# 1 Introduction

this is a LaTeX document

hello

| **Variable** | **Min** | $\mathbf{q_1}$ | $\widetilde{\mathbf{x}}$ | $\mathbf{q_3}$ | **Max** | $\bar{\mathbf{x}}$ |
|---|---|---|---|---|---|---|
| real_gdp_growth | -31.4 | 1.4 | 3.0 | 4.7 | 33.4 | 3.0 |
| inflation | -19.3 | 1.5 | 3.2 | 5.4 | 24.0 | 3.7 |
| tbill_yield | 0.6 | 3.9 | 5.7 | 7.7 | 15.3 | 6.0 |
| shiller_pe | 6.6 | 15.0 | 20.5 | 25.7 | 44.2 | 20.6 |
| consumer_confidence | 95.7 | 98.9 | 100.5 | 101.1 | 103.1 | 100.0 |
| mktcap_gdp_ratio | 0.0 | 0.1 | 0.1 | 0.1 | 0.2 | 0.1 |
| sp500_return | -20.4 | -1.2 | 1.0 | 2.8 | 12.0 | 0.6 |
| sp500_re3 | -31.1 | -1.7 | 2.4 | 6.2 | 25.9 | 2.0 |
| sp500_re6 | -37.8 | -2.4 | 4.5 | 9.9 | 38.0 | 4.0 |
| sp500_re12 | -42.5 | -0.8 | 9.7 | 18.3 | 52.7 | 8.0 |
| sp500_re60 | -32.6 | 9.4 | 45.4 | 70.4 | 213.9 | 46.1 |

Table 1: Summary of features

**hello** *hello test* hello world hello world what do you think is the future of the world

this is the future of our life

$$f(x) = (x+2)^3$$

$f(x) = x$

$$f(x) = x \tag{1}$$

$$1 + 1_2\,(hello) \tag{2}$$

$$\begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix}$$

| | | | |
|---|---|---|---|
| a | b | c | d |
| a | d | | c |

Table 2:

| | *Dependent variable:* |
|---|---|
| | bubble |
| real_gdp_growth | $-0.007$ |
| | (0.035) |
| inflation | $0.099^{***}$ |
| | (0.028) |
| tbill_yield | $0.237^{***}$ |
| | (0.073) |
| shiller_pe | $-0.658^{***}$ |
| | (0.058) |
| consumer_confidence | $-1.182^{***}$ |
| | (0.147) |
| mktcap_gdp_ratio | $216.592^{***}$ |
| | (18.361) |
| sp500_return | $-0.105^{***}$ |
| | (0.033) |
| sp500_re3 | 0.018 |
| | (0.022) |
| sp500_re6 | $-0.021$ |
| | (0.020) |
| sp500_re12 | $-0.143^{***}$ |
| | (0.016) |
| sp500_re60 | $0.075^{***}$ |
| | (0.006) |
| Constant | $106.314^{***}$ |
| | (13.641) |
| Observations | 1,112 |
| Log Likelihood | $-410.346$ |
| Akaike Inf. Crit. | 844.693 |
| *Note:* | $^{*}$p<0.1; $^{**}$p<0.05; $^{***}$p<0.01 |

| | Model | Sensitivity | Specificity | Balanced Accuracy |
|---|---|---|---|---|
| 1 | Logit-P | 0.727 | 0.721 | 0.724 |
| 2 | Logit-RW | 0.727 | 0.735 | 0.731 |
| 3 | RF-CV | 1 | 0.86 | 0.93 |
| 4 | RF-RW | 0.455 | 1 | 0.727 |
| 5 | RNN-BiLSTM-focal | 0 | 1 | 0.5 |

Table 3: The peformance of models

| | 0.005 | 0.01 | 0.015 | 0.05 |
|---|---|---|---|---|
| 3 | 0.67 | 0.88 | 0.84 | 0.85 |
| 5 | 0.95 | 0.95 | 0.83 | 0.86 |
| 6 | 1.00 | 0.93 | 0.88 | 0.84 |
| 7 | 0.95 | 0.95 | 0.89 | 0.80 |
| 12 | 0.89 | 0.85 | 0.96 | 0.86 |

Table 4: Balanced accuracy of RF-CV with different quantiles (column) and periods (row)