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Business School

WORKING PAPER SERIES

Working Paper

2014-050

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Volatility spillovers and macroeconomic announcements: evidence from crude oil markets

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Abstract

The paper employs an event study methodology to investigate the macroeconomic announcements effects on S&P500 and oil prices. Our results provide evidence of a significant impact of the US macroeconomic news on oil prices. This impact is split into two components, namely the direct effect (common response) and indirect effect (volatility transmission). Altogether our results show that the volatility transmission is bidirectional since a significant volatility transmission from the oil market to the US stock market is revealed. Furthermore, a higher volatility transmission is recorded from the oil market to the stock market especially after the release of consumption indicators.

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1. Introduction

The relationship between commodity markets and macroeconomic fundamentals receives a considerable amount of interest in both the economic press and the academic literature. While some papers test whether oil prices reflect economic fundamentals and thus affect the macroeconomy (Hamilton, 2008; Kilian and Lutz, 2008) or monetary policy rules (Kilian and Vega, 2011; Elder et al, 2012) investigate the impact of macroeconomic news on commodity markets, to select the indicators mostly considered by professionals, especially when valuing oil prices. Understanding the impact of scheduled macroeconomic announcements on commodity markets is indeed of great interest to test the market efficiency hypothesis and anticipate the reaction of domestic as well as foreign investors and policymakers to news arrival.

This paper contributes to the analysis of the relationship between scheduled macroeconomic announcements and oil prices. Previous literature on the impact of macroeconomic announcements has mostly focused on financial markets (e.g. Mcqueen and Roley, 1993; Rigobon and Sack, 2006; Dubreuille and Mai, 2009, Dimpfel, 2011). Moreover, some papers have tested the relationship between US macroeconomic announcements and some foreign markets. This is motivated by the central role of the U.S in determining the development of the world economy For instance Nikkinen and Sahlstrom (2004) find a significant impact of such announcements on foreign financial markets. Dubreuille and Mai (2009) argue that the volatility in the European stock market doubles five minutes following US macroeconomic announcements. So far, few papers to date investigated the impact of macroeconomic news on commodity markets (Barnhart, 1989; Hess et al., 2008; Roache and Rossi, 2010) and specially oil markets (Kilan and Vega, 2011; Chatrath et al., 2011). Almost all of these studies agree that macroeconomic news have little impact on commodity returns and volatility. However, the literature shows mixed results regarding the impact of US announcement on commodity prices. These results are sensitive to data frequency (daily, monthly or quarterly) and business cycle (expansion versus recession). Hess et al. (2010) find that the reaction is state dependant. During recessions, news about higher inflation and real activity lead to positive adjustments of commodity futures prices. In contrast, they find no significant reactions during economic expansions. Elder et al. (2012) use intraday data and find strong evidence of significant jumps around some macroeconomic news. Engle and Rangel (2008) find evidence of a significant relationship between the market volatility and macroeconomic variables such as inflation, growth and macroeconomic volatility.

The event study methodology several advantages over competing methods. First, it allows assessing the impact of the US news immediately after their release and thus the contemporaneous effect of the news on stock prices can be measured. Second, the methodology allows treating the US announcements as exogenous variables and thus the problem of endogeneity is avoided in the regression.

We go beyond this result by disclosing the sources of the reaction to such announcements. In a standard way, and according to the market efficiency hypothesis, an unanticipated U.S. macroeconomic announcement, as any other public information, must be directly incorporated into oil prices (Balduzzi et al, 2001). Another possible explanation is that this reaction is indirect and is due to cross market hedging (Fleming et al., 1998; Belgacem and Lahiani, 2012). Explicitly, macroeconomic announcements, like any other information, may affect the volatility of financial markets, a movement that spreads to commodity markets.

Several studies have focused on this channel of volatility spillover effect in the context of stock markets (Hsin, 2004 ; Harju and Hussain, 2008), exchange markets (Kanas, 2000; Chen and Gau, 2010 ; Ben Omrane and Heinen, 2011), CDS markets (Galil and Soffer, 2011) options markets (Diavatopoulos et al, 2012) interest rate markets (Monticini et al., 2011), metal futures markets (Elder et al., 2012) and commodity markets (Roache and Rossi, 2010). These studies generally find evidence of return and volatility transmission across major market returns and volatilities and argue that good (bad) news in one market can stabilize (destabilize) other markets (Belgacem and Lahiani, 2012). So far, there is no attempt to test if macroeconomic news causes volatility transmission across markets[5].). Our paper fills this gap by looking at oil prices and stock markets.

Event studies on the impact of macroeconomic announcements and studies about volatility spillovers in oil markets have been investigated independently. However, combining the two themes gives some more explanations to the issue of the impact of macroeconomic approaches on crude oil markets and particularly allows to answer the following question: do the movements observed in crude oil markets after the release of U.S. economic news represent common responses to such information (direct responses) or a transmission effect from financial market to oil market (indirect response)? This study is the first attempt to answer the latter question.

Using daily data over the period from January 3, 2000 to May 31, 2011, we find evidence of significant responses of oil market to some US macroeconomic announcements. This result is in line with those found in the related literature and confirms that foreign investors regard US macroeconomic news as an important source of information when valuing oil prices. Furthermore, results show evidence of volatility spillovers from the oil market to the US stock market.

The remaining of the paper is organized as follows. In section 2 we introduce the model. Section 3 presents the data and preliminary results. Section 4 discusses the main findings of the paper. Section 5 concludes.

2. Methodology

As shown in the introduction above, there is no consensus about the transmission effect from financial markets to the crude oil market. We thus propose to revisit this question and study the interactions between the US stock market and the crude oil market. The existence of volatility spillovers between the two markets may confirm our hypothesis of a transmission effect from financial to the crude oil market after the release of macroeconomic announcements.

In order to highlight the spillover effect between financial and energy markets, multivariate GARCH-type models have mostly been used in the literature on volatility transmission as they allow for the joint modeling of variances and covariances between different variables. Among the different specifications of the multivariate GARCH models, (i.e CCC, DCC,

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[5] Belgacem and Lahiani (2012) argue that this distinction between good and bad news is in some cases criticized. In some circumstances, the same information may be considered as good or bad news, depending on investors' perception of it, making unclear the distinction between the two categories of news. It becomes therefore crucial to analyze volatility transmission by considering the nature and the type of the announcement, rather than its sign.

VECH and BEKK[6]), we propose to use the DCC-GARCH of Engle (2002). This choice is motivated by the following three reasons (Belgacem and Lahiani, 2012): first, the superiority of the DCC-GARCH model over the other multivariate GARCH specifications when studying financial markets dynamics is largely documented in the literature, as it takes into account dynamic correlation between financial and economic data. Second, the conditional correlation between equity markets is shown to time-varying (see also Longin and Solnik, 1995). Finally, compared to the other multivariate GARCH specifications, the DCC-GARCH presents the advantage of having less parameters to estimate, which allows us to augment the model by introducing a set of macroeconomic variables and testing for the direct/indirect effects of US macroeconomic news without burdening the estimation procedure.

Consider the vector of returns in two markets $R_t \equiv [R_t^E, R_t^{SP}]'$, with R_t^E and R_t^{SP} being the returns on energy market and the US stock market at time t, respectively. The conditional mean equation can be written as follows:

$$R_t = \alpha + \sum_{i=1}^{n} \beta_i R_{t-i} + \varepsilon_t \qquad (1)$$

Where

- $\varepsilon_t \equiv [\varepsilon_t^E, \varepsilon_t^{SP}]'$ with ε_t^E and ε_t^{SP} being error terms from the mean equations of energy and the US stock markets respectively.
- $H_t \equiv D_t C_t D_t$ is the variance-covariance matrix
- $D_t = diag\{\sqrt{h_{E,t}}, \sqrt{h_{SP,t}}\}$ is the diagonal matrix of time varying standard deviations, which can be estimated using a GARCH (p, q) model.
- $C_t = \{\rho_{E/SP,t}\}$ represents the conditional correlation matrix between energy market and stock market. The dynamic conditional correlation (DCC) process of orders M and N has the following representation:

$$C_t = (Q_t^*)^{-1} Q_t (Q_t^*)^{-1} \qquad (2)$$

$$Q_t = \left(1 - \sum_{m=1}^{M} a_m - \sum_{n=1}^{N} b_n\right) \bar{Q} + \sum_{m=1}^{M} a_m(\xi_{t-m}\xi'_{t-m}) + \sum_{n=1}^{N} b_n Q_{t-n} \qquad (3)$$

where ξ_t is the vector of the standardized residuals extracted from the estimation of the univariate GARCH, Q_t is the variance-covariance matrix of these conditional standardized residuals, $\bar{Q} = E(\xi_t \xi'_t)$ represents the unconditional variance-covariance matrix, and finally Q_t^* is the diagonal matrix containing the square root of the diagonal elements of Q_t. For a pair of markets i and j, the conditional correlation at time t can be written as:

$$\rho_{ij,t} = \frac{(1 - \theta_1 - \theta_2)\bar{q}_{ij} + \theta_1 u_{i,t-1} u_{j,t-1} + \theta_2 q_{ij,t-1}}{[(1 - \theta_1 - \theta_2)\bar{q}_{ii} + \theta_1 u_{i,t-1}^2 + \theta_2 q_{ii,t-1}]^{\frac{1}{2}} [(1 - \theta_1 - \theta_2)\bar{q}_{jj} + +\theta_1 u_{j,t-1}^2 + \theta_2 q_{jj,t-1}]^{\frac{1}{2}}} \qquad (4)$$

where q_{ij} is the element on the ith line and i^{th} column of the matrix Q_t.

The parameters are estimated using Quasi-Maximum Likelihood Estimation (QMLE) introduced by Bollerslev and Wooldridge (1992). So, for each variable, we can obtain the conditional variance and the conditional covariance. Under the Gaussian assumption, the likelihood function can be rewritten as:

$$L(\theta) = -\frac{1}{2}\sum_{t=1}^{T}(nlog(2\pi) + 2log|D_t| + log|R_t| + u_t'R_t^{-1}u_t) \tag{5}$$

with $u_t = \frac{\varepsilon_t}{\sqrt{h_t}} = D_t^{-1}\varepsilon_t u_t$

In order to take into account the spillovers between stock and oil markets, we augment the basic model (Eq. 1) so that it allows detecting not only the direct reaction of the energy market to the release of US macroeconomic announcements, but also the transmission (indirect) effects from US stock market to the oil market. To do so, we consider two augmented DCC-GARCH models. The first one is modified by adding the variance of the stock market in the variance equation of the oil market and vice versa. We can therefore test volatility transmission between the two markets. Formally, the regression is as follows:

$$h_{E,t} = \omega_E + \alpha_E \varepsilon_{E,t-1}^2 + \beta_E h_{E,t-1} + \theta_E h_{SP,t-1} \tag{6}$$

$$h_{SP,t} = \omega_{SP} + \alpha_{SP} \varepsilon_{SP,t-1}^2 + \beta_{SP} h_{SP,t-1} + \theta_{SP} h_{E,t-1} \tag{7}$$

Afterwards, we augment the basic model by jointly adding the variance of the US market in the variance equation of the energy market and vice versa as well as the US macroeconomic shocks simultaneously in the two volatility equations. The model has the following specification:

$$h_{E,t} = \omega_E + \alpha_E \varepsilon_{E,t-1}^2 + \beta_E h_{E,t-1} + \sum_{k=1}^{11} \delta_{E,k} S_{k,t} + \sum_{k=1}^{11} \theta_{E,k} D_k h_{SP,t-1} \tag{8}$$

$$h_{SP,t} = \omega_{SP} + \alpha_{SP} \varepsilon_{SP,t-1}^2 + \beta_{SP} h_{SP,t-1} + \sum_{k=1}^{11} \delta_{SP,k} S_{k,t} + \sum_{k=1}^{11} \theta_{SP,k} D_k h_{E,t-1} \tag{9}$$

S_t is the standardized surprise[7] of the kth US macroeconomic announcement, D_k is a dummy variable taking the value 1 on the days of kth news announcements, and 0 otherwise. The term $\sum_{k=1}^{11} \theta_{E,k} D_k h_{SP,t-1}$ in eq. (8) and (9) allows detecting the volatility spillover from US market to oil market after the release of US macroeconomic indicators, while the term $\sum_{k=1}^{11} \emptyset_{E,k} S_{k,t}$ captures the direct effect of the US announcements on the volatility of oil market.

3. Data and descriptive statistics

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[7] A surprise is the unexpected component of the macroeconomic announcement and calculated as the difference between the real change and the market expected change. This issue will be explained with more details in Section 3.

We collect prices of the S&P500 and WTI from *Datastream* over the period from February 3rd, 2000 to May 31st, 2011. We should notice that the WTI price is used in this paper rather than BRENT as a proxy of oil market in order to handle out the problem of nonsynchronous trading, which arises due to the difference between trading hours across countries when using daily data (Belgacem and Lahiani, 2012; Martens and Poon, 2001; Soriano and Climent, 2005).

Descriptive statistics of the S&P500 and WTI returns are summarized in Panel A and B of Table 1 in the Appendix. The average daily returns are low and negative for the US market under the effect of the global financial crisis and positive and close to zero for the WTI market. Skewness is negative for the WTI series and positive for SP500 indicating that extreme negative and positive returns are likely to be present in the two market return series. Kurtosis values are high meaning that outliers may occur with a higher probability than that of a normal distribution. Moreover, we carried out the LM ARCH test of Engle (1982). Results show that the null hypothesis of no ARCH effect, are rejected at the 1% significance level for the two return series. This confirms that a GARCH modelling is adequate to capture the heteroskedasticity in the volatilities series. Panel C reveals a positive and significant unconditional correlation coefficient across the two considered markets suggesting that these markets are relatively dependent on each others. All of these preliminary results confirm that the VAR-GARCH used hereafter is adequate to describe the dynamics of the two markets around macroeconomic announcements.

Regarding macroeconomic announcements, the data sample consists of the following U.S. news which have been shown to significantly affect equity prices in recent papers:[8]

- Consumer and producer price indices (monthly) as indicators of inflation;

- Unemployment rate (monthly) considered as one of the most timely indicators of the economic state;

- Industrial production (monthly), the gross domestic production (quarterly), the leading indicator that predicts change in the economy as a whole, the ISM index that allows understanding national economic conditions and the trade balance to proxy the state of the economic activity;

- Consumer confidence index (monthly) and household consumption (monthly);

- Housing starts (monthly) as a real estate indicator.

We use American economic announcements to investigate their effect on oil and stock markets respectively. Announcement dates of macroeconomic indicators are collected from both BLS (Bureau of Labor Statistics) web site and checked afterwards through *Bloomberg*. We also try to separate the expected from the unexpected components of the news. The standard way to do this is to compute the surprise as the difference between the real change of the indicator value from the market consensus forecast. One way of making surprises comparable is to divide them by their standard deviation, as described in Fleming and Remolona (1997) and Balduzzi et al. (2001). Bloomberg and MMS9 forecasts are used to measure the market median consensus forecasts of macroeconomic news. Descriptive statistics of the latter are presented in panel B in the appendix 1 and show that most of the news are characterized by negative average returns due to the global financial crisis.

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[8]See e.g. Jones et al. (2005), Rigobon and sack (2006) and Dubreuille (2007). The data is also chosen according to its availability in Money Market Services Database.

[9] MMS : Money Market Services Database

4. Volatility spillovers between oil and stock markets

Estimation results of the first augmented model c.f Eqs (6) and (7) are reported in Table 2. Firstly, it should be noted that the coefficients a_1 and b_1 of the DCC equation are highly significant, which confirm the adequate specification of the model and the existence of a time varying correlation between the two series.

< Insert Table 2 here >

As for the volatility transmission, our results show strong volatility spillovers across these markets, with a neat transmission from the US stock market to the oil market. The table also shows that a positive (negative) shock causes an increase (decrease) of volatility in the US market which, in turn, leads to a rise (fall) of volatility of the WTI. A similar effect is also observed from the oil market to the stock market: an increase of 0.2% of the volatility in the U.S. market is explained by a rise of volatility of the WTI. Our results are in line with the conclusions of Sadorsky (1999), Chiou and Lee (2009), Hammoudeh (2010) who argue for the existence of a volatility spillover from the US market to oil prices.

5. Volatility spillovers and macroeconomic announcements

Do the movements observed in the two markets after the release of U.S. macroeconomic surprises represent a common response to such information or a transmission effect from U.S. market, or even both? One way to empirically answer the question is to use the augmented DCC-GARCH model as described by Eqs. (8) and (9). Results are reported in Table (3).

< Insert Table 3 here >

Regarding the direct effect of US macroeconomic news on the oil market news, we note that the volatility of the WTI stock index increases significantly following a positive surprise in the U.S. unemployment rate and housing starts announcements. The opposite effect is observed following a positive surprise increase in industrial production and GDP index, with a stronger sensitivity to the latter type of news. This result confirms the hypothesis that oil prices are in some proportion driven by macroeconomics.

Table 3 also reports significant volatility spillovers from the US stock market to the oil market after the announcement of the US unemployment, consumer price index, household consumption, GDP, housing market increase, consumer confidence index and the leading indicator. Indeed, an increase in the previous three indicators leads to an increase in the volatility of the US stock market, which in turn impacts positively the volatility of the oil market.

In addition, Table (3) shows a significant spillover effect from the oil market to the US stock market after the release of information on the US household consumption, consumer confidence and ISM indicator. An increase in the WTI's volatility leads to an increase in the S&P500's volatility, with the highest effect for the ISM index and the lowest effect for consumer confidence. These results confirm the hypothesis that some of the US macroeconomic announcements are able to generate volatility transmission from the US stock market to the oil market and vice versa.

All in all, our results show evidence of a significant impact of the US macroeconomic surprises on oil markets. This impact is split into two types namely the direct effect (common response) and indirect effect (volatility transmission). Moreover, our results show that the volatility transmission is bidirectional since a significant volatility transmission from the oil market to the US stock market is revealed. Furthermore, an important volatility transmission

is recorded from the oil market to the stock market, especially after the release of consumption indicators.

The previous results - mainly those concerning the bidirectional volatility spillover between the two markets - show that interactions are bidirectional and therefore they highlight an important integration between the US stock market and oil market. These findings are in line with those of Hammoudeh et *al.* (2004) on the two-way interactions between the S&P Oil Composite index, and oil spot and futures prices, as well as with Chiou and Lee (2009) on the asymmetric unexpected effects of oil prices on stock returns, and finally with Malik and Ewing (2009) regarding spillover mechanisms between weekly WTI oil prices and equity sector returns.

5. Conclusion

This paper investigates the effects of US macroeconomic surprises on US stock market index and oil prices volatilities using an augmented multivariate GARCH framework. We introduce a multivariate GARCH model that accounts for cross effects of volatilities in the two markets which allows measuring the volatility transmission.

Our setting provides interesting insights into the dynamics of international equity markets. This paper mainly contributes to the existing literature by separating the direct effect from indirect effect of US macroeconomic news on US stock market and oil prices. Thus, this paper presents evidence of common reactions of international investors to US macroeconomic announcements. The latter reactions represent the direct effects of US macroeconomic surprises on the US stock market and oil prices. The paper also allows to explain the causes of volatility transmission between the US market and oil prices by selecting the most significant news that drive this volatility spillover as well as the direction of the transmission. The volatility transmission is considered as the indirect effect of US macroeconomic news on oil prices in our setting.

These results have important implications for market participants and portfolio managers as US macroeconomic announcements have direct and indirect impacts on asset prices and oil prices. Investors in the US stock market as well as those in the Oil market should be able to measure the direct and immediate impact of the US releases and also aware of the risk coming from the transmission of volatility from the other market. Availing their selves of the investment opportunities that occur shortly after the macroeconomic announcement in the US and hedging against the risk of contagion are of great importance for the actors in the stock and oil markets.

Appendix

Table 1: Descriptive statistics

Panel A: Market returns descriptive statistics

	WTI	S&P 500
Mean	4.4 E-4	-3.41 E-5
Std deviation	0.026	0.013
Skewness	-0.162	0.013
Kurtosis	8.114	10.829
Jarque-Bera	3228.65	7541.35
p-value	[0.000]	[0.000]
ARCH(10)	32.987	48.560
p-value	[0.000]	[0.000]
ARCH(20)	43.763	67.24
p-value	[0.001]	[0.000]
Q(10)	15.171	13.253
p-value	[0.126]	[0.209]

Panel B: Unconditional Correlations across stock markets

	WTI	S&P500
WTI	1	0.164 [0.000]
SP500		1

p-values are between brackets

Panel C:

Descriptive statistics of (non standardized) macroeconomic surprises

	CPI	PPI	HCON	UNEM	GDP	IP	CONF	HS	LI	ISM	TB
Observations	136	136	136	136 (M)	47	136	136	136	136	136	136
Mean	-0.005	0.035	-0.006	-0.012	-0.16	-0.084	-0.03	8.992	-0.004	0.089	0.016
Std Error	0.18	0.523	0.201	0.158	0.874	0.467	5.26	89.477	0.224	2.111	3.231
Maximum	0,4	1.6	0.6	0.5	0.8	1.5	12.8	275	0.6	7.4	11.1
Minimum	-0,6	-1.3	-0.8	-0.5	-5.6	-3.3	-13	-253	-0.5	-6.1	-9.1

Notes: (M): Monthly, (Q): Quarterly, CPI: Consumer price index, PPI: Producer price index, HCON: Household consumption, UNEM: Unemployment rate, GDP: Gross domestic production, IP: Industrial production, CONF: Consumer confidence, HS: Housing starts, LI: Leading indicator, ISM: ISM manufacturing, TB: Trade Balance

Table 2: Estimation of the augmented model in Eqs (5) and (6)

	S&P500		WTI	
	Coefficient	t-value	Coefficient	t-value
Mean Equation				
Constant	**4.17E-4**	2.48	**9.87 E-4**	2.519
S&P (1)	**-0.066**	-3.21	**0.095**	2.809
WTI(1)	-4.05 E-3	-0.531	**-0.037**	-2.069
Variance Equation				
Constant	5.64 E-7	1.261	**1.86 E-5**	5.37
ε_{t-1}^{SP}	**0.077**	10.532	-------	-------
ε_{t-1}^{WTI}	-------	--------	**0.068**	10.057
h_{t-1}^{SP}	**0.912**	113.69	**0.038**	2.332
h_{t-1}^{WTI}	**1.84 E-3**	1.978	**0.892**	72.445

DCC Equation	
a_1	**0.024 (8.53)**
b_1	**0.973 (304.32)**
Log-Likelihood	15848.36
Q(12)	47.6 [0.48]

Note: *t*-statistics are between parentheses, p-values are between brackets

Table 3: Estimation of the augmented model Eqs (7) and (8)

Variables	S&P500	*t*-value	WTI	*t*-value
Mean Equation				
Constant	**0.36 E-3**	2.001	**0.84 E-3**	2.318
CAC(1)	**-0.057**	-2.632	**0.093**	2.633
SP(1)	-0.007	-0.928	-0.029	-1.567
Variance Equation				
Constant	0.75 E-6	1.507	**0.183 E-4**	3.924
ε_{t-1}^2	**0.079**	10.013	**0.055**	5.866
h_{t-1}	**0.91**	106.86	**0.899**	50.518
Direct Effects				
Unemployment	**6.918 E-06**	1.742	**5.178 E-05**	2.5
CPI	4.257 E-06	1.037	-2.357 E-05	-0.715
Household Cons	-2.868 E-06	-0.751	1.677 E-05	0.729
Industrial Prod	-4.59 E-06	-0.979	**-7.273 E-05**	-2.162
Housing Starts	**-6.136 E-06**	-1.898	**7.586 E-05**	2.635
GDP	**2.847 E-05**	2.188	**-2.2 E-04**	-2.32
Consumer Confidence	2.952 E-06	0.583	3.844 E-05	1.316
ISM Index	4.283 E-06	1.133	4.139 E-06	0.158
PPI	**6.394 E-06**	2.409	-3.158 E-05	-1.11
Leading Indicators	-2.388 E-06	-0.7	7.232 E-06	0.268
Trade Balance	-3.556 E-06	-1.138	-1.731 E-06	-0.052
Indirect Effects				
Unemployment	-0.006	-0.553	**-0.607**	-3.566
CPI	-0.018	-1.363	**-0.935**	-1.777
Household Cons	**-0.047**	-6.578	**-0.652**	-2.315
Industrial Prod	0.023	1.249	0.261	0.51
Housing Starts	0.023	1.135	**0.604**	1.651
GDP	0.018	1.442	**-0.932**	-3.794
Consumer Confidence	**0.027**	2.311	**1.208**	3.473
ISM Index	**0.049**	3.479	0.436	1.583
PPI	0.008	0.655	0.161	0.773
Leading Indicator	-0.015	-1.003	**0.839**	2.502
Trade Balance	-0.013	-1.232	0.342	1.203
DCC Equation				
a_1	**0.025 (3.467)**			
b_1	**0.972 (118.87)**			
Log-Likelihood	15916.49			
Q(12)	49.37 (0.41)			

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