Conditional Currency Hedging

Melk C. Bucher

Angelo Ranaldo

Swiss Institute of Banking and Finance, University of St.Gallen

melk.bucher@unisg.ch

Preliminary work. Comments welcome

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How to optimally hedge currency risk?

- Global investors inherently face currency (FX) exposure through their international investments
- Question of optimal hedging of FX risk is thus inevitable
- Literature: No hedging, full hedging, unconditional mean-variance hedging ... how about *conditional* hedging?
- What is the target of FX hedging? (FX risk, total portfolio risk, risk/return)

Agenda

- 1 Contribution to literature & Motivation
- 2 Research design
- 3 Major results
- 4 Conclusion

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Optimal FX exposure in the literature

- Speculative demands
  - ① Siegel paradox (Siegel, 1972).
  - ② Expected excess returns, such as the carry trade (Hansen & Hodrick, 1980; Fama, 1984; Hodrick, 1987; Engel, 1996; Burnside et al., 2006; Brunnermeier, Nagel & Pedersen, 2009)
- Risk management (Hedging):
  - ① No domestic asset riskless in real terms (Adler and Dumas, 1983).
  - ② Risk management demands depend on correlation with given baseline assets.
  - ③ If equities and currencies are uncorrelated, risk management demands are zero, implying full FX hedging (Solnik, 1974).
  - ④ Optimal (unconditional) mean-variance hedging strategies can reduce total return volatility (Campbell, Serfaty-de-Medeiros & Viceira, 2010; Glen & Jorion, 1993).

Research gap

What if time-varying correlation structure is conditional on certain risk factors? Question of *Conditional Currency Hedging*.

Conditioning information: global risk factors

- What can serve as useful information to predict future inter-asset class correlation? Global and FX risk factors with forward-looking content
- Recent literature on global risk factors across asset classes (e.g. Lettau, Maggiori & Weber, 2014; Cenedese, Payne, Sarno & Valente, 2016)
  - implied equity and FX volatility; downstate pricing (DR-CAPM)
- Recent literature in FX asset pricing: risk factors accounting for the *Carry Trade and Momentum* excess returns (e.g. Lustig et al., 2011; Burnside, 2012; Menkhoff et al., 2012a; Mancini et al., 2013; Mueller et al., 2012; Ready et al., 2015; Richmond, 2016)
  - DOL, HML, VOL, MOM, IML, COR, IMX, PMC

Research gap

Use lagged FX and global risk factors to predict future across-asset correlation and thus conditional hedging

An empirical motivation for conditional currency hedging

Figure 1: Correlation of global equities, bonds and commodities with DOL_{FX} and HML_{FX} across lagged implied FX volatility (1995:02-2015:12)

An empirical motivation for conditional currency hedging

Figure 2: Correlation of global equities with six G20 currency pairs (against USD) across lagged implied FX volatility (1995:02-2015:12)

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- 7 developed countries: Australia, Canada, Eurozone, Japan, Switzerland, UK, USA (data going back the longest)
- Data sources:
  - ① Stocks: MSCI country indices
  - ② Bonds: 10 Year Yields, 3m interest rates, FX against USD from International Financial Statistics database (IMF); if not available, OECD
  - ③ Global risk factors: VIX pulled from Wharton Research Database; FX implied volatility from Datastream (1995:2-2015:12); FX risk factors from authors (Menkhoff et al., 2012b; Mueller et al., 2012; Ready et al., 2015; Richmond, 2016)
- Data transformation: Excess log returns over domestic risk-free rate (3m); Log bond returns using approximation suggested in Campbell, Lo & MacKinlay (1997)
- Baseline analysis in monthly returns; Robustness with 3m (non)overlapping returns

Mean-variance OLS approach to minimize total portfolio variance

$$r_{p,t+1}^h - i_{1,t} = \mathbf{1}' \boldsymbol{\omega}_t (\mathbf{r}_{t+1} - \mathbf{i}_t) + \boldsymbol{\psi}'_t (\boldsymbol{\Delta} \mathbf{s}_{t+1} + \mathbf{i}_t - \mathbf{i}_t^d) + \frac{1}{2} \sum_t^h \quad (1)$$

$$\arg \min_{\boldsymbol{\psi}_t} (\sigma_{p,t+1}^2) \quad (2)$$

$$\begin{aligned} \mathbf{1}' \boldsymbol{\omega}_t (\mathbf{r}_{t+1} - \mathbf{i}_t) &= \gamma_0 - \boldsymbol{\psi}'_u (\boldsymbol{\Delta} \mathbf{s}_{t+1} + \mathbf{i}_t - \mathbf{i}_t^d) \\ &\quad - \boldsymbol{\psi}'_{c,t} (\boldsymbol{\Delta} \mathbf{s}_{t+1} + \mathbf{i}_t - \mathbf{i}_t^d) RF_t \end{aligned} \quad (3)$$

$$\boldsymbol{\psi}_t = \boldsymbol{\psi}_u + \boldsymbol{\psi}_{c,t} RF_t \quad (4)$$

- Mean-variance approach: Variance minimization of total portfolio returns through optimal FX weights. Optimal FX weights arrived at by regression of domestic excess portfolio returns on FX excess returns and taking negative of regression coefficients (e.g. Campbell et al., 2010).
  - ① Ordinary least squares (OLS) (Campbell, 2010). Optimal FX weights linear function of risk factor
  - ② Logistic smooth transition regression model (LSTAR) (Christiansen, Rinaldo, Soderlind, 2011). Optimal FX weights logistic function of risk factor
- In- and out-of-sample testing of the models in terms of optimal FX weights as well as portfolio variance
- Primary: risk minimization; Secondary: Risk/return trade-off

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Risk-minimizing conditional currency weights

Table 1: Optimal Currency Exposure for the Equally-Weighted Global Equity Portfolio: Unconditional Case and Sensitivity to *lagged* implied and realized volatility

	Unconditional	implied VOL	realized VOL
	Estimate (Std. Error)	Estimate (Std. Error)	
EUR_USD	0.03 (0.12)	-1.47** (0.55)	0.03 (0.32)
AUD_USD	-0.25** (0.06)	0.38 (0.38)	-0.16 (0.20)
CAD_USD	-0.63*** (0.10)	-0.35 (0.39)	-0.21 (0.30)
JPY_USD	0.03 (0.06)	0.63** (0.23)	0.27* (0.15)
CHF_USD	0.27** (0.10)	1.21** (0.37)	0.30 (0.25)
GBP_USD	-0.05 (0.07)	0.60* (0.32)	0.19 (0.18)
USD	0.66*** (0.24)	NA	NA
EUR * VOL_i		0.06 (0.05)	
AUD * VOL_i		-0.08* (0.04)	
CAD * VOL_i		-0.09* (0.04)	
JPY * VOL_i		-0.03 (0.02)	
CHF * VOL_i		0.35* (0.17)	
GBP * VOL_i		-0.04 (0.03)	
EUR * VOL_r			-0.06 (0.69)
AUD * VOL_r			-0.23 (0.44)
CAD * VOL_r			-0.81 (0.64)
JPY * VOL_r			-0.58* (0.31)
CHF * VOL_r			-0.02 (0.51)
GBP * VOL_r			-0.51 (0.36)

In-sample performance of various hedging regimes

Table 2: Risk reduction due to conditional currency hedging

	Unconditional hedging (1976:3-2015:12)	implied VOL (1995:2-2015:12)	realized VOL (1976:3-2015:12)
	[Full hedging]	[Full hedging]	[Full hedging]
annualized return	0.036 [0.047]	0.018 [0.049]	0.036 [0.047]
annualized std	0.119 [0.134]	0.09 [0.135]	0.117 [0.134]
Sharpe ratio	0.30 [0.35]	0.18 [0.3]	0.31 [0.35]
Max drawdown	-0.255 [-0.286]	-0.086 [-0.158]	-0.249 [-0.286]
Skewness	-1.419 [-1.658]	-0.539 [-1.132]	-1.45 [-1.658]
Kurtosis	9.88 [10.62]	3.28 [4.97]	9.95 [10.62]

- In-sample, both unconditional as well as conditional hedging lead to a reduction in risk at the cost of lower expected returns
- Hedging through implied volatility strongly further decreases risk in terms of std. dev., drawdown, skewness and kurtosis relative to full and unconditional hedging.

Out-of-sample performance of various hedging regimes

Table 3: Risk reduction due to conditional currency hedging

	UC optimal hedging (1985:1 - 2015:12)	VOL_i (1995:2-2015:12)	VOL_r (1985:1 - 2015:12)
	[Full hedging]	[Full hedging]	[Full hedging]
annualized return	0.023 [0.049]	0.056 [0.065]	0.049 [0.049]
annualized std	0.127 [0.139]	0.101 [0.128]	0.139 [0.139]
Sharpe ratio	0.18 [0.35]	0.55 [0.51]	0.36 [0.35]
Max drawdown	-0.283 [-0.286]	-0.085 [-0.158]	-0.302 [-0.286]
Skewness	-1.896 [-1.750]	-0.010 [-1.264]	-1.820 [-1.750]
Kurtosis	13.50 [11.01]	4.39 [5.83]	12.912 [11.01]

- Out of sample, hedging through implied volatility strongly outperforms all other forms of hedging in terms of risk (and even risk/return trade off).
- Unconditional hedging as proposed by Campbell et al. (2010) does not lead to strong risk reduction, but lower expected returns.

Implied volatility as a strong hedge signal during crisis periods

Figure 3: Correlation of global equities with six G20 currency pairs (against USD) across lagged implied FX volatility (1995:02-2015:12)

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Conclusion

- Implied FX volatility can reduce portfolio risk in and out-of sample. This is particularly true during crisis periods.
- Unconditional currency hedging as proposed by Campbell et al. (2010) does not hold up out-of-sample (higher risk than full hedging).
- Reduction in portfolio risk across the board: Variance, negative skewness, kurtosis and crash risk (drawdown) are significantly reduced.
- However, the risk reduction is no free lunch: reduction in expected returns with same or decreasing Sharpe ratio.
- So far analysis conducted with Equities and Bonds. Commodities, role of emerging market currencies and transaction costs still to be included