

Labour Market Flows, Unemployment & the Phillips Curve

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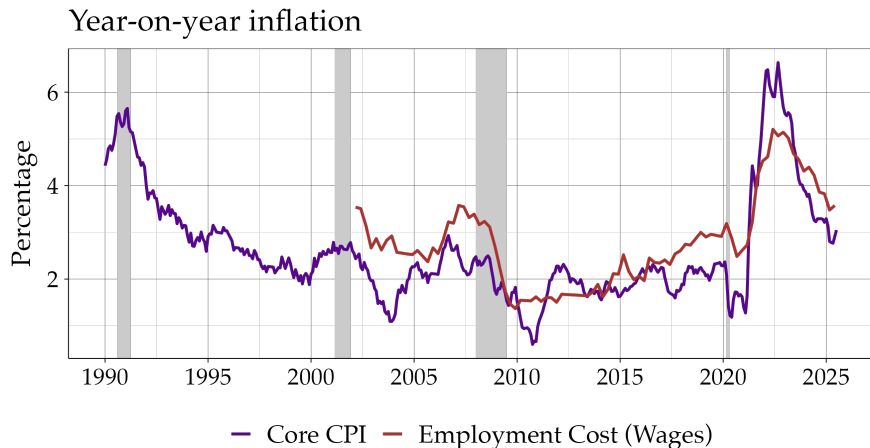
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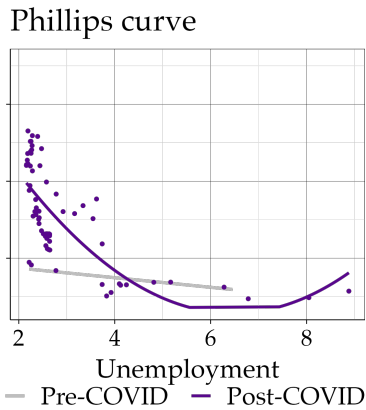
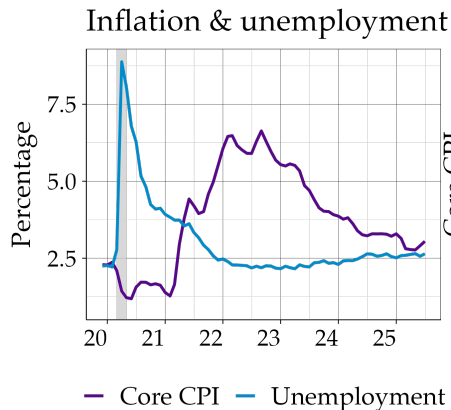
*The views expressed are those of the authors and do not necessarily reflect those of the BIS.

Historically high inflation after Covid...



- Price and wage inflation peaked in 2022

...but relationship with labour market is unclear



- Why did inflation increase so much? (The L-shaped Philips curve)
- Could the post-COVID inflation surge have been anticipated, at least partly?

Two important but separate questions:

① Why did inflation increase so much?

- Disentangle demand and supply effects
([Bernanke and Blanchard, 2023](#); [Gagliardone and Gertler, 2023](#); [Benigno and Eggertsson, 2023](#); [Akinci et al., 2025](#))

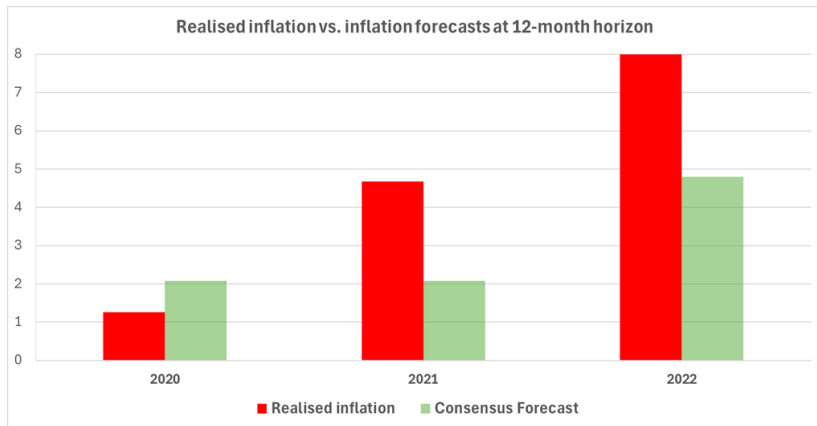
② Could labour market indicators have helped anticipate the post-COVID inflation surge?

- Traditional measures have fallen short
- Need to work on alternatives

Our focus is on the second question.

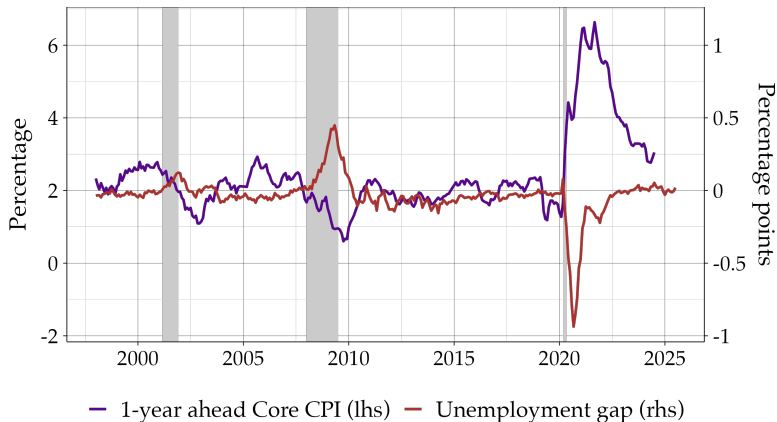
Nobody saw it coming

Consensus lagged behind by about 3 percentage points over 2021-2022



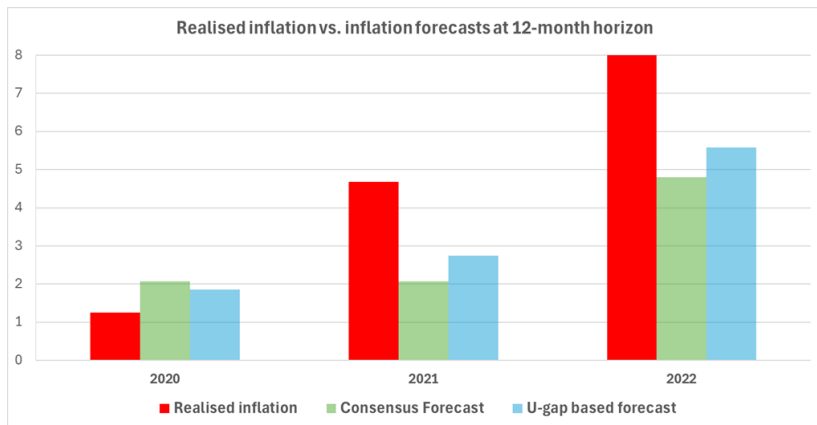
This paper: Novel measure of labour market dynamics

Unemployment gap as difference between unemployment rate implied by labour market flows and actual unemployment rate



Labour market flows improve out-of-sample inflation forecast

Forecast error at 12-month horizon down by 25% in 2021-2022



Preview of results

- ... Labour market flows contain valuable information about *future* labour market dynamics: *a 1 sd widening of the U-gap predicts a 0.4 pp increase in unemployment at a 1-year horizon.*
- ... Higher flow-based unemployment is followed by lower core inflation and lower employment cost: *a 1 sd widening of the U-gap is followed by a **1 pp** decline in core and headline inflation over a 3-year horizon*
- ... Labour market flows *improve out-of-sample fit over the post-COVID period by about **15%** (in terms of RMSE); by **10%** (in terms of R^2)*
- ... A *search-and-matching model with nominal wage stickiness* replicates these regularities when shocks to the hiring rate are persistent.

Related literature

- **Inflation / Phillips curve:** Benigno and Eggertsson (2023); Beaudry et al. (2024); Hazell et al. (2022); Bernanke and Blanchard (2023); Forbes et al. (2021); Jørgensen and Lansing (2019); Ball et al. (2022); Michaillat and Saez (2024); Bernanke and Blanchard (2023); Michaillat and Saez (2024); Hall and Kudlyak (2023); Bok et al. (2023); Crump et al. (2019); L'Huillier and Phelan (2023); Jørgensen and Lansing (2021); Haschka (2024) ...
⇒ *Novel measure of labour market dynamics, using flow and of stock data*
- **Labour market flows:** Barnichon and Nekarda (2012), Crump et al. (2024); Donovan et al. (2023); Fontaine et al. (2020); Dixon et al. (2015); Fallick and Fleischman (2004); Blanchard and Diamond (1992); Faccini and Melosi (2023); Fujita et al. (2024); Moscarini and Postel-Vinay (2023); Pilossoph and Ryngaert (2024) ...
⇒ *Link price dynamics to labour market flows*
- **Search & matching model:** Gertler and Trigari (2009); Shimer (2005); Hall (2005); Mortensen and Pissarides (1994); Krause and Lubik (2007); Krause et al. (2008); Thomas (2008); Blanchard and Galí (2010); Crump et al. (2019); Shimer (2005, 2012); Elsby et al. (2010); Hall (2005); Elsby et al. (2009) ...
⇒ *Allow firms to negotiate wages for new hires, even under wage stickiness*

DATA & UNEMPLOYMENT GAP

Data - Labour market flows

Data

- *Labor Force Statistics* from the *Current Population Survey*; 1990-2025 (m)
- Three states: **employed**, **unemployed** and **inactive** (mutually exclusive)

Individual flows at monthly frequency

- State-persistence very high (i.e. employment stable at 96%)
- hiring rate (U to E) and unemployment persistence (U to U) most volatile flows

Unemployment measures

- **Stock-based**: main driver is the hiring rate (explains 75% [Shimer \(2012\)](#))
- **Flow-based**: inflows into unemployment most important

Transitions into unemployment

Flow dynamics mechanism

Convergence

Probability dist

Probability time series

Probability sumstat

- **Labour market dynamics:**

$$\underbrace{\begin{bmatrix} e_t \\ u_t \\ i_t \end{bmatrix}}_{m_t} = \underbrace{\begin{bmatrix} \Pr_t[e|e] & \Pr_t[e|u] & \Pr_t[e|i] \\ \Pr_t[u|e] & \Pr_t[u|u] & \Pr_t[u|i] \\ \Pr_t[i|e] & \Pr_t[i|u] & \Pr_t[i|i] \end{bmatrix}}_{M_t} \cdot \underbrace{\begin{bmatrix} e_{t-1} \\ u_{t-1} \\ i_{t-1} \end{bmatrix}}_{m_{t-1}}$$

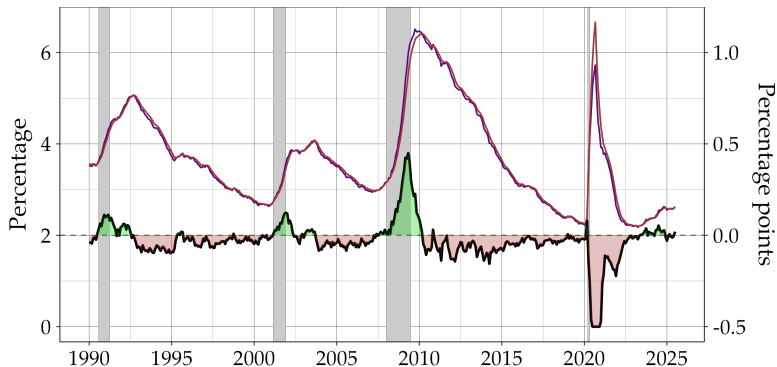
- Let \tilde{m}_t denote the steady-state of M_t and $q_t[s'|s] = \Pr_t[s'|s] - \Pr_t[s'|i]$. Then, flow-based (steady-state) unemployment satisfies:

$$\tilde{u}_t = \frac{(1 - q_t[e|e]) \cdot \Pr_t[u|i] + q_t[u|e] \cdot \Pr_t[e|i]}{(1 - q_t[u|u]) (1 - q_t[e|e]) - q_t[u|e] \cdot q_t[e|u]}$$

- Our **unemployment gap** measure is the difference between flow-based and actual unemployment:

$$\text{u-gap}_t = \tilde{u}_t - u_t$$

Unemployment gap

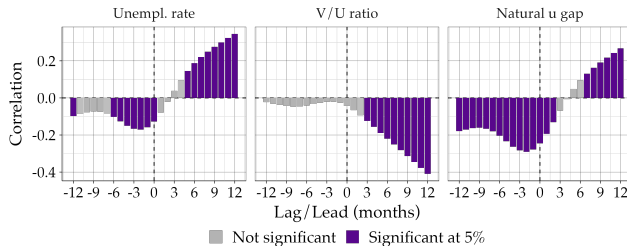


— (Stock) Unempl. rate — Flow unempl. rate — Unempl. gap (rhs)

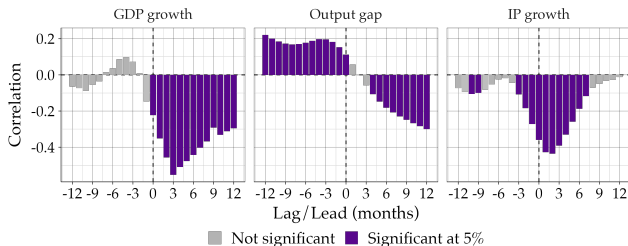
- Mostly negative ($\tilde{u}_t \leq u_t$) but positive in recessions: $\tilde{u}_t \nearrow$ relative to u_t
- Goes sharply negative after Covid: $\tilde{u}_t \searrow$ sharply relative to u_t

Some lead-lag correlations

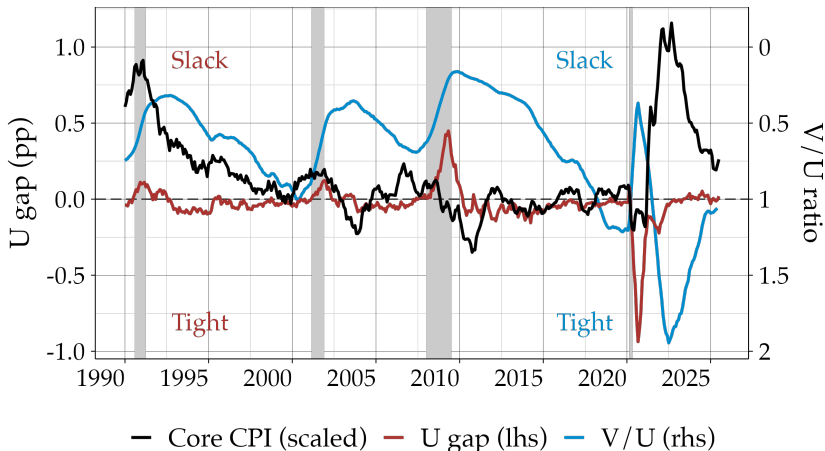
with other labour market indicators:



with business cycle indicators:

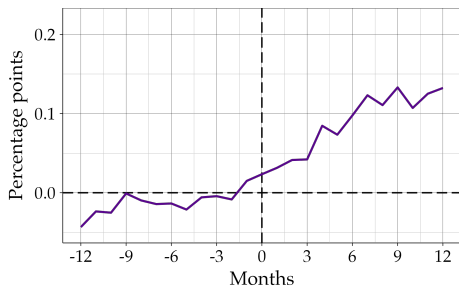


Comparison with vacancy-to-unemployment ratio

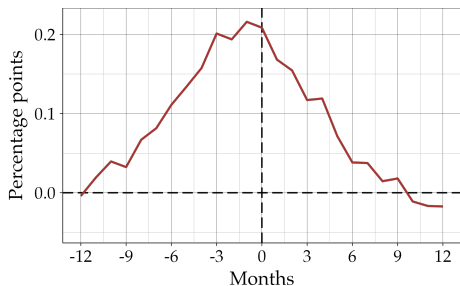


- Before Covid: positive correlation between V/U and inflation barely visible
- During and after Covid: correlation positive only after initial fall in V/U

Unemployment gap dynamics around recessions



(a) Recession start



(b) Recession end

- Recession start: Unemployment gap stable (slightly negative), then starts increasing in a consistent manner
- Recession end: unemployment gap follows inverted V-shaped trajectory

Note: Average around NBER defined recession periods (excl. Covid).

EMPIRICAL ANALYSIS

Empirical approach

Effect of unemployment gap on ...

... **labour market:**

$$\text{Urate}_{t+h} - \text{Urate}_t = \alpha_h + \beta_h \overline{\text{u-gap}}_t + \gamma_h \overline{\text{Urate}}_t + \delta_h \text{Controls}_t + \varepsilon_{t+h}$$

... **price and wage inflation:**

- Price dynamics: CPI (monthly) [core or headline]
- Wage dynamics: Employment cost index (quarterly) [ULC]

$$\ln \text{Price}_{t+h} - \ln \text{Price}_t = \alpha_h + \beta_h \overline{\text{u-gap}}_t + \gamma_h \overline{\text{Urate}}_t + \delta_h \text{Controls}_t + \varepsilon_{t+h}$$

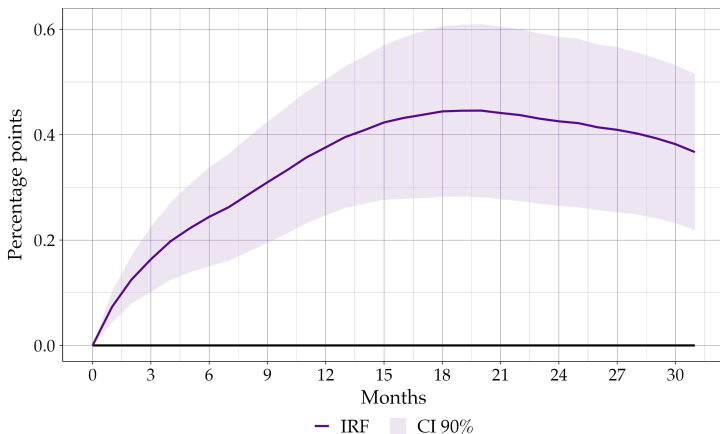
Controls: Inflation expectation (1y), productivity, oil price inflation, labour force participation, IP, etc...

Change in unemployment rate

	12-month ahead change in unemployment rate						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Stock-unempl. rate (u)	-0.344*** (0.108)		-0.407*** (0.073)	-0.302*** (0.086)	-0.213* (0.112)	-0.283*** (0.083)	-0.224*** (0.083)
Flow-unempl. rate (\bar{u})		-0.304*** (0.107)	0.370*** (0.071)				
Stock-empl. rate (e)					0.049 (0.050)		
Unemployment gap (z)				0.382*** (0.073)	0.427*** (0.094)	0.438*** (0.088)	0.340*** (0.057)
Employment gap					0.209** (0.106)		
Change in unempl.						-0.254** (0.122)	
Productivity							0.025 (0.100)
Oil price inflation							0.088 (0.083)
Labour part. rate							0.437 (0.265)
Industrial production							-0.051 (0.046)
Adj. R ²	0.146	0.111	0.296	0.296	0.335	0.331	0.340
Num. obs.	415	415	415	415	415	415	409
RMSE	0.883	0.901	0.802	0.802	0.779	0.782	0.777

Notes: Asteriks indicate significance at the 1%, 5%, and 10% level (***) $p < 0.01$; ** $p < 0.05$; * $p < 0.1$). Standard errors are NW corrected. The constant term is omitted from the table.

Local projection: dynamics and quantification



- Unemployment peaks about 18 months after U-gap widens
- 1 sd \nearrow u-gap (+0.12 pp) \Rightarrow unemployment \nearrow by ≈ 0.4 pp after 1 year

Inflation - Core CPI

	Core CPI inflation - 12-months ahead						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Stock-unempl. rate (u)	0.071 (0.091)			0.441*** (0.063)			
Flow-unempl. rate (\tilde{u})		0.020 (0.083)		-0.437*** (0.063)			
Unemployment gap (z)					-0.454*** (0.068)	-0.489*** (0.053)	-0.517*** (0.050)
Change in unempl.			-0.008 (0.225)			0.166** (0.078)	
Infl. expectation (1y)	-0.116 (0.210)	-0.127 (0.218)	-0.129 (0.223)	0.029 (0.130)	0.024 (0.133)	0.019 (0.129)	0.106 (0.124)
Productivity							0.005 (0.083)
Oil price inflation							0.085 (0.067)
Labour part. rate							-0.066 (0.112)
Industrial production							-0.064*** (0.021)
Lagged inflation	0.671*** (0.123)	0.661*** (0.123)	0.655*** (0.108)	0.615*** (0.089)	0.608*** (0.088)	0.631*** (0.083)	0.597*** (0.084)
Adj. R ²	0.517	0.513	0.512	0.694	0.694	0.707	0.715
Num. obs.	410	410	410	410	410	410	409
RMSE	0.712	0.715	0.715	0.566	0.566	0.555	0.544

Notes: Asteriks indicate significance at the 1%, 5%, and 10% level (***) $p < 0.01$; ** $p < 0.05$; * $p < 0.1$). Standard errors are NW corrected. The constant term is omitted from the table.

Summary stats y

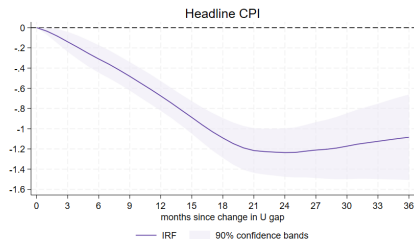
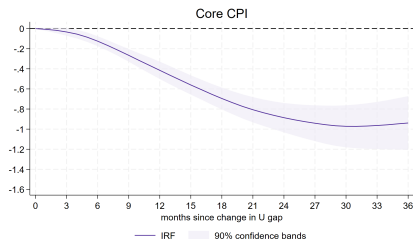
Summary stats x

Subperiods

Alternative slack measure

Further infl. measures

Local projections: dynamics and quantification

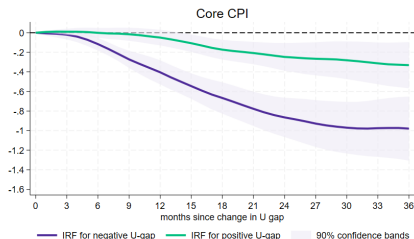
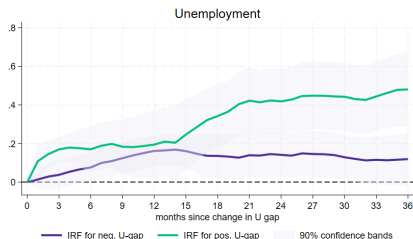


Core and headline CPI response to a standardised change in u-gap

- Inflation drops after u-gap widens, bottoming out after 24-30 months
- 1 sd wider u-gap (+0.12 pp) \Rightarrow core CPI down by 1 pp after 30 months (headline CPI down by 1.2 pp after 24 months)

Some extensions: looking for asymmetric effects

- Does the sensitivity to the u-gap change when U-gap is positive/negative?

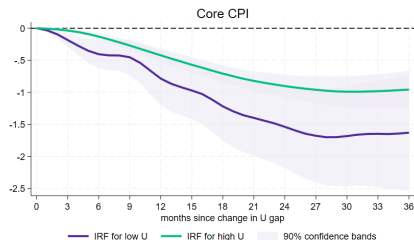
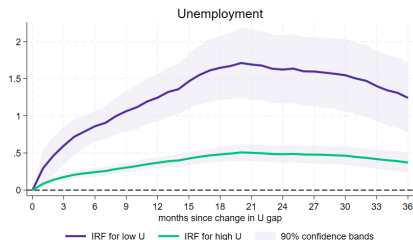


Response of unemployment and inflation to unemployment gap, conditional on positive/negative U-gap

- Unemployment:** similar responses to u-gap, up to 2 years ahead.
- Core inflation:** significantly more sensitive to u-gap ($\times 3$ more) when U-gap is negative: -1.00 pp vs. -0.35 pp after 3 years.

Some extensions: evidence of state-dependence ?

- Does the sensitivity to the u-gap depend on current unemployment?

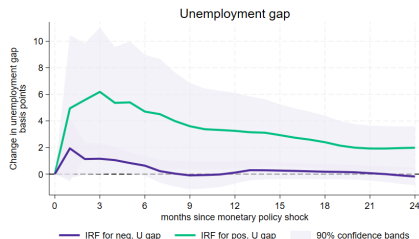
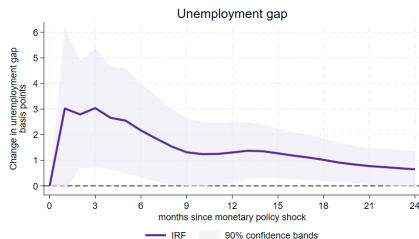


Response of unemployment and inflation to unemployment gap, conditional on high/low unemployment

- Unemployment:** displays strong difference, peak response to U-gap significantly larger ($\times 3.5$ more) when unemployment is low.
- Core inflation:** response to u-gap independent of current unemployment.

What drives the unemployment gap?

- How do monetary policy shocks affect the u-gap?



Response of unemployment gap to standardised monetary policy shock, conditional on pos./neg. u-gap

- Tightening monetary policy shocks** raise u-gap; impact peaks at $\approx 25\%$ u-gap s.d., but fades after about 9 months.
- Impact conditional on **positive** u-gap roughly twice larger, conditional on **negative** u-gap roughly zero.

Conclusion

Empirics:

- We provide a novel indicator of labour market dynamics which does a good job at predicting future unemployment and price developments.

Model:

- We build a search-and-matching model to study how labour market flows affect wage bargaining

Next steps:

- More research is needed (work still in progress)
- Use granular data to confirm the macro-based evidence
- Re-think monetary policy: benefits and costs of including u-gap in monetary policy rules.

Thank you for your attention!

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Data available here: sites.google.com/view/mariuskoechlin/flow-based-u-gap

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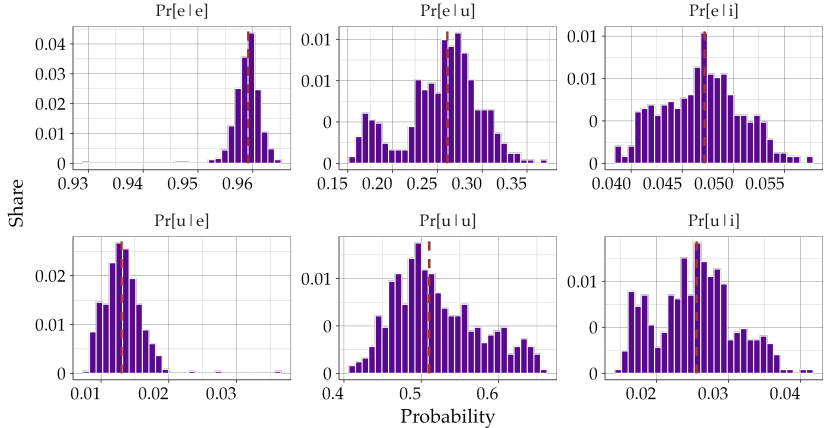
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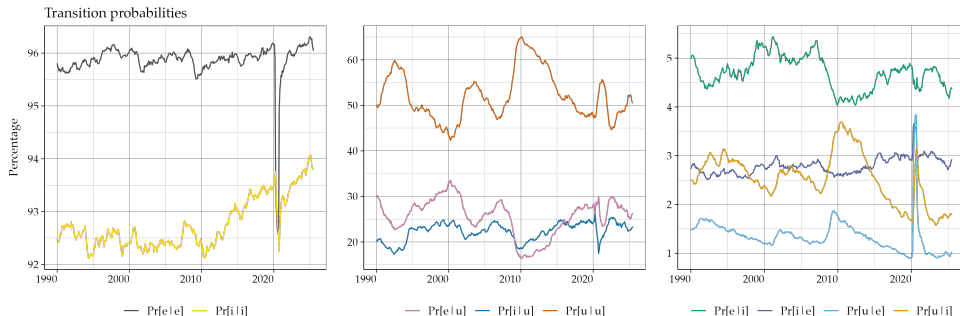
APPENDIX

Distribution of monthly transition probabilities



- Red dashed line indicates the mean

Labour market flows



- Transition probabilities very dynamic over time

Back

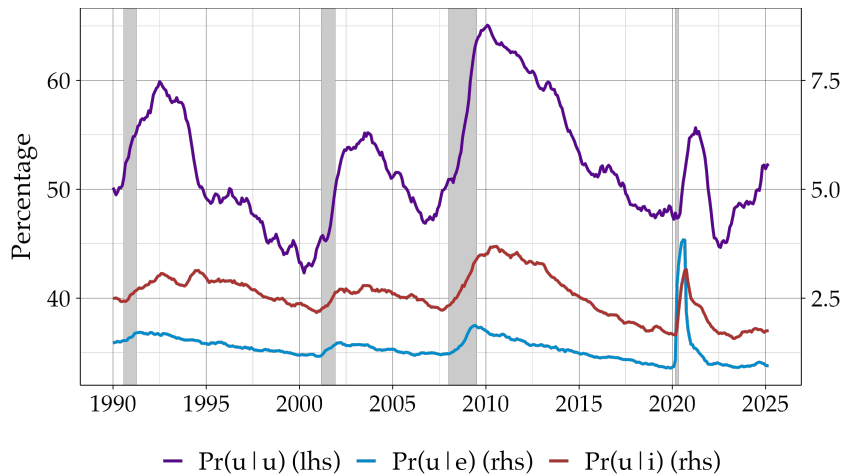
Summary statistics of transition probabilities

Transition	Mean	S.D.	Skew.	Kurt.	10 th perc.	25 th perc.	50 th perc.	75 th perc.	90 th
$\Pr_t[e e]$	95.85	0.7	-16.31	306.5	95.63	95.76	95.91	96.03	96.15
$\Pr_t[u e]$	1.351	0.56	13.48	237.3	0.98	1.17	1.32	1.5	1.66
$\Pr_t[i e]$	2.794	0.25	5.83	75.93	2.54	2.64	2.77	2.91	3.02
$\Pr_t[e u]$	25.56	4.21	-0.48	2.83	18.33	23.4	26.21	28.28	30.47
$\Pr_t[u u]$	52.09	5.55	0.51	2.52	45.75	48.17	51.14	55.75	60.52
$\Pr_t[i u]$	22.34	2.36	-0.02	5.18	19.12	20.83	22.63	24	25
$\Pr_t[e i]$	4.694	0.39	-0.02	2.62	4.15	4.42	4.72	4.95	5.2
$\Pr_t[u i]$	2.55	0.53	0.14	2.6	1.77	2.22	2.56	2.88	3.26
$\Pr_t[i i]$	92.76	0.53	0.48	3.22	92.18	92.4	92.64	93.15	93.53

Summary statistics of monthly transition probabilities

- High state-persistence, i.e. $\Pr_t[e|e]$, $\Pr_t[u|u]$, $\Pr_t[i|i]$
- $\Pr_t[u|e]$ is most volatile, followed by $\Pr_t[u|i]$ and then $\Pr_t[u|u]$

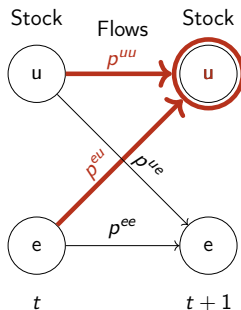
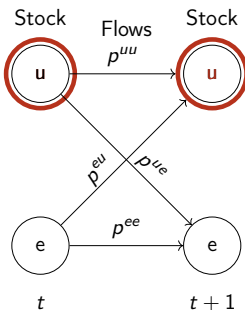
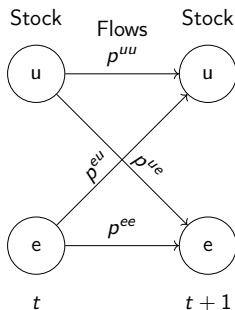
Labour flows into unemployment move a lot



- Business cycle fluctuations

Flow dynamics: Illustration

Two-state labour market economy



- Higher stock-based unemployment or higher unemployment inflows lead to higher unemployment next period

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Derivation of flow-based unemployment

Transition probabilities matrix:

$$M_t = \begin{bmatrix} \Pr_t[e|e] & \Pr_t[e|u] & \Pr_t[e|i] \\ \Pr_t[u|e] & \Pr_t[u|u] & \Pr_t[u|i] \\ \Pr_t[i|e] & \Pr_t[i|u] & \Pr_t[i|i] \end{bmatrix}$$

- Each transition matrix M_t has a steady-state
- Lets assume currently observed flows represent steady state
- Labour market dynamics are $m_{t+1} = M_{t+1} \cdot m_t$, where $m_t = (e_t, u_t, i_t)'$
- Let \tilde{m} be vector of steady-state e , u , and i , such that $\tilde{m}_t = M_t \cdot \tilde{m}_t$.
- \tilde{u} in \tilde{m} is then the flow-based unemployment rate

$$\tilde{u}_t = \frac{\Pr_t[u|i] (1 - \Pr[e|e]) + \Pr[u|e]\Pr[e|i]}{\Pr[u|i] (1 - \Pr[e|e] + \Pr[e|u]) + \Pr[u|e] (\Pr[e|i] - \Pr[e|u]) + (1 - \Pr[u|u]) (1 - \Pr[e|e] + \Pr[e|i])}$$

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Convergence: stock-based unemployment to flow-based unemployment

	Dependent var.: $u_t - u_{t-1}$	
	Month-on-month	6-month MA
$\tilde{u}_t - u_{t-1}$	0.760*** (0.019)	0.488*** (0.019)
Adj. R^2	0.797	0.622
Num. obs.	422	422
RMSE	0.149	0.076

Notes:

- Convergence of the unemployment rate to its conditional steady state \tilde{u} is quite fast (in line with [Barnichon and Nekarda \(2012\)](#)).
- 90% happens within 3 months (less than 2 months for the MoM measure)

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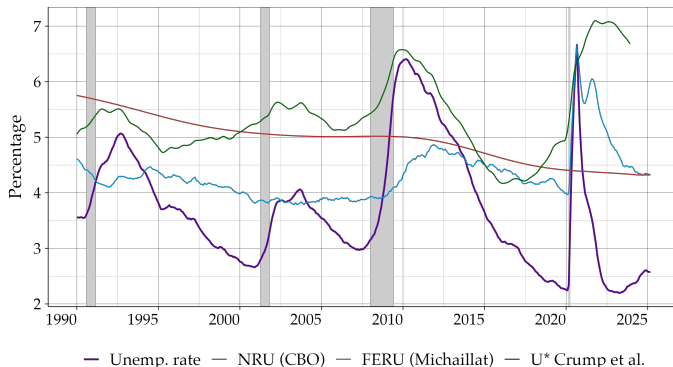
Unemployment gap summary statistics

Transition	Mean	S.D.	Skew.	Kurt.	10 th perc.	25 th perc.	50 th perc.	75 th perc.	90 th
Stock-based U	3.71	1.07	0.79	2.95	2.41	2.95	3.54	4.34	5.24
Flow-based U	3.68	1.06	0.81	3.03	2.41	2.94	3.51	4.26	5.19
U gap	−0.03	0.12	−2.47	22.82	−0.09	−0.06	−0.03	0	0.05

Notes: Summary statistics are expressed in percent. S.D. stands for standard deviation, Med. stands for median. Flow-based unemployment computed using monthly transition probabilities.

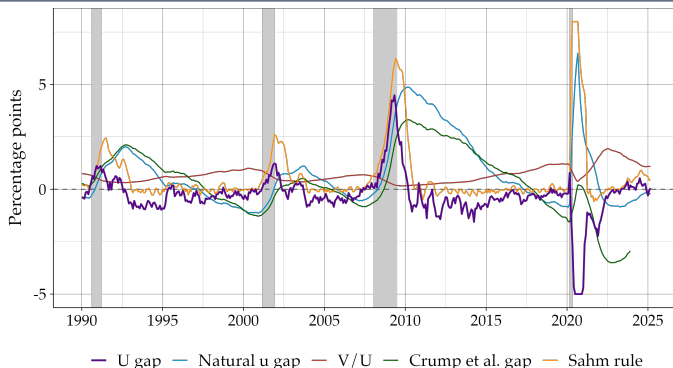
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Alternative unemployment gap measures I/II



- *NRU* stands for “Noncyclical Rate of Unemployment” (calculated by the Congressional Budget Office), and is used to calculate the *natural u-gap*. *FERU* stands for “full-employment rate of unemployment” (Michaillat and Saez, 2024). Finally, *U** Crump et al. is developed in Crump et al. (2019).

Alternative unemployment gap measures II/II



- The *Natural u-gap* is the natural unemployment gap defined as the difference between the observed unemployment rate as a share of the labour force and the Congressional Budget Office's *Noncyclical Rate of Unemployment*. *V/U* is the vacancy-to-unemployment ratio. *Crump et al. gap* is the gap based on [Crump et al. \(2019\)](#). *Sahm rule* shows the measure defined in [Sahm \(2019\)](#). The *u-gap* and the *Sahm rule* are truncated at the bottom and top, respectively.

Unemployment rate dynamics 12-months ahead - pre-COVID

	12-month ahead change in unempl. rate: pre-COVID				
	(1)	(2)	(3)	(4)	(5)
Stock-unempl. rate (u)		-0.512*** (0.119)		-0.369*** (0.114)	-0.381*** (0.114)
Flow-unempl. rate (\tilde{u})	-0.303*** (0.115)	0.467*** (0.115)			
Unemployment gap (z)			0.411** (0.173)	0.482*** (0.118)	0.514*** (0.144)
Productivity					-0.087 (0.128)
Oil price inflation					0.037 (0.072)
Labour part. rate					-0.081 (0.113)
Adj. R ²	0.124	0.266	0.088	0.266	0.268
Num. obs.	361	361	361	361	355
RMSE	0.822	0.753	0.839	0.753	0.752

Notes: Asteriks indicate significance at the 1%, 5%, and 10% level (** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$). Standard errors are NW corrected. The constant term is omitted from the table.

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Unemployment rate dynamics with different slack measures

	12-month ahead change in unempl. rate: alternatives				
	U gap	Change u rate	U gap and Change	Natural u gap	Crump et al. gap
Stock-unempl. rate (u)	-0.302*** (0.086)	-0.339*** (0.102)	-0.283*** (0.083)	0.290 (0.319)	-0.476* (0.279)
Unemployment gap (z)	0.382*** (0.073)		0.438*** (0.088)		
Change in unempl.		-0.093 (0.284)	-0.254** (0.122)		
Natural u gap				-0.004** (0.002)	
Crump u gap					0.001 (0.002)
Adj. R^2	0.296	0.149	0.331	0.200	0.152
Num. obs.	415	415	415	415	408
RMSE	0.802	0.882	0.782	0.855	0.887

Notes: Asteriks indicate significance at the 1%, 5%, and 10% level (*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$). Standard errors are NW corrected. The constant term is omitted from the table.

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Summary statistics inflation measures

Variable	Mean	S.D.	Skew.	Kurt.	10 th perc.	25 th perc.	50 th perc.	75 th perc.	90 th
Core CPI inflation	2.56	1.1	1.56	5.56	1.61	1.9	2.26	2.85	4.01
CPI core services infl.	3.22	1.12	1	5.1	2.18	2.61	3.06	3.67	4.6
CPI core goods infl.	0.87	2.13	2.47	11.39	−0.9	−0.28	0.42	1.46	2.77
Headline CPI inflation	2.62	1.56	1.11	6.4	1.12	1.7	2.57	3.18	4.14
Headline PCE inflation	2.17	1.29	1.12	6.25	0.85	1.45	2.11	2.62	3.47
Core PCE inflation	2.11	0.95	1.77	6.26	1.25	1.53	1.86	2.28	3.37
Empl. cost infl. (wages)	2.76	0.96	0.75	3.02	1.62	2.04	2.62	3.2	4.32
Empl. cost infl. (total)	3.11	0.86	0.17	2.3	1.95	2.48	3.07	3.73	4.27
ULC inflation	1.57	1.66	−0.48	4.63	−0.22	0.7	1.68	2.5	3.35

Notes: This table shows the summary statistics of the various inflation measures. The numbers are in percentages.

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Summary statistics controls

Variable	Mean	S.D.	Skew.	Kurt.	10 th perc.	25 th perc.	50 th perc.	75 th perc.	90 th
Infl. expectation (1y)	2.4	0.79	0.28	2.84	1.44	1.77	2.42	2.93	3.39
Oil price inflation	4.97	25.32	0.49	5.24	-22.98	-11.18	3.37	18.73	35.44
Productivity	1	1.12	1.12	6.96	-0.28	0.38	0.91	1.51	2.29
Labour part. rate	-0.09	0.57	-2.84	24.93	-0.6	-0.3	0	0.16	0.45
Industrial production	0.78	2.73	-1.82	13.99	-1.66	0	1.15	2.11	3.15
Supply chain pressure	0.01	0.94	2.26	8.24	-0.73	-0.53	-0.25	0.09	1.05
Vacancy/unemployment	0.68	0.38	1.2	4.32	0.3	0.4	0.6	0.87	1.19
Natural u gap	74.87	158.38	1.25	3.83	-78.48	-43.08	27.5	136.89	337.31
Output gap	-0.61	1.79	-0.52	2.44	-3.11	-1.75	-0.33	0.9	1.54

Notes: This table shows the summary statistics of the various controls. *Inflation expectation (2y)* are the 2-year expectations of inflation calculated by the [Federal Reserve Bank of Cleveland](#). *Oil price inflation* is calculated using the West Texas Intermediate (WTI) Crude Oil Price. *Productivity* is using the *Nonfarm Business labor productivity output per hour* index. The *Labour part. rate* is the labour participation rate of the working age population. And finally, *Supply chain pressure* is the *Global supply chain pressure index* published by the Federal Reserve Bank of New York ([Benigno et al., 2022](#)). Since vacancy data (i.e., the number of job openings) from the BLS is only available starting in December 2000, we extend the series back to 1990 using historical estimates constructed by [Barnichon \(2010\)](#). The *Natural u-gap* and the *Output gap* are both based on series provided by the Congressional Budget Office. The variables shown are either 6-month growth rates or 6-month moving averages.

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CPI core inflation across different periods

	Core CPI inflation - 12-months ahead				
	Whole (91-24)	Great Mod. (91-07)	Great Rec. (07-19)	Post GFC (10-19)	Pre COV. (91-19)
Unemployment gap (z)	-0.517*** (0.050)	-0.599*** (0.163)	-0.270*** (0.097)	-0.092 (0.164)	-0.280*** (0.093)
Infl. expectation (1y)	0.106 (0.124)	0.597*** (0.154)	0.065 (0.119)	0.222 (0.198)	0.443*** (0.076)
Productivity	0.005 (0.083)	0.210*** (0.064)	-0.137 (0.095)	-0.194* (0.109)	-0.018 (0.064)
Oil price inflation	0.085 (0.067)	0.108*** (0.034)	-0.029 (0.042)	-0.046 (0.048)	-0.019 (0.044)
Labour part. rate	-0.066 (0.112)	0.039 (0.092)	0.127 (0.100)	-0.026 (0.081)	-0.023 (0.098)
Industrial production	-0.064*** (0.021)	-0.090*** (0.032)	-0.036 (0.033)	-0.049 (0.046)	-0.040 (0.031)
Lagged inflation	0.597*** (0.084)	0.341*** (0.085)	0.023 (0.081)	-0.001 (0.099)	0.273*** (0.089)
Adj. R^2	0.715	0.764	0.520	0.148	0.714
Num. obs.	409	207	141	120	354
RMSE	0.544	0.304	0.269	0.269	0.343

Notes: Asteriks indicate significance at the 1%, 5%, and 10% level (***) $p < 0.01$; ** $p < 0.05$; * $p < 0.1$). Standard errors are NW corrected. The constant term is omitted from the table.

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Alternative slack measures - core CPI

	Core CPI inflation 12m ahead: alternatives						
	U gap	Change u rate	U gap and Change	V/U	U gap and V/U	Natural u gap	Output gap
Unemployment gap (z)	-0.517*** (0.050)		-0.515*** (0.048)		-0.515*** (0.051)		
Change in unempl.		-0.129 (0.302)	-0.063 (0.176)				
Vacancy/unemployment				0.222 (0.188)	0.029 (0.145)		
Natural u gap						0.000 (0.001)	
Output gap							0.026 (0.048)
Infl. expectation (1y)	0.106 (0.124)	-0.129 (0.179)	0.121 (0.109)	-0.139 (0.214)	0.108 (0.127)	-0.117 (0.176)	-0.189 (0.199)
Productivity	0.005 (0.083)	0.068 (0.123)	0.020 (0.074)	0.028 (0.121)	0.004 (0.083)	0.040 (0.122)	0.038 (0.120)
Oil price inflation	0.085 (0.067)	0.062 (0.096)	0.086 (0.067)	0.066 (0.094)	0.086 (0.067)	0.061 (0.097)	0.059 (0.098)
Labour part. rate	-0.066 (0.112)	-0.395 (0.251)	-0.091 (0.140)	-0.373* (0.222)	-0.071 (0.110)	-0.297 (0.196)	-0.372* (0.209)
Industrial production	-0.064*** (0.021)	0.024 (0.045)	-0.074* (0.039)	0.050** (0.025)	-0.063*** (0.021)	0.038 (0.026)	0.048* (0.025)
Lagged inflation	0.597*** (0.084)	0.705*** (0.113)	0.594*** (0.083)	0.668*** (0.132)	0.592*** (0.095)	0.708*** (0.115)	0.715*** (0.116)
Adj. R ²	0.715	0.539	0.715	0.542	0.715	0.540	0.539
Num. obs.	409	409	409	409	409	409	409
RMSE	0.544	0.691	0.544	0.689	0.544	0.691	0.692

Notes: Asteriks indicate significance at the 1%, 5%, and 10% level (*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$). Standard errors are NW corrected. The constant term is omitted from the table.

Further wage inflation measures

	Regression results for other price inflation measures				
	Headline CPI	Core PCE	Headline PCE	Core good CPI	Core service CPI
Unemployment gap (z)	-0.628*** (0.112)	-0.376*** (0.070)	-0.439*** (0.108)	-0.972*** (0.233)	-0.397*** (0.099)
Infl. expectation (1y)	0.211 (0.296)	-0.034 (0.112)	-0.061 (0.211)	0.244 (0.263)	0.205* (0.122)
Productivity	0.143 (0.153)	0.090* (0.054)	0.211* (0.118)	0.174 (0.159)	-0.094 (0.108)
Oil price inflation	0.085 (0.152)	0.052 (0.073)	-0.047 (0.118)	0.229 (0.169)	0.066 (0.080)
Labour part. rate	0.062 (0.271)	-0.012 (0.093)	0.078 (0.206)	-0.405 (0.249)	0.108 (0.182)
Industrial production	-0.037 (0.069)	-0.080*** (0.028)	-0.046 (0.061)	-0.193** (0.078)	-0.030 (0.037)
Lagged inflation	0.121 (0.206)	0.653*** (0.085)	0.325* (0.187)	0.423*** (0.095)	0.527*** (0.077)
Adj. R ²	0.202	0.662	0.249	0.495	0.632
Num. obs.	409	409	409	409	409
RMSE	1.327	0.528	1.070	1.441	0.627

Notes: Asteriks indicate significance at the 1%, 5%, and 10% level (***) $p < 0.01$; ** $p < 0.05$; * $p < 0.1$). Standard errors are NW corrected. The constant term is omitted from the table.

ECI wages inflation across different periods

	Employment cost (wage) inflation - 12-months ahead				
	Whole (91-24)	Great Mod. (91-07)	Great Rec. (07-19)	Post GFC (10-19)	Pre COV. (91-19)
Unemployment gap (z)	-0.294*** (0.080)	-0.238** (0.102)	-0.071 (0.065)	-0.136 (0.098)	-0.046 (0.100)
Infl. expectation (1y)	-0.158 (0.270)	0.865*** (0.072)	-0.230 (0.246)	0.489** (0.236)	0.270 (0.259)
Productivity	-0.001 (0.065)	-0.080* (0.045)	0.121 (0.085)	-0.036 (0.130)	0.017 (0.046)
Oil price inflation	0.104 (0.064)	-0.178*** (0.058)	-0.022 (0.067)	0.126*** (0.043)	0.002 (0.067)
Labour part. rate	0.157 (0.119)	0.101 (0.123)	0.416** (0.164)	0.324** (0.128)	0.346*** (0.123)
Industrial production	0.000 (0.035)	-0.008 (0.012)	0.044 (0.037)	-0.088*** (0.030)	0.036 (0.053)
Lagged inflation	0.770*** (0.131)	-0.083* (0.046)	0.546** (0.219)	0.493*** (0.167)	0.395** (0.172)
Adj. R^2	0.798	0.567	0.483	0.677	0.563
Num. obs.	92	25	47	40	74
RMSE	0.420	0.230	0.377	0.286	0.386

Notes: Asteriks indicate significance at the 1%, 5%, and 10% level (** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$). Standard errors are NW corrected. The constant term is omitted from the table.

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Alternative slack measures - employment cost

	Employment cost (wage) inflation 12m ahead: alternatives						
	U gap	Change u rate	U gap and Change	V/U	U gap and V/U	Natural u gap	Output gap
Unemployment gap (z)	-0.294*** (0.080)		-0.294*** (0.079)		-0.279*** (0.080)		
Change in unempl.		-0.055 (0.103)	-0.011 (0.103)				
Vacancy/unemployment				0.630** (0.276)	0.462 (0.306)		
Natural u gap						-0.000 (0.001)	
Output gap							0.045 (0.064)
Infl. expectation (1y)	-0.158 (0.270)	-0.445 (0.291)	-0.157 (0.270)	-0.351 (0.362)	-0.098 (0.287)	-0.466* (0.249)	-0.508** (0.234)
Productivity	-0.001 (0.065)	0.023 (0.093)	0.002 (0.055)	0.044 (0.061)	0.024 (0.071)	0.010 (0.099)	0.012 (0.087)
Oil price inflation	0.104 (0.064)	0.119 (0.088)	0.105 (0.067)	0.131 (0.084)	0.115* (0.060)	0.119 (0.076)	0.118 (0.087)
Labour part. rate	0.157 (0.119)	-0.130 (0.197)	0.152 (0.130)	-0.156 (0.169)	0.107 (0.120)	-0.125 (0.120)	-0.161 (0.137)
Industrial production	0.000 (0.035)	0.053 (0.038)	-0.002 (0.044)	0.065** (0.031)	0.005 (0.029)	0.065* (0.033)	0.066** (0.033)
Lagged inflation	0.770*** (0.131)	0.942*** (0.176)	0.770*** (0.131)	0.686** (0.265)	0.591*** (0.200)	0.935*** (0.209)	0.916*** (0.206)
Adj. R ²	0.798	0.693	0.795	0.719	0.809	0.693	0.695
Num. obs.	92	92	92	92	92	92	92
RMSE	0.420	0.517	0.422	0.495	0.408	0.517	0.516

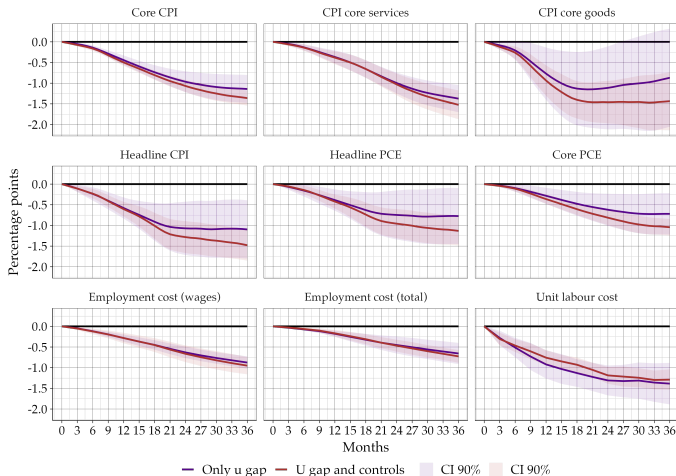
Notes: Asteriks indicate significance at the 1%, 5%, and 10% level (*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$). Standard errors are NW corrected. The constant term is omitted from the table.

Further wage inflation measures

	Regression results for other wage inflation measures	
	Employment cost (total)	ULC
Unemployment gap (z)	-0.787*** (0.114)	-0.175*** (0.051)
Infl. expectation (1y)	0.000 (0.250)	0.049 (0.119)
Productivity	0.322* (0.170)	0.129* (0.077)
Oil price inflation	0.310** (0.148)	0.097* (0.057)
Labour part. rate	0.766** (0.294)	0.179* (0.100)
Industrial production	0.142* (0.077)	0.005 (0.029)
Lagged inflation	0.021 (0.082)	0.630*** (0.087)
Adj. R ²	0.405	0.660
Num. obs.	136	136
RMSE	1.332	0.478

Notes: Asteriks indicate significance at the 1%, 5%, and 10% level (***) $p < 0.01$; ** $p < 0.05$; * $p < 0.1$). Standard errors are NW corrected. The constant term is omitted from the table.

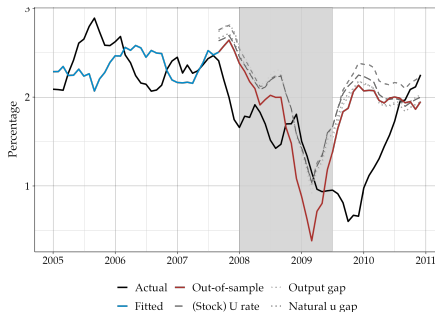
Local projection - cumulative change in inflation



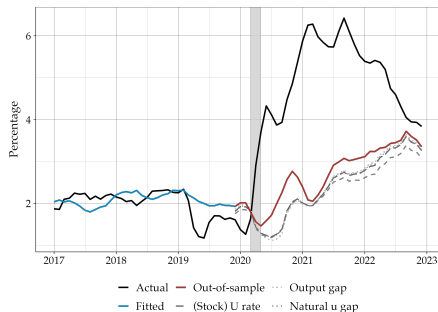
- Consistent negative effect on inflation upon increase in u-gap

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Out-of-sample fit: core CPI



(a)

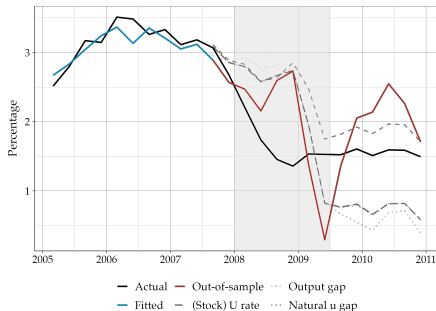


(b)

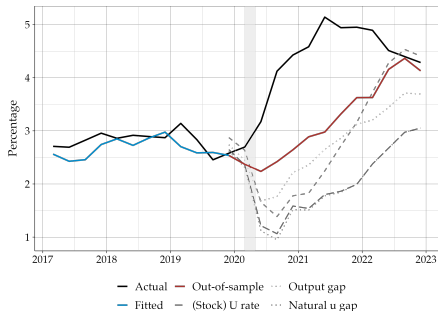
- High in-sample fit, improved RMSE in out-of-sample fit
- COVID-period exceptionally difficult

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Out-of-sample fit: Employment cost



(a)



(b)

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RMSE: Out-of-sample fit for post-GFC & post-COVID period

Inflation	Core CPI	Empl. Cost
(Stock) U rate	0.387*** (0)	0.12 (0.161)
Natural u gap	0.341*** (0)	0.285** (0.044)
Output gap	0.342*** (0)	0.125 (0.053)
V/U ratio	0.448*** (0)	0.052 (0.276)

(a) GFC period

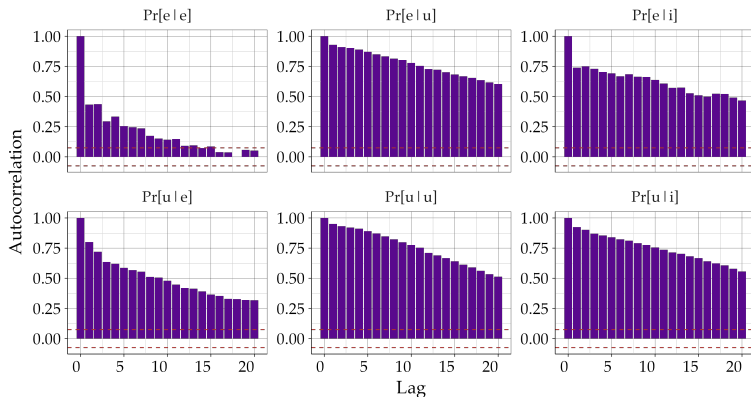
Inflation	Core CPI	Empl. Cost
(Stock) U rate	0.304*** (0)	0.565*** (0)
Natural u gap	0.304*** (0)	0.838*** (0)
Output gap	0.293*** (0)	0.33*** (0)
V/U ratio	0.297*** (0)	0.104** (0.04)

(b) COVID period

Notes: Values represent percentage deviations from benchmark RMSE. Asterisks indicate whether an alternative model performs worse. Statistical significance is assessed using the [Diebold and Mariano \(1995\)](#) test. CBO = Congressional Budget Office, V/U = vacancy-to-unemployment ratio.

- Improvement of out-of-sample RMSE by $> 10\%$

Persistence in transition probabilities (data)



- Transition probabilities very persistent (except for E-to-E)
- Hiring rate h , i.e. job-finding $\Pr[e|u]$, very persistent

Note: Two observations dropped March and April 2020.