Carry

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Why Care About Carry?

- Concept of carry almost exclusively applied to currencies
  - Carry = interest rate differential
  - Main empirical findings:
    - High Sharpe ratio
    - Large, sudden crashes
    - Substantial exposure to liquidity shocks
- We generalize the concept of carry to any asset
  - Equities, fixed income, and commodities
  - Carry = "return you earn if prices do not change"

Defining Carry

- S_t is the time-t spot price and F_t the one-month, time-t futures price
- We define the carry as the return on the futures contract assuming $S_{t+1} = S_t$:

$$C_t = \frac{S_t - F_t}{F_t}$$

- Returns equal:

$$r_{t+1} = \frac{S_{t+1} - F_t}{F_t} = \underbrace{C_t + \frac{E_t\left(\Delta S_{t+1}\right)}{F_t}}_{E_t(r_{t+1})} + u_{t+1},$$

where $u_{t+1} = \left(\Delta S_{t+1} - E_t\left(\Delta S_{t+1}\right)\right) / F_t$

$\Rightarrow$ Key question: How does C_t relate to $E_t\left(\Delta S_{t+1}\right) / F_t$

Interpreting Carry

- The currency carry equals:

$$C_t \simeq r_t^f - r_t^{f*},$$

the difference between the local and foreign interest rate

- The equity carry equals:

$$C_t \simeq \frac{E_t^{\mathbb{Q}}\left(D_{t+1}\right)}{S_t} - r_t^f,$$

the difference between the exp. dividend yield and the local rf rate

- The commodity carry equals:

$$C_t \simeq \delta - r_t^f,$$

the difference between the convenience yield and the risk-free rate

- The fixed income carry equals:

$$C_t \simeq \underbrace{y_t^T - r_t^f}_{\text{Slope}} \quad \underbrace{-D^{Modified}\left(y_t^{T-1} - y_t^T\right)}_{\text{Roll down}},$$

the slope of the yield curve and the "roll down"

Defining a Carry Trade Portfolio

- Consider a portfolio of N_t securities, indexed by i, with weights w_t^i
- We let the weight of a security depend on the rank of the carry:

$$w_t^i = z_t \left(rank\left(C_t^i\right) - \frac{N_t + 1}{2} \right),$$

  where N_t denotes the number of securities at time t

- z_t ensures that the sum of the short and the long positions equals -1 and 1, respectively

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- z_t ensures that the sum of the short and the long positions equals -1 and 1, respectively
- Results robust to using linear weights and 30% and 30% short
- The carry of a portfolio is defined as:

$$C_t^{Portfolio} = \sum_{i=1}^{N_t} w_t^i C_t^i,$$

which is always positive for the carry trade portfolio

Carry Signals

- We consider two versions of the carry strategy:
  1. "Current carry:" uses the current, 1-month carry
  2. "Carry1-12:" uses the 12-month moving average of the current carry
- 12-month moving average is not sensitive to seasonal effects
- Particularly relevant for equities and commodities
- We also form a global carry factor (GCF) with weights $\sigma_i^{-1} / \left(\sum_{i=1}^{4} \sigma_i^{-1} \right)$ for the different carry strategies

Data Overview

- Data on futures and spot prices for commodities, fixed income, and equities are from Bloomberg
- Data on currency forward and spot exchange rates are from Datastream
- Business cycle data from ECRI who follow the NBER methodology as closely as possible

Data Overview

- Equity index data from 13 countries

  US, Canada, UK, France, Germany, Spain, Italy, Netherlands, Norway, Switzerland, Japan, Hong Kong, Australia

- Currency data for 19 countries

  Australia, Austria, Belgium, Canada, Denmark, France, Germany, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, UK, Euro

- Data on 23 commodities

  Aluminium, Copper, Nickel, Zinc, Lead, Crude Oil, Gasoil, WTI Crude, Unleaded Gasoline, Heating Oil, Natural Gas, Cotton, Coffee, Cocoa, Sugar, Soybeans, Kansas Wheat, Corn, Wheat, Lean Hogs, Feeder Cattle, Live Cattle

- Fixed income data for 10 countries

  Australia, Canada, Germany, UK, Japan, New Zealand, Norway, Sweden, Switzerland, US

Data Overview

- Sample periods
  - Equities: February 1988 - February 2011
  - Commodities: February 1980 - February 2011
  - Fixed income: October 1991 - February 2011
  - Currencies: October 1983 - February 2011

$\Rightarrow$ For all asset classes, we have more than 20 years of data

Carry Portfolio Returns Within Asset Classes

	Carry Trade: Current Carry	Carry Trade: Carry 1-12	Passive Long: Equal Weighted
		Currencies	
Skewness	-0.83	-0.88	-0.10
Sharpe Ratio	**0.61**	**0.52**	**0.36**
		Global Equities	
Skewness	0.10	0.11	-0.66
Sharpe Ratio	**0.93**	**0.62**	**0.37**
		Commodities	
Skewness	-0.53	-0.92	-0.45
Sharpe Ratio	**0.50**	**0.64**	**0.18**
		Fixed Income	
Skewness	-0.13	-0.01	0.03
Sharpe Ratio	**0.82**	**0.47**	**0.78**
		Diversified Across All Asset Classes	
Skewness	-0.31	-0.44	-1.13
Sharpe Ratio	**1.41**	**0.93**	**0.74**

Correlation Structure Carry Returns

Correlations of Carry Trades: Current Carry

	Equities	Commodities	Fixed income	Currencies
Equities				
Commodities	-0.004			
Fixed income	-0.023	0.019		
Currencies	0.060	0.007	0.230	

Correlations of Carry Trades: Carry 1-12

	Equities	Commodities	Fixed income	Currencies
Equities				
Commodities	0.022			
Fixed income	0.065	-0.122		
Currencies	0.125	0.095	0.210	

- Low unconditional correlations carry strategies, leading to substantial gains to diversify across carry strategies

Risk-adjustment Performance and Exposures

	Equities		Commodities		Fixed income		Currencies	
	Current	1-12	Current	1-12	Current	1-12	Current	1-12
Alpha	0.82%	0.39%	0.79%	1.03%	0.41%	0.27%	0.35%	0.31%
t-stat	4.48	1.99	2.89	3.72	3.13	2.08	2.64	2.42
Passive long	-0.07	0.03	-0.08	-0.19	0.05	-0.07	0.11	0.06
t-stat	-1.38	0.57	-1.02	-1.82	0.64	-0.86	1.87	0.92
Value	0.12	0.32	-0.21	-0.23	-0.05	0.04	0.08	0.03
t-stat	1.19	3.59	-3.10	-3.83	-0.33	0.24	0.70	0.27
Momentum	0.02	0.08	0.28	0.33	0.12	0.06	-0.01	0.00
t-stat	0.18	1.07	4.21	5.67	0.91	0.44	-0.12	-0.03
R-square	1.86%	5.52%	17.04%	23.12%	1.31%	0.64%	2.11%	0.48%
IR (annualized)	0.93	0.45	0.49	0.66	0.80	0.51	0.53	0.48

- Low exposures to standard risk factors
- Results robust to including time-series momentum factor and market/funding liquidity factors

Does the Market Take Back Part of the Carry?

- We start from:

$$r_{t+1} = \frac{S_{t+1} - F_t}{F_t} = \underbrace{C_t + \frac{E_t\left(\Delta S_{t+1}\right)}{F_t}}_{E_t(r_{t+1})} + u_{t+1},$$

- To link expected returns to carry, we consider panel regressions of the form:

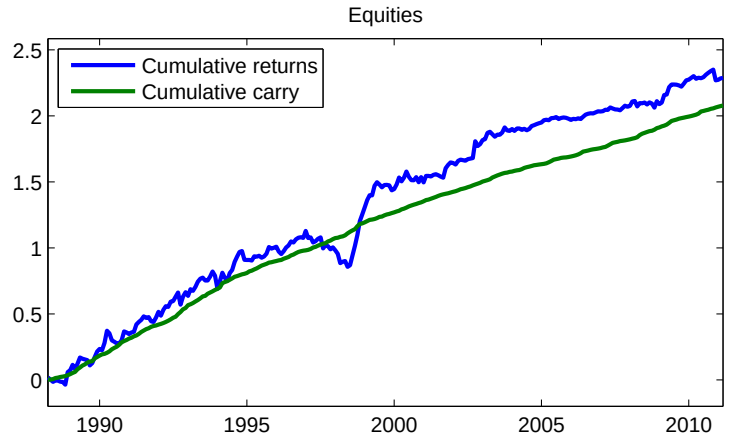
$$r^i_{t+1} = a^i + b_t + cC^i_t + \varepsilon_{i,t+1}$$

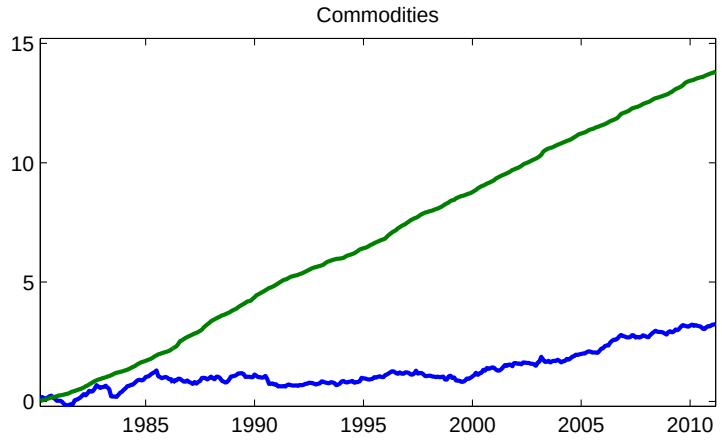
- We consider three cases:
  - Time fixed effects
  - Security fixed effects
  - Both time and security fixed effects
- Results even stronger if we use the rank of the carry instead of carry itself

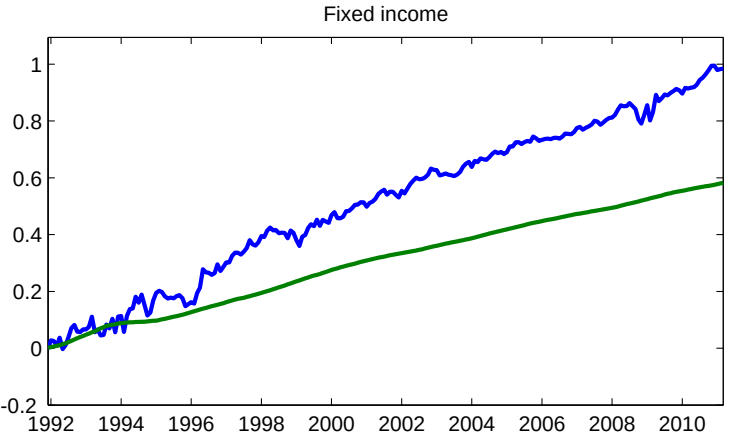
Does the Market Take Back Part of the Carry?

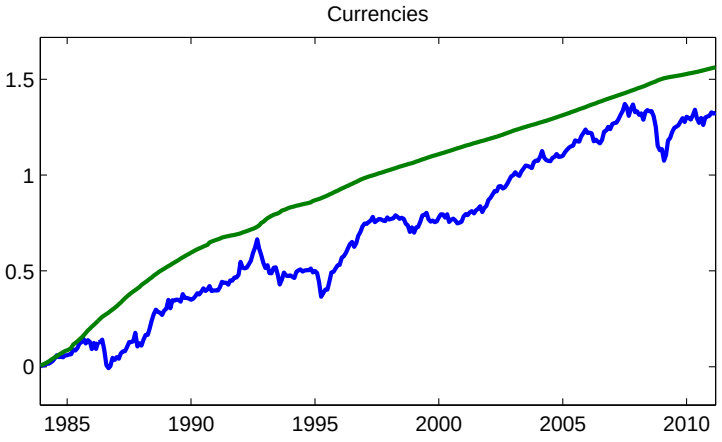
	Global Equities				Commodities			
Slope current carry	1.48	1.21	1.53	1.25	0.05	0.05	-0.01	-0.01
t-stat	3.49	4.27	3.45	4.29	0.56	0.59	-0.06	-0.12
Slope carry 1-12	2.42	1.46	2.89	1.76	0.34	0.41	0.21	0.26
t-stat	3.48	2.82	3.49	2.83	2.87	3.35	1.58	1.94
Contract FE	No	No	Yes	Yes	No	No	Yes	Yes
Time FE	No	Yes	No	Yes	No	Yes	No	Yes
	Fixed Income				**Currencies**			
Slope current carry	1.54	1.64	1.58	1.85	1.24	0.69	1.54	0.90
t-stat	2.64	3.78	2.25	3.63	3.56	2.70	3.03	2.60
Slope carry 1-12	1.52	1.05	1.56	1.03	1.14	0.53	1.48	0.61
t-stat	2.43	2.36	2.04	1.93	3.27	1.71	2.75	1.21
Contract FE	No	No	Yes	Yes	No	No	Yes	Yes
Time FE	No	Yes	No	Yes	No	Yes	No	Yes

Does the Market Take Back Part of the Carry?







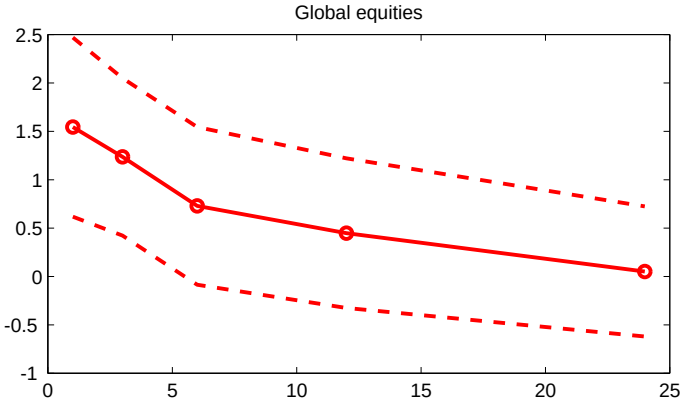


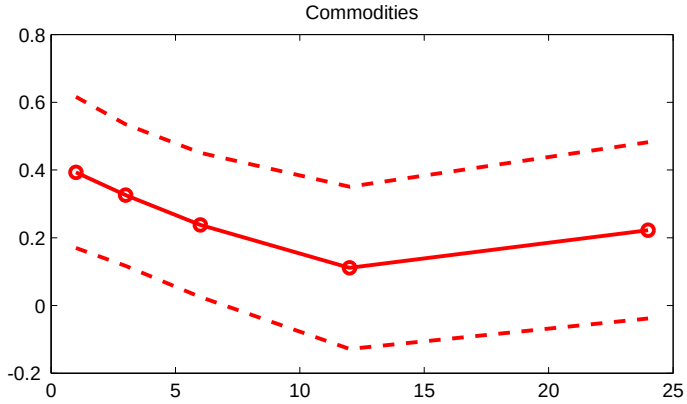
How Long Into the Future Does Carry Predict Returns?

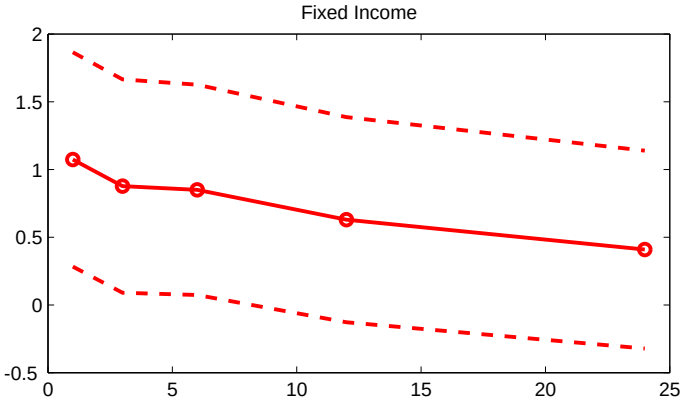
Consider the panel regression, at different horizons

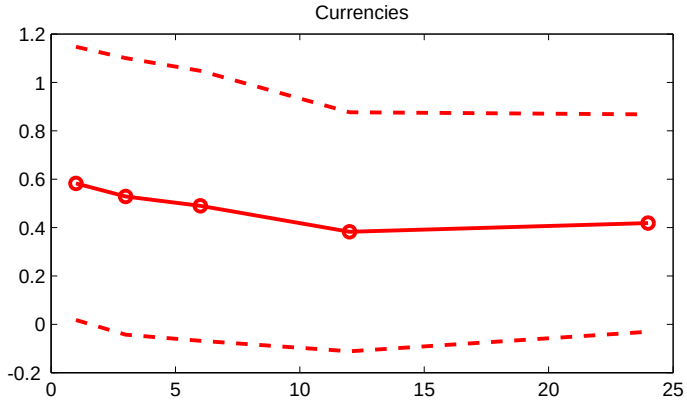
$$r^i_{t+1} = a + b_t + cC^i_{t+1-k} + \varepsilon_{i,t+1},$$

for $k = 1$, 3, 6, 12, and 24









Static and Dynamic Components of Carry Returns

- We can write the expected carry returns as:

$$
\begin{aligned}
E\left(r_{t+1}^{\text{carry trade}}\right) &= E\left(\sum_i w_t^i r_{t+1}^i\right) \\
&= \sum_i E\left(w_t^i\right) E\left(r_{t+1}^i\right) \\
&\quad + \sum_i E\left[\left(w_t^i - E\left(w_t^i\right)\right)\left(r_{t+1}^i - E\left(r_{t+1}^i\right)\right)\right]
\end{aligned}
$$

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&\quad + \sum_i E\left[\left(w_t^i - E\left(w_t^i\right)\right)\left(r_{t+1}^i - E\left(r_{t+1}^i\right)\right)\right]
\end{aligned}
$$

	Mean	Passive	Dynamic	% Dyn.	Mean	Passive	Dynamic	% Dyn.
	Global Equities				**Commodities**			
Current	0.83%	0.00%	0.83%	100%	0.87%	0.65%	0.22%	25%
C1-12	0.55%	0.14%	0.41%	75%	1.13%	0.75%	0.37%	33%
	Fixed Income				**Currencies**			
Current	0.42%	0.09%	0.34%	81%	0.40%	0.18%	0.23%	58%
C1-12	0.24%	0.10%	0.14%	58%	0.34%	0.18%	0.16%	47%

Are Carry Strategies Risky?

- Carry strategies result in high Sharpe ratios in different asset classes
- However, low exposures to known risk factors (value, momentum, liquidity)
- Negative skewness is particular to currencies
- Are carry strategies risky?

Regional Carry Strategies

- To relate carry strategies to macro-economic risk, it is easier to study carry strategies based on broad regions / groups
- Equities, fixed income, and currencies:
  1. North America
  2. Continental Europe
  3. United Kingdom
  4. Asia
  5. New Zealand / Australia
- Commodities
  1. Metals
  2. Energy
  3. Aggriculturals and livestock

Regional Carry Strategies

	Carry Trade: Current Carry	Carry Trade: Carry1-12
	Global Equities	
Skew	0.39	0.12
SR	0.65	0.47

	Carry Trade: Current Carry	Carry Trade: Carry1-12
	Commodities	
Skew	0.24	-0.07
SR	0.60	0.47

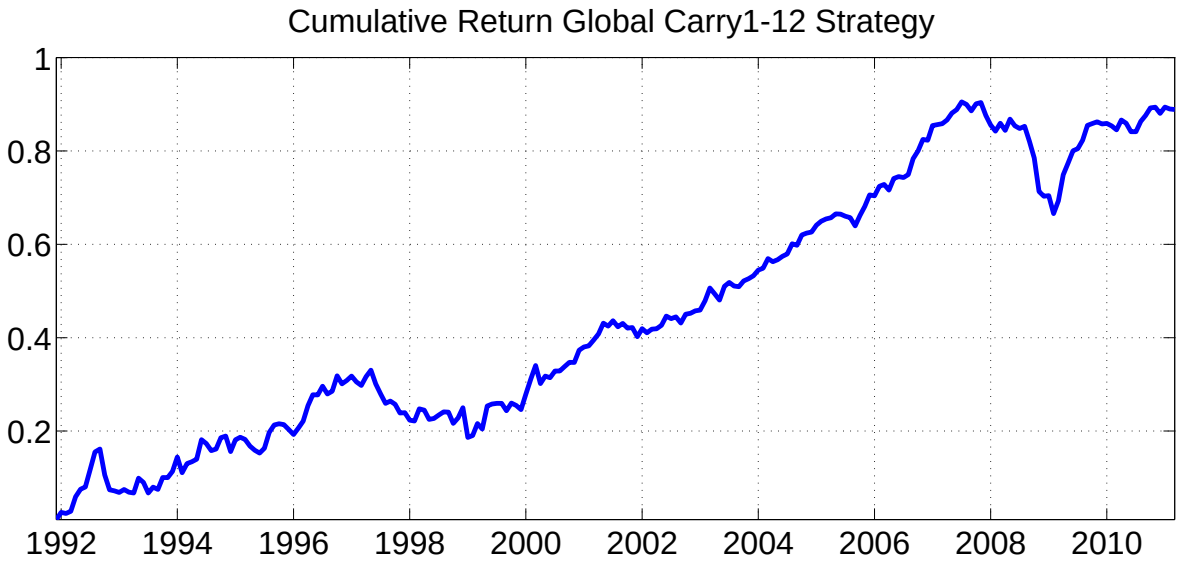
	Carry Trade: Current Carry	Carry Trade: Carry1-12
	Fixed Income	
Skew	-0.04	-0.15
SR	0.59	0.38

	Carry Trade: Current Carry	Carry Trade: Carry1-12
	Currencies	
Skew	-1.07	-1.11
SR	0.45	0.40

	Carry Trade: Current Carry	Carry Trade: Carry1-12
	Global carry factor	
Skew	-0.02	-0.58
SR	1.10	0.73

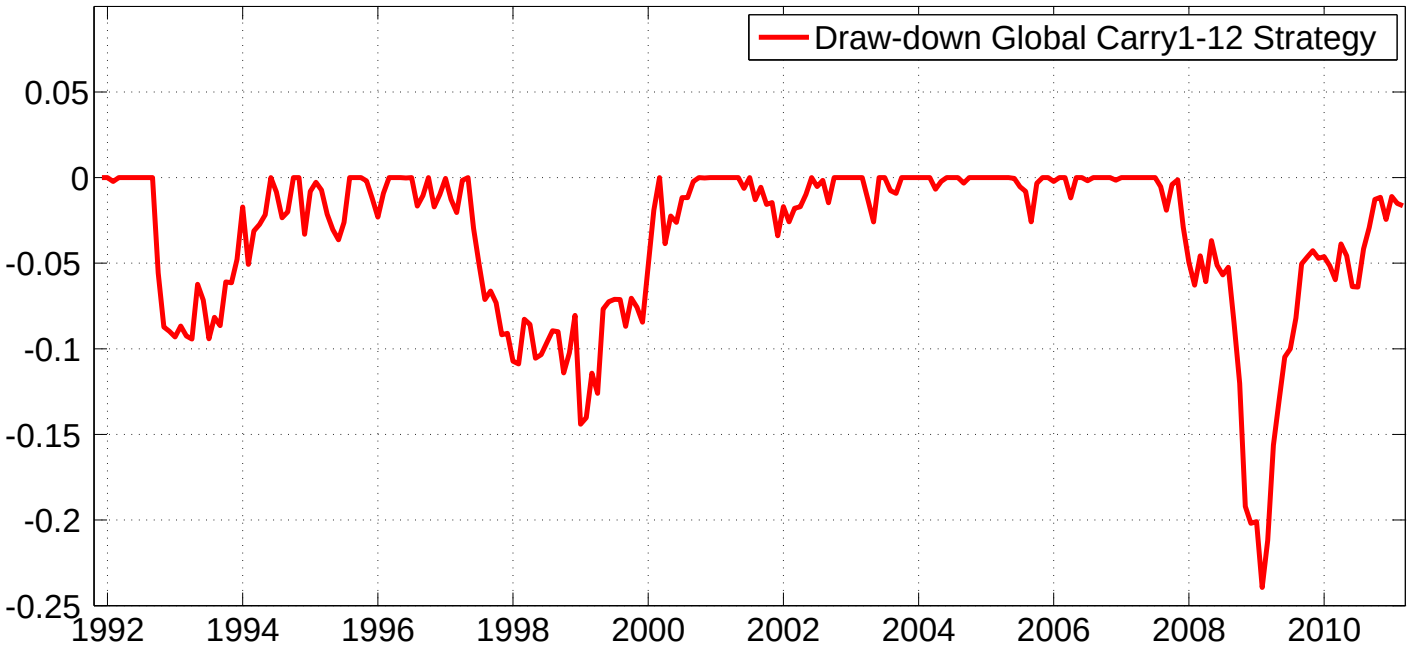
$\Rightarrow$ Important component of carry strategies comes from bets across, instead of within, regions

Cumulative Returns Global Carry Factor



Carry Downturns

Define "carry downturns" based on $D_t = \sum_{s=1}^{t} r_s - \max_{u \in \{1,\ldots,t\}} \sum_{s=1}^{u} r_s$



Carry downturns:

- August 1992 - March 1993
- April 1997 - December 1998
- June 2007 - January 2009

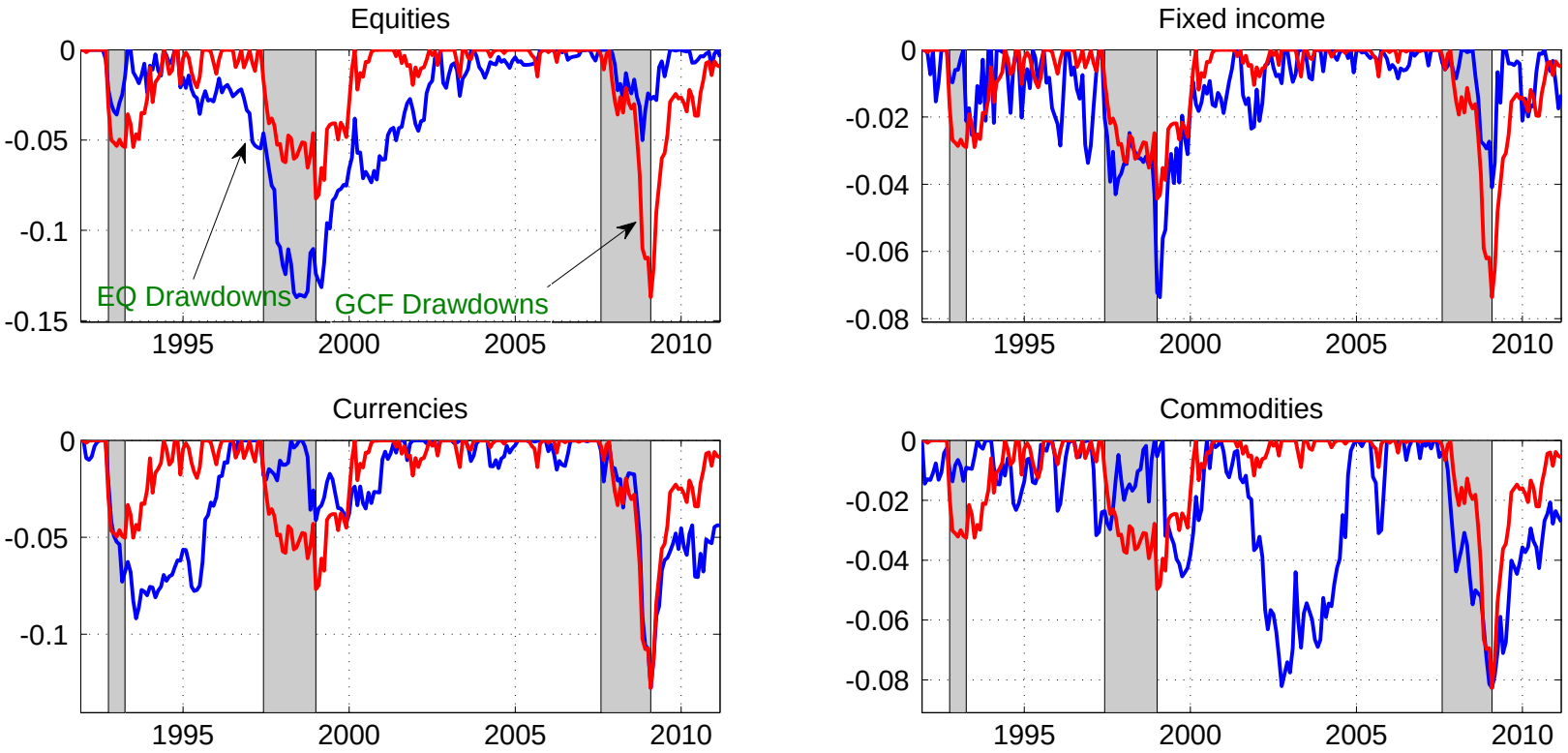
Carry Downturns: Returns per Asset Class

	Carry Trade: Current Carry				Carry Trade: Carry1-12			
Ave. ret.	EQ	CO	FI	FX	EQ	CO	FI	FX
Expansions	7.1%	27.5%	6.1%	10.7%	8.0%	17.9%	5.4%	11.2%
Downturns	0.7%	2.8%	-2.1%	-19.0%	-9.0%	-13.6%	-7.4%	-22.6%
Downturns	EQ	CO	FI	FX	EQ	CO	FI	FX
8/92-3/93	-17.4%	8.9%	-4.4%	-40.8%	-6.8%	-11.8%	-4.4%	-43.4%
4/97-12/98	0.4%	-5.8%	-1.7%	-6.5%	-16.5%	21.8%	-11.3%	-8.2%
6/07-1/09	7.7%	9.5%	-1.7%	-24.2%	-1.9%	-51.5%	-4.4%	-30.1%

Carry Strategies Using Individual Contracts

Ave. ret.	EQ	CO	FI	FX	EQ	CO	FI	FX
Expansions	9.7%	15.4%	6.2%	9.9%	7.9%	12.2%	4.4%	9.6%
Downturns	8.8%	5.1%	0.7%	-14.1%	-2.4%	1.2%	-2.8%	-17.6%

Carry Downturns: Returns per Asset Class



Carry Downturns: Economic Activity and Liquidity

Average macro and liquidity variables	Carry expansions	Carry downturns
Global recession dummy	0.17	0.35
Global liquidity shocks	0.04	-0.21

- Carry downturns tend to correspond to low returns in all asset classes
- Carry downturns coincide with low levels of economic activity and liquidity crises

Carry Downturns Measure Global Recessions

		NA	CE	UK	AS	AUS/NZ	Average
EQ	Downturn	-0.41	-2.09	-1.65	-15.18	-37.28	-11.32
	Expansion	9.33	9.02	5.00	8.65	11.20	8.64
FI	Downturn	13.62	12.24	15.41	6.47	16.09	12.76
	Expansion	3.80	3.27	1.50	5.36	0.57	2.90
FX	Downturn	-3.61	-5.53	-12.34	10.68	-12.97	-4.76
	Expansion	1.67	3.88	4.89	-2.68	8.73	3.30

		Energy	Aggs/LS	Metals	Average
CO	Downturn	-31.20	-11.38	-38.50	-27.03
	Expansion	13.83	3.25	19.46	12.18

Carry Downturns and Passive/Dynamic Decomposition

		Total	Dynamic	% Dynamic
Equities	Carry downturn	-9.01	-0.19	2%
	Carry expansion	8.03	7.55	94%
Fixed income	Carry downturn	-7.39	-2.51	34%
	Carry expansion	5.41	3.05	56%
Currencies	Carry downturn	-22.58	-5.67	25%
	Carry expansion	11.21	3.89	35%
Commodities	Carry downturn	-13.60	-6.30	46%
	Carry expansion	17.94	13.39	75%

		% Dynamic
Average	Carry downturn	27%
	Carry expansion	65%
Average w/o FX	Carry downturn	27%
	Carry expansion	75%

- Carry downturns largely driven by the passive component

Conclusion

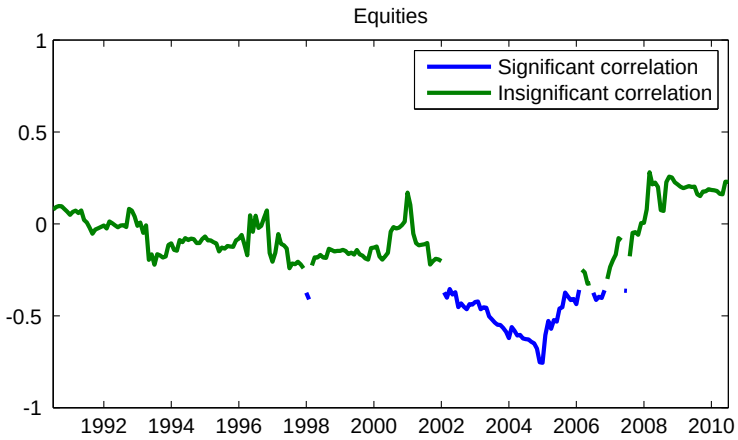
- Carry is an important component of expected returns
  - Directly observable
  - Predicts returns in the cross-section and time series
- Carry strategies are risky
  - "Carry downturns:" Carry strategies across asset classes do poorly
  - Carry downturns coincide with global recessions and liquidity crises

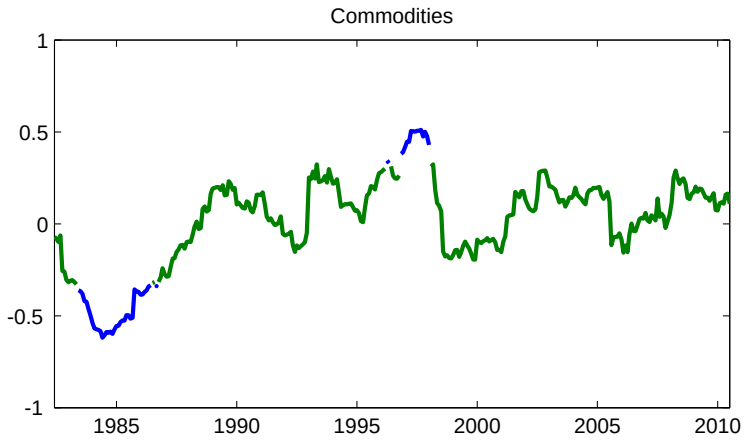
  $\Rightarrow$ Carry is a bet on global recessions across asset classes
- Most macro-finance models have direct implications for carry strategies and hence a useful new set of moments to calibrate models to
- Extensions in progress:
  - Option strategies
  - Credits *within* countries $\Rightarrow$ SR/IR in the US 0.3/0.3
  - Government bonds *within* countries $\Rightarrow$ SR/IR in the US 0.4/0.3

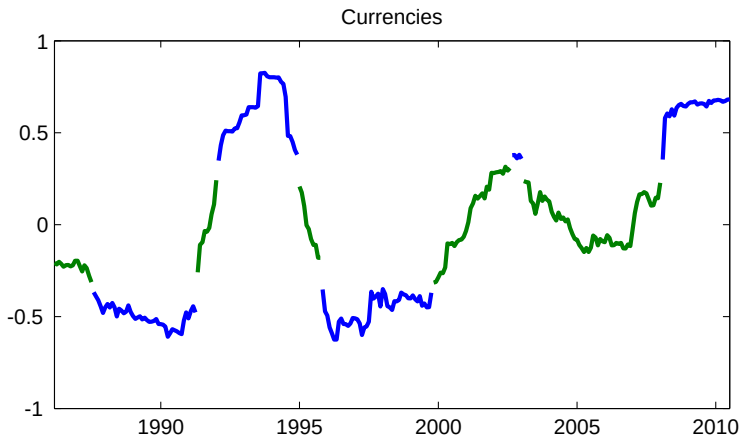
Carry signals and business cycles

- Carry signals are related to:
  - Dividend yields / short rates (equity carry)
  - Yield spreads (bond carry)
  - Convenience yields (commodity carry)
  - Short rates (currency carry)
- All signals strongly co-move with business cycles

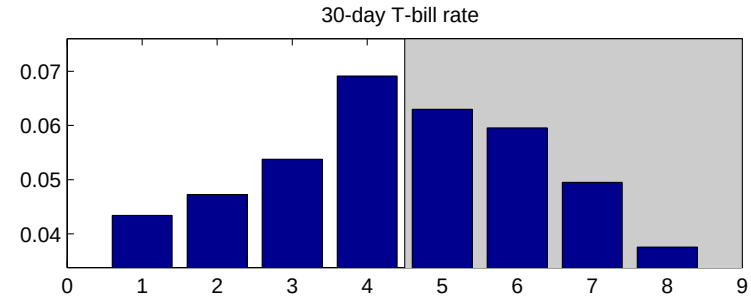
Time-varying correlations

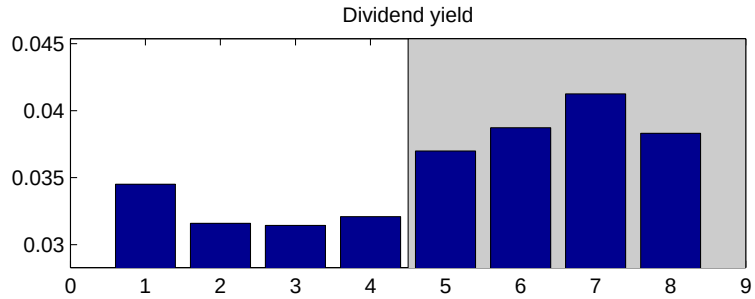


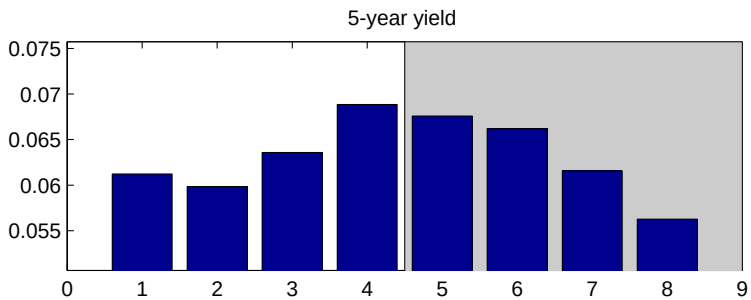


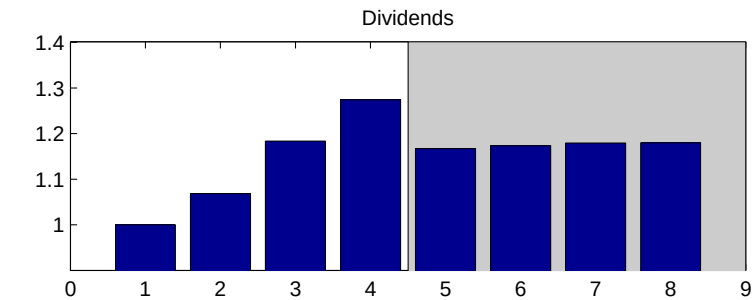


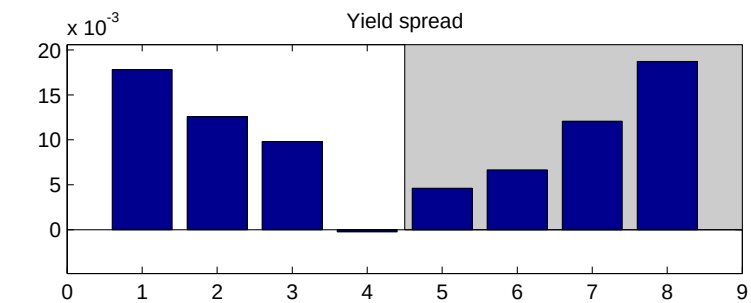
Carry signals and US business cycle

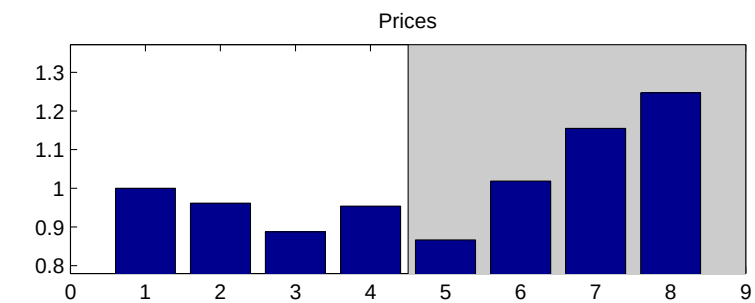












Does the Carry of a Portfolio Predict Carry Returns?

	Current carry returns predicted by current carry	Carry 1-12: Predicted by its Carry 1-12	Passive Long: Predicted by its Current Carry	Passive Long Predicted by Carry 1-12
		Global Equities		
Carry	1.29	2.52	1.84	3.38
t-stat	2.58	2.62	1.49	2.10
R-square	0.03	0.03	0.01	0.02
		Commodities		
Carry	-0.06	0.18	0.09	0.15
t-stat	-0.28	0.32	0.35	0.39
R-square	0.00	0.00	0.00	0.00
		Fixed Income		
Carry	0.43	-0.06	0.72	1.11
t-stat	0.23	-0.02	0.65	0.96
R-square	0.00	0.00	0.00	0.00
		Currencies		
Carry	0.03	-0.22	2.48	2.56
t-stat	0.05	-0.31	2.99	3.02
R-square	0.00	0.00	0.03	0.03

Cumulative Returns During Carry Downturns: FX