DETECTING INTRADAY PRICE SHOCKS AND THEIR USE IN TESTING THE EFFICIENT MARKET HYPOTHESIS

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Presentation structure

Purpose of the paper

Literature review

Price simulations methodology

Shock detection methodology

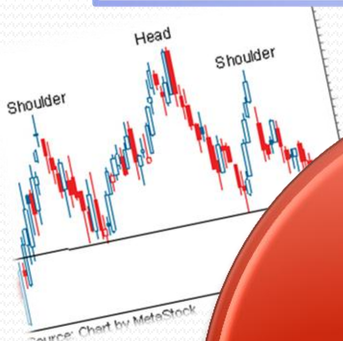
Data description

Results and interpretations

Conclusion and references

Purpose of the paper

- The aim of this paper is to find out whether there exists confirmation bias leading to one of the most well known price patterns in technical analysis – “head and shoulders”.



Efficient markets

- Market prices reflect all current and past publicly available information.
- Returns in excess of average market returns on a risk-adjusted basis cannot be achieved.

Confirmation bias

- The tendency of traders to favor information that confirms their beliefs and disregard the other.

Market overreaction

- Hypothesis assuming that people react disproportionately to news regarding their assets, followed by an adjustment to the true value.

Literature review

2003
- Ole E. Barndorff-Nielsen and Neil Shephard found a novel way of separating quadratic variation into its continuous and jump components.

2006
- George Tauchen and Hao Zhou created a finite sample experiment showing that individual jumps can be reliably extracted from intraday data series.

2007
- Lee M. Dunham and Geoffrey C. Friesen applied the previously developed theory on the stocks of S&P 100 and found that they account for about 15% of total volatility and 80% of the day's return.

2008
- Geoffrey C. Friesen, Paul A. Weller and Lee M. Dunham created a model which explains the success of certain trading rules based on price patterns.

Price simulations methodology

- In order to have a price series from where to extract price jumps, we simulated a stochastic volatility jump-diffusion process by using the following equations:

$$dp_t = \mu dt + \sigma_t dW_{1t} + J_t dq_t$$

$$d\sigma_t^2 = \beta(\theta - \sigma_t^2)dt + \gamma\sqrt{\sigma_t^2}dW_{2t}$$

1-second tick size

6.5 trading hours per day

Jump timing is exponentially distributed

Jump size is distributed normally

Shock detection methodology

Calculate realized variance and bi-power variation:

$$RV_t \equiv \sum_{j=1}^{m} r_{t,j}^2 \to \int_{t-1}^{t} \sigma_s^2 \, ds + \int_{t-1}^{t} J_s^2 \, dq_s$$

$$BV_t \equiv \frac{\pi}{2} \frac{m}{m-1} \sum_{j=2}^{m} \left| r_{t,j} \, r_{t,j-1} \right| \to \int_{t-1}^{t} \sigma_s^2 \, ds$$

Calculate the $RJ_t = (RV_t - BV_t) \div RV_t$ ratio and scale it to a standard normal distribution.

$$ZJ_t \equiv RJ_t \div \sqrt{\left[\left(\frac{\pi}{2}\right)^2 + \pi - 5\right] \times \frac{1}{m} \times \max\left(1, \frac{TP_t}{BV_t^2}\right)} \to N(0,1)$$

Use the predetermined α significance level for the scaled RJ_t and calculate the price jumps by:

$$\hat{J}_t = sign(r_t) \times \sqrt{(RV_t - BV_t) \times 1_{(ZJ_t \geq F_\alpha^{-1})}}$$

Data description

- Intraday (5-minute intervals, 24h per day, 1059 days) foreign exchange rates
- Bid-ask quotations and traded volume from 4/2/2009 to 4/23/2013
- 6 major and 2 metal exchange rates: AUD/USD, EUR/USD, USD/JPY, GBP/USD, USD/CHF, USD/SEK, XAU/USD and XAG/USD
- Offer/bid ratio filter, sandwich filter (removes any extreme quote that is between two regular quotes)
- Data provided by Dukascopy Bank SA, Geneva, Switzerland

Intermediary results

EUR/USD	Mean	Min	Max	Stdev
Realized variance (RV)	0.0000100	0.0000009	0.0001020	0.0000085
Sqrt of realized variance	0.0029630	0.0009380	0.0101160	0.0010840
Realized bi-power variance (BV)	0.0000091	0.0000007	0.0001070	0.0000081
BV/RV	0.9096870	0.3913650	1.1807540	0.0797240
RJ = (RV-BV)/RV	0.0903130	-0.1807540	0.6086350	0.0797240
ZJ = Scaled (normalized) RJ	1.6368190	-2.4250630	9.9955790	1.4404730

XAU/USD	Mean	Min	Max	Stdev
Realized variance (RV)	0.0001345	0.0000000	0.0024066	0.0001619
Sqrt of realized variance	0.0106932	0.0000003	0.0490568	0.0044912
Realized bi-power variance (BV)	0.0001198	0.0000000	0.0020668	0.0001381
BV/RV	0.8994630	0.0000000	1.1171288	0.1111046
RJ = (RV-BV)/RV	0.1005370	-0.1171288	1.0000000	0.1111046
ZJ = Scaled (normalized) RJ	1.58533474	-1.951167	21.74652	1.738649

Jump properties

EUR/USD	Mean	Min	Max	Stdev
Jump frequency	0.2011330			
Jump size	-0.0000082	-0.0036330	0.0043190	0.0014110
Abs. shock size	0.0012840	0.0004440	0.0043190	0.0005790
Abs. daily return*	0.0023470	0.0000000	0.0104990	0.0021170
Jump variance	0.0000020			
Total variance*	0.0000100			

XAU/USD	Mean	Min	Max	Stdev
Jump frequency	0.2011330			
Jump size	0.0003910	-0.0468050	0.0134190	0.0064350
Abs. jump size	0.0053660	0.0016020	0.0468050	0.0035540
Abs. daily return*	0.0079870	0.0000000	0.0408750	0.0071990
Jump variance	0.0000414			
Total variance*	0.0001150			

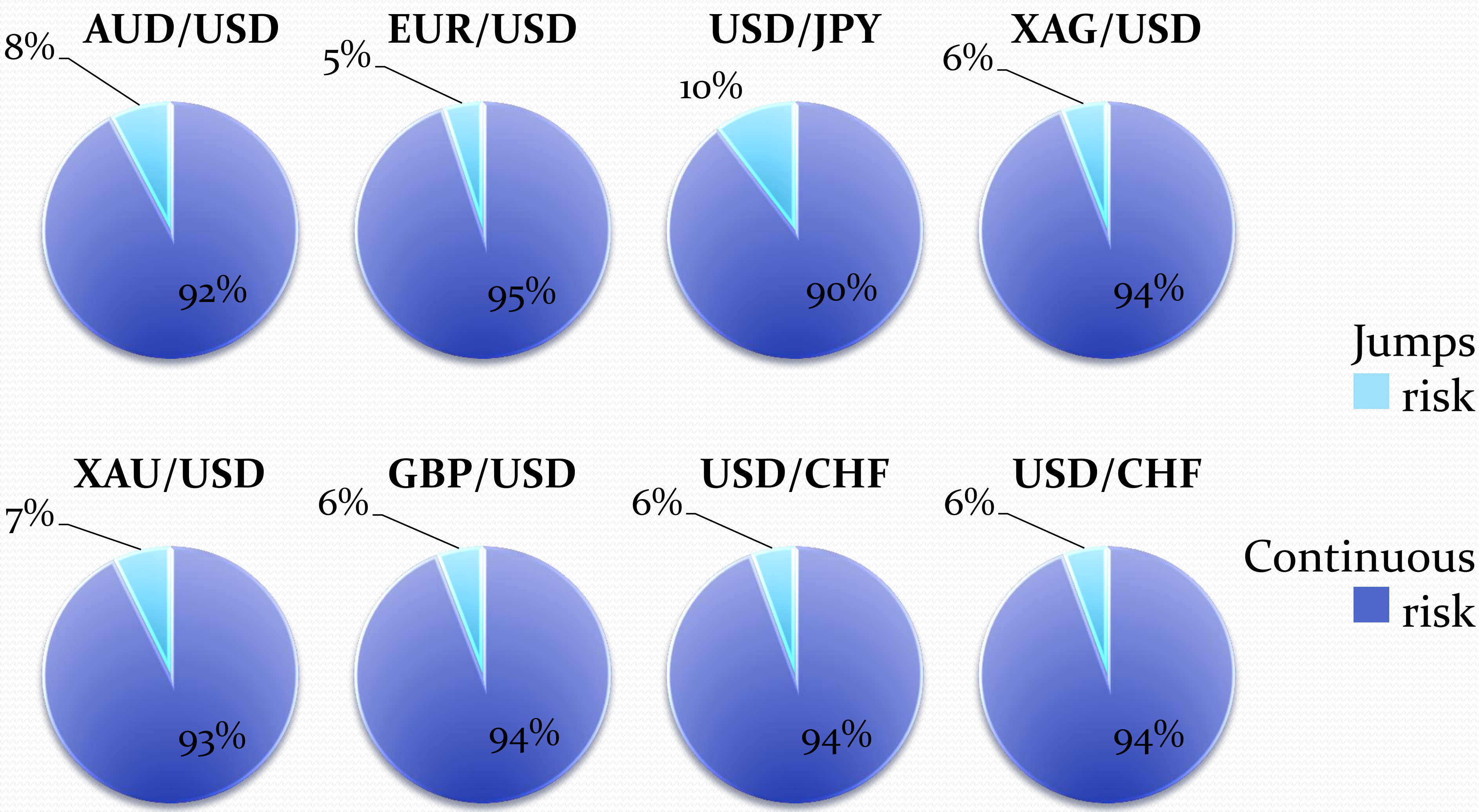
*Values are calculated for days with shocks only.

Jump properties for days with high volatility

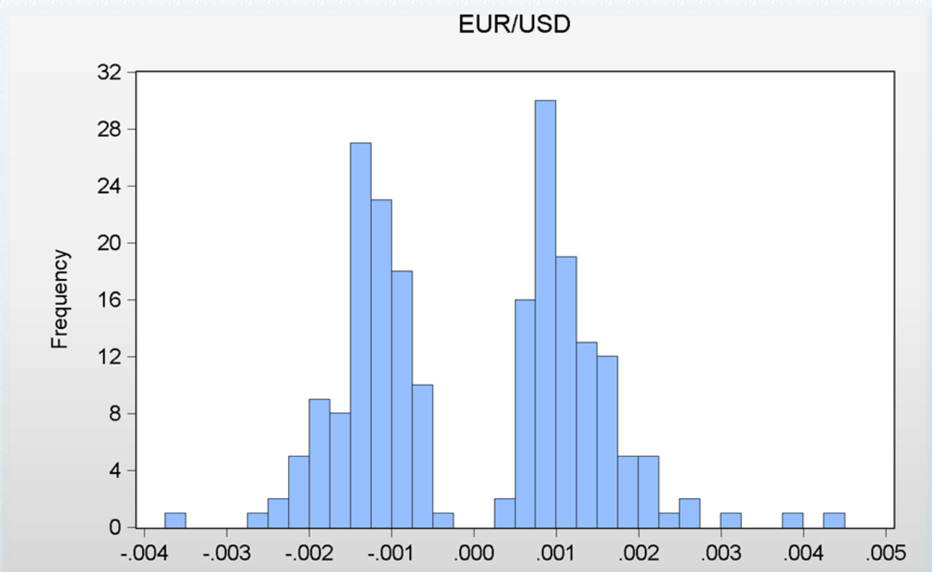
EUR/USD	Mean	Min	Max	Stdev
Jump frequency	0.1947070			
Jump size	-0.0001551	-0.0036330	0.0043190	0.0017854
Abs. jump size	0.0016914	0.0009950	0.0043190	0.0005683
Abs. daily return	0.0028753	0.0000000	0.0134814	0.0024108
Jump variance	0.0000032			
Total variance	0.0000141			

XAU/USD	Mean	Min	Max	Stdev
Jump frequency	0.2173913			
Jump size	0.0003431	-0.0468050	0.0134190	0.0080054
Abs. jump size	0.0067241	0.0036090	0.0468050	0.0043122
Abs. daily return	0.0104523	0.0000000	0.0958922	0.0093102
Jump variance	0.0000641			
Total variance	0.0001958			

Variance decomposition



Histograms and normality

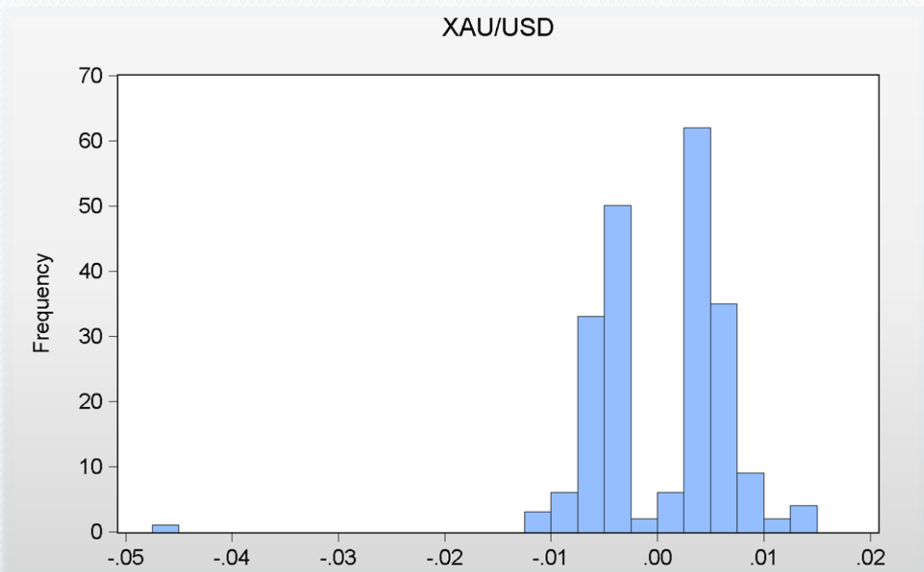


EUR/USD

Mean	Median	Maximum	Minimum	Std. Dev.
-0.0000082	0.0004910	0.0043190	-0.0036330	0.0014108
Skewness	**Kurtosis**	**Jarque-Bera**	**Probability**	**Obs.**
0.1531910	2.2441037	5.9040854	0.0522329	213

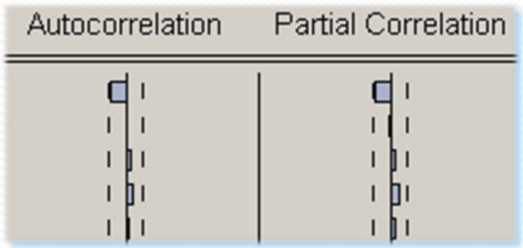
XAU/USD

Mean	Median	Maximum	Minimum	Std. Dev.
0.0003911	0.0030480	0.0134190	-0.0468050	0.0064347
Skewness	**Kurtosis**	**Jarque-Bera**	**Probability**	**Obs.**
-1.8384054	14.7604819	1347.4723643	0.0000000	213



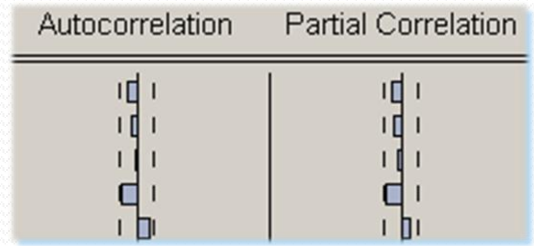
Jump autocorrelations

EUR/USD – all days



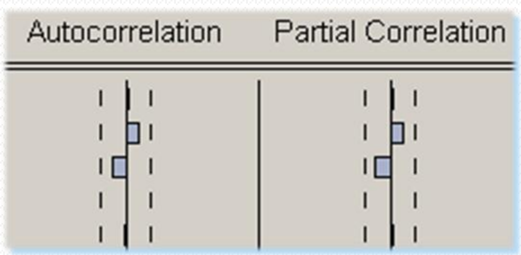
Lag	Autocorrelation	Q-Stat	Probability
1	-0.122	3.201	0.074
2	0.012	3.232	0.199
3	0.046	3.7	0.296
4	0.056	4.394	0.355
5	0.022	4.4994	0.48

XAU/USD – all days



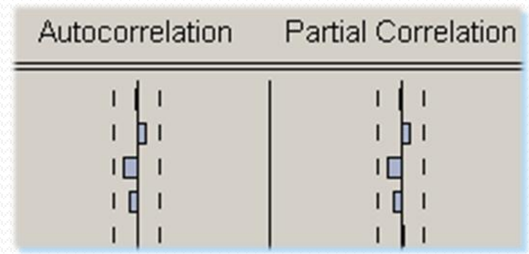
Lag	Autocorrelation	Q-Stat	Probability
1	-0.066	0.9448	0.331
2	-0.047	1.4177	0.492
3	-0.013	1.4523	0.693
4	-0.112	4.2185	0.377
5	0.098	6.3404	0.274

EUR/USD – high volatility days



Lag	Autocorrelation	Q-Stat	Probability
1	0.032	0.1114	0.739
2	0.094	1.0478	0.592
3	-0.104	2.2265	0.527
4	0.015	2.2499	0.69
5	-0.001	2.2499	0.814

XAU/USD – high volatility days



Lag	Autocorrelation	Q-Stat	Probability
1	-0.003	0.001	0.974
2	0.082	0.7947	0.672
3	-0.102	2.0478	0.563
4	-0.057	2.4451	0.654
5	0.003	2.4464	0.785

9th and 10th decile autocorrelations

By selecting the 20% largest shocks according to their absolute jump size for all currency pairs and studying their correlation with the next 3 shocks that followed, we found out the following:

Correlation matrix	Jump t	Jump t+1	Jump t+2	Jump t+3
Jump t	1	-0.10003	-0.05292	0.014124
Jump t+1		1	-0.07999	0.013818
Jump t+2			1	-0.19495
Jump t+3				1
Ljung-Box Statistic		3.451843	4.420842	4.49007
p-value		0.063181	0.109654	0.213178

All-shocks autocorrelations

We tested the autocorrelation of all the 1638 detected jumps aggregated into a single series, thus achieving a superior statistical significance, but lower correlation values.

Correlation matrix	Jump t	Jump t+1	Jump t+2	Jump t+3
Jump t	1	-0.075661	-0.069356	-0.028341
Jump t+1		1	-0.075981	-0.06701
Jump t+2			1	-0.064507
Jump t+3				1
Ljung-Box Statistic		9.393964	17.29235	18.612
p-value		0.002177	0.000176	0.000329

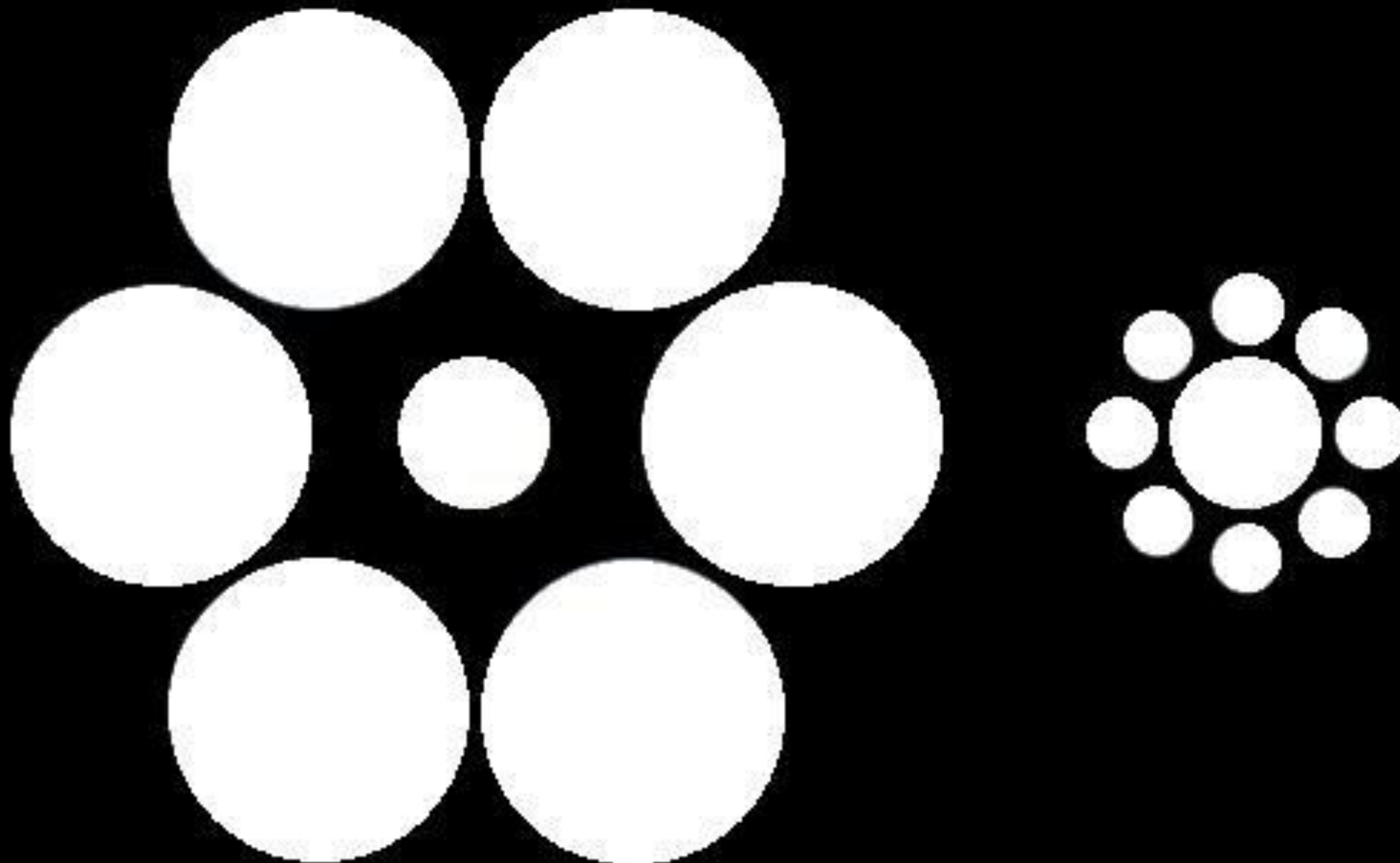
Conclusion

Significant price jumps in FX markets appear on average once every 5 days, and just as often during high volatility days.

Price jumps account for 5% to 10% of the total variance, have a mean equal to zero and account for a large part of the day's return.

Jumps have an overall negative autocorrelation, although no pair by itself revealed results statistically significant at a 5% level.

Confirmation bias could not be confirmed by the results. Actually, calculations were leading more to the market overreaction hypothesis.



THANK YOU!

References

- Barndorff-Nielsen, O., Shephard, N., 2004. Power and bi-power variation with stochastic volatility and jumps. Journal of Financial Econometrics 2, 1–48.
- Dunham, L., Friesen, G., 2007. An empirical examination of jump risk in US equity and bond markets. North American Actuarial Journal 11, 76–91.
- Friesen, G., Weller, P., Dunham, L., 2008. Price trends and patterns in technical analysis: A theoretical and empirical examination. Journal of Banking & Finance 33 (2009) 1089–1100.
- Huang, X., Tauchen, G., 2005. The relative contribution of jumps to total price variance. Journal of Financial Econometrics 3, 456–499.
- Tauchen, G., Zhou, H., 2006. Realized jumps on financial markets and predicting credit spreads. Finance and Economics Discussion Series 2006-35, Board of Governors of the Federal Reserve System.
- Daniel, K., Hirshleifer, D., Subrahmanyam, A., 1998. Investor psychology and security market under- and overreactions. The Journal of Finance • vol. LIII, no. 6, 1839-1885.