Quantitative Fundamental Track

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Abstract

The paper analyze a specific class of algorithms used in automated artificial intelligence systems. More specifically, the paper attempt to analysis the myth on the momentum strategy class: momentum cannot be captured by long-only investors as momentum can only be exploited on the short side. The analysis provided show that there is not enough evidence to conclude with the myth as the analysis of the result is mixed. One might even say that the converse of the myth is more true: long only investors seems to capture more of the benefits of momentum than short only investors.

***Keywords:** Momentum; technical analysis; factor; risk exposure*

1. Introduction

The fast pace of computing power have been the catalyst of major changes in several industries today. The portfolio management aspect of the finance industry has seen a lot of transformation as a result of the advance in computing power. Today, automated algorithm are now replacing humans in making unbiased decision in portfolio of assets.

The goal of this project is a in depth analysis of one type of anomaly that automated trading intelligent systems uses in order to make inform decision in a portfolio. This is the Momentum algorithm class.

In general, momentum algorithms or functions attempt to capture the trend of a financial asset in an attempt to help in a crucial financial decision making: Buy when prices are low and sell when prices are high. Many factors affect the prices of financial assets, most specifically the supply and demand of those assets. However, momentum algorithms allow intelligent systems to measure the speed of the uptrend and down trend in an asset price and this will in turn will inform in decision making in the portfolio.

This project will delve deeper through a set of momentum algorithms (see Appendix I) and using the Wesbsim platform as a tool to test those algorithms and analyze their various features in a market neutral environment and infer their potential choices as a measure of momentum.

2. Quantitative Equity Portfolio

It has been known traditionally that the market reward investors for taking long term risk. As a result, the best investment strategy has always been reduced to follow the market to capture that long term risk. However, recent work in the field of finance in the past decades have demonstrated that stock returns are predictable over the short term for period going from 1 year to more.

The predictable ability of stocks over the short run implies that quantitative models can be used to capture risk that will be rewarded by the market in the short term. Factor models are used to analyze the sources of risks and returns in portfolios.

$$R_i = a_i + b_{i1}F_1 + b_{i2}F_2 + \ldots + b_{iK}F_K + \epsilon_i$$

By modelling the historical returns, we can see how much of them is due to speculation on different factors and how much to asset-specific fluctuations (ϵ_p). We can also examine what sources of risk the portfolio is exposed to. In risk analysis, we often model active returns (returns relative to a benchmark) and active risk (standard deviation of active returns, also known as tracking error or tracking risk). There are several type of factors: fundamental factors (exposure to specific company metric like P/E, etc..); technical factors (exposure to technical metric like momentum); economic factors (exposure to economic data movement like the GDP or interest rate); and sentiment factors (exposure to market sentiment data like analyst rating). The primary focus of this project is on technical factors, more specifically the factor of momentum.

There have been several myths about momentum and the one we are going to investigate here is the myth that momentum cannot be captured by long-only investors as momentum can only be exploited on the short side.

3. Momentum Algorithms and their output

In an attempt to explore the question raised in the previous session, we will be looking at three momentum indicators: Money Flow Index; Know Sure Thing and Rate-of-Change (ROC). For each of those indicators, we will be looking at both the long side (bullish) evaluation of the indicator and the short side (bearish) evaluation of the indicator. All the code name used for the indicators designed in the project are found in appendix II. Appendix I shows the websim implementation of the indicator and Appendix III report the output for the indicators.

The money flow index (MFI) is an oscillator that uses both price and volume to measure buying and selling pressure. Created by Gene Quong and Avrum Soudack, MFI is also known as volume-weighted RSI. MFI starts with the typical price for each period. Money flow is positive when the typical price rises (buying pressure) and negative when the typical price declines (selling pressure). A ratio of positive and negative money flow is then plugged into an RSI formula to create an oscillator that moves between zero and one hundred. As a momentum oscillator tied to volume, the Money Flow Index (MFI) is best suited to identify reversals and price extremes with a variety of signals.

Know Sure Thing (KST) is a momentum oscillator based on the smoothed rate-of-change for four different timeframes that was developed by Martin Pring. In short, KST measures price momentum for four different price cycles. It can be used just like any momentum oscillator. Chartists can look for divergences, overbought/oversold readings, signal line crossovers and centerline crossovers.

The Rate-of-Change (ROC) indicator, which is also referred to as simply Momentum, is a pure momentum oscillator that measures the percent change in price from one period to the next. The ROC calculation compares the current price with the price “n” periods ago. The plot forms an oscillator that fluctuates above and below the zero line as the Rate-of-Change moves from positive to negative. As a momentum oscillator, ROC signals include centerline crossovers, divergences and overbought-oversold readings. Divergences fail to foreshadow reversals more often than not so this article will forgo a discussion on divergences. Even though centerline crossovers are

prone to whipsaw, especially short-term, these crossovers can be used to identify the overall trend. Identifying overbought or oversold extremes comes naturally to the Rate-of-Change oscillator.

4. Analysis

Below is a description of the metric used to assess the performance of the indicator designed in this project.

1. **Return**

Return is the gain or loss of a security or portfolio in a particular period. Return consists of the income received plus capital gains, relative to the amount of the investment. In WebSim, return = annualized PnL / half of book size.

2. **Sharpe and IR**

Information ratio (IR) measures the prediction ability of a model. In WebSim, it is defined as the ratio of a portfolio's mean daily returns to the volatility of those returns:

$$\mathrm{IR} = \frac{\mathrm{mean(PnL)}}{stDev(PnL)}$$

Where PnL is the daily profit and loss, in dollars.

Sharpe is the annualized version of the IR statistic, i.e. Sharpe = sqrt (252)*IR ≈ 15.8*IR; where 252 is the average number of trading days (days the markets are open) in the USA in a year.

Sharpe or IR measures the returns of an Alpha while attempting to identify its consistency. The higher the IR, the more consistent the Alpha's returns are, and consistency is an ideal trait. High Sharpe (or IR) is more desirable than just high return.

Note: Sharpe and IR may be defined somewhat differently elsewhere than in WebSim .

3. **Fitness**

Fitness of an Alpha is a function of Returns, Turnover and Sharpe:

$$Fitness = Sharpe \cdot \sqrt{\frac{abs(Return)}{Turnover}}$$

Good Alphas have high fitness. You can optimize the performance of your alphas by increasing Sharpe (or returns) and reducing turnover. Improving one factor normally has an adverse impact on the other factor. As you work on optimizing your alpha, an improvement in its fitness is an indication that your changes are having a positive impact.

The analysis of the Money Flow Index shows that on the return basis, the MFI+ outperform MFI - except for the years 2014 ad 2016. We observe the same result when looking at the Sharpe ratio and MFI for MFI+ vs. MFI-.

The result of the Know Sure Thing is more balanced than the of the MFI. Return:2012 (KST+ underperform KST-);2013 (KST+ underperform KST-);2014 (KST+ outperform KST-);2015 (KST+ underperform KST-);2016 (KST+ underperform KST-);2017 (KST+ outperform KST-); Sharpe:2012 (KST+ underperform KST-);2013 (KST+ underperform KST-);2014 (KST+ outperform KST-);2015 (KST+ underperform KST-);2016 (KST+ underperform KST-);2017 (KST+ outperform KST-); and Fitness:2012 (KST+ underperform KST-);2013 (KST+ underperform KST-);2014 (KST+ outperform KST-);2015 (KST+ underperform KST-);2016 (KST+ underperform KST-);2017 (KST+ outperform KST-);

Below is the result for Rate-of-Change. Return:2012 (ROC+ outperform ROC-);2013 (ROC+ underperform ROC-);2014 (ROC+ outperform ROC-);2015 (ROC+ outperform ROC-);2016 (ROC+ outperform ROC-);2017 (ROC+ outperform ROC-); Sharpe:2012 (ROC+ outperform ROC-);2013 (ROC+ underperform ROC-);2014 (ROC+ outperform ROC-);2015 (ROC+ outperform ROC-);2016 (ROC+ underperform ROC-);2017 (ROC+ outperform ROC-); and Fitness:2012 (ROC+ outperform ROC-);2013 (ROC+ underperform ROC-);2014 (ROC+ outperform ROC-);2015 (ROC+ outperform ROC-);2016 (ROC+ underperform ROC-);2017 (ROC+ outperform ROC-);

5. Conclusion

In sum, the analysis provided show that there is not enough evidence to conclude with the myth as the analysis of the result is mixed. One might even say that the converse of the myth is more true: long only investors seems to capture more of the benefits of momentum than short only investors.

Appendix

Appendix I: Indicators Studied

INDICATOR:

MFI - Money Flow Index

FORMULA:

```
Typical Price = (High + Low + Close)/3

Raw Money Flow = Typical Price x Volume
Money Flow Ratio = (14-period Positive Money Flow)/(14-period Negative Money Flow)

Money Flow Index = 100 - 100/(1 + Money Flow Ratio)
```

INTERPRETATION:

- Measure buying and selling pressure
- Money flow is positive when the typical price rises (buying pressure) and negative when the typical price declines (selling pressure)

ALGORITHMIC IMPLEMENTATION:

BULLISH

```
[type = stock] AND [country = US]
AND [Daily SMA(20,Daily Volume) > 40000]
AND [Daily SMA(60,Daily Close) > 20]

AND [Daily MFI(14) < 10]
```

BEARISH

```
[type = stock] AND [country = US]
AND [Daily SMA(20,Daily Volume) > 100000]
AND [Daily SMA(60,Daily Close) > 20]

AND [Daily MFI(14) > 90]
```

WEBSIM SCRIPT:

MFI +

```
Typical_Price=(high+low+close)/3;

diff_Typical_Price=delta(Typical_Price,1);

up_or_down=sign(diff_Typical_Price);

Raw_Money_Flow=Typical_Price*volume;

up_or_down1=abs(up_or_down);

diff_Pos = (up_or_down+up_or_down1)/2;
```

diff_Neg = abs((up_or_down-up_or_down1)/2);

Pos_money_flow=Raw_Money_Flow*diff_Pos;

Neg_money_flow= Raw_Money_Flow*diff_Neg;

Money_Flow_Ratio = sum(Pos_money_flow,14)/sum(Neg_money_flow,14);

MFI= 100-100/(1+ Money_Flow_Ratio);

sum(volume,20)/20>40000 && sum(close,60)/60>20 && MFI<10

MFI –

Typical_Price=(high+low+close)/3;

diff_Typical_Price=delta(Typical_Price,1);

up_or_down=sign(diff_Typical_Price);

Raw_Money_Flow=Typical_Price*volume;

up_or_down1=abs(up_or_down);

diff_Pos = (up_or_down+up_or_down1)/2;

diff_Neg = abs((up_or_down-up_or_down1)/2);

Pos_money_flow=Raw_Money_Flow*diff_Pos;

Neg_money_flow= Raw_Money_Flow*diff_Neg;

Money_Flow_Ratio = sum(Pos_money_flow,14)/sum(Neg_money_flow,14);

MFI= 100-100/(1+ Money_Flow_Ratio);

sum(volume,20)/20>100000 && sum(close,60)/60>20 && MFI>90

INDICATOR:
Know Sure Thing (KST)

FORMULA:

```
RCMA1 = 10-Period SMA of 10-Period Rate-of-Change
RCMA2 = 10-Period SMA of 15-Period Rate-of-Change
RCMA3 = 10-Period SMA of 20-Period Rate-of-Change
RCMA4 = 15-Period SMA of 30-Period Rate-of-Change

KST = (RCMA1 x 1) + (RCMA2 x 2) + (RCMA3 x 3) + (RCMA4 x 4)

Signal Line = 9-period SMA of KST
```

INTERPRETATION:

- Measures price momentum for four different price cycles
- KST>0, favor the Bull Market
- KST<0, favor the Bear Market

ALGORITHMIC IMPLEMENTATION:

BULLISH

```
[type = stock] AND [country = US]
AND [Daily SMA(20,Daily Volume) > 40000]
AND [Daily SMA(60,Daily Close) > 20]

AND [KST > 0]
AND [KST x KST Signal]
```

BEARISH

```
[type = stock] AND [country = US]
AND [Daily SMA(20,Daily Volume) > 40000]
AND [Daily SMA(60,Daily Close) > 20]

AND [KST < 0]
AND [KST Signal x KST]
```

WEBSIM SCRIPT:

KST+

ROC_10=(delta(close,10)/delay(close,10))*100;

ROC_15=(delta(close,15)/delay(close,15))*100;

ROC_20=(delta(close,20)/delay(close,20))*100;

ROC_30=(delta(close,30)/delay(close,30))*100;

RCMA1 = sum(ROC_10,10)/10;
RCMA2 = sum(ROC_15,10)/10;
RCMA3 = sum(ROC_20,10)/10;

RCMA4 = sum(ROC_30,15)/15;

KST = RCMA1*1 + RCMA2*2 + RCMA3*3 + RCMA4*4;

Signal= sum(KST,9)/9;

sum(volume,20)/20>40000 && sum(close,60)/60>20 && KST>0 && KST*Signal

KST-

ROC_10=(delta(close,10)/delay(close,10))*100;

ROC_15=(delta(close,15)/delay(close,15))*100;

ROC_20=(delta(close,20)/delay(close,20))*100;

ROC_30=(delta(close,30)/delay(close,30))*100;

RCMA1 = sum(ROC_10,10)/10;
RCMA2 = sum(ROC_15,10)/10;
RCMA3 = sum(ROC_20,10)/10;
RCMA4 = sum(ROC_30,15)/15;

KST = RCMA1*1 + RCMA2*2 + RCMA3*3 + RCMA4*4;

Signal= sum(KST,9)/9;

sum(volume,20)/20>40000 && sum(close,60)/60>20 && KST<0 && KST*Signal

INDICATOR:

Rate-of-Change (ROC) indicator

FORMULA:

```
ROC = [(Close - Close n periods ago) / (Close n periods ago)] * 100
```

INTERPRETATION:

- Measures the percent change in price from one period to the next
- It measures the percentage increase or decrease in price over a given period of time.
- In general, prices are rising as long as the Rate-of-Change remains positive. Conversely, prices are falling when the Rate-of-Change is negative.

ALGORITHMIC IMPLEMENTATION:

BULLISH ROC

```
[type = stock] AND [country = US]
AND [Daily SMA(20,Daily Volume) > 40000]
AND [Daily SMA(60,Daily Close) > 20]

AND [Daily ROC(125,Daily Close) > 0]
AND [Daily ROC(21,Daily Close) < -8]
AND [Yesterday's Daily Close < Yesterday's Daily SMA(20,Daily Close)]
AND [Daily Close > Daily SMA(20,Daily Close)]
```

BEARISH ROC

```
[type = stock] AND [country = US]
AND [Daily SMA(20,Daily Volume) > 40000]
AND [Daily SMA(60,Daily Close) > 20]

AND [Daily ROC(125,Daily Close) < 0]
AND [Daily ROC(21,Daily Close) > 8]
AND [Yesterday's Daily Close > Yesterday's Daily SMA(20,Daily Close)]
AND [Daily Close < Daily SMA(20,Daily Close)]
```

WEBSIM SCRIPT:

ROC +

ROC_125=[delta(close,125)/delay(close,125)]*100;

ROC_21= [delta(close,21)/delay(close,21)]*100;

sum(volume,20)/20>40000 && sum(close,60)/60>20 && ROC_125>0 &&
ROC_21<-8 && close,1 < delay(sum(close,20)/20,1) && close > sum(close,20)/20

ROC –

```
ROC_125=(delta(close,125)/delay(close,125))*100;

ROC_21= (delta(close,21)/delay(close,21))*100;

sum(volume,20)/20>40000 && sum(close,60)/60>20 && ROC_125<0 &&
ROC_21> 8 && close > delay(sum(close,20)/20,1) && close <
sum(close,20)/20
```

Appendix II: Alpha Code Names

MFI+ = Money Flow Index Bullish

MFI- = Money Flow Index Bearish

KST+ = Know Sure Thing Bullish

KST- = Know Sure Thing Bearish

ROC+ = Rate-of-Change (ROC) indicator Bullish

ROC- = Rate-of-Change (ROC) indicator Bearish

Appendix III: Websim Output

MFI+

Year	Book...	Long ...	Short ...	Pnl	Sharpe	Fitness	Returns	Draw...	Turno...	Margin
2012	20.0M	1	299	982K	1.60	1.74	42.33%	2.77%	35.71%	23.71b...
2013	20.0M	0	135	2.37M	1.61	1.61	23.51%	2.44%	23.63%	19.89b...
2014	20.0M	1	164	-1.27M	-1.08	-0.79	-12.59%	10.73%	23.56%	-10.69...
2015	20.0M	0	197	537K	0.33	0.14	5.33%	9.89%	30.32%	3.52bp...
2016	20.0M	1	170	-2.21M	-1.25	-1.18	-21.92%	13.45%	24.63%	-17.80...
2017	20.0M	0	266	142K	0.12	0.03	2.21%	5.20%	38.53%	1.15bp...
2012-...	20.0M	0	186	551K	0.07	0.01	1.12%	21.00%	27.71%	0.81bp...

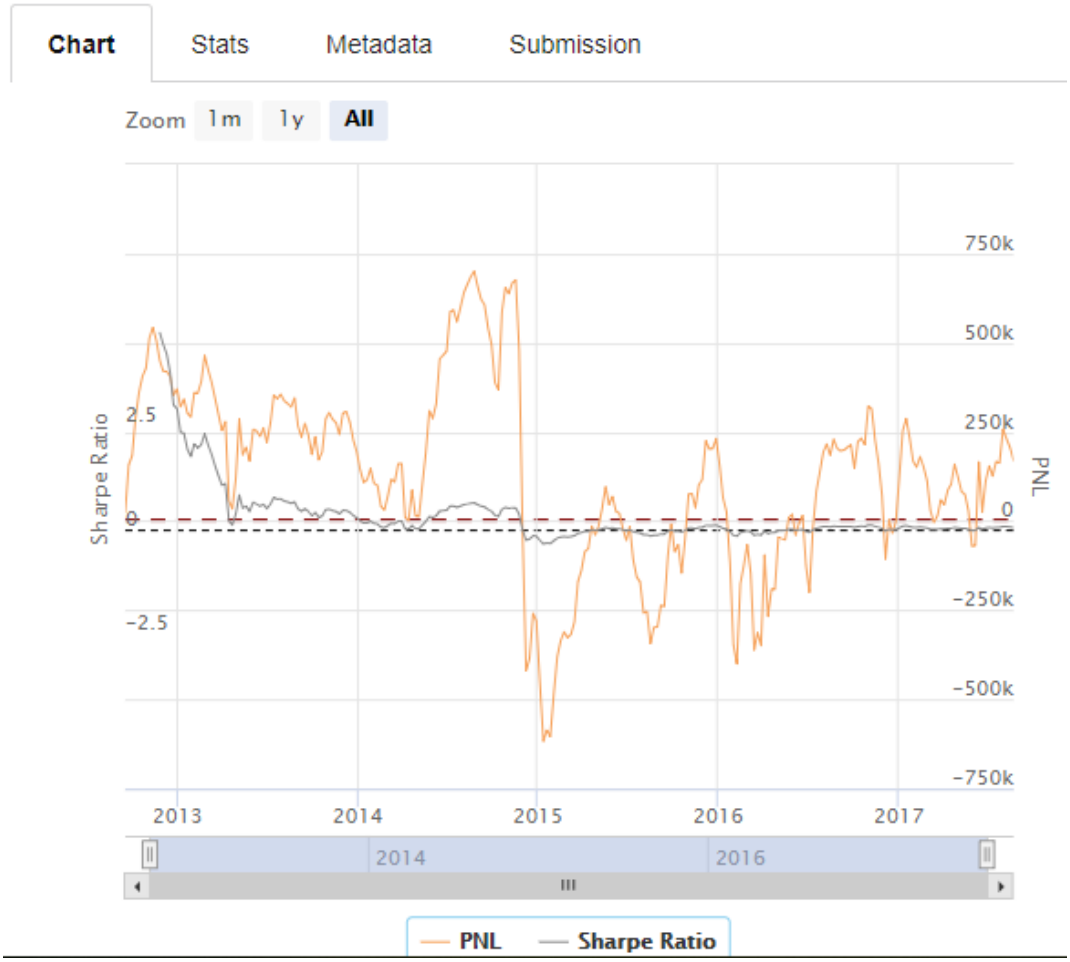
MFI –

Year	Book...	Long ...	Short ...	Pnl	Sharpe	Fitness	Returns	Draw...	Turno...	Margin
2012	20.0M	1	288	-650K	-1.97	-1.56	-22.58%	5.89%	36.12%	-12.50...
2013	20.0M	2	346	-2.20M	-1.45	-1.09	-21.79%	10.99%	38.58%	-11.30...
2014	20.0M	3	365	3.70K	0.00	0.00	0.04%	9.18%	42.11%	0.02bp...
2015	20.0M	1	244	1.89M	1.34	1.03	18.70%	4.25%	31.83%	11.75b...
2016	20.0M	1	274	-1.13M	-0.78	-0.42	-11.23%	9.08%	39.16%	-5.73b...
2017	20.0M	2	352	-1.09M	-0.83	-0.51	-17.04%	11.06%	44.67%	-7.63b...
2012-...	20.0M	2	312	-3.18M	-0.42	-0.17	-6.41%	19.73%	38.69%	-3.32b...

KST+

Year	Book...	Long ...	Short ...	Pnl	Sharpe	Fitness	Returns	Draw...	Turno...	Margin
2012	20.0M	249	247	-376K	-3.31	-3.80	-13.05%	2.49%	9.88%	-26.41...
2013	20.0M	307	190	-267K	-0.45	-0.25	-2.65%	3.72%	8.39%	-6.31b...
2014	20.0M	282	214	926K	0.99	0.97	9.19%	3.05%	9.53%	19.28b...
2015	20.0M	224	271	367K	0.44	0.27	3.64%	4.09%	9.36%	7.78bp...
2016	20.0M	257	240	-750K	-0.79	-0.71	-7.44%	9.57%	9.27%	-16.05...
2017	20.0M	290	206	368K	0.75	0.67	5.75%	2.51%	7.29%	15.78b...
2012-...	20.0M	269	227	269K	0.07	0.02	0.54%	10.04%	8.94%	1.21bp...

KST-



Year	Book...	Long ...	Short ...	Pnl	Sharpe	Fitness	Returns	Draw...	Turno...	Margin
2012	20.0M	172	325	402K	3.30	3.76	13.96%	1.19%	10.75%	25.96b...
2013	20.0M	131	366	-210K	-0.37	-0.17	-2.08%	2.73%	10.21%	-4.08b...
2014	20.0M	171	325	-483K	-0.50	-0.34	-4.79%	6.64%	10.26%	-9.35b...
2015	20.0M	228	267	526K	0.88	0.67	5.22%	2.66%	9.05%	11.54b...
2016	20.0M	193	303	-227K	-0.28	-0.13	-2.25%	4.04%	9.99%	-4.52b...
2017	20.0M	161	335	162K	0.42	0.24	2.54%	2.25%	7.95%	6.38bp...
2012-...	20.0M	178	319	170K	0.05	0.01	0.34%	6.90%	9.68%	0.71bp...

ROC+

Year	Book...	Long ...	Short ...	Pnl	Sharpe	Fitness	Returns	Draw...	Turno...	Margin
2012	20.0M	0	100	488K	1.86	1.38	19.05%	1.48%	34.43%	11.07b...
2013	20.0M	0	53	-1.37M	-1.79	-1.47	-13.64%	8.99%	20.24%	-13.48...
2014	20.0M	0	69	102K	0.09	0.02	1.01%	3.79%	20.28%	1.00bpm
2015	20.0M	0	45	-207K	-0.25	-0.09	-2.05%	5.98%	15.79%	-2.60b...
2016	20.0M	0	51	1.27M	0.97	0.85	12.56%	4.59%	16.29%	15.41b...
2017	20.0M	0	43	2.69M	1.85	2.97	42.00%	1.20%	16.25%	51.68b...
2012-2...	20.0M	0	55	2.96M	0.48	0.27	6.01%	11.72%	18.75%	6.41bpm

ROC-

Year	Book...	Long ...	Short ...	Pnl	Sharpe	Fitness	Returns	Draw...	Turno...	Margin
2012	20.0M	0	78	273K	1.60	1.03	10.83%	0.98%	26.22%	8.26bpm
2013	20.0M	0	47	60.0K	0.06	0.01	0.60%	4.29%	16.87%	0.71bpm
2014	20.0M	0	43	-146K	-0.12	-0.04	-1.45%	6.92%	13.51%	-2.14b...
2015	20.0M	0	64	-782K	-0.84	-0.53	-7.76%	7.02%	19.32%	-8.03b...
2016	20.0M	0	58	1.06M	1.21	0.91	10.54%	3.51%	18.72%	11.26b...
2017	20.0M	0	34	305K	0.73	0.46	4.76%	1.68%	11.88%	8.01bpm
2012-2...	20.0M	0	52	772K	0.16	0.05	1.57%	13.09%	16.89%	1.86bpm

Appendix IV

Appendix V

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