JACOBS LEVY EQUITY MANAGEMENT CENTER
FOR QUANTITATIVE FINANCIAL RESEARCH

Risk Premium and Factor Investing:

Trend and Carry in a Lot of Places: But will it continue to hold in the new environment?

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Risk Premium and Factor Investing

1. Trend and Carry as a simplified version of risk premium and factor investing (a higher level of abstraction)

2. Risk-premium based factor investing in a world of low and negative yields: should we continue to believe history will repeat?

3. Need for an updated framework?

A Little Bit of Framework Building
Prices = discounting + risk correction
Risk-premium = insurance premiums for factors

Prices are expectations of risk adjusted discounted payoffs

$$p_t = E_t(m_{t+1}x_{t+1})$$

$$\Rightarrow r_t^f = \delta + \gamma E_t(\Delta ln\, c_{t+1}) - \frac{\gamma^2}{2}\sigma_t^2(\Delta \ln c_{t+1})$$

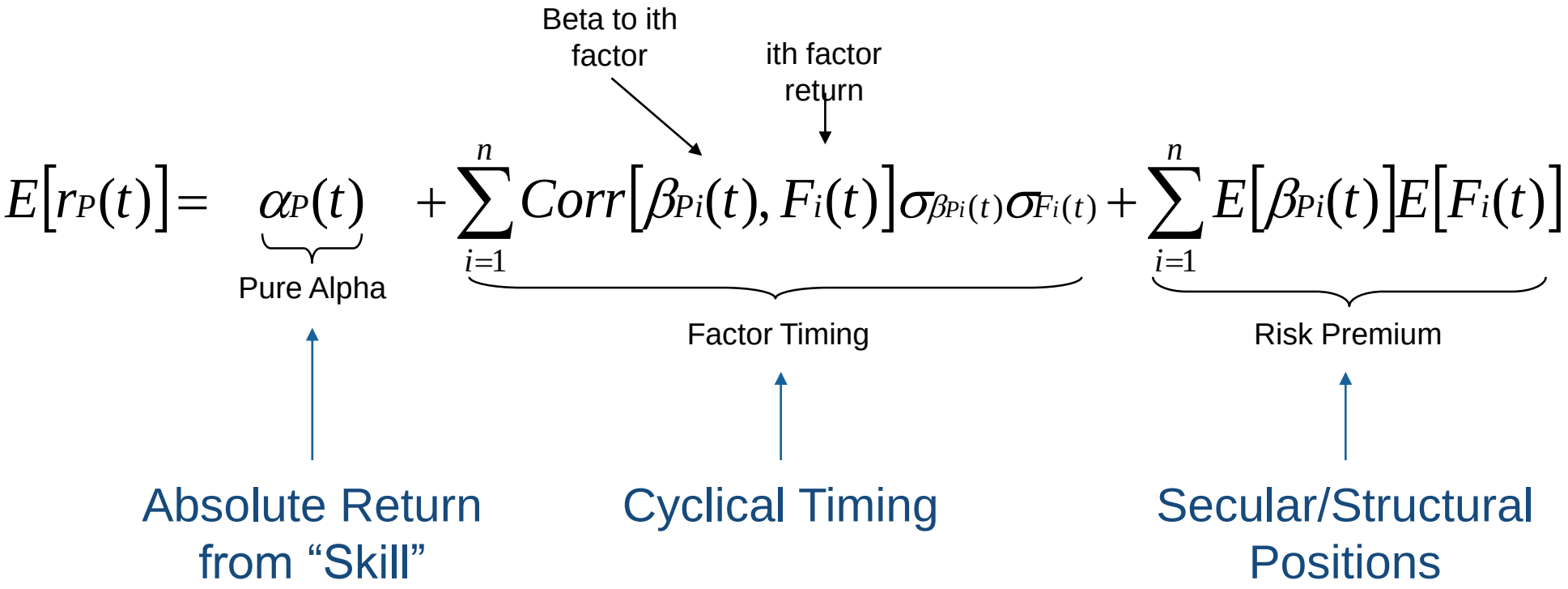
$$p = \frac{E(x)}{1+r^f} + cov(m,x)$$

$m = stochastic\ discount\ factor$
$x = payoff$
$r^f = risk\ free\ rate$
$\gamma = risk\ aversion$
$\sigma = volatility$
$c = consumption$
$F = factor\ return$
$u = utility$

Excess Returns are compensation for being short "insurance"

$$\Rightarrow E(F^i) - R^f = -R^f cov(m, F^i) = -\frac{cov(u'(c_{t+1}), F_{t+1}^i)}{E[u'(c_{t+1})]}$$

Factor Returns can be harvested by structural and cyclical positioning



See also A. Lo, The Active-Passive Decomposition
Lo, Andrew W. (2007), "*Where Do Alphas Come From?": A New Measure of the Value of Active Investment Management*", http://ssrn.com/abstract=985127

Risk premiums can classically be understood as compensation for the covariance term or sale of an implicit or explicit option

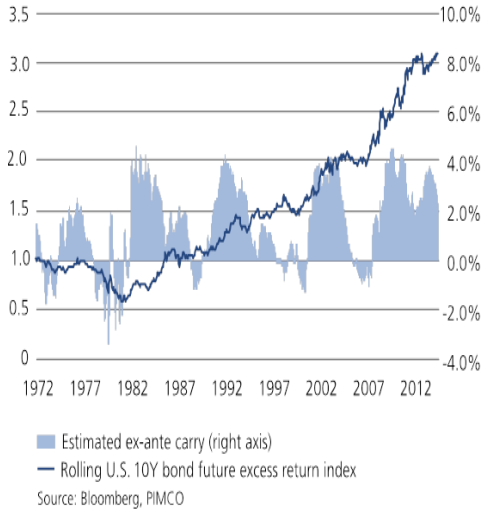
- Credit: Default risk premium
- Equity: Growth risk premium
- Duration: Cash rebalancing premium
- FX Carry: Growth, inflation differential, volatility premium
- Commodity: Hedging pressures premium
- Etc.

Carry and Trend: Summary

Joint work with J. Davis, M. Dorsten and G. Rennison, PIMCO.

- Rule 1: Don’t fight the trend
- Rule 2: Don’t pay too much to invest

Example: Ten Year Futures



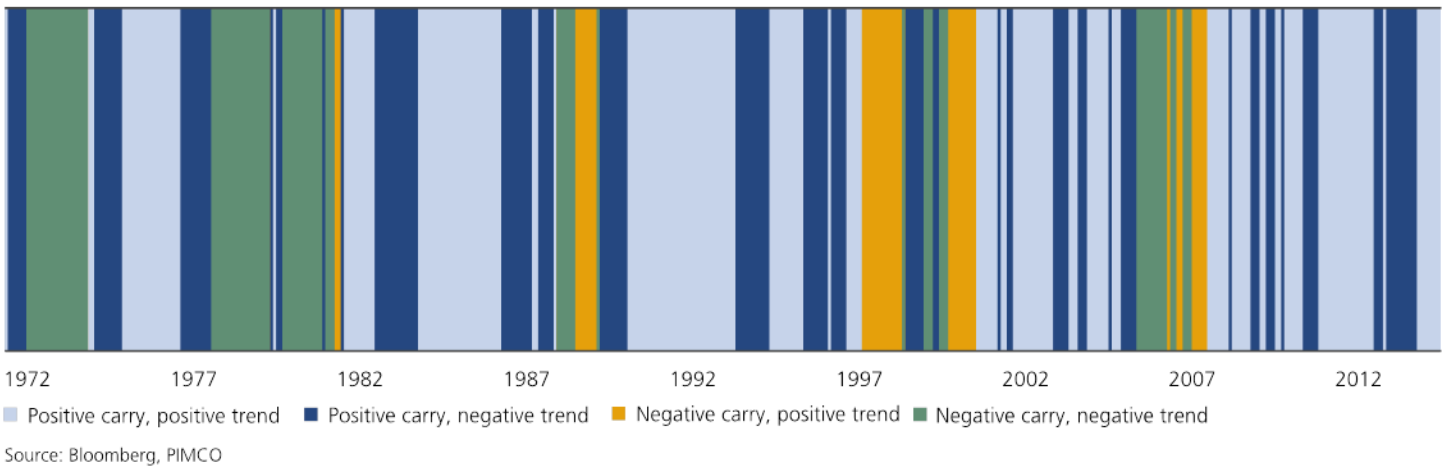


FIGURE 4: AVERAGE RETURNS AND RISK-ADJUSTED RETURNS BY CATEGORY, U.S. 10-YEAR NOTE FUTURES, 1972-2014

Market	Begins	Full sample	Annualized returns by category				Annualized return/volatility by category			
			Carry>0		Carry<0		Carry>0		Carry<0	
		Avg return	*Trend>0*	*Trend<0*	*Trend>0*	*Trend<0*	*Trend>0*	*Trend<0*	*Trend>0*	*Trend<0*
US 10Y Note	Aug '72	2.9%	5.2%	1.6%	3.0%	-4.2%	0.8	0.2	0.5	-0.5

Source: PIMCO

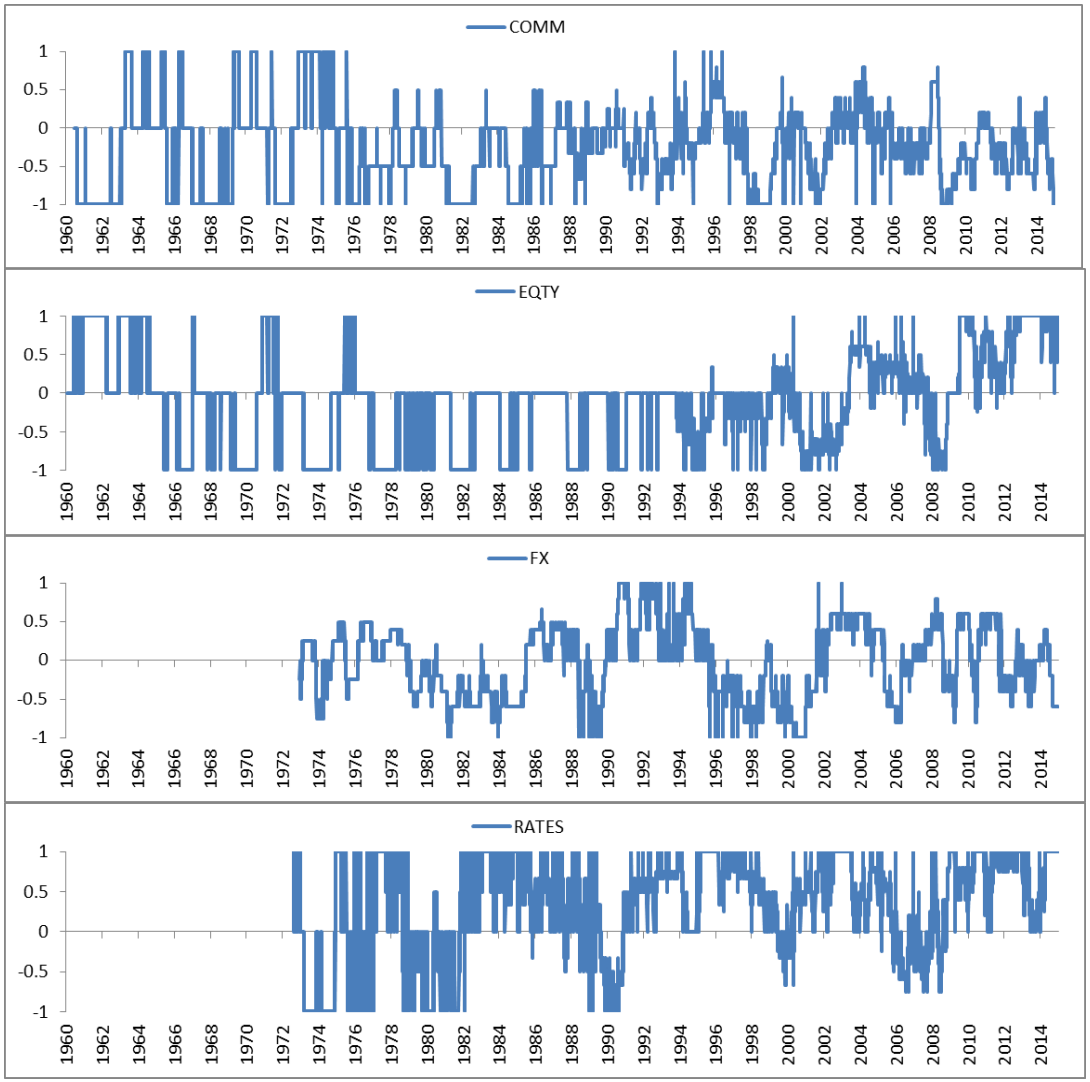
How much time did we spend in each quadrant?

FIGURE 5: PROPORTION OF HISTORY IN EACH CARRY AND TREND CATEGORY BY MARKET

Market	Begins	Frequency by category			
		Carry>0		Carry<0	
		Trend>0	*Trend<0*	*Trend>0*	*Trend<0*
Commodities					
Corn	Jun '60	17.5%	8.6%	19.5%	54.4%
Oil	Apr '87	47.7%	11.4%	11.1%	29.7%
Gold	Jan '76	0.0%	0.0%	48.4%	51.6%
Copper	Dec '89	37.6%	11.7%	17.3%	33.4%
Natural gas	Mar '91	26.0%	10.2%	7.5%	56.4%
Sector average		**25.8%**	**8.4%**	**20.8%**	**45.1%**
Equities					
Nikkei	May '93	41.4%	35.2%	10.8%	12.5%
S&P 500	Jan '60	17.9%	7.2%	48.1%	26.8%
EuroStoxx	Jun '99	44.9%	18.8%	18.0%	18.3%
S&P ASX	Apr '01	21.5%	12.6%	44.2%	21.7%
FTSE 100	May '93	21.9%	7.7%	44.6%	25.9%
Sector average		**29.5%**	**16.3%**	**33.1%**	**21.0%**
Currencies					
AUD	Dec '77	51.9%	31.7%	6.0%	10.5%
GBP	Dec '72	54.0%	35.8%	3.2%	7.1%
EUR	Dec '72	19.8%	10.7%	33.3%	36.1%
JPY	Dec '72	8.1%	3.4%	43.3%	45.2%
CHF	Dec '72	6.1%	4.1%	44.9%	44.9%
Sector average		**28.0%**	**17.1%**	**26.1%**	**28.8%**
Bond futures					
UK gilt	Nov '83	38.1%	15.5%	25.8%	20.6%
JGB	Aug '75	68.0%	16.1%	6.7%	9.1%
Bund	Jul '92	65.5%	22.4%	9.5%	2.6%
US 10Y note	Aug '72	52.9%	23.6%	10.0%	13.5%
Australia 10Y	Jun '02	34.9%	27.4%	17.5%	20.2%
Sector average		**51.9%**	**21.0%**	**13.9%**	**13.2%**

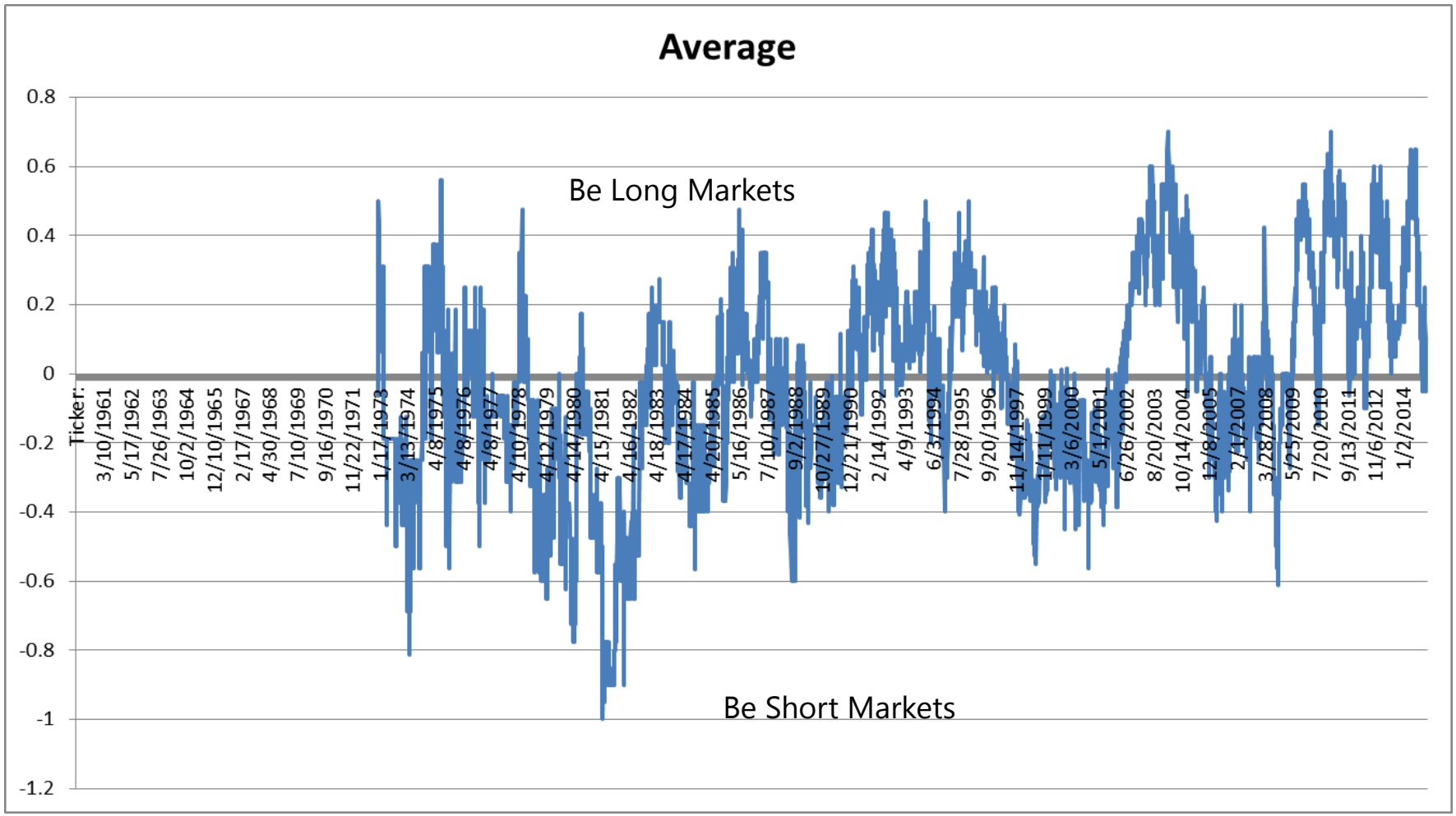
Source: PIMCO

Trend and Carry across time



Indicator:
Assume unit long position. Then,
If Trend and Carry positive, then +1.
If they disagree, 0.
If Both negative, then -1.
Average over each sector.

Average Carry and Trend Indicator across all markets.
A factor timing model of factors



Indicator Statistics (1960-2014) for timing indicator across assets

	COMM	EQTY	FX	RATES	AVERAGE
Mean	-0.23	-0.14	-0.01	0.33	-0.01
Median	-0.20	0.00	0.00	0.50	-0.03
Maximum	1.00	1.00	1.00	1.00	0.70
Minimum	-1.00	-1.00	-1.00	-1.00	-1.00
Std. Dev.	0.47	0.57	0.47	0.58	0.29
Skewness	0.40	0.02	-0.07	-0.76	-0.21
Kurtosis	3.21	2.41	2.03	2.66	2.98
Jarque-Bera	302.67	154.39	426.50	1058.11	76.15
Probability	0.00	0.00	0.00	0.00	0.00
Sum	-2466.58	-1450.60	-150.00	3505.52	-140.42
Sum Sq. Dev.	2307.15	3483.25	2321.13	3559.69	879.22
Observations	10590.00	10590.00	10590.00	10590.00	10590.00

Rank Correlations

	COMM	EQTY	FX	RATES	AVERAGE
COMM	1.00	0.05	0.23	-0.11	0.41
EQTY	0.05	1.00	0.04	0.17	0.60
FX	0.23	0.04	1.00	0.09	0.56
RATES	-0.11	0.17	0.09	1.00	0.57
AVERAGE	0.41	0.60	0.56	0.57	1.00

Carry and Trend Returns over 54 years

FIGURE 6: FULL TABLE OF RESULTS BY MARKET, MAXIMUM AVAILABLE SAMPLE PERIODS 1960-2014

Market	Begins	Full sample	Annualized returns by category				Annualized return/volatility by category			
			Carry>0		Carry<0		Carry>0		Carry<0	
		Avg return	*Trend>0*	*Trend<0*	*Trend>0*	*Trend<0*	*Trend>0*	*Trend<0*	*Trend>0*	*Trend<0*
Commodities										
Corn	Jun '60	-2.2%	21.2%	-8.9%	-5.7%	-7.4%	0.8	-0.4	-0.2	-0.4
Oil	Apr '87	9.7%	27.6%	29.6%	-15.4%	-17.1%	0.8	0.9	-0.5	-0.4
Gold	Jan '76	2.2%	-	-	7.1%	-2.4%	-	-	0.3	-0.1
Copper	Dec '89	8.7%	20.6%	8.1%	1.9%	-0.9%	0.8	0.3	0.1	0.0
Nat gas	Mar '91	-7.1%	10.5%	-46.8%	32.4%	-13.3%	0.2	-1.1	0.9	-0.3
Sector average		**2.3%**	**20.0%**	**-4.5%**	**4.1%**	**-8.2%**	**0.6**	**-0.1**	**0.1**	**-0.3**
Equities										
Nikkei	May '93	2.4%	9.1%	1.9%	-15.6%	-2.5%	0.5	0.1	-1.0	-0.1
S&P 500	Jan '60	5.5%	13.4%	21.4%	6.0%	-4.9%	1.1	0.8	0.5	-0.2
EuroStoxx	Jun '99	3.1%	6.7%	27.4%	7.3%	-35.2%	0.4	0.8	0.4	-1.1
S&P ASX	Apr '01	5.6%	14.9%	10.4%	5.7%	-6.7%	1.2	0.4	0.5	-0.3
FTSE 100	May '93	5.9%	8.4%	29.2%	5.8%	-3.2%	0.6	1.0	0.4	-0.1
Sector average		**4.5%**	**10.5%**	**18.1%**	**1.9%**	**-10.5%**	**0.8**	**0.6**	**0.1**	**-0.4**
Currencies										
AUD	Dec '77	2.5%	5.2%	2.1%	-6.5%	-4.6%	0.5	0.2	-0.9	-0.4
GBP	Dec '72	1.6%	4.7%	-2.1%	-1.5%	-2.0%	0.5	-0.2	-0.2	-0.2
EUR	Dec '72	1.2%	5.8%	3.2%	6.2%	-6.6%	0.6	0.3	0.6	-0.6
JPY	Dec '72	0.1%	5.1%	11.7%	4.7%	-6.1%	0.6	2.3	0.4	-0.6
CHF	Dec '72	1.3%	0.8%	7.4%	4.9%	-2.9%	0.1	0.6	0.4	-0.3
Sector average		**1.3%**	**4.3%**	**4.5%**	**1.6%**	**-4.4%**	**0.4**	**0.6**	**0.1**	**-0.4**
Bond futures										
UK gilt	Nov '83	2.8%	2.8%	4.9%	2.2%	2.0%	0.4	0.6	0.3	0.3
JGB	Aug '75	2.9%	3.7%	5.3%	-2.1%	-3.4%	0.9	0.9	-0.4	-0.6
Bund	Jul '92	4.6%	4.7%	2.6%	6.6%	11.8%	0.9	0.5	1.2	2.1
US 10Y note	Aug '72	2.9%	5.2%	1.6%	3.0%	-4.2%	0.8	0.2	0.5	-0.5
Australia 10Y	Jun '02	2.4%	7.3%	1.6%	-6.8%	3.1%	0.9	0.2	-0.8	0.5
Sector average		**3.1%**	**4.7%**	**3.2%**	**0.6%**	**1.8%**	**0.8**	**0.5**	**0.2**	**0.4**

Source: PIMCO

Carry and Trend Returns over Rising Rates 1960-1982

FIGURE 7: FULL TABLE OF RESULTS BY MARKET, MAXIMUM AVAILABLE SAMPLE PERIOD FROM 1960-1982

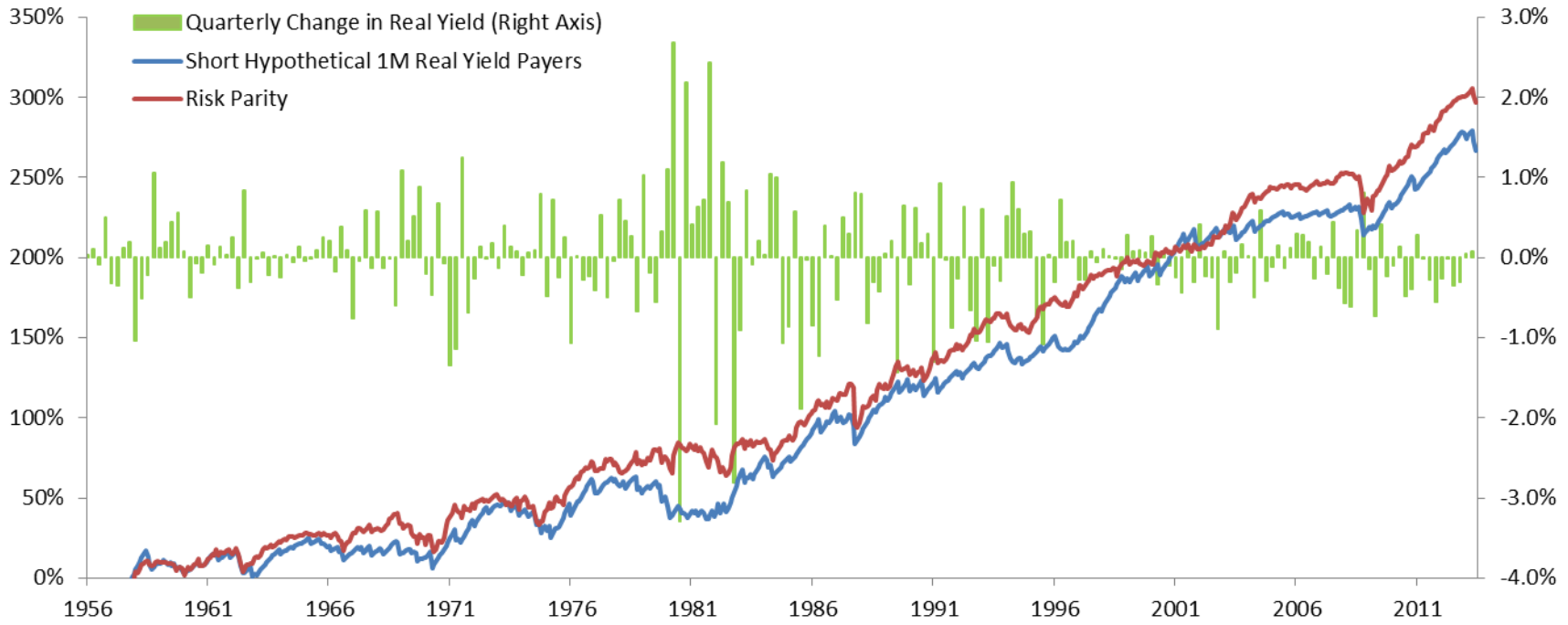
Market	Begins	Full sample	Annualized returns by category				Sharpe ratios by category			
			Carry>0		Carry<0		Carry>0		Carry<0	
		Avg return	*Trend>0*	*Trend<0*	*Trend>0*	*Trend<0*	*Trend>0*	*Trend<0*	*Trend>0*	*Trend<0*
Commodities										
Corn	Jun '60	-0.9%	42.6%	-0.9%	-7.6%	-11.4%	1.6	0.0	-0.4	-0.8
Gold	Jan '76	6.0%			30.8%	-20.6%			1.0	-0.8
Sector average		**2.6%**	**42.6%**	**-0.9%**	**11.6%**	**-16.0%**	**1.6**	**0.0**	**0.3**	**-0.8**
Equities										
S&P 500	Jan '60	1.8%	16.0%	12.9%	5.2%	-11.6%	1.9	0.7	0.5	-0.8
Sector average		**1.8%**	**16.0%**	**12.9%**	**5.2%**	**-11.6%**	**1.9**	**0.7**	**0.5**	**-0.8**
Currencies										
AUD	Dec '77	-0.3%	1.2%	-5.2%	-0.5%	1.9%	0.3	-1.3	-0.1	0.6
GBP	Dec '72	-0.5%	7.9%	-6.9%	-15.5%	-39.1%	1.1	-0.7	-1.8	-3.3
EUR	Dec '72	1.4%	13.9%	3.0%	5.4%	-6.4%	3.3	0.6	0.5	-0.6
JPY	Dec '72	0.4%	1.9%	4.8%	9.8%	-10.6%	0.5	1.4	0.9	-1.0
CHF	Dec '72	2.0%			5.8%	-1.8%			0.4	-0.2
Sector average		**0.6%**	**6.2%**	**-1.1%**	**1.0%**	**-11.2%**	**1.3**	**0.0**	**0.0**	**-0.9**
Bond futures										
JGB	Aug '75	0.1%	6.0%	-1.9%	-2.9%	-2.2%	2.7	-0.6	-0.9	-0.5
US 10Y note	Aug '72	-1.9%	4.7%	-3.8%	-5.6%	-6.6%	0.7	-0.6	-0.8	-0.7
Sector average		**-2.4%**	**5.4%**	**-2.9%**	**-4.2%**	**-4.4%**	**1.7**	**-0.6**	**-0.8**	**-0.6**

Source: PIMCO

Risk Parity and other levered strategies directly lever real rates – they can be characterized as short real-yield options. Carry and Trend in one package

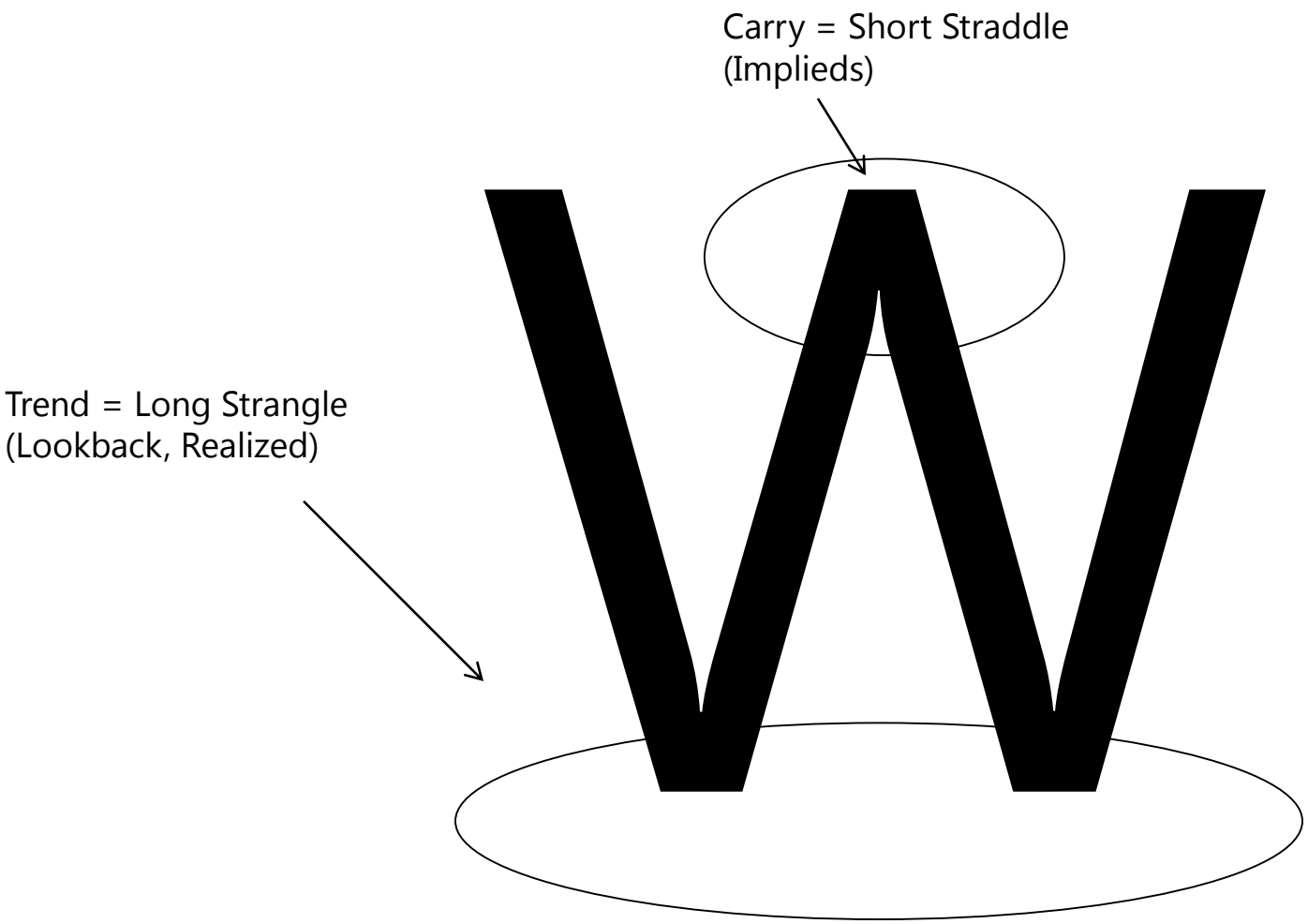
- Chart shows cumulative excess returns of hypothetical monthly sales of 1M 40-delta "real-yield payer swaptions", versus risk parity excess returns.
- Similar return profile, 69% monthly returns correlation.
- **Helps characterize the risk for which this strategy earns a premium.**

- *Implied volatility estimated as 24 month exponential weighted realized volatility multiply by 1.04, the approximate average 1M 10Y IR Swap volatility skew implied vol premium observed since 1994.*



Hypothetical example for illustrative purposes only.

So…Why Does it Work?
Think "Dubya"

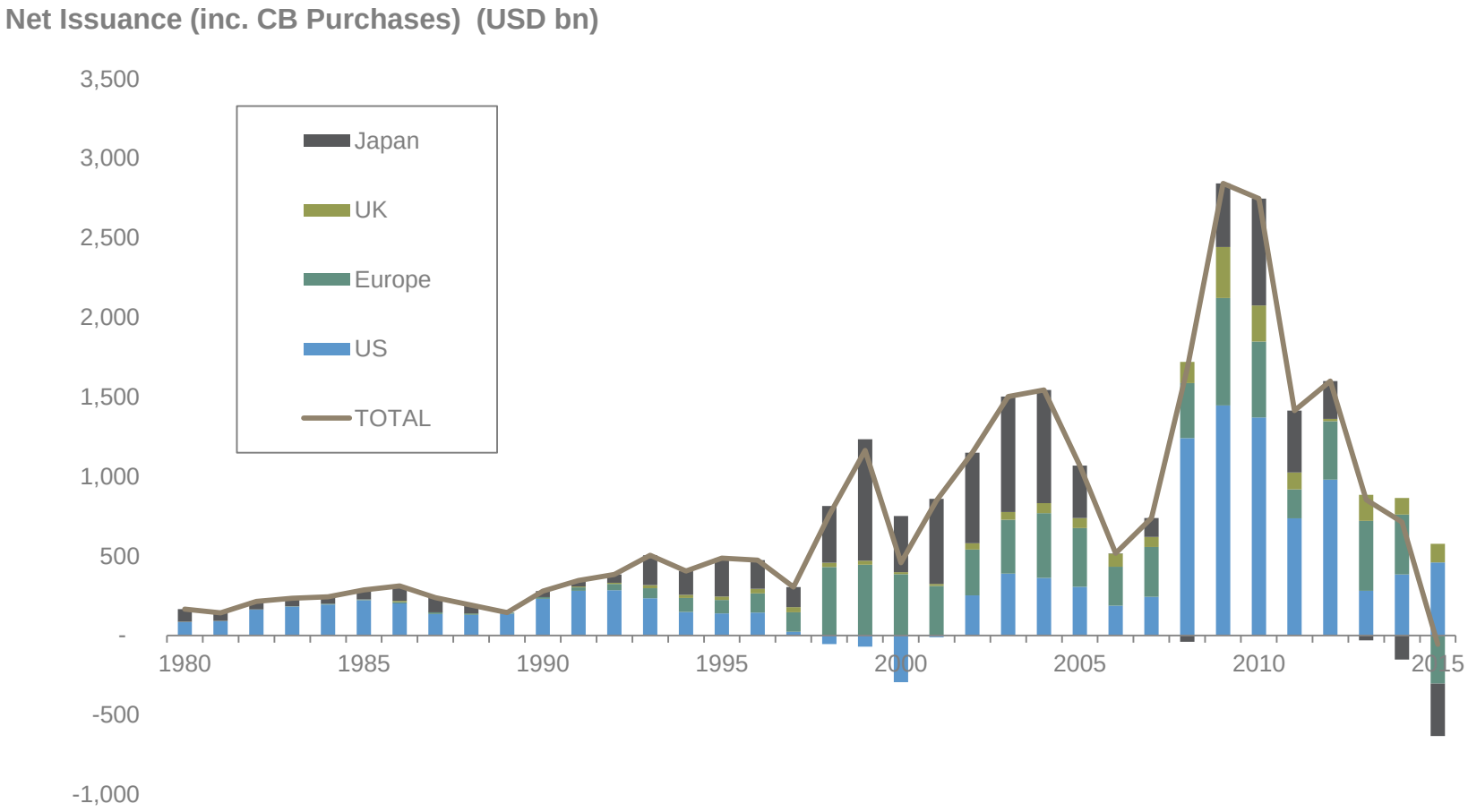


Negative Yields: A time to rethink history and the backtests

"A basic principle of Austrian economics is that the original rate of interest (the rate of discount of future goods compared to the present, otherwise identical, goods) can never be negative. The reason for this arises not because capital is productive, nor out of man's psychology. Rather, it is embedded in the very concept of human action." Walter Block [1978].

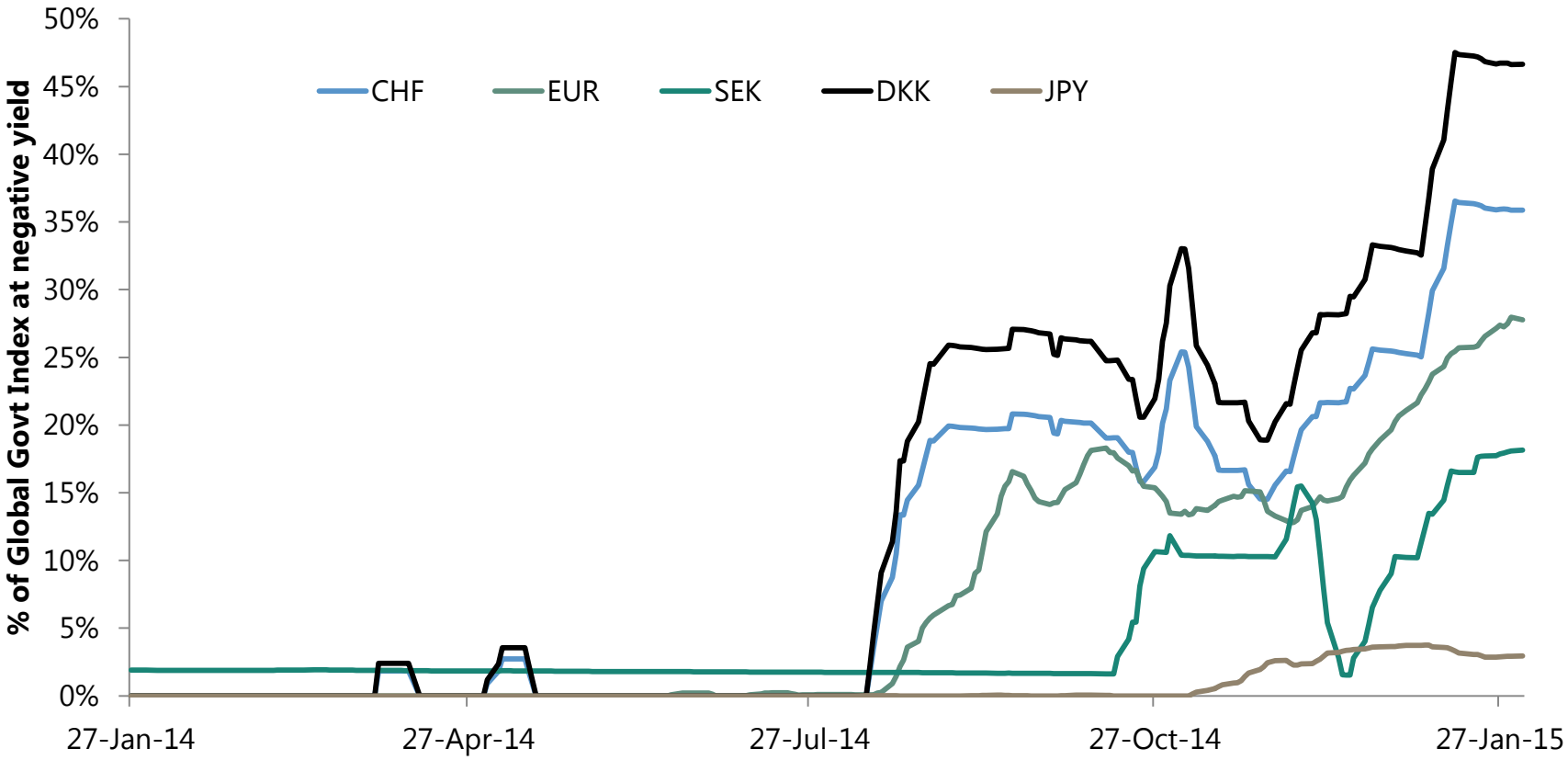
"it may be time […] to go negative", If lowering interest rates stimulates the economy and policy rates are already very low or even zero, then why not keep cutting rates and have negative interest rates? The idea of negative rates, that is, lending 100 and getting back say 95, may seem absurd "but remember this: Early mathematicians thought the idea of a negative number was absurd [too]". Benoit Coeure quoting Greg Mankiw [2014].

Central banks have investors left with fewer assets to buy



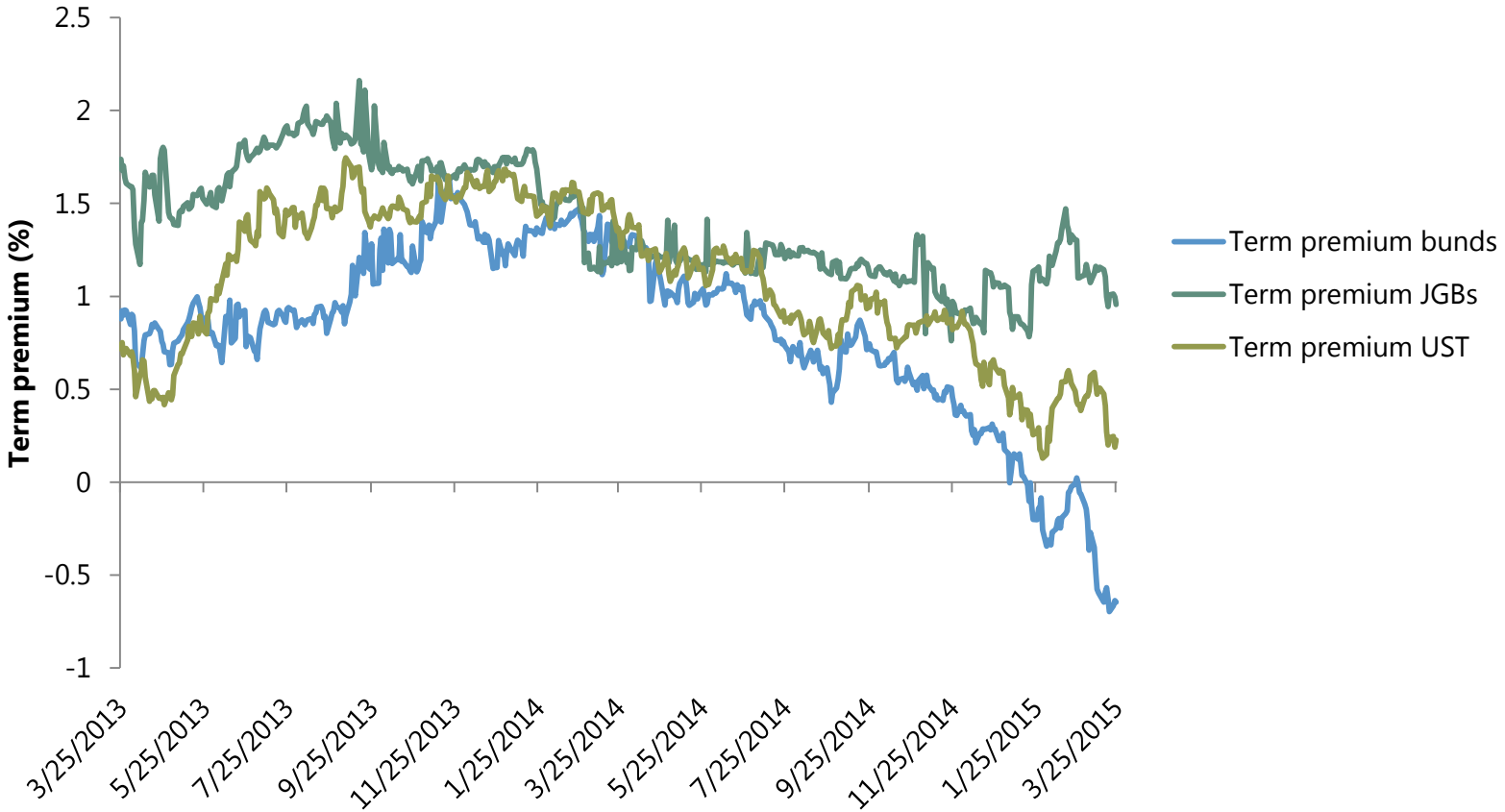
As of February 2015
SOURCE: J.P. Morgan

Part of the Bond Index Universe at Negative Yield



As of February 2015
SOURCE: J.P. Morgan

Falling Term Premiums: Is there duration risk premium when yields are negative?

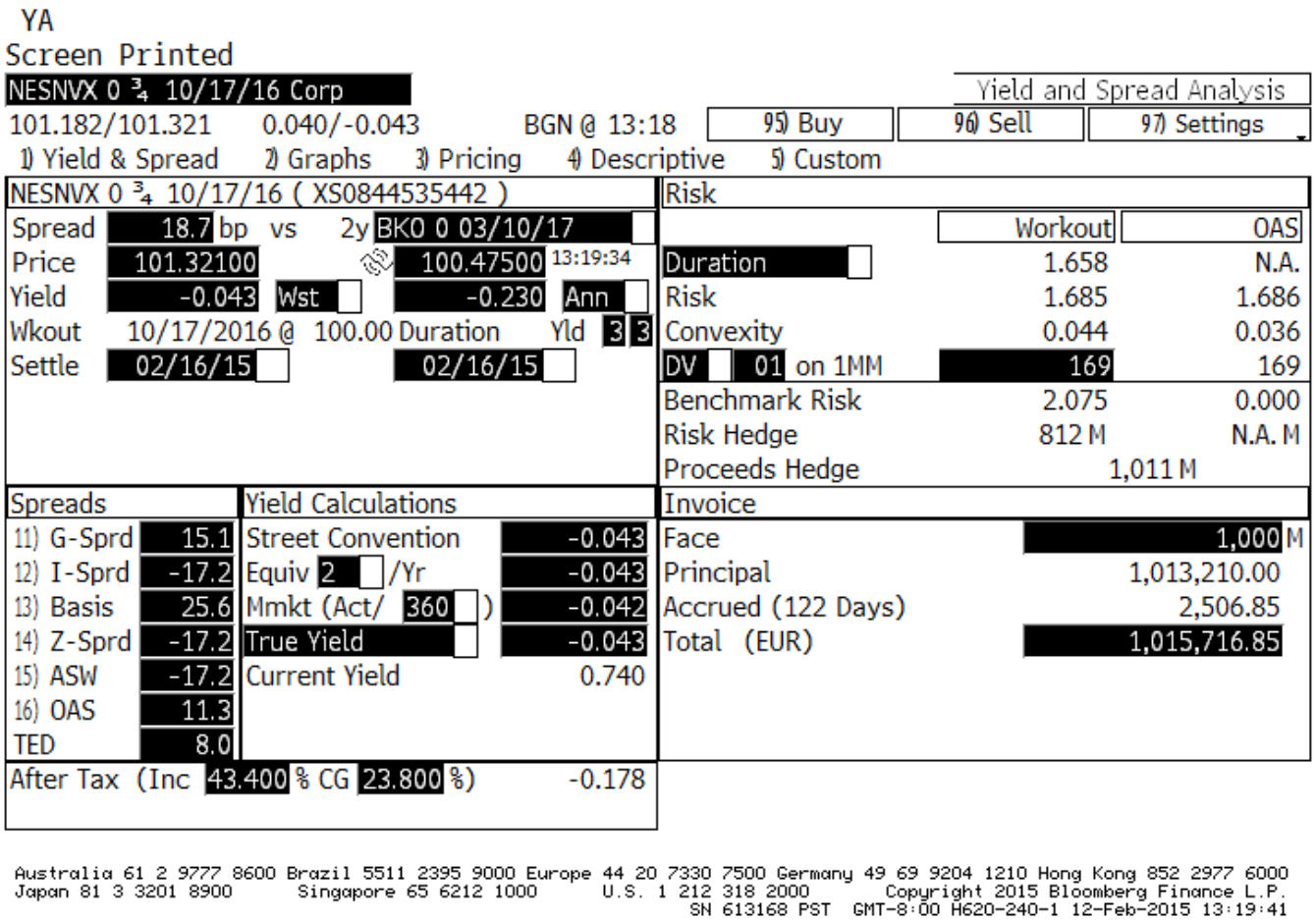


As of 27 March 2015
SOURCE: Bloomberg

Risk-premium could be even lower than yield curve suggests

- Black's original argument:
  - Observed Rate = Shadow Rate+Max[0,-Shadow Rate]
  - Nominal rates = Call options on shadow rates
  - Return to money market investor = Shadow Rate Return + Return on Floor
- So yields = compounded (expectations + risk premia + shadow call)
- So easy to mistake an upward sloping yield curve as source of risk premia rather than premium for shadow rate call

Disappearing Default Premiums: Is there default premium when floater coupons are negative?



SOURCE: Bloomberg

A Modified Classification might be needed

- Are assets (and factors) ex-ante insurance assets or investment assets? This will determine harvesting gains from risk premia.
  - For insurance assets, depending on the money-ness of the insurance, risk premium analysis probably needs to be updated.
  - For investment assets, classical risk premium analysis probably holds for now, but will get challenged.
- Buyer beware: risk premium investing should be environment aware.
  - Factor timing will probably still work, but historical metrics might not be good indicators
- Then, of course, there is alpha…