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Backtest

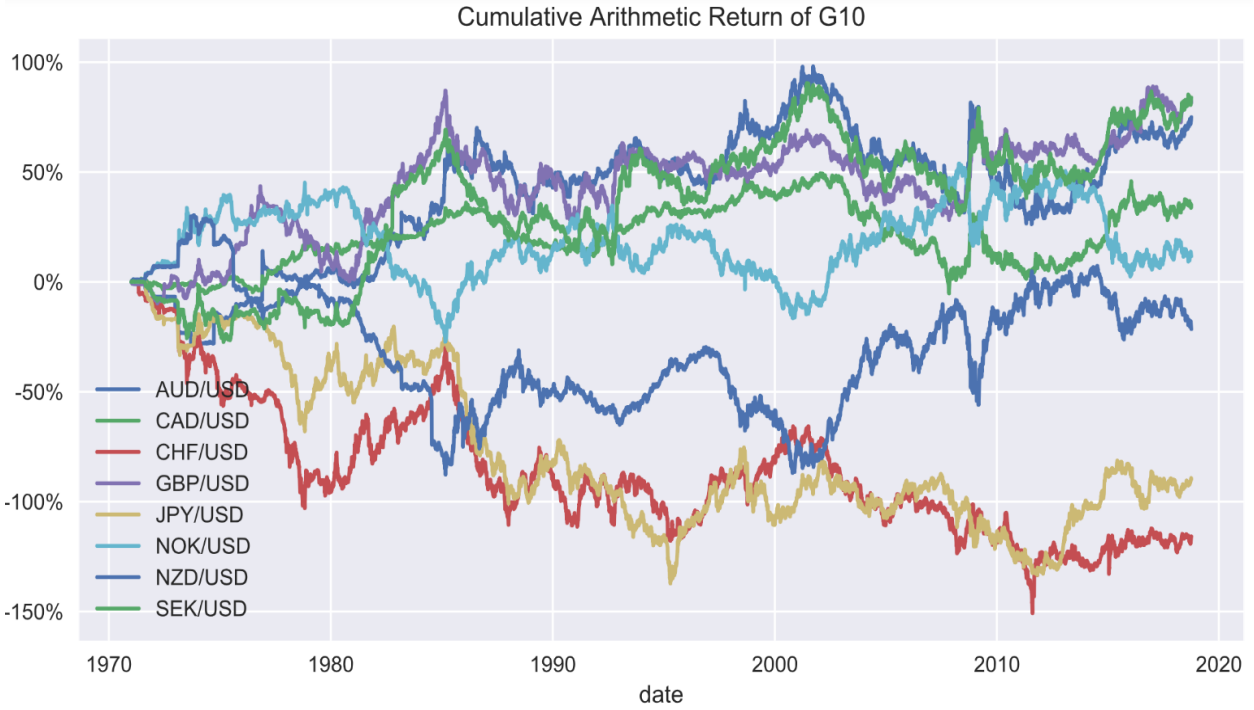
We backtest this trading strategy on three currency categories. They are G10 currencies, emerging market currencies and cryptocurrencies. We obtain the data from two websites by using their API, the FRED for fiat currency data and https://min-api.cryptocompare.com/ for cryptocurrency data.

The start of the backtest depends on the currency category. The earliest date for which data is available for all currencies of the category was used. According to the algorithm, the first 313 days are needed as a warm-up period where no trades are executed. The portfolio is rebalanced on every trading day.

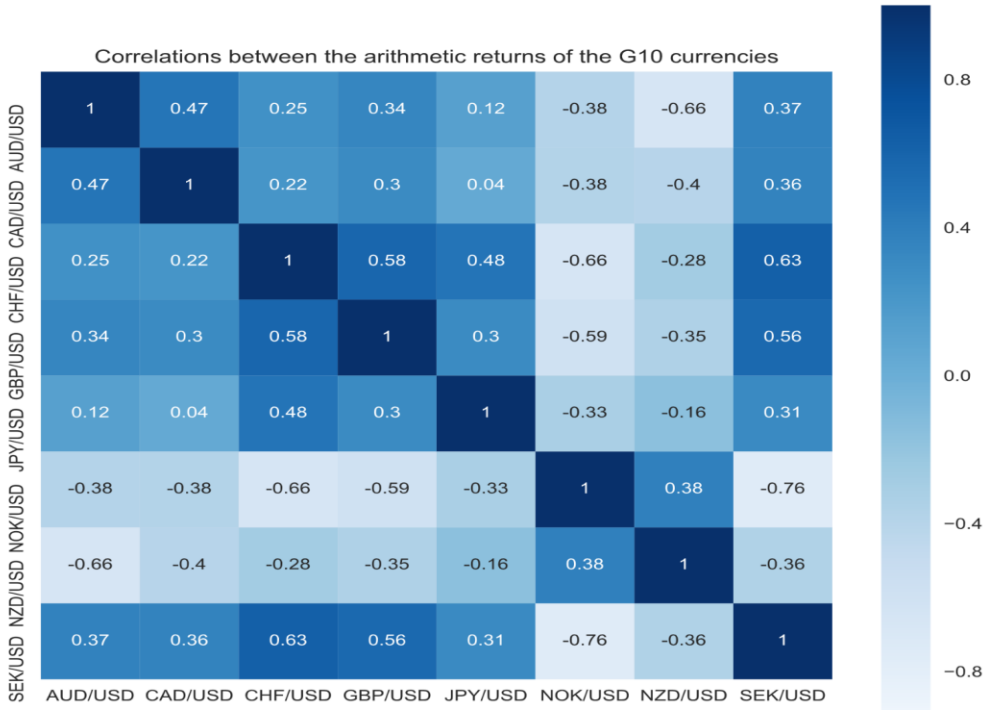
1. G10 Currencies

In this section, the trading strategy is used to perform a backtest on the G10 currencies. The data starts on 01/04/1974, and the pairs we used are CAD/USD, CHF/USD, GBP/USD, JPY/USD, NOK/USD, NZD/USD, and SEK/USD. We do not include the EUR/USD, because there are too many missing values.

The following picture shows the cumulative arithmetic return during the backtesting period. SEK/USD and GBP/USD have the highest cumulative return with 82% and 81% respectively. CHF/USD has the minimum return for -115%.



The following picture shows the correlations between the arithmetic returns of the G10 currencies.



There is a cluster of correlations all positive. NOK/USD and NZD/USD have negative correlations with other currencies while their correlation is positive. CFH/USD and SEK/USD have the largest

positive correlation with 0.63, and CHF/USD and NOK/USD have the largest negative correlation with -0.658.

	Time Series	Cross-sectional
Annualized Return	3.96%	6.55%
Annualized SD	0.0430	0.0605
Annualized SR (Rf=0%)	0.5367	0.5189

With the time series portfolio, an annualized return of 3.96% and an annualized Sharpe ratio of 0.5319 are achieved.

The cross-sectional portfolio achieved an annualized return of 6.55% and an annualized Sharpe ratio of 0.5189.

The annualized return of the cross-sectional portfolio is nearly two times the annualized return of the time series portfolio. On the other hand, the annualized standard deviation of the cross-sectional portfolio is much higher than time series portfolio. Hence, the Sharpe ratio of time series portfolio is slightly higher than cross-sectional portfolio.

The cumulative returns, daily arithmetic returns, and drawdowns of both portfolios can be seen in the following pictures.

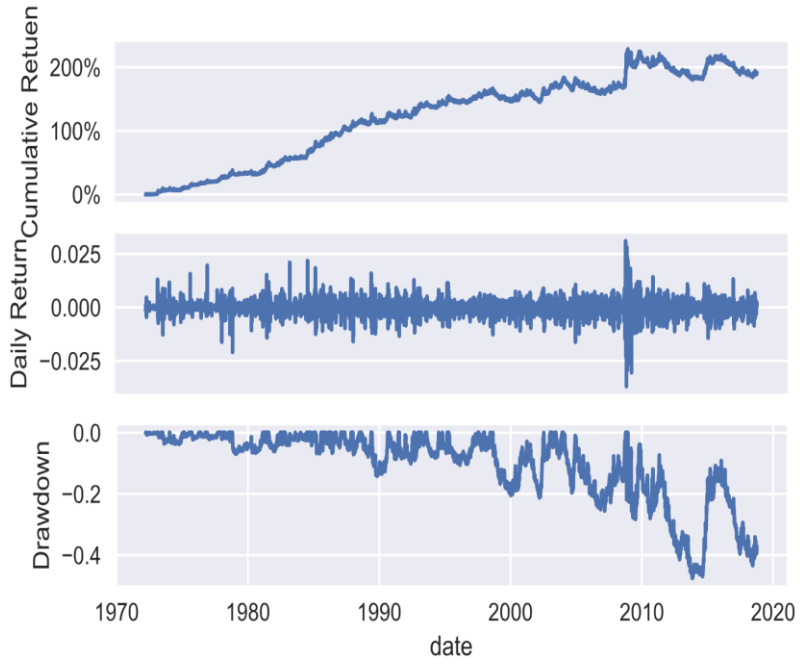


Figure X: Backtest for G10 currencies, time series portfolio

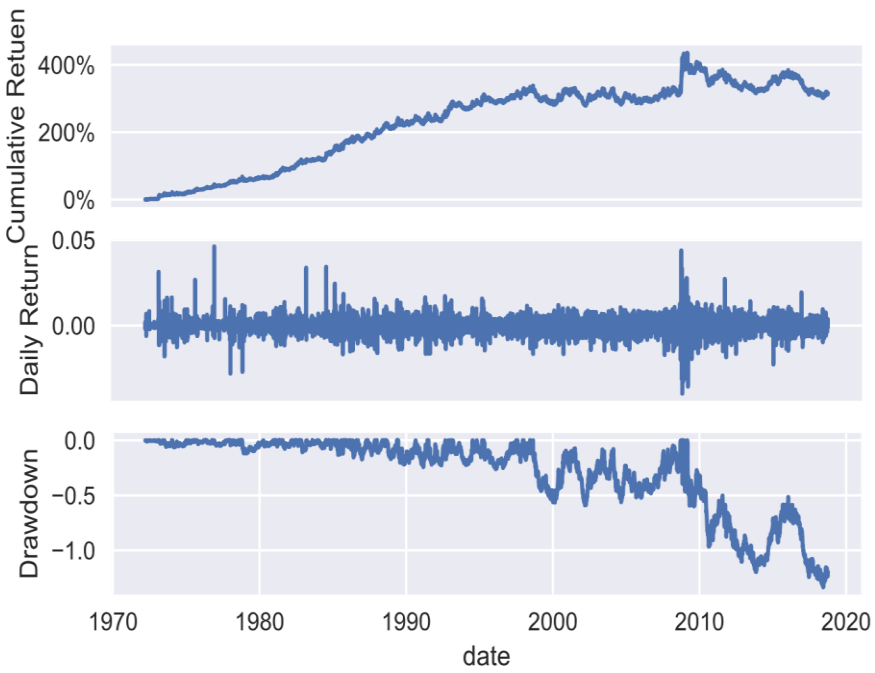


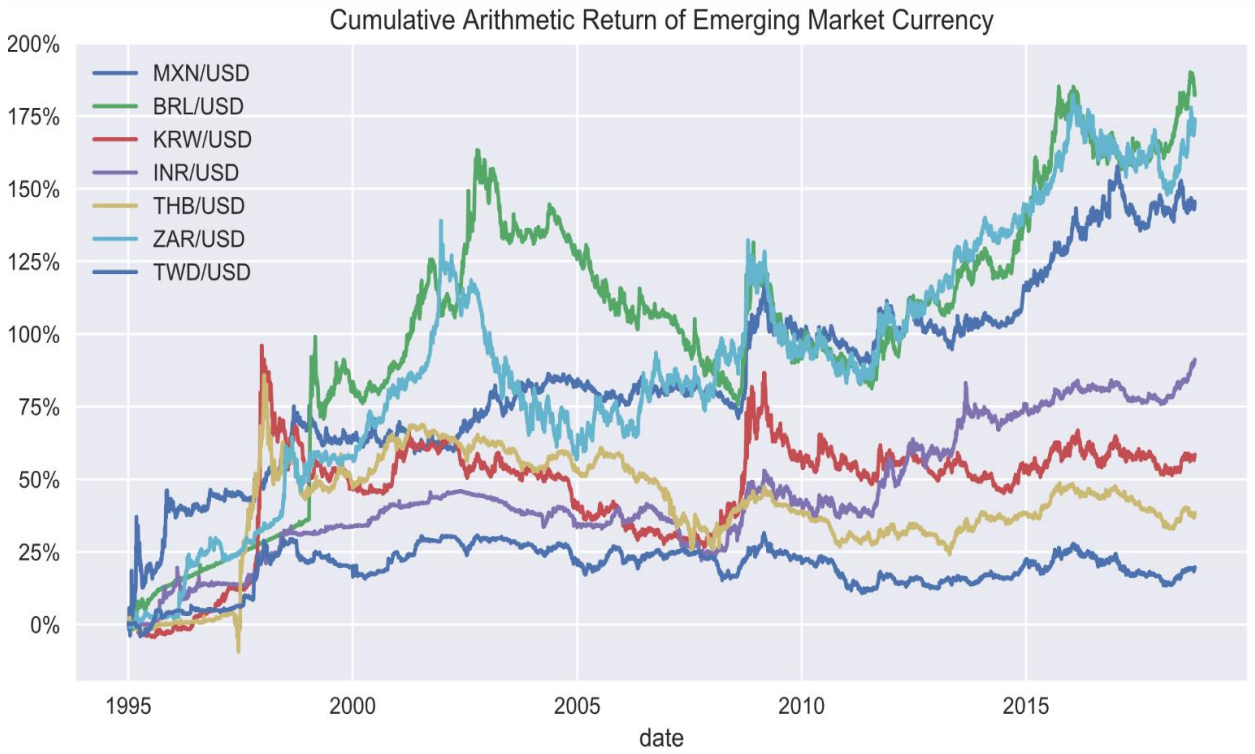
Figure X: Backtest for G10 currencies, cross-sectional portfolio

Overall we can say that cross-sectional portfolio can obtain higher return than time series portfolio, however, it also contains much higher risk. Because it has much larger drawdown and annualized standard deviation. So it is hard to say which portfolio works well, it depends on your to risk tolerance.

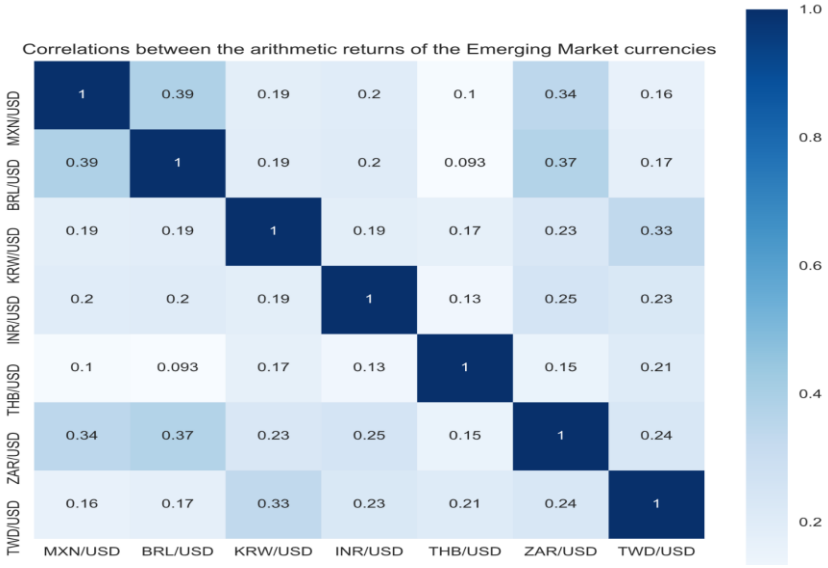
2. Emerging market currencies

In this section, a backtest is performed on emerging market currencies. These currencies are generally slightly more volatile than the G10 currencies. The data starts on 01/03/1995, and the pairs we used are BRL/USD, INR/USD, KRW/USD, MXN/USD, THB/USD, TWD/USD, ZAR/USD.

The following picture shows the cumulative arithmetic return during the backtesting period. BRL/USD and ZAR/USD have the highest cumulative return with 180% and 172% respectively. CHF/USD has the minimum return for 20%.



The following picture shows the correlations between the arithmetic returns of emerging market currencies.



All the correlations are positive and not very large. BRL/USD and MXN/USD have the largest correlation with 0.39. The correlations between THB/USD and other currencies are all small, and THB/USD and BRL/USD have the smallest correlation with 0.09.

	Time Series	Cross-sectional
Annualized Return	3.70%	1.16%
Annualized SD	0.0410	0.0435
Annualized SR (Rf=0%)	0.6718	0.2583

With the time series portfolio, an annualized return of 3.70% and an annualized Sharpe ratio of 0.6718 are achieved.

The cross-sectional portfolio achieved an annualized return of 1.16% and an annualized Sharpe ratio of 0.2583.

The annualized return of the time series portfolio is nearly three times the annualized return of the cross-sectional portfolio. Also, the annualized standard deviation of the cross-sectional portfolio is higher than time series portfolio. Hence, the Sharpe ratio of time series portfolio is much higher than cross-sectional portfolio.

The cumulative returns, daily arithmetic returns, and drawdowns of both portfolios can be seen in the following pictures.

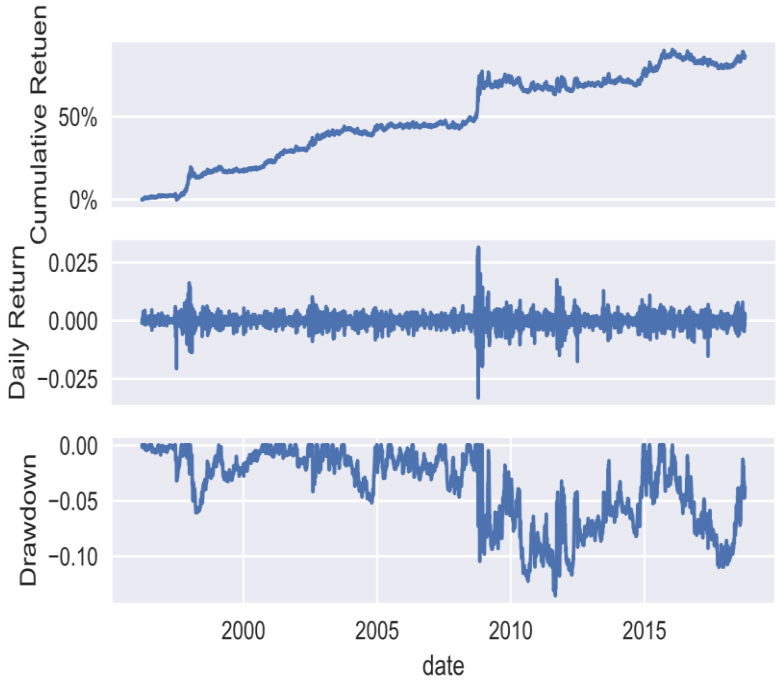


Figure X: Backtest for G10 currencies, time series portfolio

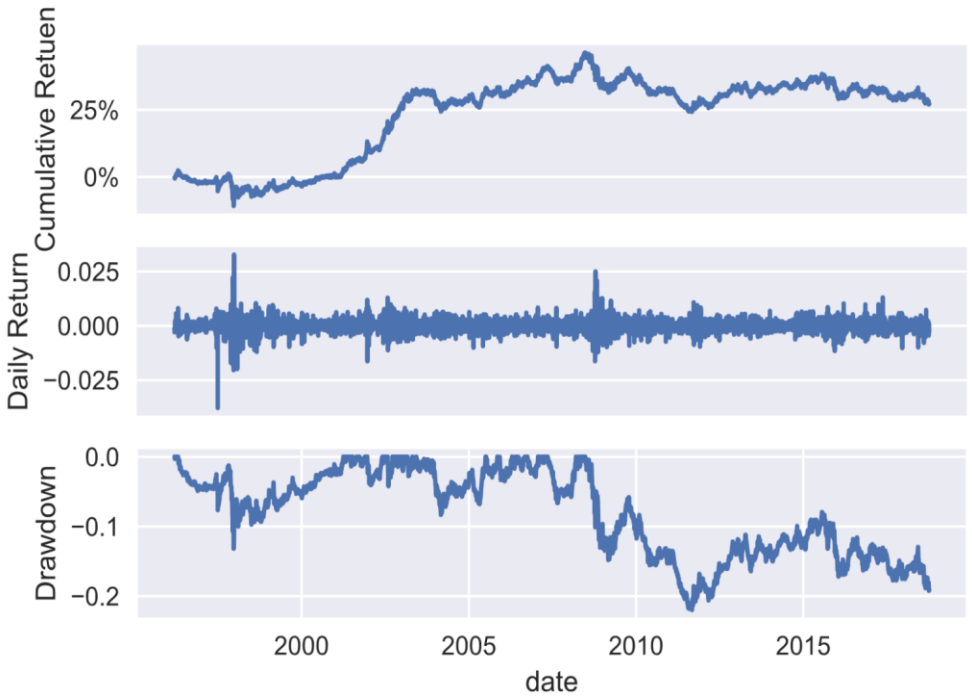


Figure X: Backtest for G10 currencies, cross-sectional portfolio

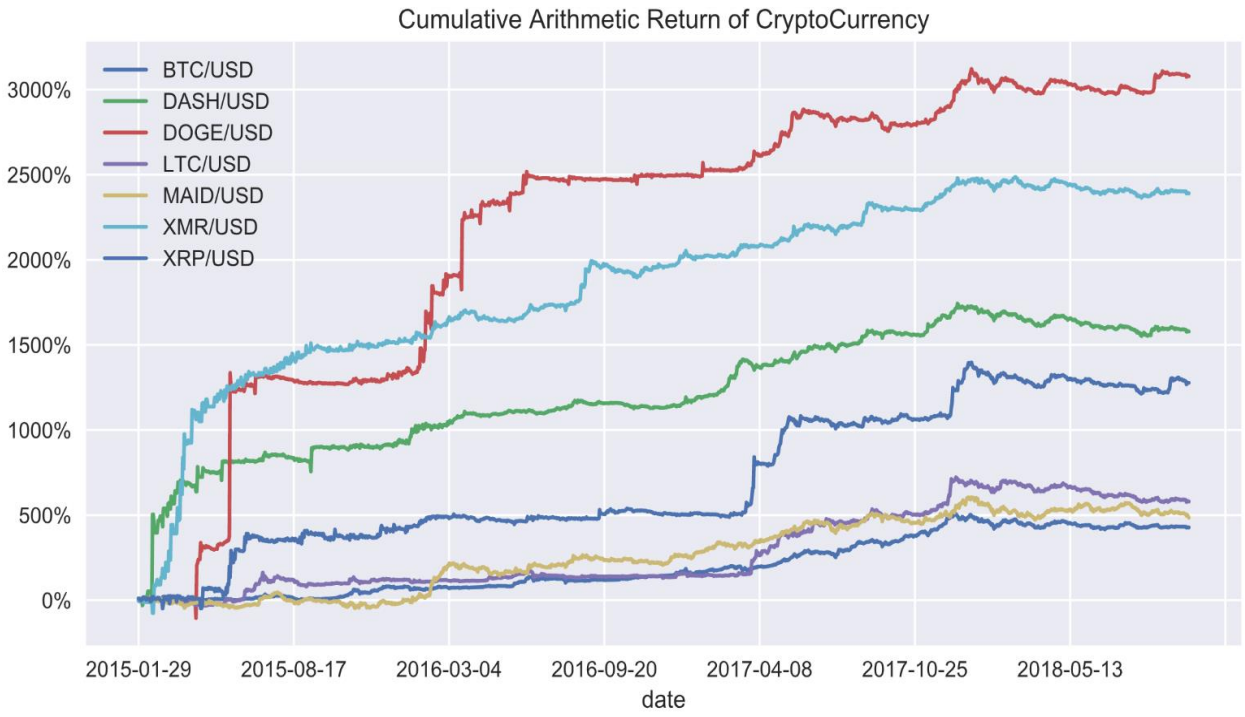
We conclude that the strategy worked well for the time series portfolio. It achieved higher return with lower risk. Thus, we need to choose time series portfolio for this strategy of emerging market currencies.

3. Cryptocurrencies

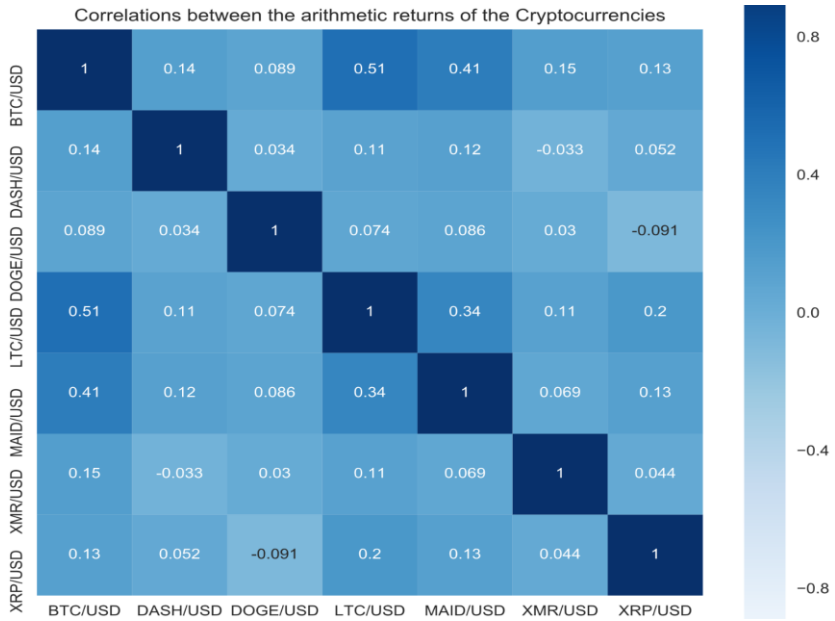
In this section, the trading strategy is used to perform a backtest on cryptocurrencies Since there are far fewer financial products for cryptocurrencies compared to the well-established fiat currencies, it is questionable whether it makes sense to apply a trading strategy to cryptocurrencies. It is difficult to short sell these currencies. However, we expect that cryptocurrency trading possibilities will grow for years to come. Hence it makes sense to consider the cryptocurrencies and to perform a backtest, even if it is just for curiosity's sake.

Since the cryptocurrencies can be traded even on weekends and bank holidays, a slight adjustment in the algorithm is necessary. The period for the moving standard deviations of algorithm have to be extended to 91 days and 365 days

The following picture shows the cumulative arithmetic return during the backtesting period. DOGE/USD has the highest cumulative return with 3064%. BTC/USD has the minimum return for 431%.



The following picture shows the correlations between the arithmetic returns of cryptocurrencies.



Only DOGE/USD and XRP/USD, and XMR/USD and XMR/USD and DASH/USD, have small negative correlation, others are all positive. LTC/USD and BTC/USD have the largest correlation with 0.51.

	Time Series	**Cross-sectional**

Annualized Return	296.26%	341.71%
Annualized SD	0.5779	0.5413
Annualized SR (Rf=0%)	1.7690	1.9381

With the time series portfolio, an annualized return of 296.26% and an annualized Sharpe ratio of 1.7690 are achieved.

The cross-sectional portfolio achieved an annualized return of 341.71% and an annualized Sharpe ratio of 1.9381.

The annualized return of the cross-sectional portfolio is higher than the annualized return of the time series portfolio. And, the annualized standard deviation of the cross-sectional portfolio is smaller than time series portfolio. Hence, the Sharpe ratio of cross-sectional portfolio is higher than time series portfolio.

The cumulative returns, daily arithmetic returns, and drawdowns of both portfolios can be seen in the following pictures.

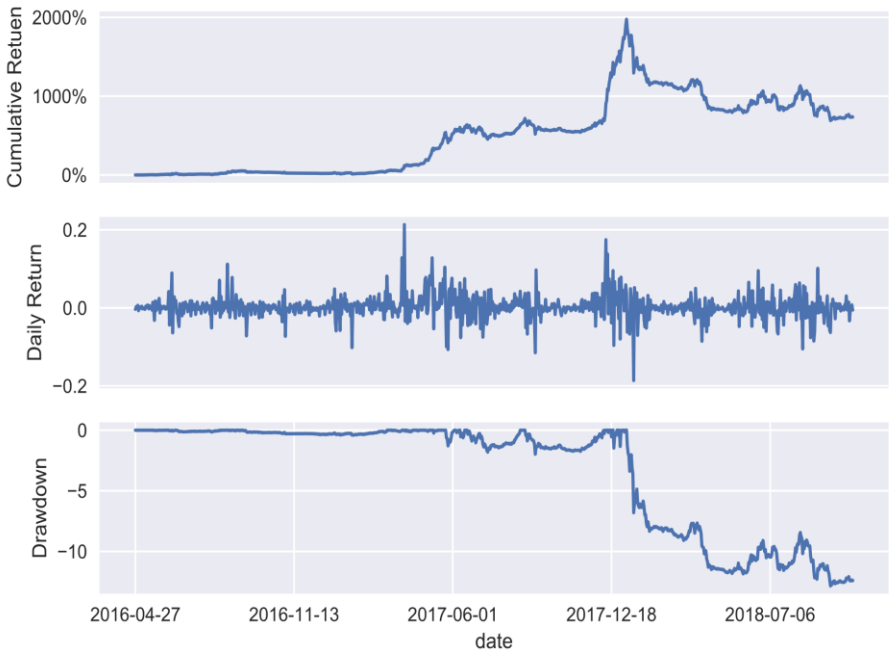


Figure X: Backtest for G10 currencies, time series portfolio

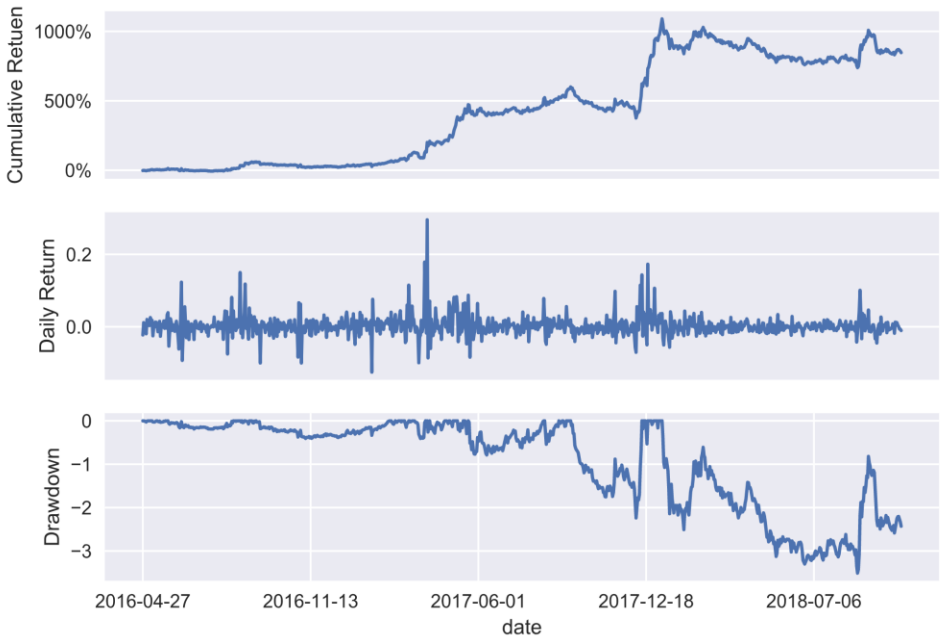


Figure X: Backtest for G10 currencies, cross-sectional portfolio

We conclude that the strategy worked well for the cross-sectional portfolio. It achieved higher return with lower risk. Thus, we need to choose cross-sectional portfolio for this strategy of cryptocurrencies.