UNEXPECTED INFLATION AND BANK STOCK RETURNS, THE CASE OF FRANCE 1977-1991

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Abstract

This paper evaluates the impact of unexpected inflation on the stock returns of a sample of French banks. It offers an empirical test of theories that have predicted an impact of inflation on the stock returns of banks. The paper complements a large literature that has focused exclusively on the impact of unexpected interest rates. The analysis provides empirical support to the hypothesis that, in period of volatile inflation, there exists an inflation risk factor which is independent of the well documented interest rate factor.

1 Introduction

There is a large theoretical and empirical literature which analyses the interest rate risk faced by banks and the impact of unexpected changes in interest rates on the returns on bank stocks. The return generating process which emerges in this literature is a two factor generating process combining a market factor and an unexpected change in interest rate[1]. In parallel, there is a theoretical literature which has discussed the impact of inflation on the market value of banks and predicts generally a negative impact of changes in inflation on the market value of banks[2]. However, empirical evidence to substantiate this hypothesis is almost non-existent. The purpose of the paper is to test empirically whether the return generating process for banks stocks can be explained by a three factor-model combining a market factor, an unexpected interest rate and an unexpected inflation component. The model will be tested on a sample of French banks listed on the Paris stock exchange over the period 1977-1991. The empirical analysis provides support to the hypothesis that, in period of volatile inflation, there exists an inflation risk factor which is independent of the interest rate factor.

2 Literature Review

The impact of inflation on the stock returns of non-financial institutions has been widely studied. The initial hypothesis was that the common stock issued by industrial firms would produce a natural hedge against inflation in a Fisherian world in which the nominal cash flows and interest rates fully incorporate inflation. In the case of

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[1]This literature includes Flannery-James (1984), Giliberto (1985), Saunders-Yourougou (1990), Yourougou (1990), Akella-Greenbaum (1992), and Choi, Elyasiani, Kopecky (1992).

[2]Kessel (1956), Kessel and Alchian (1960), Fisher and Modigliani (1978), Dermine (1985, 1987), and Perry (1992).

temporarily fixed nominal contracts, such as debt or labor, unexpected inflation would favor indebted or labor intensive firms (Kessel, 1956). However, the empirical evidence from the stock market reports generally a negative relationship between common stock returns and inflation[3]. The failure of the Fisherian and fixed term contracting hypotheses led to different explanations of the negative correlation. Geske and Roll (1977) and Fama (1981) based their analysis on the negative impact of inflation on real economic activity, while others such as Lucas (1978) or Danthine-Donaldson (1986) developed highly stylized general equilibrium asset pricing models in which inflation would reduce expected returns.

The impact of inflation on the market value of banks was studied by Kessel and Alchian (1960), Fisher and Modigliani (1978), and Dermine (1985 and 1987). With Kessel and Alchian's fixed nominal contracting hypothesis, the shareholders of banks would suffer from inflation because a financial institution is generally a net holder of financial assets. An opposite conclusion is reached by Fisher-Modigliani (1978) according to whom banks' shareholders benefit because inflation reduces the real value of non-interest bearing deposits. In Dermine (1985, 1987), the market value of a bank is a negative function of inflation. When taxes are calculated on nominal profits, it is shown that the increase in after-tax earnings fuelled by inflation is not sufficient to finance a constant level of real dividends and the retained earnings that are required to satisfy an exogenous capital adequacy ratio. Given that the impact of interest rate on bank stock returns has been extensively studied theoretically and empirically, while empirical evidence on the impact of inflation on banks stock returns is missing, there is a need to document the effect of inflation on bank stock returns and in particular the joint interaction of inflation and interest rates.

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[3]Lintner (1975), Jaffe and Mandelker (1976), Nelson (1976), Bodie (1976), Fama and Schwert (1977), Modigliani and Cohn (1979), Fama (1981), Cohn and Lessard (1981), Gultekin (1983), Geske and Roll (1983), Solnik (1983), Lee (1992).

3 Empirical Methodology

Building up on the empirical banking literature such as Saunders-Yourougou (1990) and Yourougou (1990), a three-factor APT model is used to test empirically the joint sensitivity of rates of return of common stocks to market, interest rate and inflation factors[4]. The three-factor model is assumed to apply both to banks and non-financial firms traded on the Paris stock exchange.

The Factor Model

The following three-factor model describes a firm i's stock return :

$$R_{it} = E(R_{it}) + \alpha_{i1}F_{1t} + \alpha_{i2}F_{2t} + \alpha_{i3}F_{3t} + \varepsilon_{it}, \quad \forall i \in [1, N], \forall t \in [1,T] \quad (1)$$

where R_{it} denotes the realized return on stock of firm i (i=1,...N) at time t (t=1,...T), E(.) denotes the expectation operator, F_{jt} is a risk factor j (j=1, 2, 3) at time t, α_{ij} is the sensitivity coefficient of firm i to risk factor j, and ε_{it} is an idiosyncratic term[5]. The risk factors are the unexpected changes in the market return, interest rate and inflation. If markets are efficient in the sense of APT, then returns will be sensitive only to unexpected shocks in these three economic variables.

Following Saunders-Yourougou (1990), Yourougou (1990), and Choi et al. (1992), a pooled time series-cross sectional model for the group of banks and non-banks is estimated as follows :

$$R_{it} = \alpha + \alpha_m U_{mt} + \alpha_I U_{It} + \alpha_\pi U_{\pi t} + \varepsilon_{it}, \quad \forall i \in [1, N], t \in [1, T] \quad (2)$$

where U_m, U_I, U_π represent the unexpected change in the market return, interest rate and inflation.

As in Choi et al (1992), we used the generalized least square method to estimate the

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[4] Chen, Roll and Ross (1986) and Ferson and Harvey (1993) have suggested that an inflation state variable could arise in a multibeta model if inflation produces real effects.

[5]Factors F_{jt} are assumed to have zero mean and unit variance, while idiosyncratic terms ε_{it} have zero mean and are serially uncorrelated.

equation (2). This method corrects for serial correlation in the time series, heteroskedasticity and contemporaneous correlation among the cross-section.

The following equations are postulated for the realized values of the market return, interest rate and inflation variables :

$R_{mt} = E_{t-1}(R_{mt}) + U_{mt}$ (3)

$\pi_t = E_{t-1}(\pi_t) + U_{\pi t}$ (4)

$I_t = E_{t-1}(I_t) + U_{It}, \quad \forall t \in [1, T]$ (5)

where R_m is the realized market return, π is the realized inflation rate, and I is the realized interest rate. E(.) denotes the expectation operator, while U_j is the unexpected component factor. The use of an interest rate and inflation time series creates a potential problem of multicollinearity between the two variables if the Fisherian world applies. In the empirical section which follows, great care is taken to test the absence of multicollinearity between these two variables.

Estimation of the Risk Factors

As in Sweeney and Warga (1986), Yourougou (1990), and Choi et al. (1992), autoregressive moving average ARIMA generated forecasting errors are used to generate expected variables and estimate the unexpected shocks[6].

The ARIMA model used in this paper takes the form :

$\Phi(L)\ \Delta X_t = \mu + \Gamma(L)\ \varepsilon_t$ (6)

where ΔX_t is the series of first differences, L is the back shift operator, $\Phi(L)$ is the autoregressive component, and $\Gamma(L)$ is the moving average. This specification allows to generate U_m, U_I and U_π series by taking the difference between the forecasted values and the realized values.

Estimation of the Risk Premia

Assuming no arbitrage opportunities, the expected return on stock i is given by

$E(R_i) = \lambda_0 + \alpha_{im}\lambda_m + \alpha_{iI}\lambda_I + \alpha_{i\pi}\lambda_\pi, \quad \forall\ i \in [1, N]$ (7)

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[6]An alternative method would be to use the orthogonalization method as in the early study by Flannery-James (1984). However, Giliberto (1985) has pointed out the danger of biases with this methodology.

where λ_0 is the risk free rate, α_{ij} (j=m, I, π) represents the sensitivity coefficient with respect to the three factors, and λ_j is the risk premium of factor j. Substitution in equation (1) yields

$$R_{it} = \lambda_0 + \alpha_{im}\lambda_m + \alpha_{iI}\lambda_I + \alpha_{i\pi}\lambda_\pi + \nu_{it} \quad \forall i \in [1, N], \forall t \in [1,T] \quad (8)$$

where ν_{it} is a vector of error terms.

Estimation of equation (8) will provide the risk premia on each factor. This will be estimated in a two stage process. In the first stage, the sensitivity coefficients are estimated for each stock with respect to factor j. In the second stage, the risk premia are estimated.

4 Data

Monthly (consumption price change) inflation rates and money market rates for France from January 1977 to June 1991 are obtained from the International Financial Statistics of the International Monetary Fund. Monthly stock prices for French firms and a market index are obtained from the AFFI data base. The market return is an equally weighted average index of all the stocks traded. The sample includes 34 banks[7] for which data are available for the period January 1977 to June 1991 and 74 business firms selected at random among non-financial institutions. To take into account the potential impact of the October 1987 stock market crash and to separate the period of high interest rate and inflation volatility from a period of more stable interest rates and prices, estimations are run over the entire period and over two sub-periods[8] 1977-1987 and 1987-1991.

Since the main concern of the paper is to disentangle the inflation effect from the interest rate and market effects, an important empirical issue is the correlation between inflation and interest rates and whether interest rates are good predictors of inflation. A good predictive performance would imply a high degree of collinearity and

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[7]The sample of banks does not suffer from the survivorship bias since all the banks traded on January 1977 were still trading on June 1991.

[8] An alternative procedure used was to introduce a dummy variable to let the data measure a possible shift in coefficients after 1987. As it produces very similar empirical results, these are not reported, but are available upon request.

the impossibility to dissociate both effects[9]. A proper procedure to test whether the interest rate series can forecast the inflation series is to check whether both series are cointegrated in the sense of Engle and Granger (1987). Following Mishkin (1992), we use the Engle and Granger cointegration technique to test that the interest rate and inflation series in France are not cointegrated during the time period under investigation. Both the Dickey Fuller and Augmented Dickey Fuller tests fail to reject the null hypothesis of no cointegration between the two series[10]. This means that, statistically, the two series can drift apart. Consequently, we can test whether unexpected inflation has an impact on bank stock return which is additional to the interest rate factor.

5 Empirical Results

The ARIMA (p,d,q) models were estimated with a maximum likelihood method. The expected value at month t is the one period ARIMA forecast based on the twelve month period t-12 to t-1. The best fitted models for the expected market returns, interest rate and inflation are respectively an ARIMA(0,1,1), ARIMA (0,1,4), and ARIMA (0,1,13). The unexpected variable is then calculated as the difference between the realized value and the ARIMA forecast. Table One presents summary statistics for the market return, the interest and inflation rates, and the return on the portfolio of banks and non-financial firms.

Insert Table One.

One observes a substantial increase in the standard deviation of market return after 1987, accompanied by a lower volatility of interest rate and inflation. Table Two

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[9]The early American literature on the relationship between inflation and stock returns used short term interest rates as predictors of inflation rate (Fama 1975, Bodie 1976, Fama and Schwert 1977). More recent research has concluded that this relationship has broken down after the 1979 change in monetary regime in the USA (Huizinga and Mishkin 1984, Fama 1990, Mishkin 1990a and 1990b, Jorion and Mishkin 1991).

[10]Detailed information on the cointegration test is available in the appendix.

summarizes the estimated coefficients of correlation between the unexpected variables U_I, U_π and U_m.

Insert Table Two.

Most of the correlations between the unexpected interest rate, inflation and market return are not significantly different from zero at the 5 % confidence level. The only significant, although not very large, correlation is between the unexpected market return and interest rate. A formal test of multicollinearity proposed by Besley, Kuh and Welsch (1980) indicates the absence of any serious multicollinearity pattern.

The pooled cross-sectional time series model is first estimated for the sample of banks :

$$R_{it} = \alpha + \alpha_m U_{mt} + \alpha_I U_{It} + \alpha_\pi U_{\pi t} + \varepsilon_{it}, \quad \forall i \in [1, N], \forall t \in [1,T] \qquad (9)$$

The results are reported in Table Three.

Insert Table Three.

The results confirm a statistically significant (at 5 %) impact of the market factor over the two sub-periods, and a statistically significant effect of the interest rate and inflation factors for the first sub-period 1977-1987. Thus we are able to observe an inflation effect coming in addition to the interest rate effect in the first sub-period, the period characterized by a large volatility of interest rate and inflation.

The same model is estimated for the portfolio of non-financial firms. The results are reported in Table Four.

Insert Table Four.

As observed by Saunders and Yourougou (1990) and Yourougou (1990) for the US market, the impact of interest rate factor is non-significant in both sub-periods. This analysis confirms the empirical evidence that the stock return generating process of banks and non-financial firms differ. Banks appear to be subject to an interest rate risk factor and to an inflation factor, while non-financial firms are subject only to a market risk factor.

Estimation of Risk Premia

The estimation of risk premia is conducted in two phases. In the first one, we estimate

the three-factor process for each of the individual firm in the sample (34 banks and 74 non-financial firms) :

$$R_{it} = \alpha_i + \alpha_{im} U_{mt} + \alpha_I U_{It} + \alpha_{i\pi} U_{\pi t} + \varepsilon_{it} \quad \forall i \in [1, N], \forall t \in [1,T] \quad (10)$$

In the second step, we run a pooled cross-sectional regression of the returns to estimate the possible risk premia.

$$R_{it} = \lambda_0 + \alpha_{im}\lambda_m + \alpha_{iI}\lambda_I + \alpha_{i\pi}\lambda_\pi + \nu_{it}, \quad \forall i \in [1, N], \forall t \in [1,T] \quad (11)$$

The results are reported in Table Five, indicating the existence of interest rate and inflation premia over the first subperiod.
Insert Table Five.

6 Conclusion

There is a large empirical and theoretical literature on the impact of unexpected interest rate on the stock returns of banks. In parallel, a theoretical literature has analysed the impact of inflation on the market value of banks, but empirical tests are quasi non-existent. This paper provides a first empirical analysis of the joint effect of unexpected inflation and interest rate on the stock returns of French firms. Tests of cointegration of the unexpected interest rate and inflation series have confirmed the possibility to test for an inflation effect beyond the interest rate effect for the period 1977-1991. For the first sub-period 1977-1987 characterized by volatile interest rate and inflation, we are able to document an interest rate and an inflation factor specific to French banks. For the most recent period 1987-1991, these effects are mostly non-significant. The important conclusion from this empirical analysis applied to French banks is that the stock return generating process appears to incorporate an inflation risk factor which is additional to the interest risk factor documented in other studies.

Table One Summary Statistics

	Period 1977-1991	Subperiod 1977-1987	Subperiod 1987-1991
R_m			
.Mean	0.1498	0.1771	0.0718
.Std Deviation	0.2146	0.1957	0.2599
I			
.Mean	0.1047	0.1093	0.0916
.Std Deviation	0.0257	0.0279	0.0098
π			
.Mean	0.0745	0.0893	0.0321
.Std Deviation	0.0398	0.0352	0.0038
U_m			
.Mean	0.0709	0.1040	-0.0238
.Std Deviation	0.2178	0.1992	0.2614
U_I			
.Mean	-0.00002	-0.0001	0.0003
.Std Deviation	0.0051	0.0056	0.0035
U_π			
.Mean	-0.00007	-0.0001	0.00007
.Std Deviation	0.0021	0.0022	0.0016
Return on portfolio of banks			
.Mean	0.1881	0.2545	0.0009
.Std Deviation	0.3308	0.3192	0.3562
Return on portfolio of non-banks			
.Mean	0.2382	0.2580	0.1798
.Std Deviation	0.4023	0.3808	0.4594

Notation : R_m = return on market portfolio, I = interest rate, π = inflation rate, U_m = unexpected market return, U_I = unexpected interest rate, U_π = unexpected inflation rate. These statistics are annualized rates computed from monthly figures.

Table Two Correlation Matrix for the Risk Factors

	U_I	U_π	U_m
U_I	1 (0)	0.0196 (0.7968)	-0.3105 (0.0001)
U_π	0.0196 (0.7968)	1 (0)	-0.0020 (0.9788)
U_m	-0.3105 (0.0001)	-0.0020 (0.9788)	1 (0)

Notation : U_m = unexpected market return, U_I = unexpected interest rate, U_π = unexpected inflation rate. The numbers between parentheses are probabilities. A probability higher than 5 % implies that the correlation figure is not significantly different from zero at the 5 % level.

Table Three Estimation Results for the Portfolio of Banks (Equation 9)

	Period 1977-1991	Subperiod 1977-1987	Subperiod 1987-1991
Intercept	0.1431 (10.134)*	0.1918 (11.801)*	0.0113 (0.397)
U_m	0.6081 (31.136)*	0.5834 (23.844)*	0.6333 (18.6)*
U_I	-10.0368 (-3.520)*	-9.7616 (-3.267)*	-12.1847 (-1.398)
U_π	-11.8435 (-1.753)**	-14.1260 (-1.964)*	14.7569 (0.799)
R^2	0.1755	0.1467	0.2325
F	389.591	232.175	144.784

Notation : U_m = unexpected market return, U_I = unexpected interest rate, U_π = unexpected inflation rate. Numbers between parentheses are t-values.
* Significance at the 5 % level.
** Significance at the 10 % level.

Table Four Estimation Results for the Portfolio of non-Banks (Equation 9)

	Period 1977-1991	Subperiod 1977-1987	Subperiod 1987-1991
Intercept	0.1928 (16.215)*	0.2027 (15.144)*	0.1937 (7.553)*
U_m	0.6044 (36.693)*	0.5106 (25.438)*	0.7648 (24.876)*
U_I	0.5866 (0.244)	-0.5542 (-0.244)	-1.4339 (-0.184)
U_π	-5.1958 (-0.921)	-7.6153 (-1.290)	29.1214 (1.794)**
R^2	0.1070	0.0721	0.1899
F	495.208	239.518	245.447

Notation : U_m = unexpected market return, U_I = unexpected interest rate, U_π = unexpected inflation rate. The numbers between parentheses are t-values.
* Significance at the 5 % level.
**Significance at the 10 % level.

Table Five Estimation of the Risk Premia (Equation 11)

	Period 1977-1991	Subperiod 1977-1987	Subperiod 1987-1991
Market (λ_m)	0.1534 (10.810)*	0.1921 (11.354)*	0.0645 (2.301)*
Interest Rate (λ_I)	-0.000002 (-0.004)	-0.0012 (-2.213)*	0.0007 (1.761)**
Inflation Rate (λ_π)	-0.0006 (-2.575)*	-0.0003 (-1.681)**	-0.0001 (-0.509)

Numbers between parentheses are t-values
* Significance at the 5 % level.
**Significance at the 10 % level.

Appendix Test of Cointegration

In order to dissociate an inflation from an interest rate effect, we need to ensure that one variable does not predict the other. An appropriate methodology for this purpose is the cointegration test developed by Engle and Granger (1987). Tables 1 and 2 summarize the two steps of the cointegration procedure. The first step is the test of unit root (or integration) in the interest rate and inflation series. The second step is the cointegration test.

The null hypothesis tested in Table 1 is whether the different series are integrated of order 1. It is rejected if the regression coefficients of the first lag are negative and significantly different from zero. The Dickey Fuller (DF) and Augmented Dickey Fuller statistics should be compared to critical values of respectively -3.37 and -3.17 for a 5 % significance (Engle and Granger, 1987).

Table 1 Test of Integration of Inflation and Interest Rates

Series	DF Test[1]	ADF Test[2]
π_t	-0.546	-0.510
$(1 - L)\ \pi_t$	-13.951	-7.407
I_{t-1}	-1.776	-1.645
$(1 - L)I_{t-1}$	-13.383	-6.275

1DF is the Dickey Fuller Statistic
2ADF is the Augmented Dickey Fuller Statistic

From Table 1, we are not able to reject the null hypothesis that the π_t and I_{t-1} are integrated of order 1. However, the same test run on the first difference series yield to the rejection of the null hypothesis at very low significance levels. Thus, first differences are stationary and we can conclude that both the inflation and interest rate series present unit roots.

Given that the series are non stationary, the use of cointegration technique is justified to test whether interest rates are good predictors of inflation rates.

Table 2 summarizes the results of the cointegration regression of inflation on interest rates as well as the corresponding DF and ADF tests.

Table 2 Cointegration Regression and Tests

Regression	R^2	DF Test[1]	ADF Test[2]
$\pi_t = -3.459 + 1.024\ I_{t-1}$	0.44	-1.904	-1.498

1 DF is the Dickey Fuller Statistic on the residual
2ADF is the Augmented Dickey Fuller Statistic on the residual

For the inflation and interest rate to be cointegrated, the residual from the regression of inflation on interest rates should be stationary. In Table 2, both the DF and ADF tests fail to reject the null hypothesis of no cointegration between the two series. This means, that statistically the two series can drift apart and that we can test for an inflation effect that comes in addition to the interest rate effect.

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