Exchange Rates and Commodity Prices

Séminaire de la Chaire Finance et Développement Durable
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Motivation

- Explaining exchange rate behaviour using economic fundamentals: a long-standing puzzle in IF
- Commodity prices: an attractive laboratory for the study of this relationship
  - Literature documents a long-run link but direction of causality remains largely unclear
- Can we learn anything about exchange rates using commodity prices, especially in the short-run?

This paper

- Builds on the debate that studies the elusive link between exchange rates and economic fundamentals using commodity prices
- Novelty: employment of a large cross section in an **asset pricing framework**
- In particular: a trading strategy based on exchange rate forecasting that conditions on changes in commodity prices indices
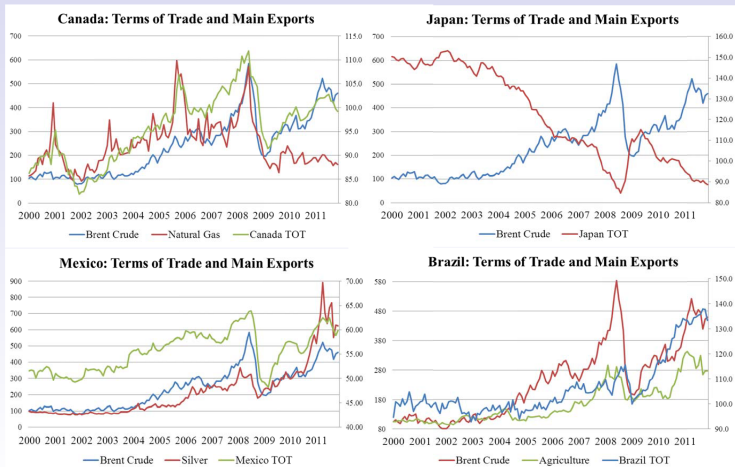
Contribution

- Contribution to literature studying the cross-section of currency returns:
  - Novel strategy with theoretical underpinnings
- Contribution to IF literature:
  - Provide more evidence on the link between exchange rates and economic fundamentals
  - Explore the cross-sectional dimension of currency returns using an asset pricing framework
  - Extend the country panel to include both commodity exporters and importers

Channel

- Theoretical relationship between commodity prices and currencies relies on simple intuition
- For commodity exporters, fluctuations in world commodity prices explain a large share of movements in their terms of trade (Bidarkota and Crucini (2000))
- This is, in turn, a key determinant to exchange rate fluctuations (De Gregorio and Wolf (1994))

Channel

Canada: Terms of Trade and Main Exports

Japan: Terms of Trade and Main Exports

Mexico: Terms of Trade and Main Exports

Brazil: Terms of Trade and Main Exports

Main findings

- Forecasting ability of commodity prices for the exchange rate
- A trading strategy that exploits this relationship leads to economically significant returns
- The strategy works across different sub-samples and fares particularly well during the crisis period
- The returns appear to be uncorrelated to the returns of popular exchange rate strategies
- The relationship is relevant for a broader set of currencies besides commodity currencies

Methodology

- Build a country-specific commodity strategy by taking into account the countries' most important commodity imports and exports
- Employ tradable commodity price indices to circumvent potential liquidity issues
- Assess the **economic** value of the OOS forecasting power of the strategy:
  - Sort the currencies in portfolios according to the strategy's predictions (Lustig and Verdelhan (2007))

Selected Literature Review

- Commodity Currencies Literature: Cashin, Cespedes and Sahay (2002), Chen and Rogoff (2003), Chen, Rogoff and Rossi (2010) and Ferraro, Rogoff and Rossi (2012).
- Portfolio Approach: Lustig and Verdelhan (2007), Lustig, Roussanov, and Verdelhan (2011), Menkhoff, Sarno, Schmeling and Schrimpf (2012a)

- $\Delta s_{k,t+1} = \alpha_k + \sum_{m \in M} \beta_{k,m} \Delta p_{t,m} + u_{k,t+1}$

Countries and Commodities

Table: Countries and Commodities

Country	Commodity Indices			
Australia	Gold	Wheat	Aluminium	Brent
Brazil	Agriculture	Brent		
Bulgaria	Copper	Energy	Brent	
Canada	Natural Gas	Brent		
Chile	Copper	Brent		
Croatia	Natural Gas	Brent		
Czech Republic	Brent			
Germany	Brent			
Hungary	Brent			
India	Precious Metals	Brent		
Indonesia	Natural Gas	Brent		
Israel	Brent			
Japan	Brent			
Mexico	Silver	Brent		
New Zealand	Livestock	Aluminium	Brent	
Norway	Natural Gas	Brent	Industrial Metals	
Philippines	Brent			
Poland	Brent			
Russian Federation	Natural Gas	Brent		
Singapore	Brent			
South Africa	Gold	Brent		
Sweden	Brent			
Switzerland	Industrial Metals	Brent		
Thailand	Brent			
United Kingdom	Brent			

Placebo Tests

Australia							Brazil			
Gold	-0.035	**	Live Cattle	-0.028	Agricultural	-0.036	**	Aluminum	-0.022
All Wheat	-0.023	**	Energy	0.000	Brent Crude	-0.008	*	Silver	-0.005
Aluminum	-0.021	*	Natural Gas	-0.007				Energy	-0.004

Granger-Causality Tests

In-sample Analysis: Granger-Causality Tests

Granger-Causality Tests: Commodities to Currencies

Country	Commodity Indices			
Australia	Gold	Wheat	Aluminium	Brent
	0.004***	0.002***	0.062*	0.159
Brazil	Agriculturals	Brent		
	0.012**	0.239		
Bulgaria	Copper	Energy	Brent	
	0.072*	0.173	0.477	
Canada	Natural Gas	Brent		
	0.182	0.013**		
Chile	Copper	Brent		
	0.221	0.268		
India	Precious Metals	Brent		
	0.000*	0.046**		
Israel	Brent			
	0.026**			
Japan	Brent			
	0.218			
Mexico	Silver	Brent		
	0.682	0.006***		
New Zealand	Livestock	Aluminium	Brent	
	0.805	0.679	0.444	
Norway	Natural Gas	Industrial Metals	Brent	
	0.052*	0.260	0.001***	
Philippines	Brent			
	0.001***			
Russian Federation	Natural Gas	Brent		
	0.295	0.003***		
United Kingdom	Brent			
	0.092*			

Granger-Causality Tests: Currencies to Commodities

Country	Commodity Indices			
Australia	Gold	Wheat	Aluminium	Brent
	0.363	0.022**	0.458	0.181
Brazil	Agriculturals	Brent		
	0.003***	0.839		
Bulgaria	Copper	Energy	Brent	
	0.080*	0.709	0.646	
Canada	Natural Gas	Brent		
	0.689	0.506		
Chile	Copper	Brent		
	0.515	0.912		
India	Precious Metals	Brent		
	0.347	0.754		
Israel	Brent			
	0.717			
Japan	Brent			
	0.244			
Mexico	Silver	Brent		
	0.093*	0.153		
New Zealand	Livestock	Aluminium	Brent	
	0.029**	0.562	0.202	
Norway	Natural Gas	Industrial Metals	Brent	
	0.833	0.418	0.772	
Philippines	Brent			
	0.186			
Russian Federation	Natural Gas	Brent		
	0.096*	0.770		
United Kingdom	Brent			
	0.711			

Out-of-Sample Forecasting

Out-of-Sample Forecasting:
Performance Relative to the Random Walk Benchmark

Out-of-Sample Forecasting Ability: Commodities to Currencies

MSFE Difference Between the "Commodity Price Model" and the Random Walk				
Country	Australia	Poland	Hungary	Sweden	Norway
MSFE dif.	0.025	0.030*	0.024	0.024	0.036**
t-statistic	1.202	1.562	1.273	1.093	1.815
Country	Czech Republic	New Zealand	South Africa	Germany	Bulgaria
MSFE dif.	0.021	0.019	0.001	0.029*	0.043**
t-statistic	0.999	0.936	0.051	1.380	2.047
Country	Canada	Croatia	Indonesia	Mexico	Brazil
MSFE dif.	0.037**	0.057***	0.058***	0.028**	0.054***
t-statistic	1.759	2.760	2.775	1.364	2.608
Country	Switzerland	Russian Federation	Chile	Israel	India
MSFE dif.	0.015	0.105***	0.052***	0.040**	0.094***
t-statistic	0.735	5.027	2.480	1.906	4.529
Country	Singapore	Thailand	Philippines	United Kingdom	Japan
MSFE dif.	0.025	0.031*	0.091***	0.048**	0.010
t-statistic	1.185	1.489	4.351	2.319	0.470

Out-of-Sample Forecasting Ability: Currencies to Commodities (Crude)

MSFE Difference Between the "Exchange Rate Model" and the Random Walk				
Country	Australia	Poland	Hungary	Sweden	Norway
MSFE dif.	-0.008	0.004	0.017	0.005	-0.008
t-statistic	-0.382	0.172	0.838	0.254	-0.397
Country	Czech Republic	New Zealand	South Africa	Germany	Bulgaria
MSFE dif.	0.003	-0.013	0.0165	-0.006	0.004
t-statistic	0.143	-0.635	0.790	-0.290	0.196
Country	Canada	Croatia	Indonesia	Mexico	Brazil
MSFE dif.	-0.010	0.010	0.003	-0.018	0.002
t-statistic	-0.456	0.473	0.120	-0.877	0.087
Country	Switzerland	Russian Federation	Chile	Israel	India
MSFE dif.	-0.017	0.017	-0.011	0.014	0.031*
t-statistic	-0.815	0.794	-0.544	0.668	1.499
Country	Singapore	Thailand	Philippines	United Kingdom	Japan
MSFE dif.	0.009	-0.036	0.028*	-0.013	0.032*
t-statistic	0.431	-1.712	1.351	-0.637	1.553

The Cross-Section of Currency Returns:
Building a "Commodity" Strategy for the Exchange Rate

- For each country, specific regression for OOS forecasting using a rolling window of 3 years.
- Order currencies according to the forecasted returns of the commodity strategy
- Overall 7 portfolios: Portfolios 1 to 5, Average and Long-Short Portfolio, both for Spot and Excess returns case
- Perform similar exercise for carry trade strategy: currency allocation according to forward discounts at the end of period t

Data

- Daily data from Reuters: Spot exchange rates and 1-day forward exchange rates versus the USD and the GBP from January 2000 to November 2011

- 25 countries: Australia, Brazil, Bulgaria, Canada, Chile, Croatia, Czech Republic, Euro area, Hungary, India, Indonesia, Israel, Japan, Mexico, New Zealand, Norway, Philippines, Poland, Russia, Singapore, South Africa, Sweden, Switzerland, Thailand and the United Kingdom

- Commodity price series: GSCI indices for agriculture, aluminium, brent crude, copper, energy, gold, industrial metals, livestock, natural gas, precious metals, silver and wheat

- Commodity shares: Data from the United Nations Commodity Trade Statistics Database

Commodity Strategy, Spot and Excess Returns

Table: Descriptive Statistics: Commodity Strategy

Spot Returns					
(Commodities Strategy)	RET	STDEV	SKEW	KURT	Sharpe Ratio
Portfolio 1	-0.24%	9.69%	-0.31	9.56	-0.21
Portfolio 2	2.58%	8.43%	0.10	8.77	0.09
Portfolio 3	2.70%	8.53%	0.07	3.90	0.10
Portfolio 4	3.64%	8.69%	-0.08	2.99	0.21
Portfolio 5	5.79%	9.66%	-0.14	4.73	0.41
Portfolio Avg	2.89%	7.79%	-0.02	4.07	0.14
Portfolio L-S	6.03%	9.32%	0.02	3.98	0.45
Excess Returns					
(Commodities Strategy)	RET	STDEV	SKEW	KURT	Sharpe Ratio
Portfolio 1	2.29%	9.69%	-0.30	9.56	0.05
Portfolio 2	4.28%	8.43%	0.11	8.79	0.29
Portfolio 3	4.05%	8.53%	0.08	3.90	0.26
Portfolio 4	5.09%	8.69%	-0.07	2.98	0.38
Portfolio 5	7.61%	9.66%	-0.13	4.72	0.60
Portfolio Avg	4.67%	7.79%	-0.02	4.08	0.37
Portfolio L-S	5.32%	9.32%	0.02	3.97	0.38

Carry Trade Strategy, Spot and Excess Returns

Table: Descriptive Statistics: Carry Trade Strategy

Spot Returns					
(Carry Trade Strategy)	RET	STDEV	SKEW	KURT	Sharpe Ratio
Portfolio 1	3.69%	7.39%	0.35	3.38	0.25
Portfolio 2	4.38%	9.00%	0.12	2.77	0.29
Portfolio 3	3.59%	9.21%	0.04	6.82	0.19
Portfolio 4	0.34%	8.59%	-0.81	7.47	-0.17
Portfolio 5	2.46%	9.64%	-0.39	4.59	0.07
Portfolio Avg	2.89%	7.79%	-0.02	4.07	0.14
Portfolio L-S	-1.23%	8.49%	-0.47	4.83	-0.36
Excess Returns					
(Carry Trade Strategy)	RET	STDEV	SKEW	KURT	Sharpe Ratio
Portfolio 1	2.89%	7.39%	0.35	3.39	0.15
Portfolio 2	4.55%	9.00%	0.13	2.78	0.31
Portfolio 3	4.90%	9.21%	0.05	6.83	0.34
Portfolio 4	3.06%	8.59%	-0.80	7.47	0.15
Portfolio 5	7.94%	9.64%	-0.38	4.60	0.64
Portfolio Avg	4.67%	7.79%	-0.02	4.08	0.37
Portfolio L-S	5.04%	8.49%	-0.47	4.83	0.38

Commodity Strategy vs Carry Trade: Cumulative Spot Returns

# Commodity Strategy vs Carry Trade: Cumulative Excess Returns
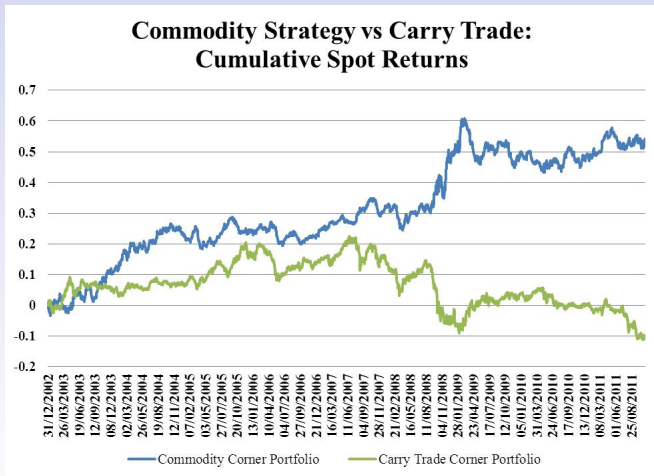
Commodity Strategy vs Carry Trade: Cumulative Excess Returns
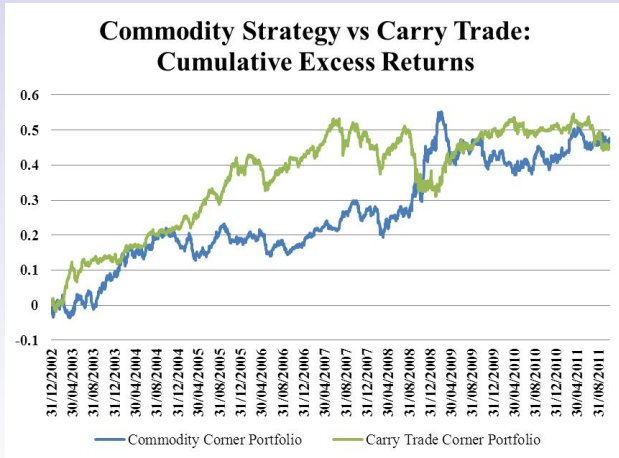
Commodity Strategy: Excess Returns Before and After the Crisis

Excess Returns: Before the Crisis					
	RET	STDEV	SKEW	KURT	Sharpe Ratio
Portfolio 1	5.06%	6.43%	-0.60	1.92	0.36
Portfolio 2	4.95%	5.21%	-0.50	3.16	0.42
Portfolio 3	5.82%	6.28%	-0.09	1.19	0.49
Portfolio 4	6.78%	7.35%	-0.04	1.44	0.54
Portfolio 5	9.92%	8.08%	-0.13	1.23	0.88
Portfolio Avg	6.51%	5.64%	-0.20	0.95	0.66
Portfolio L-S	4.86%	7.33%	0.14	1.53	0.28
Excess Returns: After the Crisis					
	RET	STDEV	SKEW	KURT	Sharpe Ratio
Portfolio 1	-0.57%	12.17%	-0.19	6.88	-0.11
Portfolio 2	3.59%	10.80%	0.18	5.59	0.26
Portfolio 3	2.23%	10.36%	0.13	2.89	0.14
Portfolio 4	3.35%	9.89%	-0.06	2.87	0.26
Portfolio 5	5.23%	11.06%	-0.11	4.92	0.40
Portfolio Avg	2.77%	9.52%	0.05	2.98	0.21
Portfolio L-S	5.80%	11.01%	-0.03	3.38	0.45

Cumulative Spot Returns of the 5 Portfolios

Cumulative Spot Returns of 5 Portfolios
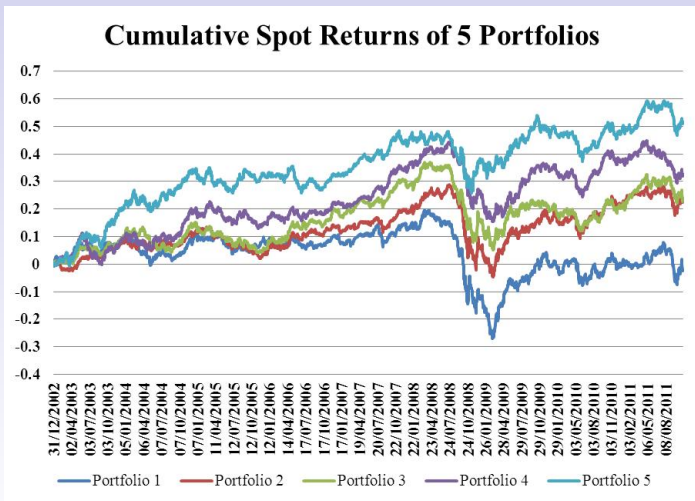
Legend: Portfolio 1, Portfolio 2, Portfolio 3, Portfolio 4, Portfolio 5

Table: Principal Components

Spot and Excess Returns					
	1	2	3	4	5
Portfolio 1	0.43	-0.53	0.59	-0.43	0.03
Portfolio 2	0.45	-0.44	-0.22	0.72	0.21
Portfolio 3	0.47	-0.03	-0.56	-0.31	-0.60
Portfolio 4	0.46	0.41	-0.22	-0.30	0.70
Portfolio 5	0.42	0.60	0.49	0.35	-0.33
% Var.	75%	12%	5%	4%	3%

Asset Pricing Methodology

- Standard SDF approach (Cochrane, 2005): The no-arbitrage relation holds so that risk-adjusted currency excess returns have a price of zero and satisfy Euler equation
- FamaMacBeth two-pass OLS methodology (Fama and MacBeth, 1973)
- Test Assets: Commodity Portfolios 1-5.
- Always a pair of risk factors: DOL and HMLFX; DOL and VOL (avg sample stdev of daily log changes in FX value); DOL and FXMOM etc.

Fama McBeth Results: Currency Factors

Table: Asset Pricing Exercise: The Carry Factor

	Panel A1 (Spot Returns)				Panel B1 (Excess Returns)			
Factor Prices and Loadings								
GMM	DOL	CHML	R2	HJ	DOL	CHML	R2	HJ
b	12.085	-23.374	0.28	0.040	12.439	-15.132	0.15	0.043
s.e	7.134	18.182		0.210	7.134	18.197		0.240
lambda	0.000	-0.001			0.000	0.000		
s.e	0.000	0.001			0.000	0.011		
FMB								
lambda	0.000	-0.001	0.28		0.000	0.000	0.15	
HAC NW	0.000	0.000			0.000	0.000		
Factor Betas								
PF	a	DOL	CHML	R2	a	DOL	CHML	R2
1	0.000	1.014	0.111	0.72	0.000	1.014	0.111	0.72
HAC NW	0.000	0.027	0.020		0.000	0.027	0.020	
2	0.000	0.932	0.019	0.75	0.000	0.932	0.019	0.75
HAC NW	0.000	0.025	0.017		0.000	0.025	0.017	
3	0.000	1.019	-0.073	0.83	0.000	1.020	-0.073	0.83
HAC NW	0.000	0.018	0.017		0.000	0.018	0.017	
4	0.000	1.009	-0.073	0.78	0.000	1.009	-0.074	0.78
HAC NW	0.000	0.024	0.014		0.000	0.024	0.014	
5	0.000	1.026	0.016	0.69	0.000	1.026	0.016	0.69
HAC NW	0.000	0.030	0.027		0.000	0.030	0.027	

Fama McBeth Results: Fama-French Factors

Table: Asset Pricing Exercise: The Equity Market Factor

	Panel A1 (Spot Returns)				Panel B1 (Excess Returns)			
	Factor Prices and Loadings							
GMM	DOL	MKT	R2	HJ	DOL	MKT	R2	HJ
b	23.293	-0.210	0.74	0.036	23.236	-0.176	0.66	0.035
s.e	12.868	0.139		0.470	12.574	0.135		0.480
lambda	0.000	-0.326			0.000	-0.266		
s.e	0.000	0.270			0.000	0.242		
FMB								
lambda	0.000	-0.326	0.73		0.000	-0.265	0.66	
HAC NW	0.000	0.094			0.000	0.079		

Factor Betas								
PF	a	DOL	MKT	R2	a	DOL	MKT	R2
1	0.000	1.023	0.0003	0.71	0.000	1.022	0.0003	0.71
HAC NW	0.000	0.029	0.0001		0.000	0.029	0.0001	
2	0.000	0.931	0.0001	0.75	0.000	0.931	0.0001	0.75
HAC NW	0.000	0.026	0.0001		0.000	0.026	0.0001	
3	0.000	0.993	0.0000	0.83	0.000	0.993	0.0000	0.83
HAC NW	0.000	0.021	0.0001		0.000	0.020	0.0001	
4	0.000	1.009	-0.0003	0.78	0.000	1.008	-0.0003	0.78
HAC NW	0.000	0.026	0.0001		0.000	0.026	0.0001	
5	0.000	1.045	-0.0002	0.69	0.000	1.046	-0.0002	0.69
HAC NW	0.000	0.031	0.0001		0.000	0.031	0.0001	

Discussion of findings

- Candidate risk factors unable to price the cross-section of currency returns. Zero or negative correlation of "commodity strategy" with carry trade

- Gorton and Rouwenhorst (2006): Commodities display low correlations with other asset classes, compatible with backwardation and market segmentation theories

- Bessembinder and Chan (1992): Negative correlation attributed to different behaviour over business cycle

- Bïuyïuksahin, Haigh and Robe (2008): Commodities yield benefits to equity investors in form of portfolio diversification

- Frankel: Real interest rates negatively correlated with commodity prices: cost of carry, financial speculation in commodity markets

Exploitability

- Analysis has so far ignored the exploitability of the proposed commodity strategy.
- Important concern given daily rebalancing frequency and emerging market currencies: high bid-ask spreads
- Calculate net spot returns by adjusting spot returns for bid-ask spreads. Following Goyal and Saretto (2009), I employ 50% of the quoted bid-ask spread as actual spread (conservative choice given findings of Gilmore and Hayashi (2011))

Incorporation of Transaction Costs

Commodities Strategy: Net Excess Returns					
	RET	STDEV	SKEW	KURT	Sharpe Ratio
Portfolio 1	-7.83%	9.81%	-0.23	9.05	-0.98
Portfolio 2	-2.60%	8.61%	0.08	8.25	-0.51
Portfolio 3	-1.73%	8.67%	0.1	3.50	-0.41
Portfolio 4	-1.82%	8.92%	-0.09	2.66	-0.41
Portfolio 5	-0.77%	9.85%	-0.14	4.46	-0.26
Portfolio Avg	-2.95%	7.96%	0.03	3.62	-0.60

Currency Participation in Portfolio 1

Currency Participation in Portfolio 5
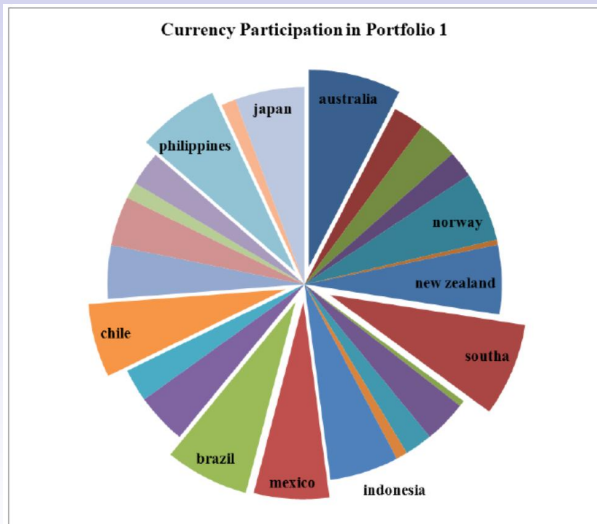
Currency Participation in Portfolio 5
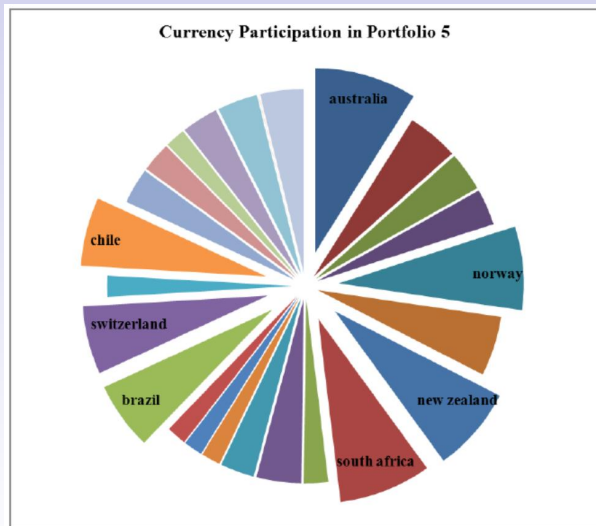
Developed Markets Panel

- Both portfolios dominated by commodity exporters: consistency of the strategy mechanics.
- Emerging market currencies which display on average higher bid-ask spreads, constitute a non-trivial portion of these portfolios.
- Carry the analysis in the developed market space: GBP, CHF, JPY, CAD, AUD, NZD, SEK, NOK, EUR, SGD, CZN, and HRK versus the USD.
- Repeat procedure: 3 portfolios.

Developed Markets, Excess Returns

Commodities Strategy: Excess Returns					
	RET	**STDEV**	**SKEW**	**KURT**	**Sharpe Ratio**
Portfolio 1	0.87%	10.05%	0.2	6.73	-0.09
Portfolio 2	4.79%	9.75%	0.19	3.28	0.31
Portfolio 3	7.45%	10.01%	-0.01	3.55	0.56
Portfolio Avg	4.37%	9.14%	0.28	3.92	0.28

Commodities Strategy: Net Excess Returns					
	RET	**STDEV**	**SKEW**	**KURT**	**Sharpe Ratio**
Portfolio 1	-3.35%	10.09%	0.19	6.72	-0.51
Portfolio 2	0.85%	9.76%	0.2	3.17	-0.1
Portfolio 3	2.88%	10.04%	-0.01	3.51	0.11
Portfolio Avg	0.13%	9.18%	0.28	3.83	-0.18

Market Timing Exercise, Net Excess Returns

Commodities Strategy with Market Timing: Net Excess Returns					
	RET	STDEV	SKEW	KURT	Sharpe Ratio
Portfolio 1	1.29%	7.95%	-0.31	13.23	0.02
Portfolio 2	5.05%	6.88%	0.28	11.97	0.57
Portfolio 3	5.07%	6.84%	0.29	5.67	0.58
Portfolio 4	5.45%	6.91%	0.04	4.73	0.63
Portfolio 5	5.93%	7.79%	-0.09	7.52	0.62
Portfolio Avg	4.56%	6.31%	0.13	6.05	0.54
Portfolio L-S	4.64%	7.53%	0.24	8.59	0.47

Main findings

- The forecasting ability of commodity prices for the exchange rate appears to be significant
- A trading strategy that exploits this relationship leads to economically significant returns
- The strategy works across different sub-samples and fares particularly well during the crisis period
- The returns appear to be uncorrelated to popular exchange rate strategies
- The relationship is relevant for a broader set of currencies besides commodity currencies
- Net profitability is restored by implementing a simple market timing rule

Thank you!

Commodity Strategy: Spot Returns Before and After the Crisis

Spot Returns: Before the Crisis

	RET	STDEV	SKEW	KURT	Sharpe Ratio
Portfolio 1	2.52%	6.43%	-0.6	1.94	-0.04
Portfolio 2	3.47%	5.21%	-0.5	3.17	0.13
Portfolio 3	4.80%	6.28%	-0.09	1.21	0.32
Portfolio 4	5.72%	7.35%	-0.05	1.45	0.4
Portfolio 5	8.52%	8.08%	-0.13	1.24	0.71
Portfolio Avg	5.01%	5.64%	-0.21	0.97	0.4
Portfolio Corner	6.00%	7.33%	0.15	1.53	0.44

Spot Returns: After the Crisis

	RET	STDEV	SKEW	KURT	Sharpe Ratio
Portfolio 1	-1.91%	12.16%	-0.08	6.86	-0.22
Portfolio 2	2.61%	10.81%	0.26	5.83	0.17
Portfolio 3	1.42%	10.36%	0.18	2.97	0.06
Portfolio 4	2.33%	9.89%	-0.01	2.96	0.15
Portfolio 5	4.01%	11.05%	-0.03	4.94	0.29
Portfolio Avg	1.69%	9.51%	0.11	3.07	0.09
Portfolio Corner	5.92%	10.99%	-0.04	3.37	0.46

Table: Asset Pricing Exercise: The VOL Factor

GMM	Panel A2 (Spot Returns)				Panel B2 (Excess Returns)			
	DOL	VOL	R2	HJ	DOL	VOL	R2	HJ
Factor Prices and Loadings								
b	9.078	169.626	0	0.200	14.174	267.367	0	0.190
s.e	10.384	296.888		0.180	10.604	310.988		0.280
lambda	0.002	0.000			0.004	0.001		
s.e	0.003	0.001			0.007	0.002		
FMB			0					
lambda	0.002	0.000			0.004	0.001	0	
HAC NW	0.001	0.001			0.001	0.001		

PF	Factor Betas							
	a	DOL	VOL	R2	a	DOL	VOL	R2
1	-0.004	1.124	0.141	0.75	-0.003	1.122	0.105	0.75
HAC NW	0.004	0.078	0.837		0.004	0.077	0.822	
2	0.000	0.913	0.071	0.82	0.000	0.913	0.087	0.82
HAC NW	0.004	0.031	0.842		0.004	0.031	0.838	
3	-0.001	1.003	0.139	0.86	-0.001	1.003	0.152	0.86
HAC NW	0.003	0.046	0.553		0.003	0.045	0.546	
4	0.006	0.989	-1.134	0.83	0.006	0.990	-1.096	0.83
HAC NW	0.003	0.051	0.534		0.003	0.050	0.526	
5	-0.001	0.971	0.784	0.69	-0.001	0.973	0.753	0.69
HAC NW	0.005	0.072	1.045		0.005	0.072	1.035	

Table: Asset Pricing Exercise: Currency Momentum

	Panel A3 (Spot Returns)				Panel B3 (Excess Returns)			
				Factor Prices and Loadings				
GMM	DOL	FXMOM	R2	HJ	DOL	FXMOM	R2	HJ
b	1.273	-14.359	0	0.170	4.632	-6.859	0	0.170
s.e.	6.533	11.839		0.380	5.594	9.225		0.310
lambda	0.002	-0.015			0.004	-0.009		
s.e.	0.002	0.014			0.007	0.012		
FMB			0					
lambda	0.002	-0.015			0.004	-0.009	0	
HAC NW	0.001	0.012			0.001	0.006		
				Factor Betas				
PF	a	DOL	FXMOM	R2	a	DOL	FXMOM	R2
1	-0.003	1.123	0.018	0.75	-0.002	1.123	0.015	0.75
HAC NW	0.001	0.061	0.043		0.001	0.059	0.038	
2	0.000	0.901	-0.058	0.83	0.000	0.891	-0.082	0.83
HAC NW	0.001	0.036	0.032		0.001	0.030	0.023	
3	0.000	1.006	0.042	0.86	-0.001	1.007	0.038	0.86
HAC NW	0.001	0.035	0.022		0.001	0.036	0.023	
4	0.000	1.034	0.052	0.83	0.000	1.032	0.040	0.82
HAC NW	0.001	0.048	0.040		0.001	0.050	0.044	
5	0.003	0.937	-0.053	0.69	0.003	0.948	-0.012	0.69
HAC NW	0.002	0.069	0.055		0.002	0.068	0.038	

Incorporation of Transaction Costs

Table: Descriptive Statistics: Commodity Strategy

Commodities Strategy: Net Spot Returns					
	RET	STDEV	SKEW	KURT	Sharpe Ratio
Portfolio 1	-9.86%	9.96%	-0.23	8.38	-1.17
Portfolio 2	-3.98%	8.78%	0.06	7.67	-0.66
Portfolio 3	-2.86%	8.80%	0.07	3.40	-0.53
Portfolio 4	-3.03%	9.08%	-0.11	2.51	-0.53
Portfolio 5	-2.18%	9.98%	-0.12	4.26	-0.40
Portfolio Avg	-4.38%	8.14%	0.00	3.42	-0.76
Commodities Strategy: Net Excess Returns					
	RET	STDEV	SKEW	KURT	Sharpe Ratio
Portfolio 1	-7.83%	9.81%	-0.23	9.05	-0.98
Portfolio 2	-2.60%	8.61%	0.08	8.25	-0.51
Portfolio 3	-1.73%	8.67%	0.1	3.50	-0.41
Portfolio 4	-1.82%	8.92%	-0.09	2.66	-0.41
Portfolio 5	-0.77%	9.85%	-0.14	4.46	-0.26
Portfolio Avg	-2.95%	7.96%	0.03	3.62	-0.60

Developed Markets, Spot and Net Spot Returns

Commodities Strategy: Spot Returns					
	RET	**STDEV**	**SKEW**	**KURT**	**Sharpe Ratio**
Portfolio 1	0.51%	10.11%	0.19	6.69	-0.13
Portfolio 2	4.11%	9.85%	0.17	3.03	0.23
Portfolio 3	7.20%	10.08%	-0.01	3.43	0.53
Portfolio Avg	3.94%	9.23%	0.27	3.73	0.23
Commodities Strategy: Net Spot Returns					
	RET	**STDEV**	**SKEW**	**KURT**	**Sharpe Ratio**
Portfolio 1	-3.64%	10.10%	0.19	6.68	-0.54
Portfolio 2	0.57%	9.85%	0.17	3.03	-0.13
Portfolio 3	2.47%	10.09%	-0.02	3.46	0.07
Portfolio Avg	-0.20%	9.23%	0.26	3.73	-0.22

Granger-Causality: Commodities to Currencies, Weekly Frequency

Weekly Frequency

Country	Commodity Indices			
Australia	Gold	Wheat	Aluminium	Brent
	0.940	0.063*	0.101	0.084*
Brazil	Agriculturals	Brent		
	0.3510	0.818		
Bulgaria	Copper	Energy	Brent	
	0.754	0.338	0.5000	
Canada	Natural Gas	Brent		
	0.274	0.311		
Chile	Copper	Brent		
	0.016**	0.217		
India	Precious Metals	Brent		
	0.013**	0.036**		
Israel	Brent			
	0.943			
Japan	Brent			
	0.285			
Mexico	Silver	Brent		
	0.888	0.345		
New Zealand	Livestock	Aluminium	Brent	
	0.317	0.446	0.316	
Norway	Natural Gas	Industrial Metals	Brent	
	0.827	0.049**	0.288	
Philippines	Brent			
	0.315			
Russian Federation	Natural Gas	Brent		
	0.164	0.005***		
United Kingdom	Brent			
	0.969			

Granger-Causality: Currencies to Commodities, Weekly Frequency

Weekly Frequency

Country	Commodity Indices			
Australia	Gold	Wheat	Aluminium	Brent
	0.228	0.286	0.101	0.627
Brazil	Agriculturals	Brent		
	0.8315	0.061*		
Bulgaria	Copper	Energy	Brent	
	0.821	0.636	0.653	
Canada	Natural Gas	Brent		
	0.839	0.605		
Chile	Copper	Brent		
	0.508	0.126		
India	Precious Metals	Brent		
	0.695	0.328		
Israel	Brent			
	0.962			
Japan	Brent			
	0.060*			
Mexico	Silver	Brent		
	0.509	0.891		
New Zealand	Livestock	Aluminium	Brent	
	0.537	0.023**	0.120	
Norway	Natural Gas	Industrial Metals	Brent	
	0.858	0.629	0.930	
Philippines	Brent			
	0.053*			
Russian Federation	Natural Gas	Brent		
	0.169	0.379		
United Kingdom	Brent			
	0.525			

Granger-Causality: Commodities to Currencies, Monthly Frequency

Monthly Frequency

Country	Commodity Indices			
Australia	Gold	Wheat	Aluminium	Brent
	0.247	0.133	0.747	0.747
Brazil	Agriculturals	Brent		
	0.512	0.494		
Bulgaria	Copper	Energy	Brent	
	0.414	0.120	0.336	
Canada	Natural Gas	Brent		
	0.310	0.136		
Chile	Copper	Brent		
	0.684	0.949		
India	Precious Metals	Brent		
	0.239	0.952		
Israel	Brent			
	0.216			
Japan	Brent			
	0.801			
Mexico	Silver	Brent		
	0.442	0.499		
New Zealand	Livestock	Aluminium	Brent	
	0.797	0.125	0.216	
Norway	Natural Gas	Industrial Metals	Brent	
	0.602	0.546	0.322	
Philippines	Brent			
	0.335			
Russian Federation	Natural Gas	Brent		
	0.343	0.196		
United Kingdom	Brent			
	0.001***			

Granger-Causality: Currencies to Commodities, Monthly Frequency

Monthly Frequency

Country	Commodity Indices			
Australia	Gold	Wheat	Aluminium	Brent
	0.839	0.257	0.197	0.425
Brazil	Agriculturals	Brent		
	0.926	0.064*		
Bulgaria	Copper	Energy	Brent	
	0.443	0.414	0.882	
Canada	Natural Gas	Brent		
	0.589	0.964		
Chile	Copper	Brent		
	0.092*	0.114		
India	Precious Metals	Brent		
	0.269	0.202		
Israel	Brent			
	0.250			
Japan	Brent			
	0.118			
Mexico	Silver	Brent		
	0.864	0.051*		
New Zealand	Livestock	Aluminium	Brent	
	0.793	0.331	0.681	
Norway	Natural Gas	Industrial Metals	Brent	
	0.415	0.420	0.291	
Philippines	Brent			
	0.137			
Russian Federation	Natural Gas	Brent		
	0.673	0.213		
United Kingdom	Brent			
	0.678			

OOS Predictive Ability: Commodities to Currencies, Weekly Frequency

| MSFE Difference Between the "Commodity Price Model" and the Random Walk, Weekly Frequency				
Country	Australia	Poland	Hungary	Sweden	Norway
MSFE dif.	0.044*	0.017	0.006	0.069*	0.041
t-statistic	1.378	0.652	0.178	1.528	0.993
Country	Czech Republic	New Zealand	South Africa	Germany	Bulgaria
MSFE dif.	0.039	0.029	0.027	0.057*	0.060*
t-statistic	1.060	0.907	0.732	1.439	1.600
Country	Canada	Croatia	Indonesia	Mexico	Brazil
MSFE dif.	0.029	0.052*	0.028	0.046	0.013
t-statistic	0.982	1.322	0.670	1.198	0.376
Country	Switzerland	Russian Federation	Chile	Israel	India
MSFE dif.	0.128***	0.085**	0.065**	0.007	-0.071
t-statistic	2.628	2.084	1.734	0.162	-1.348
Country	Singapore	Thailand	Philippines	United Kingdom	Japan
MSFE dif.	0.052*	0.059	-0.031	0.042	-0.066
t-statistic	1.534	1.231	-0.802	1.343	-1.380

OOS Predictive Ability: Commodities to Currencies, Monthly Frequency

MSFE Difference Between the "Commodity Price Model" and the Random Walk, Monthly Frequency				
Country	Australia	Poland	Hungary	Sweden	Norway
MSFE dif.	-0.061	0.111	-0.108	0.004	0.161**
t-statistic	-0.815	0.776	-1.192	0.042	1.746
Country	Czech Republic	New Zealand	South Africa	Germany	Bulgaria
MSFE dif.	-0.032	0.112*	0.036	-0.017	0.027
t-statistic	-0.333	1.426	0.490	-0.353	0.387
Country	Canada	Croatia	Indonesia	Mexico	Brazil
MSFE dif.	0.208**	0.062	0.053	0.119	0.103
t-statistic	2.052	0.950	0.670	0.771	0.734
Country	Switzerland	Russian Federation	Chile	Israel	India
MSFE dif.	0.006	0.011	-0.052	0.032	-0.030
t-statistic	0.123	0.114	-0.490	0.320	-0.370
Country	Singapore	Thailand	Philippines	United Kingdom	Japan
MSFE dif.	-0.172	-0.033	0.118	-0.115	-0.165
t-statistic	-1.964	-0.435	1.149	-1.246	-1.852

- Given that the strategy works well during the crisis period one might think that the proposed strategy is linked to liquidity.
- Use the VIX as a first proxy to market liquidity.

The Commodity Strategy and the VIX

Commodity Strategy and the VIX, 3-month MA
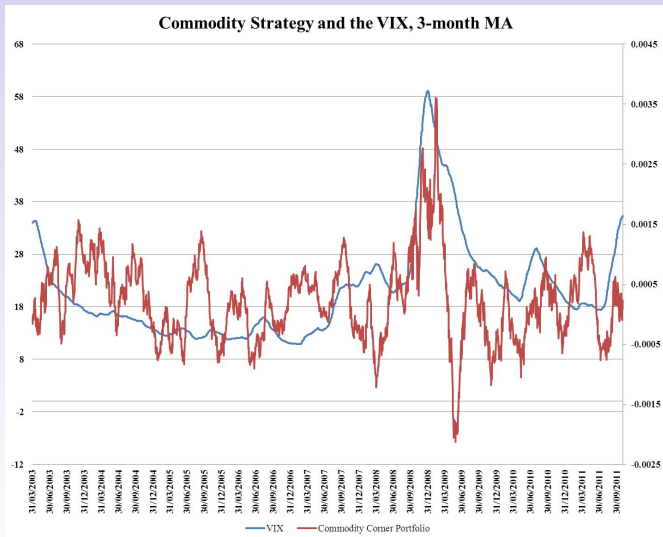
- Investigate the implications of extreme fundamental movements for exchange rate modelling
  - Topic of particular interest to small open economies
  - Question with obvious investment implications