University of Pretoria
Department of Economics Working Paper Series

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Working Paper: 2015-08
February 2015

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ON ECONOMIC UNCERTAINTY, STOCK MARKET PREDICTABILITY AND NONLINEAR SPILLOVER EFFECTS

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ABSTRACT

This paper uses a *k*-th order nonparametric Granger causality test to analyze whether firm-level, economic policy and macroeconomic uncertainty indicators predict movements in real stock returns and their volatility. Linear Granger causality tests show that whilst economic policy and macroeconomic uncertainty indices can predict stock returns, firm-level uncertainty measures possess no predictability. However, given the existence of structural breaks and inherent nonlinearities in the series, we employ a nonparametric causality methodology. We find that aside from economic policy, firm-level uncertainty indicators cause stock returns as well as market volatility. Thus, our results not only emphasize the role of economic and firm-level uncertainty measures in predicting stock returns and volatility, but also presage against using linear models which are likely to suffer from misspecification in the presence of parameter instability and nonlinear spillover effects.

JEL Codes: C32, C58, G10, G17
Keywords: Economic policy; stock markets; nonlinear causality

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1. INTRODUCTION

Stock market volatility is of utmost importance to policy makers and portfolio managers when reflecting on future corporate health and investment prospects (Poon and Granger, 2003; Rapach and Zhou, 2013). Asset returns are functions of the state variables of the real economy, and the real economy itself displays significant fluctuations. Beyond standard theoretical or empirical justifications of such fluctuations based on productivity and/or policy shocks, a recent strand of literature relates the impact of various forms of firm-level, macro-financial and policy-generated uncertainty to movements in output, inflation, investment, employment and interest rates (Bloom,

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2009; Jones and Olson, 2013; Jurado *et al.*, 2015), which in turn are expected to affect the mean and volatility fluctuations of stock returns. Empirical evidence along this line of reasoning - yet only for stock returns - can be found in the works of Antonakakis *et al.* (2013), Kang and Ratti (2013), Gupta *et al.* (2014), Chang *et al*. (2015) and Jurado *et al*. (2015).

In light of the recent evidence, we investigate whether news-based measures of economic policy uncertainty (EPU) (Baker *et al.*, 2013), firm-level and macro-financial uncertainty indices (Jurado *et al.*, 2015), could comprise reliable predictors of S&P500-based real stock returns and volatility. For our purpose, we use the recently developed nonparametric causality test by Nishiyama *et al*. (2011), which is applied to monthly and quarterly datasets that span very long periods, i.e., 1900:1-2014:2 for EPU, 1960:7-2011:12 for macroeconomic and financial uncertainty, and 1970:1-2011:2 for the firm-level uncertainty index respectively. As opposed to the results reported in recent works, this is the first study to our knowledge that compares alternative measures of uncertainties in predicting not only stock returns, but also their volatility fluctuations. Furthermore, given the use of Nishiyama *et al.* (2011) nonparametric approach, we provide evidence in favor of possible misspecification in linear models as reported in the existing studies thus far, due to structural breaks and nonlinearity. The rest of the paper is organized as follows: Section 2 presents the methodology, while Section 3 discusses the data and results. Finally, Section 4 concludes.

2. METHODOLOGY

We briefly describe the methodology proposed by Nishiyama *et al.* (2011), with the test restricted to the case when the examined series follow a stationary nonlinear autoregressive process of order one under the null. Nishiyama *et al.* (2011) motivated the high-order causality by using the following nonlinear dependence between series

$$x_t = g(x_{t-1}) + \sigma(y_{t-1})\epsilon_t \qquad (1)$$

where $\{x_t\}$ and $\{y_t\}$ are stationary time series and $g(.)$ and $\sigma(.)$ are unknown functions which satisfy certain conditions for stationary. In general, y_{t-1} has information in predicting x_t^K for a given integer *K*. Consequently, the null hypothesis of non-causality in the *K^th* moment is given by

$$H_0: E(x_t^K|x_{t-1},\dots,x_1,y_{t-1},\dots,y_1) = E(x_t^K|x_{t-1},\dots,x_1)\ w.p.1. \qquad (2)$$

where $w.p.1$ abbreviates to "with probability one". Formally, we say that y_t does not cause x_t up to the *K^th* moment if

$$H_0: E(x_t^K|x_{t-1},\dots,x_1,y_{t-1},\dots,y_1) = E(x_t^K|x_{t-1},\dots,x_1)\ w.p.1. \quad \text{for all } k = 1,\dots,K \qquad (3)$$

For $K = 1$, this definition reduces to non-causality in mean. Nishiyama *et al.* (2011) note that, it is easy to construct the test statistic $\hat{S}_t^{(k)}$ for each $k = 1,\dots,K$. We implement the test for $k = 1$ to test for causality in the 1st moment (non-causality in mean), and for $k = 2$ in the 2nd moment (non-causality in variance).

3. EMPIRICAL ANALYSIS

We analyse three types of uncertainty measures: firstly, a monthly news-based index called economic policy uncertainty (EPU) developed by Baker *et al.* (2013) for the period 1900:1-2104:2; secondly, the macroeconomic uncertainty measure developed by Jurado *et al.* (2015), which is based on a large number of monthly macroeconomic (132) and financial (147) variables for the period 1960:7-2011:12, and; thirdly, a quarterly firm-level measure of uncertainty that spans 1970:1-2011:2 and comprises 155 firm-level observations on change in pre-tax profit growth normalized by two-period moving average of sales. The latter measure was also introduced by Jurado *et al.* (2015).

In particular, the EPU index is constructed of month-by-month searches of newspaper articles related to economic and policy uncertainty[1]. The macroeconomic and firm-level measures include econometric estimates of time-varying macroeconomic and firm-level uncertainty indices at various horizons (one to twelve for the former and one to six for the latter), defined as the common volatility in the unforecastable component of a large number of economic, financial and firm-level indicators (Jurado *et al.*, 2015)[2]. We take natural logarithms of those measures. Next, we use prices of the S&P500 and the consumer price index (CPI) to deflate the nominal S&P500 series and yield real values of the index, covering the period 1899:12-2014:2 (monthly frequency)[3]. The real returns are computed as first differences of the natural logarithms of the real stock prices multiplied by 100. In order to estimate the quarterly real stock returns used in the firm-level uncertainty measure, we take the 3-month averages of the monthly real stock prices. As our causality methodology requires stationarity, we conducted unit root tests. The analysis reveals that the various uncertainty indices and the real stock returns are stationary.[4]

For the sake of comparability and completeness, we start our investigation with standard linear Granger causality tests. To keep our analysis in line with Nishiyama *et al.* (2011) we use a linear VAR(1) model specification. As can be seen from Table 1, the null that firm-level uncertainty for various horizons does not cause real stock returns cannot be rejected even at the 10% level over the period 1970:1-2011:2. In case of EPU, for the entire period 1900:1-2014:2, the null of no-Granger causality is rejected at the 10% level of significance. However, no evidence of directional predictability is found when the analysis is repeated over 1960:7-2011:12.[5] Instead, the macro-

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[1] Data and further details are available at: http://www.policyuncertainty.com/us_historical.html.
[2] Further details on the data included in the supplementary material of Jurado *et al*. (2015) are downloadable from: http://www.econ.nyu.edu/user/ludvigsons/.
[3] The data can be downloaded from the Global Financial Database
[4] Complete details of the unit root tests are available upon request from the authors.
[5] An updated version of the EPU index covering the period 1985:1-2014:12 is available from: http://www.policyuncertainty.com/us_monthly.html. However, again no evidence of causality was detected when we applied the Granger causality test to this data set. The results are available upon request.

financial uncertainty at various horizons within 1960:7-2011:12 shows strong evidence of predictability for the real stock returns at the 5% significance level.[6]

[Please insert Table 1]

However, the use of financial data spanning long time periods implies non-robustness for the linear Granger causality results due to structural breaks and nonlinear features in the examined variables. Consequently, we applied the Andrews (1993) and Andrews and Ploberger (1994) tests of parameter (in)stability and the null of stability was consistently rejected at all levels of significance by the three test statistics (*Sup-F*, *Exp-F* and *Ave-F*). In addition, the Brock *et al.* (1996) test is applied to the residuals of an AR(1) model fitted to real stock returns as well as to the VAR(1) models comprising real stock returns and the various uncertainty indices. The BDS test rejected the null hypothesis of serial dependence at the highest levels of significance across various dimensions. Hence, the results provide strong evidence of nonlinearity in the data.[7]

Given the presence of structural breaks and nonlinearity, we implement the nonparametric causality test of Nishiyama *et al.* (2011) to investigate the existence of predictability for stock returns and their volatility. The results are reported in Table 2. As opposed to the linear case, firm-level uncertainty is found to Granger cause not only returns but also volatility at 5% significance level. The profound differences in the results are most likely due to model misspecification in the presence of breaks and nonlinear spillover effects. As far as the EPU is concerned, the null of no-causality is rejected for the full-sample as well as for the sub-sample 1960:7-2011:12.[8] Recall, in the linear case no predictability of real stock returns based on EPU was detected for the sub-period 1960:7-2011:12. In accordance with the results produced by the linear tests, macroeconomic uncertainty is found to Granger-cause real stock returns at 5% level of significance. In addition, the same holds for stock volatility. In summary, unlike the linear Granger causality tests, the

[6] Similarly, an updated macroeconomic uncertainty index for 1960:7-2013:05 with 1-, 3- and 12-step ahead horizons is also available from: http://www.econ.nyu.edu/user/ludvigsons/. The standard Granger causality test at the 5% level of significance revealed again a strong interrelationship. The details are available upon request from the authors.

[7] Complete details of the tests for parameter instability, structural breaks and serial independence are available upon request.

[8] However, no evidence of causality was detected either for returns or volatility, when we applied the nonparametric causality test to data covering the period 1985:1-2014:12.

nonparametric test provided with strong evidence of firm-level, EPU and macroeconomic uncertainty predictability vis-à-vis stock returns and market volatility.

[Please insert Table 2]

4. CONCLUSIONS

Predicting stock market returns and volatility is of paramount importance to policy-makers and portfolio managers. Theoretically, asset returns are functions of the state variables of the real economy. In this vein, a rich literature exists that relates micro- and macro-economic, financial and policy uncertainty indicators to stock returns. Beyond the current literature, this paper analyzes whether alternative uncertainty measures can predict stock returns and their volatility using a k-th order nonparametric test of Granger causality. Whilst the results based on the linear Granger causality tests, show that only economic policy and macroeconomic uncertainty indicators can predict real stock returns, nonlinear causality testing revealed that firm-level uncertainty also causes real stock returns, as well as volatility. Consequently, our work aside from highlighting the role of uncertainty measurement in predicting financial market volatility also presages against using linear modeling, which is likely to suffer from misspecification in the presence of parameter instability and nonlinear spillover effects.

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TABLE 1: LINEAR GRANGER-CAUSALITY TEST

Null Hypothesis	$\chi^2(1)$-stat	p-value
f01 ≠> rsr	0.0597	0.8073
f02 ≠> rsr	0.0540	0.8166
f03 ≠> rsr	0.0697	0.7921
f04 ≠> rsr	0.0806	0.7768
f05 ≠> rsr	0.0846	0.7715
u06 ≠> rsr	0.0830	0.7736
EPU ≠> rsr, (1900:1-2014:2)	3.2444	0.0719
EPU ≠> rsr, (1960:7-2011:12)	1.5374	0.2155
u01 ≠> rsr	4.9493	0.0265
u02 ≠> rsr	5.2978	0.0217
u03 ≠> rsr	5.4178	0.0203
u04 ≠> rsr	5.2798	0.0219
u05 ≠> rsr	5.1642	0.0234
u06 ≠> rsr	5.0476	0.0250
u07 ≠> rsr	4.9329	0.0267
u08 ≠> rsr	4.8088	0.0287
u09 ≠> rsr	4.6855	0.0308
u10 ≠> rsr	4.5657	0.0330
u11 ≠> rsr	4.4475	0.0354
u12 ≠> rsr	4.3292	0.0379

Note: *rsr*: real stock returns; *f01,…, f06*: quarterly firm-level uncertainty for one-to six-steps-ahead; *EPU*: monthly economic policy uncertainty; *u01,…, u12*: monthly macroeconomic uncertainty for one to twelve-steps-ahead; ≠>: stands for "*does not Grange cause*".

TABLE 2: NONLINEAR CAUSALITY TEST

Null hypothesis	Test Statistics	
	$\hat{S}_T^{(1)}$	$\hat{S}_T^{(2)}$
f01 ≠> rsr	42.0245	39.9646
f02 ≠> rsr	41.0845	39.5792
f03 ≠> rsr	41.5961	40.3891
f04 ≠> rsr	42.2801	41.3084
f05 ≠> rsr	43.3760	42.6476
u06 ≠> rsr	44.6202	44.0884
EPU ≠> rsr, (1900:1-2014:2)	315.4940	278.7390
EPU ≠> rsr, (1960:7-2011:12)	118.0861	119.4279
u01 ≠> rsr	120.8470	113.4290
u02 ≠> rsr	121.9340	115.4960
u03 ≠> rsr	123.7030	117.9500
u04 ≠> rsr	125.2120	120.1940
u05 ≠> rsr	126.2110	121.8970
u06 ≠> rsr	126.6390	122.9920
u07 ≠> rsr	126.7250	123.7260
u08 ≠> rsr	126.5090	124.1280
u09 ≠> rsr	125.9940	124.1750
u10 ≠> rsr	125.2330	123.9160
u11 ≠> rsr	124.2820	123.4020
u12 ≠> rsr	123.1670	122.6530

Note: Same as in Table 1. Additionally, $\hat{S}_T^{(1)}$: Test statistic for causality in-mean; $\hat{S}_T^{(2)}$: Test statistic for causality in-variance. The 5% critical value for both test statistics is 14.3800.