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L'Istituto di Cultura Bancaria è un'associazione senza finalità di lucro fondata a Milano nel 1948 dalle maggiori banche dell'epoca allo scopo di diffondere la cultura bancaria e di provvedere alla pubblicazione di *Rivista Bancaria - Minerva Bancaria*. La Rivista è stata diretta dal 1945 al 1974 da Ernesto d'Albergo e poi per un altro trentennio da Francesco Parrillo, fino al 2003. In questo secondo periodo, accanto alla trattazione scientifica dei problemi finanziari e monetari, la rivista ha rafforzato il suo ruolo di osservatorio attento e indipendente della complessa evoluzione economica e finanziaria del Paese. Giuseppe Murè, subentrato come direttore dal 2003 al 2008, ha posto particolare accento anche sui problemi organizzativi e sull'evoluzione strategica delle banche. Nel 2003, l'Istituto di Cultura Bancaria è stato dedicato alla memoria di Francesco Parrillo, alla cui eredità culturale esso si ispira.

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MEAN REVERSION TO TRADE CURRENCIES ON A FUTURE-BASED APPROACH

GIOVANNI ASCIONE*

Abstract

This paper examines the potential of mean reversion in systematic currency futures trading. It proposes a monthly strategy based on calculating a mean and two thresholds to identify overbought and oversold areas. The strategy opens long positions below the lower band and short positions above the upper band, aiming for correction towards the mean. The model is tested on the seven major currency futures traded on the Chicago Mercantile Exchange, with two activation criteria corresponding to different Augmented Dickey-Fuller (ADF) test specifications. Results reveal a strong dependence on instrument and statistical filter: for NZD (New Zealand Dollar) and GBP (Great Britain Pound) with ADF excluding trend, the strategy outperforms buy-and-hold in Sharpe ratio and volatility; when a trend filter is included, the benchmark can prevail and Sharpe ratio tend to remain negative. Robustness checks highlight that the strategy works best in stationary, trend-free markets and that methodological choices have a decisive impact.

* Tirocinante Esperto Contabile (ODCEC Napoli), Studio Ascione & Partners - ascionecf@gmail.it

"Ritorno alla media" nel trading di valute con un approccio basato sui futures – Sintesi

Questo lavoro esamina il potenziale della mean reversion nel trading sistematico di futures valutari. Si propone una strategia operativa mensile, basata sul calcolo di una media e di due soglie per identificare aree di ipercomprato e ipervenduto. La strategia apre posizioni long sotto la banda inferiore e short sopra quella superiore, puntando sulla correzione verso la media. Il modello è testato sui sette principali futures valutari del Chicago Mercantile Exchange, con due criteri di attivazione secondo specifiche diverse del test Augmented Dickey-Fuller (ADF). I risultati mostrano una forte dipendenza dallo strumento e dalla specifica statistica: per NZD (New Zealand Dollar) e GBP (Great Britain Pound) con ADF senza trend, la strategia supera il buy-and-hold in Sharpe ratio e volatilità; con filtro di trend il benchmark può prevalere e gli Sharpe ratio tendono a restare negativi. Test di robustezza evidenziano che la strategia funziona meglio in mercati stazionari e privi di trend.

Parole chiave: *Stazionarietà; Ritorno alla media; Analisi tecnica; Strategia di trading; Futures finanziari.*

Codici JEL: C58; F31; G11; G15; G23.

Keywords: Stationarity; Mean-reversion; Technical analysis; Trading strategy; Financial futures

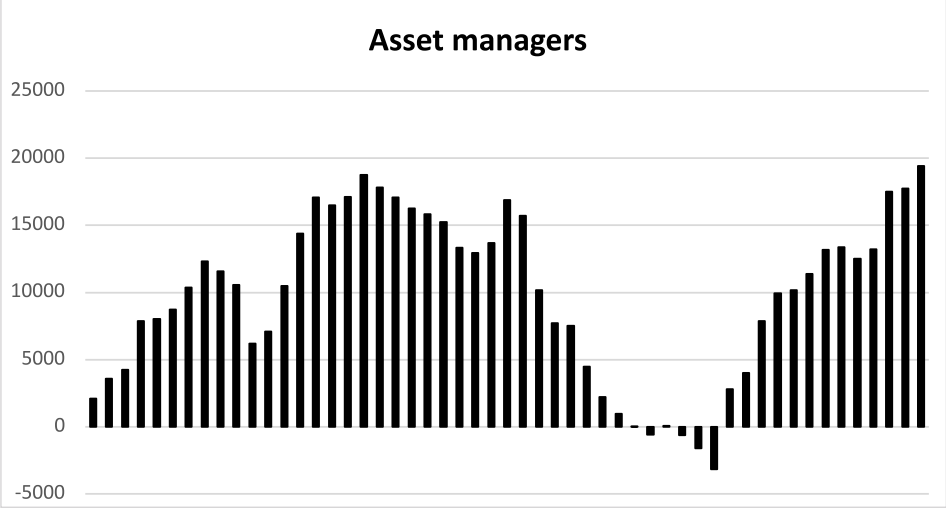
Introduction

The dynamics of currency markets present both challenges and opportunities for international investors and active market participants. While portfolio hedging remains a central theme in the financial literature, this paper instead explores the systematic exploitation of mean reversion as a basis for market timing in currency futures. Motivated by strong evidence of statistical mean reversion in major exchange rates particularly in non trending environments (Lothian and Taylor (1997), Jorion and Sweeney (1996), Taylor and Taylor (2002), Cashin and McDermott (2001)) the research develops a simple, rule-based strategy that activates when prices deviate from a computed reference mean: static bands are drawn each month and positions are entered upon crossing into overbought or oversold territory, anticipating a correction. Empirical analysis is conducted across seven major currency futures and two stationarity definitions, highlighting substantial variation in risk adjusted performance. The results show that the timing strategy can deliver superior Sharpe ratio and reduced volatility compared to buy-and-hold benchmarks for specific contracts such as NZD and GBP under the intercept only ADF filter while in other cases, especially when a trend filter is applied or when persistent market trends dominate, passive strategies remain preferable and Sharpe ratio are persistently negative. Robustness checks further confirm that the effectiveness of mean reversion trading is highly dependent on the precise statistical environment, reinforcing the importance of filter calibration. This paper is organized as follows: the first section provides an overview of currency futures trading, with particular attention to the U.S. dollar, and introduces the econometric techniques used to construct the trading strategy. The second section outlines the methodological framework and the dataset construction, while the final section presents a detailed discussion of the results and robustness checks, highlighting both the potential and the limitations of rule-based timing approaches.

1. Currency trading and mean reversion

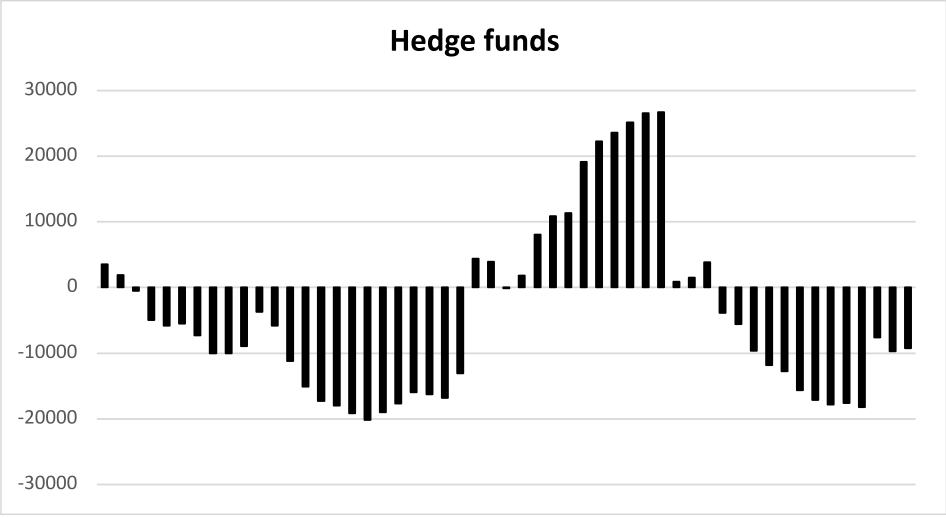
Currency transactions constitute one of the largest financial markets globally, with daily turnover exceeding five trillion dollars. 40% of these transactions are spot and over the counter, without a centralized market, while the 60% is represented by derivatives transactions. Financial institutions can operate for their clients as intermediaries or assume own positions for hedging and speculation activities. Figures 1 and 2 show net exposures of asset managers and hedge funds to the dollar index (USDX) future in 2024, tradable on the ICE market. It measures the value of the U.S. dollar relative to a basket of six major foreign currencies. Established in 1973 after the collapse of the Bretton Woods system, it serves as a benchmark for assessing the dollar's strength in global markets. The index is calculated using a weighted geometric average, with the euro (57.6%) holding the largest share, followed by the Japanese yen (13.6%), British pound (11.9%), Canadian dollar (9.1%), Swedish krona (4.2%), and Swiss franc (3.6%). According to figure 1, in 2024 traders' trust in dollar gradually increased until the end of the year, although the net exposure remained positive for almost the whole period.

Figure 1 - Weekly asset managements net exposure on dollar index in million dollars in 2024. Every bar is the difference between long and short exposure



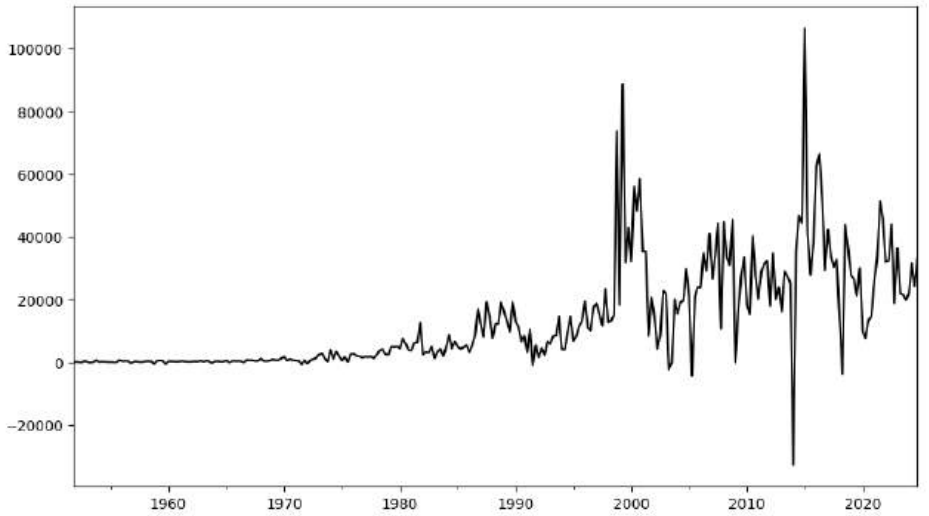
Hedge fund activity has instead mostly speculative purpose, and the figure 2 shows that the total net position was negative for a big part of the 2024. An increasing net exposure suggests improvements in traders' forecast, while a decreasing one reveals a deterioration.

Figure 2 - Weekly hedge funds' net exposure on dollar index in million dollars in 2024. Every bar is the difference between long and short exposure



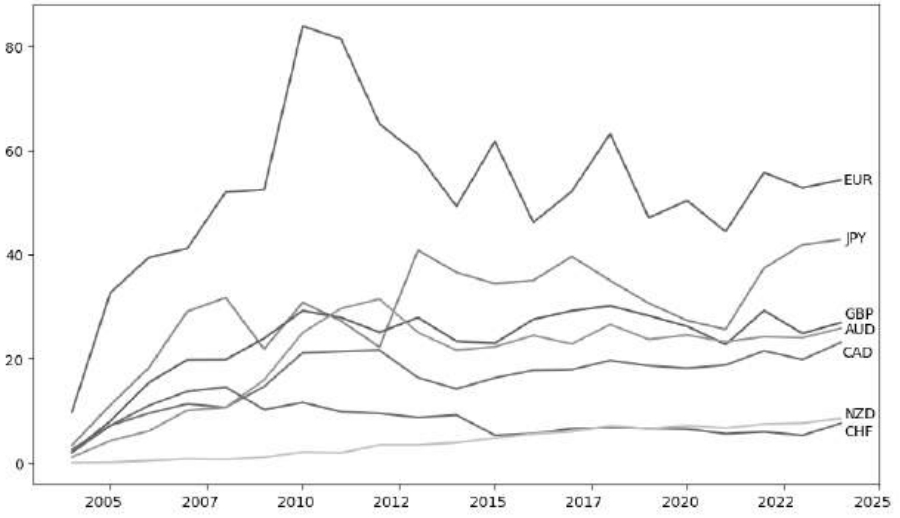
Futures were introduced in 1972 on the Chicago Mercantile Exchange (CME) in response to the increasing demand for standardized and liquid tools for currency speculation and risk transfer. Recent decades have witnessed dramatic growth in trading volume, reflecting the broad utility of futures contracts not only for directional bets, basis trades, and volatility arbitrage, but also as essential tools for hedging currency and market risk exposures: as shown in figure 3, from 70's, foreign investments in American assets started to gradually soar. Today markets offer opportunities to trade various currencies.

Figure 3 - Net foreign direct investments in U.S. assets adjusted for core inflation in million dollars - monthly datas from 1950 to 2025



The figure 4 is a representation of yearly volumes on futures used in this paper from 2004 to 2024, that is longest available dataset provided by the Chicago Mercantile Exchange. Future trades gradually increased for almost every currency, but the most massive use of them happened after the Great Financial Crisis.

Figure 4 - Volumes of major currency futures in million dollars - yealy datas from 2004 to 2025



1.1. Mean reversion

According to Defendi (2017) and Probo (2012), currencies are freely tradable assets whose value is determined by demand and supply, particularly by their attractiveness to investors. From a fundamental perspective, currencies offering higher interest rates tend to be more appealing to investors seeking portfolio returns. Equally important is the strength of the underlying economy: countries with controlled debt and deficit levels, together with low inflation, are generally preferred as they provide greater protection for investments. The balance of payments also plays a crucial role in shaping currency demand. A country that consistently imports more than it exports will typically experience downward pressure on its currency, potentially requiring corrective measures. Conversely, net exporters often benefit from maintaining a relatively weak currency, as this supports the competitiveness of their goods and services in international markets. Purchasing Power Parity (PPP) represents a foundational theory in international macroeconomics, positing that exchange rates should adjust in the long run to equalize price levels across countries. Empirical evidence, as reported by Taylor and Taylor (2002), highlights frequent and substantial short-term deviations driven by market frictions, monetary policies, and speculative flows. Nonetheless, over multi-year horizons, real exchange rates commonly exhibit mean reversion, supporting PPP as a long-run equilibrium condition and a benchmark for assessing persistent deviations. From an econometric perspective, Tsay (2013) argues that every weakly stationary and reversible stochastic process can be used to forecast future values. Weak stationarity implies that the expected value of a time series is constant (or a deterministic function of time), while the covariance depends only on the number of lags. When this condition is satisfied, the series is mean-reverting: prices fluctuate around a deterministic component after each shock. Weak stationarity is a common assumption for financial asset returns, but it is more difficult to verify for asset prices. Our objective is to isolate monthly tranches of currency futures prices in order to test stationarity and apply a

mean-reverting trading strategy. Figures 5 and 6 highlight a crucial distinction: mean reversion may respectively occur around a dynamic value, represented by a trend, or around a static value. The implication of mean reversion with trend is significant: if the time series is stationary, it will fluctuate around an increasing path rather than around a fixed constant. In this research both scenarios have been tested, but the strategy developed in section 3 assumes a static constant reference value for exploiting shocks.

Figure 5 - Example of fluctuations of a time series (the solid line) around a non-constant value (the dashed line)

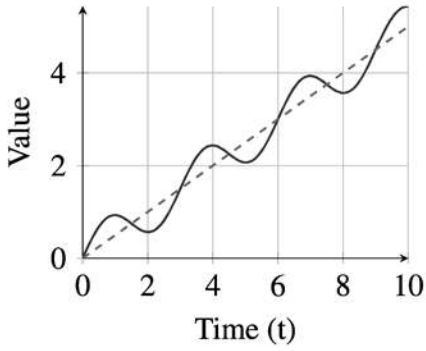
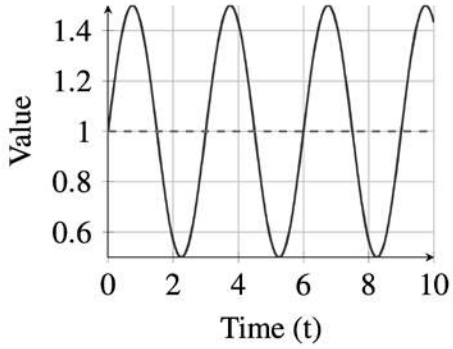


Figure 6 - Example of fluctuations of a generic time series (the solid line) around a constant mean (the dashed line)



The statistical tool employed to detect stationarity in this research is the Augmented Dickey–Fuller (ADF) test. Jorion and Sweeney (1996) document

strong evidence of mean reversion in the exchange rates between the U.S. dollar and sterling, and between sterling and the franc, using this test on the logarithm of real exchange rates. Lothian and Taylor (1997) also examine exchange rate behavior. In addition, the ADF procedure is widely applied in the finance literature to other securities and macroeconomic variables: for instance, Dehay and Leśkow (1996) and Lothian and Taylor (1997) investigate stock markets, while Ivanovski and Ivanovska (2024) focus on Gross Domestic Product. Finally, Basariya and Murugesan (2022) propose a framework for converting non-stationary time series into stationary ones, also using the ADF test. In this research, the specification of the ADF regression for the first difference of currency futures prices, Δp_t , without a deterministic trend is:

$$\Delta p_t = \alpha + \gamma p_{t-1} + \sum_{i=1}^{k} \phi_i \Delta p_{t-i} + \varepsilon_t \tag{1}$$

where $\Delta p_t = p_t - p_{t-1}$ denotes the first difference of the series p_t, used to remove potential trends or seasonality. The parameter α is the intercept, capturing any fixed mean in the differenced series. Under the null hypothesis of the ADF test, $\gamma = 0$, which indicates the presence of a unit root and therefore non-stationarity. The summation term $\sum_{i=1}^{k} \phi_i \Delta p_{t-i}$ includes lagged differences of the series up to order k. The parameter k represents the number of lags added to absorb short-run dynamics and eliminate autocorrelation in the residuals ε_t, which are assumed to be i.i.d. with zero mean and constant variance. The optimal lag length k is selected in this research using the Akaike–Schwarz information criterion. When a deterministic trend is included, equation 1 becomes:

$$\Delta p_t = \alpha + \beta t + \gamma p_{t-1} + \sum_{i=1}^{k} \phi_i \Delta p_{t-i} + \varepsilon_t \tag{2}$$

where βt represents the time trend component. This specification allows testing whether the series is stationary around a deterministic trend rather than a fixed mean.

2. Data and empirical strategy

Futures selected for this article are classified as 'major' by the (CME). They are traded in U.S. Dollars, representing following currencies: Euro (EUR), Japanese Yen (JPY), British Pound (GBP), Swiss Franc (CHF), Canadian Dollar (CAD), Australian Dollar (AUD), and New Zealand Dollar (NZD). The only one excluded is the Chinese Yuan, for two reasons: it is the only future whose settlement is not physical but in cash, and mainly because it is not denominated in U.S. Dollar. Daily data prices were downloaded from Yahoo Finance trough the python library "yfinance", with a time horizon from December, 1, 2009 to December, 31, 2024. Datas from December, 2009 are necessary to eventually apply the strategy from January, 2010. In this research, no distinction is made between in-sample and out-of-sample periods, as such an approach would require parameter optimization and the selection of the best performing parameter combination in-sample, followed by validation on out-of-sample data. Instead, a robustness analysis is conducted by testing a range of values for each parameter, allowing for the derivation of the distribution of net returns and standard deviations generated by the strategy for each asset.

2.1. Empirical strategy

The assumption made in this research to build the trading strategy is that currency rates exhibit local mean reversion episodes, which can be exploited through dynamic timing strategies rather than static hedging. The methodology is applied to each futures contract individually to assess performance contract by contract, the goal is not to build a currency portfolio. Each month, the strategy constructs two static price bands derived from the previous month's data, which serve to demarcate overbought and oversold zones. Given $\overline{C}_{t-1}$ the average closing price from the previous month, $(t-1)$, the upper barrier

and the lower one are calculated as following for the month t:

- $upper_t = \overline{C}_{t-1} + m\sigma_{t-1}$
- $lower_t = \overline{C}_{t-1} - m\sigma_{t-1}$

where σ_{t-1} is the standard deviation calculated on Close price time series of the previous month, $(t-1)$ and the parameter m is a multiplier applied to the standard deviation. Using volatility to build barriers in order to identify overbought and oversold areas is a technique also implemented by Carcano and Stefani (2005). In their study barriers served as trigger to buy and sell the underlying asset. To ensure that the trading strategy operates only after periods of statistically significant mean reversion, an Augmented Dickey-Fuller (ADF) test is performed each month on the previous month's price series. The bands and position rules described above are applied for month t only if the ADF test returns a p-value below a pre-determined significance threshold α; otherwise, no trades are executed for that month and the position remains flat. This filtering step prevents the strategy from trading in non-stationary regimes. The Augmented Dickey-Fuller test is executed in two different versions, including or not the presence of the trend, following equations 1 and 2. Both test specifications are evaluated to ensure robustness, as the presence or absence of a deterministic trend can materially affect the detection of mean-reverting regimes. The implementation therefore screens for mean reversion under alternative assumptions regarding the underlying price process. Trading activity is enabled in a given month only if at least one version of the test (with or without trend) returns a p-value below the threshold α.

This increases flexibility and avoids missing mean reverting windows due to incorrect trend specification. The strategy design is especially effective when the prior month exhibits predominantly flat price action, followed by sharp movements toward the end of the period. In such cases, the statistical bands anchored to stable averages and volatility are well calibrated to capture breakout events at month's end and systematically exploit the subsequent retracements when the strategy becomes active in the following month. Furthermore, since the two barriers are static, the strategy is expected to capture mean

reversion when prices fluctuate around a stable level, as illustrated in figure 6. The strategy opens and keeps a long position as long as the daily price is lower than the oversold barrier, while makes the opposite as long as the daily price stays above the overbought barrier. To ensure the reliability and practical significance of the findings, a comprehensive robustness check is conducted for all key model parameters. The following dimensions are systematically varied in a multidimensional grid:

- **Band multiplier** m: controls the width of the overbought/oversold barriers and thus the frequency and magnitude of trading signals.
- **ADF significance level** α: determines the strictness of mean reversion detection, trading off selectivity and coverage of active windows.
- **Transaction costs**: realistic commission, slippage, and bid-ask spread rates are included to account for execution frictions observed in currency futures markets.
- **ADF regression type**: both with and without deterministic trend, as discussed earlier, to ensure regime classification is not sensitive to trend specification.

For each combination of these parameters, the strategy is fully simulated over the entire data period. All performance indicators including compounded return, annualized volatility, and Sharpe ratio are computed for every grid point, both on the full sample and for active periods. This grid provides a stress test for the model, enabling transparent assessment of its sensitivity to variations in model specification and cost assumptions. Any time the strategy holds a long or short position, its performance is compared to a passive buy-and-hold benchmark on the corresponding future. All results are reported net of transaction costs, which are modeled as the sum of commission, slippage, and bid-ask spread per trade:

$$c_{tot} = \text{commission} + \text{slippage} + \text{spread} \tag{3}$$

For every unique combination of parameters within the robustness grid, we computed the total compounded net return, annualized volatility, and Sharpe ratio. The net compounded return is given by:

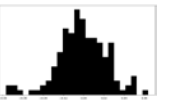
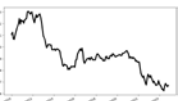
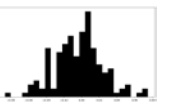
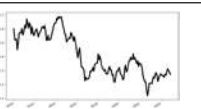
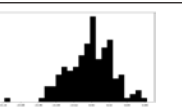
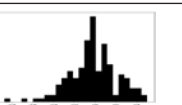
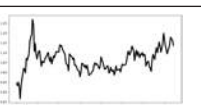
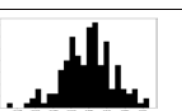
$$R_{\text{strategy, net}} = \prod_{t=1}^{n} (1 + r_t) \cdot (1 - c_{tot})^{N} - 1 \tag{4}$$

where r_t denotes the net daily log-return and N the total number of trading operations. The strategy extra return with respect to a buy-and-hold benchmark is calculated as:

$$\text{Extra Return} = R_{\text{strategy, net}} - R_{\text{benchmark}} \tag{5}$$

where $R_{\text{benchmark}}$ is the cumulative return from passively holding the same future over the entire sample. The buy-and-hold benchmark assumes a static position in the future contract over the entire sample period. All performance indicators (total compounded net return, volatility, Sharpe ratio) are reported both for the full period and for the statistically active windows to fully characterize the selective market timing behavior of the strategy. The analysis of portfolio performance is beyond the scope of this paper and is left for future research. It is important to note that the present approach is applied at the level of individual futures contracts, without any computation of aggregate portfolio volatility or currency exposure. All results are derived using trading signals based only on observable information available up to the day preceding the trading month. This ensures the elimination of look-ahead bias.

Table 1 - Descriptive statistics, monthly prices charts and returns distributions

Ticker	High	Low	Mean	Variance	Skewness	Kurtosis	Chart	Returns
EUR	1.483	0.961	-0.00177	0.00061	-0.34185	-2.15540		
JPY	0.013	0.006	-0.00329	0.00076	0.08302	-2.64327		
GBP	1.715	1.069	-0.00149	0.00066	-0.31267	-2.44304		
CAD	1.059	0.686	-0.00175	0.00052	-0.35406	-2.22750		
AUD	1.093	0.578	-0.00197	0.00108	0.13683	-2.41644		
CHF	1.399	0.861	0.00122	0.00079	-0.17706	-1.14238		
NZD	0.877	0.556	-0.00110	0.00124	-0.19496	-2.78117		

3. Empirical Results

This section presents a comprehensive assessment of the mean reversion timing strategy applied to major currency futures contracts. First of all, in the table 2 we reported a range of values for every parameter subject to robustness analysis. Every combination of these parameters was tested, reaching 1920 different combinations for every security, considering the twofold definition of mean reversion in the ADF equation. Every combination produces a result in terms of return, extra return, volatility and Sharpe ratio.

Table 2 - Parameter values tested in the robustness analysis

Parameter	Values
Commission	0.5% - 1.0% - 1.5% - 2.0%
Slippage	0.0% - 0.1% - 0.2%
Bid-ask spread	0.0% - 0.05% - 0.10% - 0.15% - 0.20%
Band multiplier ()	0.8 - 1.0 - 1.2 - 1.5
ADF significance threshold ()	1% - 2.5% - 5% - 10%

All risk and performance indicators are reported separately for the "full" sample (all days) and for "active" periods (windows where the mean reversion filter activates the strategy). Let $r_{s,t}$ and $r_{b,t}$ be the daily log-returns of the strategy and benchmark, with T_{full} days total and T_{active} days in which the strategy is active ($\mathcal{A}$). The annualized volatility are computed as:

$$\sigma_{s,full} = \sqrt{252} \cdot Std(r_{s,1},..., r_{s,T_{full}}) \quad (6)$$

$$\sigma_{s,active} = \sqrt{252} \cdot Std(r_{s,t}: t \in \mathcal{A}) \quad (7)$$

$$\sigma_{b,full} = \sqrt{252} \cdot Std(r_{b,1},..., r_{b,T_{full}}) \quad (8)$$

$$\sigma_{b,active} = \sqrt{252} \cdot Std(r_{b,t}: t \in \mathcal{A}) \quad (9)$$

with $Std(x_1, ..., x_T) = \sqrt{\frac{1}{T}\sum_{t=1}^{T}(x_t - \overline{x})^2}$, and $\overline{x}$ denoting the arith-

metic mean. Volatility indicators are computed using the population standard deviation (divisor T); given the large sample size, the difference with the sample estimator $(T-1)$ is negligible. The corresponding annualized Sharpe ratio are:

$$SR_{s,\,full} = \frac{\overline{r_{s,\,full}}}{Std\,(r_{s,t})} \cdot \sqrt{252} \tag{10}$$

$$SR_{s,\,active} = \frac{\overline{r_{s,\,active}}}{Std\,(r_{s,t}{:}\,t \in \mathcal{A})} \cdot \sqrt{252} \tag{11}$$

$$SR_{b,\,full} = \frac{\overline{r_{b,\,full}}}{Std\,(r_{b,t})} \cdot \sqrt{252} \tag{12}$$

$$SR_{b,\,active} = \frac{\overline{r_{b,\,active}}}{Std\,(r_{b,t}{:}\,t \in \mathcal{A})} \cdot \sqrt{252} \tag{13}$$

where $\overline{r_{s,\,full}}$ and $\overline{r_{b,\,full}}$ are the mean daily returns over the full sample, while $\overline{r_{s,\,active}}$ and $r_{b,\,active}$ are the mean daily returns over active periods only. For each contract and for each indicator (total compunded net return, extra return, volatility, and Sharpe ratio) we reported the minimum, maximum, mean, median, the 25th percentile and 75th percentile, both for the full period and restricted to active periods. Tables 3 and 4 have a difference: the Augmented Dickey-Fuller method, since in the first one the implemented regression does not include the trend.

Comparing the benchmark with the average values of the distributions for each indicator, starting from the Australian Dollar (AUD), both the full sample and active window Sharpe ratio of the strategy are clearly negative (mean: -0.1245 and -0.2991, respectively), performing worse than the already negative benchmark values (-0.2248 and -0.2284). While the strategy offers somewhat reduced volatility in the active window (7.84%) versus the benchmark (10.16%), this does not translate into improved risk adjusted returns. The British Pound (GBP) provides a marked exception, with the strategy delivering substantially higher Sharpe ratio both for the full sample (0.2157) and active periods (0.4620) compared to the benchmark (full:

−0.1882, active: 0.0578). The lower active-period volatility of the strategy (5.82%) versus the benchmark (8.59%) further highlights the efficacy of the rule-based approach in this case. For the Canadian Dollar (CAD), the strategy outperforms the benchmark in terms of risk adjusted returns, with both full and active-period Sharpe ratio (mean: 0.0484 and 0.1040) exceeding those for buy-and-hold (mean: −0.2772 and −0.5689). Active volatility is always lower for the strategy, confirming a modest benefit from systematic timing. Conversely, the Euro (EUR) retains negative Sharpe ratio for both strategy and benchmark, across full and active periods. While the active volatility of the strategy (6.15%) is marginally below that of the benchmark (7.99%), this does not suffice to generate positive Sharpe values. The Japanese Yen (JPY) produces negligible or slightly positive Sharpe ratio for the strategy (mean: 0.0367 full, 0.0777 active), yet these remain comparable to or only marginally better than those of the benchmark (full: −0.3720, active: 0.2737). Volatility relief is observed in the active periods (7.02% for the strategy versus 8.81% for the benchmark). The New Zealand Dollar (NZD) demonstrates robust outperformance: the strategy's Sharpe ratio (mean: 0.5062 full, 1.2790 active) are meaningfully higher than the benchmark (full: −0.1508, active: −0.2871), and active window volatility is noticeably lower for the strategy (8.04%) compared to buy-and-hold (11.74%). For the Swiss Franc (CHF), Sharpe ratio are generally negative for both strategies, but the rule-based approach manages to achieve lower volatility during activation (6.37%) than the benchmark (9.96%), though positive risk adjusted performance remains elusive.

Table 3 - Rows summarize six statistics (Min, 25th, Median, Mean, 75th, Max) for each measure. "Stat" indicates the statistic. For each ticker: R_{net} is the total compounded net return of the strategy; X is the "extra return" (strategy minus benchmark); $\sigma_{s,f}$ is the annualized volatility of the strategy over the full sample, $\sigma_{s,a}$ is the annualized volatility of the strategy over active windows, $\sigma_{b,f}$ is the annualized volatility of the benchmark over the full sample, $\sigma_{b,a}$ is the annualized volatility of the benchmark over active windows. $SR_{s,f}$ and $SR_{s,a}$ are the annualized Sharpe ratios of the strategy for full and active windows, respectively; $SR_{b,f}$ and $SR_{b,a}$ are the annualized Sharpe ratios of the benchmark for full and active windows.

Ticker	Stat	R_{net}	X	$\sigma_{s,f}$	$\sigma_{s,a}$	$\sigma_{b,f}$	$\sigma_{b,a}$	$SR_{s,f}$	$SR_{s,a}$	$SR_{b,f}$	$SR_{b,a}$
AUD	Min	-15,91%	-23,89%	2,52%	6,85%	10,85%	9,96%	-0,2263	-0,6246	-0,2248	-1,1318
	25th	-9,81%	-15,49%	3,02%	7,39%		10,04%	-0,1775	-0,4254		-0,3716
	Median	-8,07%	-7,46%	3,42%	7,88%		10,17%	-0,1297	-0,2932		-0,0051
	Mean	-7,47%	-5,78%	3,38%	7,84%		10,16%	-0,1245	-0,2991		-0,2284
	75th	-4,44%	1,47%	3,71%	8,24%		10,29%	-0,0822	-0,2016		0,1381
	Max	-0,26%	16,66%	4,24%	8,66%		10,36%	0,0050	0,0096		0,2283
GBP	Min	4,16%	-7,67%	2,21%	4,92%	9,06%	8,49%	0,1365	0,2538	-0,1882	-0,1660
	25th	5,95%	2,43%	2,61%	5,55%		8,50%	0,1773	0,3910		-0,0163
	Median	7,38%	5,50%	2,76%	6,01%		8,54%	0,2132	0,4701		0,0418
	Mean	7,78%	4,50%	2,75%	5,82%		8,59%	0,2157	0,4620		0,0578
	75th	9,15%	9,72%	2,90%	6,22%		8,63%	0,2542	0,5521		0,1160
	Max	14,69%	12,61%	3,36%	6,57%		8,78%	0,3302	0,6987		0,3138
CAD	Min	-3,72%	2,87%	1,55%	4,63%	7,67%	7,64%	-0,1071	-0,2922	-0,2772	-0,8545
	25th	-1,01%	6,94%	1,86%	5,15%		7,76%	-0,0004	-0,0009		-0,6843
	Median	0,79%	9,94%	2,01%	5,37%		7,94%	0,0550	0,1300		-0,5517
	Mean	0,95%	11,13%	2,20%	5,43%		7,91%	0,0484	0,1040		-0,5689
	75th	2,66%	13,33%	2,47%	5,70%		8,09%	0,1009	0,2704		-0,4363
	Max	7,96%	25,91%	3,22%	6,45%		8,11%	0,1857	0,4318		-0,3179

Ticker	Stat	R_{net}	X	$\sigma_{s,f}$	$\sigma_{s,a}$	$\sigma_{b,f}$	$\sigma_{b,a}$	$SR_{s,f}$	$SR_{s,a}$	$SR_{b,f}$	$SR_{b,a}$
EUR	Min	-15,32%	-6,69%	2,14%	5,30%	8,43%	7,82%	-0,4410	-1,1088	-0,2573	-0,5943
	25th	-10,13%	-0,58%	2,50%	5,83%		7,95%	-0,2473	-0,5849		-0,5690
	Median	-6,69%	4,20%	2,76%	6,21%		8,02%	-0,1640	-0,3951		-0,5168
	Mean	-7,16%	3,30%	2,77%	6,15%		7,99%	-0,1750	-0,4083		-0,4861
	75th	-4,00%	6,42%	3,00%	6,53%		8,06%	-0,0952	-0,1972		-0,4339
	Max	0,43%	10,16%	3,49%	6,90%		8,11%	0,0154	0,0293		-0,3163
JPY	Min	-10,25%	-22,50%	2,07%	5,57%	9,40%	8,51%	-0,1949	-0,4708	-0,3720	0,0137
	25th	-4,38%	-11,40%	2,67%	6,70%		8,74%	-0,0593	-0,1543		0,1482
	Median	0,72%	-6,63%	3,05%	7,29%		8,85%	0,0477	0,1049		0,2873
	Mean	0,10%	-7,25%	2,99%	7,02%		8,81%	0,0367	0,0777		0,2737
	75th	4,01%	-1,37%	3,29%	7,49%		8,92%	0,1221	0,2727		0,4128
	Max	11,84%	4,67%	3,69%	7,91%		9,03%	0,2763	0,6368		0,5064
NZD	Min	14,16%	19,00%	2,13%	6,02%	11,29%	11,58%	0,3376	0,7148	-0,1508	-0,3564
	25th	19,89%	25,60%	2,99%	7,37%		11,69%	0,4240	1,0020		-0,3016
	Median	25,20%	29,49%	3,34%	8,29%		11,77%	0,4928	1,1580		-0,2743
	Mean	24,52%	29,53%	3,32%	8,04%		11,74%	0,5062	1,2790		-0,2871
	75th	29,19%	33,30%	3,77%	8,67%		11,83%	0,5677	1,5090		-0,2599
	Max	35,24%	39,82%	4,39%	9,38%		11,85%	0,7599	2,1826		-0,2435
CHF	Min	-14,19%	-6,67%	1,98%	5,43%	10,01%	9,61%	-0,3128	-0,7202	0,0923	-0,4981
	25th	-9,56%	-3,36%	2,52%	5,97%		9,75%	-0,2205	-0,5579		-0,4445
	Median	-8,07%	0,99%	2,87%	6,38%		9,85%	-0,2061	-0,4794		-0,3977
	Mean	-8,22%	1,42%	2,81%	6,37%		9,96%	-0,1889	-0,4433		-0,3877
	75th	-6,57%	5,80%	3,09%	6,76%		10,06%	-0,1570	-0,3197		-0,3410
	Max	-2,64%	11,13%	3,56%	7,09%		10,53%	-0,0537	-0,1071		-0,2575

Table 4 - Rows summarize six statistics (Min, 25th, Median, Mean, 75th, Max) for each measure. "Stat" indicates the statistic. For each ticker: R_{net} is the total compounded net return of the strategy; X is the "extra return" (strategy minus benchmark); $\sigma_{s,f}$ is the annualized volatility of the strategy over the full sample, $\sigma_{s,a}$ is the annualized volatility of the strategy over active windows, $\sigma_{b,f}$ is the annualized volatility of the benchmark over the full sample, $\sigma_{b,a}$ is the annualized volatility of the benchmark over active windows. $SR_{s,f}$ and $SR_{s,a}$ are the annualized Sharpe ratios of the strategy for full and active windows, respectively; $SR_{b,f}$ and $SR_{b,a}$ are the annualized Sharpe ratios of the benchmark for full and active windows.

Ticker	Stat	R_{net}	X	$\sigma_{s,f}$	$\sigma_{s,a}$	$\sigma_{b,f}$	$\sigma_{b,a}$	$SR_{s,f}$	$SR_{s,a}$	$SR_{b,f}$	$SR_{b,a}$
AUD	Min	9,38%	-3,27%	2,87%	7,25%	10,85%	10,75%	0,2915	0,6746	-0,2248	-0,0556
	25th	16,53%	4,89%	3,38%	7,93%		10,80%	0,3487	0,7442		0,1559
	Median	19,12%	11,13%	3,82%	8,42%		10,99%	0,3632	0,8048		0,2322
	Mean	20,35%	10,48%	3,79%	8,31%		11,04%	0,3777	0,8343		0,2373
	75th	24,10%	15,89%	4,14%	8,75%		11,23%	0,3843	0,9195		0,3135
	Max	35,70%	21,06%	4,74%	9,32%		11,43%	0,4923	1,0572		0,5403
GBP	Min	-3,25%	8,91%	1,80%	5,92%	9,06%	8,63%	-0,0607	-0,1635	-0,1882	-0,9472
	25th	0,39%	13,30%	2,35%	6,47%		8,65%	0,0266	0,0874		-0,8975
	Median	2,45%	18,09%	2,74%	6,86%		8,76%	0,0893	0,2283		-0,8354
	Mean	3,12%	17,97%	2,62%	6,85%		8,76%	0,0965	0,2440		-0,8185
	75th	4,71%	22,05%	2,94%	7,21%		8,86%	0,1497	0,4040		-0,7564
	Max	13,95%	29,92%	3,27%	7,51%		8,88%	0,2842	0,6381		-0,6560
CAD	Min	-13,64%	-40,41%	1,66%	4,78%	7,6 7%	6,78%	-0,3706	-0,9259	-0,2772	0,6206
	25th	-9,31%	-37,87%	1,97%	5,18%		6,87%	-0,2472	-0,6352		1,0115
	Median	-7,42%	-30,61%	2,15%	5,50%		6,93%	-0,2113	-0,4892		1,3035
	Mean	-7,13%	-27,29%	2,13%	5,46%		6,91%	-0,2081	-0,5259		1,2098
	75th	-4,52%	-18,55%	2,30%	5,73%		6,96%	-0,1343	-0,3805		1,5018
	Max	-1,93%	-9,83%	2,49%	6,01%		6,98%	-0,0677	-0,1944		1,6117

Ticker	Stat	R_{net}	X	$\sigma_{s,f}$	$\sigma_{s,a}$	$\sigma_{b,f}$	$\sigma_{b,a}$	$SR_{s,f}$	$SR_{s,a}$	$SR_{b,f}$	$SR_{b,a}$
EUR	Min	-5,12%	3,85%	1,80%	5,42%	8,43%	8,40%	-0,1245	-0,3421	-0,2573	-0,7540
	25th	-2,00%	7,21%	2,21%	6,05%		8,44%	-0,0366	-0,0972		-0,6188
	Median	1,10%	12,23%	2,48%	6,47%		8,46%	0,0543	0,1380		-0,5631
	Mean	1,14%	11,99%	2,50%	6,43%		8,50%	0,0501	0,1358		-0,5743
	75th	4,10%	15,11%	2,76%	6,83%		8,52%	0,1231	0,3260		-0,5186
	Max	9,38%	24,14%	3,29%	7,46%		8,70%	0,2449	0,7538		-0,4169
JPY	Min	-3,68%	-39,05%	1,95%	5,20%	9,40%	7,78%	-0,0474	-0,1004	-0,3720	0,6564
	25th	0,86%	-30,98%	2,66%	6,06%		8,29%	0,0498	0,0975		0,9824
	Median	3,58%	-23,00%	3,10%	6,55%		8,48%	0,1077	0,2331		1,1835
	Mean	5,08%	-23,18%	2,97%	6,43%		8,31%	0,1619	0,3976		1,1229
	75th	9,38%	-15,01%	3,26%	6,83%		8,50%	0,2156	0,4904		1,3240
	Max	20,33%	-5,22%	3,79%	7,08%		8,50%	0,5378	1,4440		1,4684
NZD	Min	-29,31%	-48,62%	3,14%	7,96%	11,29%	11,51%	-0,5432	-1,1626	-0,1508	0,1194
	25th	-26,59%	-41,61%	3,71%	8,49%		11,60%	-0,4543	-0,9862		0,2954
	Median	-23,87%	-38,19%	4,06%	8,96%		11,69%	-0,4075	-0,8841		0,3757
	Mean	-22,21%	-37,54%	4,05%	9,00%		11,73%	-0,3965	-0,8823		0,3410
	75th	-17,80%	-33,11%	4,39%	9,54%		11,82%	-0,3367	-0,7603		0,4214
	Max	-12,81%	-27,28%	5,02%	10,13%		12,04%	-0,2519	-0,6601		0,4933
CHF	Min	-5,58%	-26,02%	2,35%	5,94%	10,01%	9,02%	-0,1184	-0,3171	0,0923	0,1977
	25th	-4,15%	-20,61%	2,82%	6,62%		9,12%	-0,0660	-0,1554		0,2318
	Median	-2,44%	-14,03%	3,13%	7,12%		9,17%	-0,0321	-0,0718		0,4009
	Mean	-2,74%	-15,03%	3,11%	7,07%		9,25%	-0,0423	-0,1064		0,4066
	75th	-1,79%	-9,10%	3,37%	7,56%		9,30%	-0,0130	-0,0303		0,5757
	Max	0,96%	-6,16%	3,98%	8,35%		9,65%	0,0262	0,0509		0,6268

Including the trend in the ADF specification leads to different patterns across instruments. The Australian Dollar (AUD) now benefits from consistently positive strategy Sharpe ratio (mean: 0.3777 full, 0.8343 active), significantly above the benchmark (mean: −0.2248 full, 0.2373 active), with strategy volatility again lower in active periods (8.31% vs 11.04%). For the British Pound (GBP), the Sharpe ratio improvement persists, with averages modestly positive for the strategy (mean: 0.0965 full, 0.2440 active) versus negative for the benchmark (mean: −0.1882 full, −0.8185 active). Volatility in the active periods remains lower for the strategy. The Canadian Dollar (CAD) results reveal a major reversal, with strategy Sharpe ratio dropping notably below those of the benchmark, which reaches a mean of 1.2098 in active windows. Here, trend filtering appears to be counterproductive for the timing strategy. Similarly, the Euro (EUR) sees a substantial improvement, with the strategy transitioning from negative to positive Sharpe ratio (0.0501 full, 0.1358 active versus −0.2573 and −0.5743 for the benchmark), and experiencing reduced volatility during activations. For the Japanese Yen (JPY), the strategy's active Sharpe ratio remains positive (0.3976), but the benchmark now achieves superior performance (1.1229 active), indicating that simple buy-and-hold is more effective in this regime. The New Zealand Dollar (NZD) transitions to markedly negative Sharpe ratio for the strategy (−0.3965 full, −0,8823 active), with the benchmark now consistently outperforming in risk adjusted terms. Finally, the Swiss Franc (CHF) sees some improvement for the rule-based approach in active window Sharpe ratio but generally remains subdued for both strategies.

The relative merits of the market timing strategy with respect to volatility and Sharpe ratio are highly instrument and specification dependent. For certain contracts, particularly GBP, NZD, AUD, and EUR the timing rule can reduce risk and substantially improve risk adjusted returns compared to a buy-and-hold strategy, especially when the filter is restricted to mean reversion around a static mean. However, these results are not universal. For other contracts, notably CAD and JPY (when filtering by trend), the buy-and-hold

approach outpaces the rule-based strategy, and both volatility and Sharpe ratio advantages shift to the benchmark. A crucial methodological insight is that including a trend component in the mean reversion filter tends to worsen the results for the timing strategy. This aligns with the underlying logic of the approach: static, horizontal bands are designed to capture reversion toward a fixed mean, not a moving trend. Therefore, the strategy is most effective when market conditions actually support the key assumption of no persistent trend. These findings emphasize the need for careful, asset-specific calibration of mean reversion tests and activation rules to maximize the market timing edge, and underscore the importance of statistical regime identification for systematic trading.

4. Concluding remarks

This research has developed and empirically tested a systematic trading strategy that targets mean reversion regimes in major currency futures. The results provide a differentiated picture: while rule-based timing using dynamic price bands anchored to monthly averages outperforms passive buy-and-hold in certain contracts most notably for the New Zealand Dollar and British Pound under the intercept only ADF specification, the approach offers limited or even negative risk adjusted returns in others, such as the Australian Dollar and Euro, depending on the model parameters and activation windows. Crucially, the effectiveness of mean reversion trading depends both on the underlying statistical regime (stationarity versus trending behavior) and the selected ADF specification, underlining the necessity of precise filter calibration and instrument selection. Performance is robust only in those conditions where price series are demonstrably stationary and free of persistent trends; in trending or volatile periods, benchmark strategies remain advantageous. Robustness testing across alternative parameter sets and mean reversion definitions further reveals the conditional nature of the strategy's

success, highlighting that mean reversion signals can provide a practical basis for market timing, but not universally across all market regimes or instruments. Future research may explore adaptive variants using moving averages as reference levels, testing different rules for band construction, or integrating machine learning models to optimize activation and execution in real time (Pagnottoni and Spelta (2024)). The findings illustrate both the promise and the limitations of quantitative timing strategies in currency futures, establishing a clear foundation for further investigation into statistical filtering and robust empirical validation in diverse market conditions. In addition, future work could refine the mean reversion entry and exit logic, for instance by closing positions upon reaching an intermediate threshold such as the moving average, rather than maintaining trades until reversal signals occur. The mean reversion strategy described is most effective in environments where the preceding month has been largely flat, followed by sharp movements in the closing days. In these scenarios, subsequent retracements are systematically captured by the activated rule in the following month, highlighting the regime-dependent nature and practical value of statistical band-based timing. A further possible extension of this research would be to adopt an alternative validation approach by splitting the dataset into in-sample and out-of-sample periods, in order to assess the robustness of the results across different combinations of strategy parameters. Finally, it would also be of interest to apply the strategy to a portfolio of assets rather than to individual securities.

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