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Lyócsa, Štefan and Baumöhl, Eduard and Výrost, Tomáš

Faculty of Business Economics in Košice, University of Economics in Bratislava

17 December 2012

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Štefan Lyócsa* – Eduard Baumöhl – Tomáš Výrost

Faculty of Business Economics in Košice
University of Economics in Bratislava, Slovak Republic

*Corresponding author. E-mail: stefan.lyocsa@gmail.com.

Abstract

Using dynamic conditional correlations (DCCs), we estimate the time-varying relationship between stock market returns and output growth based on monthly data for the US over the 1964:01 to 2012:07 time period. We demonstrate that in general, this relationship is positive and present during the entire study period. Furthermore, our findings suggest that this relationship is strengthened during recessions.

Keywords: stock market returns, real activity, dynamic conditional lagged correlations, recessions

JEL Classification: E44, G15

Support by the Slovak Grant Agency for Science (VEGA project No. 1/0393/12) is gratefully acknowledged.

I. Introduction

Theories explaining the relationship between the stock market and real economic activity stem from the notion that stock market prices reflect the present value of all future payouts. Because the value of these payouts is associated with the growth of the real economy, stock market returns should be related to future output growth. It is widely believed that this "returns – growth" relationship holds for most developed countries, particularly the US (e.g., Fama, 1990; Schwert, 1990; Mauro, 2003; Panopoulou *et al*., 2010).

Schwert (1990) confirmed the results of Fama (1990) with respect to the "returns – growth" relationship and extended the analysis of this relationship to a timespan of 100 years. To a certain extent, the belief in a strong "returns – growth" relationship has been challenged by the studies of Binswanger (2000, 2004), Canova and De Nicoló (2000) and Dufour and Tessier (2006). In a bivariate analysis, Binswanger (2000, 2004) argued that a break in this relationship (or at least its weakening) occurred during the mid-1980s, i.e., at approximately the endpoint of the periods that were assessed by Fama (1990) and Schwert (1990).

The goal of this study is to estimate the dynamics of the "returns – growth" relationship in the US. To achieve that, we estimate the time-varying correlations between lagged stock market returns and contemporary output growth.

II. Data and methodology

The data sample spans the 1964:01 to 2012:07 time period. Seasonally adjusted monthly data from the Industrial Production Index and the Consumer Price Index (CPI) of the US were obtained from the OECD's Main Economic Indicators database. The daily closing prices of the S&P 500 were obtained from Datastream. Monthly stock market prices were calculated by averaging the daily observations and adjusted by the CPI to obtain real stock prices. We used log differences as a proxy for stock market returns (ΔSm_t) and output growth (ΔIm_t).[1]

To estimate the time-varying correlations, we used the two-step DCC MV-GARCH model by Engle and Sheppard (2001). Mean (ARMA) and variance equations were estimated in the first step of the model estimation. The resulting standardized residuals were tested for the presence of autocorrelation and ARCH effects using the Ljung–Box test. We considered

[1] According to the ADF-GLS test, log levels of the examined series may be regarded as integrated of order one. Results are available upon request.

both the standard GARCH and the asymmetric E-GARCH and GJR-GARCH models. The Bayesian information criterion (BIC) was used to choose between the GARCH models.[2]

We assume that the variance-covariance matrix of paired residuals (from filtered series) $\mathbf{r}_t = (\varepsilon_{i,t}, \varepsilon_{j,t})^T$ decomposes to $\mathbf{D}_t\mathbf{R}_t\mathbf{D}_t$, where $\mathbf{D}_t$ is a diagonal matrix of time-varying conditional standard deviations from univariate GARCH models. Given this assumption, the DCC(1,1) model takes the following form:

$$\mathbf{R}_t = diag\{\mathbf{Q}_t\}^{-1}\mathbf{Q}_t diag\{\mathbf{Q}_t\}^{-1} \tag{1}$$

$$\mathbf{Q}_t = (1-\alpha-\beta)\overline{\mathbf{Q}} + \alpha\mathbf{s}_{t-1}\mathbf{s}_{t-1}^T + \beta\mathbf{Q}_{t-1} \tag{2}$$

$$\rho_{i,j,t} = \frac{q_{i,j,t}}{\sqrt{q_{i,i,t}\, q_{j,j,t}}},\ i, j = 1,2,\ldots,n; i \neq j \tag{3}$$

where $\mathbf{R}_t$ is the time-varying correlation matrix, $\overline{\mathbf{Q}}$ is the unconditional correlation matrix in the dynamic correlation structure $\mathbf{Q}_t$, and $\mathbf{s}_t$ is a vector of standardized residuals. A typical element of $\mathbf{R}_t$ takes the form of $\rho_{i,j,t}$, which are the estimated DCCs. We refer to the DCCs between ΔIm_t and ΔSm_{t-p} as dynamic conditional lagged correlations if lag $p > 0$ (if $p = 0$, these DCCs are the usual contemporaneous DCCs). This approach allows us to observe how stock market returns lead output growth and how this relationship has evolved over time.

III. The estimation results

For the DCC models, we have considered $p = 0,1,\ldots,5$. The estimation results are presented in Table 1 and 2.

Table 1. The specification of the mean and variance equations

	ΔIm	ΔSm
mean equation	ARMA(1,1)	ARMA(1,1)
variance equation	GJR-GARCH(1,1)	E-GARCH(1,1)
LB pval[lag]	0.0588[5]	0.3655[7]
LB^2 pval[lag]	0.2491[2]	0.5971[9]
BIC	-7.1959	-3.9058
EN test (joint)	0.6597	0.8956

Note: LB stands for the Ljung–Box test. Autocorrelation and ARCH effects were tested for up to 12 lags. We report minimum p-values at the corresponding lags in brackets. The EN test corresponds to the Engle and Ng (1993) specification test. For the sake of brevity, only the p-values of the joint effect hypothesis are reported. The sign bias, negative bias and positive bias were insignificant.

[2] In all of the GARCH models, we assumed generalized error distributions (GED) of $\varepsilon_{i,t}$, $\varepsilon_{j,t}$. For the DCC models, a multivariate Student distribution was assumed.

Fig. 1 illustrates $DCC_{t,p}$, the correlations for each p. In each chart of Fig. 1, the dotted line corresponds to the maximum correlation, i.e., $maxDCC_t = max_p\{DCC_{t,p}\}$. From the maximum correlations, we may be able to observe the general strength of the "returns – growth" relationship and the relative strength of other correlations. The shaded areas in Fig. 1 correspond to economic or stock market events (such as recessions or stock market bubbles; see Table 3).

At $p = 0$ and $p = 5$, the correlations are negligible (averages –0.006 and –0.017, respectively; standard deviations 0.037 and 0.021, respectively). The low contemporaneous correlations suggest that with respect to the real economy, investors appear to be forward-looking; thus, the expectations for current output may already be reflected in previous prices. Descriptive statistics of the dynamic conditional lagged correlations (for $p = 1,\ldots,4$) may be found in Panel A of Table 3. Stock markets appear to predict output growth one to four months in advance ($p = 1,\ldots,4$).[3] This relationship is positive but exhibits considerable variation; notably, at different periods, the strongest correlations occur for different lags. For example, prior to the occurrence of the dot-com bubble (before 1998:07), the highest correlations were found for $p = 2$ and $p = 3$. During the creation and burst of this bubble (1998:07 to 2000:03), the highest correlations "switched" to $p = 1$, whereas the correlations rapidly decreased for $p = 2$ and remained steady for $p = 3$ and $p = 4$. These types of trade-offs are visible throughout the entire time period and often occur between $p = 1$ and $p = 2$.

Table 2. The parameter estimates from the DCC models

ΔIm_t	p	alpha	beta	shape
ΔSm_t	0	0.0139	0.9150***	6.6413***
		[0.0204]	[0.0435]	[1.0808]
ΔSm_{t-1}	1	0.0233	0.8926***	7.0741***
		[0.0161]	[0.0380]	[1.1797]
ΔSm_{t-2}	2	0.0349**	0.8717***	7.6220***
		[0.0162]	[0.0299]	[1.3401]
ΔSm_{t-3}	3	0.0122	0.9236***	7.0857***
		[0.0137]	[0.0650]	[1.2145]
ΔSm_{t-4}	4	0.0242	0.8664***	7.3531***
		[0.0198]	[0.0567]	[1.2449]
ΔSm_{t-5}	5	0.0035	0.9866***	6.9915***
		[0.0071]	[0.0063]	[0.9371]

*Note: ** and *** denote significance at the 5% and 1% levels, respectively. In the table above, "Shape" represents the shape parameter for the multivariate Student's distribution. Standard errors are provided in brackets.*

[3] As argued by Fama (1990), information about the state of future production is spread over many previous periods.

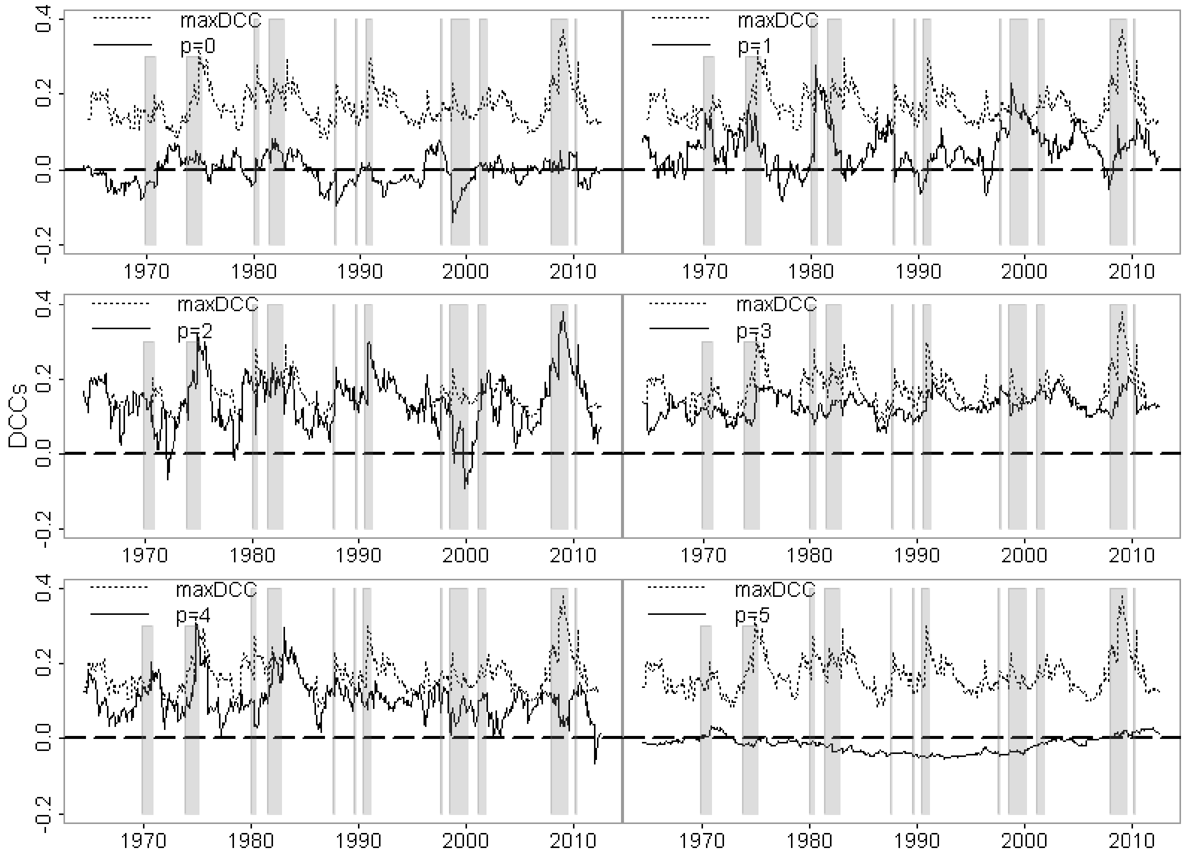

Fig. 1. The dynamic conditional lagged correlations with the lags of stock market returns for *p* = 0,…,5.

Descriptive statistics also suggest that the "returns – growth" relationship is very stable at $p = 3$ and that much of the variation occurs in the first two lags, which most likely indicate corrections to previous expectations. In the next step of the analysis, we used simple linear regressions that included dummy variables corresponding to various economic and market events. Our goal was to explain the variance of lagged correlations for lag $p = 1,\ldots,4$ and for the maximal correlations ($maxDCC_t$). The regression results are reported in Panel B of Table 3.

There are many significant events that affected the "returns – growth" relationship; the coefficients for these events often demonstrated different signs across the regression equations. However, we observed that stock market predictions responded more quickly (i.e., $p = 1$ or $p = 2$) to the occurrence of particular economic events (recessions, oil crises, stagflation and the subprime mortgage crisis) than to typical economic conditions. This result suggests that these events were not anticipated three to four months before they occurred but that a correction developed one to two months ahead of the real economic effects. Finally, the results for $maxDCC_t$ indicate that the "returns – growth" relationship increases during a recession (with an exception in 2001); in fact, the recent subprime mortgage crisis produced an effect on this relationship that was two to ten times greater than the impacts of previous recessions.

Table 3. Descriptive statistics for the lagged correlations and the regression parameter

Panel A	***p* = 1**	***p* = 2**	***p* = 3**	***p* = 4**	**maxDCC$_t$**
Min.	-0.0855	-0.0910	0.0532	-0.0662	0.0835
Max.	0.2777	0.3781	0.2075	0.3047	0.3781
Average	0.0534	0.1367	0.1278	0.1030	0.1683
Std.	0.0564	0.0729	0.0303	0.0491	0.0482
Panel B	**Parameter estimates [SE]**				
Constant	0.0444***	0.1316***	0.1277***	0.1011***	0.1737***
	[0.0058]	[0.0069]	[0.0040]	[0.0058]	[0.0145]
1969:12-1970:11	0.0582***	-0.0222	-0.017***	0.0373***	-0.0139
Recession	[0.0149]	[0.0166]	[0.0062]	[0.0098]	[0.0093]
1973:11-1975:03	0.0568***	0.0799***	-0.0131	0.0596	0.0545**
Recession	[0.0161]	[0.0268]	[0.0198]	[0.0426]	[0.0265]
1980:01-1980:07	0.1115***	0.0279***	-0.0315***	-0.0394***	0.0465***
Recession	[0.0392]	[0.0083]	[0.0047]	[0.0121]	[0.0115]
1981:07-1982:11	0.0241	0.0580***	0.0031	0.0692***	0.0426***
Recession	[0.0228]	[0.0075]	[0.0082]	[0.0148]	[0.0092]
1987:10	0.0423***	-0.0206***	-0.0259***	0.013**	-0.0380***
Market-crash	[0.0058]	[0.0069]	[0.0040]	[0.0058]	[0.0093]
1989:10	-0.0555***	-0.0007	-0.037***	0.0141**	-0.0320***
Market-crash	[0.0058]	[0.0069]	[0.0040]	[0.0058]	[0.0059]
1990:07-1991:03	-0.0378***	0.0941***	0.0172*	0.0014	0.0628***
Recession	[0.0131]	[0.0243]	[0.0100]	[0.0087]	[0.0183]
1997:10	0.0694***	0.0219***	0.0541***	0.0111*	0.0243***
Market-crash	[0.0058]	[0.0069]	[0.0040]	[0.0058]	[0.0057]
1998:09-2000:03	0.1138***	-0.1172***	0.0006	-0.0271**	-0.0045
Dot-com bubble	[0.0124]	[0.0234]	[0.0046]	[0.0115]	[0.0127]
2001:03-2011:11	0.0528***	-0.1195***	0.0118***	-0.028**	-0.0175***
Recession	[0.007]	[0.0111]	[0.0039]	[0.0111]	[0.0057]
2007:12-2009:06	-0.0024	0.1554***	0.0203	-0.0290*	0.1241***
Recession	[0.0140]	[0.0295]	[0.0161]	[0.0165]	[0.0278]
2010:06	0.045***	0.1588***	0.0030	0.0100*	0.1275***
Market-crash	[0.0058]	[0.0069]	[0.0040]	[0.0058]	[0.0059]
p					-0.0054
					[0.0053]
N	580	579	578	577	576
adj.R^2	23.05%	35.88%	3.68%	13.07%	31.52%

Note: The recessions are dated by NBER. The HAC standard errors are in brackets. Each of the dummy variables that represented an examined event was set to 1 when its corresponding event occurred and 0 otherwise. In the regression on maxDCC$_t$, "p" denotes the lag for which the maximum correlation occurred.

IV. Conclusions

In this study, we used dynamic conditional lagged correlations to observe the time-varying relationships between current output growth and past stock market returns. Based on US data, we found that stock markets predict economic growth that will occur one to four months in the future but that this relationship was most stable for projecting economic performance three months in advance. Our results also suggest that stock market changes that occur one to two months prior to real economic developments serve as corrections to the previous expectations of the stock market. In addition, we found evidence that the "returns – growth" relationship becomes stronger during recessions.

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