"Factor Mimicking Portfolios" – An Illustration

Factor Mimicking Portfolios

Useful standard method in empirical finance:
Replacing some variable with a function of a bunch of other variables.
More specifically:
some variable of interest can be written as a *portfolio* of a number of tradable assets.
Usually: Want to use data about tradeable assets to proxy for some other economic variable that is not observable.

Economic Tracking Portfolios

See Lamont [2001]. Idea: Construct, from financial assets traded often, a "matching portfolio" of some economic factor that one wants an estimate of.
Say one want current estimates of GDP or Inflation. Construct the portfolio of financial variables (e.g. industry portfolios, that most closely matches the time series evolution of the macro variable.
Use the most recent estimates of stock returns to predict the macro variable.
Note: Lehmann and Modest [1988] has some of the same ideas in the context of the APT.

Example of Factor Mimicking Portfolios

Illustrate with a simple example.
Consider a value weighted market portfolio for the stocks at the Oslo Stock Exchange.
Constructed as a sum of returns on individual assets times the market weight of each asset.
What if we don't have the individual asset returns,
all we have is returns of a bunch of industry portfolios?
Still possible to estimate the market return as a weighted average of the industry portfolios.

Example of Factor Mimicking Portfolios ctd

Actually know industry weights, for example:
Panel A: Subperiod 1980–1989

	1980	1981	1982	1983	1984	1985
Energy and consumption	10.80	9.50	8.46	8.77	8.93	8.17
Material/labor	8.86	8.95	8.25	10.10	10.81	11.12
Industrials	57.95	50.83	39.25	36.68	32.59	32.98
Consumer Discretionary	1.01	1.53	3.19	2.38	3.53	5.39
Consumer Staples	2.30	4.75	5.50	5.02	6.87	6.47
Health Care/liability	1.13	1.23	2.34	3.43	3.31	4.45
Financials	18.29	23.89	27.13	21.40	21.80	20.98
Information Technology	0.81	3.73	5.96	12.23	12.15	10.53
Telecommunication Services	0.00	0.00	0.00	0.00	0.00	0.00
Utilities	0.00	0.00	0.00	0.00	0.00	0.00

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Ignore that we know the industry weights.
Can estimate them by:
regression of market portfolio returns on the returns on the sector portfolios.

$$r_{tm} = a + \sum_k b_k r_{kt} + \varepsilon_t$$

If we run this regression without a constant term,

$$r_{tm} = \sum_k b_k r_{kt} + \varepsilon_t$$

it looks very much like a portfolio.
Let us do this regression using data 1980-2013, and see what the weights look like.

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Download returns for eight norwegian industries (10-45) for 1980-2013.
Similarly download the value weighted portfolio for the same period.
Regress the market on the eight industries.
This procedure is also termed to *project* the market on the industries

```
> IndustryRets <- IndustryRets[,1:8]
> head(IndustryRets)
          Energy10  Material15  Industry20 ConsDisc25 ConsStapl3
Jan 1980  0.097561  0.01221640  0.02154350  0.0489160  -0.002549
Feb 1980  0.011111  0.07595600  0.04081450  0.1203870   0.082781
Mar 1980 -0.098901 -0.10693300 -0.09349900  0.0128427  -0.045725
...
> Ri <- window(IndustryRets,end=as.yearmon("2013-12"))
> Rm <- window(Rmvw,end=as.yearmon("2013-12"))
```

```
> regr <- lm(Rm ~
+              0
+              + Ri$Energy10
+              + Ri$Material15
+              + Ri$Industry20
+              + Ri$ConsDisc25
+              + Ri$ConsStapl30
+              + Ri$Health35
+              + Ri$Finan40
+              + Ri$IT45 )
```

	Dependent variable: R_m
Energy10	0.170***
	(0.026)
Material15	0.043***
	(0.016)
Industry20	0.298***
	(0.045)
ConsDisc25	0.039
	(0.030)
ConsStapl30	0.178***
	(0.031)
Health35	0.098***
	(0.020)
Finan40	0.148***
	(0.047)
IT45	0.005
	(0.018)
Observations	408
Adjusted R^2	0.783
Note	*p<0.1; **p<0.05; ***p<0.01

If this was a portfolio, the weight should sum to one. Let us look at how close we get:

```
 > sum(coefficients(regr))
[1] 0.9798838
```

Now, to the typical usage of this kind of procedure:
Prediction into the future.
Download the industry returns for 2014.
Use the estimated relationship to predict the return to the value weighted market portfolio.
Compare your prediction with the actual market returns.

```
>                                                    #now look at pred
> Ri <- window(IndustryRets,start=as.yearmon("2014-01"))
> rm <- window(Rmvw,start=as.yearmon("2014-01"))
> Rmpred <- predict.lm(regr,Ri)
> data <- merge(rm,Rmpred)
> print(data)
                    rm         Rmpred
Jan 2014 -0.017441  0.024426508
Feb 2014  0.031665  0.011566819
Mar 2014  0.015775  0.012166395
Apr 2014  0.029255  0.010763492
May 2014  0.049615  0.033303480
Jun 2014  0.025168  0.023292721
Jul 2014 -0.001637  0.016756078
Aug 2014 -0.001261 -0.016250066
Sep 2014  0.003305  0.003561559
Oct 2014 -0.032450 -0.015193497
Nov 2014 -0.026977 -0.017774517
Dec 2014  0.028808  0.028986437
```

	R_m (actual)	R_m (predicted)
2014 Jan	-0.0174	0.0244
2014 Feb	0.0317	0.0116
2014 Mar	0.0158	0.0122
2014 Apr	0.0293	0.0108
2014 May	0.0496	0.0333
2014 Jun	0.0252	0.0233
2014 Jul	-0.0016	0.0168
2014 Aug	-0.0013	-0.0163
2014 Sep	0.0033	0.0036
2014 Oct	-0.0324	-0.0152
2014 Nov	-0.0270	-0.0178
2014 Dec	0.0288	0.0290

This kind of procedure is often called construction of "factor mimicking" portfolios.
In the example the "factor" we are constructing is the value weighted market portfolio.
This type of procedure obviously extends to non-traded "factors," and that is the usage one typically runs into it.

Owen A Lamont. Economic tracking portfolios. *Journal of Econometrics*, 105: 161–184, 2001.

B N Lehmann and David M Modest. The empirical foundations of the Arbitrage Pricing Theory. *Journal of Financial Economics*, 21:213–254, 1988.