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ABSTRACT

This study identifies empirically the impact of various macroeconomic factors on the default risk premium. Using monthly data for the period 1970-2010 for the U.S., our estimations indicate that the monetary policy aggregates, risk-free interest rate, term structure of interest rates, inflation, and the state of the business cycle influence the risk premium. The results also provide some evidence in support of the hypothesis that the development of information technology has had a decreasing impact on the risk premium. Expectedly, various financial crises have had substantial and long-lasting effects on the premium. The results suggest that the direct impact of subprime crisis and Lehman collapse on the risk premium was as large as 2.5 %-points for a sustainable period. Foreign financial crises, in turn, have lowered the risk premium in the U.S. market suggesting flight-to-safety phenomenon.

JEL Classification: G10; E40; E44

Keywords: Financial crisis; financial accelerator, external finance premium; information technology; flight-to-safety

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Introduction

The default risk premium is of great importance in the operation of financial markets. For one, the risk premium signals the prevailing level of financial market and general economic uncertainty. The risk premium also greatly affects the financial market and general economic development through the financial accelerator mechanism. From an individual borrower's point of view, the risk premium may have considerable effects on the liquidity constraints and on the profitability of investment opportunities. Moreover, Jarrow and Turnbull (2000) show that there is a clear connection between the market risk and firm-specific default risk. Therefore, it is important for both investors and economic policy makers to understand how the risk premium is determined and affected by the general macroeconomic conditions.

Despite the importance of the default risk premium, empirical research on the determination of the premium is relatively scarce. In an early study, Fama and French (1993) identify common risk factors in the returns on stocks and bonds. Clinebell *et al.* (1996), in turn, model the bond default risk premium by univariate time series models. They conclude that univariate models explain only a small percentage of the variation in the default risk premium and suggest that multivariate time series models are needed to build better forecasting procedures. Traichal and Johnson (1999) show that the default risk premia of different bonds are interconnected, whereas Ewing (2003) estimates a VAR model to examine the dynamic impact of three macroeconomic variables, the federal funds rate growth, real output growth and inflation, on the risk premium. More recently, Ramchander *et al.* (2005) study the role of macroeconomic news on interest rates and yield

spreads, while Thompson (2007) finds that the adjustment of risky corporate bond yields towards their long-term relationship with the 10 year government bond yield is asymmetric in the U.S.

The aim of this study is to provide new empirical information on the main determinants of default risk premium using monthly data over 1970-2010 for the U.S. market. The theoretical basis of the empirical analysis lies in the financial accelerator mechanism (Bernanke *et al.*, 1996; Kiyotaki and Moore, 1997). In contrast with most of the previous studies, our aim is neither to examine the predictability of default risk premium nor to study the dynamics of the premium after a shock. Rather, we aim to estimate a multiple-variable model that explains the time-variation in the level of default risk premium and that identifies the main determinants of the premium. We add several fundamental variables in the analysis that are not present in the previous examinations, such as information technology, the quantity of money and the term structure of interest rates. One of our main aims is to examine whether the growth of information technology has notably affected the premium. We hypothesize that the increase in information technology has diminished the asymmetric information problem and thereby has had a decreasing impact on the premium. Furthermore, we investigate the contributions of the most prominent financial crises on the risk premium. Since the sample period spans until 2010, we are able to study the impact of the most recent financial crisis as well.

Our empirical results are based on a linear regression model and the Fully Modified Least Squares (FMOLS) estimation technique. We apply FMOLS, since the risk premium appears to be non-stationary. The FMOLS estimation allows us

to do inferences based on a cointegrating (i.e. stationary) relationship for the risk premium.

As proposed by the theory, the results show that the monetary policy, risk-free interest rate, term structure of interest rates, monetary aggregates, inflation rate and the state of business cycle influence the level of risk premium. Expectedly, various financial crises appear to have had substantial and long-lasting impacts on the premium. The results indicate that the impact of subprime crisis and Lehman collapse on the risk premium was as large as 2.5 %-points for a sustainable time period. Furthermore, the empirical results provide evidence of flight-to-safety during the crises that take place outside of the U.S. It appears that the Japanese and East-Asian crises increased capital flows into the U.S. financial market thereby reducing the default risk premium in the U.S. The results also provide some evidence in support of the hypothesis that the development of information technology has had a decreasing impact on the default risk premium over the last 40 years. However, the standard error on the estimated coefficient on information technology is large and therefore the coefficient is not statistically significant.

In the next section, we outline briefly the connection between the external finance premium, financial accelerator, and the default risk premium. The third and fourth sections present the data and methodology used in the empirical analysis. The empirical findings are reported in section five, after which the study is concluded.

External finance premium, financial accelerator, and default risk premium

Ultimately, the default risk premium is determined at the micro level by the characteristics of firms and other individual borrowers. Bernanke *et al.* (1996) and Kiyotaki and Moore (1997) introduce the idea of External Finance Premium (EFP). The EFP refers to the crucial fact that firms cannot obtain external finance at the risk-free rate. The EFP is caused by the existence of asymmetric information and is defined as an implicit measure of agency costs of lending that increase the risk of default. In other words, the EFP can be interpreted to be a risk premium that should be added to a riskless rate in case of possible default risk.

The EFP is not directly observable. There are two approaches to tackle the unobservability dilemma. First, microeconomic balance sheet and bond market data can be used to estimate the premium of given firms (Bernanke *et al.*, 1999). Alternatively, corporate bond spreads can work as an indicator of the premium for external finance (De Graeve, 2008). Bernanke *et al.* (1996) relate the default risk premium theoretically to the EFP by using Townsend's (1979) costly state verification framework. In this model, borrowers must compensate lenders for their expected cost of auditing in case of default. This compensation is interpreted as the deadweight loss of bankruptcy. The costly state verification model implies that a rise in a borrower's net worth reduces the cost of external finance, i.e., of the default risk premium caused by the possibility of bankruptcy. Furthermore, in the Myers *et al.* (1984) model, manager's private information about the quality of the firm adds a 'lemons premium' (Akerlof, 1970) to the cost of external finance.

The EFP, and consequently the risk premium, is related to the financial accelerator mechanism introduced by Bernanke *et al.* (1996). Due to the financial

accelerator mechanism, large fluctuations in the aggregate economic activity may arise from relatively small impulses. These fluctuations affect firms' net worth. Changes in firms' net worth, in turn, affect the EFP and thereby the risk premium. An increase (decrease) in economic activity generally increases (decreases) firms' net worth and lowers (raises) the EFP. A decline in net worth affects especially those firms that are subject to serious agency problems, i.e., the firms with relatively low credit ratings. Hence, fluctuations in the economic activity are expected to affect the required return on bonds asymmetrically and are thereby expected to influence the level risk premium. The financial accelerator mechanism also states that the EFP and net worth are interconnected: a rise in the EFP decreases net worth. This two-way interaction may create strongly autocorrelated processes and vicious cycles. Economic downturns and financial crises can be explained, at least to some extent, by this mechanism. Consequently, our analysis on the linkages between macroeconomic fundamentals and the risk premium may give some insight into the recent financial crises.

We measure the default risk premium as the spread between Baa rated corporate bond yield and the yield on 10-year government bonds. In the spirit of the financial accelerator approach, the model by Bernanke *et al.* (1996) illustrates that any factor that affects firm's cash flows or the net value of its assets should influence the EFP and the default risk premium. That is, any fall in firm's net worth increases its riskiness and thus the agency premium or EFP. Higher risk-free interest rate hits the firms with leverage by increasing the cost of debt and decreasing the discounted net worth of the firm, thereby increasing the risk premium. On the other hand, tightening of monetary policy in the form of an increase in the federal funds rate may be a signal of a recovering and booming

economy as the central bank starts to fight against inflation. Hence, an econometric model trying to capture the main determinants of the risk premium should include both the risk-free interest rate and the federal funds rate. Greater term spread of interest rates, in turn, signals higher future interest rates and costs of debt. Since higher expected future interest rate should decrease firms' expected net worth, greater term spread is expected to increase the risk premium. Moreover, higher inflation rate increases firms' nominal cash flow expectations and reduces the real debt and real cost of debt thereby decreasing the EFP.

Also credit expansion may affect the risk premium. According to Allen and Gale (2000), financial liberalization or a conscious decision by the central bank to increase lending may create a financial bubble: rapid credit creation may raise asset prices over their long-run sustainable (fundamental) level. It can be expected that the greater the credit expansion has been, the more likely is an asset overpricing and the more probable is a notable decrease in asset prices in the future. The risks regarding future asset price movements affect the real sector of the economy adversely. Thus, higher probability of an asset price collapse reduces the expected cash flows of firms. This, in turn, reduces the expected net worth of firms raising their EFP. Because the banking system creates endogenously money through credit, we can use monetary aggregates to indicate the level of credit creation.

We also hypothesize that information technology improves the quality and dissemination of relevant market information reducing uncertainty and agency problems. This can be expected to reduce the EFP and the default risk premium.

In sum, by relating the risk premium to the EFP and financial accelerator we achieve some important insights. Firstly, in addition to the traditional financial

theory, the expected signs of the variables can be explained theoretically also by the financial accelerator hypotheses. Secondly, the accelerator mechanism can explain the strong autoregressive nature of the risk premium (e.g. Clinebell *et al.*, 1996). Thirdly, our results can give some insights into the transmission mechanisms of financial crises and the relationship between financial markets and the real sector.

Data

We use monthly data for the period 1970:2-2010:12 for the U.S. to examine empirically the impact of various fundamental factors and of several crisis periods on the default risk premium. The data are sourced from the U.S. Federal Reserve database.

Following previous related literature (Chen *et al*., 1986; Bernanke and Blinder, 1992; Ewing, 2003; Thompson, 2007), we use the spread between low grade corporate bond (Baa) yield and 10-year government Treasury bond yield as a measure of the default risk premium (*rp*). The computed risk premium together with the Baa bond yield and 10-year government bond yield are graphed in Fig. 1.

[Figure 1 near here]

Regarding the fundamentals that are expected to affect the risk premium, the U.S. federal funds rate (*fed*) is used to measure the monetary policy, the risk-free interest rate included in the analysis is the three-month T-bill rate (r^f), and the state of business cycle is described by the change in the U.S. industrial production

during previous six months (*y*). Furthermore, the term spread of interest rates (*s*) is computed as the difference between the 10-year government treasury-bond rate and the three-month T-bill rate, and the change in consumer price index is the measure for inflation (*i*). The role of improved market information and information technology, in turn, is captured by the investments in information technology and related equipment (*info*). Finally, the monetary expansion is measured as the change in monetary aggregate *M2* (*ΔM2*). Together, *fed* and *ΔM2* cater for the effects of the monetary policy. However, *ΔM2* is also dependent on the credit creation of commercial banks and on the net foreign capital inflows. It is largely recognized that the foreign capital flows to the U.S. had a significant role in the recent subprime crisis (Reinhart and Rogoff, 2008). All variables except for the interest and inflation rates are in natural logs. *y*, *info* and *ΔM2* are in real terms. The consumer price index is used to deflate these series.

Financial crises have a tendency to notably affect the supply of credit and to increase the uncertainty in financial markets. Hence, financial crises may have significant impacts on the risk premium that are not captured by the fundamental variables included in the analysis. Therefore, we include in the analysis several dummy variables to cater for the potential structural breaks caused by the several financial crises that took place during the sample period. These crises include the 1987 Black Monday (*BM*), the South-East Asian crises (*SEA*), the financial crisis in Japan (*JPN*), the dotcom bubble and subsequent stock market collapse in the late 1990s and early 2000s (*DC*), the 11 September 2001 attack (*9/11*), and the subprime crisis (*SP*). In addition, within the subprime crisis a separate dummy variable caters for the effect of the 2008 Lehman Brothers shock (*LE*). The

starting and ending dates of the crisis dummy variables are selected by the Akaike Information Criteria (AIC).

Also the effects of the oil shocks in the 1970s and in the early 1980s are considered. However, the reported models do not include the oil shock variables, since these shocks do not appear to have had a significant additional contribution on the risk premium. It is not unexpected that the oil crises did not have an independent impact on the risk premium, since these shocks were not financial crises. In other words, the fundamental variables included in the analysis are likely to cater for any influence that the oil crises had on the premium.

Out of the variables included in the analysis, risk premium, *info*, r^f and *fed* appear to be I(1), while the rest of the fundamentals are stationary based on the DF-GLS unit root test (see Table 1). Since our main aim is to examine the determination of the *level* of default risk premium, the dependent variable in our estimation is the level of *rp*. That is, the dependent variable is non-stationary. However, since the estimated model also includes other I(1) variables, the model itself can be stationary, and we formally test for the stationarity of the error term.

[Table 1 near here]

Methodology

A regression involving the levels of I(1) variables can produce misleading results, if estimated by Ordinary Least Squares (OLS). In particular, the presence of I(1) variables may cause a spurious regression (e.g. Enders, 2004). However, it is well-known that if the series are cointegrated, the static OLS estimation is

consistent, converging at a faster rate than is standard (Hamilton, 1994). The static OLS has several important shortcomings regarding a cointegrating regression, though (e.g. Phillips and Hansen, 1990). Therefore, the conventional testing procedures are not valid unless modified substantially, and the static OLS is generally not recommended if one wishes to conduct inference on the cointegrating vector.

To overcome the complications with the static OLS, we use the Fully Modified OLS (FMOLS) technique, proposed by Phillips and Hansen (1990), to estimate the model for default risk premium. Phillips and Hansen (1990) show that the FMOLS estimator performs well even in small samples when doing inferences on a cointegrated system. The use of FMOLS allows us to contribute to the empirical literature on the theme by estimating a cointegrating equation for the non-stationary risk premium. That is, by FMOLS we can estimate a multiple-variable model that identifies the main determinants of the *level* of default risk premium and explains, at least to a notable extent, the time-variation in the premium.

We formally test for the stationarity of the error term by the Engle-Granger cointegration test. The Engle-Granger test works here as a specification check; non-stationarity of the residual series would indicate specification problems. The lag length in the Engle-Granger tests is selected by the Schwartz Information Criteria (SIC). Finally, as the residual series in the estimated models exhibit autocorrelation, we report standard errors that are estimated based on the Bartlett Kernel and Newey-West (1987) covariance matrix with lag length five.

Empirical results

Table 2 reports three models that are estimated with Fully Modified Least Squares (FMOLS). Model 1 includes only those coefficients that are considerably large relative to their standard errors and that belong to the model based on the AIC. Model 2 also includes the information technology variable. In addition to the variables in Model 2, Model 3 incorporates two more crisis dummy variables that should be included in the model according to the AIC. The Engle-Granger tau- and z-statistics suggest that the models are stationary. That is, the risk premium appears to be cointegrated with the explanatory [I(1)] variables. The shown Engle-Granger critical values should be taken only as suggestive though, since the inclusion of the dummy variables may somewhat affect the critical values. The Hansen stability test accepts the stability of the estimated parameters over the sample period.

[Table 2 near here]

As Fig. 2 and Table 2 show, the estimated models explain reasonably well the movements in risk premium (non-adjusted R^2 of Model 3 is 72.4%). Also a visual inspection of the residual series suggests that Model 3 is stationary (Fig. 3).

[Figure 2 near here]

[Figure 3 near here]

An economic interpretation can be found for the signs of the variables. The economic growth measured by *y* has negative influence on the risk premium: rapid economic growth is expected to improve the profitability of firms and thereby to reduce financial risks. This is also consistent with the financial

accelerator hypothesis. The increase of industrial production increases firms' net worth and decreases the EFP, which explains the negative sign of industrial production.

The AIC select the change in fed rate (Δfed) in the model instead of the level of *fed*. The coefficient on the change in the fed rate is negative. This indicates that the financial markets interpret a tightening of monetary policy as a signal of a recovering and booming economy. Ewing (2003) obtains a similar result. In contrast, the signs on risk-free interest rate and term spread are positive. Also this is in accordance with the theory: higher current and future risk-free cost of debt lowers the net worth of a firm thereby raising the EFP. In addition, the liquidity premium that affects the term spread is likely to be positively related to market uncertainty and the risk premium.

The sign on $\Delta M2$ is positive, which is in line with the expectation as explained in section 2. Furthermore, since inflation reduces the real debt burden of especially the highly indebted and consequently high risk borrowers, the sign on i is negative. The negative sign is also consistent with the financial accelerator. Because inflation makes the real value of debt smaller, it increases the net discounted assets of firms and their net worth. This, in turn, decreases the EFP. In line with our results, Ramchander *et al.* (2005) find that weaker economic growth leads to an increase in the quality spread and unexpected increase in the consumer price index lowers the premium.

The interpretation of the impacts of financial crises is rather straightforward. Financial crises, in general, have negative effects on firms' net worth and, consequently, increase the risk premium. The signs of the U.S. financial crises (*BM, DC*, *SB* and *LE*) are positive, as expected. The foreign

financial crises (*SEA* and *JPN*), instead, decreased the risk premium in the U.S. market. This may be explained by the flight-to-safety effect. Foreign crises cause investors to move their investments from the crisis areas to the U.S., since the U.S. has generally been considered as a safe haven for capital. Because of the foreign financial crises, the relative default risk of domestic low grade bonds decrease in international portfolios as investors in the high yield markets prefer U.S. bonds, which are considered to be less risky, over bonds in the crisis regions. This can be expected to increase the demand for U.S. high yield bonds inducing lower risk premiums.

While the notable impact of the Lehman Brothers collapse lasted until May 2009 based on the AIC, the subprime effect did not disappear before the end of the sample period. The fact that the coefficient on Lehman dummy is substantially greater in magnitude than the coefficients on any of the other crisis variables emphasizes the severity of the Lehman crisis. The results suggest that the Subprime crisis, including the impact of the Lehman collapse, increased the risk premium directly by some 2.5 percentage points for a sustainable period. In addition to this direct effect, the crisis also increased the risk premium by having an adverse impact on economic growth and by increasing the term spread of interest rates.

One of our hypotheses is that the advance of information technology has permanently reduced the level of default risk premium, since the development of information and communications technology improves the quality and dissemination of relevant market information. Better information, in turn, reduces the asymmetric information complications and uncertainty in the financial markets. In other words, the development of information technology reduces the

agency problems caused by asymmetric information thereby decreasing the risk premium. In line with this hypothesis, the point estimate on information technology is negative and the AIC and adjusted coefficient of determination propose that *info* belongs to the model. However, the magnitude of the coefficient (approximately .02) is small relative to its standard error. That is, *info* is not statistically significant in the model.

If we assume that the point estimate on *info* in Model 3 is correct, the results imply that, due to the more than 450% increase in *info*, the risk premium was approximately nine basis points lower in 2010 than it would have been if the information technology had not gone forward. This may not sound much, but it may have significant impacts concerning a number of firms and investment opportunities.

Summary and conclusions

The aim of this study is to examine empirically the determination of the default risk premium. Using monthly data for the U.S. for the period 1970-2010 and the Fully Modified Least Squares estimation technique, we estimate a cointegrating regression model for the level of risk premium. The model includes as explanatory variables the main macroeconomic fundamentals that are expected to affect the risk premium as well as several dummy variables for the major financial crisis that took place during the sample period. In addition to the fundamentals that have been conventionally conceived as the major determinants of the financial market risk premium, we are interested in the effect of information technology on the premium. We hypothesize that the increase and improvement in

information technology improves market information thereby reducing the problem of asymmetric information, uncertainty, and ultimately the risk premium.

In accordance with our hypothesis, the Akaike Information Criteria and adjusted coefficient of determination propose that our information technology variable adds information to a model explaining the evolution of the default risk premium, and the point estimate on information technology is negative. However, the size of the coefficient is small relative to its standard error, i.e., the coefficient is not statistically significant. In line with the theory, the results also indicate that the macroeconomic growth, risk-free interest rate, term-spread of interest rates, inflation, monetary policy and credit creation influence the risk premium. While domestic (U.S.) crises increase the risk premium, foreign crises appear to reduce the premium. We suggest that the latter effect is due to the flight-to-safety from the crisis areas to the U.S. Our results also provide some insight into the transmission mechanism of the recent financial crises.

The findings entail several policy relevant messages. For one, supporting the advancement of information diffusion in the financial markets may lower the cost of debt finance for risky companies by diminishing the complications caused by asymmetric information. Second, the results indicate that the financial markets generally interpret a tightening of monetary policy as a signal of a recovering and booming economy. Third, risky firms can benefit from higher inflation rate as higher inflation appears to cause lower default risk premium. Finally, financial crises that take place abroad may lower artificially the risk premium in the U.S. market thereby leading to too many risky investments being done.

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Figure 1. Default risk premium, Baa bond yield, and 10-year government bond yield (%)

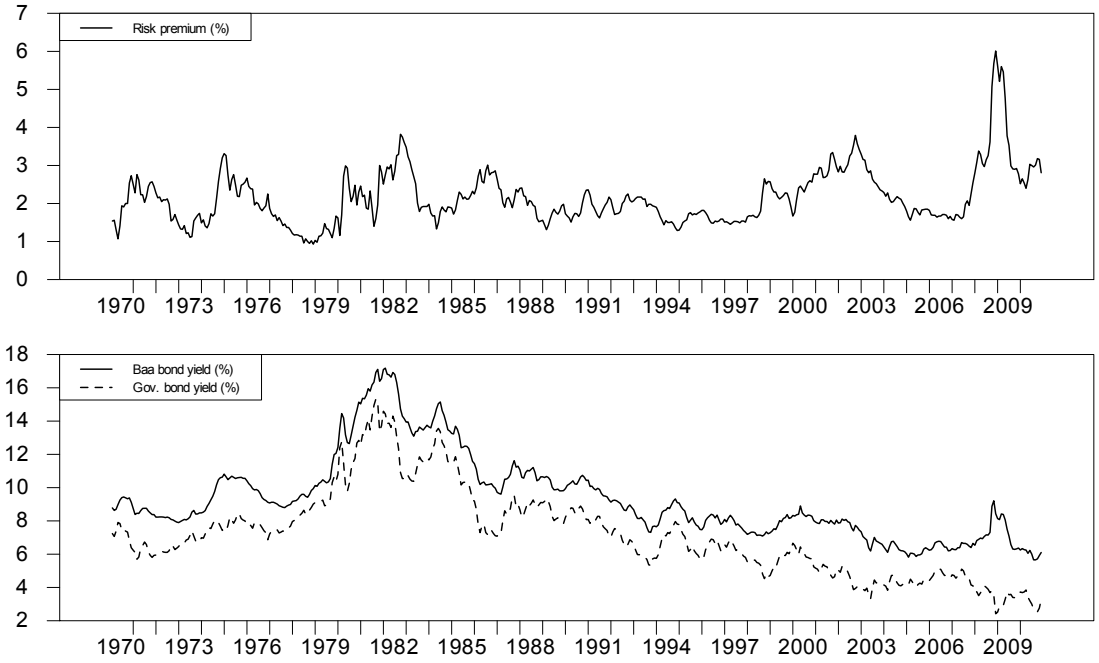

Fig. 2. Actual default risk premium and fit from Model 3 (%)

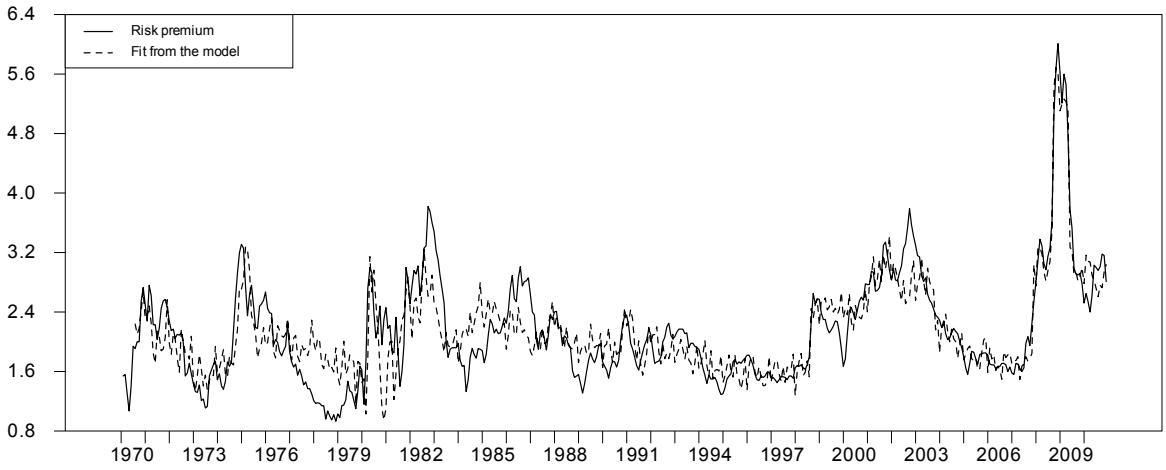

Fig. 3. Difference between the actual default risk premium and the fit from Model 3 (%-points)

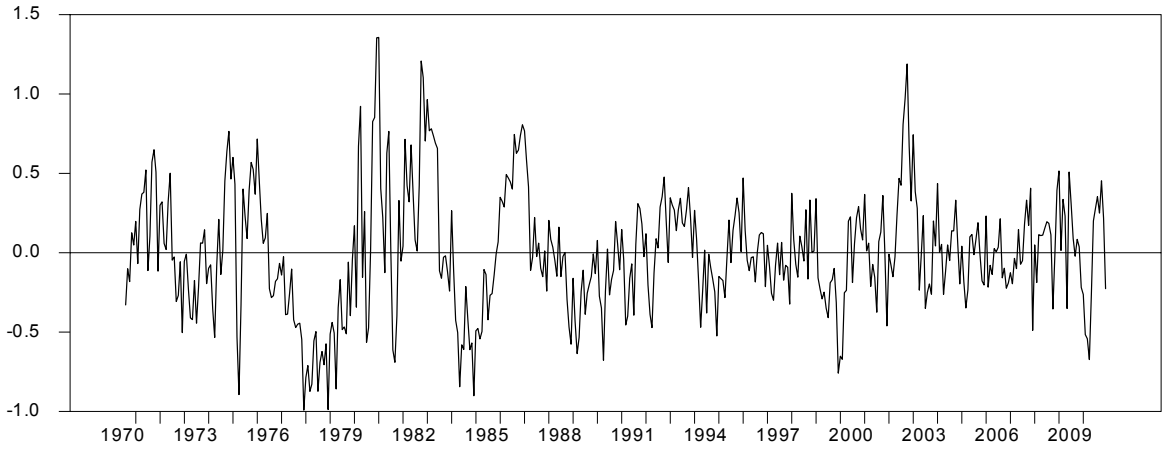

Table 1. DF-GLS unit root test results

Variable	Level (lags)	Difference (lags)
Risk premium (*rp*)	-0.89 (2)	-15.9*** (1)
Information technology production (*info*)	1.39 (14)^{c}	-2.57*** (13)
Industrial production growth (*y*)	-5.20*** (9)	
Inflation rate (*i*)	-1.71* (11)	
Fed funds rate (*fed*)	-1.50 (2)	-14.5*** (1)
Three-month t-bill rate (*T-bill*)	-1.07 (13)	-5.61*** (12)
Term spread (*s*)	-1.99** (2)	
ΔM2	-1.62* (15)	

The sample period is 1970:2-2010:12. *, ** and *** denote statistical significance at the 10%, 5% and 1% level, respectively. Critical values at the 10%, 5% and 1% significance levels are -1.62, -1.94 and -2.57. The number of lags included in the tests is decided by the Schwarz Information Criteria. A constant term (^{c}) is included in the tested model if it is plausible that the variable exhibits a time trend and if the series seem to be trending.

Table 2. FMOLS estimation results

Dependent variable: *rp*	Model 1		Model 2		Model 3	
Explanatory Variable	Coefficient	(SE)	Coefficient	(SE)	Coefficient	(SE)
constant	1.72	(.173)	1.89	(.200)	1.91	(.361)
info			-.018	(.038)	-.021	(.038)
y	-.063	(.012)	-.061	(.012)	-.062	(.012)
ΔM2	.114	(.065)	.100	(.066)	.102	(.065)
i	-.235	(.138)	-.241	(.143)	-.243	(.142)
Δfed	-.146	(.065)	-.138	(.064)	-.137	(.064)
T-bill	.024	(.018)	.022	(.018)	.022	(.018)
s	.154	(.037)	.152	(.037)	.147	(.037)
BM					.244	(.373)
JPN	-.296	(.116)	-.308	(.117)	-.297	(.117)
SEA	-.678	(.315)	-.847	(.311)	-.846	(.311)
DC	.623	(.131)	.631	(.142)	.637	(.143)
9/11					.089	(.587)
SP	.927	(.188)	.883	(.200)	.898	(.199)
LE	1.52	(.357)	1.59	(.354)	1.59	(.352)
Adjusted R^2	.714		.715		.715	
Standard error of regression	.389		.388		.388	
JB	.00		.00		.00	
DW	.57		.56		.56	
tau-statistics (5% critical value)	-8.14	(-3.35)	-8.19	(-3.76)	-8.17	(-3.76)
z-statistics (5% critical value)	-116.8	(-20.3)	-118.1	(-26.2)	-117.7	(-26.2)

The sample period is 1970:2 – 2010:12. The standard errors are estimated based on the Bartlett Kernel and Newey-West (1987) covariance matrix with lag length five. The tau- and z-statistics refer to the Engle-Granger cointegration test statistics. The critical values for these statistics are computed based on the MacKinnon (1996) response surface simulation results. The Engle-Granger tests include zero lags (selected by the Schwartz Information Criteria). Due to the non-normally distributed residuals, statistical significances of the coefficients are not reported. JB stands for the Jarque-Bera test on residual normality, and DW denotes the Durbin-Watson test for first order autocorrelation in the residuals. The crisis variables take the value one in the following periods and are zero otherwise: *BM*, 1987:10-1988:2; *JPN*, 1991:2-1997:8; *SEA*, 1998:1–1998:8; *DC*, 1998:1-2003:10; *9/11*, 2001:9-2001:10; *SP*, 2007:12-2010:12; *LE*, 2008:9-2009:5.

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