Household Inequality and the Transmission of Unconventional Monetary Policy

Presentation at CRETE 2023, Naxos

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    - What is the role of labor market parameters therein?
    - What is the role of financial frictions therein?

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- Established fact that *conventional* monetary policy transmits differently in Eurozone countries & that inequality has an effect on the transmission of *conventiona*l monetary policy
- Evidence that *QE* reduces income inequality in the Eurozone, mainly through labour channel (Lenza/Slacalek, 2022)

Eurozone countries

Our contribution (1)

Using an NK DSGE model with financial frictions, hand-to-mouth consumers (h2m) and CB asset purchases, we derive hypotheses regarding the transmission of QE shocks:

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- wage rigidity $\uparrow \rightarrow$ effectiveness of QE $\downarrow$ (inequality reduction weakened)

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- Price stickiness, capital adjustment costs, standard Taylor rule...

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$$\underbrace{V_{j,t}}_{\text{Value of the bank}} \geq \underbrace{\theta[Q_t S_t + \Delta P_t^B B_t^b + \omega M_t]}_{\text{Gain from diverting}}$$

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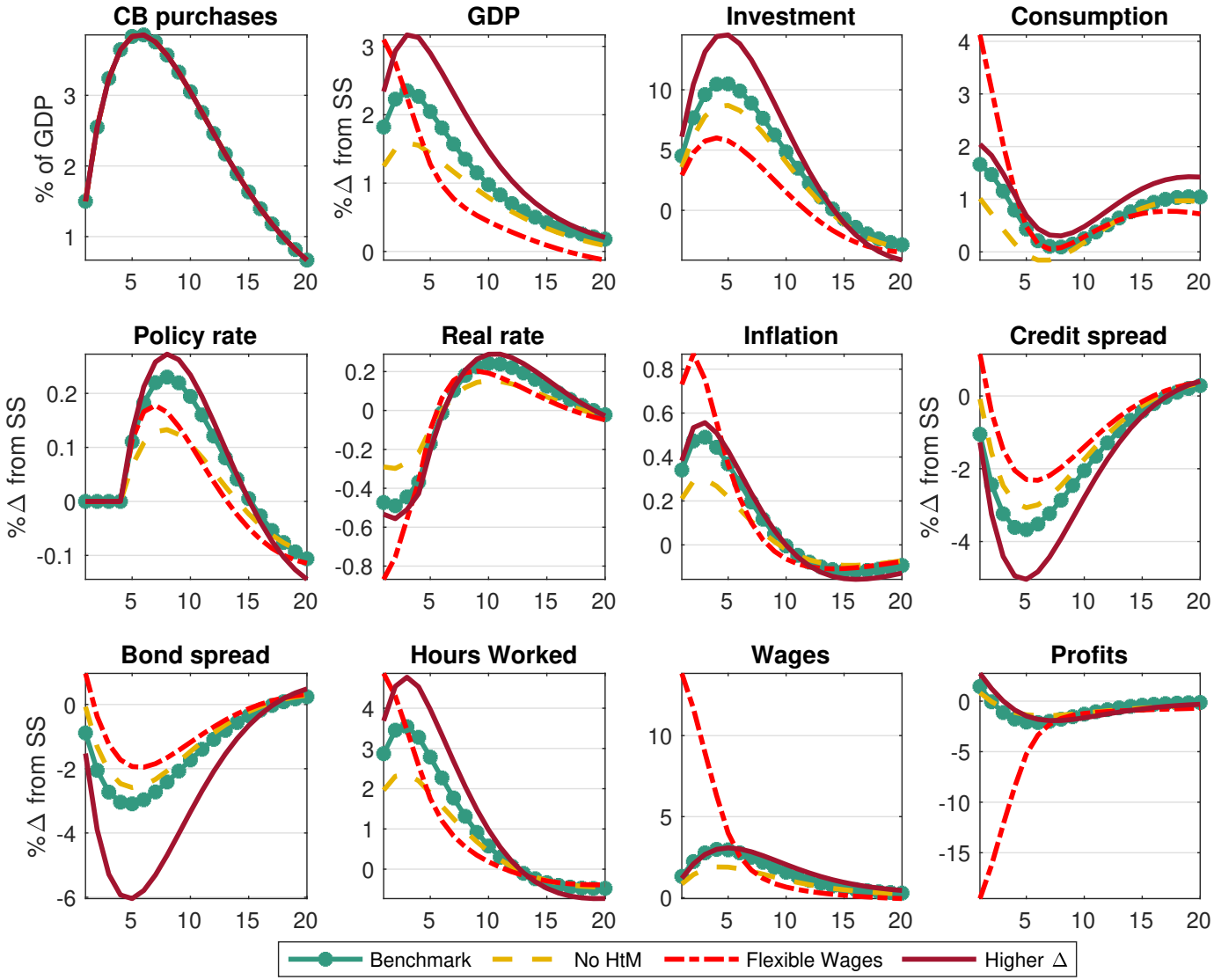
  where Δ is potentially different btw EA countries
- Reserves are risk-free asset: $\omega = 0$

Impulse responses of the model economy

back to main



Benchmark, EA average: h2m 20%, wage stickiness 0.77, Δ 84%

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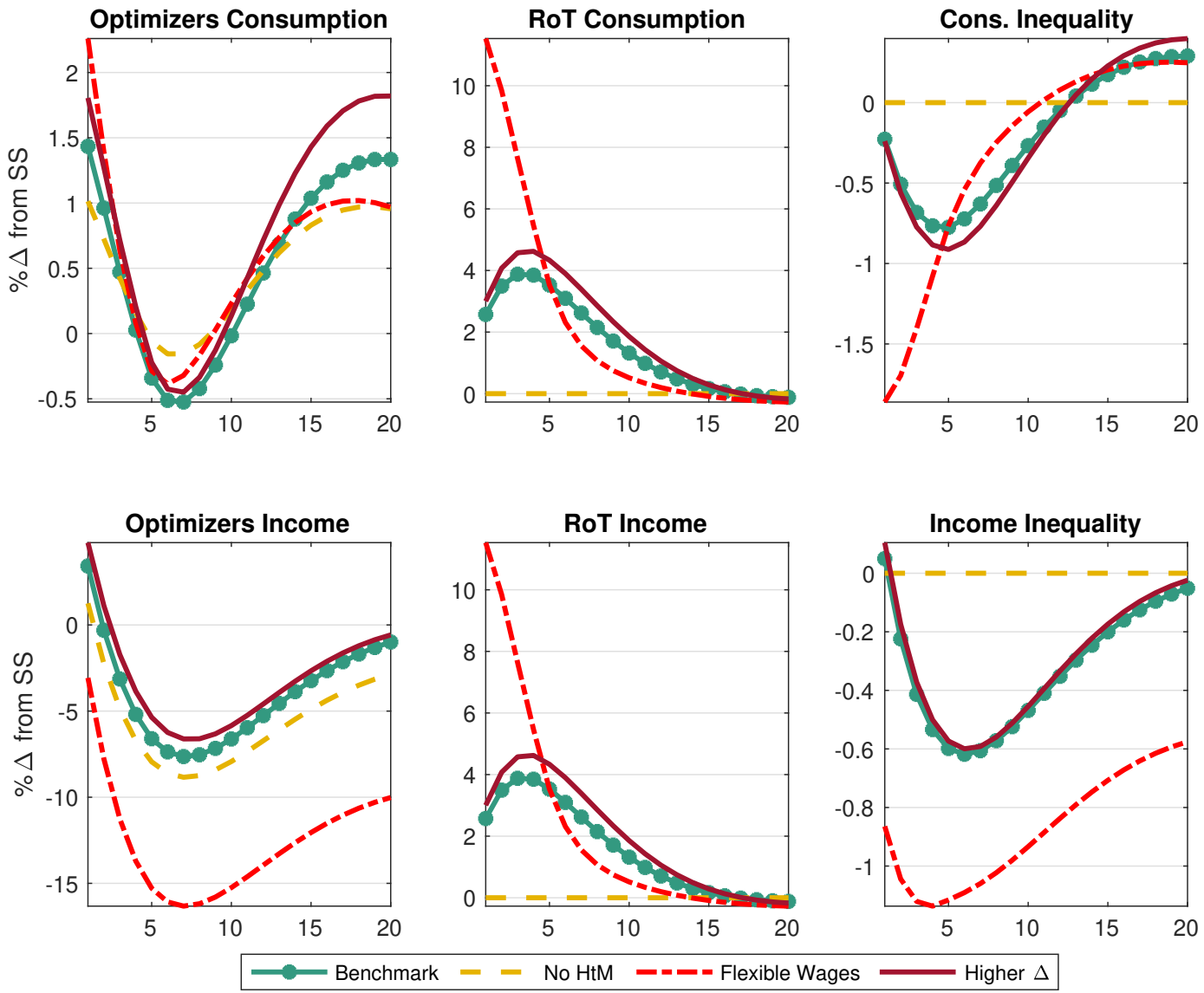

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Empirical strategy

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2. Estimate panel LPIV for Eurozone
3. Calibrate DSGE model with respect to wage stickiness, fraction of h2m and financial friction (size of st. st. credit and government bond spread) for each country *and compare IR for each country with IR from 1*

Macro and financial data

- Monthly macro and financial data from Eurostat and ECB Statistical Data Warehouse; currently from 2014m6-2018m12
- Real GDP only available at quarterly frequency: interpolated to monthly frequency using monthly data for industrial production and retail trade (Almgren et al., 2022; Burriel/Galesi, 2018)
- QE shock is the Euro area 10-year Government Benchmark bond yield instrumented by QE factor identified by Altavilla et al. (2019) based on Euro Area Monetary Policy Event Study Database (EA-MPD, v. 10/2022) and Gürkaynak et al. (2005) and Swanson (2017) methodology

Details on QE shock

Country LPIV

Second-stage-regression equation for each country n and horizon h,

$$y_{n,t+h} - y_{n,t-1} = \alpha_n^h + \beta_n^h \hat{i}_{n,t}^{10yr} + \sum_{j=1}^{p} \Gamma_{n,j}^h X_{t-j} + \sum_{j=1}^{p} \theta_{n,j}^h y_{n,t-j} + u_{n,t+h}$$

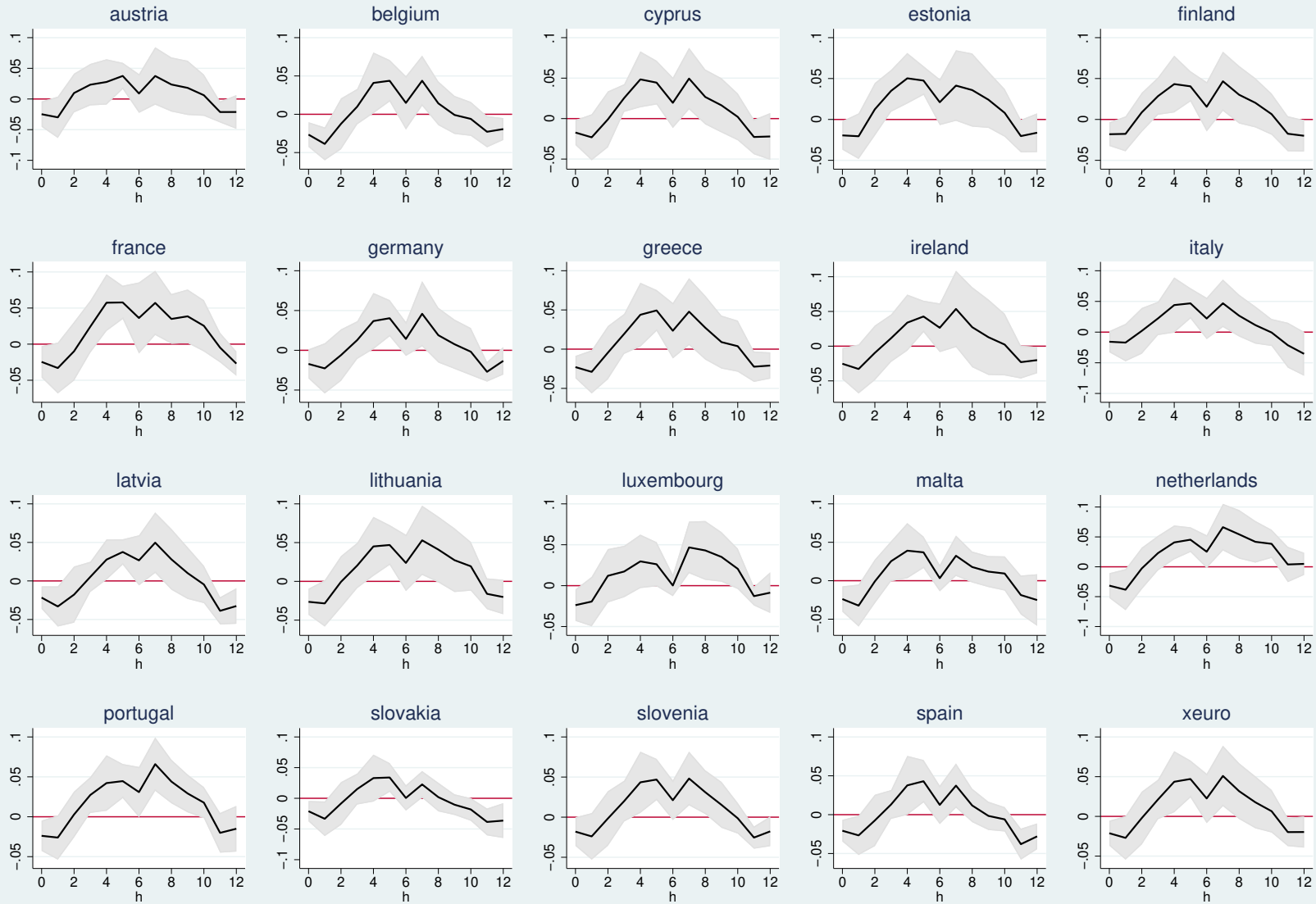
- y_n – log output in country n
- X – union-wide control variables: log HICP, log GDP, Δten-year-rate, QE
- p – number of lags (currently 3)
- $\hat{i}_{n,t}^{10yr}$ fitted values from first-stage regression

First-stage-regression equation for each country n,

$$i_t^{10yr} - i_{t-1}^{10yr} = c_n + \rho_n Z_t + \sum_{j=1}^{p} G_{n,j} X_{t-j} + \sum_{j=1}^{p} T_{n,j} y_{n,t-j} + e_{n,t}$$

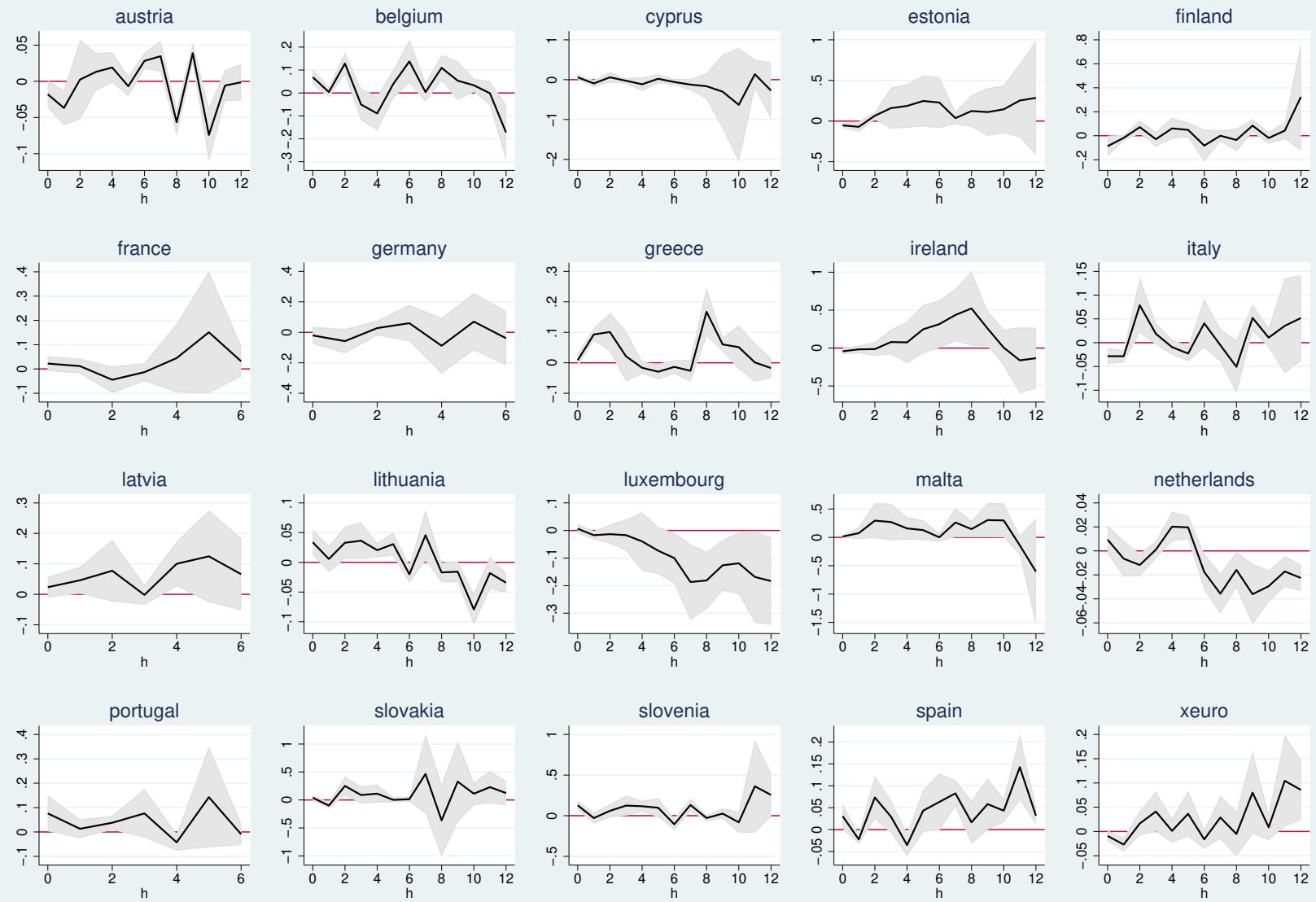
- Z – instrument, i.e., QE_t

Effect of QE on ten-year-rate (at h=0: 1st stage)



Grey area shows 90% confidence intervall

Effect of QE on GDP



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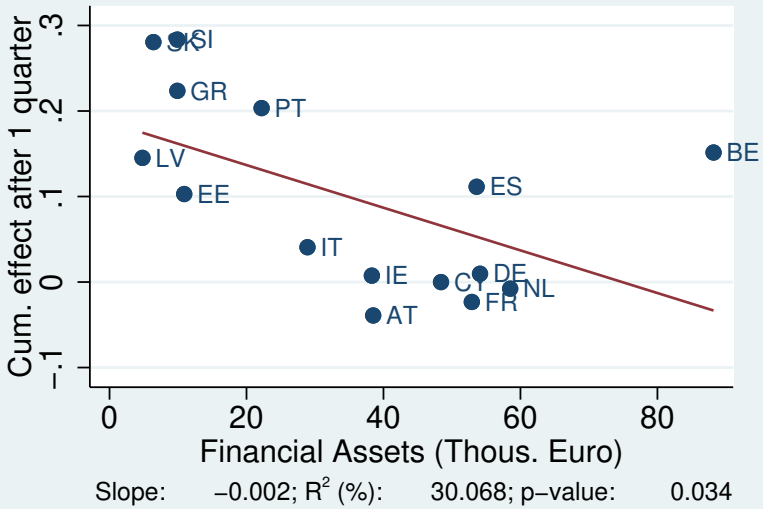
QE effects and asset market participation

DSGE model:
Share of financially constrained households $\uparrow \rightarrow$ effectiveness of QE $\uparrow$

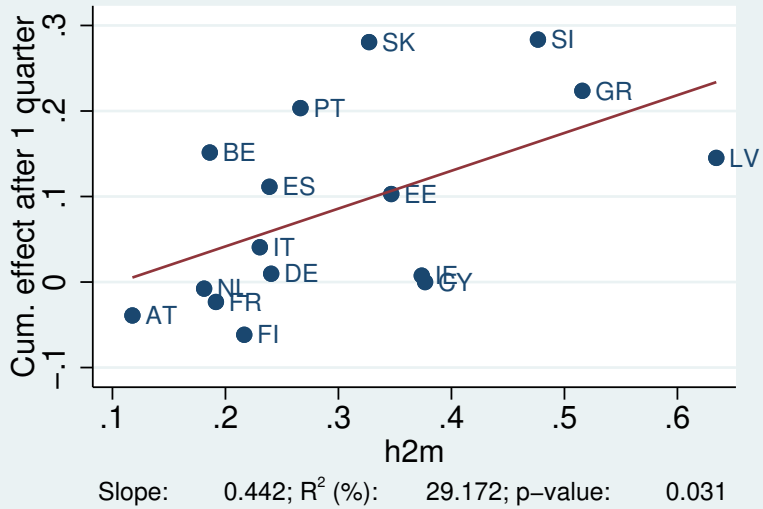
- *Financial Assets*: average holdings of financial asset per household in thous. Euro (Eurosystem Household Finance and Consumption Survey – HFCS, 2016)
- *Share of financially constrained households* (cf. Almgren et al., 2022, based on HFCS 2016 & 2020 and European Union Statistics on Income and Living Conditions – EU-SILC, 2005), different measures

Correlation b/w measures

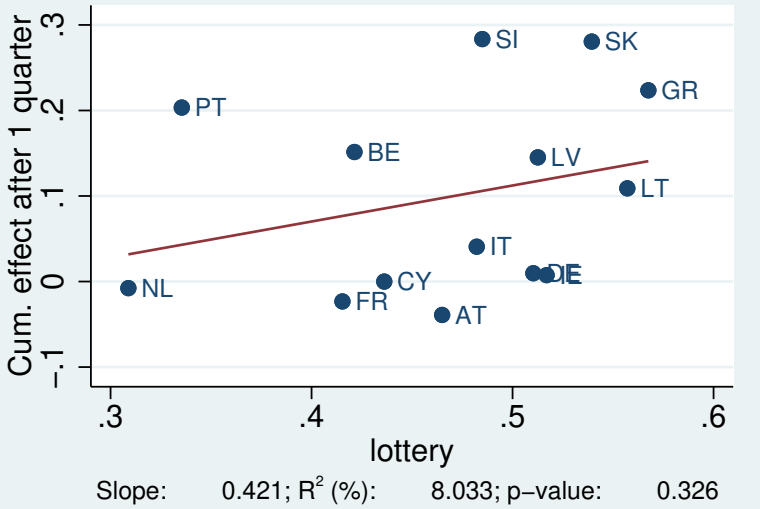
Effect of QE on GDP & asset market participation



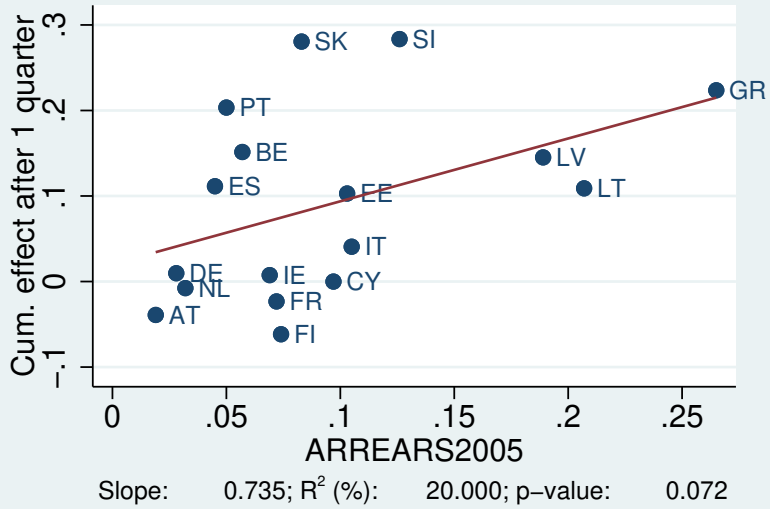
Slope: −0.002; R^2 (%): 30.068; p−value: 0.034



Slope: 0.442; R^2 (%): 29.172; p−value: 0.031



Slope: 0.421; R^2 (%): 8.033; p−value: 0.326



Slope: 0.735; R^2 (%): 20.000; p−value: 0.072

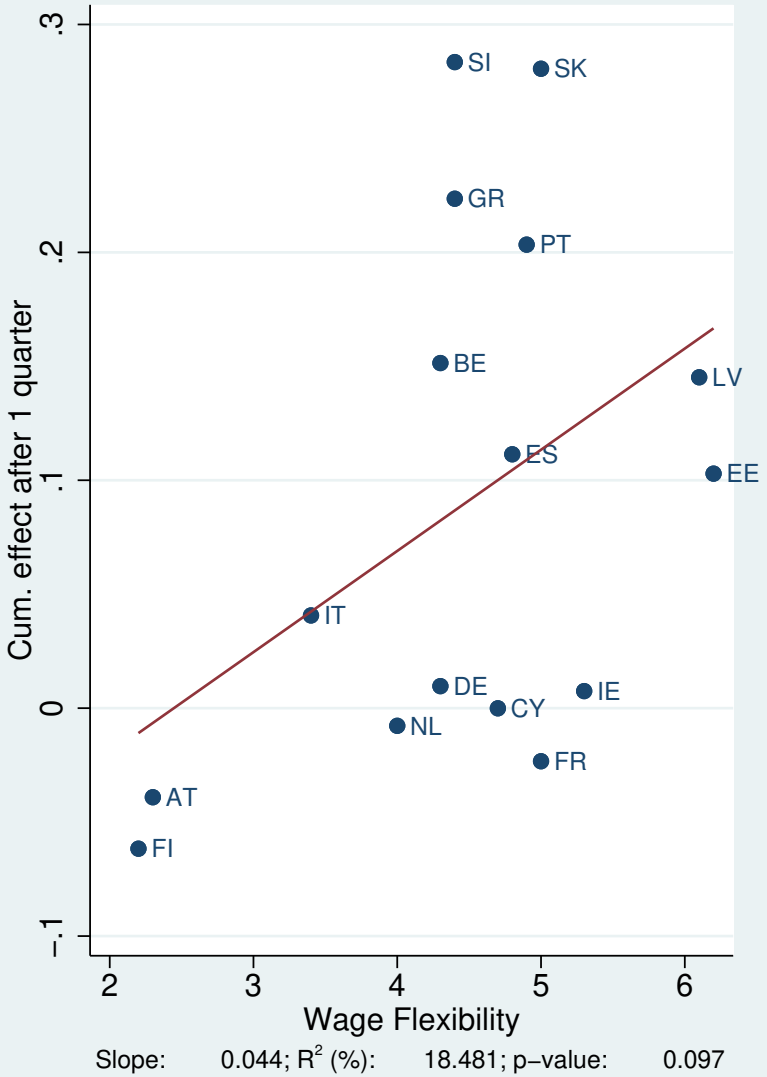
→ After 1 year, the effect vanishes/changes sign Effect over 1 year

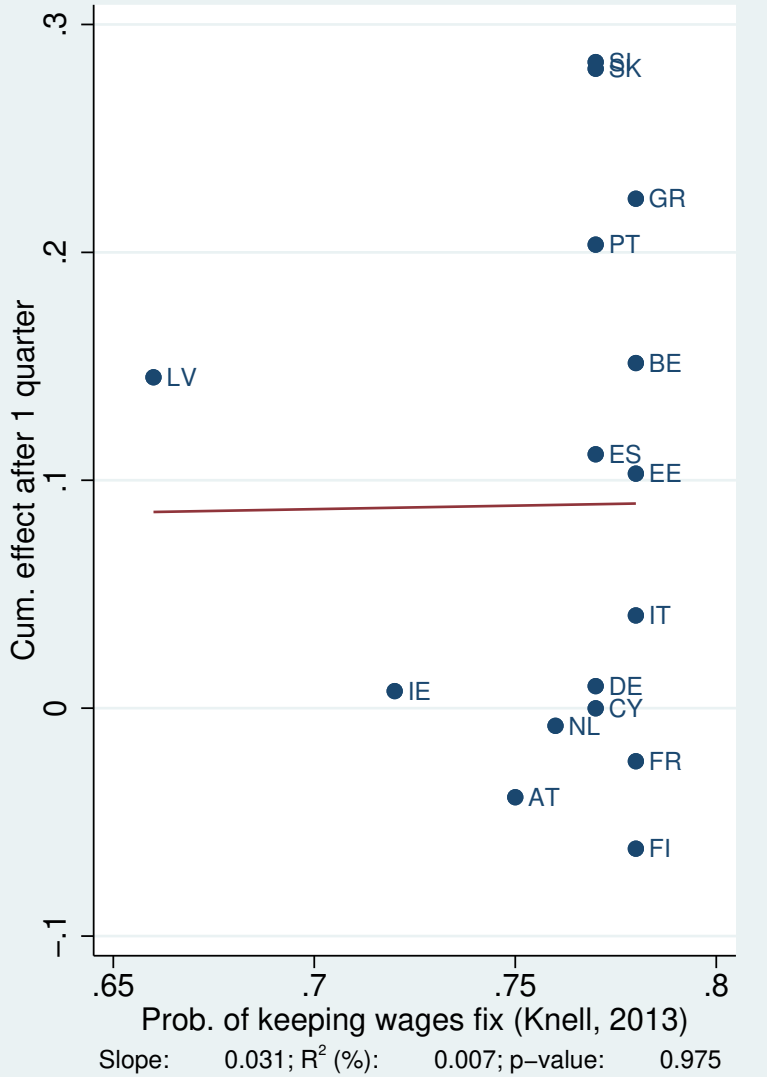
QE effects and wage flexibility

DSGE model:
wage flexibility $\uparrow \rightarrow$ effectiveness of QE $\uparrow$

- Flexibility of wage determination
  - *wage flexibility*: 1 = highly centralized; 7 = highly decentralized; measure from survey conducted by World Economic Forum (WEF)
  - *probability of keeping wages fix*: raction of firms able to reset price in a given month ("Calvo parameter"); measure constructed from survey conducted by ESCB's Wage Dynamics Network (Knell, 2013)

Effect of QE on GDP & wage flexibility





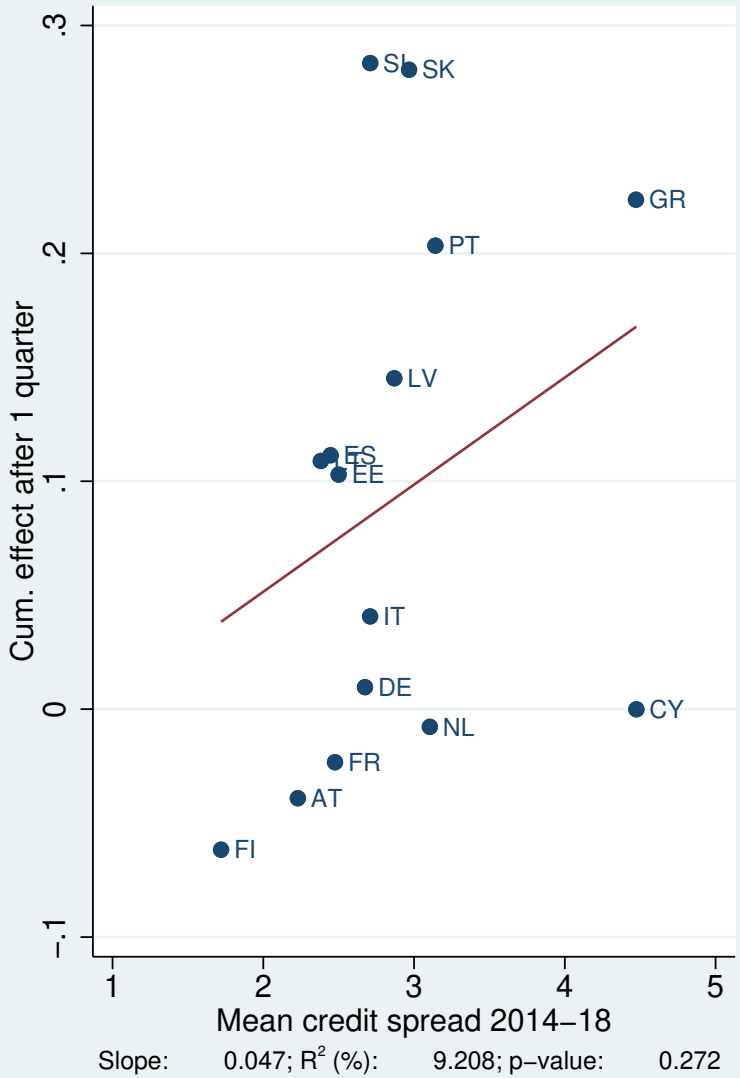
→ After 1 year, the effect vanishes/changes sign Effect over 1 year

QE effects and financial frictions

DSGE model:
financial frictions $\uparrow \rightarrow$ effectiveness of QE $\uparrow$

- Financial frictions
  - *credit spread*: mean difference between interest rate on loans to corporations with an original maturity of over five years (outstanding amounts) and Euribor 3-month-rate from 2014m6-2018m12
  - *bond spread*: mean difference between 10-year-government bond rate and Euribor 3-month-rate from 2014m6-2018m12

Effect of QE on GDP & fin. frictions



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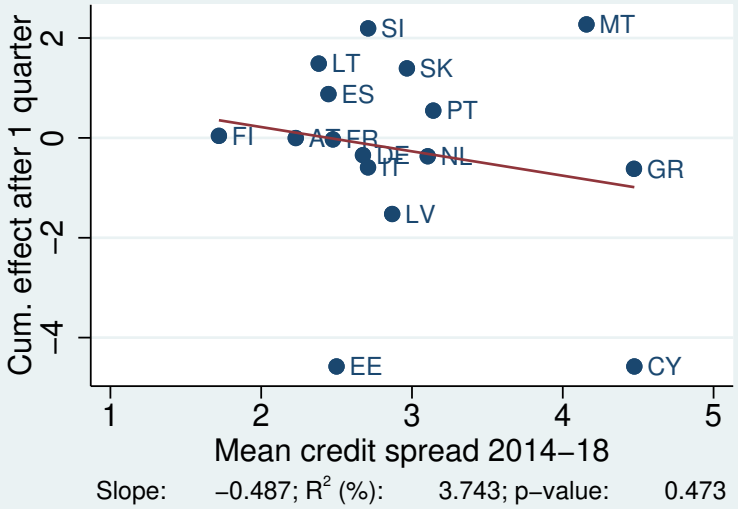
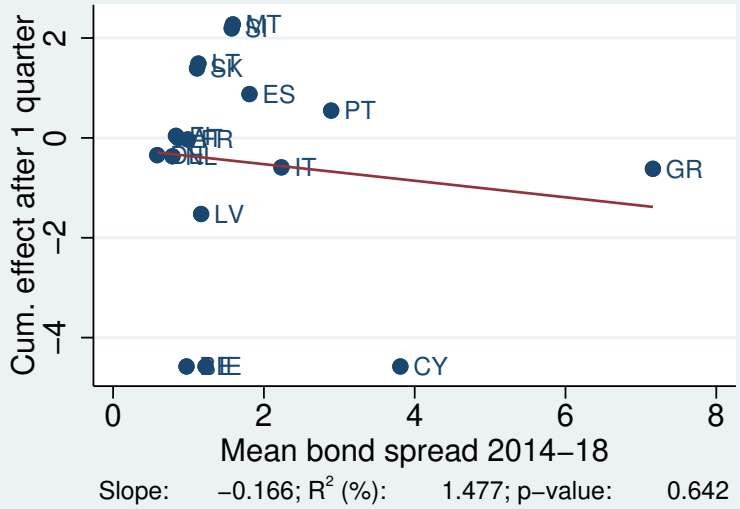
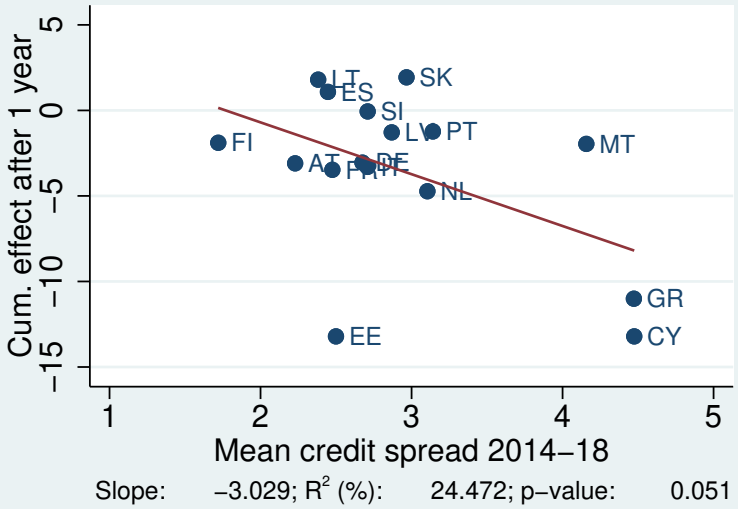
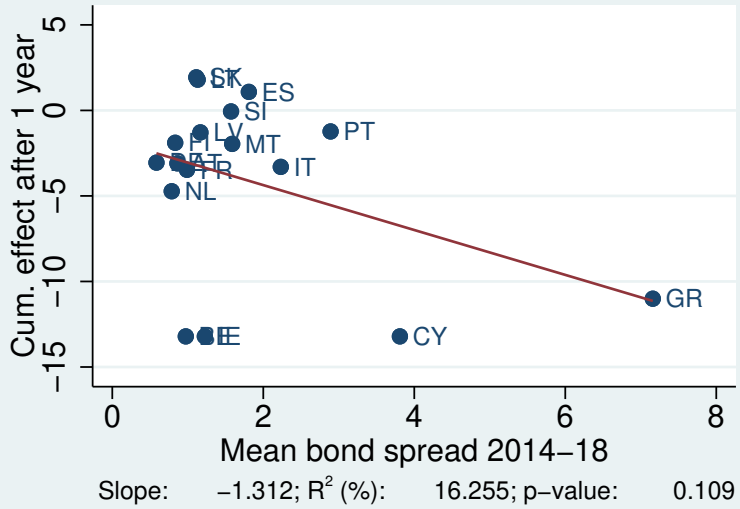
Effect of QE on credit spread & fin. frictions









Conclusion

- Very heterogeneous transmission of QE in European countries.
- First empirical results, i.e., relationships between LPIV results and data on asset market participation, wage flexibility and financial frictions indicate that relevant transmission channels of the DSGE model are also present in the data and might be able to explain some of the heterogeneity in the transmission of the shock.
- Would be interesting to include further variables to understand further channels, e.g. house prices, credit, trade, actual asset purchases per country...
- Much remains to be done: improve panel regressions, country calibration, understand structural breaks...
- Do we instrument the "right" rate?

Thank you for your attention!

Appendix

Households

- Two types of agents $s \in \{o, h\}$ (o = optimizers, h = hand to mouth)
- λ hand to mouth, $1 - \lambda$ optimizers
- Hand to Mouth (h)

$$P_t C_t^h = P_t W_t L_t^h + P_t T_t^h.$$

- Optimizers (o)

$$P_t C_t^o + D_t^o + q_t B_t^o + Q_t S_t^o + T_t^o + \underbrace{q_t [\frac{1}{2}(B_t^o - \bar{B}^o)^2] + Q_t [\frac{1}{2}(S_t^o - \bar{S}^o)^2]}_{\text{holding costs}}$$
$$= P_t W_t L_t^o + \Pi_t + R_{d,t} D_{t-1}^o + R_{b,t} B_{t-1}^o + R_{k,t} S_{t-1}^o$$

Back

Households

- Households demand for shares

$$S_t^o = \bar{S}^o + \mathbb{E}_t \, \Lambda_{t,t+1}(R_{k,t+1} - R_{t+1})$$

- Households demand for bonds

$$B_t^o = \bar{B}^o + \mathbb{E}_t \, \Lambda_{t,t+1}(R_{b,t+1} - R_{t+1})$$

Financial Intermediaries

- Bank's balance sheet:

$$\underbrace{Q_t S_{j,t} + q_t B_{j,t} + M^B_{j,t}}_{\text{Assets}} = N_{j,t} + \underbrace{D_{j,t}}_{\text{Liabilities}}$$

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- Bank's evolution of net worth at period $t+1$:

$$N_{j,t+1} = \underbrace{R_{k,t} Q_t S^B_{j,t} + R_{b,t} q_t b^B_{j,t} + R_t M_{j,t}}_{\text{interest gains}} - \underbrace{R_t D_{j,t}}_{\text{interest losses}}$$

Financial Intermediaries: Constraint

- Bankers face a moral hazard problem
- At t the banker can choose to divert funds from her assets and transfer them back to her household members
- Cost: depositors can force the intermediary into bankruptcy and get the remaining assets
- Depositors supply funds such as

$$\underbrace{V_{j,t}}_{\text{Value of the bank}} \geq \underbrace{\theta[Q_t S^B_{j,t} + \Delta q_t B^B_{j,t} + \omega M^B_{j,t}]}_{\text{Gain from diverting}}$$

- Easier for the bank to divert loans rather than bonds. Cannot divert reserves $\omega = 0$

Financial Intermediaries: Constraint

- This places a "risk- adjusted" constraint on the bank's leverage ratio (ϕ_t) and net worth N_t:

$$Q_t S_t^B + \Delta q_t B_t^B + \underbrace{\omega}_{=0} M_{j,t}^B \leq \phi_t N_t$$

- When CB acquires bonds the constraint loosens and more capital is available for new loans $Q_t S_t^B$
- Easier credit conditions stimulate aggregate demand, $\uparrow$ asset prices, $\downarrow$ spreads, $\uparrow$ bank's NW

Back

Central Bank Purchases

- Central Bank purchase bonds B_t^{CB}
- Asset purchases are financed by reserves

$$q_t B_t^{CB} = M_t$$

- Total quantity of bonds decomposition

$$B_t = B_t^B + B_t^H + B_t^{CB}$$

- Asset purchases process

$$B_t^{CB} = \phi_{b,t} B_t.$$

- Loosen financial constraint of the banks
- Households prefer to hold less bonds due to the lower excess returns

Monetary Policy - Government

- The government budget constraint

$$G - T_t + \bar{B}(R_{b,t} - 1) + \underbrace{q_{t-1}B^G_{t-1} + Q_{t-1}S^G_{t-1}}_{\text{Asset Purchases}} = N^G_t + M_t$$

where the government's net worth evolution is

$$N^G_t = R_{s_t} q_t B^G_t + R_{b,t} Q_t S^G_t - R_t M_{t-1}$$

- Taylor rule

$$i_t = i + \kappa_\pi \pi + \kappa_y (\log Y - \log Y^*) + \epsilon_{m,t},$$

- Asset purchases process

$$S^G_t = \phi_{s,t} S_t,$$

$$B^G_t = \phi_{b,t} B_t.$$

Back

Calibration

- Hand to mouth share λ = 20%
  - In line with similar EA studies. (see Slacalek, Tristani, and Violante (2020), Ampudia et. al (2018))
- Household and production parameter values from the New Area-Wide Model (NAWM)
  - Interest rate of 2% per annum
- Calibrate banking parameters to reach long term:
  - Private credit spread = (2.45 percent) EA long-term composite cost of borrowing indicator - EONIA rate in 2003-2015 (Andrade et. al 2016)
  - Leverage of financial institutions of 6 (Andrade et. al 2016)

Back

Calibration

- Household and production parameter values from the New Area-Wide Model (NAWM) - $\lambda = 20\%$
- Calibrate capital requirements and assets risk weights according Basel III Minimum Capital Requirements
  - Minimum common equity tier + capital conservation buffer + discretionary counter-cyclical buffer + G-SII + O-SII
  - Big systemic bank capital requirements are about $\theta = 20\%$
  - Risk Weights for Assets:
    - Bonds (Δ) 50%: BBB+ to BBB- grade sovereign debt
    - Loans 100%: claims on BBB+ to BBB- corporates
    - Central Bank Reserves (ω) 0%
- Calibrate banking parameters to reach long term:
  - Private credit spread = (2.45 percent) EA long-term composite cost of borrowing indicator - EONIA rate in 2003-2015 (Andrade et. al 2016)
  - Leverage of financial institutions of 6 (Andrade et. al 2016)

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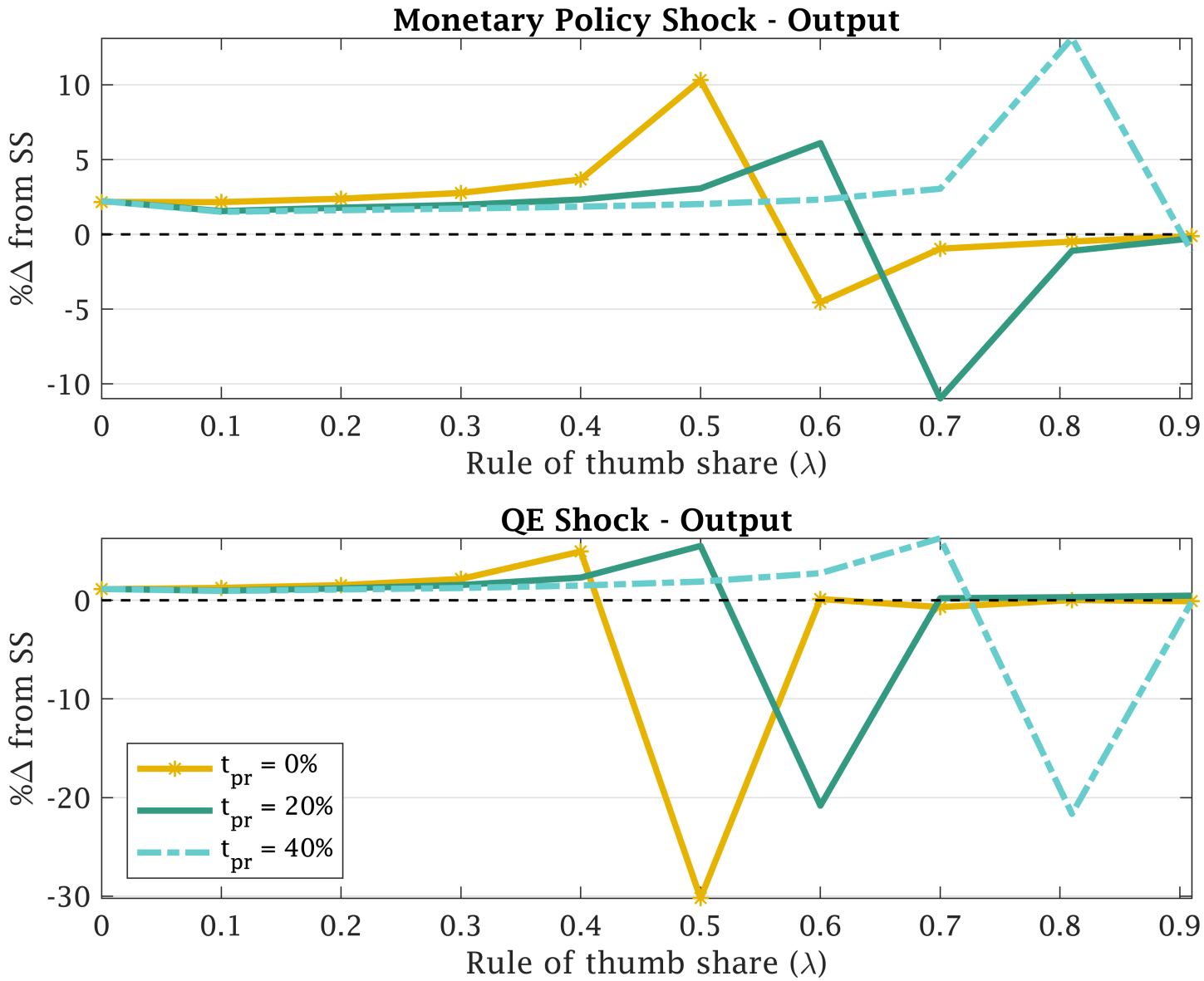
Profit Redistribution



Financial Intermediaries: Solution II

$$\text{Credit spread: } R_{k,t+1} - R_{t+1} = \overbrace{\frac{\lambda_t}{1+\lambda_t}}^{\text{Lagrange multiplier}} \theta$$

$$\text{Bond spread: } R_{b,t+1} - R_{t+1} = \overbrace{\frac{\lambda_t}{1+\lambda_t}}^{\text{Lagrange multiplier}} \Delta\theta$$

$$R_{b,t} = \Delta R_{b,t} + (1-\Delta) R_t$$

$$R_{k,t} = \frac{[Z_t + (1-\delta)Q_t]}{Q_{t-1}}$$

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Appendix: Capital Goods Producers

- **Capital goods producers** produce new capital in order to sell it to the goods producers subject to investment adjustment costs.

$$\max_{I_\tau} E_t \sum_{\tau=t}^{\infty} \Lambda_{t,\tau} \left\{ Q_t I_t - \left[1 + f\left(\frac{I_\tau}{I_{\tau-1}} \right) \right] I_\tau \right\}$$

$$Q_t = 1 + \left(\chi \frac{I_\tau}{I_{\tau-1}} \left(\frac{I_\tau}{I_{\tau-1}} - 1 \right) + \frac{\chi}{2} \left(\frac{I_\tau}{I_{\tau-1}} - 1 \right)^2 - \chi \Lambda_{t,\tau} \frac{I_{\tau+1}^2}{I_\tau^2} \left(\frac{I_\tau}{I_{\tau-1}} - 1 \right) \right)$$

Intermediate Good Firms

- Production Function

$$Y_t = K_t^{\alpha} L_t^{1-\alpha}$$

- Capital evolves according to the law of motion of capital

$$K_{t+1} = I_t + (1 - \delta)K_t.$$

Price Setting

- Intermediate firms are not freely able to change prices each period
- There is a fixed probability $(1-\gamma)$ that a firm can adjust its price.

From the law of large numbers, the following relation for the evolution of the price level emerges:

$$P_t = [(1-\gamma)(P_t^*)^{1-\epsilon} + \gamma(\Pi_{t-1}P_{t-1})^{1-\epsilon}]^{\frac{1}{1-\epsilon}}$$

where P_t^* represents the price chosen by firms resetting prices at time t.

Wage Setting: Perfectly Competitive Labour Markets

- Households choose optimally their labour supply taking wages as given

$$u^j_{c,t} W_t = \chi (L^j_t)^{\epsilon}. \tag{1}$$

Wage Setting: Sticky Wages

- Wage decisions are delegated to a continuum of labour unions
- The problem of the union is to maximize its objective function:

$$\lambda \left[u^r_{c,t} W_{h,t} L_{h,t} - \frac{\chi}{1+\epsilon} L_t^{1+\epsilon} \right] + (1-\lambda) \left[u^o_{c,t} W_{h,t} L_{h,t} - \frac{\chi}{1+\epsilon} L_t^{1+\epsilon} \right]$$

.

- subject to a labour demand schedule

$$L_{h,t} = \left(\frac{W_{h,t}}{W_t} \right)^{-\epsilon_w} L_t$$

where ϵ_w is the elasticity of substitution between labour inputs.

- In each period, a union faces a constant probability $1 - \xi_w$ of being able to re-optimize the nominal wage.

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Wage Setting: Sticky Wages

- Wage decisions are delegated to a continuum of labour unions
- Hours are determined by firms taking the wages set by unions as given
- Households supply the hours required by the firms given the wage set by unions
- Probability $1 - \xi_\omega$ that the wage for each particular labour service $W_{h,t}$ is set optimally

The union buys homogeneous labour at nominal price $W_{h,t}$, repackages it by adding a mark-up and chooses the optimal wage W_t^* to maximize the objective function. The FOC is:

$$\left(\frac{\lambda}{u_{c,t}^r u_{l,t}^r} + \frac{1-\lambda}{u_{c,t}^o u_{l,t}^o} \right) W_t = \mu^W$$

Robustness to Inverse Frisch Elasticity: MP

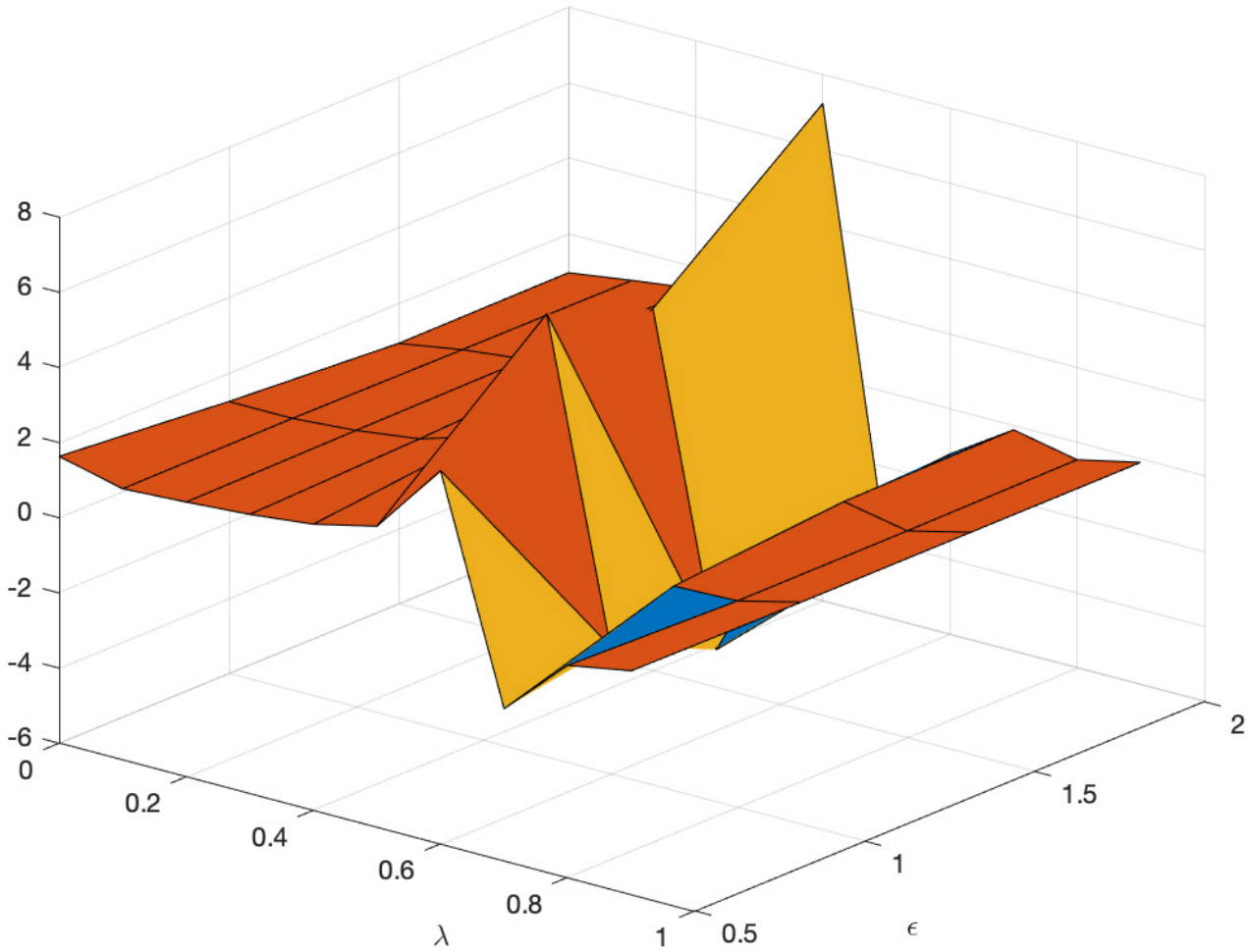

Figure: Sensitivity to Inverse Frisch Elasticity Values: MP Shock

Robustness to Inverse Frisch Elasticity: QE

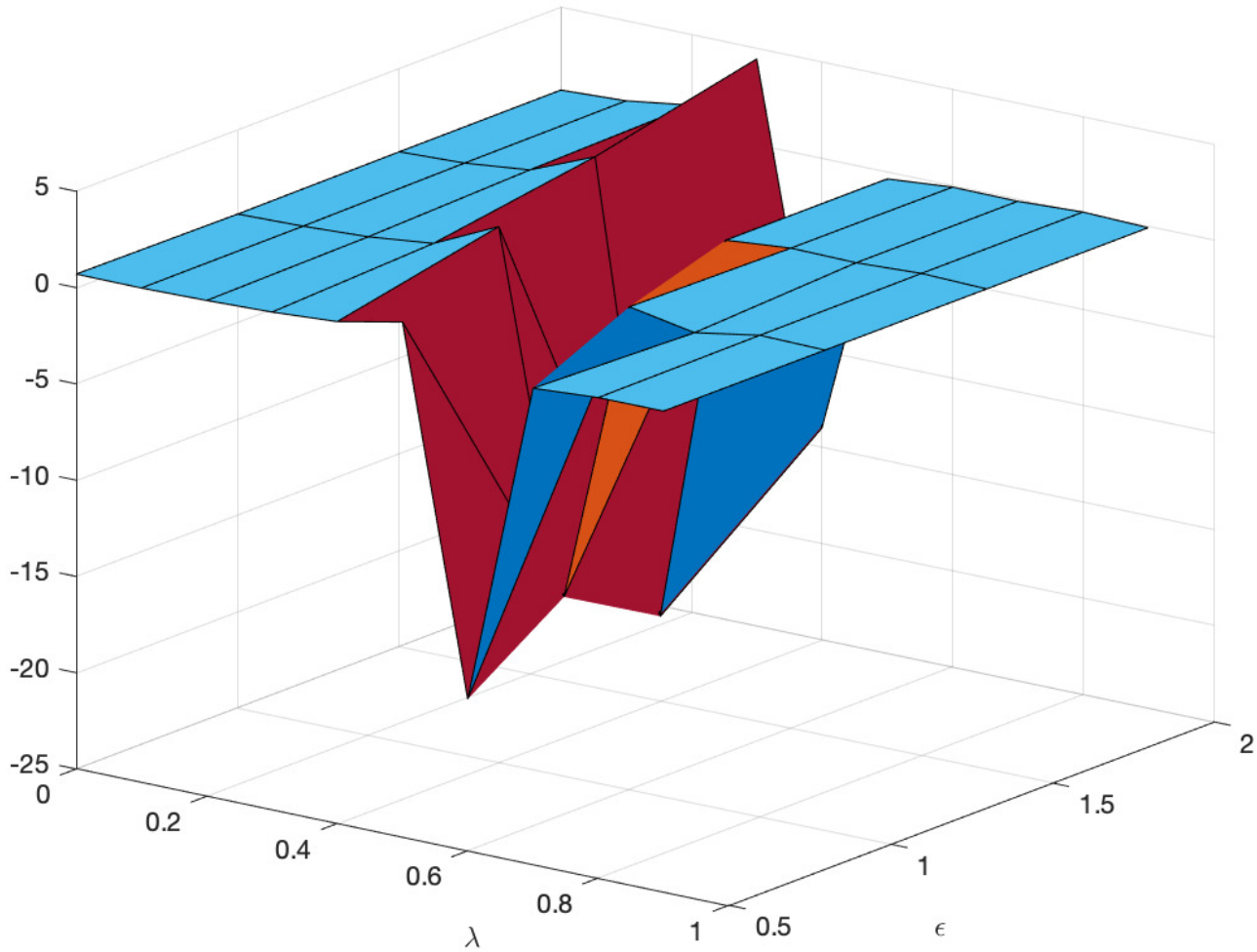

Figure: Sensitivity to Inverse Frisch Elasticity Values: QE Shock

Correlation between financial constrainedness measures

	h2m	lottery	PFV1	PFV2	PFV3	finAssetsall
h2m	1.00					
lottery	0.50	1.00				
PFV1	0.68**	0.39	1.00			
PFV2	0.68**	0.50	0.63*	1.00		
PFV3	0.80***	0.58*	0.57*	0.59*	1.00	
finAssetsall	-0.60*	-0.54*	-0.60*	-0.57*	-0.56*	1.00

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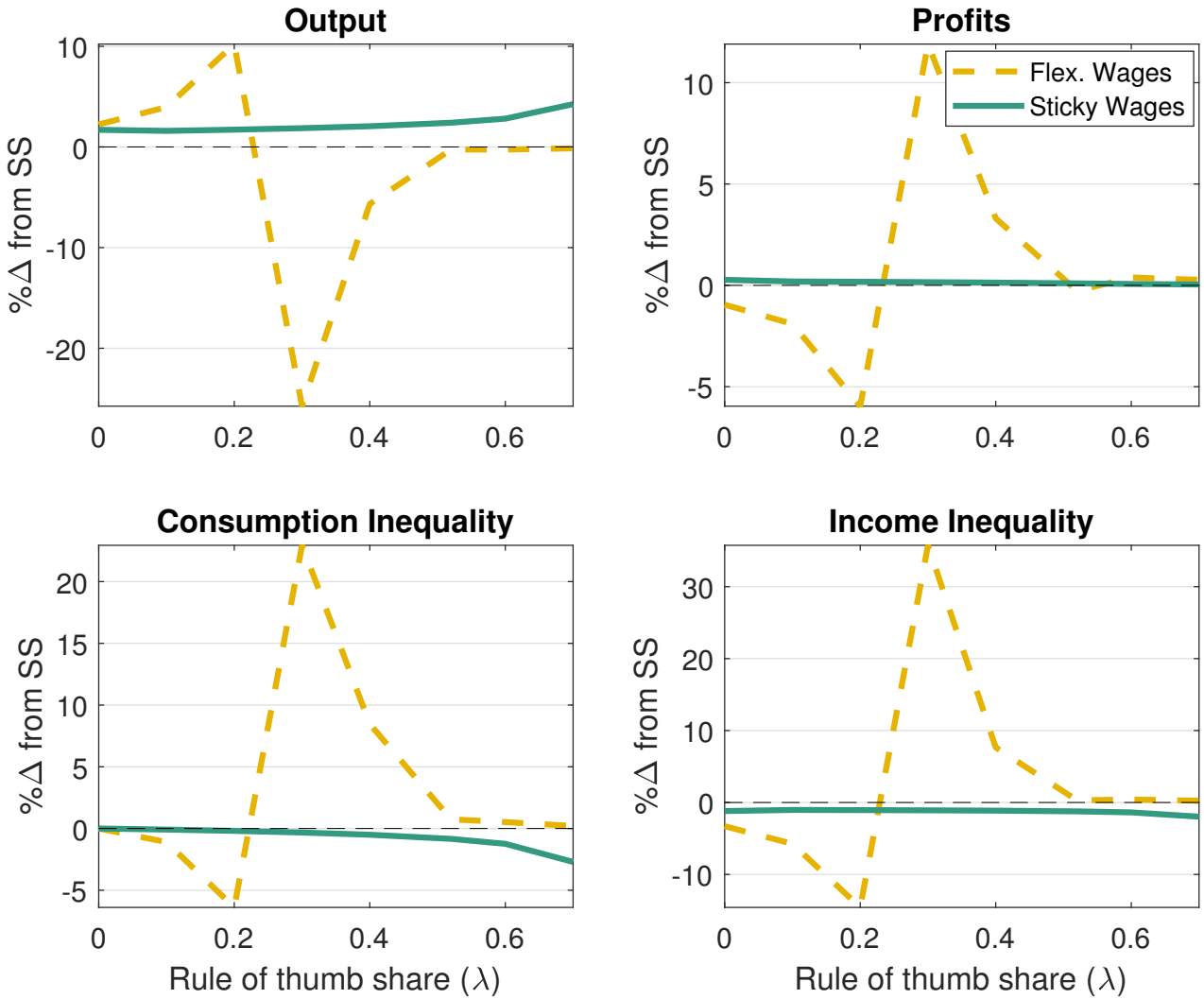
Inverse aggregate demand logic



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Identification of QE shock

- EA-MPD contains intraday asset price changes around policy decision announcement and press conference
- By PCA, four factors are extracted: QE-related policy factor has been dominant in the recent period (from 01/2014 onwards); active in press conference window; effects get larger with increasing maturity, peaking at 10-year maturity
  - $\rightarrow$ QE has substantial immediate effects on yields, and long lasting effects (half-life of one year)
- Monthly QE shock (QE_t), as in Almgren et al. (2022):

$$QE_d^{cum} = \begin{cases} QE_d^{cum} + QE_d^{PCA} & \text{if } QE_d^{PCA} \neq 0 \text{ on day d} \\ QE_{d-1}^{cum} & \text{otherwise} \end{cases}$$

$$QE_t = \frac{1}{D_m} \sum_{D \in m} QE_d^{cum}$$

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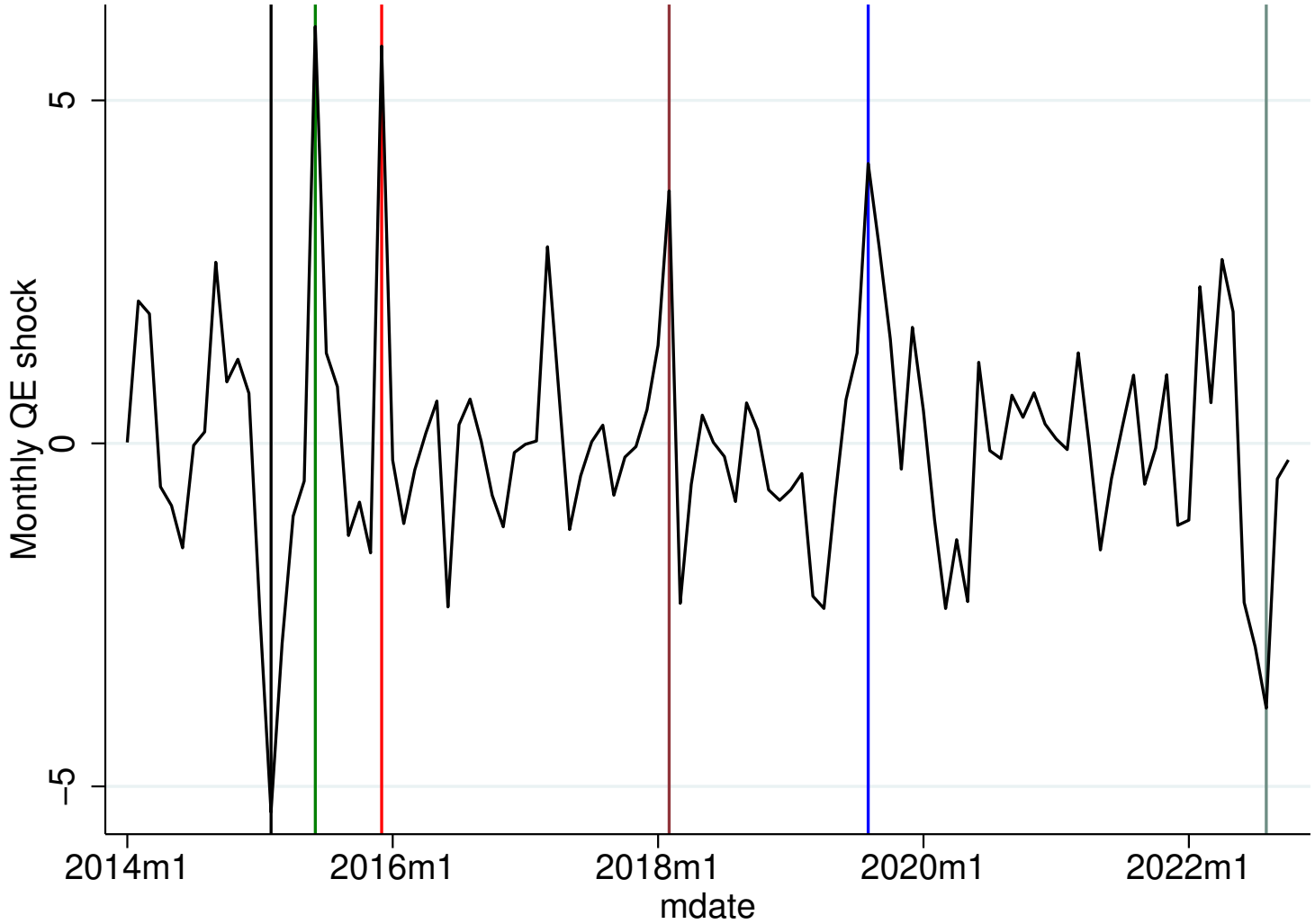
QE shock



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The DSGE model (Tsiaras, 2022)

banks Model equations back to main

- Household sector composed of optimizers $(1-\lambda)$ and hand-to-mouth (λ) without access to financial markets
  - $\rightarrow$ Different transmission channels of QE for each group; effect of QE on income inequality
- Banks receive deposits from optimizers & hold loans to non-financial corporations, government bonds and reserves; face a moral hazard problem similarly to Gertler/Karadi (2011, 2013)
  - $\rightarrow$ Eliminates perfect substitutability of assets and breaks QE's neutrality
- Bond purchases by an unconstrained central bank in exchange for reserves
  - $\rightarrow$ QE loosens bank's constraint and stimulates supply of loans
- Wage setting by unions with probability ξ_ω, i.e., nominal wage rigidity
  - $\rightarrow$ Procyclical profits, affects transmission of QE
- Price stickiness, capital adjustment costs, standard Taylor rule...

Impulse responses of the model economy

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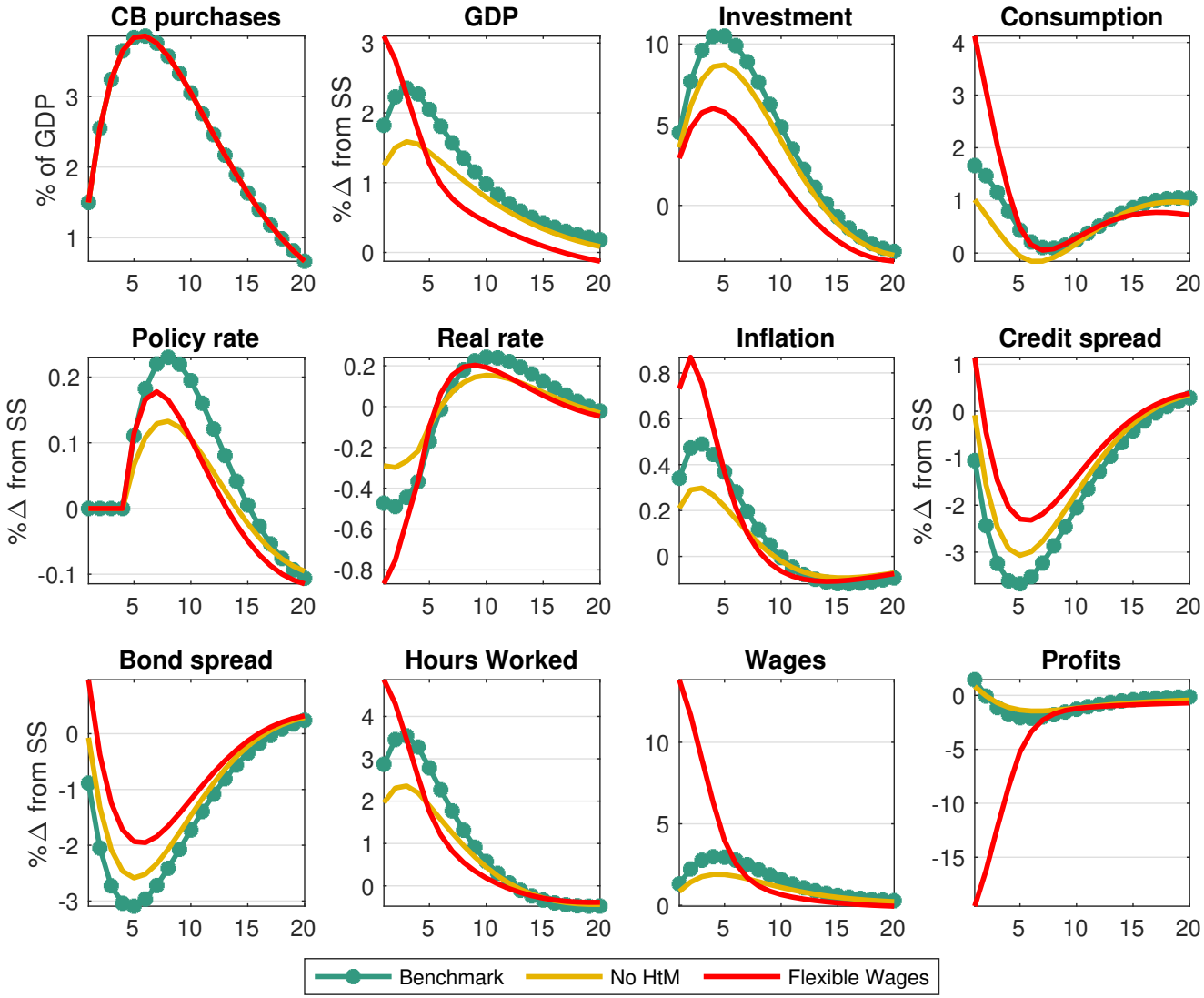

Benchmark: h2m 20% and wage stickiness 0.77

Impulse responses of the model economy

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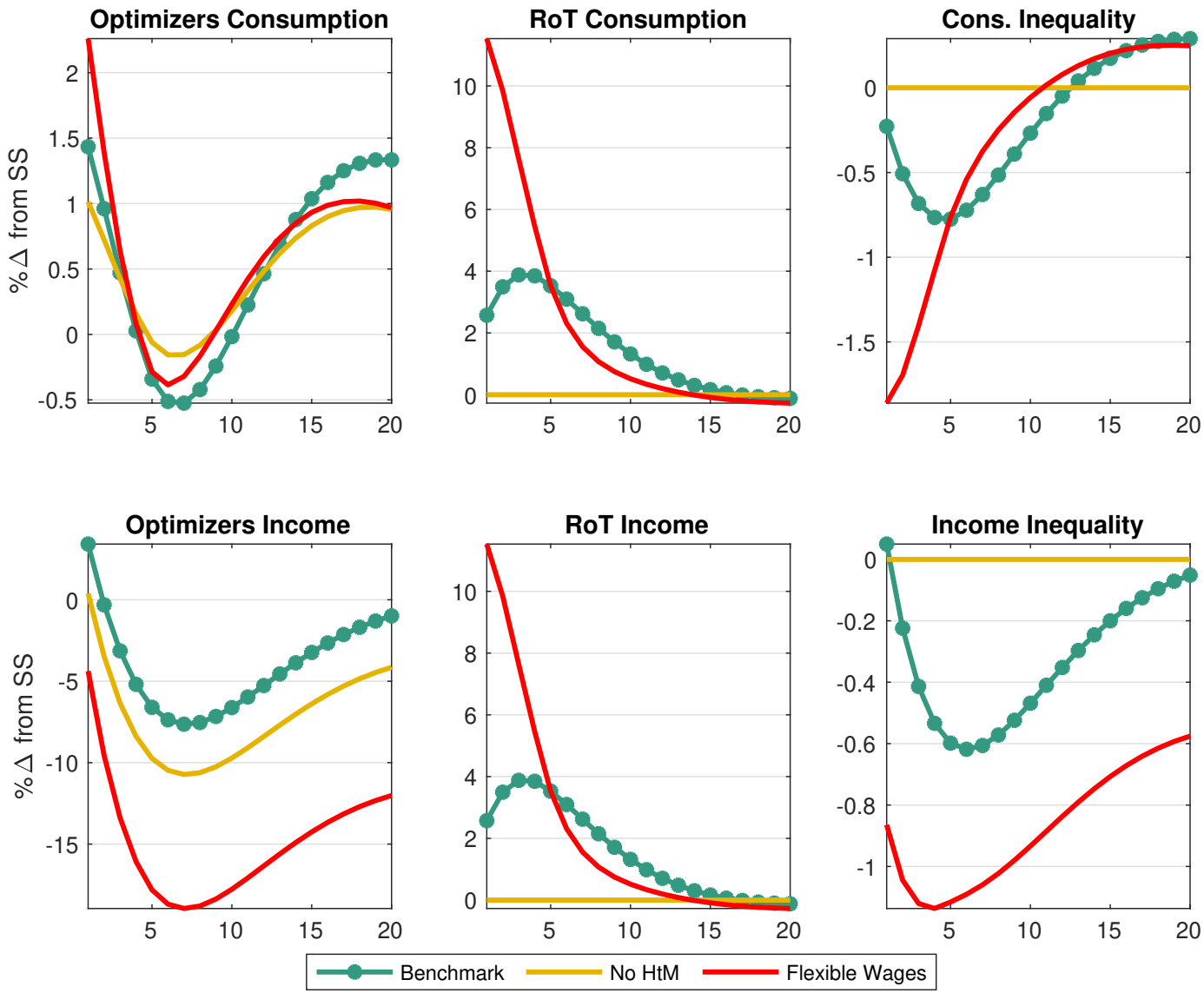
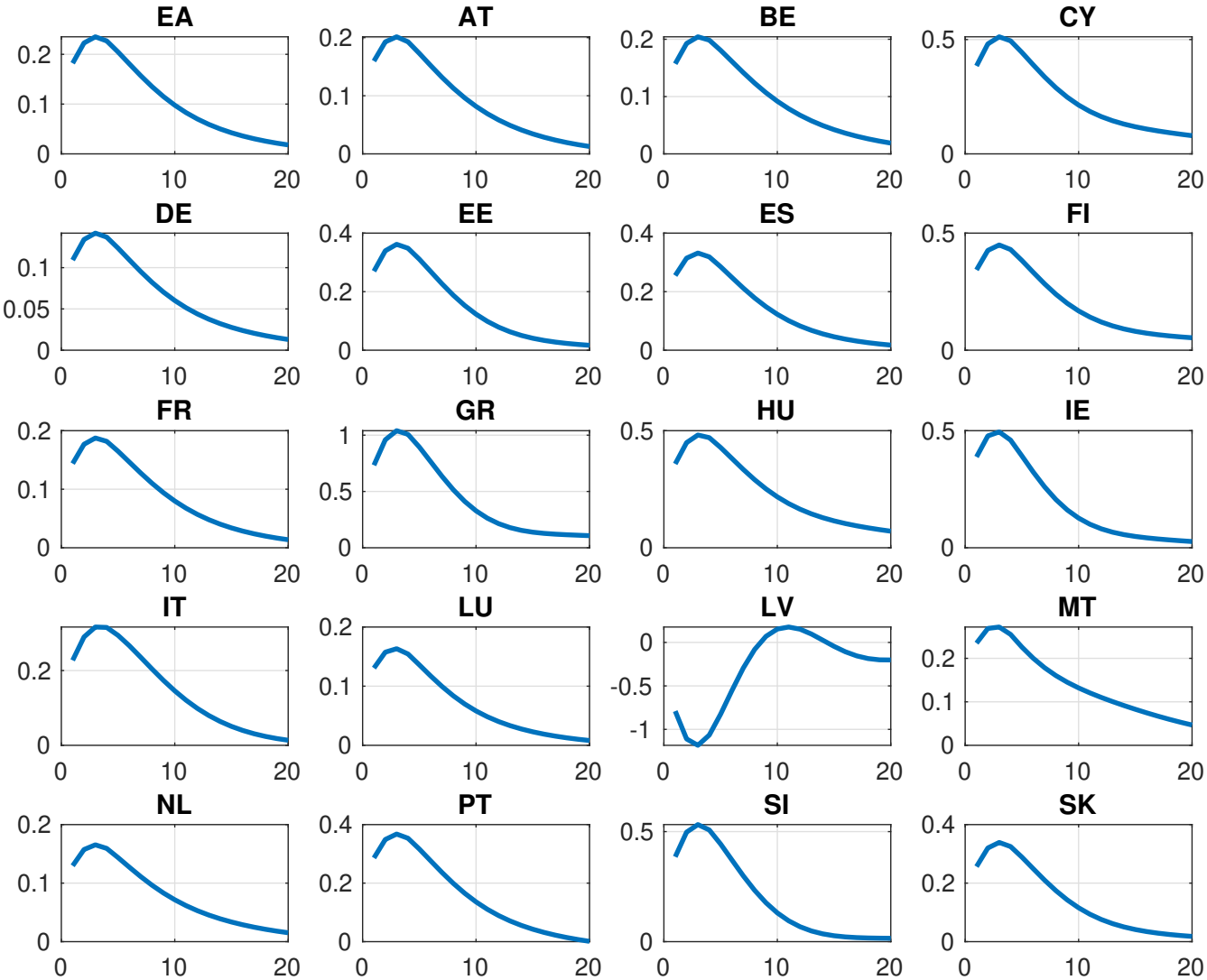


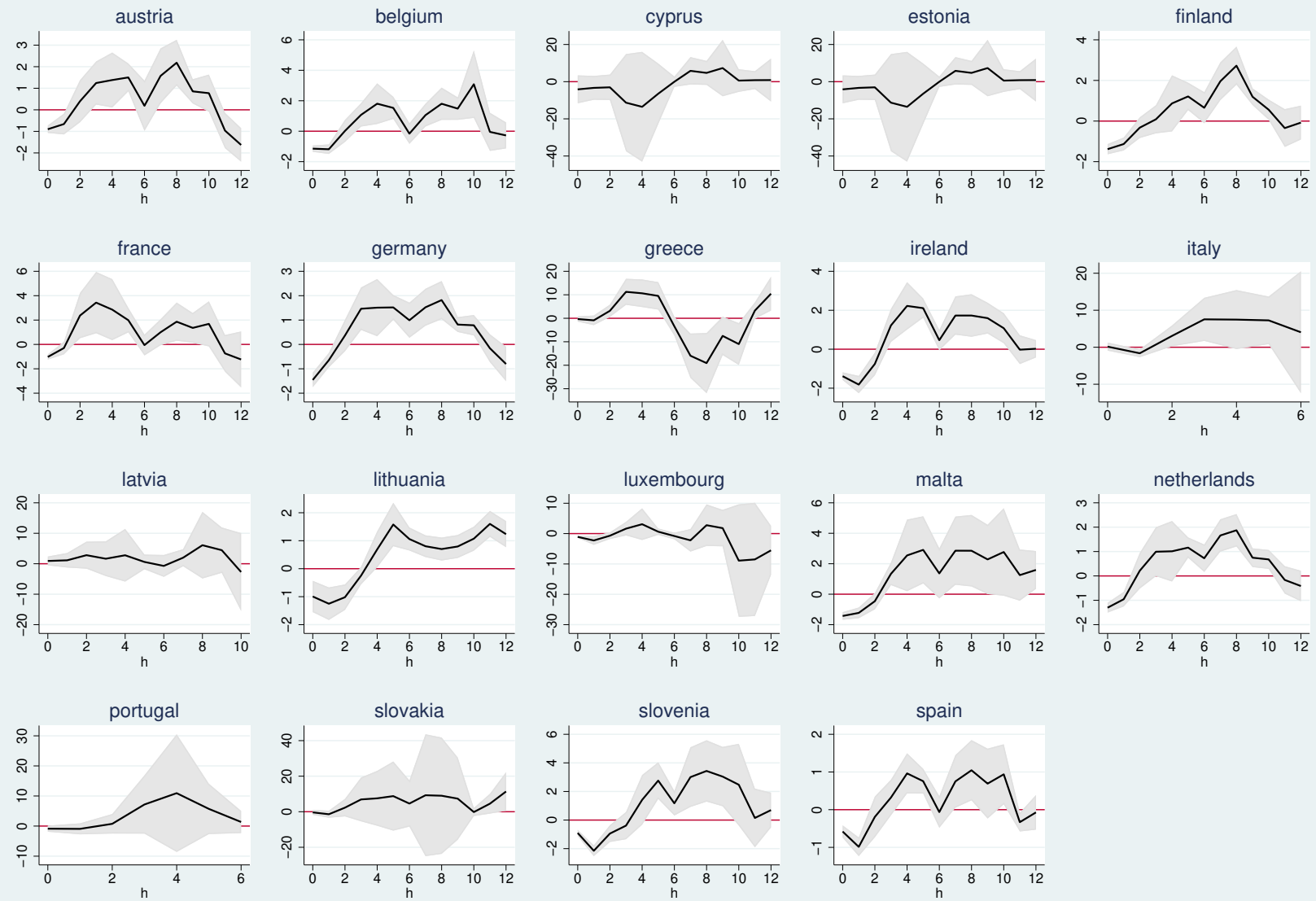
Benchmark: h2m 20% and wage stickiness 0.77

Impulse responses of GDP to QE shock for country calibrations

Eurozone countries | banks



Effect of QE on government bond spreads



Grey area shows 90% confidence intervall

Effect of QE on corporate credit spreads (5-years)

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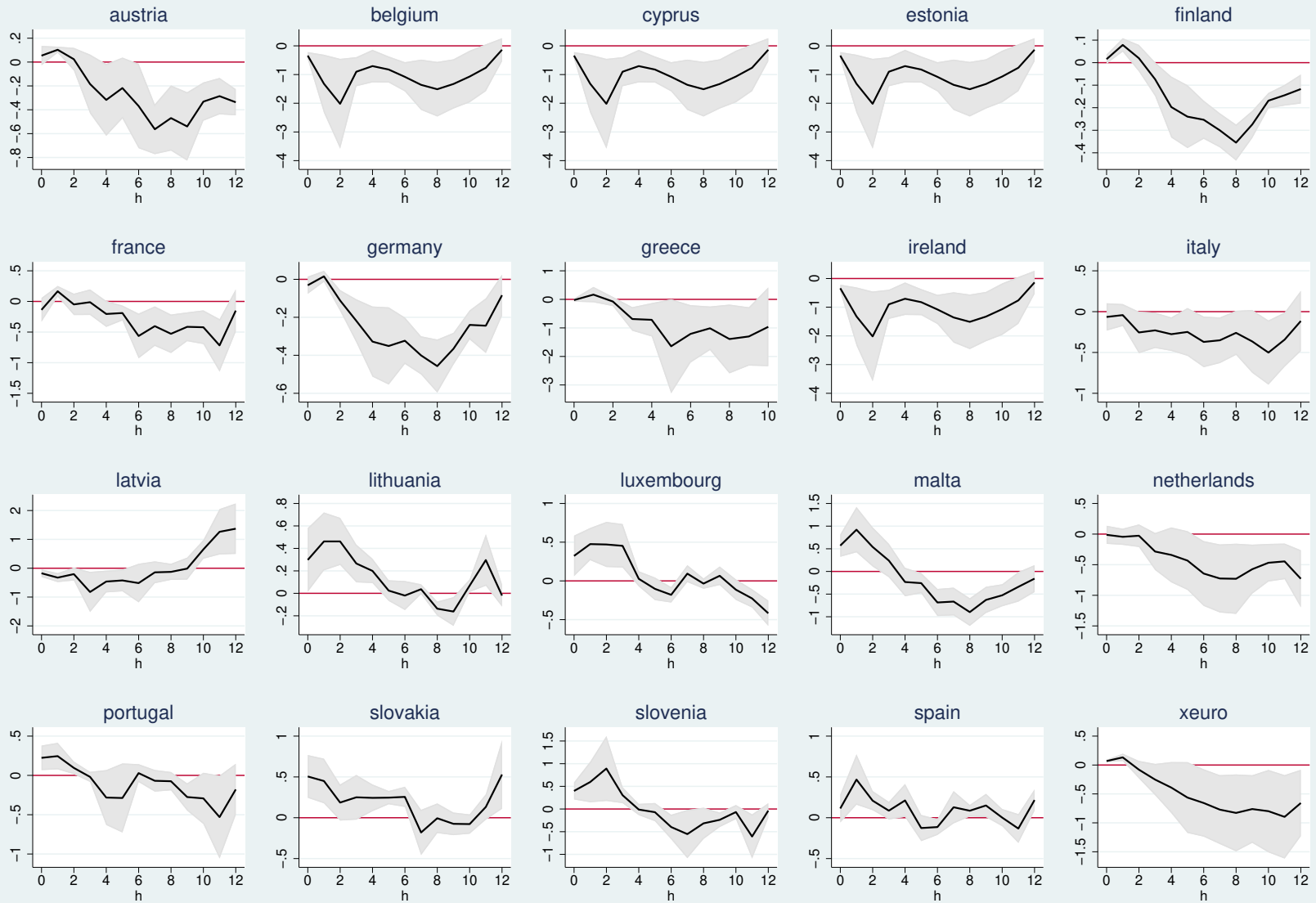
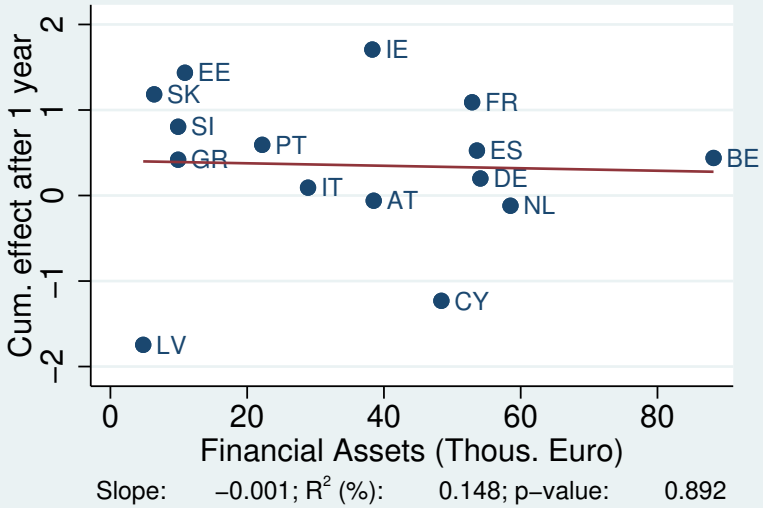
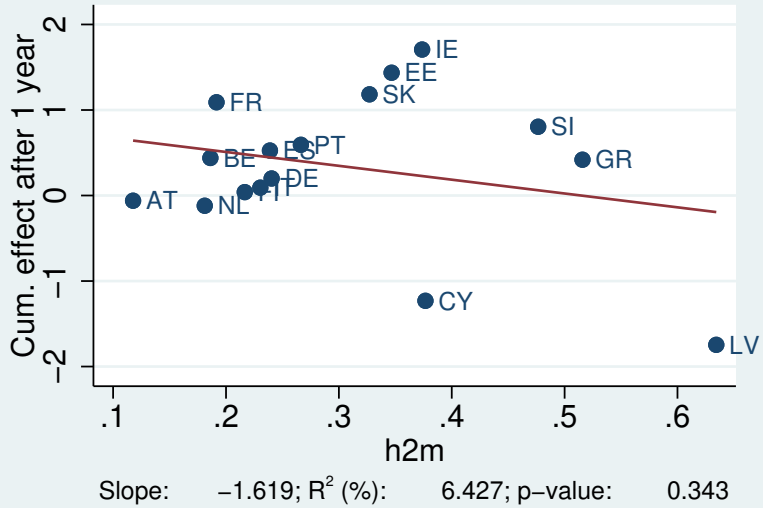


Grey area shows 90% confidence intervall

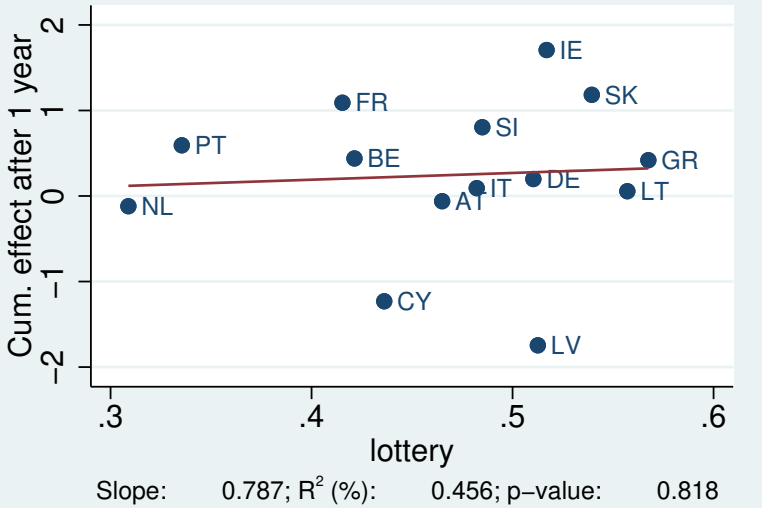
Effect of QE on GDP & asset market part. (over 1st y.)



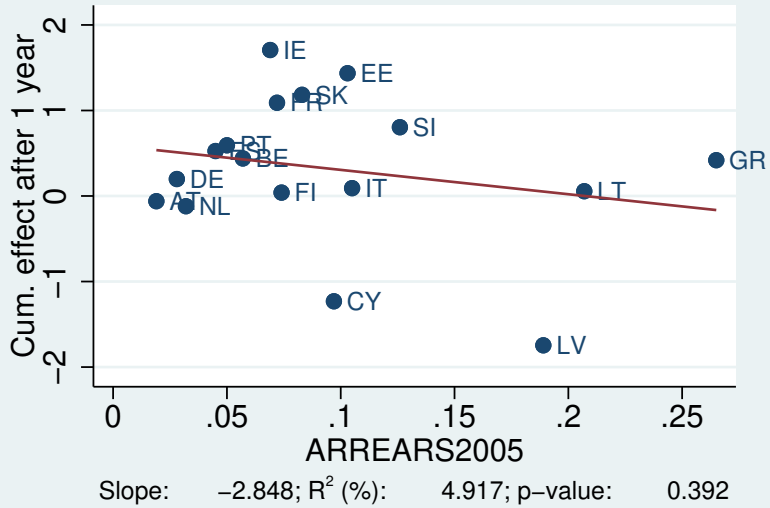
Slope: −0.001; R^2 (%): 0.148; p−value: 0.892



Slope: −1.619; R^2 (%): 6.427; p−value: 0.343



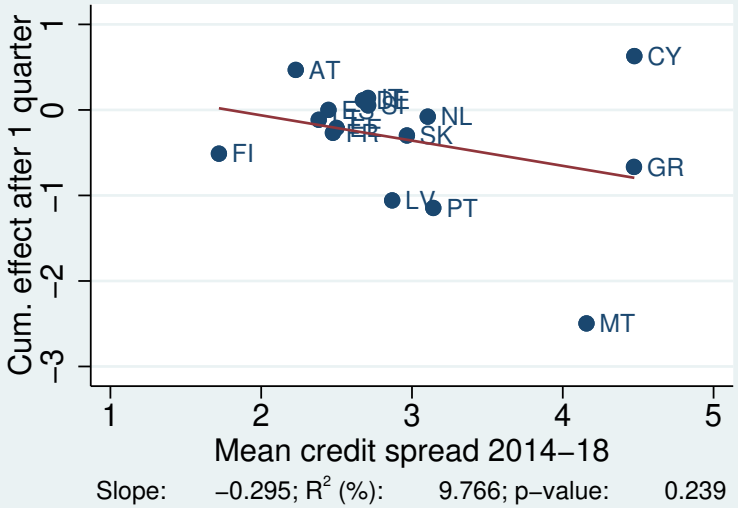
Slope: 0.787; R^2 (%): 0.456; p−value: 0.818



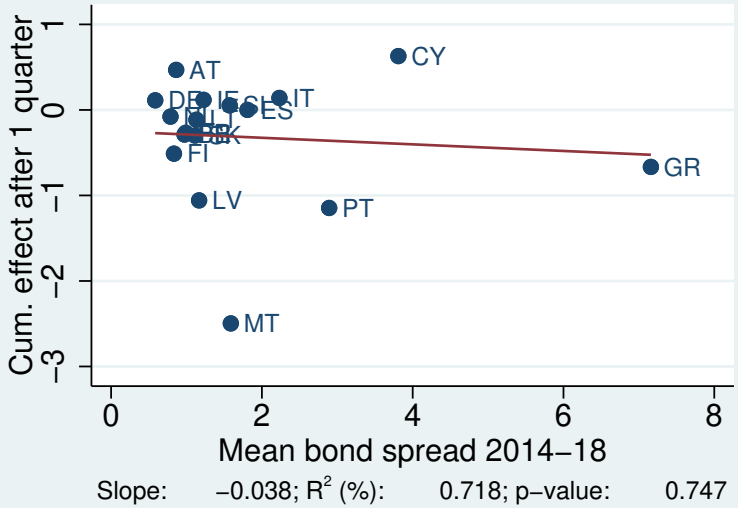
Slope: −2.848; R^2 (%): 4.917; p−value: 0.392

back to main | Effect on une. over 1st q. | Effect on une. over 1st y.

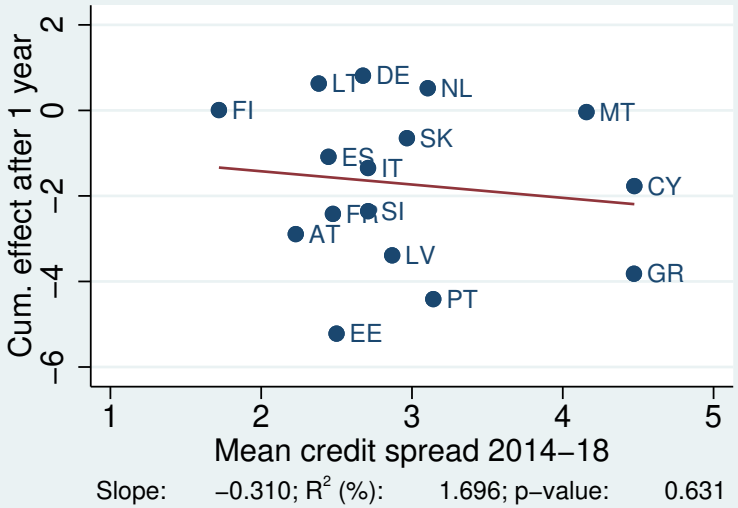
Effect of QE on une. & fin. frictions



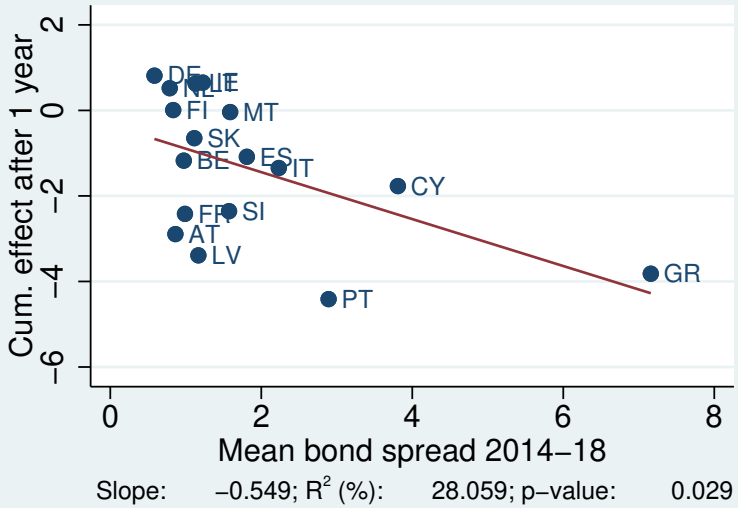
Slope: −0.295; R^2 (%): 9.766; p−value: 0.239



Slope: −0.038; R^2 (%): 0.718; p−value: 0.747

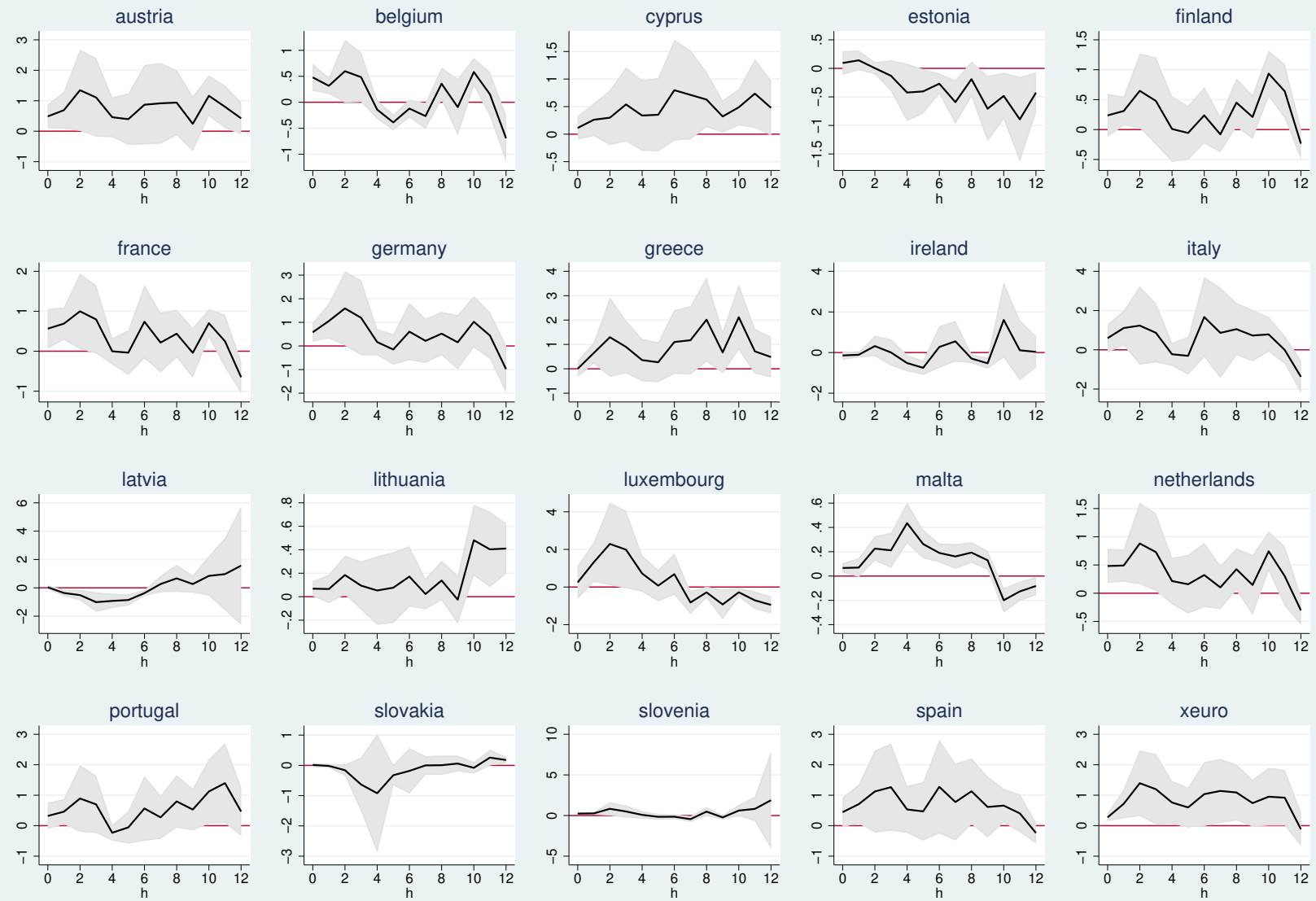


Slope: −0.310; R^2 (%): 1.696; p−value: 0.631

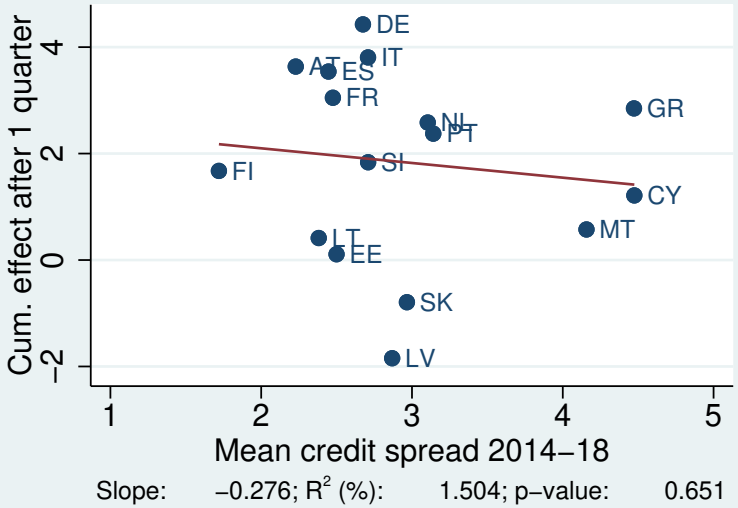


Slope: −0.549; R^2 (%): 28.059; p−value: 0.029

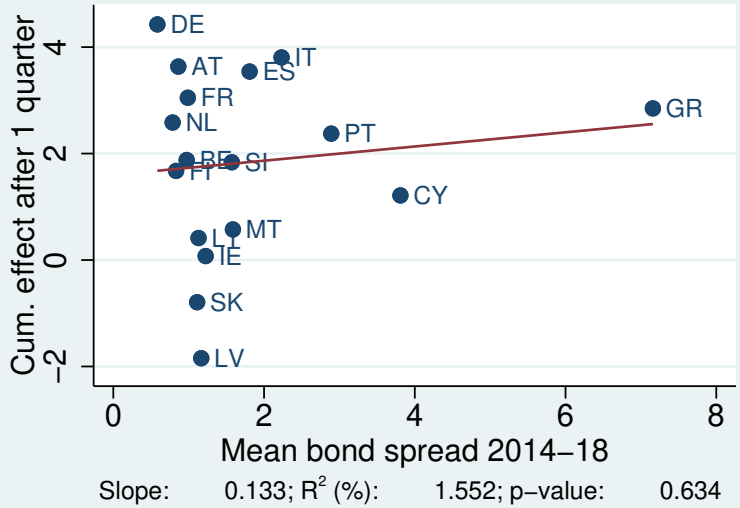
Effect of QE on stock market indices



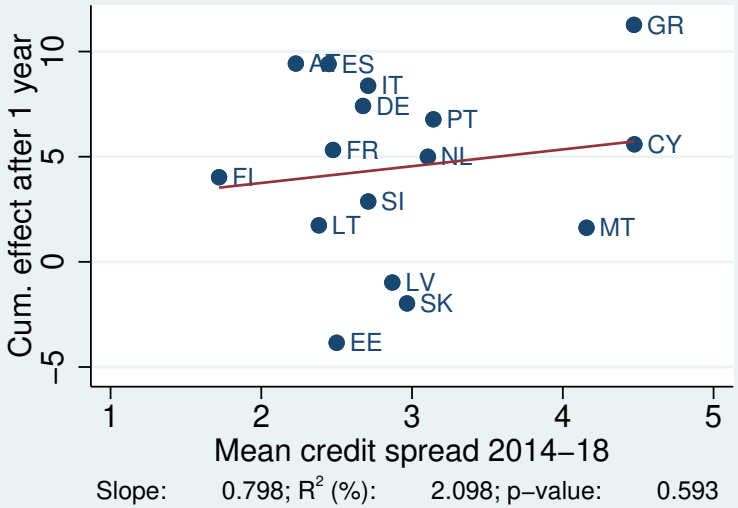
Effect of QE on stock market & fin. frictions



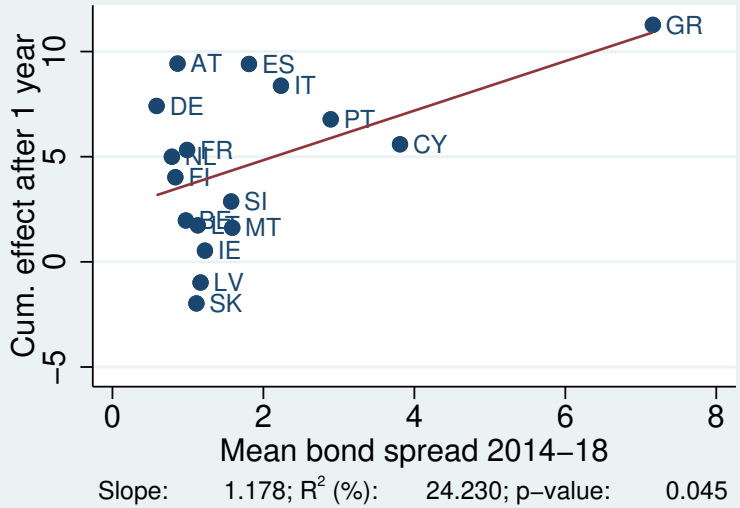
Slope: −0.276; R^2 (%): 1.504; p−value: 0.651



Slope: 0.133; R^2 (%): 1.552; p−value: 0.634

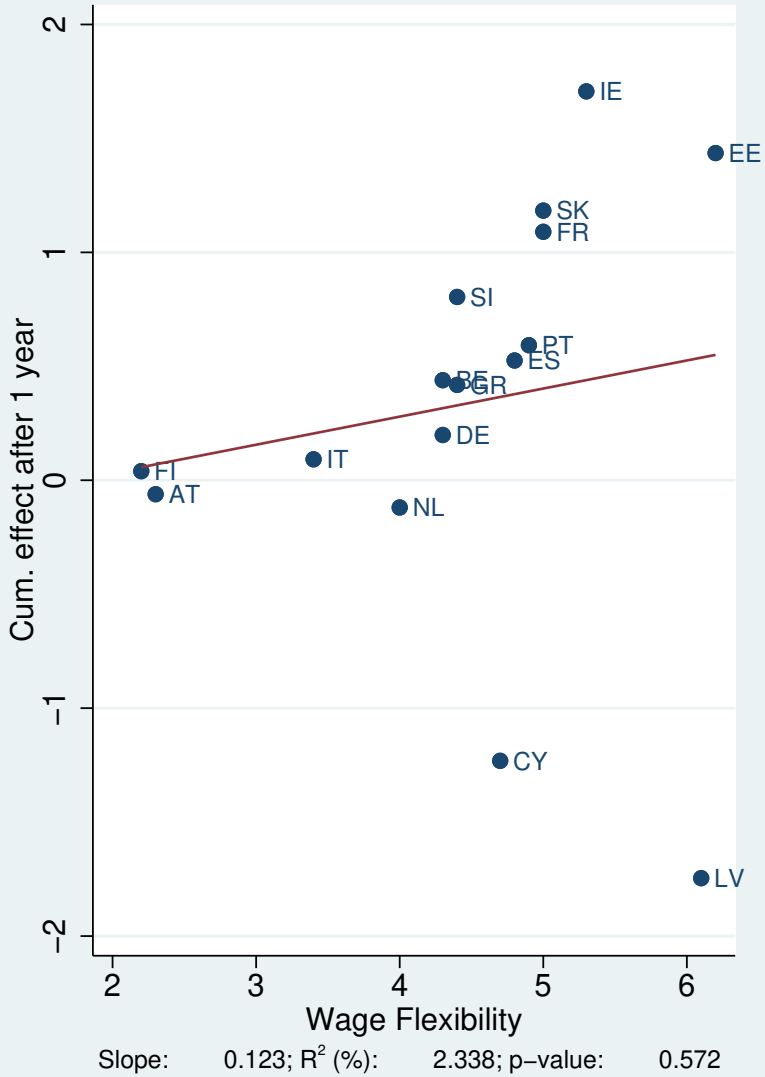


Slope: 0.798; R^2 (%): 2.098; p−value: 0.593

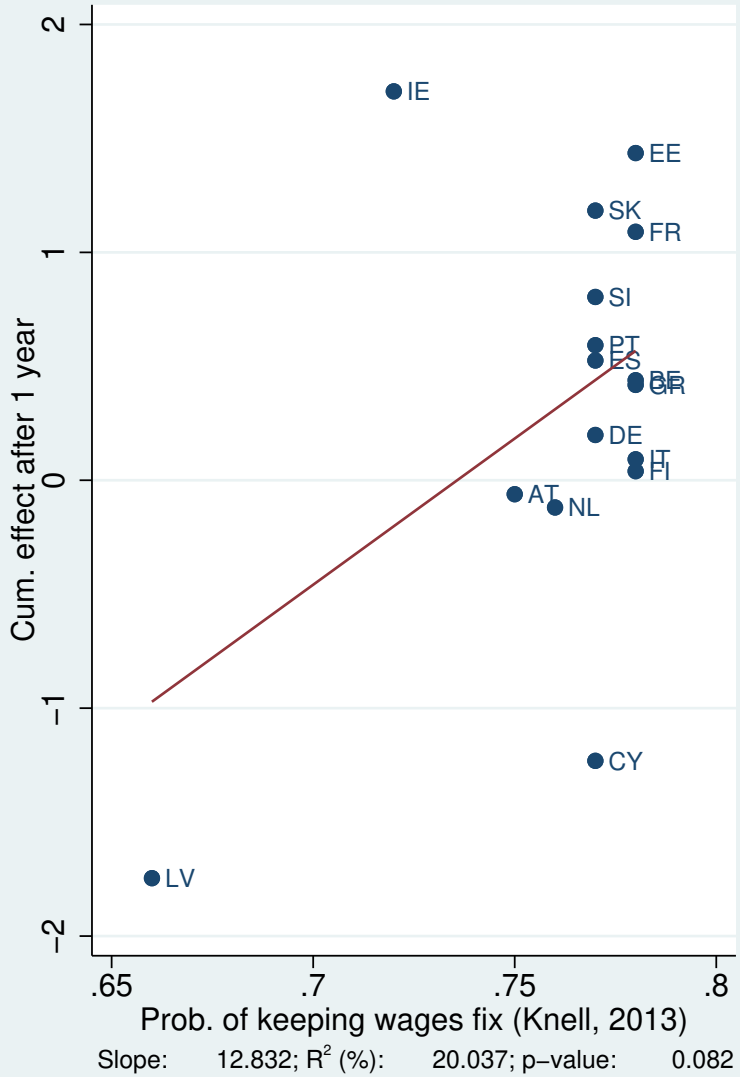


Slope: 1.178; R^2 (%): 24.230; p−value: 0.045

Effect of QE on GDP & wage flex.



Slope: 0.123; R^2 (%): 2.338; p−value: 0.572



Slope: 12.832; R^2 (%): 20.037; p−value: 0.082

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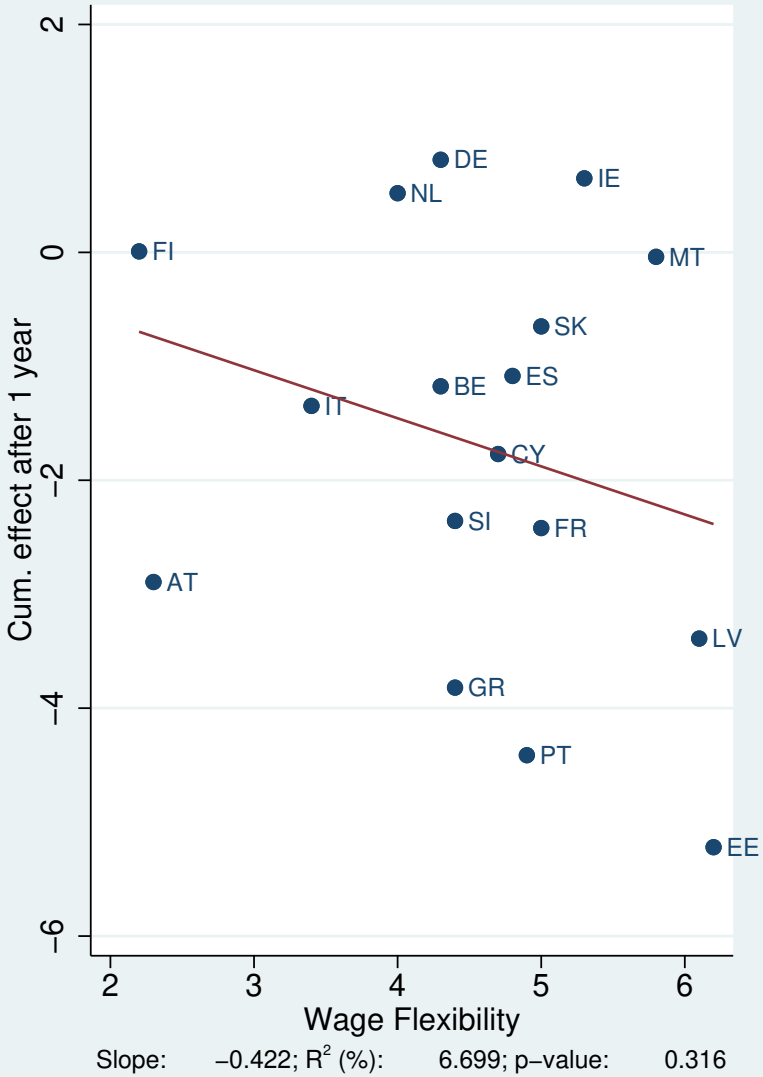
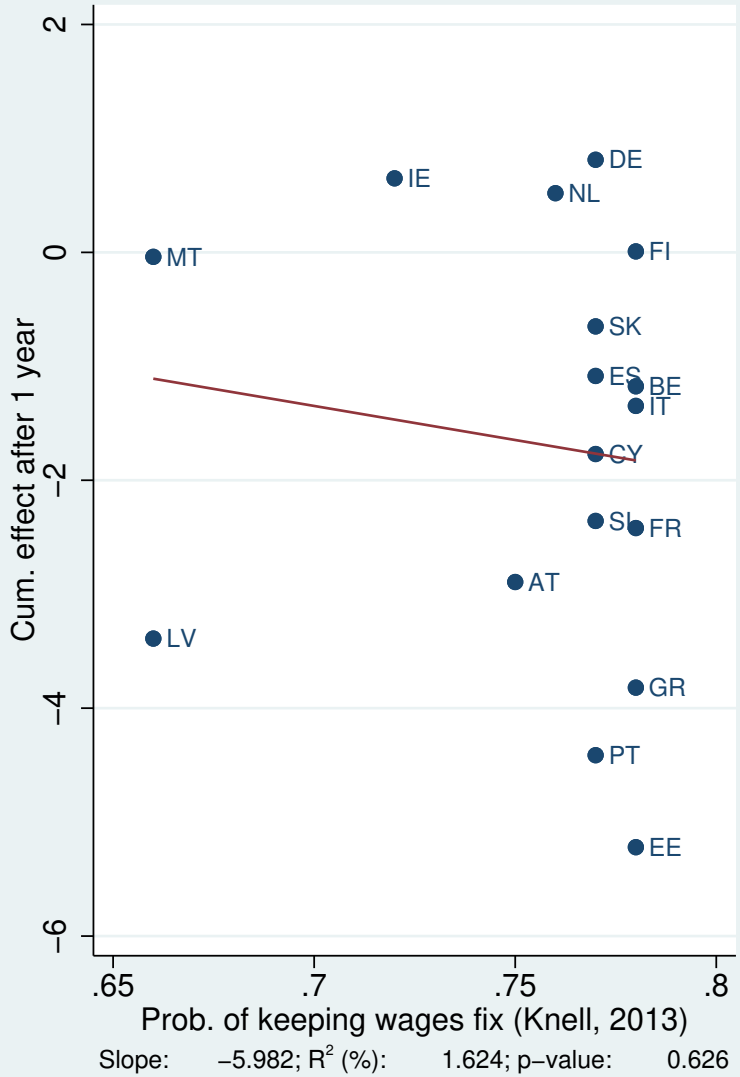
Effect of QE on une. & wage flex.





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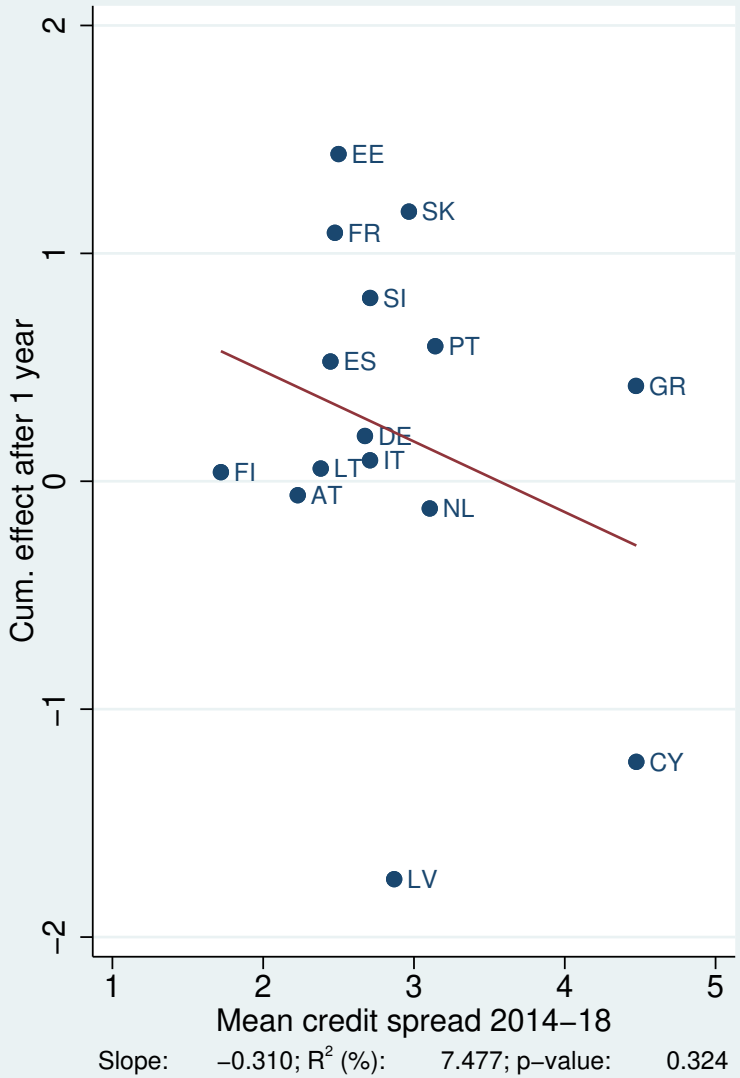
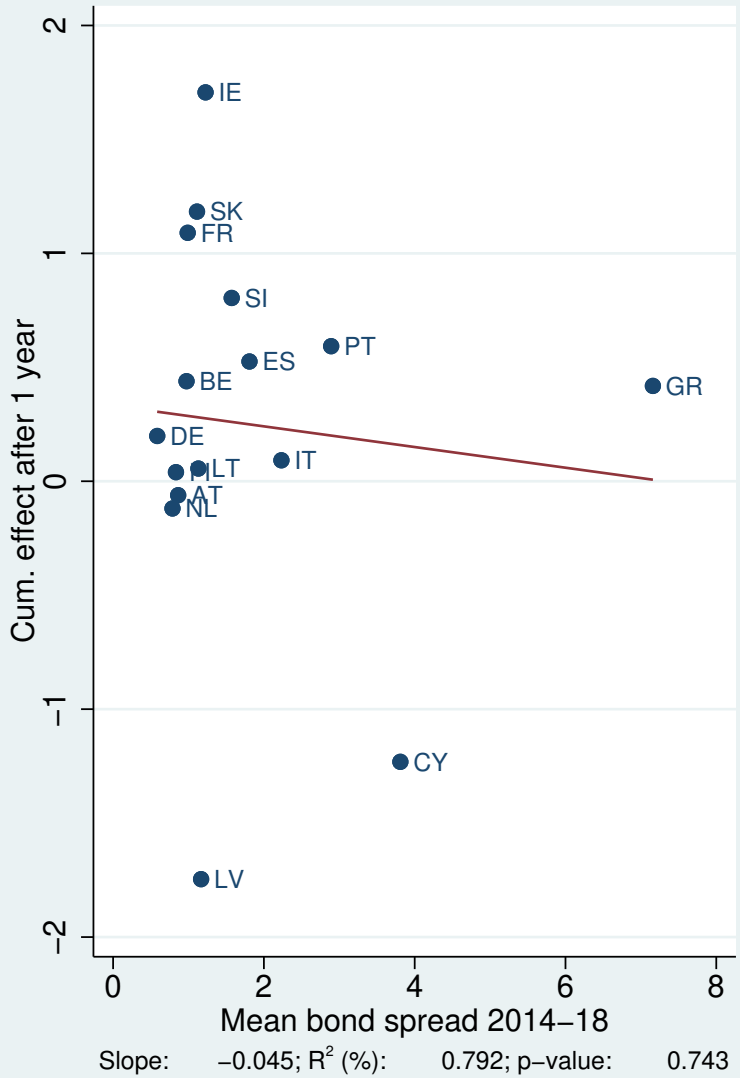
Effect of QE on GDP & fin. frictions





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