

PCA on different asset classes

Are there specific topics driving asset prices?



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High Level Roadmap

The research problem can be divided into the following three steps:

- (1) Data Preparation & Brainstorming
- (2) Statistical analysis & macro-economic interpretation
- (3) Visualization & Next Steps

High Level Roadmap (Part 1)

I. Data Preparation & Brainstorming

1. Data Preparation

a. Define theoretically suitable Data

Economic and Capital Markets related time series across all asset classes, especially Factor-based Time-Series

b. Identify Data Sources

Bloomberg, Yahoo Finance, Kenneth R. French Library on Stock Return Factors, etc.

c. Data Preparation & Quality Assurance

2. Statistical Methods Brainstorming

Pro & Contra of e.g. Hidden Markov-Chains, Principal Component Analysis, Bayesian Nets, Neural Nets, etc.

Devise Long-List and most promising short list of suitable methods

High Level Roadmap (Part 2)

II. Statistical Analysis & Macro-economic Interpretation

a. Application of short-listed models to data, identify issues & solutions and come up with macro-economic interpretation of results

b. Time-Series Regression of Principal Components onto macro-economic/ Factor-Portfolios

III. Visualization of Theme Evolution through time

In progress



Outcome

- Fully integrated R Code (Data Input, Data Quality Checks, Statistical Analysis, Output)
- Sensitivity Assessment: Which asset classes are more heavily influenced by the identified topics, which are defensive safe havens?
- Interactive visualization dashboard / web application (e.g. R Shiny, Power BI) of "Driving Topics" through time (incl. conditional correlations)

Financial Data for PCA

COMMODITIES		BOND INDICES		EQUITY INDICES		CREDIT INDICES		GVT BOND SPREADS	
Ticker	Description	Ticker	Description	Ticker	Description	Ticker	Description	Ticker	Description
HG1 Comdty	Copper Futures	GOBR10 Index	Germany GVT 10Y	ASE Index	Athens Stock Exchange General Index	BAMLC0R1CAAAY	ICE US High Yield	US2Y2Y10 Index	US 2Y/10Y
LA1 Comdty	Aluminium Futures	USGG10YR Index	US GVT 10Y	BEL20 Index	Euronext Brussels Index			JPYC1030 Index	Japan 10Y/30Y
LL1 Comdty	Lumber Futures	USGG2YR Index	US GVT 2Y	BVLX Index	PSI General Index Portugal			USYC1030 Index	US 10Y/30Y
LN1 Comdty	Lean Hog Futures	GBTP-GR10 Index	Italy GVT 10Y	NIKJ Index	Nikkei 225, Japan			FRYC1030 Index	France 10Y/30Y
LT2 Comdty	Gasoline Futures	IO0163US Index		KOSPI Index	Korea Composite Stock Price Index			ATYC2YQ0 Index	Austria 2Y/10Y
KAG Curncy	Silver Spot Price			HSI Index	Hang Seng Index, Hong Kong				
KAU Curncy	Gold Spot Price								
XP D Curncy	Palladium Spot Price								
XPT Curncy	Platinum Spot Price								
NG1 Comdty	Natural Gas Futures								
W 1 Comdty	Wheat Futures								
SBM1 Comdty	Soybean Meal Futures								
RR1 Comdty	Rough Rice Futures								
QW1 Comdty	Sugar Futures								
O 1 Comdty	Oran Futures								
LH1 Comdty	Live Hog Futures								
LC1 Comdty	Live Cattle Futures								
KC1 Comdty	Coffee C Futures								
JO1 Comdty	Orange Juice Futures								
CT1 Comdty	Cotton No. 2 Futures								
CC1 Comdty	Cocoa Futures								
C1 Comdty	Corn Futures								

Macroeconomic Data for Regression

CPI Index (monthly)		UNEMPLOYMENT RATE (quarterly)		REAL GDP % (yearly)		CURRENCY (daily)	FAMA French Factors
Ticker	Country	Ticker	Country	Ticker	Country	Ticker	Factors
CPI YOY Index	US	EHUPCN Index	China	EHGDDEY Index	Germany	EURJPY Curncy	FF3 Mkt.Rf
CNCPIYOY Index	China	EHUPAT Index	Austria	EHGDAUY Index	Australia	EURCHF Curncy	FF3 SMB
JNCPIYOY Index	Japan	EHUPIT Index	Italy			EURGBP Curncy	FF3 HML
BZPIIPCY Index	Brazil	EHUPHK Index	Hong Kong			EURSEK Curncy	FF5 Mkt. Rf
HKCPIY Index	Hong Kong	EHUPBR Index	Brazil			EURCAD Curncy	FF5 SMB
AUCPIYOY Index	Australia	EHUPSE Index	Sweden			EURCZK Curncy	FF5 HML
EHPILAT Index	Latin America	EHUPCA Index	Canada			EURKRW Curncy	FF5 RM W
EHPIASP Index	Asian Pacific	EHUPASAY Index	South East Asian				FF5 CM A
SACPIYOY Index	South Africa						
RUCPIYOY Index	Russia						

Use of **Kaiser-Meyer-Olkin (KMO)** for optimal window size estimation

➤ **Single Assets**

- For Threshold **0.9** -> Optimal window size: **423 days**
- For Threshold **0.85** -> Optimal window size: **80 days**

➤ **Avarage of Assets per Asset Class**

- For Threshold **0.7** -> Optimal window size: **770 days**

PCA Results – Rolling event window

- Variance explained by each Principal Component

- **Window size 423**

```
> print(results_table)
Window    PC1    PC2    PC3    PC4    PC5
1    423 72.5698 5.624469 4.292571 3.197415 2.235493
```

- **Window size 80**

```
> print(results_table)
Window    PC1    PC2    PC3    PC4    PC5
1    80 72.3648 4.8534 4.689563 2.71653 2.63407
```

Regression results PCA 1

```
> results_table
```

	Variable	Coefficients	Std.Error	t.Value	P.Value
CNCPIYOY.Index	CNCPIYOY.Index	0.0200773079	0.001188966	16.8863573	6.027199e-62
BZPIIPCY.Index	BZPIIPCY.Index	-0.0059108268	0.001207282	-4.8959786	1.014937e-06
HKCPIY.Index	HKCPIY.Index	0.0093817330	0.001201090	7.8110141	7.116596e-15
AUCPIYOY.Index	AUCPIYOY.Index	-0.0046284282	0.001249300	-3.7048177	2.142658e-04
EHPILAT.Index	EHPILAT.Index	-0.0113242864	0.001204368	-9.4026813	8.505398e-21
EHPIASP.Index	EHPIASP.Index	0.0157129036	0.001186272	13.2456203	2.905203e-39
SACPIYOY.Index	SACPIYOY.Index	0.0106400311	0.001198276	8.8794466	9.775491e-19
RUCPIYOY.Index	RUCPIYOY.Index	-0.0016497962	0.001211429	-1.3618599	1.733152e-01
EHUPCN.Index	EHUPCN.Index	-0.0026829144	0.001208723	-2.2196266	2.649736e-02
EHUPIT.Index	EHUPIT.Index	-0.0155458034	0.001195672	-13.0017253	6.399415e-38
EHUPHK.Index	EHUPHK.Index	0.0014226021	0.001219623	1.1664275	2.435079e-01
EHUPBR.Index	EHUPBR.Index	0.0015277210	0.001209412	1.2631934	2.065898e-01
EHUPSE.Index	EHUPSE.Index	-0.0007851598	0.001210801	-0.6484630	5.167210e-01
EHGDSE.Index	EHGDSE.Index	-0.0049833913	0.001214523	-4.1031661	4.152670e-05
EHGDMXY.Index	EHGDMXY.Index	-0.0077672749	0.001204126	-6.4505524	1.240676e-10
EURJPY.Curncy	EURJPY.Curncy	0.0067846000	0.001242144	5.4620086	4.980165e-08
EURCHF.Curncy	EURCHF.Curncy	0.0165865361	0.001201444	13.8054956	1.971403e-42
EURSEK.Curncy	EURSEK.Curncy	0.0010438173	0.001280105	0.8154157	4.148807e-01
EURCAD.Curncy	EURCAD.Curncy	0.0048038179	0.001206467	3.9817227	6.957508e-05
EURCZK.Curncy	EURCZK.Curncy	-0.0022951846	0.001226693	-1.8710343	6.140984e-02
EURKRW.Curncy	EURKRW.Curncy	0.0078501312	0.001202300	6.5292607	7.396569e-11

CPI

Unemployment

GDP

Currency

Regression results PCA 2

```
> results_table2
```

	Variable	Coefficients	Std.Error	t.Value	P.Value
CNCPIYOY.Index	CNCPIYOY.Index	-0.0012664295	0.0007292742	-1.7365615	8.253796e-02
BZPIIPCY.Index	BZPIIPCY.Index	-0.0017521791	0.0007183639	-2.4391247	1.476404e-02
HKCPIY.Index	HKCPIY.Index	-0.0030890071	0.0007167325	-4.3098467	1.671107e-05
AUCPIYOY.Index	AUCPIYOY.Index	0.0010132167	0.0007428245	1.3640056	1.726389e-01
EHPILAT.Index	EHPILAT.Index	-0.0019823742	0.0007219416	-2.7458929	6.060358e-03
EHPIASP.Index	EHPIASP.Index	-0.0058487119	0.0007132323	-8.2002907	3.155035e-16
SACPIYOY.Index	SACPIYOY.Index	-0.0015038479	0.0007177571	-2.0952046	3.621257e-02
RUCPIYOY.Index	RUCPIYOY.Index	0.0017898786	0.0007189196	2.4896783	1.282429e-02
EHUPCN.Index	EHUPCN.Index	0.0034721478	0.0007161035	4.8486672	1.287906e-06
EHUPIT.Index	EHUPIT.Index	-0.0019052829	0.0007234912	-2.6334568	8.483056e-03
EHUPHK.Index	EHUPHK.Index	0.0025192981	0.0007232297	3.4833998	5.001438e-04
EHUPBR.Index	EHUPBR.Index	0.0008563777	0.0007181085	1.1925464	2.331145e-01
EHUPSE.Index	EHUPSE.Index	-0.0023075535	0.0007180720	-3.2135404	1.321012e-03
EHGDSE.Index	EHGDSE.Index	0.0030742996	0.0007210138	4.2638571	2.053453e-05
EHGDMXY.Index	EHGDMXY.Index	0.0023967606	0.0007175366	3.3402627	8.443000e-04
EURJPY.Curncy	EURJPY.Curncy	0.0006748035	0.0007400712	0.9118088	3.619217e-01
EURCHF.Curncy	EURCHF.Curncy	0.0019650003	0.0007287461	2.6964129	7.037046e-03
EURSEK.Curncy	EURSEK.Curncy	-0.0024555951	0.0007591826	-3.2345249	1.227895e-03
EURCAD.Curncy	EURCAD.Curncy	-0.0022269048	0.0007168733	-3.1064134	1.906360e-03
EURCZK.Curncy	EURCZK.Curncy	0.0013909968	0.0007283418	1.9098133	5.622534e-02
EURKRW.Curncy	EURKRW.Curncy	-0.0034913333	0.0007154604	-4.8798416	1.101098e-06

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Interpretation of Regression results

PCA 1:

- Chinese inflation rates are positively linked to the main trend of financial assets.
- Poor GDP performance seems to be associated with better performance of the composite financial asset indicator.
- Lower unemployment rates may drive the financial asset trend upward.
- The value of the euro against the Japanese yen is positively associated with the trend in financial assets.

PCA 2:

- Inflation rates do not have a clear link with the secondary trend of financial assets.
- Higher unemployment rates might be related to the increase in the secondary trend captured by PCA 2.
- Better GDP performance appears to be related to higher values of the secondary financial asset trend.
- A stronger euro in relation to the Korean won is associated with a decrease in the secondary financial asset trend.

PCA Results (aggregated) – Rolling event window

- Aggregated data by each asset class
- As estimated by the KMO test, the optimal window size is 770 for a threshold of 0.7 (more observations needed)
- R^2 for PC1 is 0.8, for PC2 it is 0.84
- Variance explained by each Principal Component:

```
> print(results_table)
Window    PC1    PC2    PC3    PC4    PC5
1      770 67.15422 16.54273 9.041535 7.261516 6.961157e-29
```

Regression results (aggregated) for PC1

Variable	Coefficients	Std.Error	t.Value	P.Value
CNCPIYOY.Index	2.132630e-02	0.001342866	15.88118113	6.706543e-55
BZPIIPCY.Index	1.491640e-02	0.001594765	9.35335544	1.469935e-20
HKCPIY.Index	2.362631e-02	0.001309143	18.04715827	1.075952e-69
AUCPIYOY.Index	4.382092e-02	0.002225293	19.69219968	5.762742e-82
EHPILAT.Index	-3.090369e-02	0.002388983	-12.93591847	1.998716e-37
EHPIASP.Index	2.840866e-02	0.001336481	21.25631015	2.039357e-94
SACPIYOY.Index	2.493356e-02	0.001268498	19.65596300	1.096973e-81
RUCPIYOY.Index	3.853958e-02	0.001283376	30.02984269	1.580538e-176
EHUPCN.Index	3.652932e-03	0.001326495	2.75382395	5.920697e-03
EHUPIT.Index	-1.313356e-02	0.001308871	-10.03426986	2.220434e-23
EHUPHK.Index	-2.057720e-02	0.001752710	-11.74021759	3.023726e-31
EHUPBR.Index	-2.297111e-02	0.001402586	-16.37768568	3.770061e-58
EHUPSE.Index	-2.364264e-02	0.001393164	-16.97046234	3.844929e-62
EHGDSE.Index	1.274237e-02	0.001447294	8.80427767	2.030349e-18
EHGDMXY.Index	6.348840e-02	0.001602317	39.62287270	4.342286e-284
EURJPY.Curncy	2.462270e-02	0.001305480	18.86104178	1.172165e-75
EURCHF.Curncy	1.974362e-02	0.001405690	14.04550149	1.222643e-43
EURSEK.Curncy	-3.366440e-02	0.001535677	-21.92153911	6.197367e-100
EURCAD.Curncy	-1.756932e-03	0.001338210	-1.31289683	1.893036e-01
EURCZK.Curncy	1.189489e-03	0.001494843	0.79572830	4.262438e-01
EURKRW.Curncy	9.514361e-05	0.001286006	0.07398382	9.410275e-01

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Interpretation of Regression results (aggregated) for PC1

- **Consumer Price Index (CPI) Variables:**

Positive coefficient for China CPI Index suggests that an increase in the year-over-year change in consumer prices is associated with an increase in the principal component score

Negative coefficient for Hong Kong Index suggests that higher inflation in Hong Kong has a dampening effect on the overall economic conditions represented by the principal component.

- **Exchange Rate Variables:**

Negative coefficient for EURJPY.Currency suggests that a weaker euro relative to the yen has a negative impact on the economic conditions captured by the principal component.

Positive coefficient for EURSEK.Currency indicates that a stronger euro relative to the krona has a positive effect on the broader economic conditions represented by the principal component.

- **Employment and Wage Variables:**

Negative coefficient for EHUPCN.Index suggests that declining urban employment in China negatively impacts the overall economic conditions captured by the principal component.

Positive coefficient for EHUPBR.Index implies that higher unemployment in Brazil has a positive effect on the broader economic conditions represented by the principal component.

Regression results (aggregated) for PC2

Variable	Coefficients	Std.Error	t.Value	P.Value
CNCPIYOY.Index	0.0104036071	0.0009942182	10.464109	2.961066e-25
BZPIIPCY.Index	-0.0259967195	0.0010871861	-23.911932	3.411100e-117
HKCPIY.Index	-0.0049214114	0.0009903531	-4.969350	7.038991e-07
AUCPIYOY.Index	-0.0214474990	0.0016640040	-12.889091	3.572100e-37
EHPILAT.Index	0.0039382469	0.0017744922	2.219366	2.652559e-02
EHPIASP.Index	-0.0009312508	0.0010310218	-0.903231	3.664653e-01
SACPIYOY.Index	-0.0260909131	0.0008648382	-30.168549	5.704366e-178
RUCPIYOY.Index	-0.0373402275	0.0008332957	-44.810296	0.000000e+00
EHUPCN.Index	-0.0194322328	0.0009067913	-21.429663	7.659938e-96
EHUPIT.Index	-0.0009989177	0.0009638779	-1.036353	3.001090e-01
EHUPHK.Index	0.0069015195	0.0012923117	5.340445	9.861471e-08
EHUPBR.Index	0.0124299666	0.0010357096	12.001401	1.503079e-32
EHUPSE.Index	0.0147160501	0.0010226531	14.390071	1.163514e-45
EHGDSE.Index	0.0023867861	0.0010617859	2.247898	2.464458e-02
EHGDMXY.Index	-0.0442673455	0.0011837376	-37.396248	6.692732e-258
EURJPY.Currency	-0.0219054537	0.0009236298	-23.716703	1.879717e-115
EURCHF.Currency	-0.0121616585	0.0010288091	-11.821103	1.201248e-31
EURSEK.Currency	0.0122030515	0.0011711320	10.419877	4.653060e-25
EURCAD.Currency	-0.0135945572	0.0009445378	-14.392814	1.120736e-45
EURCZK.Currency	-0.0188956581	0.0010376950	-18.209261	7.266997e-71
EURKRW.Currency	-0.0045086734	0.0009307702	-4.844024	1.327388e-06

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Interpretation of Regression results (aggregated) for PC2

- **Consumer Price Index (CPI) Changes:**

Positive coefficients for CPI indices (China, Brazil, Hong Kong, Australia, South Africa, Russia) suggest that increases in the year-over-year change in CPI for various economies are associated with higher values of the second principal component (PC2).

This indicates that inflationary pressures, as reflected in higher CPI indices, contribute positively to the economic conditions captured by PC2.

- **Unemployment Rates:**

Negative coefficients for unemployment rates (China, Italy, Great Britain, Southeast Asia) suggest that increases in unemployment rates for various economies are associated with lower values of PC2.

Higher unemployment rates indicate weaker labor market conditions, which negatively impact the economic conditions represented by PC2.

- **Currency Exchange Rates:**

Positive coefficients for currency exchange rates (EURJPY.Currency, EURCHF.Currency) suggest that appreciations of the Euro against the Japanese Yen and Swiss Franc are associated with higher values of PC2.

Conversely, the negative coefficient for EURSEK.Currency suggests that an appreciation of the Euro against the Swedish Krona is associated with lower values of PC2.