement of all trades concluded.

Usage: Libor futures are available for trading for the next four years (i.e. the next 16 settlement dates). Most trading activity takes place for Libor future contracts expiring within the next year (see Table 1). As of year-end 2016, the open interest of CHF Libor futures was approximately CHF 220 billion (source: Bloomberg). Moreover, Swiss banks disclose a total amount of CHF 370 billion open interest in interest rate future contracts across different currencies and products.⁶ Overall, Libor futures are a liquid trading instrument and no adjustment for a potential illiquidity premium is necessary, as is the case, for example, in the US TIPS market (Grishchenko and Huang, 2013).

3.2 SNB's monetary policy regimes

During the sample period (1990 – 2016), the SNB used two different monetary policy frameworks. First, between 1990 and 1999, the SNB used a monetary targeting regime to achieve price stability. It was conducted by publishing a target growth rate for the seasonally adjusted monetary base. Second, up from 2000, the SNB implements monetary policy by steering short-term interest rates. The SNB's monetary policy reference interest rate is the three-month CHF Libor for which a target range of usually 100 bps is announced as the operational target. Typically, the SNB aims to keep the reference rate in the middle of the target range (Swiss National Bank, 1999). Beginning at the end of 2008, the CHF experienced a significant appreciation in value in the wake of the financial crisis. The SNB fought the overvaluation of the CHF with an expansionary monetary policy. This included lowering interest rates, FX interventions (starting in March 2009) and implementing a minimum exchange rate of CHF 1.20 against the euro as an additional operational target between September 2011 and January 2015. Since the discontinuation of the minimum exchange rate, the SNB applies a tiered remuneration system with a negative interest rate of -0.75%. In the tiered remuneration system, reserve holdings that exceed an individually defined threshold are remunerated at -0.75%, while reserves below this threshold are remunerated at 0%.

⁵See also ICE product description: www.theice.com/products/Futures-Options/Interest-Rates

⁶See SNB data portal: <https://data.snb.ch/en>.

4 Excess returns, term premium and forecast errors

In this section we define excess returns, term premium and forecast errors. The excess return of a Libor future is the difference between the interest rate implied by a Libor future and the three-month Libor fixing at the maturity of the future (see, e.g. Piazzesi and Swanson (2008)). Excess returns are either the result of forecast errors or the term premium. The term premium reflects the markup that market participants are willing to pay for hedging or speculation. Forecast errors occur due to unexpected interest rate changes.

Excess returns: Formally, the excess return ϵ_t^n at time t with corresponding maturity n is defined as the Libor future Y_t^n traded at time t with n days to maturity minus the three-month Libor fixing R_{t+n} at time $t+n$.

$$\epsilon_t^n = Y_t^n - R_{t+n} \quad (1)$$

The excess return is positive (negative) if the three-month Libor fixing at maturity of the future R_{t+n} is below (above) the Libor future Y_t^n . Economically speaking, the buyer (seller) of the future earns (pays) the excess return.⁷ Hence, a positive excess return corresponds to a cash flow from the future seller to the buyer, and vice versa for a negative excess return.

Term premium and forecast errors: We decompose excess returns into the term premium and forecast errors. As a proxy for risk-neutral interest rate expectations, we use interest rate surveys S_t^n of n day forecasts conducted at time t . Survey responses reflect risk-neutral expectations, i.e., they do not contain a term premium because they are not traded. Equation 2 formally illustrates the decomposition of excess returns into the two components.

$$\epsilon_t^n = \underbrace{Y_t^n - S_t^n}_{\text{term premium}} + \underbrace{S_t^n - R_{t+n}}_{\text{forecast error}} \quad (2)$$

The first term is the term premium, which is the difference between the Libor future Y_t^n and the interest rate survey S_t^n . A non-zero term premium implies that the Libor futures market is not in its risk-neutral “equilibrium”. The term premium can be interpreted as the markup that one side of the market (buyer or seller) is willing to pay to lock in a future interest rate. In the case of a positive (negative) term premium, sellers (buyers) have a higher demand to hedge against or speculate on increasing (decreasing) interest rates and are therefore willing to pay the term premium to the buyers (sellers). The second term in Equation 2 represents the forecast error, which is the difference between the interest rate survey S_t^n and the three-month Libor fixing at the maturity of the future R_{t+n} .

⁷Recall that the price of a future is defined as 100 minus the forward interest rate (see Section 3.1).

5 Data and descriptive statistics

5.1 Data

Survey data: Interest rate survey data are obtained from Consensus Economics.⁸ Consensus Economics is a company specialized in preparing forecasts of macroeconomic and financial market indicators, based on individual forecaster predictions. The survey has a monthly frequency and is available from 1989 onwards. Survey participants are typically associated with financial institutions, mostly domestic and international banks. Each month, forecasters estimate what the CHF three-month Libor will be at month's end three and twelve months later. Consensus Economics typically receives survey responses on the second Monday of each month (survey date). For the entire sample period, Consensus Economics reports the average value submitted by all survey participants while individual survey estimates are available from 1999 onwards. For this period, eight individual survey responses are available on average.

Libor fixings and futures: Libor fixings and Libor futures are obtained from Bloomberg and have a daily frequency. CHF Libor fixings started in 1989 and Libor futures have been available from March 1991 onwards. Libor futures are settled on IMM dates and thus have a non-constant maturity. This contrasts Consensus surveys, which have constant maturities of three and twelve months. To make the two datasets comparable we compute Libor futures with maturities identical to Consensus surveys using spline interpolation (see also Table 2 for a description of the data transformation). Moreover, the frequency of Libor futures and fixings is reduced from daily to monthly using the survey date as reference.

5.2 Descriptive statistics

During the sample period, interest rates were declining from approximately 8% to -0.75% (see Figure 1). On average, the three-month Libor is 1.91%, whereas the Libor future and interest rate survey, both with a twelve-month maturity, are 2.17% and 2.19%, respectively (see Table 3, Panel A).

Excess returns: Table 3, Panel B provides descriptive statistics of excess returns. Excess returns are positive, on average, for both maturities (three-month and twelve-month) and increase with the duration of the contract (ranging from 12 bps to 63 bps). Median excess returns are generally lower than average excess returns; hence, the distributions are skewed to the right. To test whether average excess returns are statistically significantly different from zero, we compute standard errors that are heteroscedasticity and autocorrelation consistent, using the Newey and West (1987) correction.⁹ For both maturities, excess returns are statistically significant.

Term premium: Table 3, Panel B shows that the average term premium is close to zero and not statistically significant for both maturities. The black bars in Figure 2 and 3 illustrate the development of the term premium, which fluctuates in the range of +/- 100 bps. Perhaps most striking, the figures show that the term premium has been persistently negative between 2010 and 2016. Thus, Libor future buyers paid a premium to insure themselves against declining interest rates. By contrast, the term premium was

⁸Note that interest rate survey data are also available from other sources (see discussion in Section 7). Moreover, risk-neutral interest rate expectations could also be derived from option prices on Libor futures (Söderlind, 2010). For the CHF market, this is currently not feasible, as the trading activity in the interest rate option market is very low (see BIS Triennial).

⁹The number of lags used equals the length of the contract (number of months).

positive and persistent between 1999 and 2001 and between 2005 and 2007, both periods of increasing interest rates. Thus, the positive term premium during these periods implies that Libor future sellers paid a premium to ensure themselves against or to profit from increasing interest rates. The estimated term premium has several interesting empirical properties. First, the correlation between the three-month and twelve-month term premium is high, with a correlation coefficient of about 0.78. Thus, we document considerable co-movements in the term premium for different maturities. Second, the term premium accounts for the bulk of the variation in Libor future rates, which is illustrated in Figure 4. Thus, the largest part of changes in Libor futures does not reflect a change in future expected short-term interest rates but a change in the term premium.

Forecast errors: Table 3, Panel B shows that forecast errors are positive and statistically significant for both maturities and account for the largest part of excess returns. The development of forecast errors over the sample period is illustrated in Figure 2 and 3. The figures reveal that market participants have been surprised by unexpected economic downturns and corresponding interest rate declines. For example, the interest rate cuts during the financial crisis of 2008 coincide with significant positive forecast errors, indicating that most market participants did not expect these events. Moreover, also the beginning of the sample period in 1991, characterized by high inflation and a pronounced weakening of economic activity, coincides with large forecast errors as well. In the very long run, average forecast errors can be expected not to be statistically significant, if expectations are rational. However, there are reasons why forecast errors may be persistently positive in our sample period (Ichiue and Yuyama, 2009). First, although we have observations for the past 25 years, interest rates are generally declining, and thus, market participants could be surprised negatively when not adapting their expectations to the permanent decline. Second, in our sample period, interest rate hikes are fairly continuous and accompanied by corresponding forward guidance, in particular between 2005 and 2008 (see, e.g., SNB monetary policy assessment of June 2006), whereas interest rate cuts are rather abrupt and unanticipated.

6 Regression analysis

6.1 Uncertainty and the size of the absolute term premium

In this subsection, we study the link between uncertainty and the size of the absolute term premium. Put differently, we are interested in the magnitude of the term premium, regardless of whether it is positive or negative.¹⁰ We expect that in periods of greater uncertainty, the size of the absolute term premium in CHF Libor futures is higher (Wright, 2011). To test this hypothesis, we employ three measures of uncertainty. As a first interest rate uncertainty measure, we use the standard deviation of CHF Libor futures (“realized uncertainty”). The standard deviation of CHF Libor futures is calculated using its time variation over the last 7 days prior to the survey date. As a second interest rate uncertainty measure, we use the standard deviation of Consensus survey responses (“expected uncertainty”). The standard deviation of survey responses is a good measure of the uncertainty of professional forecasters (Zarnowitz and Lambros, 1987), however, it is only available from June 1998 onwards. Furthermore, we use the

¹⁰Note that in the existing literature (see, e.g., Gameiro (2006)), it is typically tested whether the term premium itself is affected by uncertainty.

Chicago Board Options Exchange Volatility Index (VIX) as a measure for the uncertainty sentiment in global financial markets.

To test the hypothesis, we regress the absolute term premium ($|r_t|$) on the respective measure of uncertainty (u_t), see Equation 3.¹¹ The regression analysis is conducted separately for the three- and twelve-month maturity and we apply heteroscedasticity- and autocorrelation-consistent standard errors, using the Newey and West (1987) correction. All variables used are described in Table 4.

$$|r_t| = \beta_0 + \beta_1 u_t + \epsilon_t \quad (3)$$

The regression results are illustrated in Table 5 and provide the following insights. First, we find a positive and statistically significant relationship between the standard deviation of Libor futures, and the absolute term premium (Columns (1) and (2)). In terms of economic magnitude, the results indicate that a 1 bps higher standard deviation of Libor futures results in a roughly 3 bps higher term premium (for both maturities). Second, Columns (3) and (4) illustrate that the regression coefficients are also positive and statistically significant when using the expected uncertainty measure, i.e., the standard deviation of survey responses. In terms of economic magnitude, a 1 bps higher expected uncertainty goes along with a 0.5 bps higher term premium. Third, Columns (5) and (6) illustrate that the regression coefficients are close to zero and statistically not significant for the VIX. Consequently, the results provide evidence that the size of the absolute term premium is affected by the expected and realized interest rate uncertainty but not affected by the general uncertainty sentiment in financial markets.

6.2 Economic variables and the term premium

In this subsection, we analyze the link between different economic variables and the term premium. First, we study the relationship between the business cycle and the term premium. We expect that in an economic upturn (downturn) the term premium is increasing (decreasing), as market participants would like to protect themselves against further increasing (decreasing) rates or speculate on a stronger than expected increase in interest rates (Gameiro, 2006). To do so, we use the Swiss business cycle index (BCI) as constructed by Galli (2017), which captures current economic conditions in Switzerland on a monthly frequency.¹² Second, we analyze whether changes in the term premium in CHF Libor futures are correlated with current short-term interest rate movements. We expect that in an environment of increasing (decreasing) interest rates, the term premium is increasing (decreasing). To measure changes in short-term interest rates, we use first differences of the CHF three-month Libor. Third, Switzerland is a small and open economy, and the exchange rate plays an important role. Consequently, we test whether the term premium in CHF Libor futures is affected by the value of the CHF. As a measure of the strength of the CHF, we use the real effective CHF index (see Müller (2017)). We expect that a stronger CHF correlates with a lower term premium, as market participants expect the SNB to decrease interest rates in periods of CHF strength.

The relationship between economic variables and the term premium is assessed on first differences by regressing changes in the term premium (Δr_t) on changes in the different independent variables (Δx_t) on a univariate and multivariate basis (see Equation 4). Again, the regression analysis is conducted

¹¹Note that we have also conducted a regression analysis using the squared value of the respective uncertainty measure as an additional independent variable to test for a non-linear relationship. Using such a specification yields to similar results and the squared terms are not statistically significant.

¹²To measure the Swiss business cycle, the growth rate of the gross domestic product (GDP) would also be a variable to use. However, this variable is only available on a quarterly frequency and with a considerable time lag.

separately for the three- and twelve-month maturity.

$$r_t = \beta_0 + \sum_{n=1}^N \beta_n \Delta x_{t,n} + \epsilon_t \quad (4)$$

The regression results are illustrated in Table 6. Columns (1) – (6) illustrate the univariate regression results, while Columns (7) and (8) depict the multivariate regression results. The coefficients for changes in the business cycle are positive and statistically significant. Consequently, our analysis shows that in Switzerland the term premium is increasing (decreasing) in an economic upturn (downturn). The regression coefficient of 0.08 is identical for the univariate and the multivariate regression for the twelve-month maturity. In case of the three-month maturity it is slightly declining from 0.05 for the univariate to 0.03 for the multivariate regression. In terms of economic magnitude, the results indicate that a one standard deviation increase in the business cycle index is associated with a roughly 0.1 standard deviation increase in the term premium. The coefficients for changes in three-month Libor rates are also positive and statistically significant in the univariate and multivariate regressions and for both maturities. For all regression specifications, the change in the term premium is estimated to be about 0.3 bps if the three-month Libor increases by 1 bps. The effect is comparable to the BCI, as a one standard deviation increase in the three-month Libor is associated with a roughly 0.2 standard deviation increase in the term premium. This provides evidence that market participants pro-cyclically hedge interest rate risks or speculate on interest rate movements. Moreover, it is important to note that this variable explains changes in the term premium to a considerable extent which is indicated by the according R-squares. Finally, the regression analysis provides no evidence that changes in the term premium are influenced by changes in the real effective CHF index. Neither the univariate nor the multivariate regression coefficients are statistically significant.

7 Robustness

7.1 Quality of survey data

The advantage of using interest rate surveys is that they enable us to disentangle forecast errors from the term premium in a relatively simple way. The disadvantage is that the conclusions crucially rely on the assumption that surveys reflect risk-neutral interest rate expectations.¹³ To ensure that the decomposition of excess returns is robust with regard to the source of the survey, we use alternative survey data sources from Bloomberg and KOF Consensus Forecasts, which are available in a similar manner as Consensus surveys.¹⁴ Figure 5 compares different interest rate surveys. For the available sample period of those surveys (2009 through 2016) the differences between the different interest rate surveys are rather small. However, all interest rate surveys are considerably higher than Libor futures, indicating a negative term premium. In numbers, for the period 2009 until 2016 the average term premium based on the Consensus survey is -17 bps; for the Bloomberg survey, it is -13 bps; and for the KOF Consensus Forecasts, it is -18 bps. Hence, we conclude that the decomposition of excess returns is robust with regard to the choice of

¹³Note that surveys potentially contain some caveats. First, the mean estimate is usually based on few survey participants. Second, forecasters may use Libor futures to derive their interest rate estimates, which would lead to an endogeneity issue. Third, survey participants receive the survey questions a few days before they must submit their responses. Thus, individual survey estimates may contain information from slightly different points in time.

¹⁴Other interest rate surveys in CHF are, for example, the CS-CFA survey (formerly the CS-ZEW survey). However, these surveys are characterized by notable methodological differences, which makes a comparison with the Consensus survey difficult.

survey source.

7.2 Interpolation of Libor futures

To obtain Libor futures with a constant maturity of three- and twelve-months we use a spline interpolation as of the survey date. To ensure that our findings are robust with regard to the interpolation method, we also apply a polynomial interpolation method. Table 7 illustrates that the two techniques result in virtually identical estimations. On average, the absolute difference between the polynomial and the spline estimation is only 0.2 bps for the three- and the twelve-month maturity. Thus, we conclude that our findings are robust with regard to the interpolation method.

8 Conclusion

In this paper, we analyze excess returns of CHF Libor futures over the past 25 years. We find that excess returns are, on average, positive and statistically significant. Using interest rate surveys, we decompose excess returns into a term premium and forecast errors. The large part of excess returns arises from forecast errors, while the term premium is time varying but on average zero.

Our regression results show that the size of the absolute term premium is positively affected by the degree of uncertainty about future stance of monetary policy. Moreover, we show that variations in the term premium correlate to a considerable degree with changes in the Swiss business cycle index and short-term interest rates.

With the methodology and the data at hand, further research on the term premium in Libor futures can be done. For example, it might be worth investigating how the term premium reacts in response to unanticipated changes in monetary policy. Moreover, it could also be interesting to derive a daily estimation of the term premium, using financial market variables.

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Figure 1: Interest rate developments

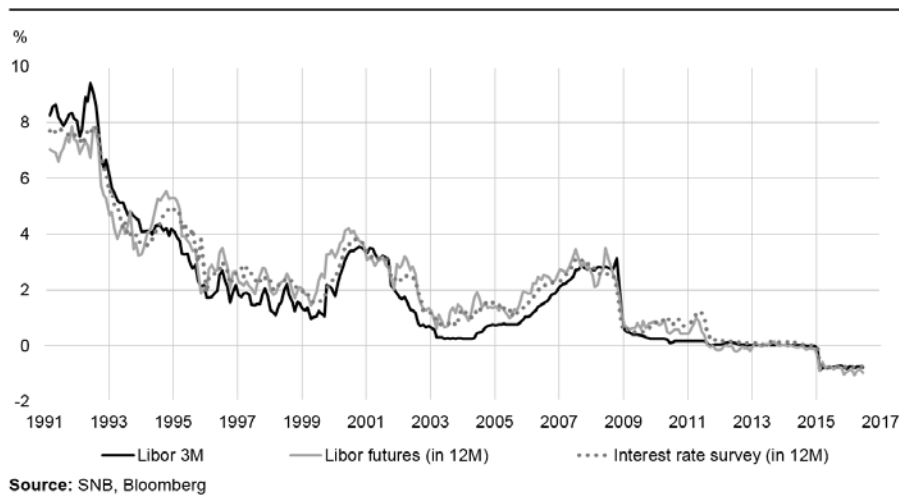


Figure 1 shows the development of the CHF three-month Libor fixing (black line), the interest rate survey with an end-of month maturity in twelve months (gray dotted line), and Libor futures with an end-of month maturity in twelve months (gray line). The dataset contains monthly observations from March 1991 through August 2016.

Figure 2: Decomposition of excess returns (three-month maturity)

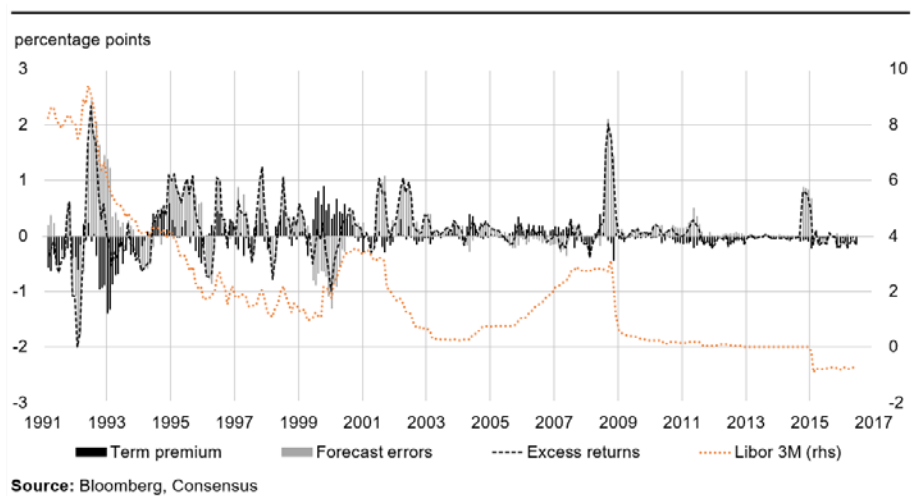


Figure 3 shows the development of excess returns with an end-of month maturity in three months (black dashed line) and its decomposition. The term premium is depicted in black bars, and forecast errors are depicted in gray bars. The dataset contains monthly observations for Libor futures and interest rate surveys from March 1991 through August 2016.

Figure 3: Decomposition of excess returns (twelve-month maturity)

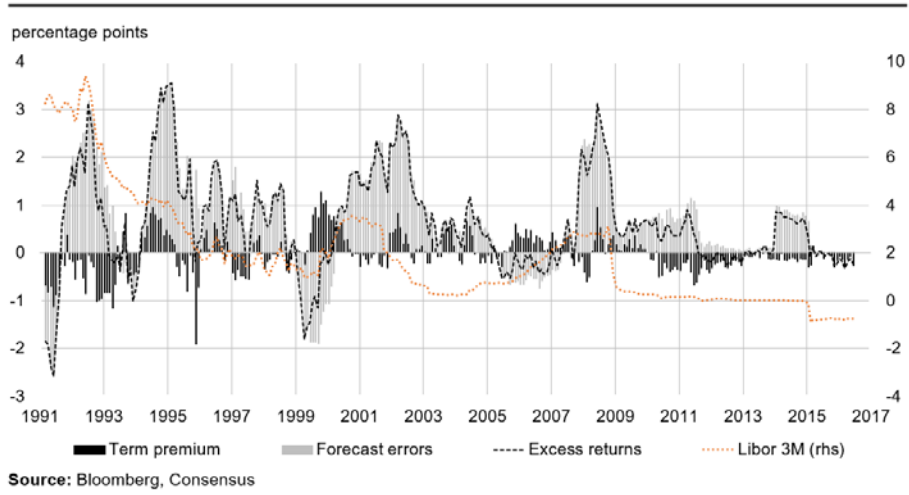


Figure 3 shows the development of excess returns with an end-of month maturity in twelve months (black dashed line) and its decomposition. The term premium is depicted in black bars, and forecast errors are depicted in gray bars. The dataset contains monthly observations for Libor futures and interest rate surveys from March 1991 through August 2016.

Figure 4: Correlation of Libor futures and term premium

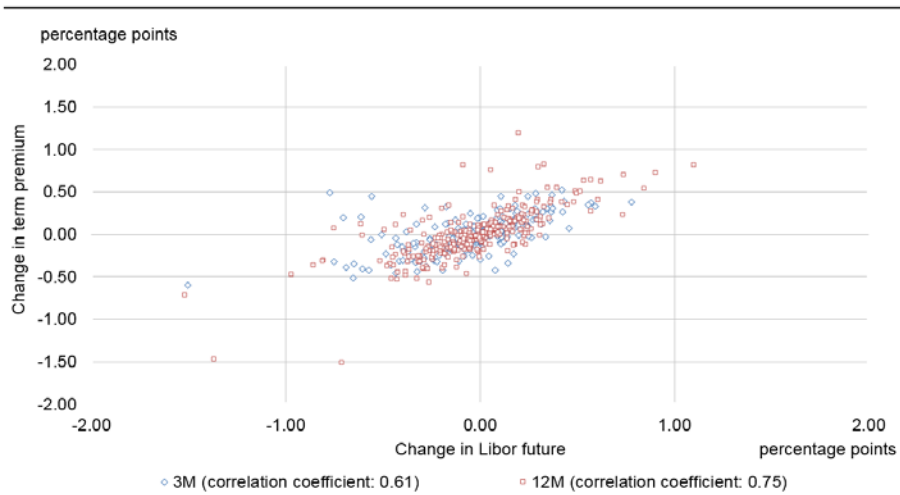


Figure 4 shows a scatterplot of monthly changes in Libor futures and monthly changes in the term premium for the three-month and the twelve-month maturity.

Figure 5: Comparison of interest rate surveys (twelve-month maturity)

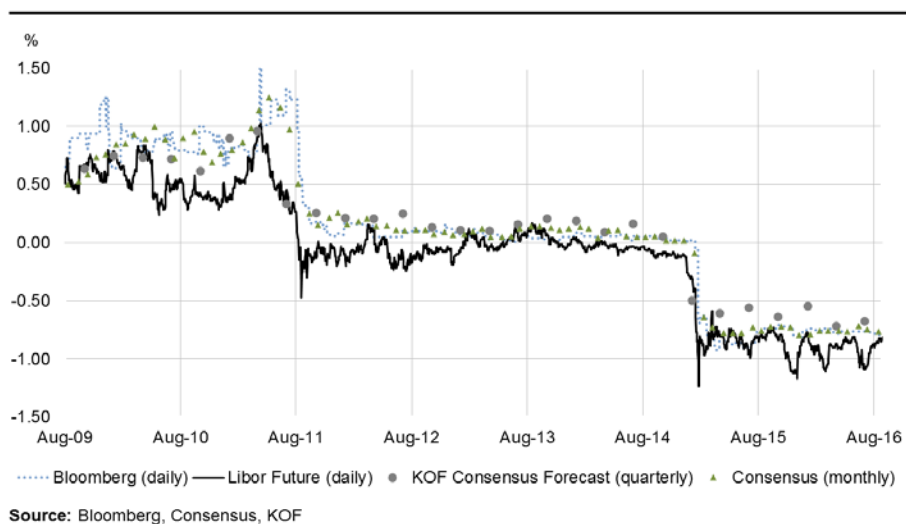


Figure 5 compares different interest rate surveys with Libor futures (black line). The Bloomberg survey is depicted by the blue dotted line, the Consensus survey by the green triangles, and the KOF Consensus Forecast by the gray circles.

Table 1: Trading activity

1st	2nd	3rd	4th	5th	6th	7th	8th
4'826	5'937	4'482	3'159	1'765	1'016	585	415

Table 1 reports the average daily trading activity (number of trades) in CHF Libor futures. Libor futures are based on a CHF 1 million notional. Averages are reported for International Monetary Market (IMM) dates (columns) and are based on business days during the year 2016. IMM dates are the third Wednesday of March, June, September, and December of each year.

Table 2: Data preparation

Instrument	Input data			Final data		
	Frequency	Availability	Maturity	Frequency	Availability	Maturity
Survey data	Monthly	Dec. 89 – Aug. 16	In 3M and 12M (end of month)	Monthly	Mar. 91 – Aug. 16	In 3M and 12M (end of month)
Libor futures	Daily	Mar. 91 – Aug. 17	IMM dates*	Monthly**	Mar. 91 – Aug. 16	In 3M and 12M (end of month)**
Libor 3M	Daily	Dec. 89 – Aug. 17	3M	Monthly	Mar. 91 – Aug. 16	3M

Table 2 describes the dataset and the transformation of the data. * International Monetary Market (IMM) dates are the third Wednesday of March, June, September, and December of each year. ** Libor futures as of the survey date are used. *** Adjustment is performed via spline interpolation.

Table 3: Descriptive statistics

	unit	mean	t stat	p50	min	max	sd	count
<i>Panel A: Interest rates</i>								
Libor 3M	%	1.91		1.34	-0.90	9.41	2.27	306
Future 3M	%	1.92		1.59	-0.99	8.71	2.16	306
Future 12M	%	2.17		2.04	-1.06	7.86	2.02	306
Survey 3M	%	1.94		1.51	-0.94	8.80	2.22	306
Survey 12M	%	2.19		2.04	-0.79	7.88	2.05	306
<i>Panel B: Excess returns and decomposition</i>								
Excess return 3M	pp	0.12**	2.55	0.04	-2.00	2.34	0.48	306
Excess return 12M	pp	0.63***	3.89	0.56	-2.57	3.56	1.02	306
Term premium 3M	pp	-0.02	-0.90	-0.03	-1.39	0.88	0.27	306
Term premium 12M	pp	-0.02	-0.30	-0.05	-1.91	1.29	0.41	306
Forecast error 3M	pp	0.14***	2.83	0.06	-1.60	2.42	0.50	306
Forecast error 12M	pp	0.64***	3.86	0.53	-1.88	3.28	1.00	306
<i>Panel C: Explanatory variables</i>								
std(survey 3M)	pp	0.13		0.12	0.02	0.51	0.08	219
std(survey 12M)	pp	0.27		0.27	0.03	0.74	0.13	219
std(futures 3M)	pp	0.03		0.02	0.00	0.16	0.03	306
std(futures 12M)	pp	0.05		0.03	0.00	0.29	0.04	306
VIX	pp	19.67		17.63	10.64	62.47	8.07	306
Δ BCI	index	0.01		0.04	-2.55	1.92	0.63	306
Δ Libor _{3M}	pp	-0.03		0.00	-1.19	1.19	0.24	306
Δ CHF real	index	0.00		0.00	-0.10	0.08	0.02	306

Table 3 provides descriptive statistics for interest rates (Panel A), excess returns, term premiums, forecast errors (Panel B), and independent variables used in the regression analysis (Panel C). The statistical significance of mean values (Column 3) is based on t-statistics (Column 4). Heteroscedasticity and autocorrelation robust t statistics are reported, using the Newey and West (1987) correction. The number of lags used equals the length of the contract (number of months). ***, ** and * denote statistical significance (two-tailed) at the 1%, 5%, and 10% significance levels, respectively. The dataset contains monthly observations from March 1991 through August 2016.

Table 4: Description of regression variables

Name	Unit	Abbreviation
Risk premium	pp	r_t
Absolute risk premium	pp	$ r_t $
Realized uncertainty	pp	std(futures)
Expected uncertainty	pp	std(survey)
CBOE volatility index	index	VIX
Δ Business cycle index	index	Δ BCI
Δ three-month Libor	pp	Δ Libor _{3M}
Δ Real Swiss franc index	index	Δ CHF real

Table 5: Uncertainty and the size of the absolute term premium

	(1)	(2)	(3)	(4)	(5)	(6)
	$ r_{3M} $	$ r_{12M} $	$ r_{3M} $	$ r_{12M} $	$ r_{3M} $	$ r_{12M} $
Constant	0.08*** (0.02)	0.19*** (0.03)	0.06*** (0.02)	0.14*** (0.04)	0.22*** (0.05)	0.36*** (0.07)
$std(futures_{12M})$		2.48*** (0.37)				
$std(futures_{3M})$	3.16*** (0.63)					
$std(survey_{12M})$				0.39*** (0.13)		
$std(survey_{3M})$			0.49** (0.19)			
<i>VIX</i>					-0.00 (0.00)	-0.00 (0.00)
Adjusted R ²	0.16	0.13	0.07	0.05	0.00	0.00
Observations	306	306	219	219	306	306

Table 5 shows the regression results for uncertainty measures and the size of the absolute term premium. The standard deviation of CHF Libor futures is calculated using the time variation over the last 7 working days prior to the survey date. The standard deviation of survey estimates is the standard deviation of all survey estimates for a specific survey date. The dataset contains monthly observations from March 1991 through August 2016. Note that the standard deviation of survey estimates is not available for the entire sample period but only from June 1998 onwards, which reduces the number of observations in our regression analysis. Heteroscedasticity- and autocorrelation-consistent standard errors (in parentheses) are applied, using the Newey and West (1987) correction. The number of lags used equals the length of the contract (number of months). ***, ** and * denote statistical significance (two-tailed) at the 1%, 5%, and 10% significance levels, respectively.

Table 6: Economic variables and the term premium

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Δr_{3M}	Δr_{12M}	Δr_{3M}	Δr_{12M}	Δr_{3M}	Δr_{12M}	Δr_{3M}	Δr_{12M}
Constant	0 (0.01)	0 (0.01)	0.01 (0.01)	0.01 (0.01)	0 (0.01)	0 (0.01)	0.01 (0.01)	0.01 (0.01)
ΔBCI	0.05*** (0.01)	0.08*** (0.03)					0.03** (0.02)	0.08** (0.03)
ΔLibor_{3M}			0.31*** (0.08)	0.29*** (0.08)			0.29*** (0.08)	0.26*** (0.07)
$\Delta \text{CHF real}$					-0.82 (0.67)	-1.12 (0.75)	0.23 (0.57)	0.78 (0.92)
Adjusted R ²	0.02	0.03	0.16	0.05	0	0	0.16	0.07
Observations	305	305	305	305	305	305	305	305

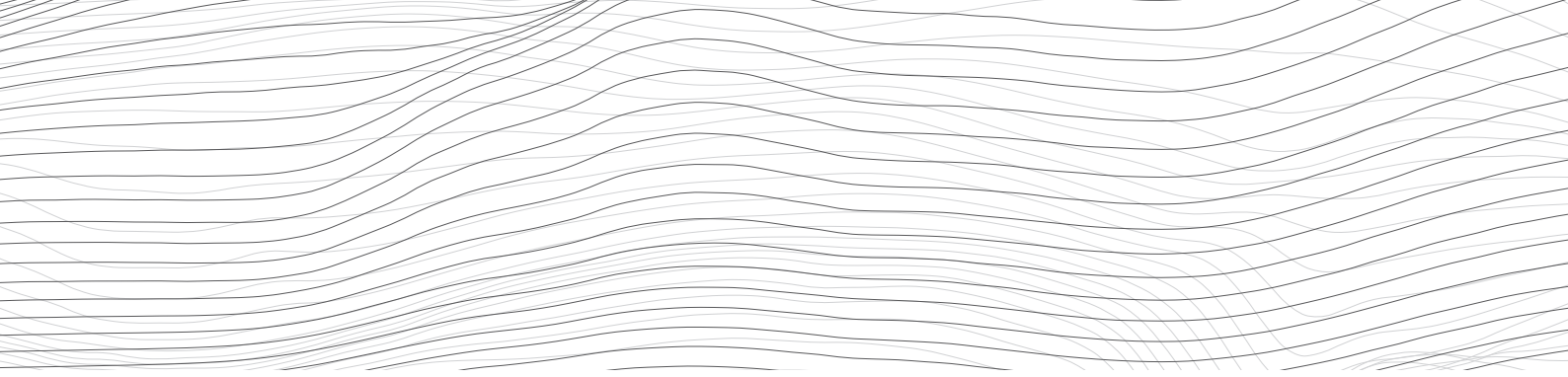
Table 6 shows the regression results for economic variables and the term premium. All variables are in first differences. The dataset contains monthly observations from March 1991 through August 2016. Heteroscedasticity-consistent standard errors (in parentheses) are applied. ***, ** and * denote statistical significance (two-tailed) at the 1%, 5%, and 10% significance levels, respectively.

Table 7: Interpolation of Libor futures

Libor future (in %)	3M	12M
Spline interpolation	1.917	2.171
Polynomial interpolation (1 day)	1.917	2.171
Polynomial - spline (avg.)	0.000	0.000
polynomial - spline (avg.)	0.002	0.002

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