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EUR/USD HIGH FREQUENCY TRADING: INVESTMENT PERFORMANCE

Summary: The paper tackles the problem of currency as an attractive investment alternative. It aims to present the benefits of diversification into the FX assets by analyzing the performance of chosen intraday EUR/USD trading strategies and comparing it to the performance of more traditional investment assets. The study is based on 1-minute Bid and Ask EUR/USD rates. It covers the period 2004–2006. The performance is measured by the ratio of return to total risk. The study reveals the superiority of the FX investments performance as compared to the performance of stocks and bonds. This together with low correlation of EUR/USD returns with returns generated by bonds and stocks provides an evidence of benefits of diversification of traditional portfolio into FX market. Therefore the study calls for rebalancing of the investment portfolios to include more FX assets.

Keywords: intraday, foreign exchange, EUR/USD, random, portfolio, performance, investment.

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1. Introduction

The FX market is the most liquid market with daily turnover counted in trillions of USD.¹ Currency has many functions, yet one of them, i.e. being an investment asset, is not fully acknowledged by portfolio managers. Traditional assets (such as stocks and bonds) still correspond to majority of portfolio allocation, with other assets playing often rather marginal role.² Although the constant development of new financial products is leading to changes in asset management [NAPF 2013], still treating currency as a purely investment asset remains rare. Currency is very often not even included in the universe of possible investments alternatives. Yet currency

¹ The average daily turnover for April 2010 was 3.98 USD [BIS 2011].

² For example in 2011, 17% of UK defined contribution pension funds' assets were allocated to investments other than equities and fixed income. The 'other' category includes: hedge funds, property, private equity and infrastructure [NAPF 2013].

seems to be a rather interesting investment asset. Not only it can have an immense impact on economy,³ but also due to its multifunction character the demand and supply of currency is created by agents of diverse origin and motives.

There is a vast literature on what drives the exchange rates, with monetary models providing some long term indications [Syczewska 2007; Dornbusch 1976; Frenkel 1976] and monetary news announcement having an impact on exchange rates in short term [Andersen et al. 2003; Faust et al. 2007]. At the same time temporal fluctuations in exchange rates are often explained by non-linear models [Kliber, Kliber 2010; Taylor, Taylor 2004; Boero, Marrocu 2002]. Previous studies revealed that in short term horizon, when intraday data is analyzed, foreign exchange markets prove to be inefficient in the weak sense. Such inefficiency could possibly be explored in trading. Moreover since currency has other functions than being an investment asset, thus the turnover generated by those other transactions should ensure the persistence of the inefficiencies.

This paper attempts to answer the question whether currency should be treated as an investment asset by portfolio managers, and whether it should be included in portfolio alongside stocks and bonds. The paper aims to present the benefits of diversification into the FX assets by analyzing the performance of chosen intraday EUR/USD trading strategies in comparison to performance of more traditional investment assets. The study is based on 1-minute Bid and Ask EUR/USD rates.⁴

The remaining of the paper is organized as follows: firstly methodology is briefly outlined with particular focus on investment performance measures utilized in later sections of the paper. Next chosen intraday trading strategies are being presented. Following that the performance of selected portfolios is investigated. Final section draws conclusions coming from prior empirical analysis.

2. Portfolio investments: performance measures

Traditional portfolio theory assumes investors are only concerned about two quantities: return and risk. Rational investors will choose an investment that for given level of risk provides highest rate of return, or for given level of return bears lowest risk. What if investment offers lower rate of return and at the same time bears lower risk? Then the choice depends on the risk awareness and risk preferences of the particular investor. Portfolio theory provides performance measures that can be used in such a situation.

³ For example depreciation of currency can have positive effect on the export.

⁴ Last Bid and Last Ask rates for 1-minute horizon were obtained from Bank of America. There are 1440 bid/ask quotes daily. The dataset covers period of 1st Jan 2004 to 17th October 2006. Any empirical evidence presented in this paper is based on this time period only.

The classical measures include Sharpe ratio, Traynor ratio and Jensen's alpha. These measures vary in how they perceive risk and what is important to investors.⁵

2.1. Portfolio performance measures

Sharpe ratio prices the value of total risk in terms of investment returns corrected for risk free rate:

$$\text{Sharpe ratio} = \frac{(R_A - r_f)}{\sigma_A},$$

where: R_A – the mean rate of return on the asset A (referred later as a “mean”);
 r_f – the risk free rate, σ_A is standard deviation (std.dev.) of returns of asset A .

It seems that with regard to currency investment, since we do not expect the investors to be well diversified across available investment options, total risk is an appropriate measure of risk. At the same time defining a risk free rate can be somewhat challenging. Should it be US or European risk free rate? Perhaps a domestic rate for an investor, that could yet be even more different, should be chosen? Due to lack of clarity what perspective to use (how to define home market) for currency investor, for the purpose of this paper it has been assumed that risk free rate is equal to zero.⁶ Therefore the performance measure utilized further in the paper is reduced to:

$$\frac{R_A}{\sigma_A} = \frac{\text{Mean}}{\text{Std.dev.}}$$

The higher the ratio, the better the investment performance is.

2.2. Diversification benefits

Portfolio performance can be improved by adding assets whose returns are less than perfectly positively correlated with returns of the portfolio. This diversification benefits translate into risk reduction of the portfolio. Modern portfolio theory states there are limits of diversification benefits, namely total risk can be reduced to systematic risk, yet systematic risk will stay no matter how many new securities are added into the portfolio.

⁵ Sharpe ratio focuses on total risk [Haugen, Pajak 1996; Jajuga, Jajuga 2008], while Traynor ratio on systematic risk [Ostrowska 2003].

⁶ Furthermore since the investment horizon is very short (intraday trading strategies), it seem that ignoring risk free rate on such short time interval should have small impact on the results.

Table 1 presents expected return and risk associated with investing in chosen traditional asset classes and in EUR/USD. Table 2 outlines correlation coefficients of their returns.⁷ Equities provide the highest rate of return, and also the highest risk. Investment in Corporate Bonds yielded negative rate of return. Investing in EUR/USD provided small, positive returns, which have low and negative correlation with returns of all assets but FTSE100. This low correlation means including EUR/USD into portfolio should bring substantial benefits of diversification.

Table 1. Risk and return of various asset classes⁸, daily frequency

Variable	Mean	Std.dev.	Min	Max	Mean/Std.dev.
FTSE100	0.0005583	0.0066995	-0.028704	0.0260451	0.083334577
SP500	0.0003493	0.0066014	-0.0184888	0.0213789	0.052913018
GER3mdr	0.0000895	0.0000149	0.0000726	0.0001318	6.006711409
UK3mdr	0.0001713	8.61E-06	0.0001466	0.0001873	19.89547038
US3mdr	0.0001114	0.000052	0.0000326	0.0001877	2.142307692
DJCB	-0.000093	0.0029029	-0.0130165	0.0114395	-0.032036929
EUR/USD	8.07E-06	0.0057147	-0.0195877	0.0173824	0.001412148

Source: own calculations.

Table 2. Correlation coefficient of (logarithmic) returns of various asset classes, daily frequency.

Variable	FTSE100	SP500	GER3mdr	UK3mdr	US3mdr	DJCB	EUR/USD
FTSE100	1						
SP500	0.4145	1					
GER3mdr	0.0018	0.0222	1				
UK3mdr	0.0266	0.0155	0.2734	1			
US3mdr	0.0148	0.0178	0.8177	0.3039	1		
DJCB	-0.0723	0.0503	0.016	0.0433	-0.0129	1	
EUR/USD	0.0898	-0.0251	-0.0187	-0.0071	-0.0094	-0.23	1

Source: own calculations.

⁷ Returns are calculated as logarithmic returns (or translated into logarithmic returns under the assumption of 260 trading days). All data was denominated in local currency, thus all returns are in local currency.

⁸ Data comes from DataStream: GER3mdr – Germany: BD EU-MARK 3M DEPOSIT (FT/TR) – MIDDLE RATE, UK3mdr – UK TREASURY BILL TENDER 3M – MIDDLE RATE, US 3mdr – US T-BILL SEC MARKET 3 MONTH (D) – MIDDLE RAT, DJCB – DOW JONES CORPORATE TOTAL INDEX, EUR/USD – daily exchange rate.

Next section will focus on selected intraday EUR/USD trading strategies.⁹ The performance of those strategies will be analysed.

3. EUR/USD intraday trading

Figure 1 presents how EUR/USD Bid rate changed in time. In the time period under the study the EUR/USD varies between 1.164 and 1.366, with the mean rate being equal to 1.244. Table 3 outlines summary statistics of both Bid and Ask rate. The spread between the rates varies in time. The average spread is being equal to 0.0001777, with maximum value of 0.0010999.

Table 3 shows also MaxLongRet and MaxShortRet. These are logarithmic daily returns calculated for every minute of the day (thus 1440 returns in a day). MaxLongRet are maximum long returns achievable by holding a long position for up to 24 hours after the position was open (at time $t = 0$, thus holding it maximum until $t = 1440$). They are calculated as:

$$\text{MaxLongRet} = \ln \text{MaxBid} - \ln \text{Ask},$$

where: $\ln \text{MaxBid}$ – the maximum Bid rate within 24 hours period after the position was open (so between time $t = 0$ and $t = 1440$); $\ln \text{Ask}$ – the ask rate at time $t = 0$.

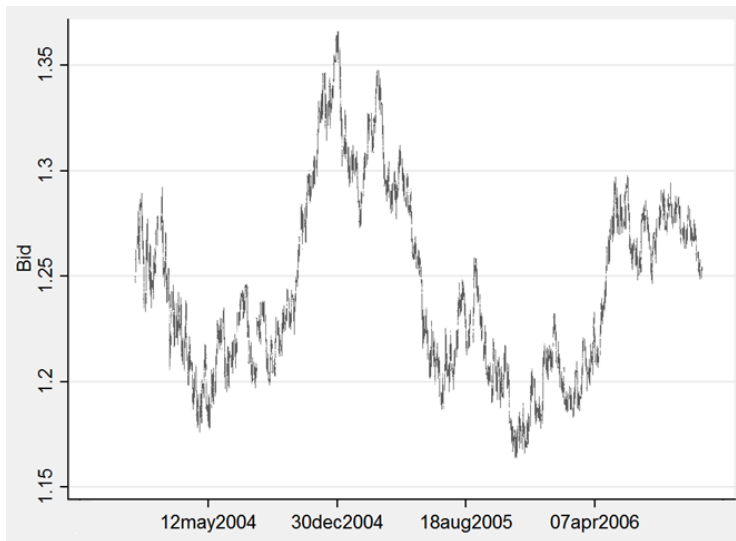


Figure 1. EUR/USD Bid rate, 1-minute frequency

Source: own calculations.

⁹ Based on 1-minute data from the Bank of America. This section was based on daily data from DataStream.

MaxShortRet are calculated as a difference between the Bid rate obtained at $t = 0$ and a minimum ask rate achievable within 24 hours following opening of the position (thus until time $t = 1440$):

$$\text{MaxShortRet} = \ln\text{Bid} - \ln\text{MinAsk}.$$

Table 3. Summary statistics, EUR/USD Bid and Ask rates and Long and Short daily returns, based on data of 1-minute frequency

	BID	ASK	MaxLongRet	MaxShortRet
Mean	1.244321	1.244498	0.0046533	0.0046558
Median	1.2348	1.235	0.0036024	0.0035576
Std.dev.	0.0435961	0.0435922	0.0040753	0.0041416
Skewness	0.4667209	0.4712998	1.272444	1.517764
Kurtosis	2.363259	2.374524	4.620842	5.851421
Min	1.164	1.1641	-0.0119253	-0.0139252
Max	1.366	1.3665	0.024996	0.029123
1 percentile	1.1719	1.1722	-0.0003	-0.0002498
5 percentile	1.1846	1.1848	0.0001534	0.0001667
10 percentile	1.1932	1.1934	0.0004881	0.0005805
25 percentile	1.2084	1.2085	0.0015228	0.0016322
75 percentile	1.2777	1.2775	0.06775	0.0065453
90 percentile	1.3036	1.3039	0.0103443	0.0103039
95 percentile	1.3257	1.326	0.012926	0.0130093
99 percentile	1.3473	1.3477	0.0181122	0.018674

Source: own calculations.

Both long and short position provide average maximum daily logarithmic returns in the range of 0.00465, with 95% of observations resulting in returns higher than 0.00015. The distribution of both returns is also quite similar, which implies that for an intraday trading, on average, it shouldn't matter what position, long or short, is open. This in turns leads to a conclusion that within 24 hours intervals EUR/USD must be relatively highly volatile and mean reverting. These outcomes are stable in time because as can be seen on Figure 2 the maximum returns distribution is relatively stable, with rare negative returns, and rare high returns above 0.02.

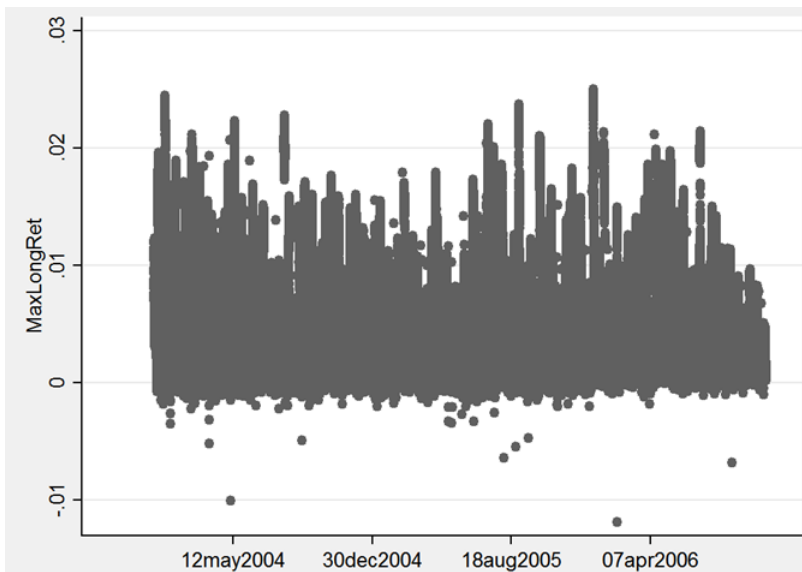


Figure 2. MaxLongRet, daily returns, 1-minute frequency

Source: own calculations.

Maximum return analyzed so far can only be calculated *ex post*. They assume closing a position at the most favorable rate within 24-hour period. Yet this rate is only known once the time period has passed. For trading purposes it would be better to establish trading rule that would govern how to close the position and that could be implemented while the 24-hour period still lasts. The remaining of this chapter deals with chosen trading strategies that differ in selection of exit mode.

3.1. Trading strategies

Trading strategies investigated further in the study assume closing a position when return from the position reaches certain target rate. The level of target return is chosen based on Table 3 and corresponds to various percentiles of the returns distribution. When the target return is not reached within the 24-hour period (for 1 day strategy), then last rate of the period is used to close out the position. Furthermore the study is extended to n -day strategies. If the target return is not reached within n -days then again last rate of the n -day period is implemented. Those strategies will be referred to as LongRetDayn strategies (where $n = 1, 3, 5, 15$) or ShortRetDayn strategies (for example ShortRetDay3, where $n = 3$).

Moreover the study investigates also two alternative strategies: MeanRet strategy and MaxYRet strategy. MeanRet strategy allows for closing the position in case the

target is not reached, at the mean level of the rate from previous trading day. If that rate is again not reached within n -days the last rate of the time period is being used. MaxYRet allows for closing the position, in case the target is not reached, at the maximum value of the rate (of the bid rate in case of long position) or minimum value of the rate (of the ask rate in case of short position) of the previous 24-hour period.¹⁰ Otherwise the last rate of the n -day period is being used to close out the position.

3.2. Investment performance

The outcomes of LongRetDay1 and ShortRetDay1 strategies are presented in the first panel of Table 4. The higher the target rate, the better the performance. Both long and short positions were providing similar outcomes. Remaining panels of Table 4 allow for keeping the position open for n -days ($n = 3, 5, 15$). Allowing for keeping the position open for 3 days drastically improves the performance, i.e. on average the investment outcome is over 7 times better then when the position is closed within 24 hours (i.e. when $n = 1$). Further increase in the time of exposure increases the performance, but not as drastically (increase to $n = 15$ leads to around 3 times improvements in performance). These results are consistent with expectations, i.e. due to mean reversions even if initially the position is not closed by reaching the target rate, it should reach the target in the near future.

Figure 3 summarizes the relationship between the target rate, length of time the position can remain open and portfolio performance. In case of position open for 3 days or more the optimal target rate is in the range of 25 percentile (0.0015228) and the median (0.0036024, compare to Table 3).

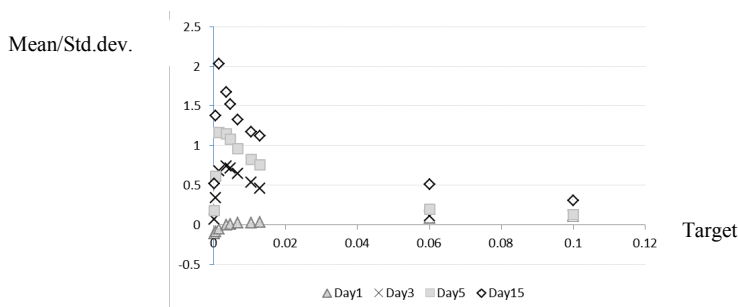


Figure 3. LongRetDay n , various target rations

Source: own calculations.

¹⁰ The alternative returns will be referred to as: MeanLongretDay n , MeanShortRetDay n , MaxYLongRetDay n , MaxYShortRetDay n , for example MaxYLongRetDay2.

Table 4. Performance of long and short strategies, with position closed out at either a target level or the last quote at the period

Target	Variable	Mean	Std.Dev.	Mean/Std.dev.	Variable	Mean	Std.	Mean/Std.dev.
1	2	3	4	5	6	7	8	9
0.00015	<i>LongRetDay1</i>	-0.0001965	0.0018099	-0.108569534	<i>ShortRetDay1</i>	-0.0001546	0.0016658	-0.09280826
0.0004881	<i>LongRetDay1</i>	-0.0001925	0.0024553	-0.078401825	<i>ShortRetDay1</i>	-0.0001081	0.002293	-0.04714348
0.0015228	<i>LongRetDay1</i>	-0.0001852	0.0036367	-0.050925289	<i>ShortRetDay1</i>	-0.000077	0.0035271	-0.021830966
0.0036024	<i>LongRetDay1</i>	4.96E-06	0.0047225	0.001050291	<i>ShortRetDay1</i>	-0.0000408	0.0047169	-0.008649749
0.00465	<i>LongRetDay1</i>	0.0000486	0.0050917	0.009544946	<i>ShortRetDay1</i>	-0.0000482	0.0050456	-0.009552878
0.006775	<i>LongRetDay1</i>	0.0001352	0.0056024	0.024132515	<i>ShortRetDay1</i>	0.000024	0.0055216	0.004346566
0.0103443	<i>LongRetDay1</i>	0.0001795	0.0060117	0.029858443	<i>ShortRetDay1</i>	0.0001659	0.005978	0.027751756
0.012926	<i>LongRetDay1</i>	0.000207	0.0061764	0.033514669	<i>ShortRetDay1</i>	0.0002046	0.0061592	0.0332186
0.06	<i>LongRetDay1</i>	0.0008667	0.0096473	0.089838608	<i>ShortRetDay1</i>	0.0008633	0.00964	0.089553942
0.1	<i>LongRetDay1</i>	0.001538	0.0141019	0.109063318	<i>ShortRetDay1</i>	0.0015346	0.0140971	0.108859269
0.00015	<i>LongRetDay3</i>	0.0000515	0.0007747	0.066477346	<i>ShortRetDay3</i>	0.0000662	0.000697	0.094978479
0.0004881	<i>LongRetDay3</i>	0.000324	0.0009553	0.339160473	<i>ShortRetDay3</i>	0.0003495	0.0008564	0.40810369
0.0015228	<i>LongRetDay3</i>	0.0010182	0.0014999	0.678845256	<i>ShortRetDay3</i>	0.0010766	0.0013511	0.796832211
0.0036024	<i>LongRetDay3</i>	0.0018999	0.0025529	0.744212464	<i>ShortRetDay3</i>	0.0019648	0.0023797	0.825650292
0.00465	<i>LongRetDay3</i>	0.0021505	0.0029942	0.718221896	<i>ShortRetDay3</i>	0.0021831	0.0028439	0.767643025
0.006775	<i>LongRetDay3</i>	0.002421	0.0037291	0.64921831	<i>ShortRetDay3</i>	0.0024127	0.0036097	0.668393495
0.0103443	<i>LongRetDay3</i>	0.0024073	0.0045142	0.533272784	<i>ShortRetDay3</i>	0.0023643	0.0044395	0.532559973
0.012926	<i>LongRetDay3</i>	0.0022606	0.0048759	0.463627228	<i>ShortRetDay3</i>	0.0022013	0.0048136	0.457308459
0.06	<i>LongRetDay3</i>	0.0009824	0.0084526	0.116224594	<i>ShortRetDay3</i>	0.0010913	0.0085038	0.128330864
0.1	<i>LongRetDay3</i>	0.0016128	0.0132967	0.121293253	<i>ShortRetDay3</i>	0.0016782	0.0132864	0.12630961

1	2	3	4	5	6	7	8	9
0.00015	<i>LongRetDay5</i>	0.000096	0.0005304	0.180995475	<i>ShortRetDay5</i>	0.0001096	0.0004332	0.253000923
0.0004881	<i>LongRetDay5</i>	0.0003906	0.0006412	0.609170306	<i>ShortRetDay5</i>	0.0004127	0.000527	0.783111954
0.0015228	<i>LongRetDay5</i>	0.0011647	0.0010029	1.161332137	<i>ShortRetDay5</i>	0.0012141	0.0008618	1.408795544
0.0036024	<i>LongRetDay5</i>	0.0021914	0.0019073	1.148954019	<i>ShortRetDay5</i>	0.002262	0.0017335	1.304874531
0.00465	<i>LongRetDay5</i>	0.0025095	0.0023226	1.080470163	<i>ShortRetDay5</i>	0.0025696	0.0021423	1.199458526
0.006775	<i>LongRetDay5</i>	0.0029067	0.0030308	0.959053715	<i>ShortRetDay5</i>	0.0029597	0.0028539	1.037072077
0.0103443	<i>LongRetDay5</i>	0.0031183	0.0037882	0.823161396	<i>ShortRetDay5</i>	0.0031422	0.0036785	0.854206878
0.012926	<i>LongRetDay5</i>	0.0031371	0.0041614	0.753856875	<i>ShortRetDay5</i>	0.003138	0.0040882	0.767574972
0.06	<i>LongRetDay5</i>	0.001708	0.0086665	0.197080713	<i>ShortRetDay5</i>	0.0017565	0.0087075	0.201722653
0.1	<i>LongRetDay5</i>	0.0016937	0.0131803	0.128502386	<i>ShortRetDay5</i>	0.001827	0.0132173	0.138227929
0.00015	<i>LongRetDay15</i>	0.000129	0.0002499	0.516206483	<i>ShortRetDay15</i>	0.0001382	0.0002192	0.630474453
0.0004881	<i>LongRetDay15</i>	0.0004345	0.0003153	1.378052648	<i>ShortRetDay15</i>	0.0004492	0.0002716	1.653902798
0.0015228	<i>LongRetDay15</i>	0.0012427	0.0006117	2.031551414	<i>ShortRetDay15</i>	0.0012753	0.0005535	2.304065041
0.0036024	<i>LongRetDay15</i>	0.0023652	0.0014125	1.674477876	<i>ShortRetDay15</i>	0.0023998	0.0013431	1.786761969
0.00465	<i>LongRetDay15</i>	0.0027308	0.0017905	1.52516057	<i>ShortRetDay15</i>	0.0027509	0.0017123	1.60655259
0.006775	<i>LongRetDay15</i>	0.0032281	0.0024308	1.327999013	<i>ShortRetDay15</i>	0.0032406	0.002337	1.386649551
0.0103443	<i>LongRetDay15</i>	0.0036097	0.0030731	1.174611955	<i>ShortRetDay15</i>	0.0036339	0.0029986	1.211865537
0.012926	<i>LongRetDay15</i>	0.0037701	0.0033604	1.12192001	<i>ShortRetDay15</i>	0.0037969	0.0033022	1.149809218
0.06	<i>LongRetDay15</i>	0.004352	0.0085585	0.508500321	<i>ShortRetDay15</i>	0.0042921	0.008601	0.499023369
0.1	<i>LongRetDay15</i>	0.0041514	0.0134982	0.307552118	<i>ShortRetDay15</i>	0.0040572	0.0135393	0.299660987

Source: own calculations.

Table 5 and Figure 4 provide overview of alternative strategies. MeanRet provides better results initially (i.e for example when $n = 2$), whereas MaxYRet is better for higher n . Yet for even higher n the initial trading strategy (i.e. LongRet) yields best results. When comparing those results (Table 4) with results of investing on stock market (Table 1), it is clear that EUR/USD intraday trading can bring superior results. When mean returns are used for comparison, EUR/USD trading strategies outperformed both investments in stocks and bonds.

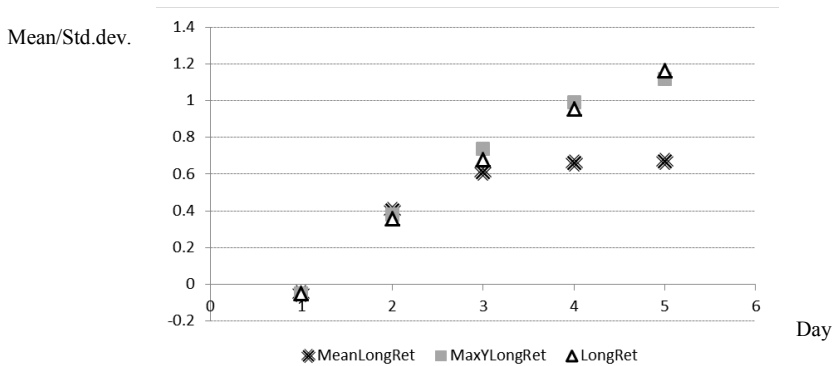


Figure 4. Performance comparisons, target 0.001528

Source: own calculations.

Table 5. Alternative investment strategies: investment performance

Variable	Mean	Std.dev.	M/S.D	Variable	Mean	Std.dev.	M/S.D
1	2	3	4	5	6	7	8
target: 0.001528							
<i>MeanLRet1</i>	-0.0001852	0.003636	-0.0509	<i>MeanSRet1</i>	-0.000077	0.003527	-0.0218
<i>MeanLRet2</i>	0.0007821	0.001932	0.4047	<i>MeanSRet2</i>	0.0008842	0.001729	0.5114
<i>MeanLRet3</i>	0.0009135	0.001497	0.6102	<i>MeanSRet3</i>	0.0009927	0.001359	0.7301
<i>MeanLRet4</i>	0.0009362	0.001413	0.6624	<i>MeanSRet4</i>	0.0010042	0.001311	0.7656
<i>MeanLRet5</i>	0.0009386	0.001404	0.6683	<i>MeanSRet5</i>	0.0010052	0.001311	0.7666
<i>MaxYLRet1</i>	-0.0001852	0.003636	-0.0509	<i>MaxYSRet1</i>	-0.000077	0.003527	-0.0218
<i>MaxYLRet2</i>	0.0007848	0.002053	0.3822	<i>MaxYSRet2</i>	0.000879	0.001848	0.4755
<i>MaxYLRet3</i>	0.0010232	0.001388	0.7369	<i>MaxYSRet3</i>	0.001095	0.001214	0.9017
<i>MaxYLRet4</i>	0.0010982	0.001109	0.9896	<i>MaxYSRet4</i>	0.0011406	0.001041	1.0947
<i>MaxYLRet5</i>	0.0011223	0.001005	1.1163	<i>MaxYSRet5</i>	0.0011686	0.000895	1.3047

1	2	3	4	5	6	7	8
target: 0.0036024							
<i>MeanLRet1</i>	0.0000049	0.004722	0.0011	<i>MeanSRet1</i>	-0.0000408	0.004716	-0.0086
<i>MeanLRet2</i>	0.0014395	0.003083	0.4668	<i>MeanSRet2</i>	0.0015735	0.002868	0.5486
<i>MeanLRet3</i>	0.0016789	0.002578	0.6512	<i>MeanSRet3</i>	0.0017941	0.002412	0.7438
<i>MeanLRet4</i>	0.0017259	0.002467	0.6995	<i>MeanSRet4</i>	0.001817	0.002356	0.771
<i>MeanLRet5</i>	0.0017345	0.002450	0.7079	<i>MeanSRet5</i>	0.0018208	0.002353	0.7738
<i>MaxYLRet1</i>	0.0000049	0.004722	0.0011	<i>MaxYSRet1</i>	-0.0000408	0.004716	-0.0086
<i>MaxYLRet2</i>	0.0014612	0.003205	0.4559	<i>MaxYSRet2</i>	0.0015518	0.003025	0.513
<i>MaxYLRet3</i>	0.0018977	0.002415	0.7858	<i>MaxYSRet3</i>	0.0019991	0.002214	0.9027
<i>MaxYLRet4</i>	0.0020399	0.002084	0.9786	<i>MaxYSRet4</i>	0.0020996	0.001990	1.0546
<i>MaxYLRet5</i>	0.0020915	0.001951	1.0717	<i>MaxYSRet5</i>	0.0021538	0.001824	1.1808

Source: own calculations.

3.3. Time of the day effect

High intraday volatility is behind the success of EUR/USD intraday trading strategies. Figure 5 outlines how the risk is changing through the day, dependent at what time the position was opened. Also the returns are affected by the time of the day the position was opened (see Figure 6). Therefore the overall performance is not stable during the day (Figure 7). The peaked performance of both short and long strategy is achieved for positions opened between 7 pm and 9 pm. This is due to relatively low risk at that time. The worst time to open long position is when European markets are open, before US markets opens. This is time of high volatility.

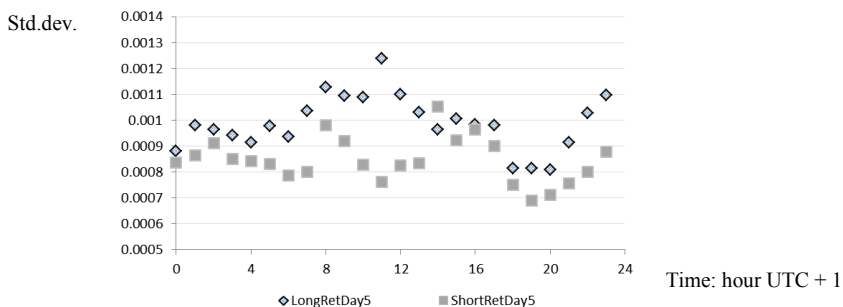


Figure 5. LongRet strategy performance, target 0.0015228

Source: own calculations.

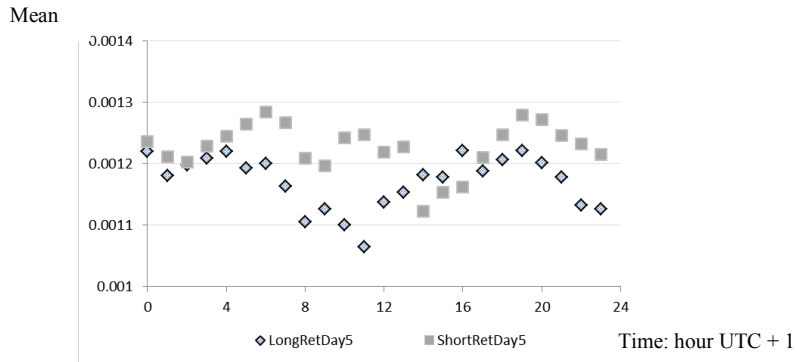


Figure 6. LongRet strategy performance, target 0.0015228

Source: own calculations.

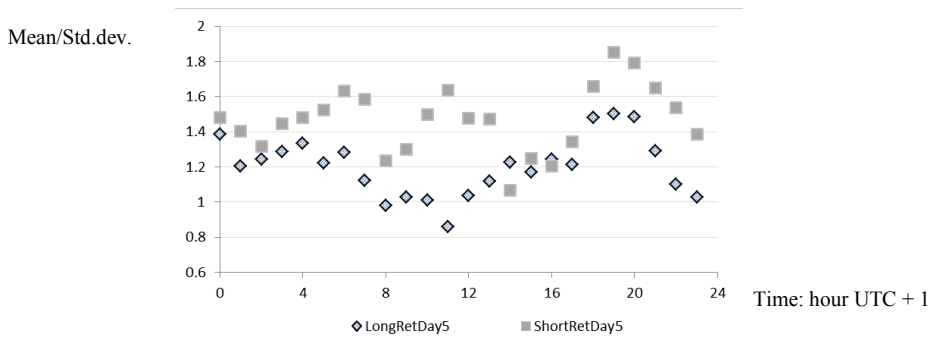


Figure 7. LongRet strategy performance, target 0.0015228

Source: own calculations.

4. Conclusions

This paper tackles the question whether currency should be treated as an investment asset by portfolio managers. It aims to present the benefits of diversification into the FX assets by analyzing the performance of chosen intraday EUR/USD trading strategies and comparing it to the performance of more traditional investment assets. The study is based on 1-minute Bid and Ask EUR/USD rates. The paper provides a proof that intraday FX investment can outperform traditional investments. Furthermore low correlation between EUR/USD returns and traditional asset returns provides yet another proof that currency should be perceived as an investment asset, and should be included in portfolio selection.

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EUR/USD TRANSAKCJE WYSOKIEJ CZĘSTOTLIWOŚCI: WYNIKI INWESTYCYJNE

Streszczenie: Artykuł porusza problem waluty jako przedmiotu inwestowania. Ukazuje zalety dywersyfikacji portfela inwestycyjnego w instrumenty *runky forex* poprzez analizę krótkookresowych strategii inwestycyjnych w EUR/USD. Badanie empiryczne opiera się na 1-minutowych kursach kupna/ sprzedaży EUR/USD za okres 2004–2006. Efektywność inwestycji mierzona stosunkiem stopy zwrotu do ryzyka ukazuje zalety inwestycji w instrumenty *forex* w stosunku do tradycyjnych instrumentów inwestycyjnych. Jednocześnie niska korelacja z tymi tradycyjnymi instrumentami powoduje, że instrumenty rynku *forex* powinny być uwzględnione w konstrukcji portfela inwestycyjnego.

Słowa kluczowe: inwestycje portfelowe, efektywność, *intraday*, EUR/USD, *forex*.