Equity Analysis
in the Wolfram Language

Part 1: Equities Entity Store

EntityStores

Somewhat incongruously for a functional programming language, WL incorporates a powerful object-oriented concept known as the *Entity Store*

- Details: https://reference.wolfram.com/language/ref/EntityStore.html
- An Entity Store appears at first to be only a partial implementation of the OO idea:
  - Entities have properties
  - No methods
- However, Entity Store "properties" can be functions, i.e. "methods"

EquitiesEntityStore

- Includes over 1,000 equity entities

- Stocks and stock indices

- Fundamental, technical and historical data

- Ideal for cross-sectional analysis

- Applications:

    - Portfolio construction

    - Statistical Arbitrage

Installation

```
Get[StringJoin[dirEntityStore, "EquitiesEntityStore.mx"]];
```

Typically you would register the store on all kernels, to enable parallelization:

In[ ]:=
```
task = Quiet@Table[ParallelSubmit[{i},
        {EntityUnregister[EquitiesEntityStore], $KernelID}], {i, Length@Kernels[]}];
WaitAll[task];
task = Table[ParallelSubmit[{i}, {EntityRegister[EquitiesEntityStore], $KernelID}],
    {i, Length@Kernels[]}];
WaitAll[task]
```

```
{{{"Equities"}, 1}, {{"Equities"}, 2}, {{"Equities"}, 3}, {{"Equities"}, 4}}
```

EquityStoreProperties

In[ ]:= `EntityList["Equities"] // Length`

Out[ ]=

1005

EquityIndices

In[ ]:= `EntityList[EntityClass["Equities", "Stock Indices"]]`

Out[ ]=

{ SP500 }

Stocks

Select a sample of individual equity entities:

In[ ]:= `selectedStocks =`

{ **APA** EQUITIES , **CTSH** EQUITIES , **CZR** EQUITIES , **DD** EQUITIES ,

FIVN EQUITIES , **HUBS** EQUITIES , **MPC** EQUITIES ,

PRU EQUITIES , **UMPQ** EQUITIES , **WMT** EQUITIES };

SelectIndexComponents

Often we want to define a universe of stocks for analysis that correspond to common index memberships, for example:

In[ ]:= `SelectIndexComponents[selectedStocks, "DOW30"]`

Out[ ]=

{ WMT }

In[ ]:= `SelectIndexComponents[selectedStocks, "SP500"]`

Out[ ]=

{ APA , CTSH , CZR , DD , MPC , PRU , WMT }

Selectby StartDate

When performing time series cross-sectional analysis we typically want to select subsets of stocks that were extant on or before specified dates:

In[ ]:= `EntityStartDate[#] & /@ selectedStocks`

Out[ ]=

{ Tue 2 Jan 1990 , Fri 19 Jun 1998 ,

Mon 22 Sep 2014 , Fri 1 Sep 2017 , Fri 4 Apr 2014 ,

Thu 9 Oct 2014 , Thu 23 Jun 2011 , Thu 13 Dec 2001 ,

Wed 18 Dec 1996 , Tue 2 Jan 1990 }

This is easy to accomplish in the WL operating on the Entity Store:

In[ ]:= `SelectEntitiesStartDateBefore[selectedStocks, {2001, 1, 1}]`

Out[ ]=

{ APA , CTSH , UMPQ , WMT }

EquityProperties

Each entity in the Equities Entity Store contains the following properties:

In[●]:= **WMT** EQUITIES ["Properties"]

Out[●]= { Company Information , Fundamentals , Historical Data ,

Index Memberships , Performance , Price-Volume }

CompanyInformation

We can use the company information to group equities by sector:

In[●]:= **WMT** EQUITIES ["Company Information"]

Out[●]=

⟨ | Symbol → NYSE:WMT, Exchange → NYSE,

Start Date → Tue 2 Jan 1990 00:00:00 GMT−5 ,

Company → Walmart , Sector → DiscountStores, SICCode → 5331 | ⟩

FundamentalInformation

The fundamental information property gives a limited snapshot of current fundamental data for the stock:

In[●]:= **WMT** EQUITIES ["Fundamentals"]

Out[●]=

⟨ | MarketCap → 3.8642×10^{11}, PERatio → 28.14,

EarningsPerShare → 5.0096, EBITDA → 35 286 000 000 | ⟩

However, a much more complete dataset of fundamental information is available, as properties of the Company entity:

In[●]:= **WMT** EQUITIES ["Company Information"]["Company"]["Properties"] // Short

Out[●]//Short=

{ accounts payable , accounts receivable ,

accumulated depreciation , additional paid in capital ,

address , amortization , assets turnover ,

beginning cash position , capital expenditures , cash ,

cash and cash equivalents , cash dividends paid ,

cash equivalents , cash flow from continuing financing activities ,

cash flow from continuing investing activities ,

cash flow from continuing operating activities ,

cash flow from discontinued operation ,

cash from discontinued financing activities ,

cash from discontinued investing activities ,

change in accrued expense , change in interest payable ,

change in inventory , change in payable , change in tax payable ,

change in working capital , change in cash and cash equivalents ,

change in receivables , city , common shares , common stock ,

common stock issuance , common stock payments ,

coordinates , corporate structure , cost of revenue ,

current accrued expenses , current assets , current debt ,

current liabilities , current notes payable , current ratio ,

deferred assets , deferred costs , deferred tax assets ,

defunct date , depreciation , depreciation amortization depletion ,

depreciation and amortization , earnings before interest and tax ,

earnings before interest tax depreciation and amortization ,

total employees , end cash position , entity classes ,

equity investments , financial health grade ,

financial leverage , ≪71≫ , position , postal code ,

predecessor companies , preferred stock ,

preferred stock dividends , preferred stock issuance ,

preferred stock payments , pre-tax income , profitability grade ,

purchase of business , purchase of equity securities ,

purchase of fixed maturity securities , purchase of intangibles ,

purchase of investment , purchase of long-term investments ,

purchase of properties plants and equipments ,

purchase of short-term investments , purchase of technology ,

research and development , retained earnings ,

revenue growth , revenue per employee , return on assets ,

return on equity , sales of business , sale of intangibles ,

sales of investment , sale of long-term investments ,

sales of properties plants and equipments ,

sales of short-term investments , sales of equity securities ,

sales of fixed maturity securities , selling and marking expense ,

selling general and administration , short-term debt issuance ,

short-term debt payments , status , stockholders equity ,

successor companies , tax provision , total assets , total debt ,

total deposits , total expenses , total investments , total liabilities ,

total non-current assets , total non-current liabilities , total revenue ,

total tax payable , trading liabilities , trading securities ,

treasury stock , unearned income , website , working capital }

IndexMemberships

In[ ]:= **WMT** EQUITIES **["Index Memberships"]**

Out[ ]=

⟨|DOW30 → True, SP500 → True, Russell 1000 → True|⟩

Price-VolumeInformation

In[ ]:= **WMT** EQUITIES **["Price-Volume"] // Dataset**

Out[ ]=

Volume	4 889 768
AverageVolume3Month	7 171 903.
AdjustedClose	140.97
High52Week	160.77
Low52Week	117.27
Average200Day	136.235
Average50Day	134.658
FractionalChange200Day	3.4758
FractionalChange50Day	4.68712
Volatility250Day	26.6432
Volatility50Day	19.7909
Volatility20Day	17.6923

HistoricalData

In[57]:= **WMT** EQUITIES `["Historical Data"]`

Out[57]=

⟨| Daily Prices → TimeSeries [
Time: 02 Jan 1990 to 31 Oct 2022
Data points: 8273
],

Data not in notebook. Store now →

Daily Returns → TimeSeries [
Time: 03 Jan 1990 to 31 Oct 2022
Data points: 8272
],

Monthly Prices → TimeSeries [
Time: 31 Jan 1990 to 31 Oct 2022
Data points: 394
],

Monthly Returns → TimeSeries [
Time: 31 Jan 1990 to 31 Oct 2022
Data points: 394
],

Monthly Performance →

TimeSeries [
Time: 31 Jan 1995 to 31 Oct 2022
Data points: 334
] |⟩

Data not in notebook. Store now →

Historical data associated with each entity includes daily/monthly price and returns series from Jan 2, 1990 (or the start date of the series, if later).

We can access historical data immediately for analysis, without requiring any data downloading or database retrieval:

In[ ]:= **WMT** EQUITIES `["Historical Data"]["Daily Returns"] // Histogram`

Out[ ]=
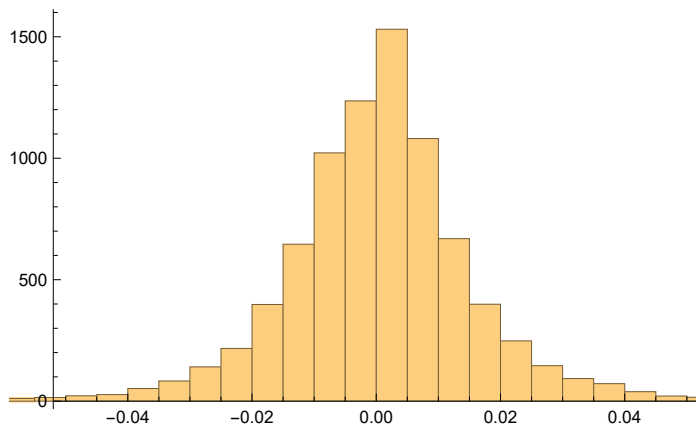
Of course, it is also easy to perform a combined analysis for equity entities in the WL, for instance:

In[ ]:= `Histogram[(#["Historical Data"]["Daily Returns"]) & /@ Take[selectedStocks, 3],`
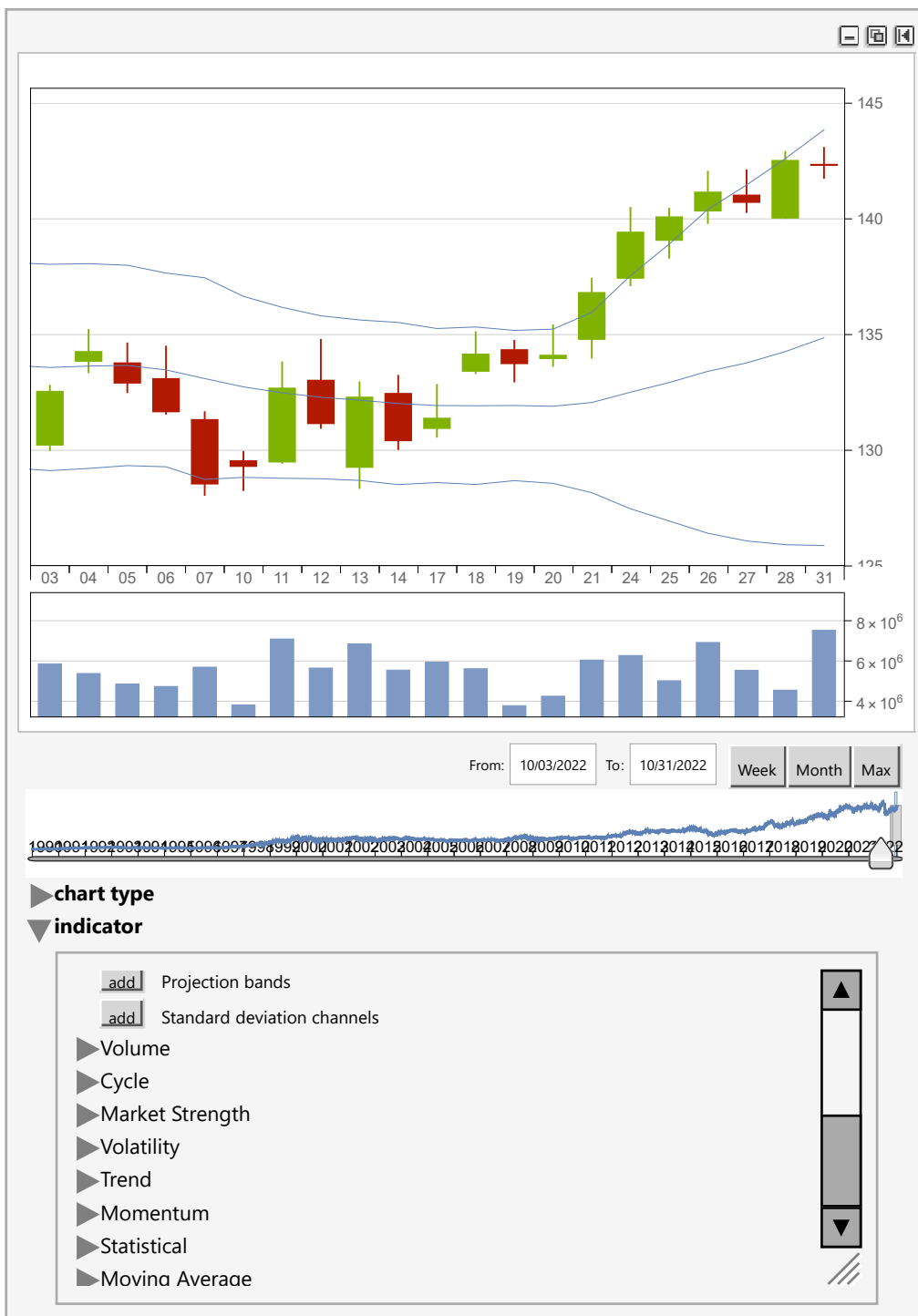`ChartLegends → Take[selectedStocks, 3]]`

Out[ ]=
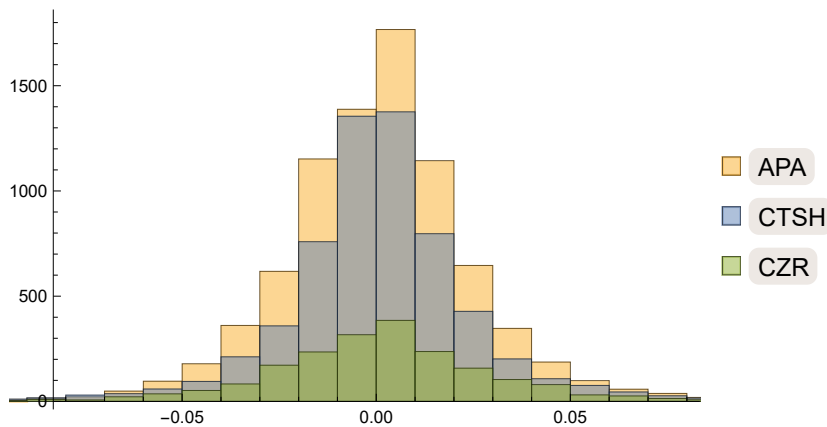
We can construct trading charts using the historical price series:

In[ ]:= **WMT** EQUITIES `["Historical Data"]["Daily Prices"] // InteractiveTradingChart`

Out[ ]=

PerformanceData

The information we have considered so far can be retrieved using the FinancialData function, albeit that it is presented in a much more convenient and rapidly accessible form in the Equities Entity Store.

However, the Performance property of equity entities contains a substantial amount of pre-computed information that is not directly available from Wolfram:

In[◦]:= `Dataset[` **WMT** EQUITIES `["Performance"], HeaderStyle → {Normal, Bold}, DatasetTheme →`

`{"AlternatingRowColumnBackgrounds", LightBlue, LightOrange}, MaxItems → {8, 14}]`

Out[◦]=

	Date	Period(ı	relPrice	SP500 Correla	AutoCorrelati	Total Ret
Inception	Wed 3 Jan 1990	394	3.57	0.52	0.259	3746.38
60–Months	Wed 1 Nov 2017	60	1.19	0.47	0.053	78.9
12–Months	Mon 1 Nov 2021	12	1.15	0.36	−0.045	−3.23
9–Months	Tue 1 Feb 2022	9	1.2	0.38	0.139	3.01
6–Months	Mon 2 May 2022	6	1.0	0.41	0.02	−6.22
3–Months	Mon 1 Aug 2022	3	1.15	0.59	0.031	8.25
1–Month	Mon 3 Oct 2022	1	1.02	0.69	−0.103	9.74

Most of the data items are self explanatory, but some require others elucidation:

- The relPrice is the price of the stock relative to the SP500 index, starting from an initial value of 1.0, for periods commencing 1-month, 3-months,..., 60-months ago and from inception. In this example we can see that WMT has matched or outperformed the index in every period, including from inception of the series.

- Autocorrelation refers to the autocorrelation in 1-month, 3-month,... etc, returns. The autocorrelation from inception is the autocorrelation in daily returns, from the start of the data series.

- The IR is the information ratio, defined here as the ratio of the CAGR to the annualized volatility, estimated for the last 1-month, 3-month,... etc period.

- The Alpha and Beta are the CAPM regression estimates obtained by regressing the (excess) daily returns in the stock against those of the index, for the corresponding 1-month, 3-month,.. etc period.

- μ and σ are the annualized, instantaneous drift and volatility parameters for a Geometric Brownian Motion process estimated using daily closing prices over the last 1-month, 3-month, .. etc period.

- The IIR , the instantaneous information ratio is the ratio $\frac{\mu}{\sigma}$

Cross-Sectional Analysis

Fundamental Information Dataset

In[ ]:= `Dataset[<|# → #["Fundamentals"] & /@ selectedStocks|>, HeaderStyle → {Normal, Bold},`
`DatasetTheme → {"AlternatingRowColumnBackgrounds", LightBlue, LightOrange}]`

Out[ ]=

	MarketCap	PERatio	EarningsPerShare	EBITDA
APA	16 332 955 473.	5.5118	8.8882	5 696 000 000
CTSH	27 262 340 553.	12.2253	4.305	3 540 000 000
CZR	9 115 416 185.	—	−6.8981	2 545 000 000
DD	31 020 516 063.	16.9862	3.6459	2 945 000 000
FIVN	3 483 474 544.	—	−1.1898	−74 023 000
HUBS	12 758 221 365.	—	−2.0124	−36 084 000
MPC	60 354 450 783.	7.94203	14.8136	16 396 000 000
PRU	39 147 548 743.	—	—	3 975 000 000
UMPQ	4 393 071 103.	—	—	—
WMT	386 419 925 895.	28.14	5.0096	35 286 000 000

Cross-Sectional Performance Dataset

We might want to carry out a comparative analysis, looking at performance over, say, the last nine months:

In[ ]:=
```
Dataset[<|# → #["Performance"]["9-Months"] & /@ selectedStocks|>,
  HeaderStyle → {Normal, Bold}, DatasetTheme →
    {"AlternatingRowColumnBackgrounds", LightBlue, LightOrange}, MaxItems → {10, 14}]
```
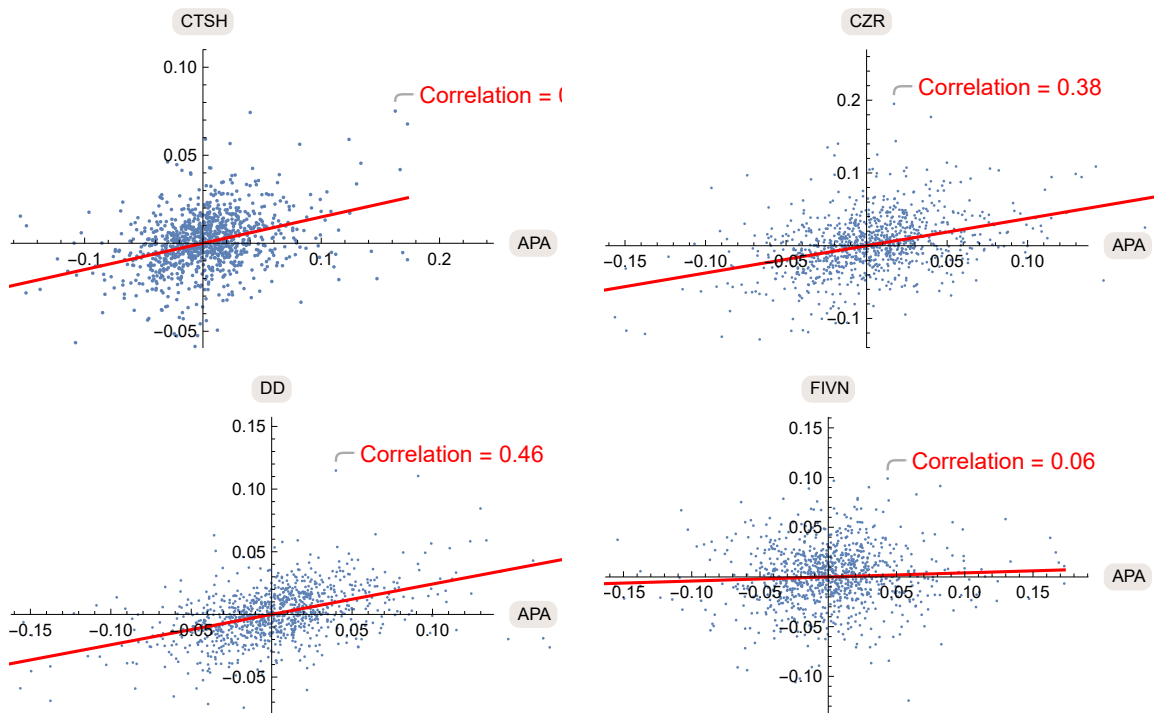
Out[ ]=

	Date	Period(r	relPrice	SP500 Correla	AutoCorrelati	Total Retur
APA	Tue 1 Feb 2022	9	1.62	0.45	−0.044	38.64
CTSH	Tue 1 Feb 2022	9	0.86	0.78	−0.104	−26.33
CZR	Tue 1 Feb 2022	9	0.67	0.73	−0.126	−42.57
DD	Tue 1 Feb 2022	9	0.88	0.83	−0.004	−24.24
FIVN	Tue 1 Feb 2022	9	0.56	0.55	−0.042	−52.06
HUBS	Tue 1 Feb 2022	9	0.71	0.69	−0.041	−39.33
MPC	Tue 1 Feb 2022	9	1.88	0.48	−0.02	61.44
PRU	Tue 1 Feb 2022	9	1.14	0.78	−0.005	−2.45
UMPQ	Tue 1 Feb 2022	9	1.2	0.65	0.073	2.66
WMT	Tue 1 Feb 2022	9	1.2	0.38	0.139	3.01

CorrelationPlots(withoutlierdetection)

In this example we are looking at correlation plots for pairs of equities, using WL's Anomaly Detection functionality to remove outliers from the data:

In[ ]:= ```
plots = CorrelationPlot[selectedStocks〚1〛, #, True, 1000] & /@ selectedStocks〚2 ;; 5〛;
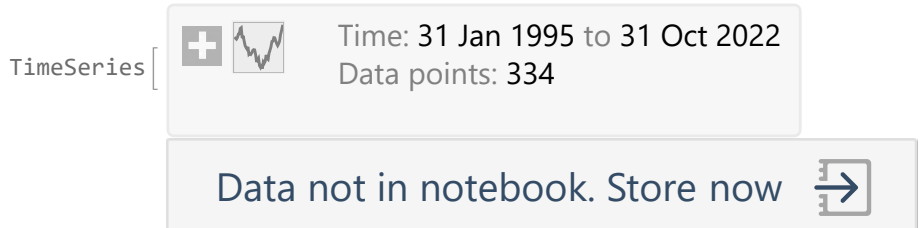GraphicsGrid[{plots〚1 ;; 2〛, plots〚3 ;; 4〛}]
```

*Out[ ]=*

# HistoricalPerformanceData

While the snapshot performance information contained in the Performance property of each equity entity is interesting, much more useful is the historical performance data contained in the Historical Data property:

In[59]:= **tsPerformance = | WMT EQUITIES ["Historical Data"]["Monthly Performance"]**

Out[59]=

TimeSeries [ 🞢 〽 Time: 31 Jan 1995 to 31 Oct 2022
Data points: 334 ]

Data not in notebook. Store now →

This time series comprises a dataset of performance metrics for each month since inception of the series (334 months). For example, the performance data for WMT on Oct 20, 2015 (month 250 of the series) was as follows:

In[77]:= **date = DateObject[tsPerformance["Dates"]⟦250⟧, "Day"]**
**Dataset[tsPerformance[First@tsPerformance["Dates"]], DatasetTheme →**
**{"AlternatingRowColumnBackgrounds", LightBlue, LightOrange}, MaxItems → {8, 14}]**

Out[77]=

Fri 30 Oct 2015

Out[78]=

|  | Date | Period(month) | relPrice | SP500 Correlat | AutoCorrelatio | Tot |
|---|---|---|---|---|---|---|
| 60–Months | Thu 1 Feb 1990 | 60.0 | 1.54 | 0.63 | 0. + Missing | 119 |
| 12–Months | Tue 1 Feb 1994 | 12.0 | 0.89 | 0.48 | −0.138 | −1: |
| 9–Months | Mon 2 May 1994 | 9.0 | 0.87 | 0.44 | −0.073 | −8. |
| 6–Months | Mon 1 Aug 1994 | 6.0 | 0.89 | 0.42 | −0.072 | −8. |
| 3–Months | Tue 1 Nov 1994 | 3.0 | 0.98 | 0.25 | 0.158 | −2. |
| 1–Month | Tue 3 Jan 1995 | 1.0 | 1.05 | 0.23 | −0.045 | 7.6 |

Why is this useful?

In cross-sectional strategy design we typically look at performance metics for a universe of stocks at the end of each month, using these to decide which stocks to go long and which to short for the next month.

The Historical Performance Data contained in the Equities Entity Store provides exactly the information we

would need to construct such long/short equity portfolios.

We will discuss this application in Part 2 of the presentation.