

When is monetary policy more powerful?

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European Central Bank, Frankfurt

Central Bank of Ireland



Banc Ceannais na hÉireann
Central Bank of Ireland

Eurosystem

Introduction

Introduction

- The idea that monetary policy transmission might be non-linear has a long history (Keynes, 1936).
- Empirically, we're often interested in relations of the form:

$$\Delta Y_t = \alpha + \beta MPS_t + \delta MPS_t \times Z_{t-1} + \phi' \mathbf{X}_{t-1} + \varepsilon_t,$$

where:

- Y_t is the dependent variable of interest;
 - MPS_t is a monetary policy shock;
 - Z_{t-1} is a state variable of interest;
 - \mathbf{X}_{t-1} is a vector of controls;
 - ε_t is an exogenous error.
- For example, Z_{t-1} could be a business cycle indicator, or a measure of uncertainty.

- The literature has proposed many different state variables of interest (Z_{t-1}).
 - **Business cycle:** Tenreyro and Thwaites (2016), Mumtaz and Surico (2016)
 - **Financial cycle:** Alpanda and Zubairy (2019), Rünstler and Bräuer (2020)
 - **Uncertainty:** De Pooter et al. (2021), Bauer et al (2022), Tillman (2019)
 - **The Zero Lower Bound:** Kiley and Roberts (2017)
 - **Multiple interactors:** Alpanda et al. (2021), El-Shagi (2021).

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- Generally, these studies take a *low dimensional* approach to non-linearity.
- Issues:
 - The proposed state-variables can be correlated with each other.
 - Alternative interactors are often studied in *ad hoc* horse races.

- We propose a *high dimensional* approach to non-linearity.

$$\Delta Y_t = \alpha + \beta MPS_t + \underbrace{\boldsymbol{\delta}' \mathbf{z}_{t-1}}_{(K \times 1)} MPS_t + \boldsymbol{\phi}' \mathbf{X}_{t-1} + \varepsilon_t.$$

- Our contribution in a nutshell: we allow K to be “large”.

- We propose a *high dimensional* approach to non-linearity.

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- Our contribution in a nutshell: we allow K to be “large”.
- Our investigation focusses on financial transmission:
 - A static (high-frequency) event study;
 - ΔY_t will be changes in asset prices around policy meetings;
 - MPS_t will be a high-frequency monetary policy surprise.

Basic facts about the transmission mechanism

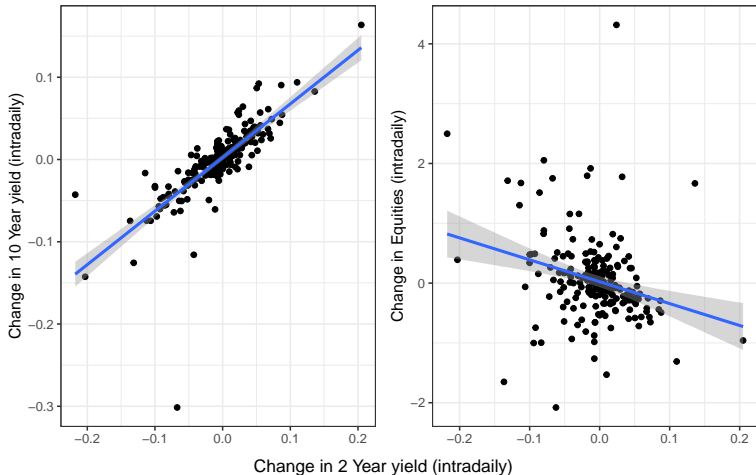


Figure 1: Transmission down the yield curve and to equities (US)

Source: Bauer and Swanson (2023) data-set

Transmission depends on macro-financial variables

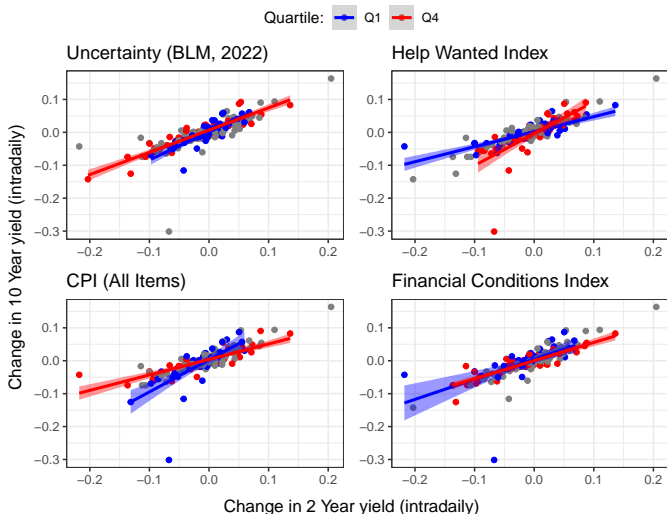


Figure 2: Yield curve transmission, by macro-financial variables

Contributions

- Constructing novel, large, mixed-frequency datasets of real and financial variables for the US and euro area.
 - Specifically designed to incorporate non-linear mechanisms from the literature.

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 - Specifically designed to incorporate non-linear mechanisms from the literature.
- Taking a “big data” approach to non-linear transmission.
 - Establishing that transmission of monetary policy to asset prices has **multi-dimensional** state dependence.
 - Showing that these non-linearities have economically large effects on transmission.
 - Decomposing non-linear transmission over time.

Contributions

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 - Specifically designed to incorporate non-linear mechanisms from the literature.
- Taking a “big data” approach to non-linear transmission.
 - Establishing that transmission of monetary policy to asset prices has **multi-dimensional** state dependence.
 - Showing that these non-linearities have economically large effects on transmission.
 - Decomposing non-linear transmission over time.
- Documenting evidence that low-dimensional non-linear specifications suffer from considerable omitted variable bias
 - We propose a factor approach to account for this.

Methodology and Data

The Approach: Big Data

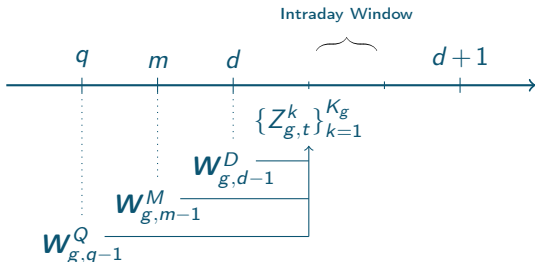
- We use “large N” methods to estimate multidimensional non-linear transmission.

$$\Delta Y_t = \alpha + \beta MPS_t + \boldsymbol{\delta}' \mathbf{Z}_{t-1} MPS_t + \boldsymbol{\phi}' \mathbf{X}_{t-1} + \varepsilon_t.$$

- A factor approach:
 - We take a large dataset of financial and macroeconomic variables, $\{w_{i,t-1}\}_{i=1}^N$.
 - We divide the dataset into G “groups”. For example, activity, prices, interest rates...
 - Estimate K_g factors for each group, $g \in \{1, \dots, G\}$.
 - Arrange these factors in vector \mathbf{Z}_{t-1} .
 - Controls: we set $\mathbf{X}_{t-1} = \mathbf{Z}_{t-1}$.
- Alternative approaches are feasible.
 - We also use LASSO algorithms, and Random Forests.

The Approach: Group Factors

- Take a meeting t , taking place on day d of month m in quarter q
- Gather (lagged) quarterly data $\mathbf{W}_{g,q-1}^Q$, monthly data $\mathbf{W}_{g,m-1}^M$, and daily data $\mathbf{W}_{g,d-1}^D$ for each group g
- Estimate K_g factors for each group g by PCA:



The Approach: State-dependence

- Our approach is an application of the K-O-B decomposition (Cloyne et al. 2023).
- Our factors are mean zero by construction.

Direct Effect : $\hat{\beta}$

Indirect Effect : $\hat{\delta}(\mathbf{Z}_{t-1} - \bar{\mathbf{Z}})$

Total Effect : $\hat{\beta} + \hat{\delta}(\mathbf{Z}_{t-1} - \bar{\mathbf{Z}})$

- Monetary policy transmission is the **Total Effect**.
- K-O-B allows us to decompose this into effect at the mean of all variables (**Direct Effect**) and *potential* state-dependence around the mean (**Indirect Effect**).
 - Cloyne et al. (2023) emphasise the importance of *instrumenting* interaction variables, to claim causality.
 - Our approach is complementary: We seek to (greatly) expand the set of controls.

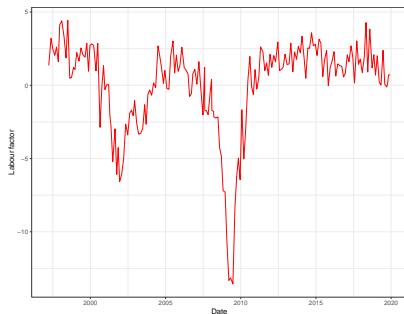
Data I: Dependent variables and shocks

- We quantify transmission of monetary policy surprises down the yield curve, and to various asset prices
- Intra-day event study data from the Fed and euro area, using the Bauer and Swanson (2023) and Altavilla et al. (2019) datasets
- Two-year sovereign yields as our measure of the monetary policy shock (DE for the euro area)
- The following sample periods:
 - US: 05/02/1997 to 11/12/2019 ($T = 193$)
 - EA: 08/01/2004 to 12/12/2019 ($T = 173$)

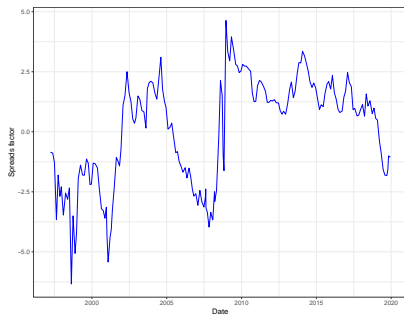
Data II: States and control variables

- Starting point: FRED-MD dataset (McCracken and Ng, 2016) and CBI monetary policy data-set
- Extensions using evidence from the literature such as uncertainty, financial cycle, Bauer and Swanson (2023) variables:
 - US: 10 groups and 155 variables
 - EA: 11 groups and 152 variables Data-sets
- Extracting factors at meeting frequency
- Number of factors by Bai and Ng (2002) and thresholds based on explained variation in the data

A closer look into the US group factors:



(a) Labour



(b) Spreads

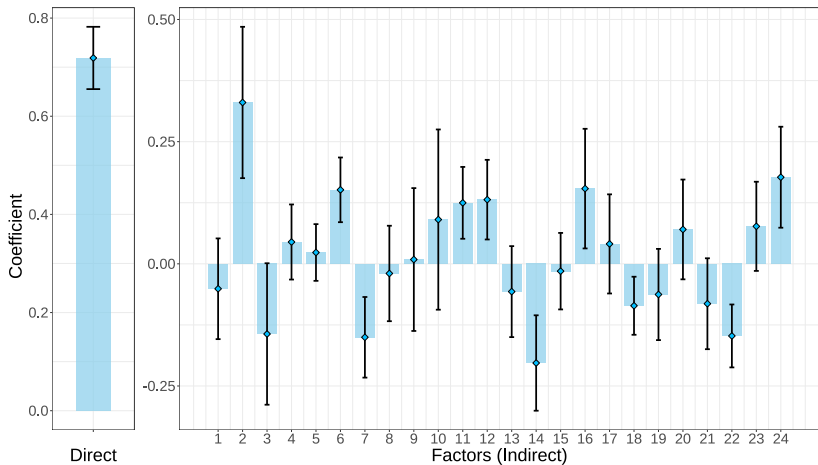
Figure 3: Estimated group factors from the US data-set

Note: Top loadings for labour factor are employees in non-farm, goods, trade, transp. and utilities; for spreads factor are 10Y Treasury FFR spread, FFR, Corporate AAA FFR spread and BAA FFR spread.

Empirical Results

- Is non-linearity multi-dimensional?

US 10Y Yield transmission: 10 factors matter



Note: Factors are scaled to 1 S.D. increase. The box-plot error bands show 90 per cent confidence intervals. Adj. R^2 equals 0.82 for the US 10Y yields.

Factors

Equities

LASSO

- Is non-linearity multi-dimensional?

Yes.

- Is non-linearity multi-dimensional?

Yes.

- Are these non-linear effects large?

Tight labour markets amplify transmission

- 1 SD above the mean of labour factor \Rightarrow 46 % stronger

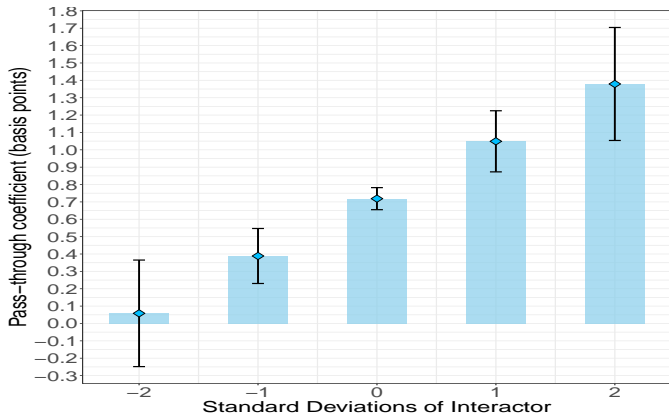


Figure 4: US10 Year Yield: Labour factor (PC2)

Stronger transmission when spreads are high

- 2 SD above the mean \Rightarrow 42% stronger

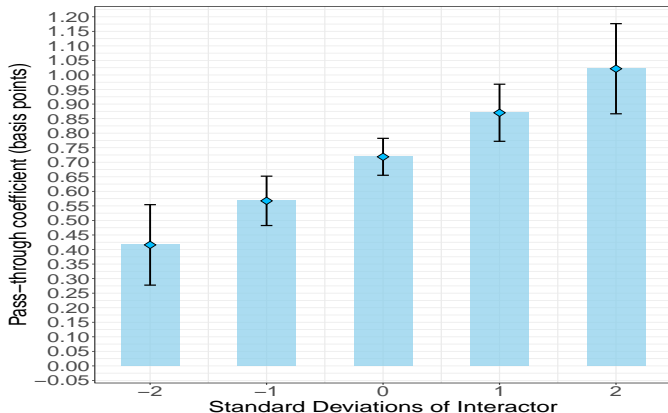


Figure 5: US10 Year Yield: Spread factor (PC6)

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- When is monetary policy more powerful?

Total effect pro-cyclical, but “re-bounded” during late GFC

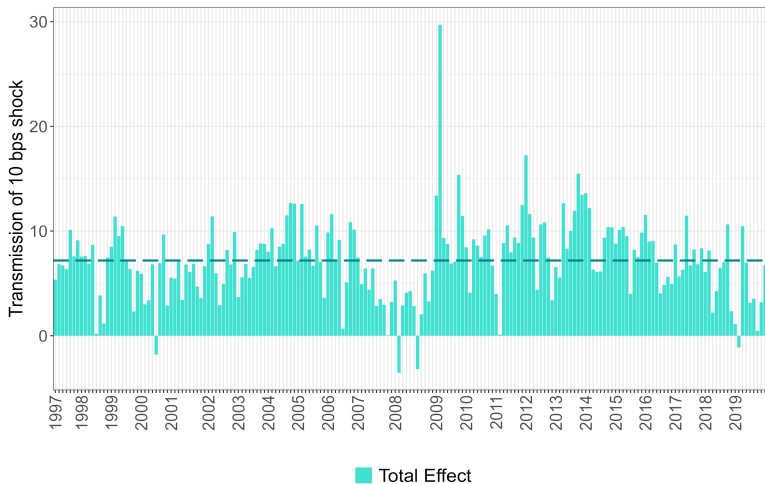
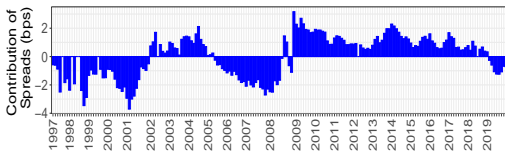
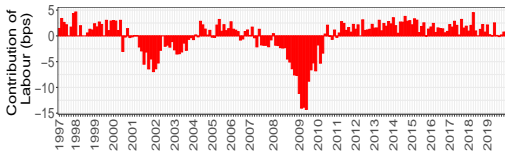
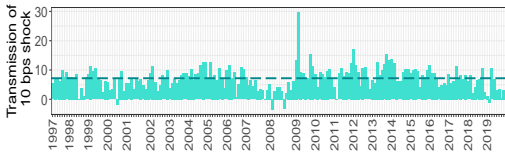


Figure 6: Total Effect Across the Sample

Different factors playing a role at the same time



- Transmission is **weaker** when labour factor is weak.
- However, it is not the only factor driving transmission.
- Spreads factor also matters and anticipates labour factor.
- Labour impact can be swamped by other factors in addition to spreads.
- Understanding transmission requires multiple factors and more complicated than just a recession & expansion story.

Empirical Results

- Is non-linearity multi-dimensional?

Yes.

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- When is monetary policy more powerful?

- Overall (total) monetary policy transmission is pro-cyclical.
- The overall non-linear effect is a function of multiple factors, that can push in different directions.
- The GFC period features a portion of weak transmission, and a “rebound”.
 - The use of GFC-period dummies will miss this...

High dimensional vs. low dimensional state-dependence

- Low dimensional data stratification approaches often used in applied work.
 - Tenreyro and Thwaites (2016) found “pushing on a string” when examining macro-variables.
 - Bauer et al. (2023) find stronger transmission to the long-end of the yield curve in recessions, in very similar regressions to ours.

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 - Tenreyro and Thwaites (2016) found “pushing on a string” when examining macro-variables.
 - Bauer et al. (2023) find stronger transmission to the long-end of the yield curve in recessions, in very similar regressions to ours.
- Though we find evidence for pro-cyclical total transmission, our findings are not reducible to analyses applied to sub-periods.
 - We have seen that the 2007Q4-2009Q2 recession comprised an early period of weak transmission, and a “re-bound” of strong transmission.

Low dimensional: Transmission *countercyclical*?

	Model			
	Weak growth (dummy) (1)	Unemployment (2)	GDP growth (3)	Regimes (ST) (4)
2 Yr. Shock	0.568*** (0.047)	0.690*** (0.038)	0.648*** (0.039)	
Weak x Shock	0.243** (0.082)			
Weak	0.003 (0.391)			
Unemp. Rate x Shock		0.131** (0.027)		
Unemp. Rate		-0.003 (0.108)		
GDP growth x Shock			-0.056* (0.023)	
GDP growth			-0.001 (0.120)	
Constant (expansion)				0.282 (0.266)
Shock (expansion)				0.478** (0.052)
Constant (recession)				0.355 (0.468)
Shock (recession)				1.100** (0.105)
Constant	0.316 (0.268)	0.278 (0.187)	0.326 (0.199)	
Adjusted R ²	0.607	0.634	0.600	0.630
F Statistic	98.690*** (df = 3; 187)	110.727*** (df = 3; 187)	96.185*** (df = 3; 187)	82.272*** (df = 4; 187)

*p<0.1; **p<0.05; ***p<0.01

Results not robust to addition of non-macroeconomic factor interactions

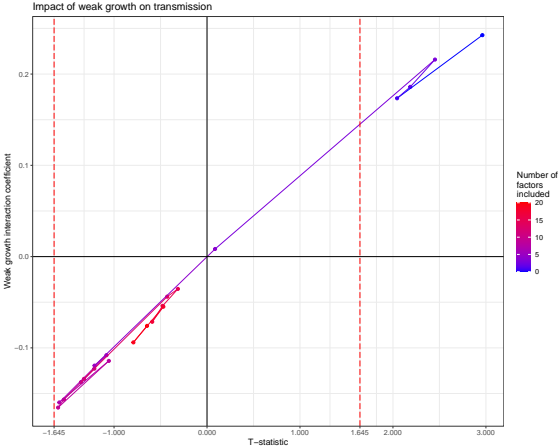


Figure 7: *t*-Statistics with additional non-macroeconomic factor interactions

Euro area results: DE10Y Yields [Preliminary]

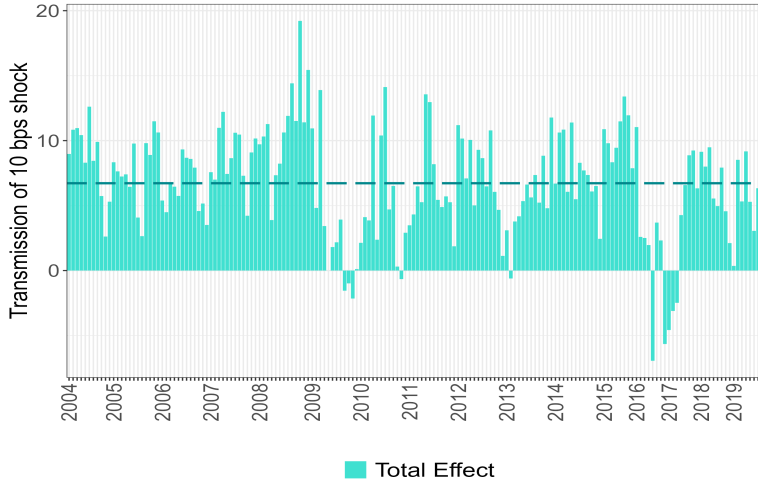


Figure 8: Total Effect Across the Sample EA results

- **Robustness:**
 - Quantitative easing (Swanson, 2021; LSAP).
 - Information effects (Jarocinski and Karadi, 2020) .
 - Alternative shocks (Swanson, 2021; three shocks).
 - Scheduled and unscheduled meetings.
 - Intra-day to daily, two-day changes.
 - Alternative approaches (LASSO, Random Forests).

- **Ongoing:**
 - Euro area results.
 - Sign and size of shocks.
 - Inclusion of post-Covid period.

Conclusion

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- We find evidence of multi-dimensional state-dependence for the US (and for the EA)
 - Weak macro conditions, summarised by labour factor, dampen transmission (Keynes, 1936; Tenreyro and Thwaites, 2016).
 - Spreads factor amplifies transmission when it is high.
 - Other factors: prices, monetary and financial also play different roles.

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 - Other factors: prices, monetary and financial also play different roles.
- These state-dependent effects are economically large.
- Understanding the state-dependence in transmission is more complicated than a recession-expansion narrative.
- Stratifying data can make interpretation easier, but potentially suffers from considerable omitted variable bias.

Appendix

Transmission depends on macro-financial variables

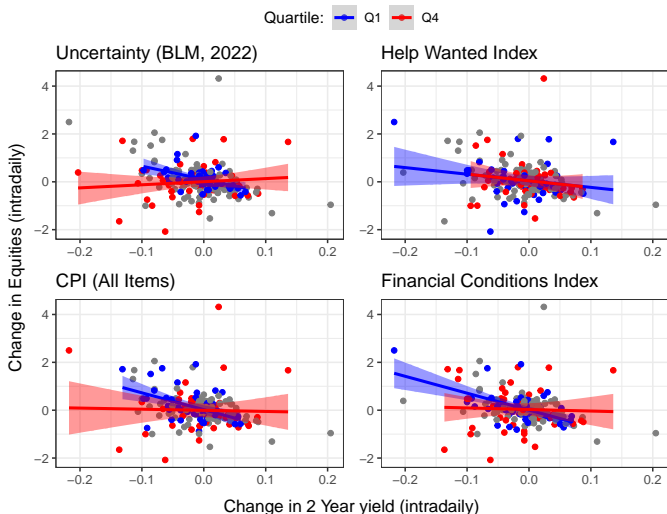


Figure 9: Equities transmission, by macro-financial variables

Data-sets

United States		Euro area	
Output	16	Output	26
Labour	31	Labour	16
Housing	3	Exchange rates	5
Consumption and inventories	11	Confidence	5
Money and credit	12	Money and credit	17
Interest and exchange rates	22	Interest rates	14
Prices	10	Prices	38
Stock market	5	Stock prices	6
Uncertainty	31	Uncertainty	5
Financial cycle	14	Financial frictions	8
		The US	12
	155		152

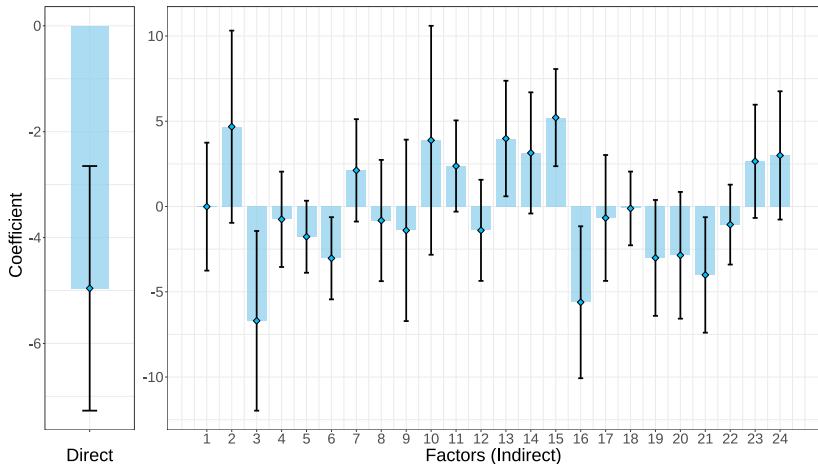
Group Factors

Factor	Name
1	Production
2	Labour
3	Housing
4	Orders & Inventories
5	Credit & Loans
6	Spreads
7	Oil prices
8	Equity prices
9	Uncertainty
10	Financial stress
11	Output
12	Reserves

Yields

Factor	Name
13	Int.rates
14	Food and comm. prices
15	Equity valuations
16	Volatility
17	Financial conditions
18	Income
19	Money supply
20	Exc. rates
21	Consumer prices
22	Equities III
23	Policy uncertainty
24	Financial cycle

US Equities transmission: 6 factors matter



Note: Factors are scaled to 1 S.D. increase. The box-plot error bands show 90 per cent confidence intervals. Adj. R^2 equals 0.18 for the US equities. Yields

LASSO confirms the multiple interactions

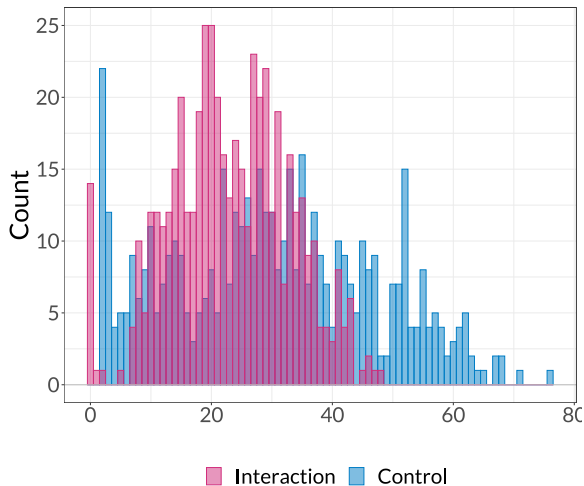


Figure 10: US 10 Year Yield

Preliminary euro area results

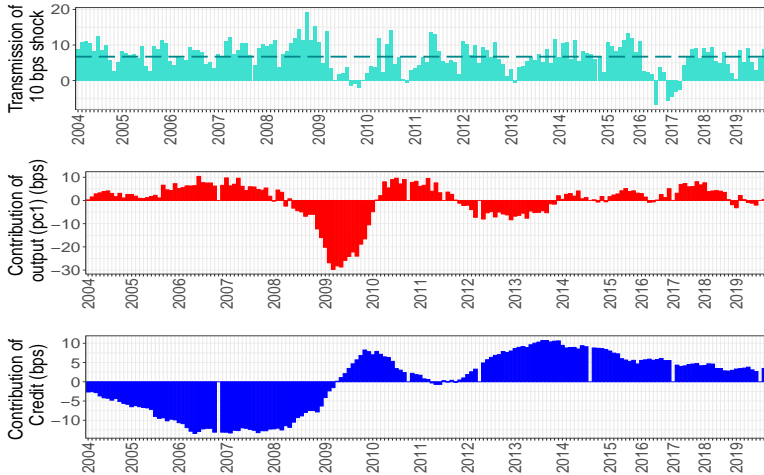


Figure 11: Total Effect Across the Sample EA results