The Risk of Inflation Dispersion in the Euro Area

Journée du Club ERM - 26 avril 2023

Stéphane Lhuissier[a] Aymeric Ortmans[b] Fabien Tripier[c]

[a]Banque de France

[b]Université Paris-Saclay & Sciences Po

[c]Université Paris Dauphine - PSL & LEDa

Outline

Motivation

Methodology

Quantile Phillips Curve

Dispersion of IaR

Conclusion

Where we stand

HICP inflation in the **euro area** decreased to **6,9%** in **mars 2023** compared to **8,5%** in février 2023

	Euro area	Lowest Luxembourg	Highest Latvia
mars 2023	**6,9**	**2,9**	**17,2**

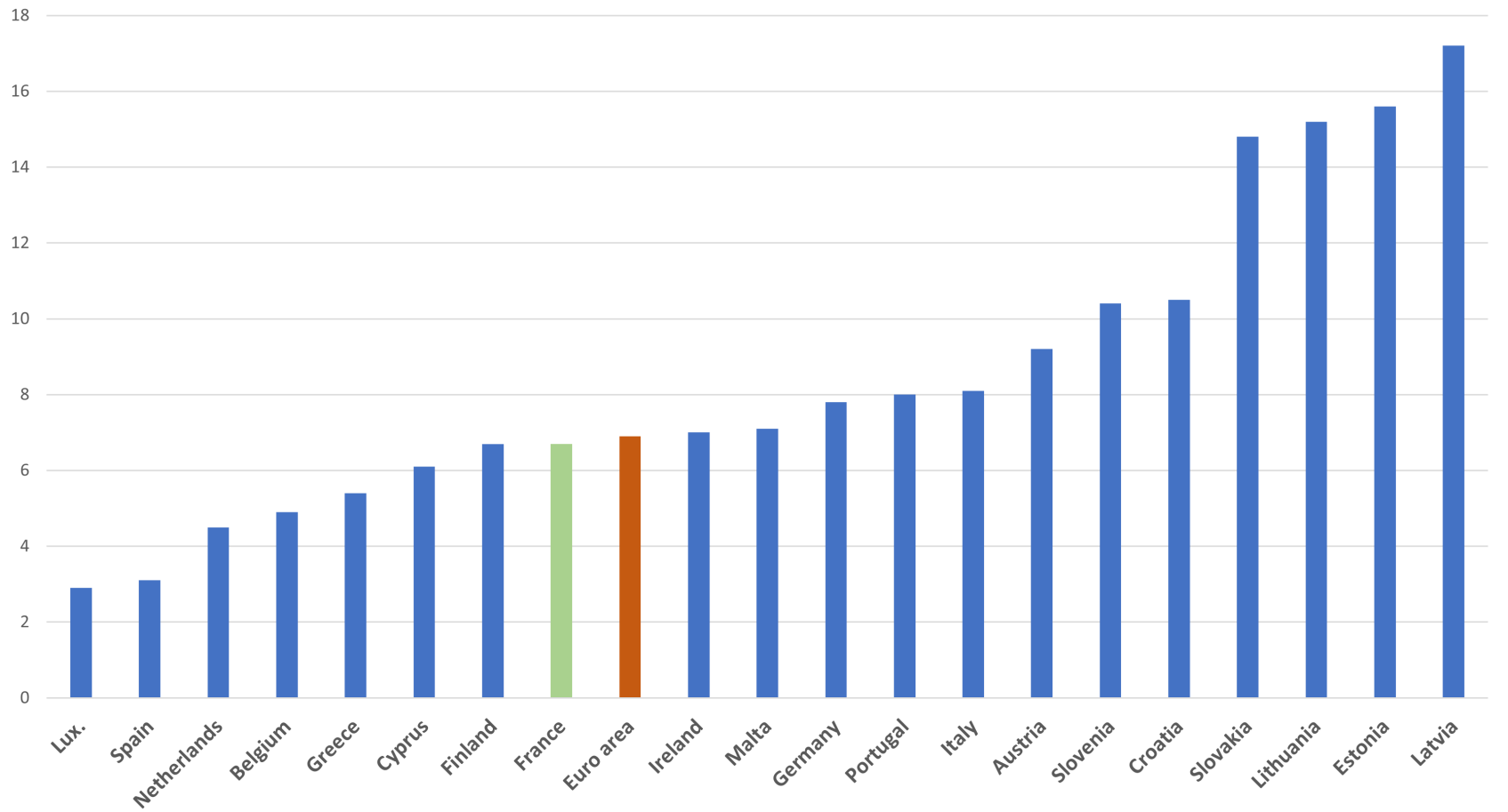
Source: ECB's Inflation dashboard

- The average inflation rate is 6.9 percent in the euro area.
- The range of inflation rate is $17.2 - 2.9 = 14.3$.

$\Rightarrow$ Dispersion of inflation in the euro area need more attention.

Where we stand

We focus thereafter on the 12 first members of the EA (still a high gap between Austria and Lux. of 6.3).



Is there really a ***risk*** of inflation dispersion? The macroeconomic point of view

- Until recently, the ECB's point of view was "No".
  - Inflation dispersion has decreased since the creation of the euro area and remain moderate afterwards.

Is there really a ***risk*** of inflation dispersion? The macroeconomic point of view

- Until recently, the ECB's point of view was "No".
  - Inflation dispersion has decreased since the creation of the euro area and remain moderate afterwards.
- The current crisis with a "high divergence of inflation in the euro area" puts into question this view (I. Schnabel, Monetary Dialogue 2022).
  - Targeting an average inflation rate in a monetary union is not optimal when union's members are heterogeneous.
  - The current ECB policy can be costly for the countries with the most extreme inflation rates (too reactive for some, insufficient for others).

Is there really a ***risk*** of inflation dispersion? The financial/insurance point of view

- Inflation dispersion matters besides the direct consequence trough the ECB's decision on monetary policy.

Is there really a ***risk*** of inflation dispersion? The financial/insurance point of view

- Inflation dispersion matters besides the direct consequence trough the ECB's decision on monetary policy.
- Inflation is (obviously) key for real returns, hence
  - inflation dispersion implies dispersion of real returns
  - with implications for portfolio management and risk diversification.

Is there really a ***risk*** of inflation dispersion? The financial/insurance point of view

- Inflation dispersion matters besides the direct consequence trough the ECB's decision on monetary policy.
- Inflation is (obviously) key for real returns, hence
  - inflation dispersion implies dispersion of real returns
  - with implications for portfolio management and risk diversification.
- Hence, the interest of monitoring the inflation dispersion risk as we do.

Outline

Motivation

Methodology

Quantile Phillips Curve

Dispersion of IaR

Conclusion

Our statistical approach: from the VaR to the IaR

VaR Value-at-Risk: the portfolio losses associated to a risk level.

- Key indicator of portfolio (extreme) risk.

Our statistical approach: from the VaR to the IaR

VaR Value-at-Risk: the portfolio losses associated to a risk level.

- Key indicator of portfolio (extreme) risk.
- Can we apply this concept to macroeconomics? Yes

Our statistical approach: from the VaR to the IaR

VaR Value-at-Risk: the portfolio losses associated to a risk level.

- Key indicator of portfolio (extreme) risk.
- Can we apply this concept to macroeconomics? Yes

IaR Inflation-at-Risk: the inflation rate associated to a risk level.

- What is the inflation rate such that there is 10% of chance to observe a higher inflation rate.
- For upward inflation risks, but also for downward inflation risks.

Our statistical approach: from the VaR to the IaR

VaR Value-at-Risk: the portfolio losses associated to a risk level.

- Key indicator of portfolio (extreme) risk.
- Can we apply this concept to macroeconomics? Yes

IaR Inflation-at-Risk: the inflation rate associated to a risk level.

- What is the inflation rate such that there is 10% of chance to observe a higher inflation rate.
- For upward inflation risks, but also for downward inflation risks.

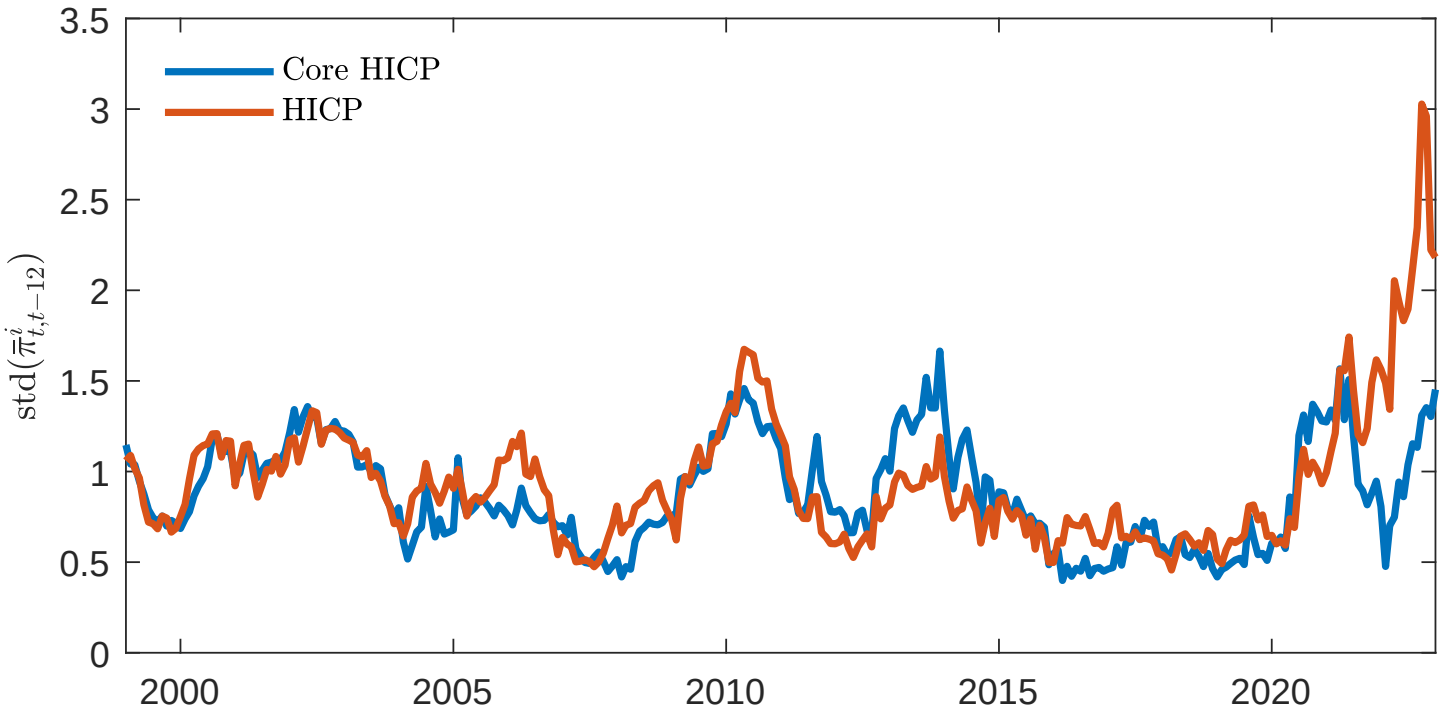
Why? Two facts on inflation dispersion

Two facts on inflation dispersion motivate our approach

#1 The cross-sectional standard deviation of inflation rates is time varying.

#2 Tail moments of inflation are more dispersed than median and mean.

#1 The cross-sectional standard deviation of inflation rates is time varying



Note: $\bar{\pi}^i_{t,t-12}$ denotes the average over the last 12 months of the monthly inflation rate (core and headline inflation rates, annualized) for the country i of the euro area (12 countries, fixed composition, Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain). The sample is January 1999 to January 2023. The figure shows the cross-country unweighted standard deviation of annual inflation rates in the euro area..

#2 Tail moments of inflation are more dispersed [in red] than the median and the mean [in blue].

	Core HICP				HICP			
	Mean	Median	10^{th}	90^{th}	Mean	Median	10^{th}	90^{th}
Germany	1.19	1.10	0.43	2.06	1.63	1.44	0.33	3.16
Greece	1.33	1.47	-1.22	3.70	1.95	1.79	-0.87	4.99
France	1.18	1.16	0.53	1.87	1.62	1.50	0.66	2.72
Italy	1.70	1.76	0.68	2.64	1.73	1.75	0.28	3.16
Spain	1.65	1.70	0.24	3.01	2.16	2.00	-0.12	4.67
Netherlands	1.63	1.41	0.60	2.91	2.04	1.75	0.44	3.98
Finland	1.37	1.30	0.47	2.37	1.68	1.48	0.28	3.31
Ireland	1.46	1.43	-0.89	3.86	1.73	1.61	-0.87	4.53
Austria	1.76	1.69	1.07	2.56	1.94	1.78	0.73	3.36
Portugal	1.57	1.45	-0.03	3.36	1.87	1.73	-0.12	4.06
Belgium	1.77	1.68	1.19	2.45	1.97	1.92	0.61	3.43
Luxembourg	1.74	1.70	1.12	2.41	2.45	2.32	0.67	4.43
Mean	1.53	1.49	0.35	2.77	1.90	1.75	0.17	3.82
Std. Dev.	**0.22**	**0.22**	**0.75**	**0.62**	**0.25**	**0.25**	**0.56**	**0.72**

Note: Mean, median, 10^{th} and 90^{th} quantiles for each country of the euro area (12 countries, fixed composition: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain). The sample is January 1999 to January 2023. The last two rows are the unweighted means and the standard deviations of moments across countries.

To monitor [#1], time-varying dispersion of inflation,
we need to taking into account [#2], dispersion in inflation tails.

We propose a time-varying measure of the dispersion of tail inflation risks in the euro area

- In practice, at each period time, for each country of the euro area (12),
  1. we estimate the distribution of future inflation (e.g. forecast) to get moments for future inflation (e.g. median and tail quantiles),
  2. then, we can compute the standard deviation of moments (e.g. median and tail quantiles) for each period of time.

We propose a time-varying measure of the dispersion of tail inflation risks in the euro area

- In practice, at each period time, for each country of the euro area (12),
  1. we estimate the distribution of future inflation (e.g. forecast) to get moments for future inflation (e.g. median and tail quantiles),
  2. then, we can compute the standard deviation of moments (e.g. median and tail quantiles) for each period of time.
- We can respond to the following questions
  - Where does the greatest risk of dispersion come from?
    - From the median, the 10^{th} quantile (e.g. downward inflation risks) or the 90^{th} quantile (e.g. upward inflation risks)?
  - What are the origins of this dispersion risk?
    - Does it come from financial market turbulence, unemployment gaps, or pressures on supply chains?

Outline

Motivation

Methodology

Quantile Phillips Curve

Dispersion of IaR

Conclusion

Tools

- Phillips curve
  - the macroeconomic tool to analyze the determinants of inflation.
- Quantile regression
  - the econometric tool to analyze the determinants of quantiles.

Phillips Curve Quantile Regressions

Based on López-Salido and Loria (2022)

- We estimate the conditional inflation quantiles $\hat{Q}_\tau$ by country i:

$$\hat{Q}_\tau(\bar{\pi}^i_{t+1,t+h}|x^i_t) = x^i_t \hat{\beta}^i_\tau, \tag{1}$$

- τ is the quantile (10^{th}, 50^{th}, and 90^{th} in the paper)
- $\bar{\pi}^i_{t+1,t+h}$ is the inflation rate between $t+1$ and $t+h$ for $h = \{3, 12\}$
- x^i_t is the vector containing the conditioning variables
- $\hat{\beta}^i_\tau$ is the vector of estimated quantile-specific parameters

Remark If there is only a constant in x^i_t, $\hat{\beta}^i_\tau$ are the unconditional quantiles.

Phillips Curve Quantile Regressions: Key variables in x_t^i

1. Unemployment gap (traditional Philips curve)
2. Average past inflation rate (inertia of inflation)
3. Long-term inflation expectations (anchoring of inflation expectations)
4. Average relative oil price inflation (energy crisis)
5. Financial stress indicator (financial crisis)
6. Pressures on global supply chains (covid crisis)

Data

Inflation-at-Risk

→ *With* 10% *confidence we shall experience, on average, inflation below the level* ${}^{-}IaR$ *and above the level* ${}^{+}IaR$ *over the next h periods*

- We define the downside Inflation-at-Risk as

$$\Pr\left(\bar{\pi}^{i}_{t+1,t+h} \leq {}^{-}IaR^{i}_{t+h}\left(\alpha|x^{i}_{t}\right)\right) = \alpha, \tag{2}$$

- Similarly, we define the upside Inflation-at-Risk as

$$\Pr\left(\bar{\pi}^{i}_{t+1,t+h} \geq {}^{+}IaR^{i}_{t+h}\left(\alpha|x^{i}_{t}\right)\right) = \alpha, \tag{3}$$

- Based on quantiles of inflation rates for a probability α (we set $\alpha = 10\%$) between periods t and $t+h$ given x^{i}_{t} (information set at t)

The Risk of Inflation Dispersion

→ *The risk of inflation dispersion is measured by the dispersion of Inflation-at-Risk across countries.*

- Our measure of dispersion is the cross-country standard deviation of Inflation-at-Risks at horizon h, according to:

$$\sigma_{RISK_{t+h}} = \sqrt{\left[\frac{1}{N}\sum_{i=1}^{N}\left(RISK^{i}_{t+h} - \overline{RISK}_{t+h}\right)^{2}\right]} \tag{4}$$

where $RISK^{i}_{t+h} = [{}^{-}IaR^{i}_{t+h}, {}^{+}IaR^{i}_{t+h}]$, and $\overline{RISK}_{t+h}$ is the mean of our risk measures across countries

Sample

- Monthly time series from January 1999 to January 2023.
- 12 euro area countries, fixed composition.
  Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain.
- Core HICP as inflation measure (extension to HICP in the paper)
- $h = 12$ one-year forecast (extension to $h = 3$ in the paper)

Outline

Motivation

Methodology

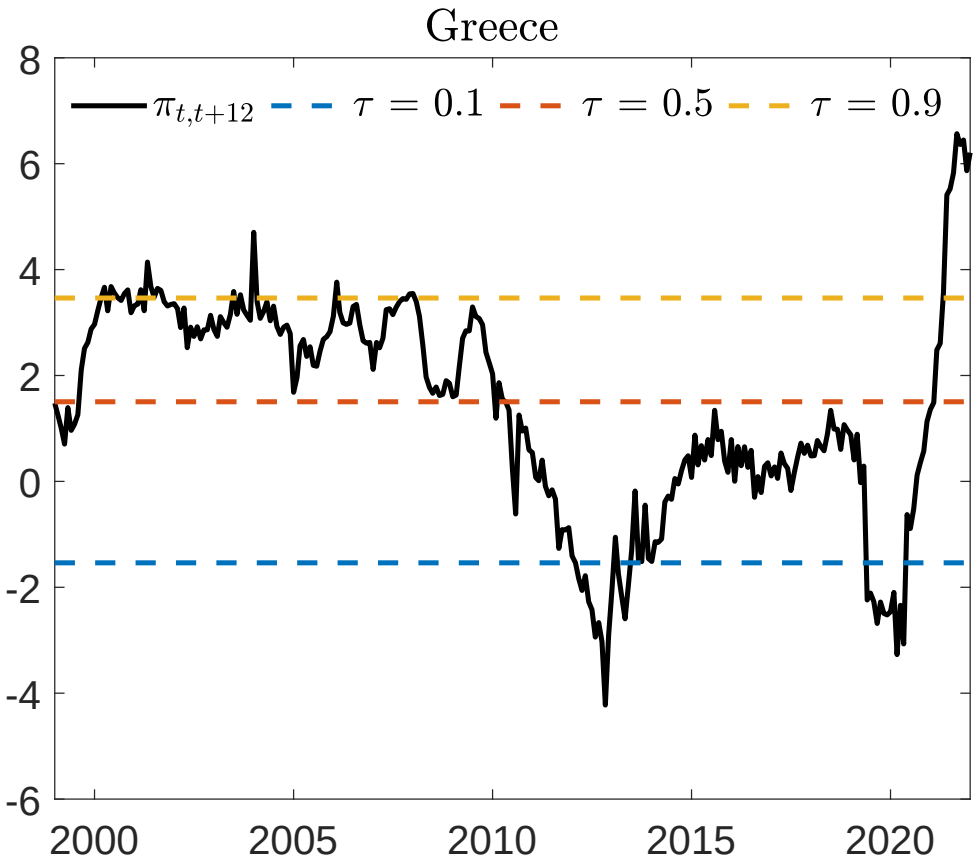
Quantile Phillips Curve

Dispersion of IaR

Conclusion

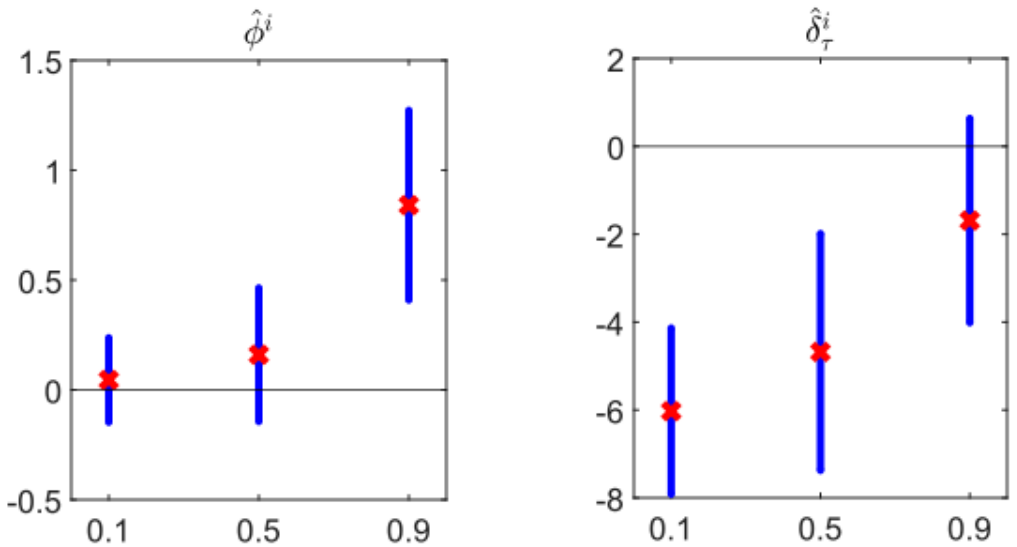
Let us start with one country

IaR at the country level: unconditional quantiles



IaR at the country level: estimated coefficients by quantile

1. $\hat{\phi}_{\tau=0.90} > \hat{\phi}_{\tau=0.10} \approx 0$: the pressure on supply chains impacts the upward IaR, but not the downward IaR.
2. $\hat{\delta}_{\tau=0.10} < \hat{\delta}_{\tau=0.90} \approx 0$: the stress on financial markets impacts the the downward IaR, but not the upward IaR.

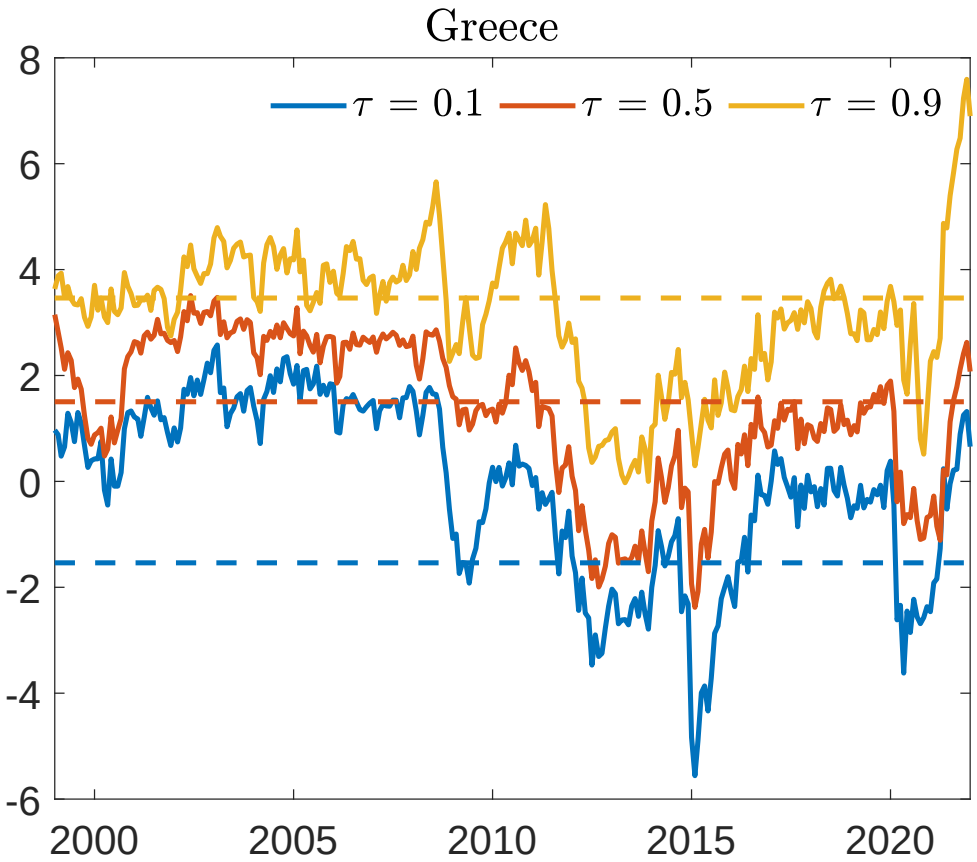


IaR at the country level: implications for conditional quantiles

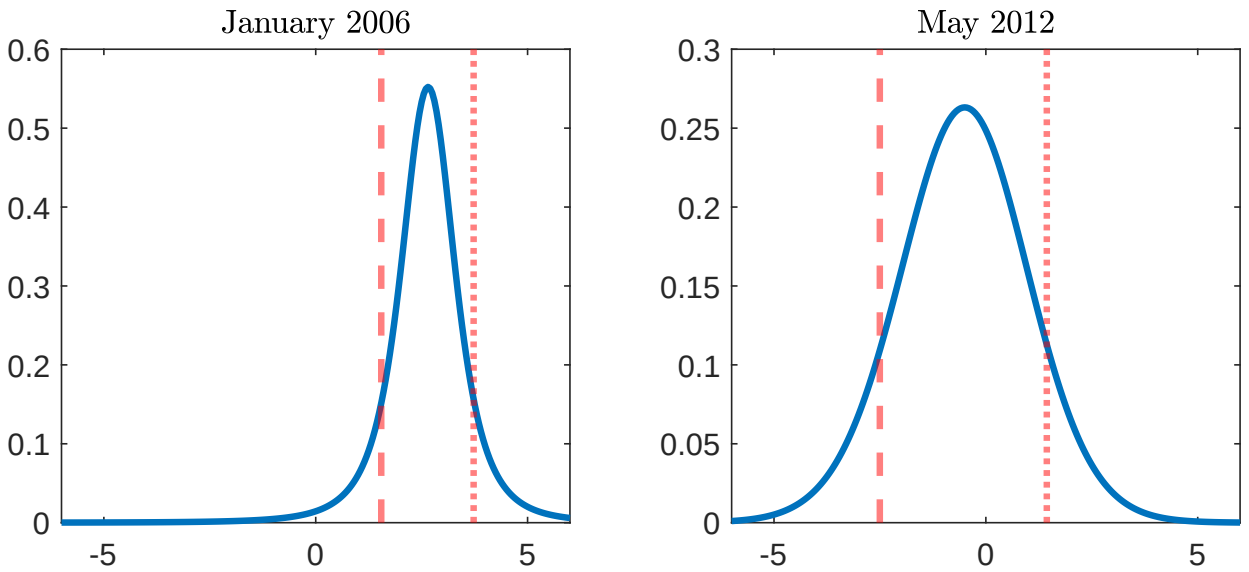
- Variables x_t^i in the Phillips curve are time-varying.
- Elasticity of $\pi_{t+1,t+h}^i$ to x_t^i are non-linear according to the quantile.

$\Rightarrow$ Heterogeneous dynamics of conditional quantiles of $\pi_{t+1,t+h}^i$.

IaR at the country level: conditional quantiles



IaR at the country level: How the Great Recession has moved the Greek predictive distribution



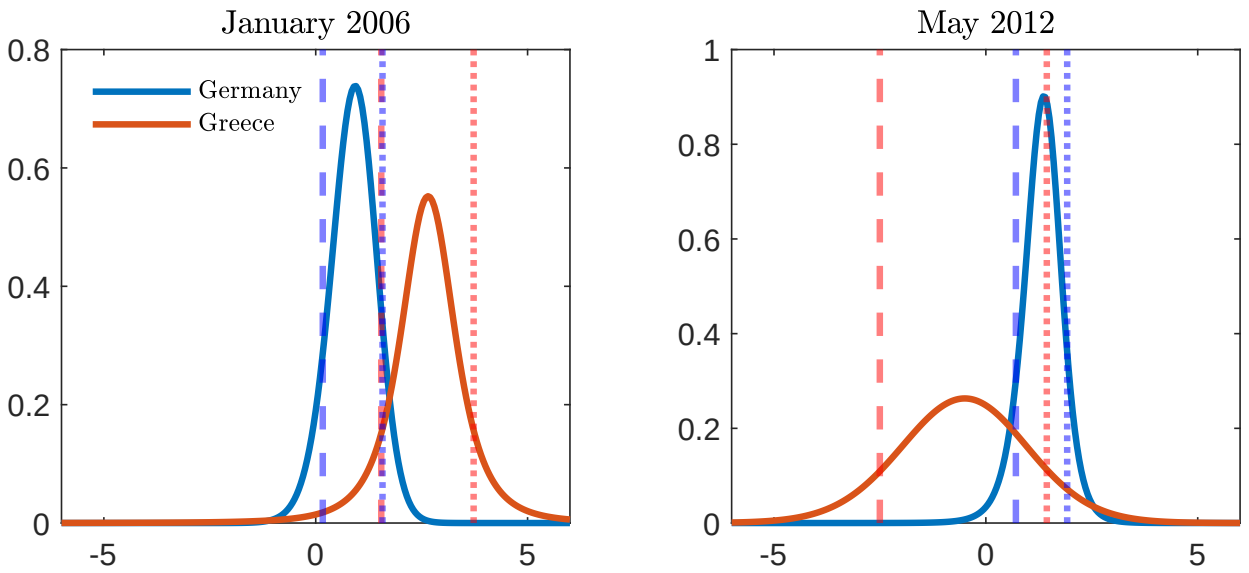
- The shift of the distribution is driven by the left tail movement.
  - Right tail (dotted, $\tau = 0.9$): $3.8 - 1.9 = 1.9$
  - Left tail (dashed, $\tau = 0.1$): $1.5 - (-2.4) = 3.9$ ($\times 2$ the right tail's shift)

Skew-t distribution

From one to two countries

Predictive distribution for Greece and Germany

- Greece's distribution shifted from the right to the left of Germany's distribution, which was less affected by the Great Recession.
- What does this imply for the dispersion of inflation risks?



A reversal from the dispersion of upward inflation risks to downward inflation risks

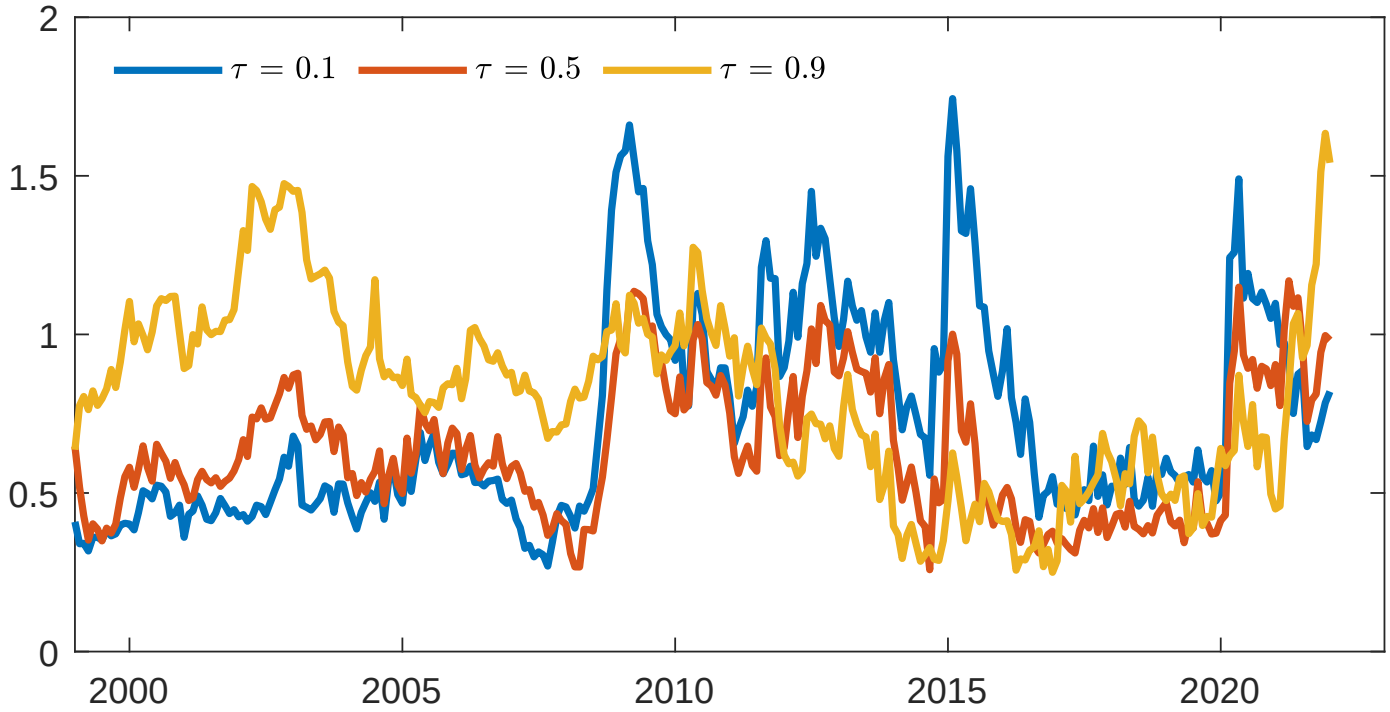
- $\tau = 0.1$ $\Uparrow$: increase in dispersion of downward inflation risks [+1.8]
- $\tau = 0.5$ $=$: stable dispersion of the middle of the distribution [-0.3]
- $\tau = 0.9$ $\Downarrow$: less dispersion of upward inflation risks [-2.2]

	2006			2012			2012-2006
Quantiles	Greece	Germany	Dispersion	Greece	Germany	Dispersion	Δ Dispersion
$\tau = 0.10$	1.5	0.2	1.3	-2.3	0.7	3.1	$+1.8$
$\tau = 0.50$	2.8	0.9	1.9	-0.3	1.3	1.6	-0.3
$\tau = 0.90$	3.8	1.6	2.2	1.8	1.8	0	-2.2

From two to twelve countries

The Dispersion of IaR: Tails > median

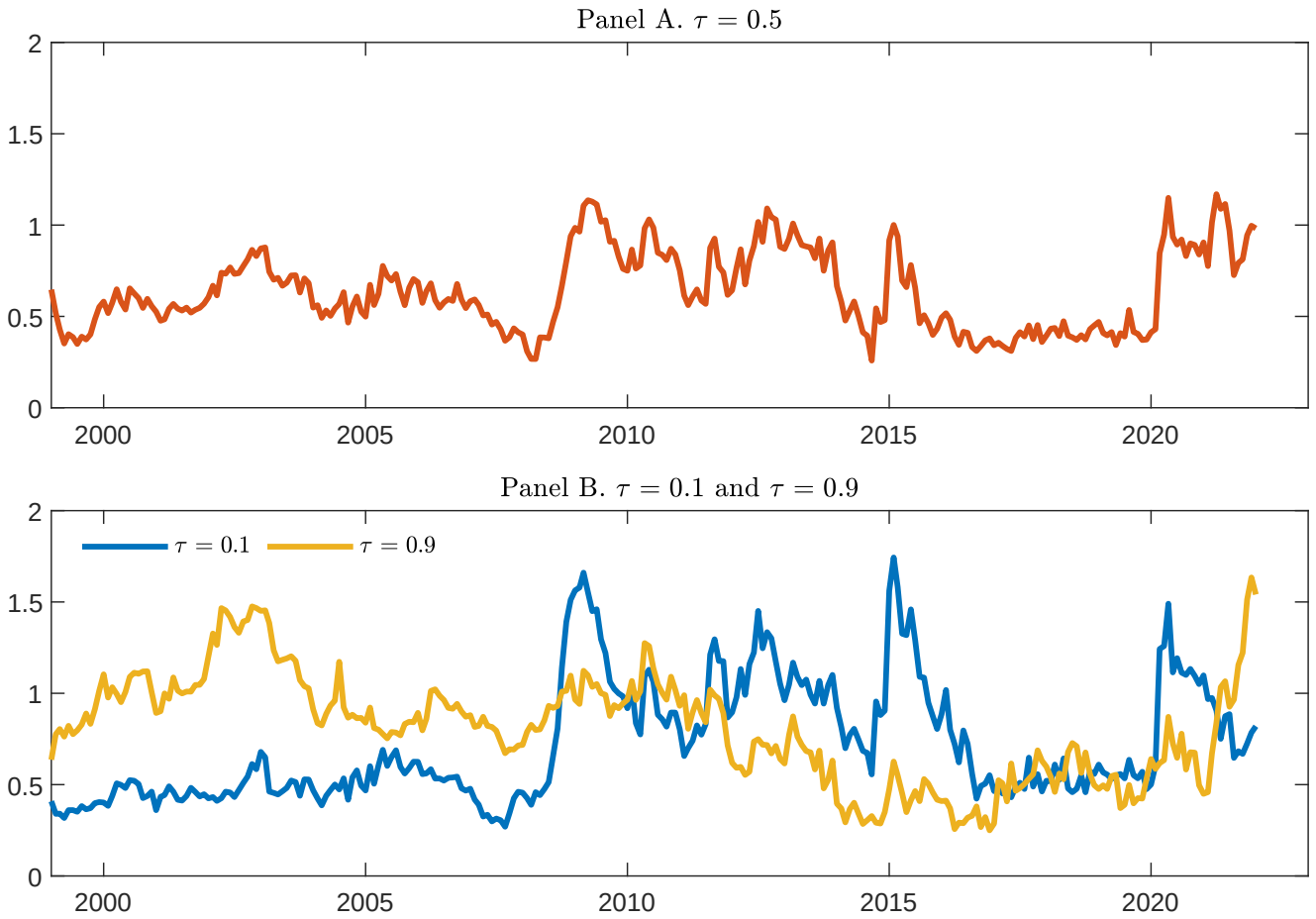
Standard deviation of conditional quantiles across countries



Estimated coefficients

The Dispersion of IaR: Upward, Downward, Upward

Standard deviation of conditional quantiles across countries



One step forward

Can we identify the drivers of the risk of inflation dispersion?

The Drivers of Inflation Dispersion

We build counterfactual scenarios based on our benchmark specification

1. We take our estimated quantile Phillips curves.
2. We shut down selected variables for all periods/countries.
3. We simulate the conditional quantiles under this assumption and compute the standard deviation of these counterfactual quantiles.
4. We compare the benchmark and the counterfactual measures of the risk of inflation dispersion.

Financial stress

- Dispersion of downward inflation risks ($\tau = 0.1$) would have remain stable without financial stress.

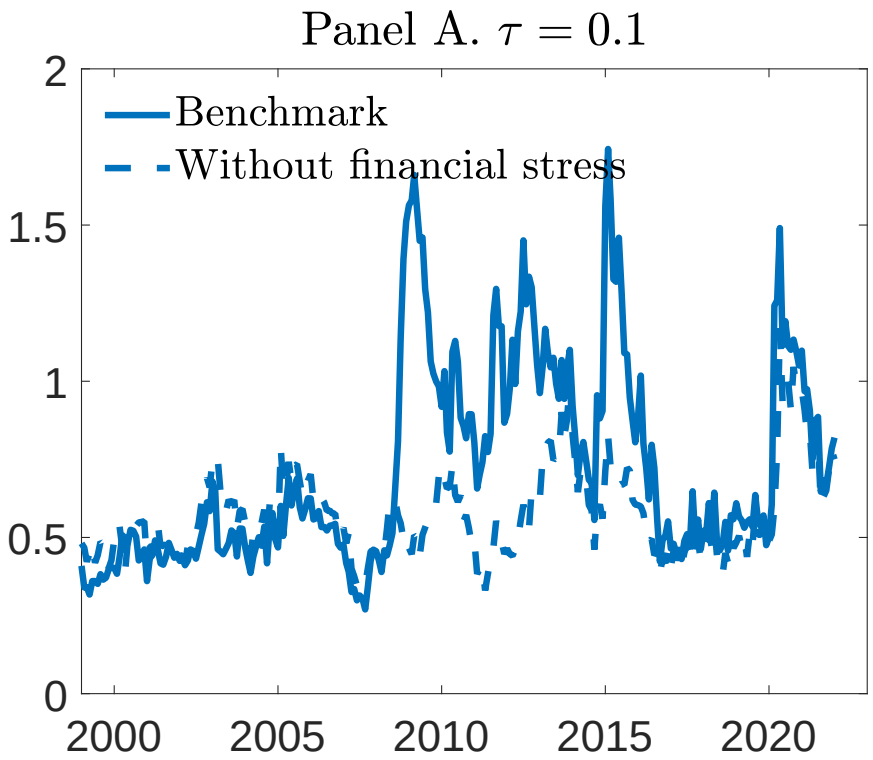


Figure: Dispersion of conditional quantiles without financial stress ($f_{t,i} = 0$)

Pressures on supply Chains and energy Prices

- Supply chain pressures drive the dispersion of upward inflation risks ($\tau = 0.9$) in the recent period.

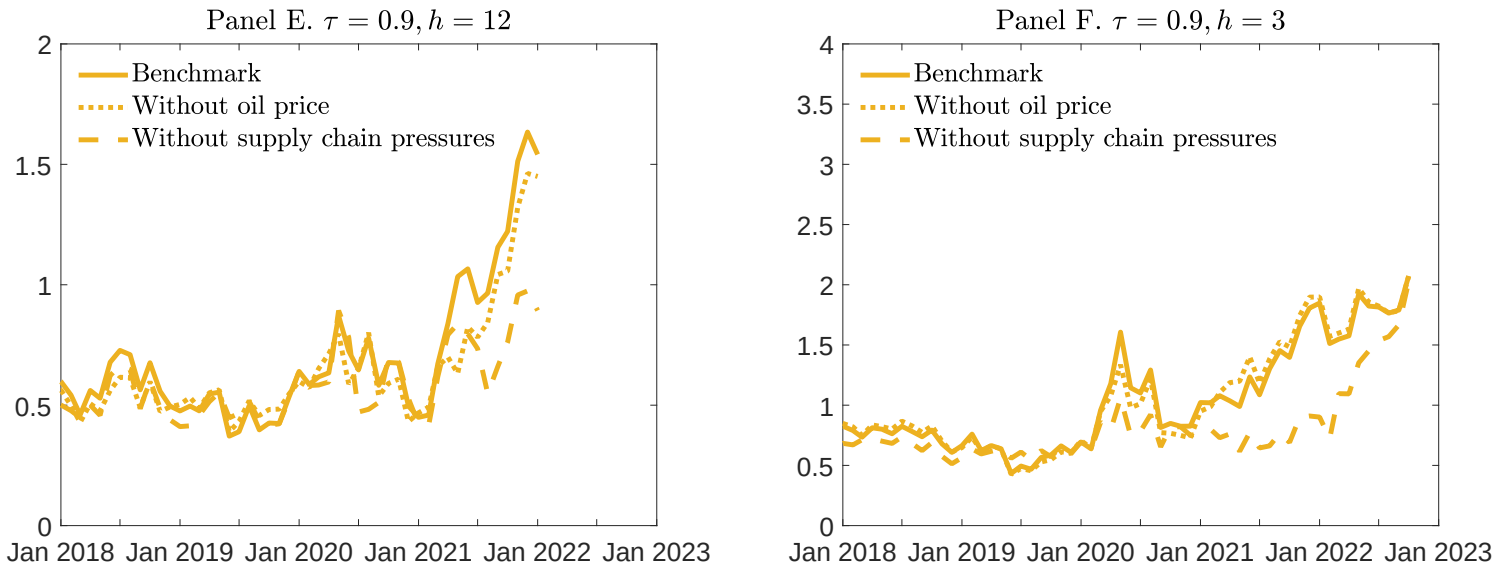


Figure: Dispersion of conditional quantiles for $\pi_t^{o,*} = \pi_t^{*,i}$ and $sc_t = 0$.

Pressures on supply Chains and energy Prices: HICP

- Supply chain pressures drive the dispersion of upward inflation ($\tau = 0.9$) risks in the recent period.

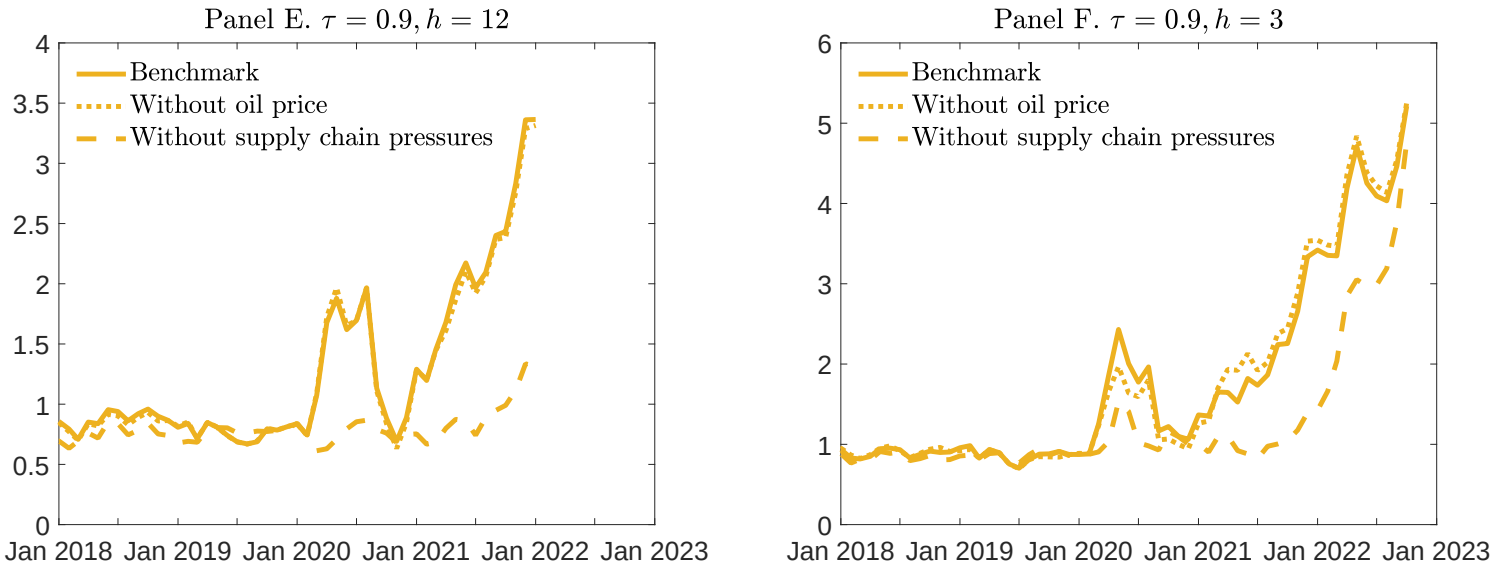
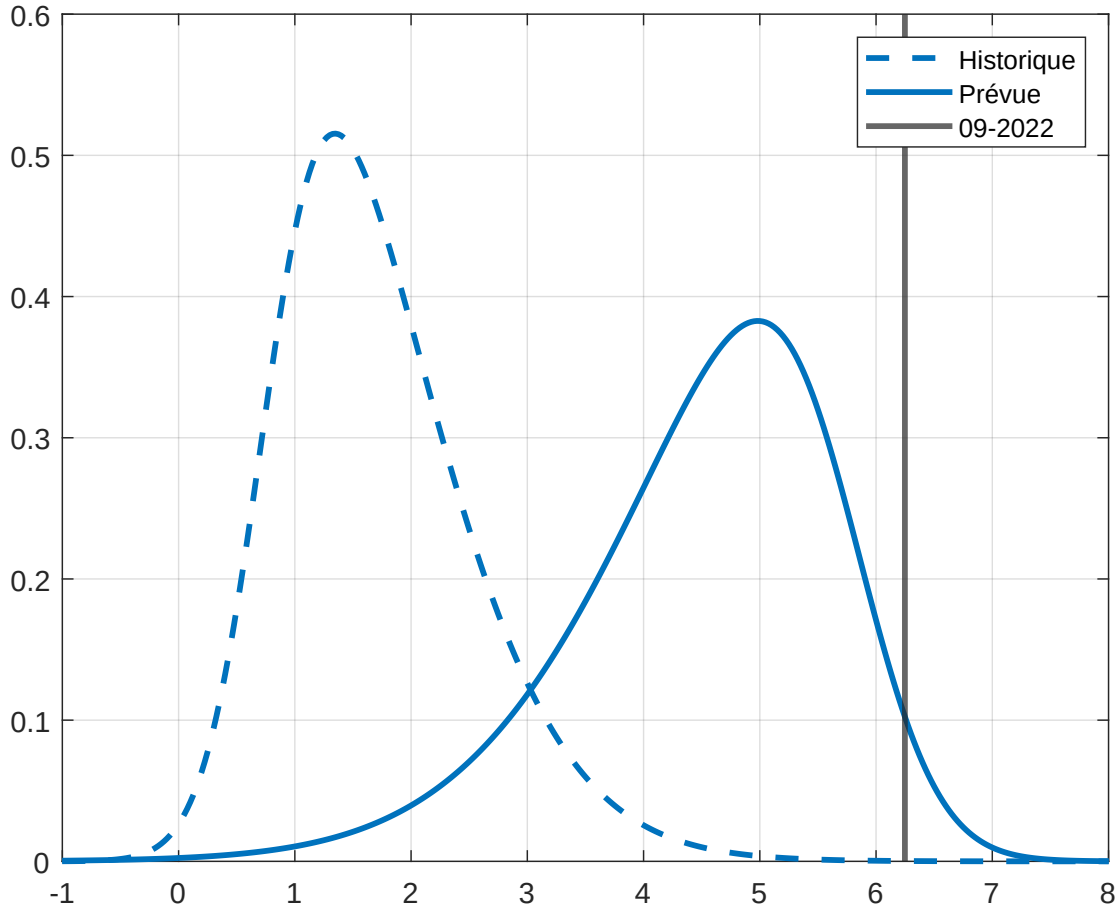


Figure: Dispersion of conditional quantiles for $\pi_t^{o,*} = \pi_t^{*,i}$ and $sc_t = 0$.

Pressures on supply Chains: France versus Germany

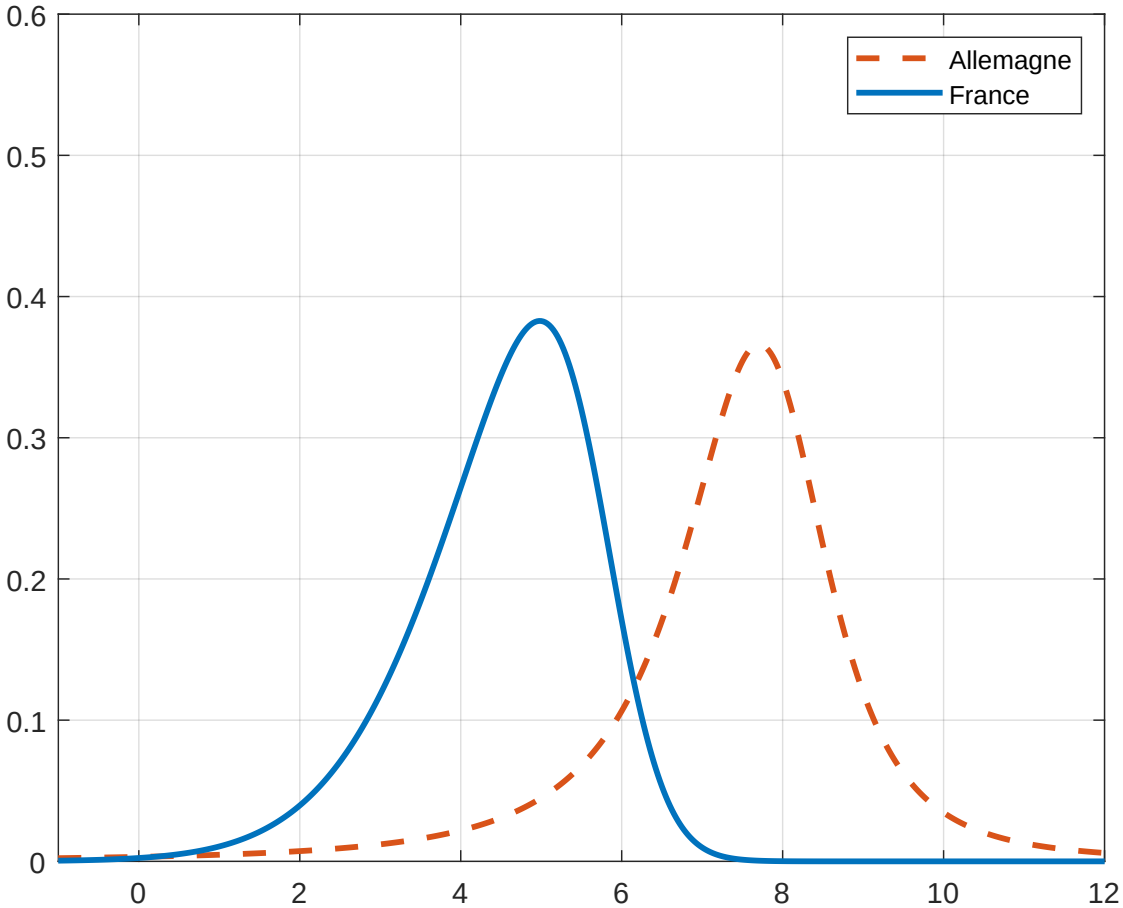
- A focus on the recent divergence between France versus Germany.
- Reference: Le risque d'inflation en France et en Allemagne : le rôle des chaînes de valeur, Note de l'observatoire macroéconomie du CEPREMAP.

La distribution de l'inflation en France s'est déplacée à droite ...



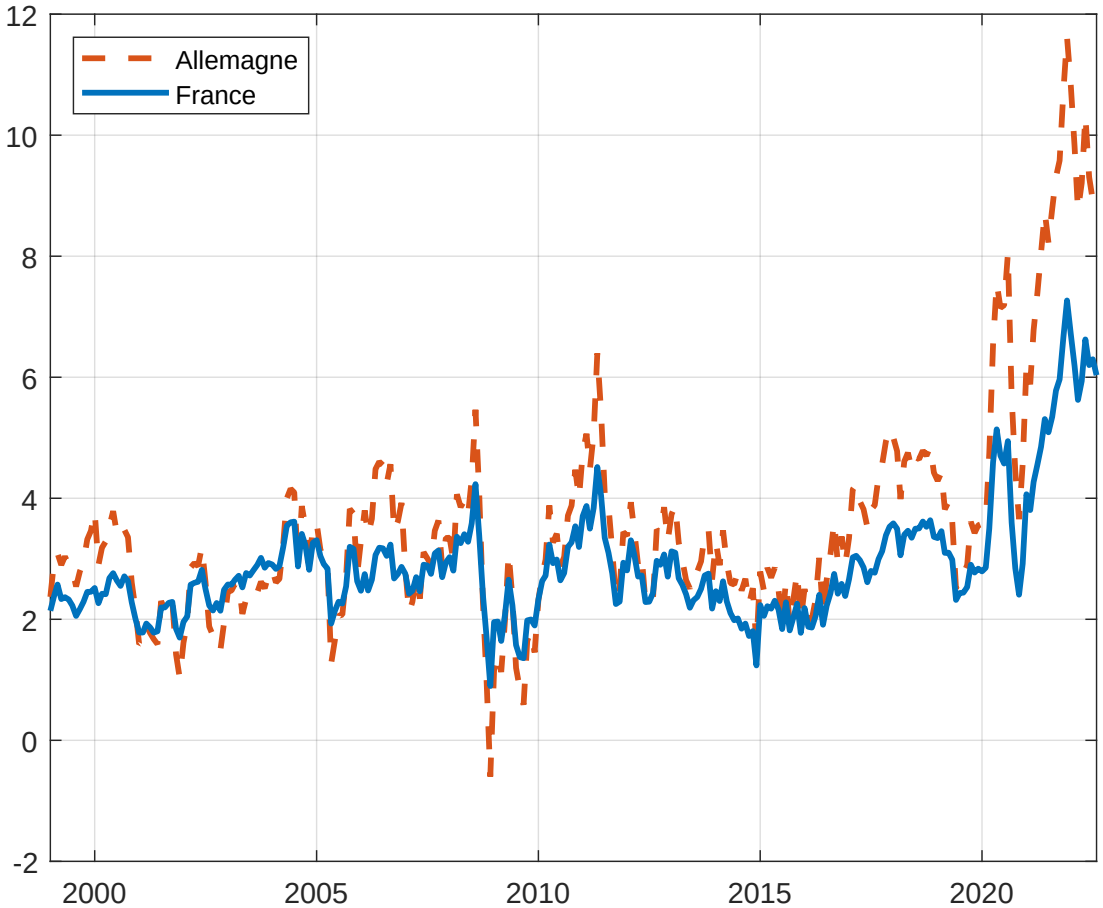
Note: Inflation HICP, glissement annuel, source: Eurostat, DBNOMICS.

... dans une proportion moindre que l'Allemagne ...



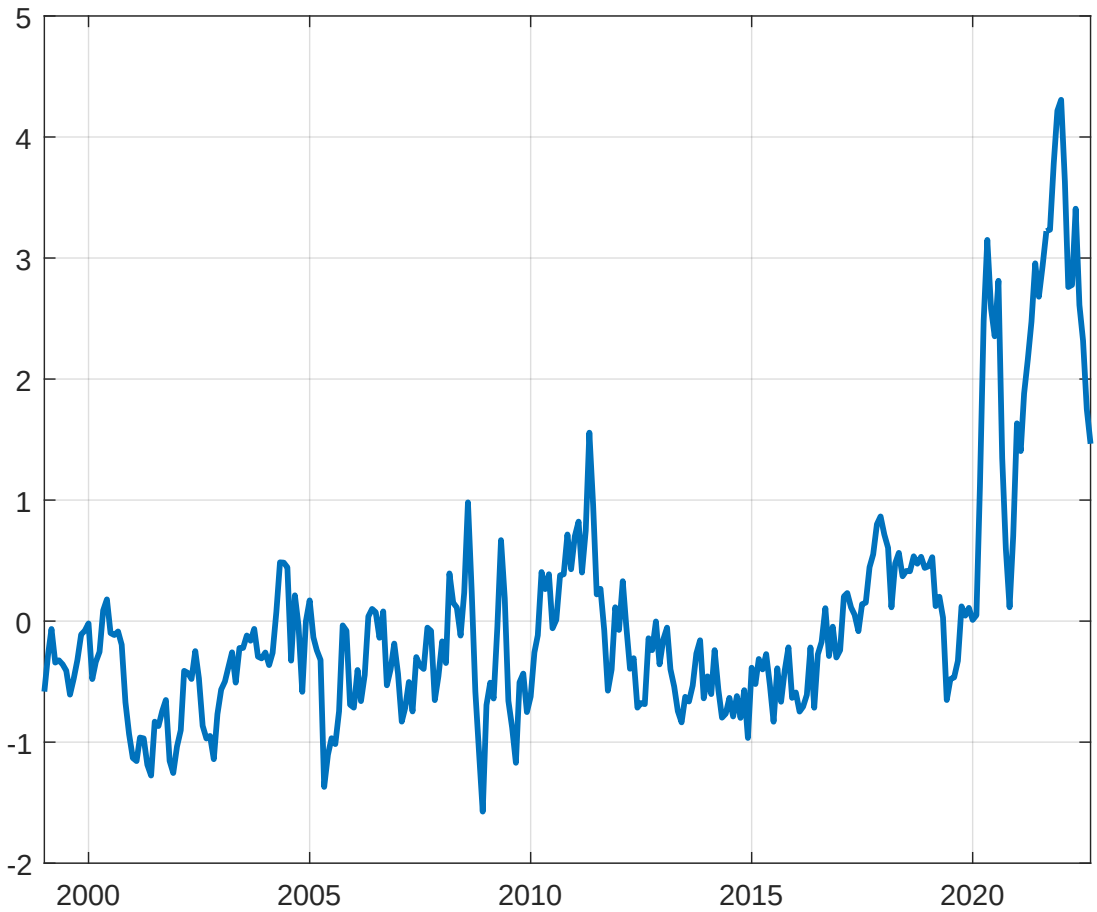
Note: Inflation HICP, glissement annuel, source: Eurostat, DBNOMICS.

... où le risque d'inflation a plus fortement progressé



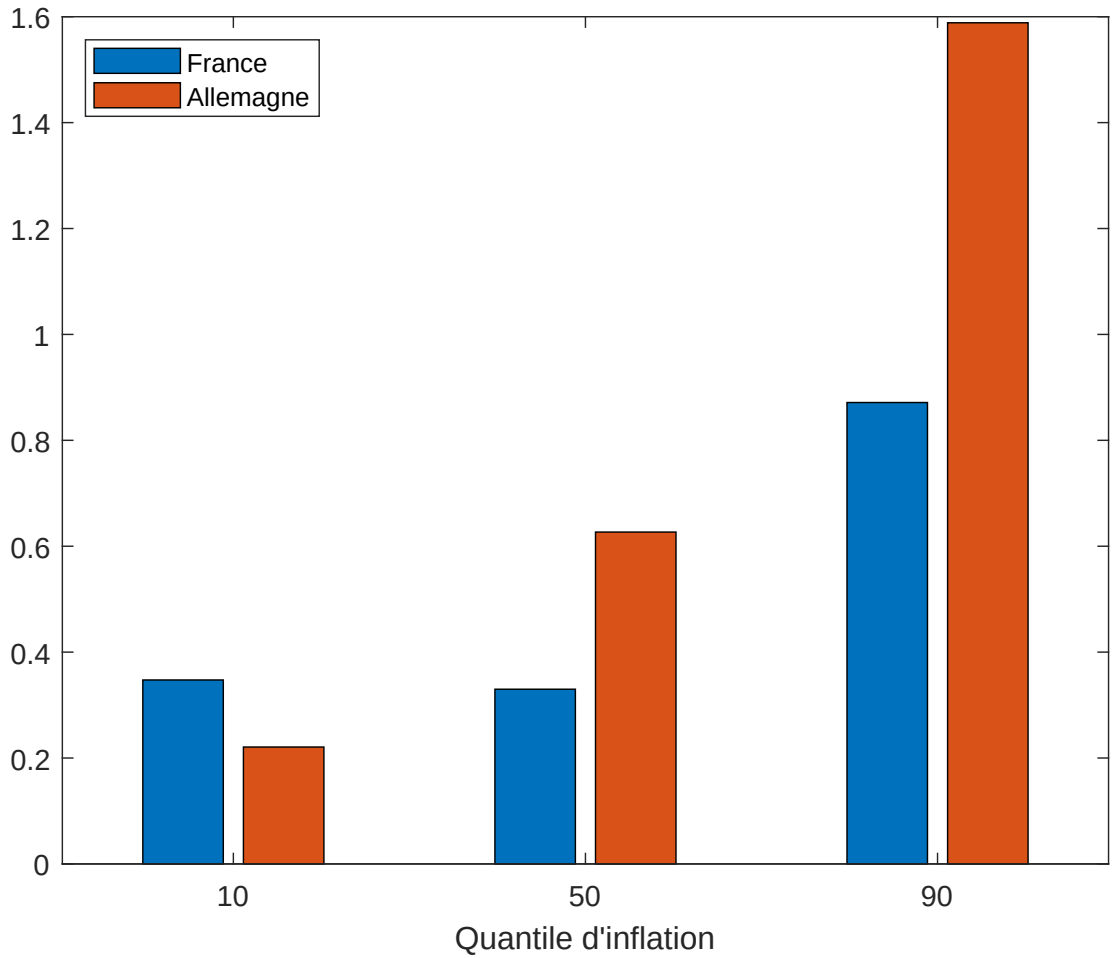
Note: Inflation HICP, glissement annuel, source: Eurostat, DBNOMICS.

France et Allemagne sont exposées aux pressions mondiales sur les chaînes de valeur



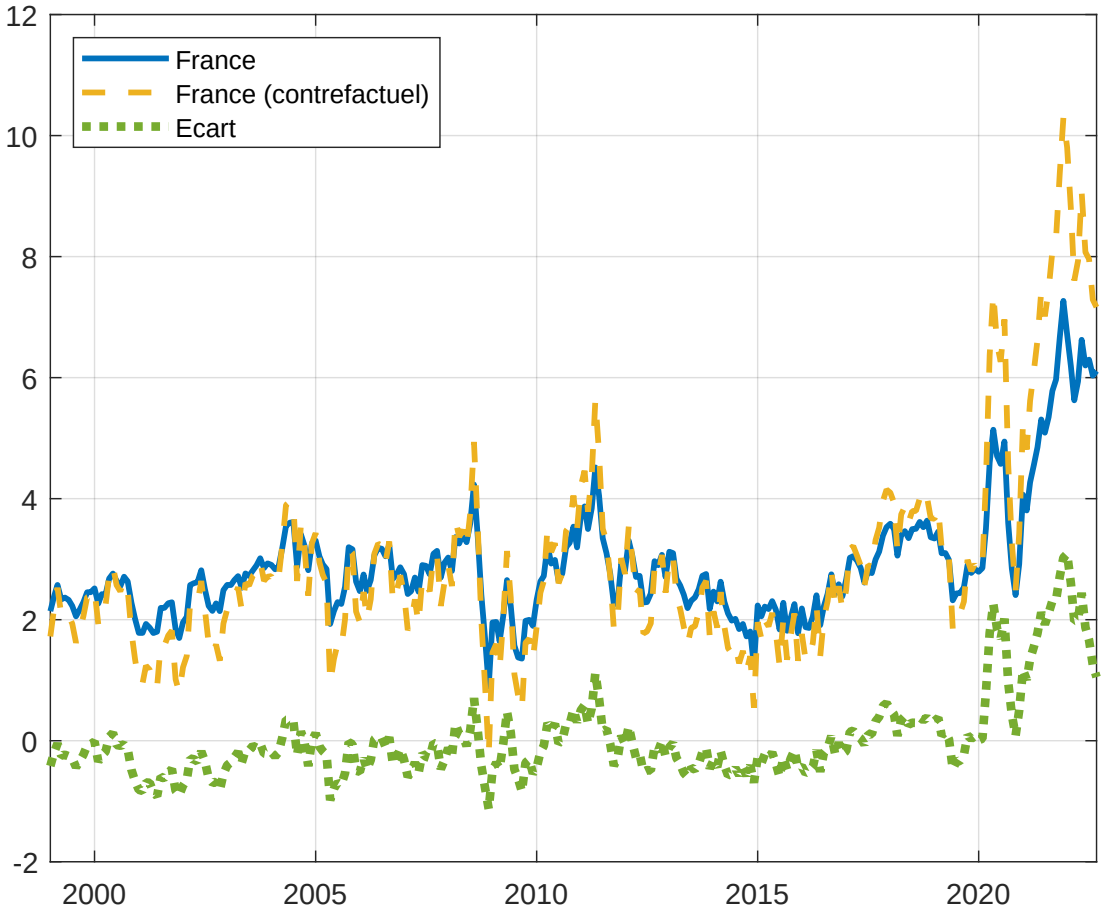
Note: Source: Federal Reserve Bank of New York.

L'inflation est plus sensible aux pressions sur les chaînes de valeur en période de forte inflation en Allemagne qu'en France



Note: Inflation HICP, glissement annuel, source: Eurostat, DBNOMICS.

Le risque d'inflation en France aurait été supérieur de 2 points avec la sensibilité de l'Allemagne aux pressions sur les chaînes de valeur



Note: Inflation HICP, glissement annuel, source: Eurostat, DBNOMICS.

Back

Last investigation

What is the role of structural heterogeneity in inflation dispersion

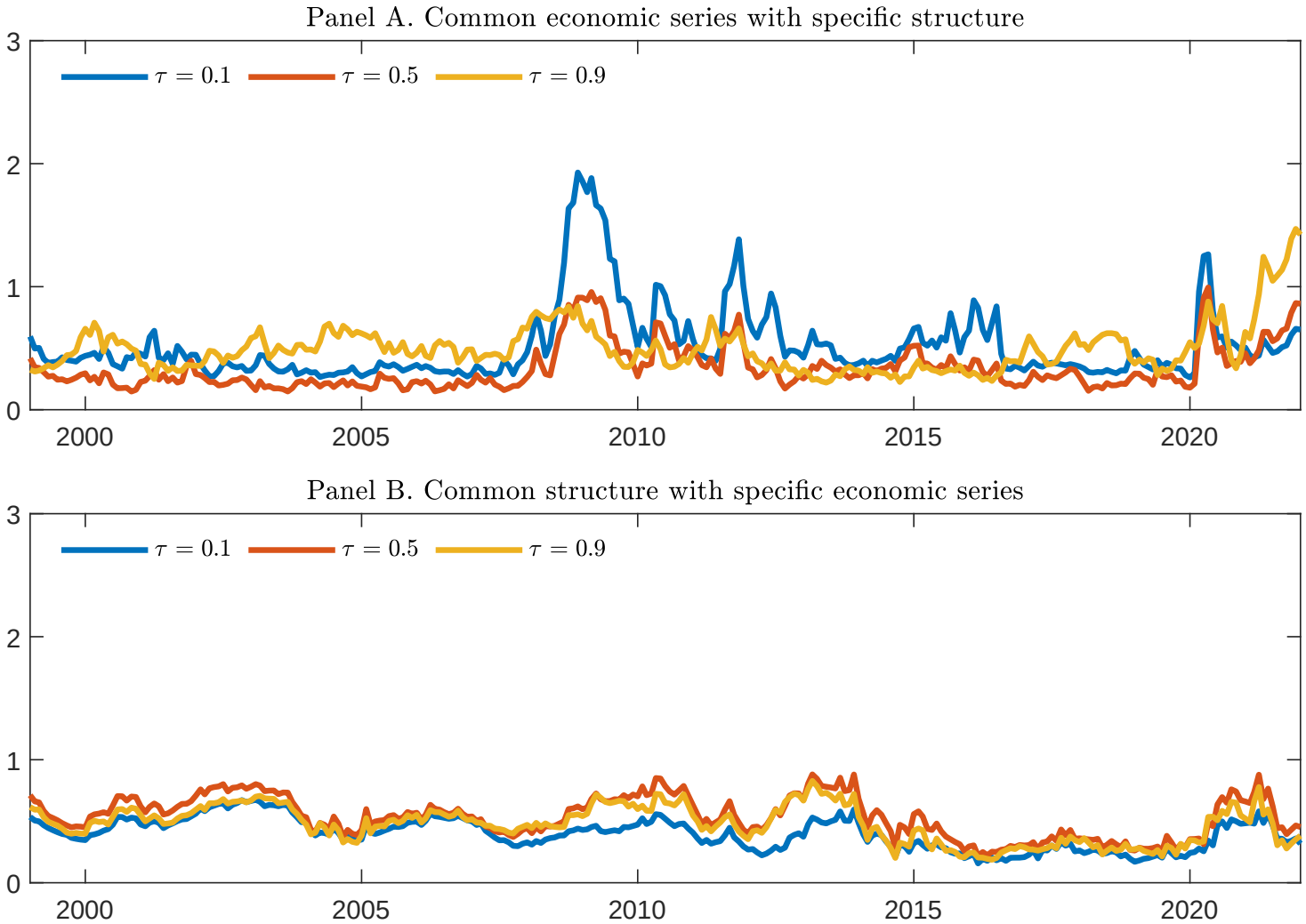
On the role of structural heterogeneity

- Inflation dispersion may come from either different economic events or different economic structures.
- To investigate this question, we take France as a reference country and simulate the conditional quantiles under two assumptions.

#1. All countries share the same economic series than France, but we take the national Phillips curve. (e.g. common context)

#2. All countries share the same Phillips curve than France, but we take national series. (e.g. common structure)

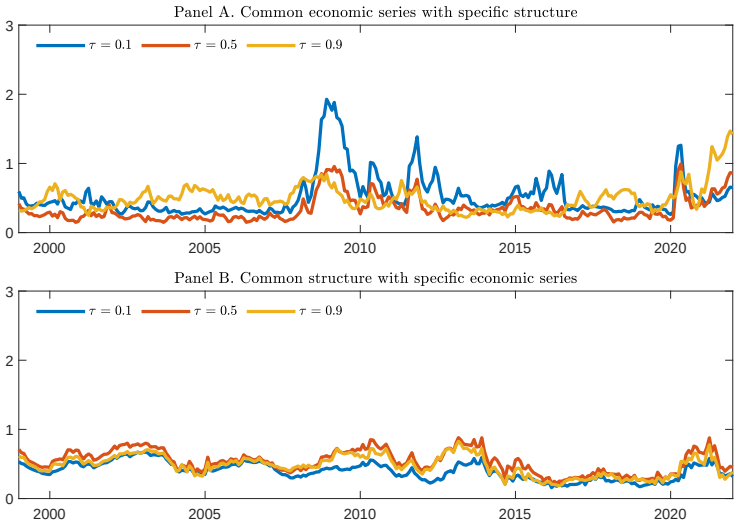
The heterogeneity in the national Phillips curves is the key feature of inflation dispersion in the euro area



The heterogeneity in the national Phillips curves is the key feature of inflation dispersion in the euro area

#1. Substantial fluctuations in the risk of dispersion even series are the same (panel A).

#2. Almost no fluctuations in the risk of dispersion when structures are identical (panel B).



Outline

Motivation

Methodology

Quantile Phillips Curve

Dispersion of IaR

Conclusion

The Risk of Inflation Dispersion in the Euro Area

To Wrap Up

- In this paper, we assess the evolution and the sources of cross-country dispersion of inflation-at-risk in the euro area.
- We show that the risk of inflation dispersion is mostly driven by the inflation risk tails (with a shift from the right tail to the left one).
- We highlight the role of the heterogeneity across countries.
- If you are concerned by inflation differential within the euro area: focus on financial stress and supply chains indicators.

Data

- Harmonized Index of Consumer Prices
  - Source: ECB - ICP (Indices of Consumer prices) and core ICP
- Unemployment rate
  - Source: Eurostat - Unemployment by sex and age – monthly data
  - Details: Monthly – Seasonally adjusted data, not calendar adjusted data – Total – Percentage of population in the labor force
- Natural Rate of Unemployment
  - Source: Authors' calculations
  - Details: HP-filtered trend (with smoothing parameter $\lambda = 14,400$ of unemployment rate).

Back

- Oil Prices
  - Source: U.S. Energy Information Administration - Spot Prices
  - Details: Crude Oil Prices: Brent - Europe - Dollars per Barrel, Not Seasonally Adjusted
- Supply Chain index
  - Source: New York Fed's website
  - Details: Global Supply Chain Pressure Index (GSCPI)
- Financial conditions (CISS)
  - Source: ECB - CISS
  - Details: Daily – ECB – Economic indicator – New Composite Indicator of Systemic Stress (CISS) – Index
  - Data transformation: Authors' calculations to get monthly average of the series.

Back

- Financial conditions (CLIFS)
  - Source: ECB - CLIFS
  - Details: Monthly – ECB – Economic indicator – Country-Level Index of Financial Stress (CLIFS) Composite Indicator – Index
- Long-Term Inflation Expectations
  - Source: Consensus Economics
  - Details: Six-to-ten-year-ahead mean CPI inflation forecasts.
  - Data transformation: Euro area forecasts for Luxembourg (no forecast available), spline interpolation for all missing data in April 1999.

Back

Relation to the literature (see the paper for a review)

- We contribute to the literature on macroeconomic tail risks
  - Growth-at-Risk by Adrian et al. (2019); quantile regression of growth.
  - Extended to Inflation-at-Risk by López-Salido and Loria (2022) for the US and the euro area as a whole; quantile regression of Phillips curve.
  - Our contribution: the cross-sectional dispersion of tail risks.
- We contribute to the literature on the euro area by providing
  - new evidence on the issue of euro area heterogeneity (e.g. ECB (2005), Angeloni and Ehrmann (2007), Estrada et al. (2013)): tail risks matter.
  - new evidence on the Phillips curve of european countries (e.g. Blanchard et al. (2015), Eser et al. (2020), Ball and Mazumder (2021)): non linearities with respect to the quantiles.