The Rise and Fall of the Carry Trade: Links to Currency Return Predictability

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Carry trade

- $RX^i_{t+1} \approx \underbrace{r^i_t - r^{\text{US}}_t}_{\substack{\text{forward} \\ \text{premium} \\ \text{(via CIP)}}} - \underbrace{\left(S^i_{t+1} - S^i_t\right)/S^i_t}_{\substack{\text{currency} \\ \text{return}}}$
  - r^i_t (r^{US}_t) $\Rightarrow$ country-i (US) government bill interest rate
  - $S^i_t \Rightarrow$ country-i currency per USD
- Carry trade experienced extended bullish run
  - Until the Global Financial Crisis (Melvin & Taylor 2009)
- Currency return predictability (or lack thereof)
  - Difficult to beat random walk (Meese & Rogoff 1983)
- Can currency return predictability guard against carry crash?

What we do

- Rich set of potential predictors for currency returns
  - Country characteristics & global variables
- Panel predictive regression (PR) model
  - Shrinkage via machine learning $\Rightarrow$ avoid overfitting
- Statistical criterion $\Rightarrow$ out-of-sample MSFE
  - Pre-crisis $\Rightarrow$ PR performs similarly to random walk
  - Post-crisis $\Rightarrow$ PR outperforms random walk
- Economic value $\Rightarrow$ portfolio based on predictability
  - Pre-crisis $\Rightarrow$ PR portfolio performs similarly to carry portfolio
  - Post-crisis $\Rightarrow$ PR outperforms carry portfolio

Currency returns—summary statistics

Country	Sample period	Ann mean	Ann vol	Autocorr
United Kingdom	1985:01–2017:08	0.17%	10.16%	0.07
Switzerland	1985:01–2017:08	−2.40%	11.47%	−0.01
Japan	1985:01–2017:08	−1.89%	11.21%	0.04
Canada	1985:01–2017:08	0.13%	7.42%	−0.04
Australia	1985:01–2017:08	0.83%	11.94%	0.06
New Zealand	1985:01–2017:08	−0.52%	12.29%	−0.02
Sweden	1985:01–2017:08	0.26%	11.23%	0.12
Norway	1985:01–2017:08	0.13%	11.03%	0.03
Denmark	1985:01–2017:08	−1.25%	10.62%	0.03
Europe	1999:02–2017:08	0.25%	10.07%	0.04
Germany	1985:01–1998:12	−3.87%	11.64%	0.03
Italy	1985:01–1998:12	−0.48%	11.54%	0.10
France	1985:01–1998:12	−3.27%	11.18%	0.02
Netherlands	1985:01–1998:12	−3.89%	11.59%	0.04

Country characteristics

- Differential vis-à-vis US
  - Inflation (INF) & unemployment rate (UN)
    - Publication lag
  - Gov bill (BILL), note (NOTE), & bond (BOND) yields
  - Dividend yield (DP) & price-earnings (PE)
  - Stock market cap growth (MKT)
- Currency excess returns vis-à-vis USD
  - Idiosyncratic volatility (IV) & skewness (IS)
- Z-vector of country characteristics $\Rightarrow \mathbf{z}_{i,t}$ $(Z = 10)$

Global/US variables

- Policy uncertainty indices (Baker et al 2016)
  - Economic (EPU) & monetary (MPU)
- Geopolitical risk index (GR; Caldara & Iacoviello 2018)
- Macroeconomic uncertainty index (MU; Jurado et al 2015)
- Global FX market conditions
  - Volatility (GVOL; Menkhoff et al 2012)
  - Illiquidity (GILL; Menkhoff et al 2012)
  - Correlation (GCOR; Mueller et al 2017)
- G-vector of global variables $\Rightarrow \mathbf{g}_t$ $(G = 7)$

Panel predictive regression

- Interact country characteristics with global variables
  - $\mathbf{h}_{i,t} = \mathbf{z}_{i,t} \otimes \mathbf{g}_t$
- Vector of predictors $\Rightarrow \mathbf{x}_{i,t} = \begin{bmatrix} \mathbf{z}'_{i,t} & \mathbf{h}'_{i,t} \end{bmatrix}'$
  - Deviation form $\Rightarrow \tilde{\mathbf{x}}_{i,t} = \mathbf{x}_{i,t} - \bar{\mathbf{x}}_i$
  - Number of predictors $\Rightarrow Z + ZG = 10 + 10 \cdot 7 = 80$
- Panel predictive regression $\Rightarrow \delta_{i,t} = \tilde{\mathbf{x}}'_{i,t-1}\mathbf{b} + \varepsilon_{i,t}$
  - $\delta_{i,t} = (S_{i,t} - S_{i,t-1})/S_{i,t-1}$
  - Equivalent to fixed effects with zero average currency return
- Out-of-sample forecast $\Rightarrow \hat{\delta}^{\text{PR}}_{i,t+1|t} = \tilde{\mathbf{x}}'_{i,t}\hat{\mathbf{b}}_{1:t}$

Machine learning

- Conventional OLS estimation susceptible to overfitting
  - High-dimensional regression model
  - Inherently small predictable component in $\delta_{i,t}$ (ie, noisy data)
- Penalized regression $\Rightarrow$ LASSO (Tibshirani 1996)
  - ℓ_1 penalty $\Rightarrow$ permits shrinkage to zero (ie, variable selection)
  - Select regularization parameter λ via BIC_λ (Wang et al 2009)
- Refinement $\Rightarrow$ ENet (Zou & Hastie 2005)
  - Combines ℓ_1 (LASSO) & ℓ_2 (ridge) penalties
  - Tends to select highly correlated predictors as group

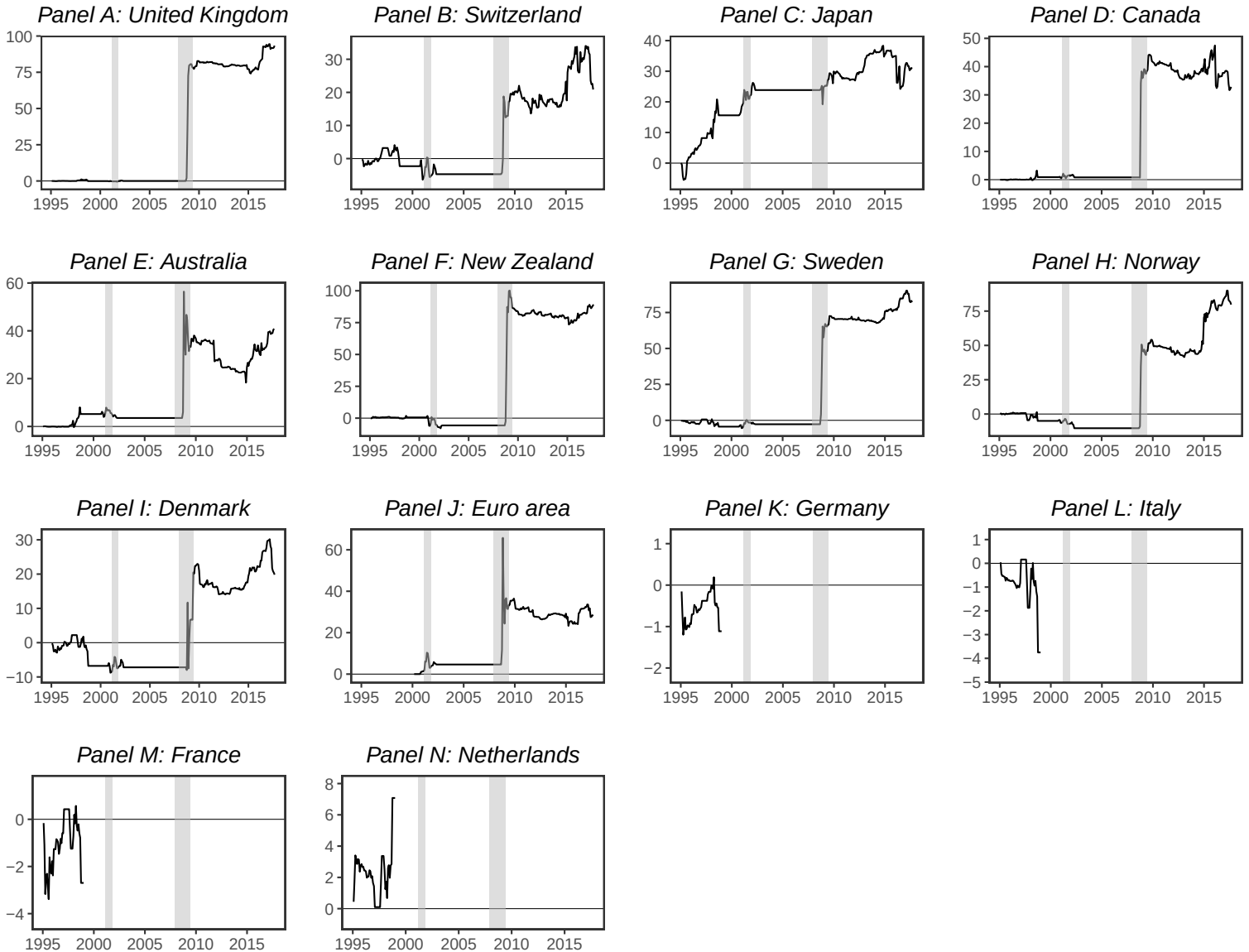
Statistical criterion

- Benchmark forecast $\Rightarrow \hat{\delta}^{RW}_{i,t+1|t} = 0$
  - Random walk without drift (Rossi 2013)
- Campbell & Thompson (2008) out-of-sample R^2 statistic
  - % $\downarrow$ MSFE for PR forecast vis-à-vis RW benchmark
- Clark & West (2007) MSFE-adj statistic
  - Appropriate for nested model comparison
- All countries
  - $R^2_{OS} = 2.00\%$ [MSFE-adj $= 4.73^{***}$]

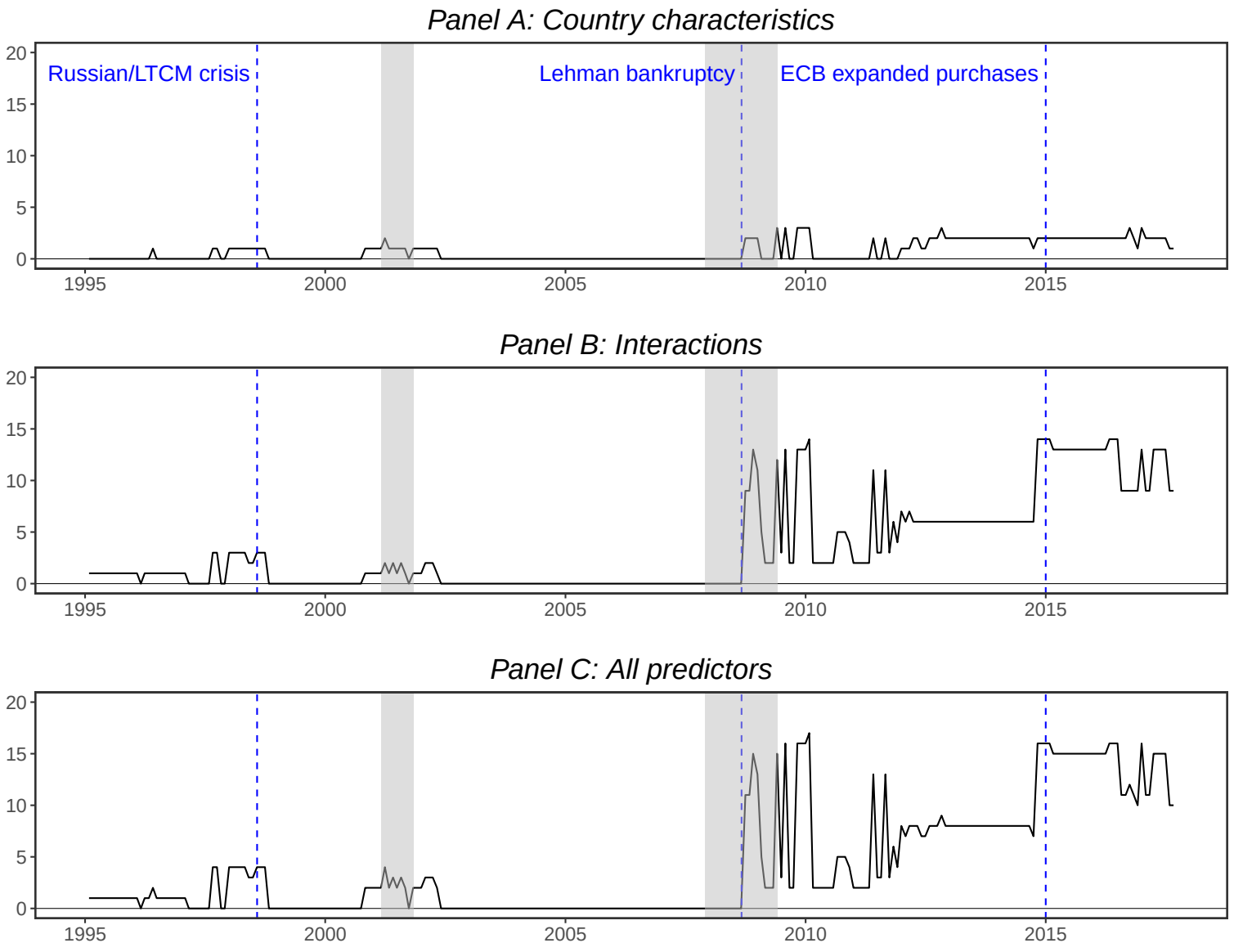
Out-of-sample R^2 statistics

Country	Out-of-sample period	R^2_{OS}	MSFE-adj
United Kingdom	1995:01–2017:08	5.71%	1.77**
Switzerland	1995:01–2017:08	0.84%	1.38*
Japan	1995:01–2017:08	1.14%	1.89**
Canada	1995:01–2017:08	2.05%	1.53*
Australia	1995:01–2017:08	1.24%	1.54*
New Zealand	1995:01–2017:08	2.49%	1.40*
Sweden	1995:01–2017:08	3.15%	1.77**
Norway	1995:01–2017:08	2.98%	1.81**
Denmark	1995:01–2017:08	0.91%	1.86**
Europe	2000:02–2017:08	1.55%	1.24
Germany	1995:01–1998:12	−0.32%	−0.79
Italy	1995:01–1998:12	−1.70%	−0.95
France	1995:01–1998:12	−0.79%	−0.43
Netherlands	1995:01–1998:12	1.99%	1.32*

Differences in cumulative mean squared forecast error



Number of selected predictors



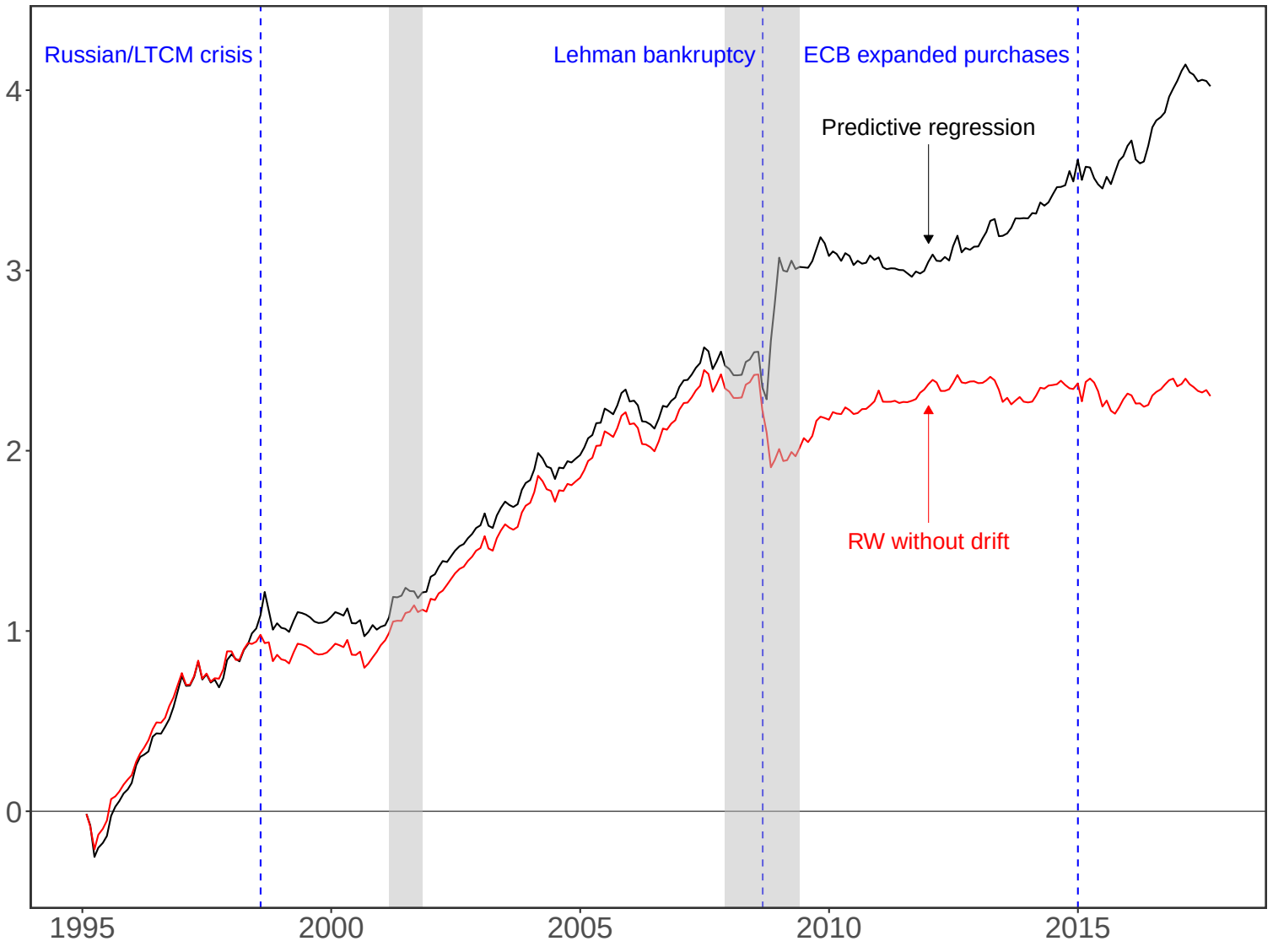
Economic value—asset allocation

- Investor with mean-variance preferences
  - Invests in foreign & US government bills
- $\arg\min_{\mathbf{w}_t} \mathbf{w}_t' \hat{\boldsymbol{\mu}}_{t+1|t} - 0.5\gamma \mathbf{w}_t' \hat{\boldsymbol{\Sigma}}_{t+1|t}^{-1} \mathbf{w}_t$ subject to $-\boldsymbol{\iota} \leqslant \mathbf{w}_t \leqslant \boldsymbol{\iota}$
  - $\hat{\boldsymbol{\mu}}_{t+1|t} \Rightarrow$ vector of currency excess return forecasts
    - $\widehat{RX}^{\text{RW}}_{i,t+1|t} = \left(r^i_t - r^{\text{US}}_t\right) - \underbrace{\hat{\delta}^{\text{RW}}_{i,t+1|t}}_{0}$
    - $\widehat{RX}^{\text{PR}}_{i,t+1|t} = \left(r^i_t - r^{\text{US}}_t\right) - \hat{\delta}^{\text{PR}}_{i,t+1|t}$
  - $\hat{\boldsymbol{\Sigma}}_{t+1|t} \Rightarrow$ EWMA estimate of variance-covariance matrix
  - Coefficient of relative risk aversion $\Rightarrow \gamma = 5$
- Portfolio based on $\hat{\delta}^{\text{RW}}_{i,t+1|t} \Rightarrow$ 'optimal' carry trade portfolio

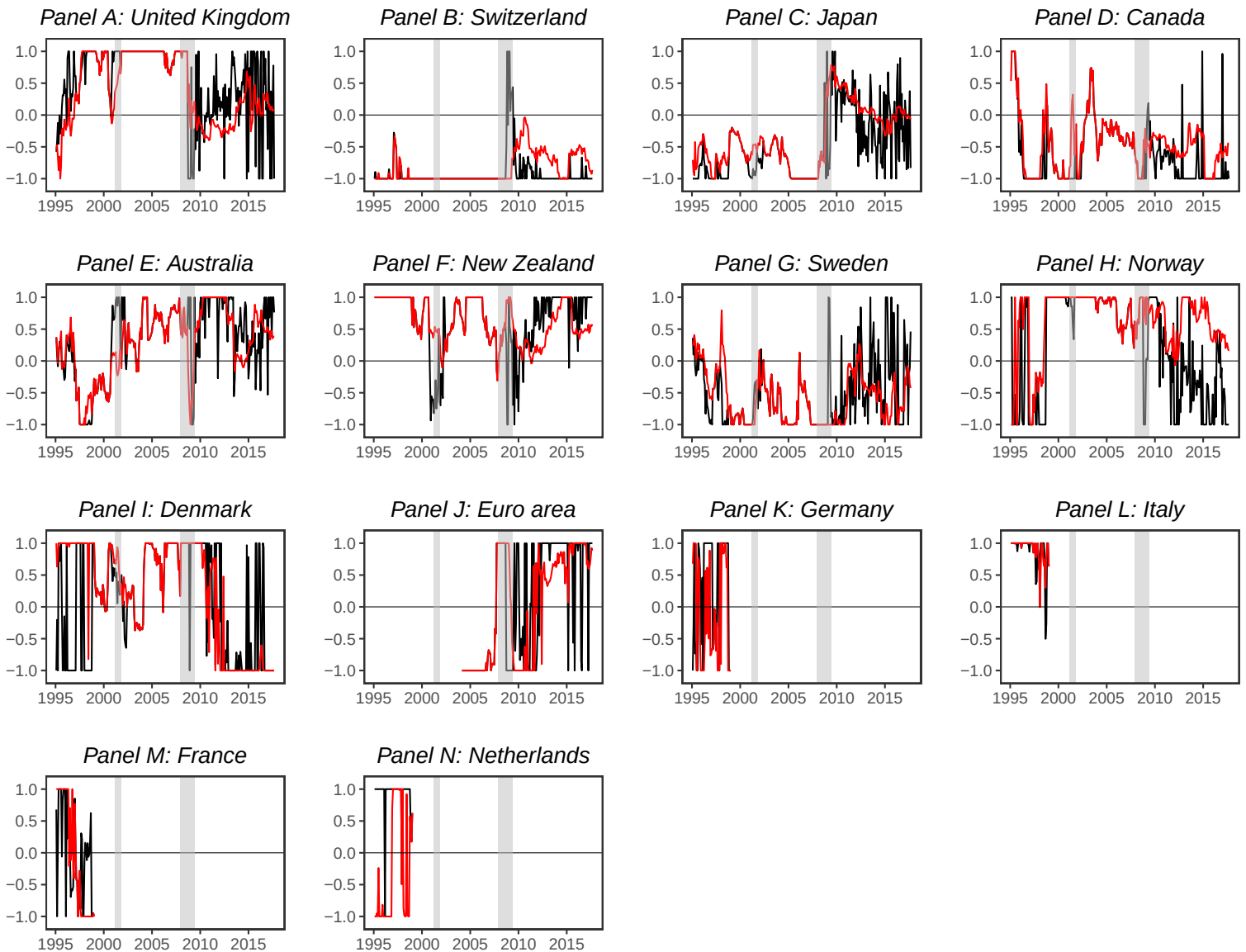
Portfolio performance metrics

Portfolio	Ann mean	Ann vol	Ann SR	MDD	Ann Δ
Full sample (1995:01–2017:08)					
RW	11.38%	15.20%	0.75	41.70%	–
PR	19.73%	19.74%	1.00	25.05%	4.38%
Pre-crisis (1995:01–2007:07)					
RW	20.53%	14.83%	1.38	19.49%	–
PR	21.78%	16.36%	1.33	21.79%	0.06%
Post-crisis (2007:08–2017:08)					
RW	–0.04%	15.07%	–0.003	40.30%	–
PR	17.17%	23.34%	0.74	23.26%	9.27%

Log cumulative excess return



Portfolio weights



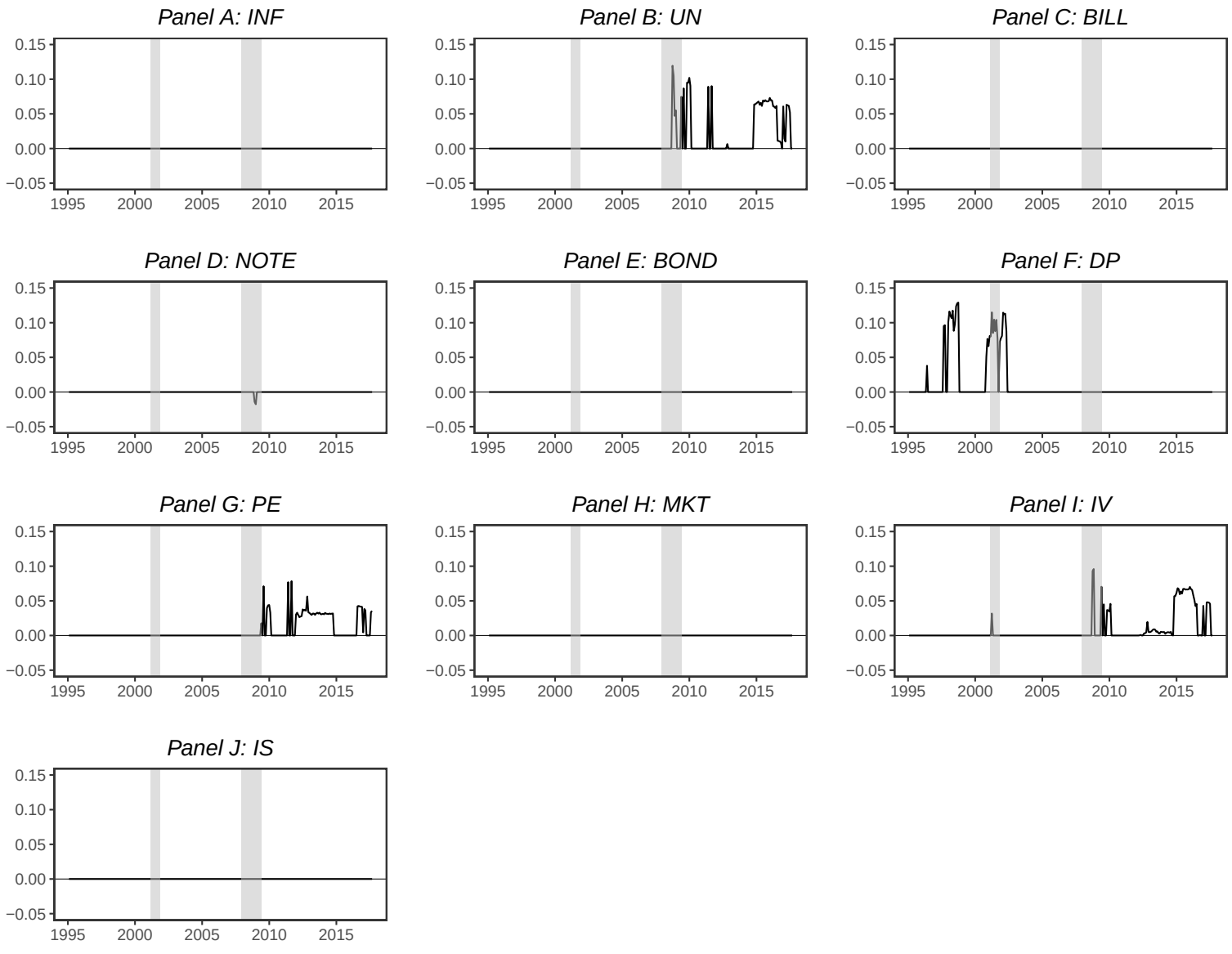
Multifactor model estimation results

Factor	Coef	t-stat	Factor	Coef	t-stat
Full sample (1995:01–2017:08)			**Post-crisis (2007:08–2017:08)**		
α	1.34%	4.22^{***}	α	1.41%	2.42^{**}
DOL	−0.39	-2.74^{***}	DOL	−0.18	−0.71
HML-FX	0.70	6.06^{***}	HML-FX	0.35	1.72^{*}
MOM-FX	0.55	4.60^{***}	MOM-FX	0.73	3.87^{***}
R^2	17.45%		R^2	12.22%	
Pre-crisis (1995:01–2007:07)					
α	0.91%	3.02^{***}			
DOL	−0.22	-2.74^{***}			
HML-FX	1.33	10.45^{***}			
MOM-FX	−0.01	−0.10			
R^2	44.59%				

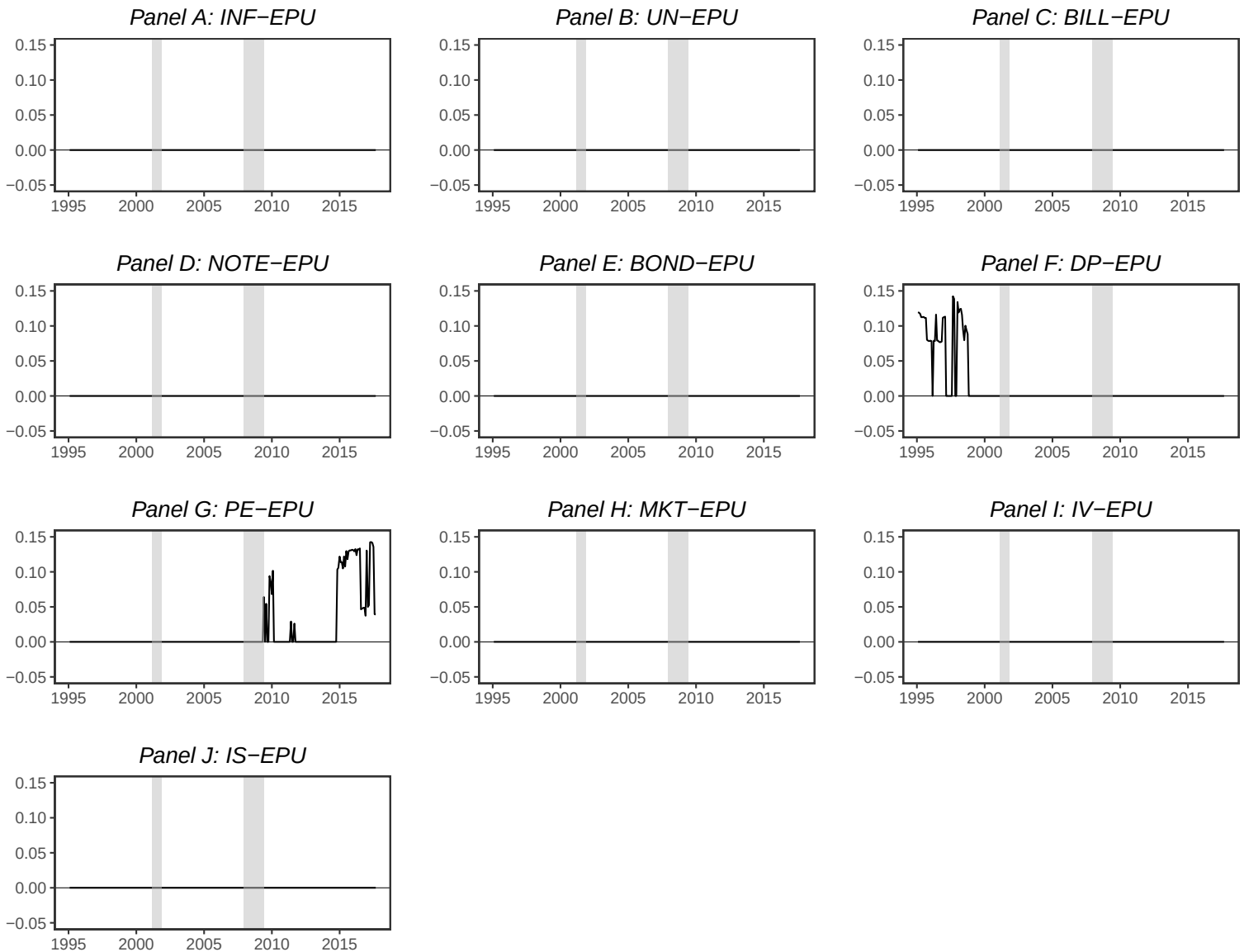
Conclusion

- Investigate currency return predictability
  - Rich information set
  - LASSO/ENet $\Rightarrow$ avoid overfitting
- Global Financial Crisis
  - Deterioration of carry trade
  - Enhanced currency return predictability
- Currency return predictability significant since GFC
  - Improvements in forecast accuracy (MSFE)
  - Substantially improves portfolio performance

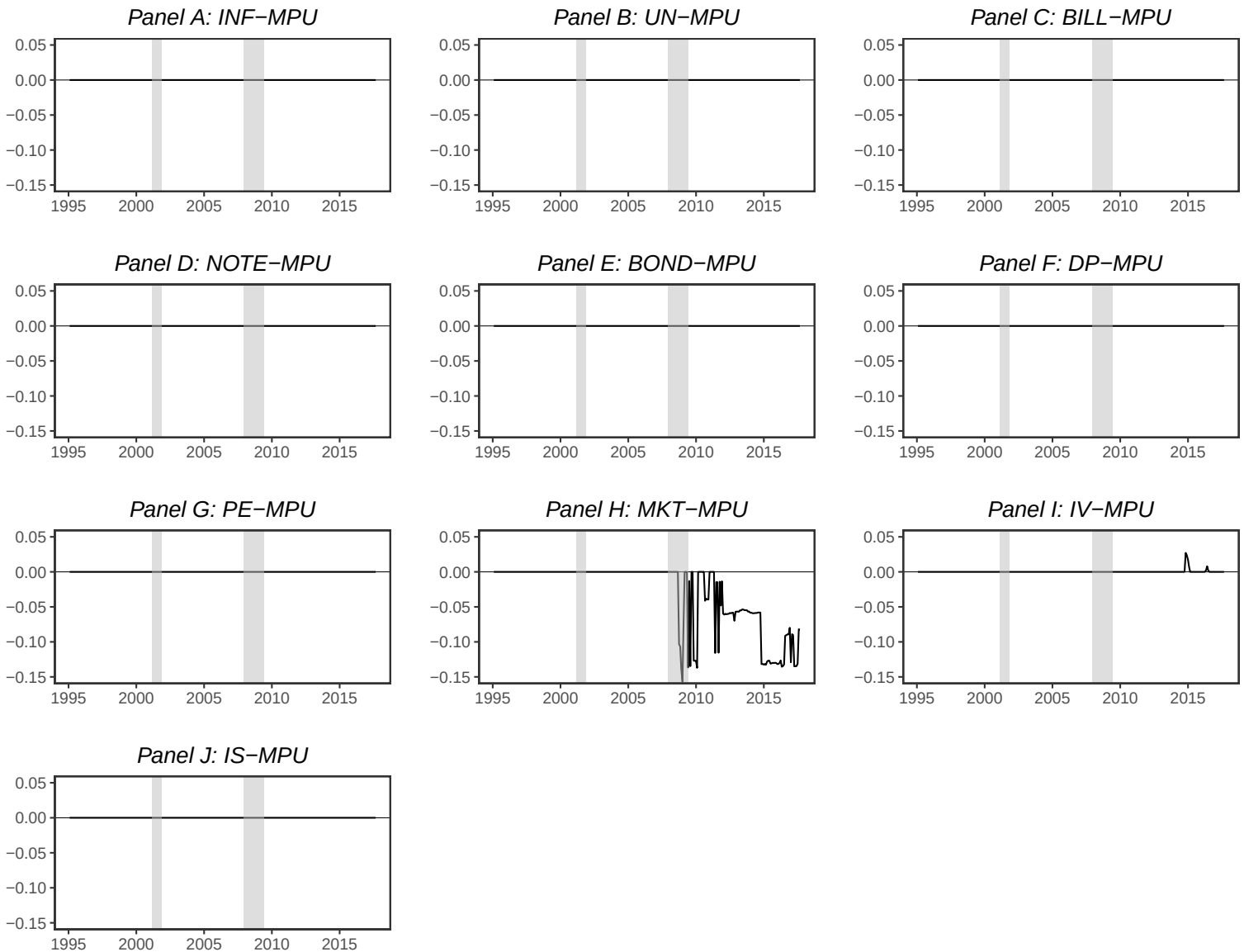
Recursive coefficients—country characteristics



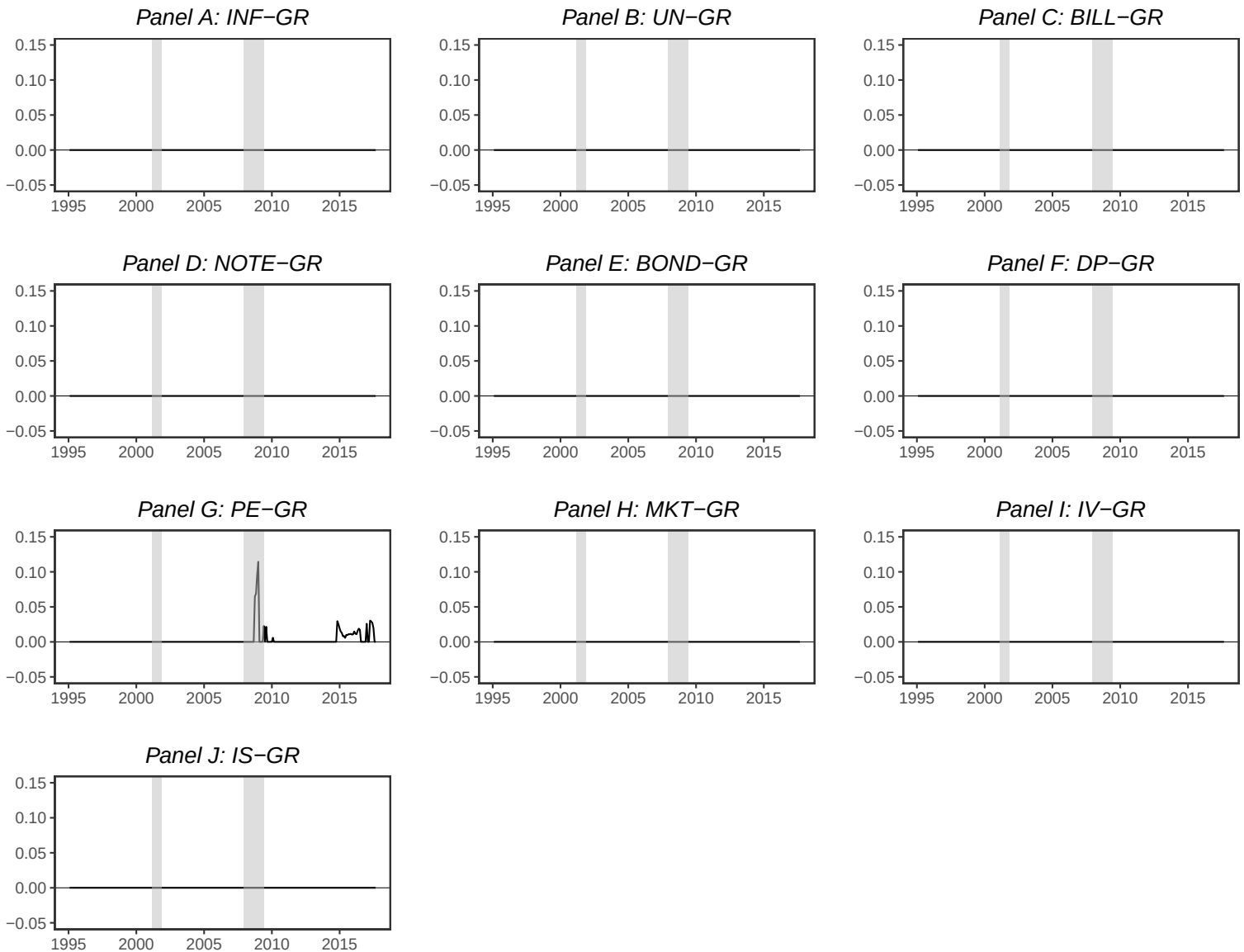
Recursive coefficients—EPU interactions



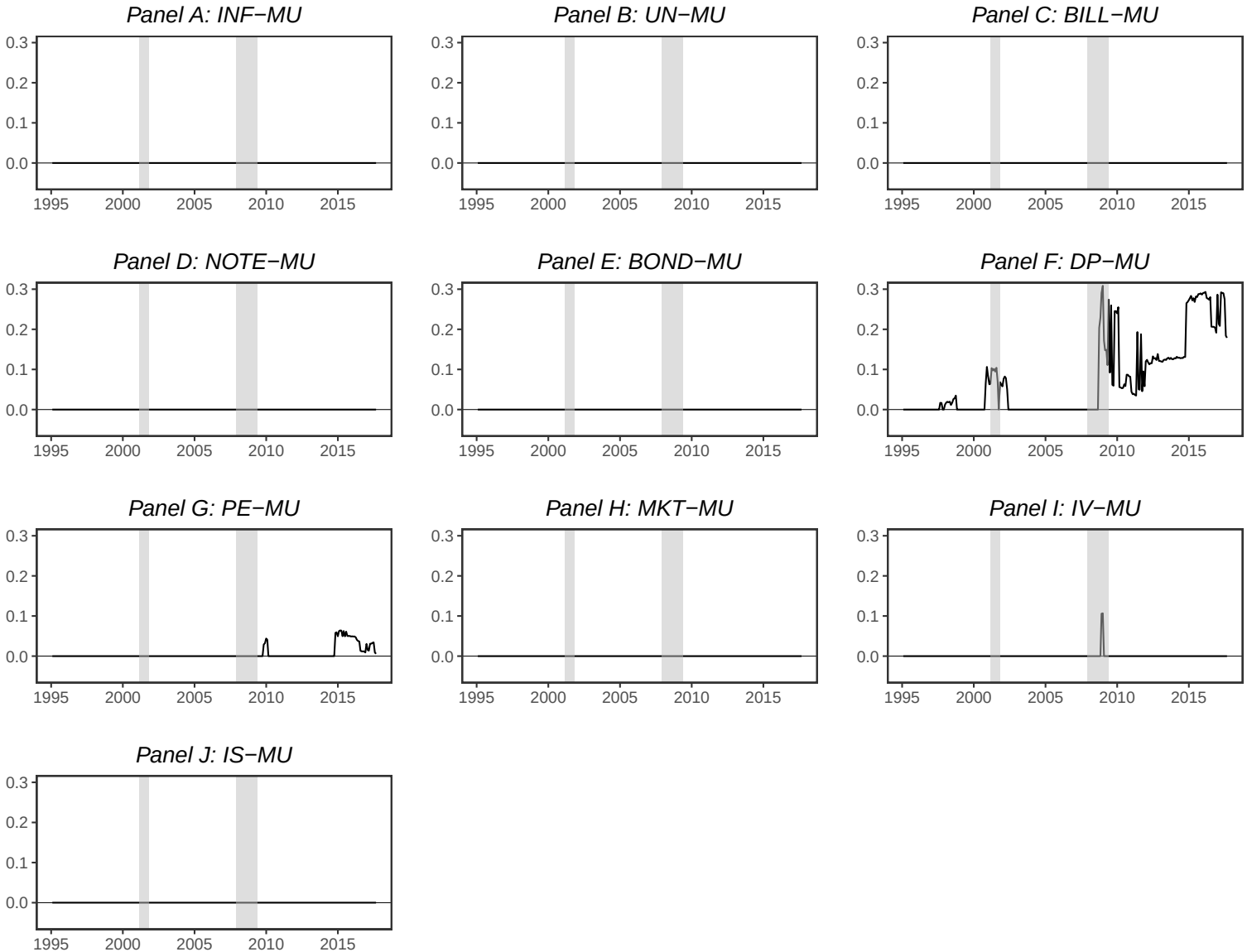
Recursive coefficients—MPU interactions



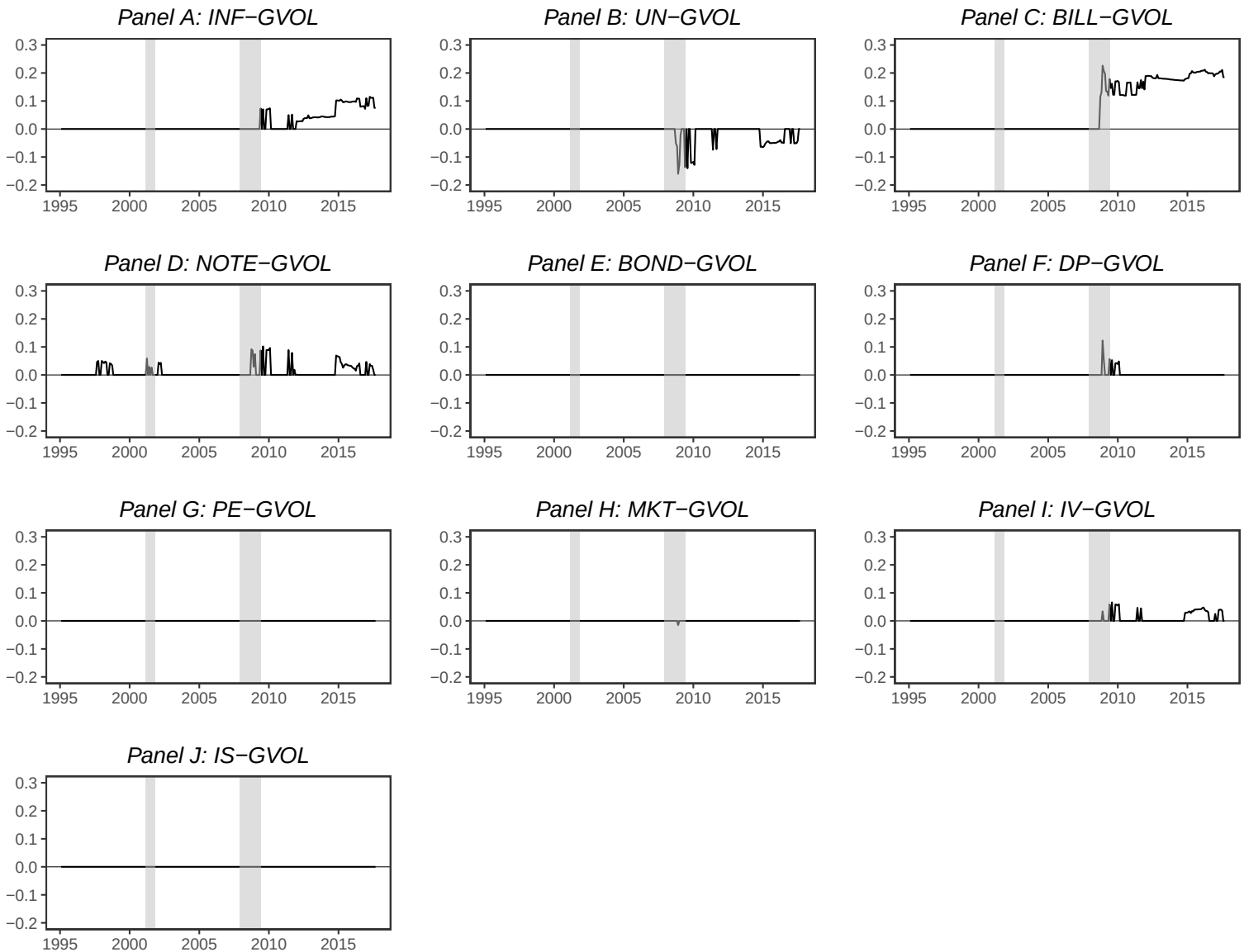
Recursive coefficients—GR interactions



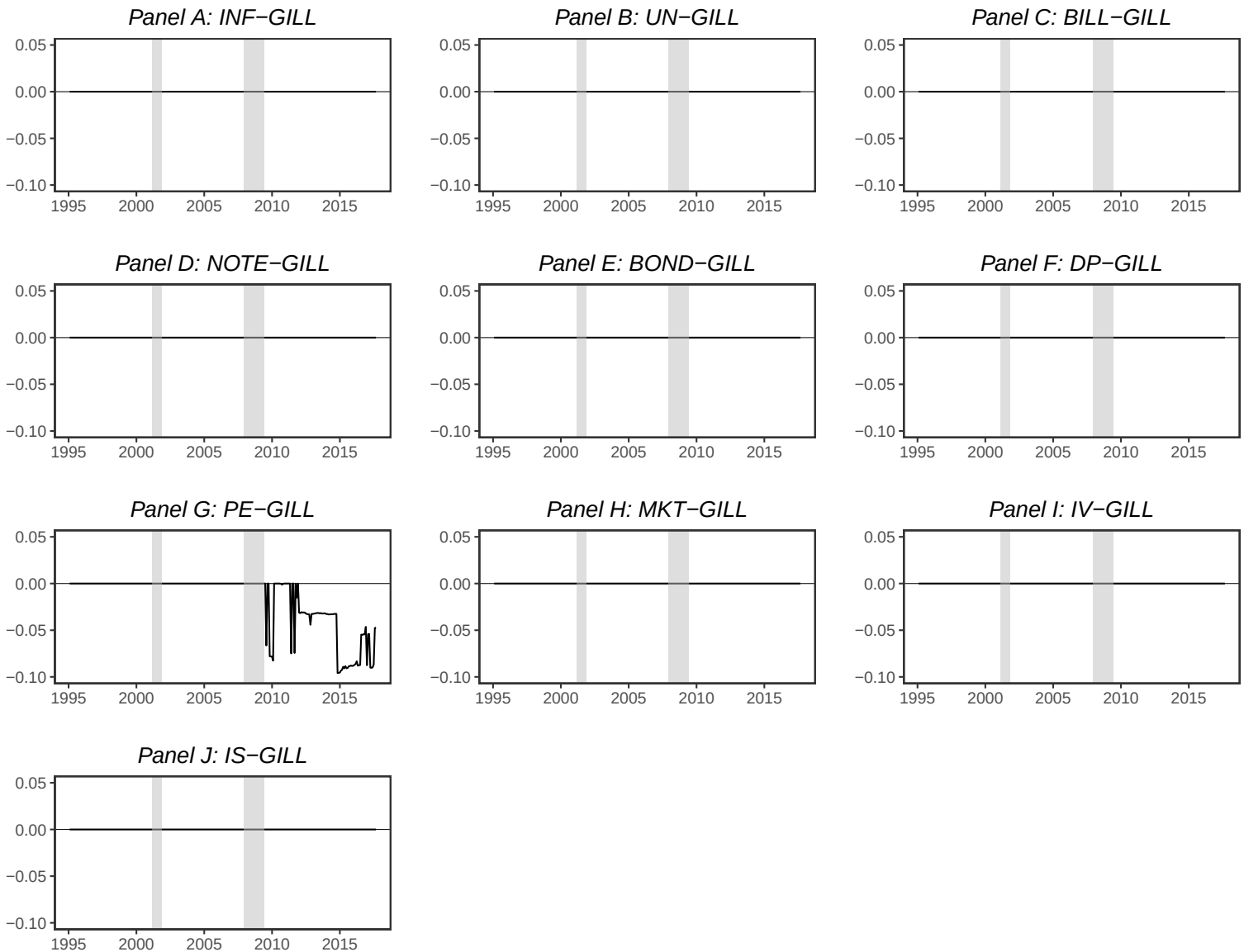
Recursive coefficients—MU interactions



Recursive coefficients—GVOL interactions



Recursive coefficients—GILL interactions



Recursive coefficients—GCOR interactions