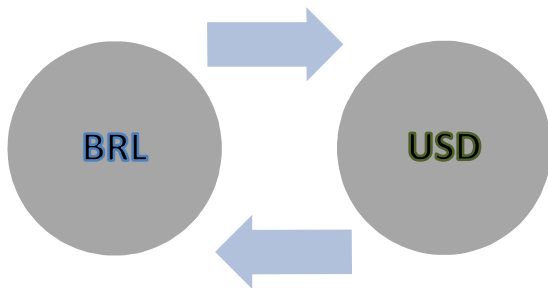


Is cross-hedging an optimal hedging strategy for commodity currencies?



July 2019
Stefan Colza Lee
William Eid Jr.
EAESP/FGV

Research Questions

- Do commodity currencies have risk premiums?
- What are the optimal hedging ratios using currency future contracts?
- Is it possible to reduce variance of a commodity currency exposure with a basket of commodity future contracts that are based on exports?
- What are the expected returns of a portfolio of commodity futures used for cross-hedging?
- What is the optimal hedging strategy for commodity currency exposure considering a quadratic utility function?

Research Questions

- Do commodity currencies have risk premiums?
- What are the optimal hedging ratios using currency future contracts?
- Is it possible to reduce variance of a commodity currency exposure with a basket of commodity future contracts that are based on exports?
- What are the expected returns of a portfolio of commodity futures used for cross-hedging?
- What is the optimal hedging strategy for commodity currency exposure considering a quadratic utility function?

Risk Premiums of Commodity Currencies

	Start of Sample	obs	Forward Premiums	Spot Returns	Risk Premium
Australia	jan-88	33	2.9%	0.3%	2.7%
Canada	jan-88	33	0.7%	0.1%	0.6%
Chile	mar-04	14	2.3%	0.8%	1.5%
Indonesia	ago-00	17	3.1%	1.9%	1.2%
Mexico	dez-96	21	7.1%	4.4%	2.5%
Newzealand	jan-88	31	3.0%	0.2%	2.9%
Norway	dez-92	25	0.9%	1.3%	-0.4%
Thailand	dez-96	20	1.6%	-0.9%	2.5%
Southafrica	jul-97	21	17.6%	6.2%	10.8%

$$s_t \equiv -(i_t - i_t^*) + E_t[s_{t+1}] + \lambda_t$$

Research Questions

- Do commodity currencies have risk premiums?
- What are the optimal hedging ratios using currency future contracts?
- Is it possible to reduce variance of a commodity currency exposure with a basket of commodity future contracts that are based on exports?
- What are the expected returns of a portfolio of commodity futures used for cross-hedging?
- What is the optimal hedging strategy for commodity currency exposure considering a quadratic utility function?

Utility Function

$$U = E(r) - \frac{1}{2}A \cdot \sigma^2$$

$$E(r) = -E(\text{spot}) + HR(E(\text{spot}) - FP - TC)$$

$$\text{Var}(R_{Hed}) = (1 - HR)^2 \text{Var}(\text{spot return})$$

$$U = -E(\text{spot}) + HR(E(\text{spot}) - FP - TC) - \frac{1}{2}A \cdot \sigma^2 + A\sigma^2 HR - \frac{1}{2}A\sigma^2 HR^2$$

Utility Function

$$U = -E(\text{spot}) + HR(E(\text{spot}) - FP - TC) - \frac{1}{2}A \cdot \sigma^2 + A\sigma^2 HR - \frac{1}{2}A\sigma^2 HR^2$$

F.O.C.

$$1 - \frac{FP + TC - E(\text{spot})}{A\sigma^2} = HR^*$$

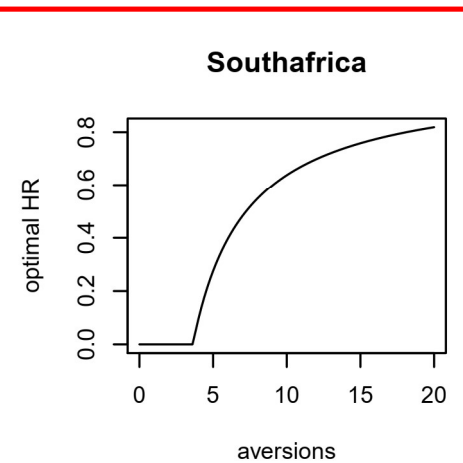
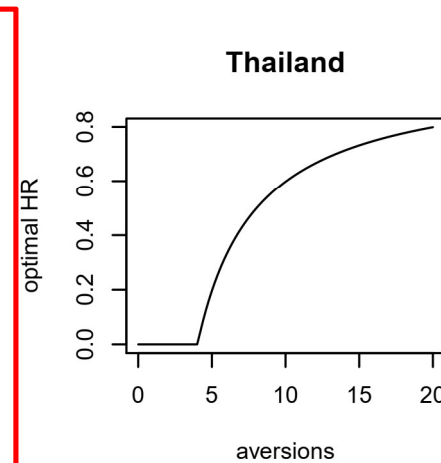
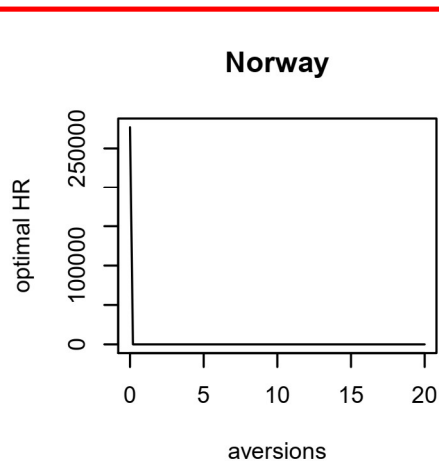
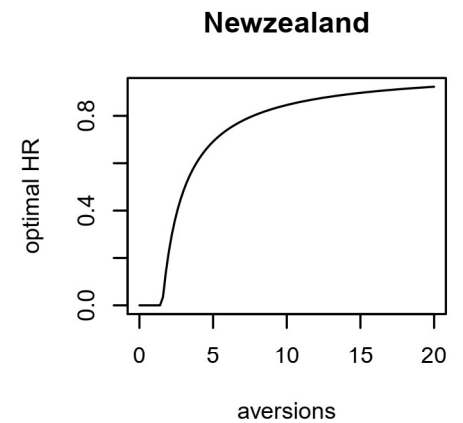
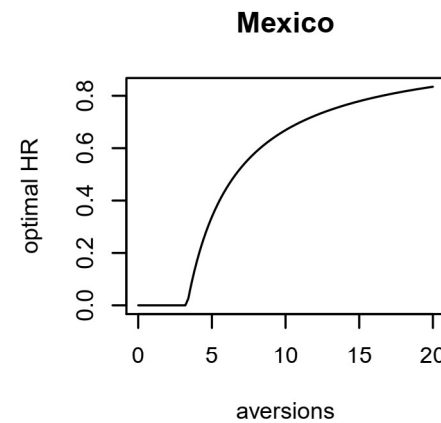
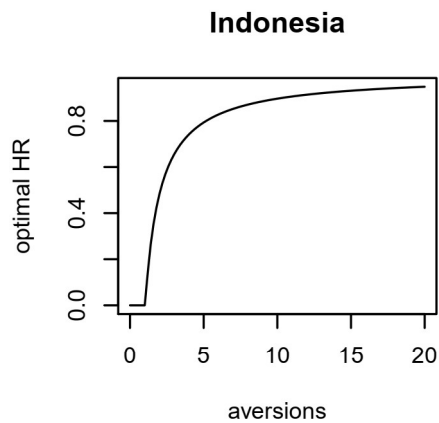
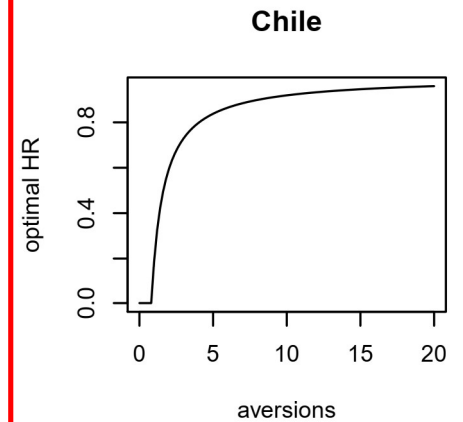
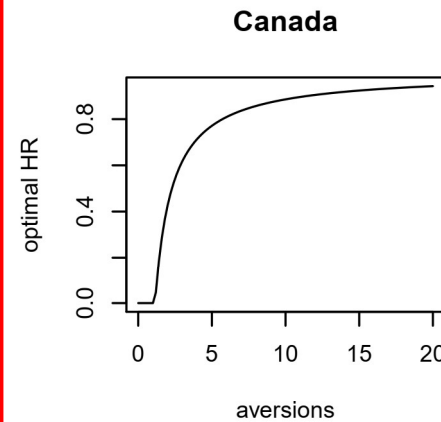
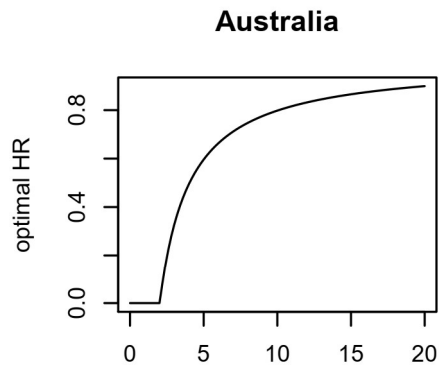
Lower Bound

$$HR^* = \min\left(0, 1 - \frac{FP+TC - E(\text{spot})}{A\sigma^2}\right)$$

$$1 - \frac{FP + TC - E(\text{spot})}{A\sigma^2} = HR^* \text{ aversions}$$

Optimal
Hedge
Ratios using
currency
Futures

No
Transaction
Costs



Research Questions

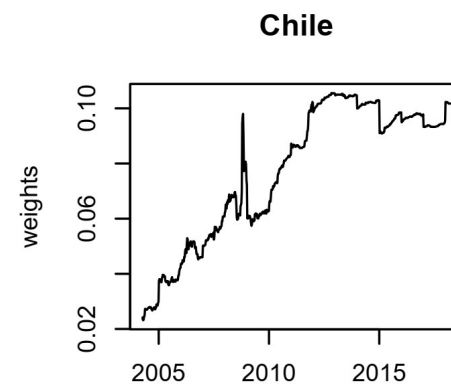
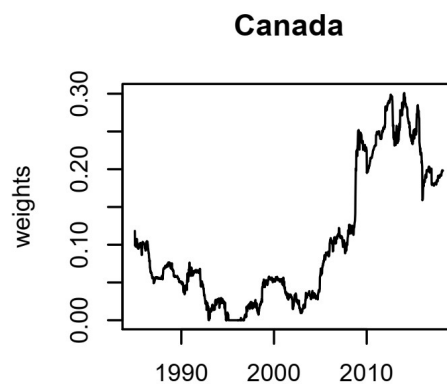
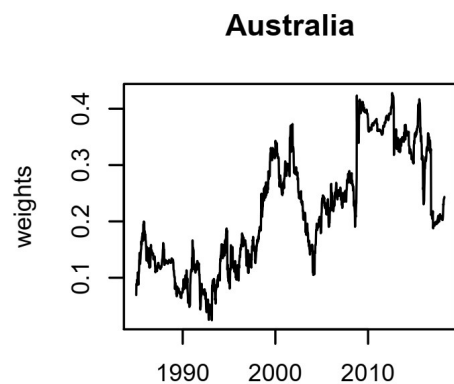
- Do commodity currencies have risk premiums?
- What are the optimal hedging ratios using currency future contracts?
- Is it possible to reduce variance of a commodity currency exposure with a basket of commodity future contracts that are based on exports?
- What are the expected returns of a portfolio of commodity futures used for cross-hedging?
- What is the optimal hedging strategy for commodity currency exposure considering a quadratic utility function?

	AUSDOL	CNDOLLR	CHILPES	INDORUP	MEXPESO	NZDOLLR	NORKRON	THABAHT	COMRAND
BO	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
O	0.8%	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
RR	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.7%	0.0%
W	4.1%	1.9%	0.1%	0.0%	0.1%	0.0%	0.0%	0.0%	0.2%
SM	0.1%	0.1%	0.9%	0.2%	0.0%	0.3%	0.2%	0.0%	0.1%
S	0.0%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
1CB	0.2%	0.0%	0.0%	0.0%	0.0%	4.2%	0.0%	0.0%	0.0%
DCS	0.9%	0.1%	0.2%	0.1%	0.0%	10.6%	0.0%	0.1%	0.1%
FC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
LB	0.0%	3.2%	1.8%	0.4%	0.1%	2.1%	0.2%	0.3%	0.1%
LH	0.1%	0.6%	0.6%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%
CC	0.0%	0.0%	0.0%	0.8%	0.0%	0.0%	0.0%	0.0%	0.0%
OJ	0.2%	0.0%	0.5%	0.0%	0.1%	0.2%	0.0%	0.2%	1.1%
SB	0.9%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	1.2%	0.7%
CL	3.7%	7.7%	0.0%	8.0%	10.1%	2.0%	37.4%	0.7%	0.7%
GC	0.6%	0.1%	2.4%	0.7%	0.3%	0.2%	0.1%	1.6%	2.2%
HG	2.5%	1.2%	49.3%	4.0%	0.7%	0.2%	0.3%	0.3%	0.8%
PL	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.0%	7.6%
RB	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
SI	0.3%	0.4%	0.6%	0.2%	0.6%	0.1%	0.0%	0.0%	0.7%
C	0.0%	0.1%	0.3%	0.0%	0.0%	0.0%	0.0%	0.1%	0.7%
LC	4.5%	0.7%	0.1%	0.0%	0.3%	6.4%	0.0%	0.0%	0.2%
PB	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
CT	1.1%	0.0%	0.0%	0.4%	0.1%	0.0%	0.0%	0.1%	0.0%
KC	0.0%	0.1%	0.0%	0.7%	0.3%	0.0%	0.0%	0.1%	0.0%
MAL	3.4%	2.0%	0.1%	0.6%	0.1%	3.4%	4.1%	0.3%	2.4%
MNI	1.1%	1.0%	0.0%	0.9%	0.0%	0.0%	1.1%	0.0%	0.6%
MPB	0.8%	0.1%	0.0%	0.0%	0.2%	0.0%	0.0%	0.0%	0.1%
MSN	0.1%	0.0%	0.0%	0.9%	0.0%	0.0%	0.0%	0.1%	0.0%
MZN	1.5%	0.5%	0.1%	0.0%	0.2%	0.0%	0.3%	0.0%	0.1%
HO	0.7%	0.1%	0.0%	0.1%	0.0%	0.0%	0.2%	0.0%	0.1%
NCU	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
NG	3.4%	4.4%	0.1%	9.2%	0.1%	0.0%	16.5%	0.2%	0.1%
NHU	0.4%	0.5%	0.0%	0.0%	0.0%	0.2%	1.2%	0.2%	0.2%
PA	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
QL	14.5%	1.2%	0.0%	7.9%	0.0%	0.3%	0.0%	0.3%	6.5%
Total	46.4%	26.5%	56.9%	35.2%	13.7%	30.5%	61.8%	8.8%	25.3%

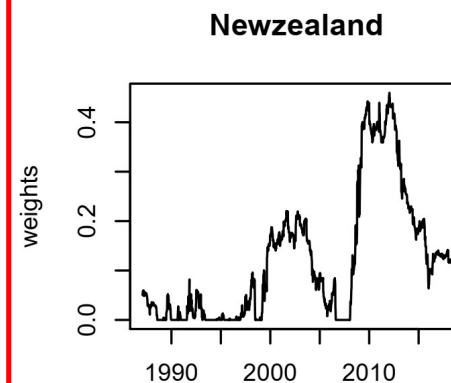
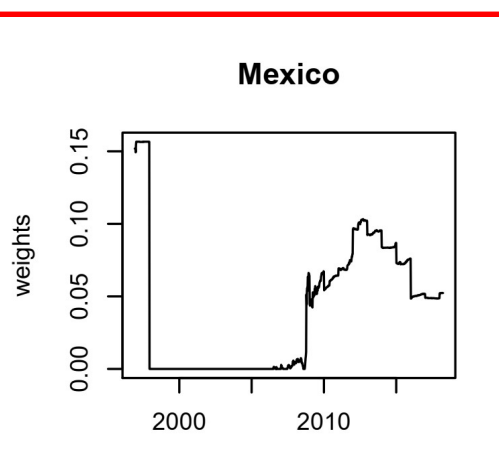
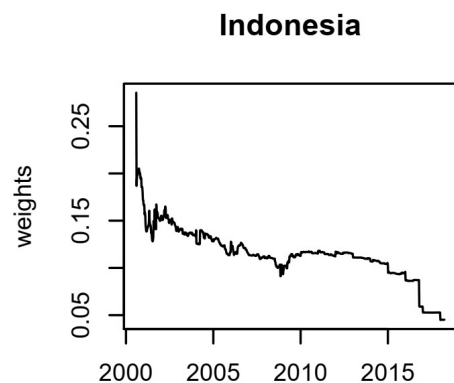
Composition of
Basket of
Commodity
Futures given
exports



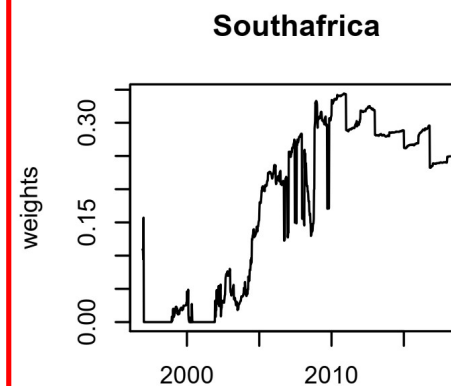
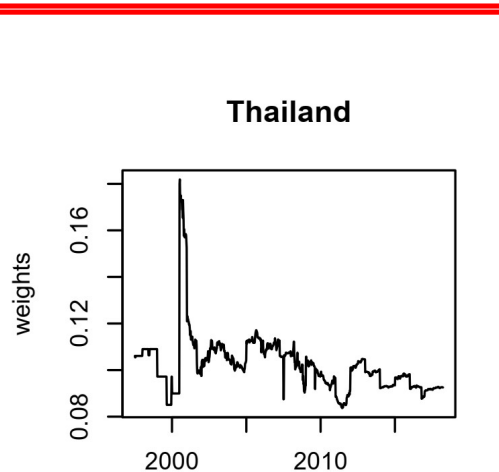
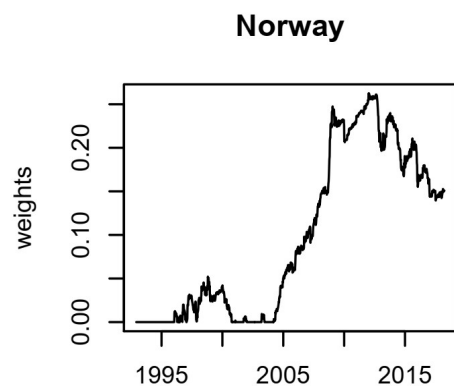
Regression
based
weight of
commodity
basket



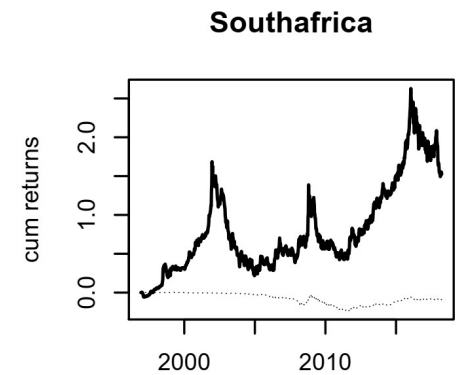
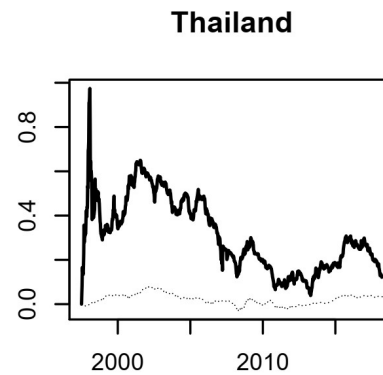
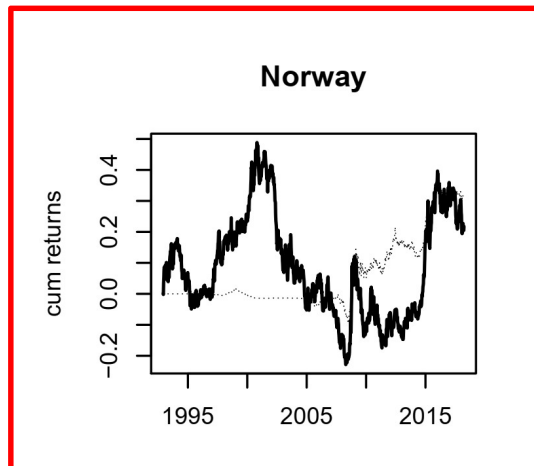
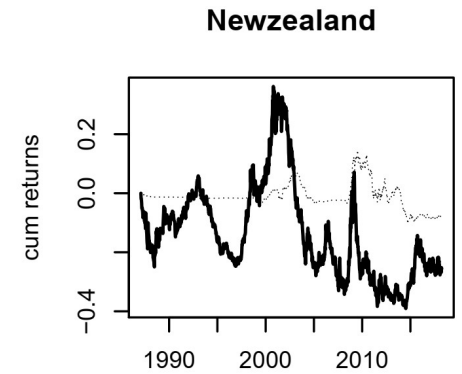
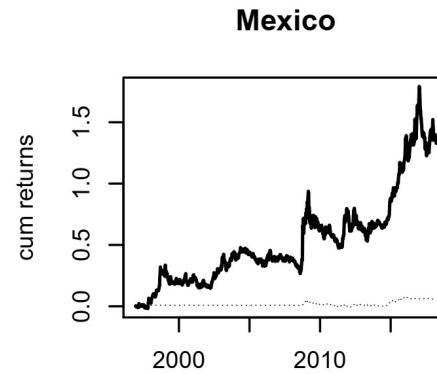
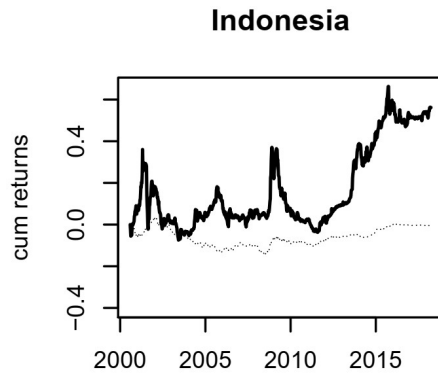
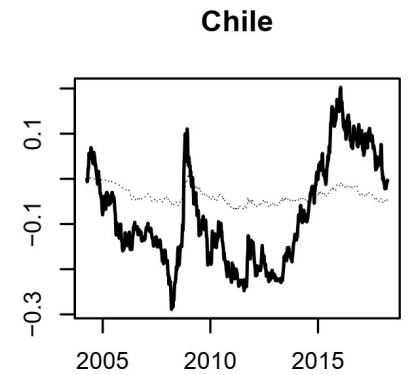
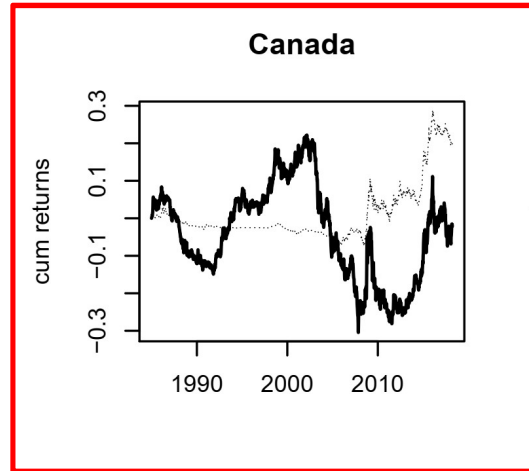
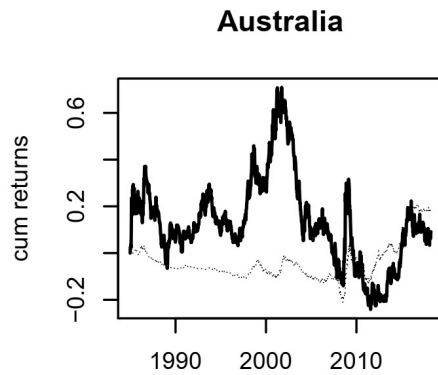
Emerging
markets
cumulative
regression



Developed
markets 4
years
moving
window



Spot
cumulative
returns dark
line and
commodity
basket
returns x
weight
cumulative
returns in
spotted line



Reduction of Variance with CH

	Start of Sample	obs	Spot Std	Cross Hedged Std	Ederington
Australia	jan-88	33	11.5%	9.5%	32.2%
Canada	jan-88	33	7.5%	5.6%	44.2%
Chile	mar-04	14	13.5%	11.7%	25.0%
Indonesia	ago-00	17	10.7%	9.6%	19.4%
Mexico	dez-96	21	8.7%	7.8%	20.2%
Newzealand	jan-88	31	13.7%	12.4%	18.2%
Norway	dez-92	25	12.7%	9.6%	43.2%
Thailand	dez-96	20	7.9%	7.1%	17.6%
Southafrica	jul-97	21	17.2%	15.9%	15.1%

$$HE = 1 - \frac{Var(Hedged)}{Var(Unhedged)}$$

Research Questions

- Do commodity currencies have risk premiums?
- What are the optimal hedging ratios using currency future contracts?
- Is it possible to reduce variance of a commodity currency exposure with a basket of commodity future contracts that are based on exports?
- **What are the expected returns of a portfolio of commodity futures used for cross-hedging?**
- What is the optimal hedging strategy for commodity currency exposure considering a quadratic utility function?

Returns of Commodity Portfolio

	Start of Sample	obs	Average Return % per year	Return Std	Mean Test p-value
Australia	jan-88	33	0.7%	6.0%	0.521
Canada	jan-88	33	0.6%	3.8%	0.365
Chile	mar-04	14	-0.3%	2.1%	0.597
Indonesia	ago-00	17	0.3%	3.3%	0.697
Mexico	dez-96	21	0.2%	1.4%	0.432
Newzealand	jan-88	31	-0.2%	3.5%	0.780
Norway	dez-92	25	1.2%	5.0%	0.240
Thailand	dez-96	20	0.2%	2.1%	0.734
Southafrica	jul-97	21	-0.4%	4.0%	0.680

Research Questions

- Do commodity currencies have risk premiums?
- What are the optimal hedging ratios using currency future contracts?
- Is it possible to reduce variance of a commodity currency exposure with a basket of commodity future contracts that are based on exports?
- What are the expected returns of a portfolio of commodity futures used for cross-hedging?
- What is the optimal hedging strategy for commodity currency exposure considering a quadratic utility function?

Utility Function

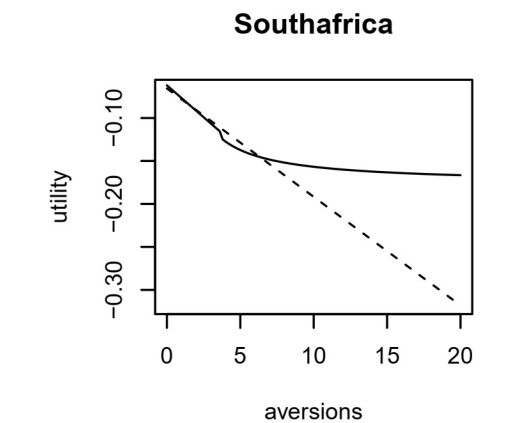
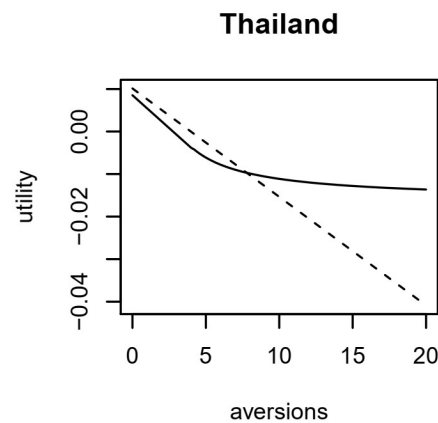
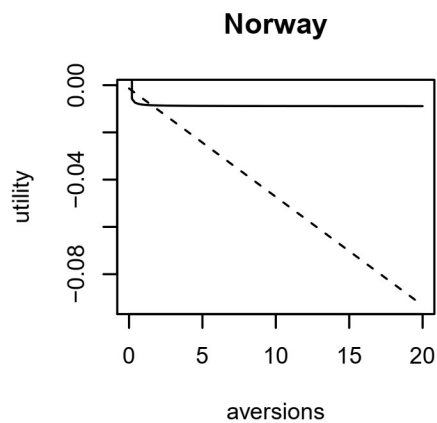
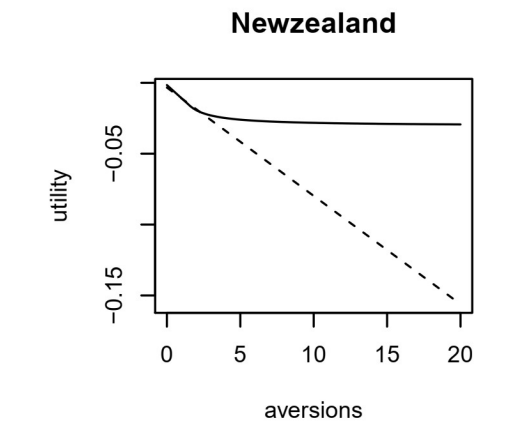
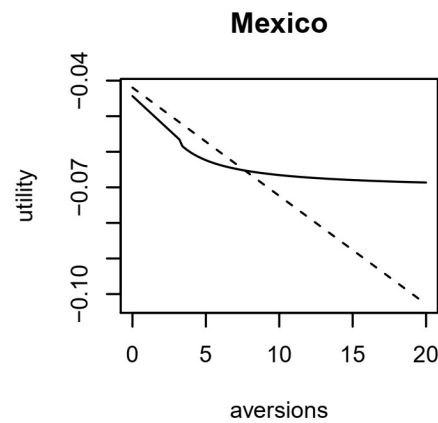
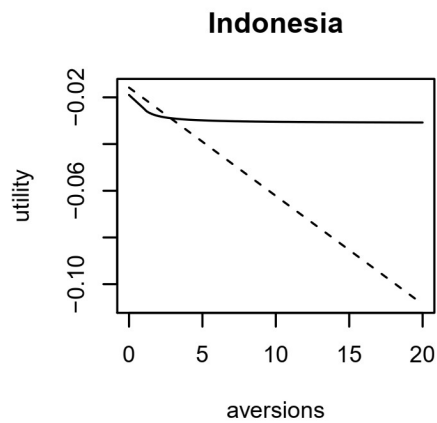
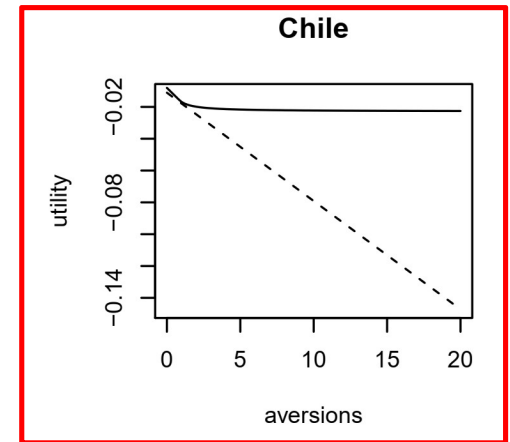
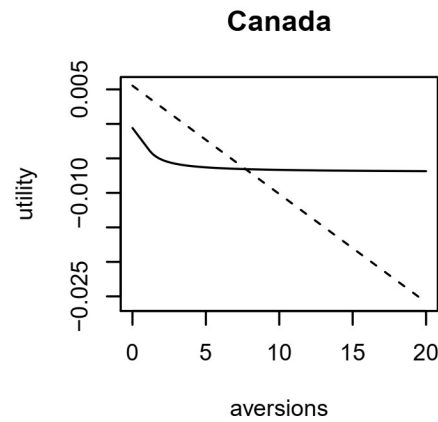
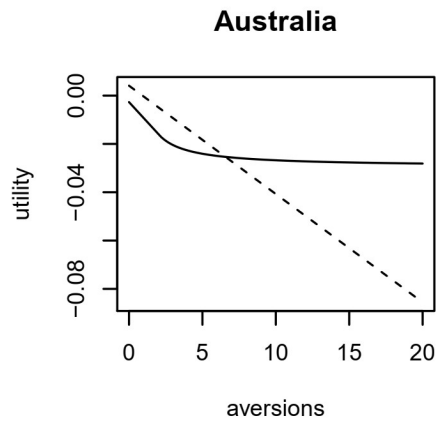
$$U = E(r) - \frac{1}{2}A \cdot \sigma^2$$

$$E[r] = -E[Spot] + w_{hv}(E[R_{hv}] + TC)$$

$$Var[R_{CH}] = Var[R_{spot}] + w_{hv}^2 Var[R_{hv}] - 2w_{hv} Cov_{Rspot, Rhv}$$

$$U = -E[Spot] + w_{hv}(E[R_{com}] + TC) - \frac{1}{2}A \cdot Var[R_{CH}]$$

Utility of Hedging with currency futures x cross hedging



ROBUSTNESS TESTS

Australia

Horizon	obs	Risk Premium	Ederingto n	Var Test	Com Returns	Mean Test	CH start	CH finish	Spot VaR @95%	CH VaR @95%
52	1685	2.6%	26.3%	***	0.6%	***	0.0	5.4	-17.8%	-15.4%
104	1633	5.3%	29.0%	***	1.3%	***	0.0	6.4	-25.5%	-22.1%
156	1581	7.9%	32.1%	***	1.9%	***	0.0	7.1	-29.2%	-26.7%
208	1529	10.7%	31.3%	***	2.4%	***	0.0	6.7	-30.4%	-28.7%
260	1477	13.8%	29.0%	***	2.9%	***	0.0	7.2	-32.7%	-29.5%



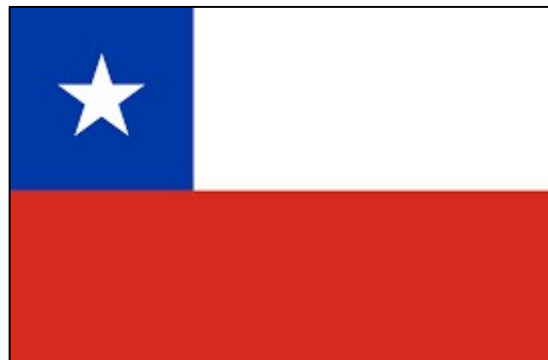
Canada

Horizon	obs	Risk Premium	Ederington	Var Test	Com Returns	Mean Test	CH start	CH finish	Spot VaR @95%	CH VaR @95%
52	1685	0.6%	38.0%	***	0.7%	***	0.0	7.1	-11.8%	-10.7%
104	1633	1.2%	32.7%	***	1.4%	***	0.0	6.4	-16.9%	-16.2%
156	1581	1.6%	30.8%	***	2.1%	***	0.0	5.4	-21.0%	-20.6%
208	1529	2.2%	27.0%	***	2.5%	***	0.0	4.7	-25.5%	-24.6%
260	1477	3.1%	21.6%	***	3.0%	***	0.0	4.5	-27.9%	-27.0%



Chile

Horizon	obs	Risk Premium	Ederingto n	Var Test	Com Returns	Mean Test	CH start	CH finish	Spot VaR@9 5%	CH VaR@9 5%
52	679	1.4%	27.1%	***	-0.3%	***	NA	NA	-13.5%	-11.8%
104	627	2.0%	27.8%	***	-0.4%	***	NA	NA	-17.9%	-14.4%
156	575	2.0%	25.6%	***	-0.3%	**	NA	NA	-19.0%	-14.7%
208	523	2.7%	24.0%	***	-0.2%	**	0.5	1.0	-23.7%	-19.2%
260	471	5.8%	25.8%	***	-0.5%	***	0.8	2.3	-15.2%	-12.3%



Indonesia

Horizon	obs	Risk Premium	Ederington	Var Test	Com Returns	Mean Test	CH start	CH finish	Spot VaR@9 5%	CH VaR@9 5%
52	871	0.5%	11.9%**		0.2%**		0.0	1.5	-13.8%	-12.5%
104	819	2.5%	9.7%*		0.2%		0.0	2.1	-18.7%	-15.5%
156	767	3.0%	22.6%***		0.4%**		0.0	2.4	-16.7%	-13.7%
208	715	3.9%	31.8%***		0.6%***		0.0	2.9	-11.2%	-10.7%
260	663	5.7%	34.0%***		1.1%***		0.0	3.8	-12.0%	-10.3%



Mexico

Horizon	obs	Risk Premium	Ederington	Var Test	Com Returns	Mean Test	CH start	CH finish	Spot VaR@9 5%	CH VaR@9 5%
52	1062	2.2%	15.9%	***	0.3%	***	0.0	4.3	-7.8%	-7.4%
104	1010	4.4%	22.7%	***	0.6%	***	0.0	5.8	-7.7%	-7.0%
156	958	7.0%	26.0%	***	0.9%	***	0.0	7.7	-6.0%	-6.0%
208	906	9.9%	27.6%	***	1.0%	***	0.0	10.5	-5.7%	-4.4%
260	854	12.7%	31.9%	***	1.1%	***	0.0	16.1	-2.0%	-0.8%



New Zealand

Horizon	obs	Risk Premium	Ederington	Var Test	Com Returns	Mean Test	CH start	CH finish	Spot VaR@9 5%	CH VaR@9 5%
52	1576	2.8%	14.1%	***	-0.2%	**	1.6	2.1	-19.0%	-18.8%
104	1524	5.4%	5.4%		-0.4%	***	NA	NA	-27.7%	-24.8%
156	1472	8.2%	1.3%		-0.6%	***	NA	NA	-34.1%	-33.2%
208	1420	11.7%	2.5%		-0.8%	***	NA	NA	-37.7%	-35.0%
260	1368	16.1%	2.6%		-0.8%	***	NA	NA	-36.5%	-33.4%



Norway

Horizon	obs	Risk Premium	Ederington	Var Test	Com Returns	Mean Test	CH start	CH finish	Spot VaR@9 5%	CH VaR@9 5%
52	1271	-0.3%	32.8%	***	1.2%	***	0.0	2.0	-16.3%	-15.6%
104	1219	-0.7%	28.1%	***	2.5%	***	0.0	1.9	-20.6%	-20.5%
156	1167	-1.6%	25.2%	***	3.9%	***	0.0	1.4	-23.9%	-24.2%
208	1115	-1.5%	25.1%	***	4.9%	***	0.0	1.6	-26.9%	-26.3%
260	1063	-0.3%	21.8%	***	5.9%	***	0.0	2.3	-29.6%	-28.2%



Thailand

Horizon	obs	Risk Premium	Ederington	Var Test	Com Returns	Mean Test	CH start	CH finish	Spot VaR@9 5%	CH VaR@9 5%
52	1032	2.4%	8.8%*		0.2%***		0.0	6.3	-10.3%	-11.0%
104	980	4.0%	24.0%***		0.2%***		0.0	8.7	-16.3%	-15.2%
156	928	5.9%	35.3%***		0.3%***		0.0	11.9	-17.1%	-14.9%
208	876	9.1%	35.2%***		0.2%		0.0	13.1	-18.9%	-16.8%
260	824	13.1%	36.5%***		-0.2%*		0.7	17.4	-22.9%	-20.3%



South Africa

Horizon	obs	Risk Premium	Ederingto n	Var Test	Com Returns	Mean Test	CH start	CH finish	Spot VaR@9 5%	CH VaR@9 5%
52	1062	10.7%	15.9%	***	-0.4%	***	1.5	5.3	-25.3%	-22.0%
104	1010	28.4%	16.7%	***	-0.8%	***	1.4	6.7	-35.0%	-34.4%
156	958	50.1%	19.2%	***	-1.2%	***	1.2	7.9	-33.8%	-32.4%
208	906	76.0%	21.9%	***	-2.0%	***	1.1	8.3	-29.8%	-26.5%
260	854	109.7%	26.3%	***	-3.0%	***	1.1	10.5	-31.3%	-25.2%

