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INTERDEPENDENCE OF SENTIMENT INDICATORS – A CASE OF THE POLISH OTC MARKET

WSPÓŁZALEŻNOŚĆ WSKAŹNIKÓW SENTYMENTU NA PRZYKŁADZIE POLSKIEGO RYNKU POZAGIEŁDOWEGO

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Summary: Prices observed on emerging markets are affected by market sentiment changes. The article presents an interdependence analysis of a chosen set of sentiment indicators observed on the Polish OTC market. The set contains both interest rate market (basis swap, asset swap, convergence swap, overnight index swap), foreign exchange market (ATM volatility, risk reversal) and equity market (WIG20). The analysis is focused on cointegration and Granger causality approach in order to present forecasting power of elaborated models. Evidence from the market reveals economic link between the time series that comes from the strong influence of the cross-border trading between non-residents and local market makers. High responsiveness of daily prices of OTC instruments to the changes of the market sentiment and a level of the risk aversion can be proven. Moreover, error correction model using foreign exchange options has practical forecasting power generating adequate trading decisions taken by market makers.

Keywords: emerging markets, market sentiment, cointegration analysis.

Streszczenie: Ceny na rynkach wschodzących są podatne na zmiany sentymentu rynkowego. Artykuł przedstawia analizę współzależności wybranych wskaźników sentymentu obserwowanych na polskim rynku pozagiełdowym. Zbiór wskaźników obejmuje rynek stopy procentowej (swap bazowy, swap kapitałowy, spread konwergencyjny, OIS), rynek walutowy (zmienności ATM, *risk reversal*) i rynek kapitałowy (WIG20). Analiza wykorzystuje zjawisko kointegracji zmiennych oraz analizę przyczynowości Grangera w celu optymalizacji siły prognostycznej opracowanych modeli. Wyniki badań ujawniają powiązania ekonomiczne między analizowanymi szeregami czasowymi, co wynika z silnego wpływu wymiany transgranicznej pomiędzy nierezydentami a lokalnymi animatorami rynku. Można zatem wykazać zależność wahań cen od zmian sentymentu rynkowego i poziomu awersji do ryzyka. Co więcej, model korekty błędem oparty o ceny opcji walutowych daje praktyczne możliwości

generowania przychodów dzięki generowanym przez model sygnałom tradingowym, które mogą być pomocne dla animatorów rynku.

Słowa kluczowe: rynki wschodzące, sentyment rynkowy, analiza kointegracji.

1. Introduction

Interdependence of prices on the financial market is a well investigated topic in economic literature. Researchers look for measuring a direction, strength, asymmetry and reciprocity of signals generated by changes in market prices of various financial instruments. The signals may refer both to price levels and their volatility or higher moments of distribution. The analysis is crucial for understanding a process of shock spillovers – its reason, persistence and consequences for valuation and risk profile of market portfolios.

The interdependence analysis has been mostly performed for equity markets, i.e. [Diebold, Yilmaz 2008; Diebold, Yilmaz 2009] or has been related to contagion effects [Pritsker 2001; Pericoli, Sbracia 2003; Serwa, Bohl 2005]. The literature about converging markets like the Polish one is more modest [Gębka, Serwa 2007; Adam, Bańbuła, Markun 2013] and focuses on equity and bond markets. This paper provides interdependence analysis on OTC derivative market which is less transparent than capital market.

A derivative market is used mostly for hedging unwanted exposures in order to diminish profit volatility or for speculation with leverage that is assured by off-balance character of derivatives. On emerging markets it is dominated by non-residents due to low capitalisation of the local financial institutions. Therefore price changes are determined both by local and global events and are vulnerable on risk aversion swings and market sentiment.

Market sentiment is a state of a given market generating longer term price trends [Barberis, Shleifer, Vishny 1998] and can be measured as an indicator of price movements [Baker, Wurgler 2007] or volatility changes [Lee, Jiang, Indro 2002]. One can use various instruments to measure such a "state of the market" – current liquidity, instability of market returns and – last but not least – a chosen set of financial instruments that are treated as proxy of investors' demand for risk [Oet et al. 2011; Slingenberg, de Haan 2011].

Especially on emerging markets, a market sentiment is a crucial determinant of a risk aversion that shapes observed and expected price patterns. Contagion effects coming from developed markets are strengthened by thought contagion and behavioural convergence due to limited number of market participants providing information and liquidity to the market [Hirshleifer, Teoh 2008; Shiller 2000].

The paper joins the two approaches described above – the authors verify the interdependence between a set of derivative prices that are treated as sentiment indicators in order to identify a path of spillover impulses that are observed on the

Polish financial market. The elected group of instruments is specific for emerging OTC markets. The next chapter describes a rationale of such an approach.

The paper is structured as follows: we present economic background in order to explain a choice of instruments and its significance for financial market in Poland, than we present methodology of data collection and its modelling. A Granger causality tests and cointegration analysis was performed in order to build ECM models and check their forecasting power.

2. Economic background

The emerging markets have the specific features that make them both more risky and more attractive for investors. First of all they offer higher expected returns, but these returns are not normally distributed due to strong asymmetry of risk [Hwang, Pedersen 2004; Bond, Satchel 2006]. In consequence, market participants cope with skewness and kurtosis of price returns, instable volatility and contracted liquidity causing higher bid-offer spreads. Trading is mostly performed on OTC basis in foreign exchange and interest rate products with a significant share of non-residents [Narodowy Bank Polski 2015; 2016]. These features promote some derivative products that are utilised in cross border trading. In order to have a full picture of the market, the authors added a benchmark equity index into the interdependence analysis.

The empirical analysis comprises the following seven time series:

- Overnight Index Swap spread (3 months PLN vs WIBOR).[1]
- Cross-currency basis swap (5 year EUR vs PLN).[2]
- Treasury bonds asset swap (5 year PLN).
- Convergence spread (5 year forward on 5 year interest rate swap, as a spread EUR vs PLN).
- Implied foreign exchange volatility (1 year at-the-money, ATM, EUR/PLN).
- Risk reversal for currency options (1 year 25-delta, EUR/PLN).
- Benchmark local equity index for blue chips (Warsaw Stock Exchange, WIG20).

Table 1 summarises an economic rationale and risk pattern for each product.

[1] After a breakout of the financial crises, OIS spread is the most popular and robust "stress indicator" [Taylor, Williams 2008; Płuciennik 2013] and OIS itself is crucial for derivative valuation [Bianchetti 2010].

[2] CCBS is a float-float subtype of CIRS [Boenkost, Schmidt 2005].

Table 1. The characteristics of the sentiment indicators

Instrument	Underlying risk	Representation	Risk measure	Emerging price pattern
OIS spread	Local liquidity	Unsecured deposits	A measure of liquidity and credit risk comparing overnight and term horizon	OIS prices are below IBOR prices and overnight risk is much lower than term risk of unsecured interbank deposits
Cross-currency basis spread	Cross border liquidity	Secured loan market	A measure of imbalance between supply and demand on a loan market secured by the other currency. The demand comes from foreign currency mortgage loans that must be hedged by local banks	Basis spread may be large and usually has a fixed sign (foreign currency is borrowed with premium vs. lending local currency)
Asset spread	Interest rate sovereign curves	A relative measure of reliability of local sovereign debt	A measure of risk aversion and a lack of liquidity on the local bond market	Asset spread is usually positive, i.e. bond yield is over swap yield (as reliability of a local issuer is rather low)
Convergence spread	Interest rate off-balance curves	An expected path of local interest rates vs. global interest rates	A pure measure of reliability of a convergence process of the local economy that encompasses a probability of a local currency conversion to the Euro	For prevailing emerging markets convergence spreads are high and have a constant sign (local yields are higher than reference ones)
ATM volatility	Foreign exchange (the second moment)	Expected instability of a local currency rate	A measure of expected instability of daily FX returns taking into account non-normality of the distribution	Implied volatility is volatile and diverges from realised volatility (is quoted with premium due to non-normality of distribution of daily returns)
Risk reversal	Foreign exchange (the third moment)	Expected probability of a currency crises	A measure of expected skew (asymmetrical price dynamics)	Risk reversal is significant and has a stable sign (high strike options are much dearer in volatility terms than low strike options)
WIG20	Equity market	Blue chip valuation	A measure of broad sentiment among investors	Index returns are leptokurtic and negatively skewed

Source: own elaboration partly on the basis of [Fronc, Mielus 2017].

3. Methodology and data sources

The described market data has been collected form the Thomson Reuter's Eikon financial system. It consists of daily time series data from 22/07/2010 to 07/07/2016. The data are expressed in the terms of basis points for the first six variables and in natural logarithm for WIG20 index.

To check interrelationships between those financial indicators at first the integration level of variables has been checked by using modified Dickey–Fuller t test (known as the DF-GLS test). After that Granger causality has been investigated by using a vector auto regressive model and Wald test, using the first-difference data which were all stationary on that level. Based on causality test's findings Error Correction Models (ECM's) were performed in which the dependent variables have been those suggested in the causality tests. At the end the ECM models were tested for their predictive power.

Evidence from the market reveals economic link between the time series that comes from a strong influence of the cross-border trading between non-residents and local market makers. In Figure 1 we can observe the behaviour of individual series on which this research is based.

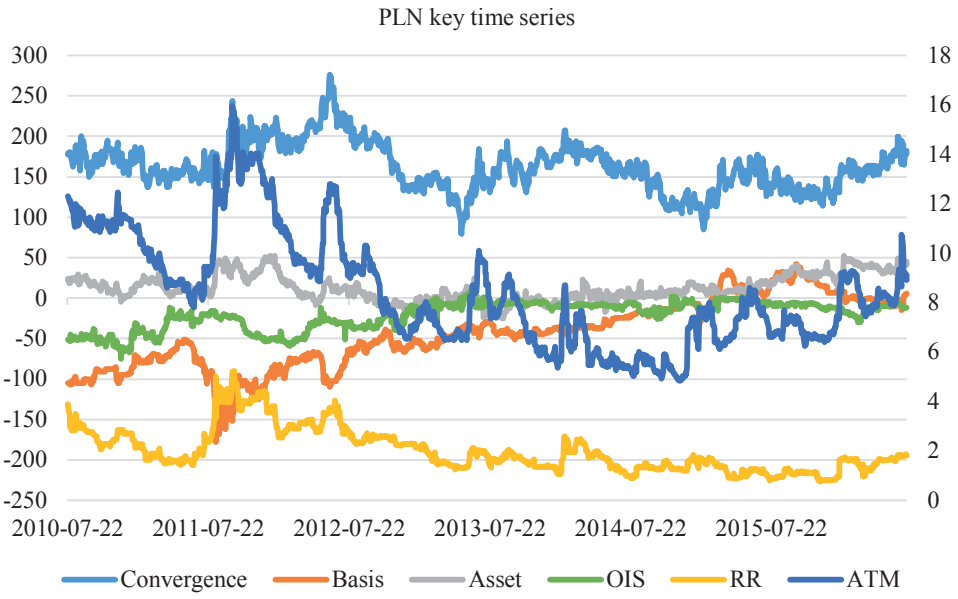


Figure 1. Time series of PLN OTC prices

Source: Thomson Reuters.

Convergence, Basis, Asset and OIS are on the left hand axis (price in basis points). RR and ATM are on the right hand axis (price in volatility % p.a.). For Basis and OIS the more negative value the higher risk.

4. Empirical evidence

The series have been tested for being stationary with DF-GLS test. Most of them appeared to be non-stationary on every checked lag specification (1-10). Some were stationary because they are spreads, so a difference of two series that probably have been nonstationary, but then differentiated, is that they became stationary. However, after differentiating all of them by the first order all of them appeared to be stationary. From this we conclude that the levels of series are integrated with the first order, what is not surprising because a very big group of financial time series is like that, and its first differences are stationary, integrated with zero order I(0).

The Engel-Granger causality tests discovered the following relationships between variables, described in the figure below (arrows indicate the direction of the relationship, they can be single or double-sided):

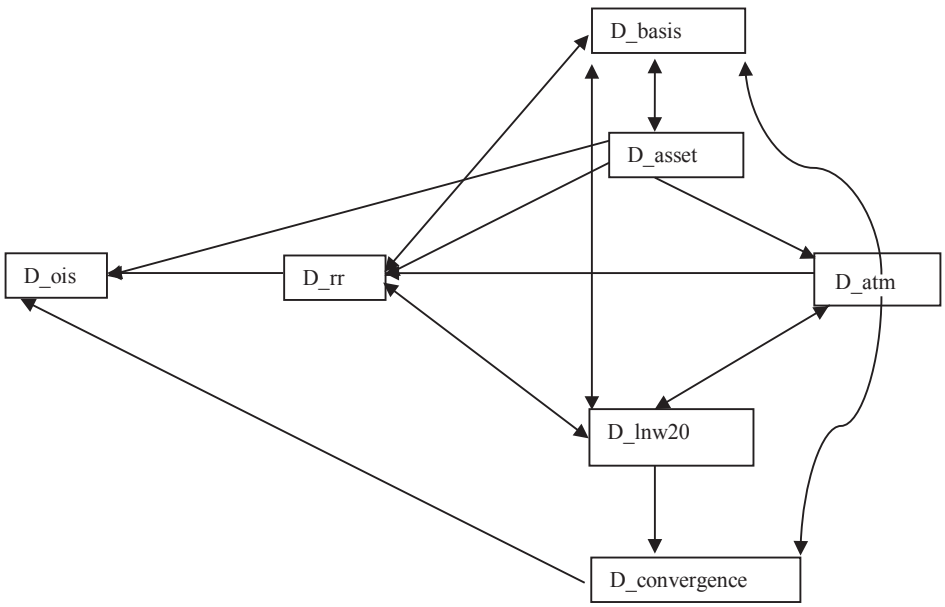


Figure 2. The relationships between market sentiment measures

Source: own elaboration.

The central variable in this relationship is a variation OIS spread and Risk Reversal, and those have been used as dependent variables of the ECM models.

The Engel-Granger procedure has been used. The first step has been to perform a cointegration regression on the levels of variables suggested in the causality test. The parameters estimated in such a model are as follows:

$$RR_t = 18.66 - 0.1378 \times Basis_t - 0.0032 \times Asset_t + 0.1475 \times ATM_t - 2.376 \times \ln(WIG20)_t + \varepsilon_t$$

The model describes the behaviour of analysed variables very well, what is pointed by its R-square parameter at the level of 86.54%. All the variables are strongly significant statistically by t-Student tests. Then the residuals from above regression have been tested for being stationary with DF-GLS test at 1% level. They appeared to be stationary on every checked lag specification (1-10). Because of those results the second stage of building Error Correction model could be implemented, this time using the first differences between the variables (it is represented with letter d in front of the variable name). The parameters estimated in second model are as follows:

$$dRR_t = -0.0005 - 0.0062 \times dBasis_t + 0.0002 \times dAsset_t + 0.23 \times dATM_t + 0.4224 \times d\ln(WIG20)_t - 0.0428 \times EC_{t-1} + \varepsilon_t$$

where all variables are analogical as is the first model and EC represents the ECM module.

The model has R-square parameter at the level of 29.36% and all variables, without dAsset and constant, are statistically important by t-Student statistic. What is important the Error Correction Mechanism's (EC) regressor is below zero, what indicates that abnormal differences from long term equilibrium state in previous observes series is corrected in estimated model to comply with the steady state. After estimating the model its ability to forecast values of 25-delta Risk Reversal has been checked. It is summarized in figures 3a and 3b. As we can see the forecast (orange line) goes in line with the empirically observed variables.

The predictive power has also been checked out of the sample period which contains last 100 observations, not taken into the estimation period. The results could be seen below in figure number 4. As it can be seen the model predicts the values of 25-delta Risk Reversal very well.

The second interdependence suggested by the causality test is the one that puts OIS-WIBOR in the central place. The parameters estimated in such a model are as follows:

$$OIS_t = 10.67 - 0.1481 \times Asset_t - 9.9981 \times RR_t - 0.0626 \times Convergence_t + \varepsilon_t$$

The model describes the behaviour of analysed variables in an average way, what is pointed by its R-square parameter at the level of 41.06%. All the variables are strongly significant statistically by t-Student tests. Then the residuals from above

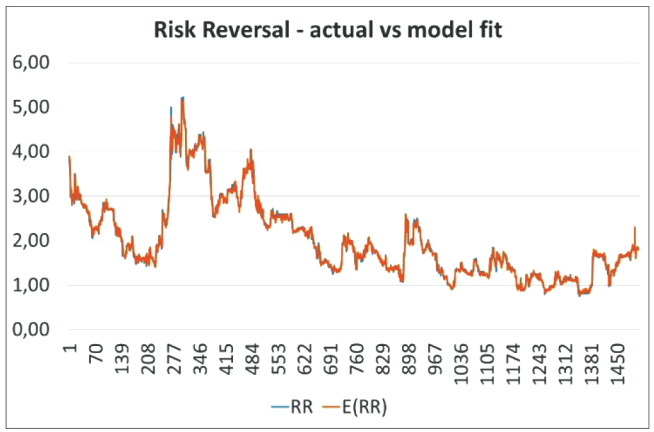


Figure 3a. Risk Reversal model fit

Source: own elaboration.

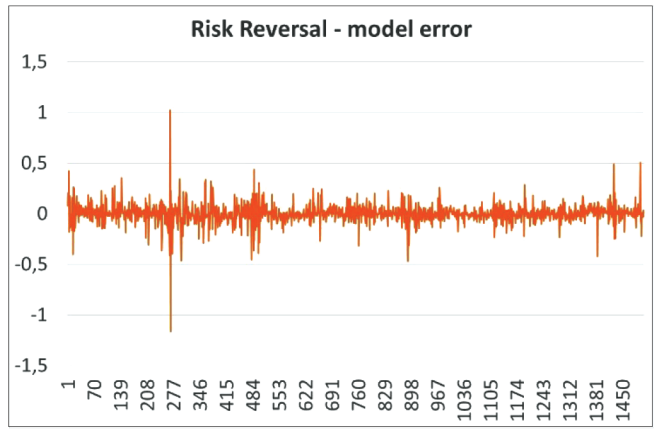


Figure 3b. Risk Reversal model error

Source: own elaboration.

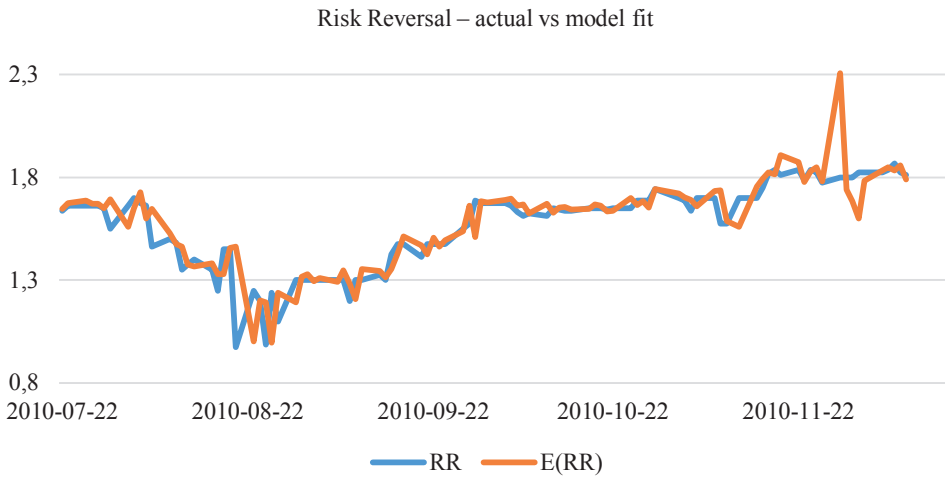


Figure 4. Risk Reversal model forecasts

Source: own elaboration.

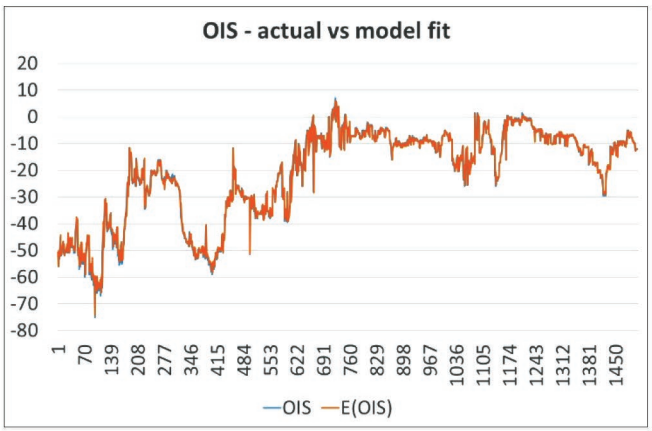
regression have been tested for being stationary with DF-GLS test at 1% level. They appeared to be stationary on every checked lag specification (1-10). Because of those results the second stage of building Error Correction model could be implemented, this time using the first differences between the variables (it is represented with letter *d* in front of the variable name). The parameters estimated in the second model are as follows:

$$dOIS_t = 0.00187 + 0.011 \times dAsset_t - 1.7065 \times dRR_t + 0.0139 \times \\ \times dConvergence_t - 0.0316 \times EC_{t-1} + \varepsilon_t$$

where all variables are analogical as is the first model and EC represents the ECM module.

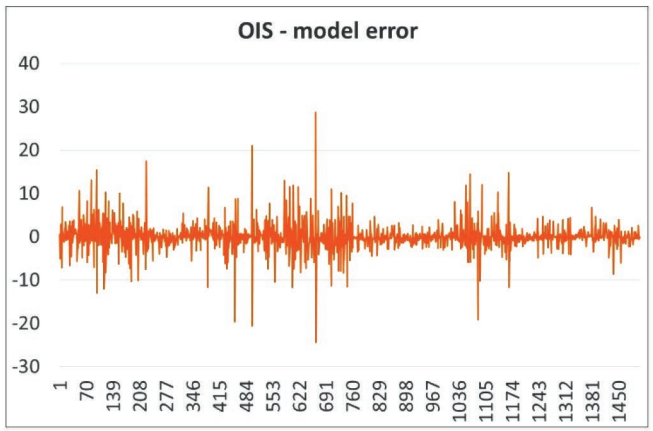
The model has R-square parameter at the level of 2.26% and only Risk Reversal and Error Correction module are statistically important by t-Student statistic. What is important the Error Correction Mechanism's (EC) regressor is below zero, what indicates that abnormal differences from long term equilibrium state in the previously observed series are corrected in the estimated model to comply with the steady state. After estimating the model its ability to forecast values of OIS spread has been checked. It is summarized in figures 5a and 5b.

The predictive power has also been checked into out of the sample period which contains last 100 observations not taken into the estimation period. The results could be seen in figure number 6. As it can be seen the model predicts the values of OIS spread very well.



Graph 5a. OIS model fit

Source: own elaboration.



Graph 5b. OIS model error

Source: own elaboration.

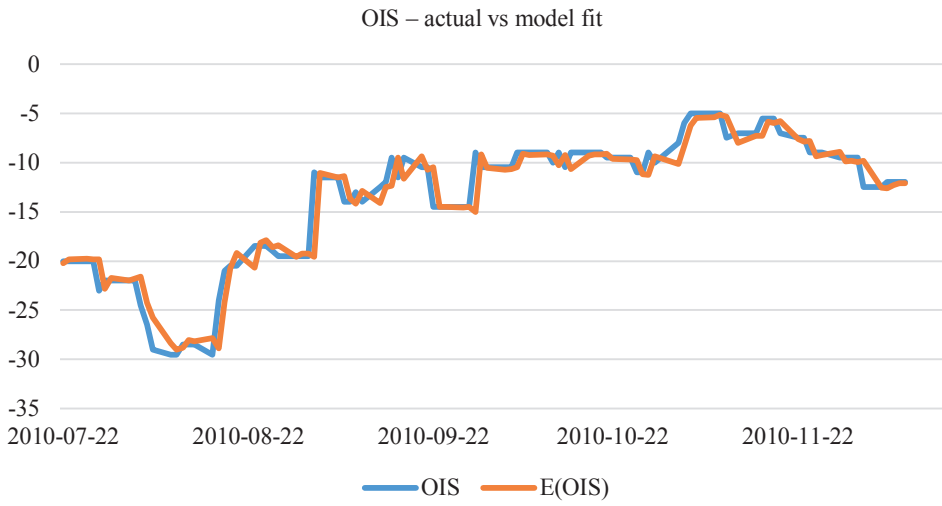


Figure 6. OIS model forecasts

Source: own elaboration.

5. Forecasting analysis

Following Levich [1998], the forecasting power of the presented models can be analysed from two angles:

- statistical accuracy,
- profitability of trading decisions taken on the basis of the estimated models.

One should distinguish between "accurate forecasts" and "useful forecasts", i.e. those that lead to correct trading decisions although the forecasted magnitudes were not accurate in terms of statistical significance.

Therefore Directional Quality Measure (DQM) is introduced, which results can be viewed in table number 2 below. It has been performed for all the observations and using out of sample periods which contain 100, 200 and 300 last observations, while the calibration period is the rest of full data set. DQM contains two elements:

1) sign convergence, measuring share of observations when the model shows the same price direction that occurred in a real sample,

2) accrued P&L, measuring accrued profit (or loss) taking into account decisions taken on the basis of the model and economic result coming from a real change of the price.

From the above results we can assume two conclusions. First: the RR model has a good trading forecasting power, OIS model is inferior in this matter, and second: RR model gains are smaller than transaction costs and therefore they are obtainable for market makers only.

Table 2. Directional quality measure for RR and OIS models

Period	Risk Reversal Model		OIS Model	
# observations	sign convergence	accrued P&L	sign convergence	accrued P&L
All	62%	33.10 pp	48%	–2.85 pp
Last 300	53%	1.30 pp	46%	–0.76 pp
Last 200	54%	0.77 pp	48%	–0.44 pp
Last 100	68%	1.89 pp	40%	–0.31 pp

Source: own elaboration.

6. Conclusions

On emerging markets traders and investors face an asymmetry of risk that means different speed of price changes depending on the current market sentiment. Therefore a measurement of the sentiment level is crucial for taking good investment decisions and the optimal risk assessment. Market participants analyse particular sentiment indicators that allow them to asses a scope of risk aversion and indirectly forecast future market flows. The market flows that create price movements on emerging markets are strictly dependent on the sentiment so their analysis allow traders to evaluate the probability of various market scenarios.

The paper presents most common sentiment indicators observed on the Polish OTC market that is a good example of sufficiently liquid emerging market with significant market flows caused both by local players and cross border investors. The analysis covers foreign exchange, interest rate and equity markets pointing out interdependences between these markets due to the commonality of market makers and its clients.

The authors publish empirical evidence of existence of the causal link between some daily changes of the sentiment indicators and cointegration of time series of its daily values. One can build ECM models which can be used for forecasting a direction of price movements that allows profits generated by correct trading decisions. Forecasts based on ECM models can be evaluated both from statistical and trading point of view. The latter is more practical as it shows profits that might be generated by using the model in the real market activity.

Option strategies modelling gives better results than liquidity derivatives modelling due to higher responsiveness of daily prices to the changes of the market sentiment and a level of the risk aversion, though one should take in mind that the effectiveness of trading strategies is obtainable for market makers that do not incur bid-offer spreads. The possible gain is smaller than transaction costs and therefore trading using own prices is a prerequisite of positive result based on model indicators.

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