Different strokes for different folks

Untangling supply and demand shocks using survey data to assess sectoral inflationary pressures in Croatia

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The opinions contained in this paper are the authors' exclusively and do not necessarily reflect those of the Croatian National Bank and the Bank of Italy.

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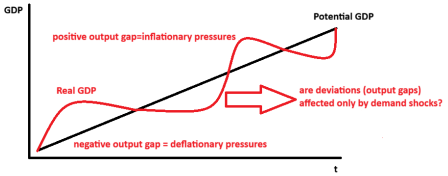
Motivation (I): economic slack and inflation

- Economic slack is traditionally viewed as one of the key determinants of inflation dynamics through the Phillips curve relationship.
- Price developments are primarily linked to economic slack: the intensity with which firms use resources such as equipment, technology or labour compared to installed capacity (ECB, 2018).
- Strong demand increases production intensity and firms' pricing power, while supply constraints raise production costs and inflationary pressures.
- Measuring economic slack accurately is therefore important for understanding inflation developments and conducting monetary policy.

Motivation (II): traditional output gap measures

- The output gap measures the deviation of actual output from potential output and is widely used to assess inflationary pressures.
- Central banks use output gap estimates to evaluate overheating and guide monetary policy decisions.
- Traditional measures are commonly estimated using HP filters, one-sided HP filters, Hamilton filters or production-function approaches.
- A crucial assumption is that supply shocks are permanent and thus mainly affect potential output (Blanchard and Quah, 1989).



Source: authors

Motivation (III): why did traditional gaps struggle after COVID-19?

- After the pandemic, inflation reflected both strong demand and large supply-side disturbances, including energy shocks and supply bottlenecks.
- Traditional output gaps tended to underestimate the role of supply-side factors, such as energy price spikes and supply chain disruptions, which were critical in small open economies.
- This raises the question of whether conventional measures of economic slack adequately capture inflationary pressures in the presence of large supply shocks.

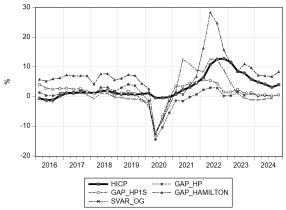
Research questions

- Can traditional output gaps adequately capture inflationary pressures in Croatia after the pandemic?
- Can survey-based sectoral indicators provide a more informative measure of inflation-relevant economic slack?
- Does the importance of demand and supply shocks differ between services and manufacturing sectors?

Motivation for an alternative approach

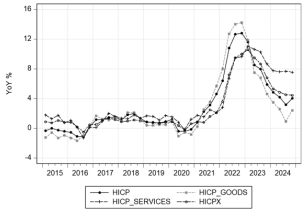
- Blanchard (2018) emphasizes that statistical filters cannot properly distinguish between demand and supply shocks in periods of strong macroeconomic disturbances.
- Traditional aggregate output gaps did not adequately capture post-pandemic inflationary pressures in Croatia.
- Post-pandemic inflation developments revealed a pronounced divergence between goods and services inflation.

Figure 1 Output gaps (% of pot. GDP) and HICP (YoY%) in HR



Source: authors and Eurostat

Figure 2 Price developments in HR



Source: Eurostat

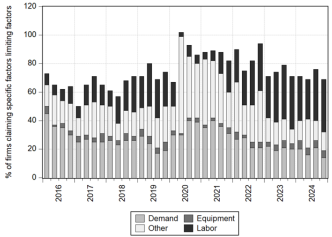
Alternative approach to output gap

- Since the aggregate output gap cannot signal inflationary pressures coming from a rich mix of shocks, we propose a novel approach to estimate sectoral output gaps.
- We construct survey-based output gaps in services and manufacturing using European Commission Business Survey data on capacity utilization and factors limiting production.
- Sample period: 2008Q3–2024Q4.
- In any given quarter, firms indicate whether insufficient demand, labour shortages, lack of equipment/materials or other factors limit production, and the percentage of capacity used.

Factors limiting production in Croatia

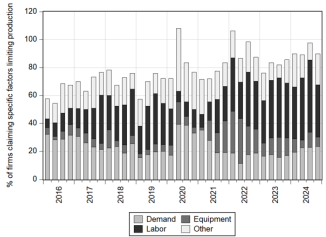
- Services experienced a strong post-pandemic demand recovery, with labour shortages becoming increasingly important after 2021.
- Manufacturing recorded stronger demand as well, but with a more pronounced role of equipment bottlenecks after the pandemic.

Figure 3 Factors limiting production in services



Source: EC

Figure 4 Factors limiting production in manufacturing



Source: EC

Constructing sectoral output gaps (I)

- We use demeaned sectoral variables ($x_{s,t} - \bar{x}_s$) to isolate cyclical inflationary signals.
- To address endogeneity, demand fluctuations are extracted from supply-side factors.
- Equipment, labour and other factors are regressed on demand:

$$F_{s,t} = \gamma_s^F + \gamma_{1,s}^F D_{s,t} + \eta_{s,t}^F, \qquad F \in \{E, L, O\}$$

- Demand-netted factors correspond to the residuals: $N_{s,t}^F = \eta_{s,t}^F$.

Constructing sectoral output gaps (II): inflation equation

Sectoral inflation is regressed on demand and demand-netted supply factors:

$$\pi_{s,t} = \alpha_s + \delta_s t + \beta_{1,s} D_{s,t} + \beta_{2,s} N^E_{s,t} + \beta_{3,s} N^L_{s,t} + \beta_{4,s} N^O_{s,t} + \varepsilon_{s,t}$$

- The equation is estimated separately for services and manufacturing.
- $\pi_{s,t}$ denotes demeaned sectoral inflation.
- The fitted component captures inflationary pressures explained by survey-based factors.

Constructing sectoral output gaps (III): results

Table 1 Survey-based sectoral factors limiting production

	Manufacturing	Services
Demand	-0.102***	-0.220***
	(0.022)	(0.053)
Other factors	0.014	0.026
	(0.061)	(0.042)
Labour	0.086*	0.312***
	(0.042)	(0.072)
Equipment	0.208***	0.117
	(0.053)	(0.234)
Constant	1.402***	245.25
	(0.363)	(252.372)
Observations	64	64
Joint significance (chi2)	52.094	75.490
p	0.000	0.000
* p<0.10, ** p<0.05, *** p<0.010		

Source: authors

- Insufficient demand enters with a negative coefficient, implying that weaker demand lowers inflationary pressures.
- Labour shortages and equipment bottlenecks enter with positive coefficients, reflecting cost-push inflationary pressures.
- Demand and supply factors are jointly significant in both sectors.

Constructing sectoral output gaps (IV)

- The sectoral output gap is constructed using fitted inflationary pressures from the estimated regressions.
- The measure is normalized using the volatility of capacity utilization.

$$\widehat{OG}_{s,t} = (\pi_{s,t} - \widehat{\varepsilon}_{s,t}) \frac{\sigma_{CU_s}}{\sigma_{(\pi_s - \widehat{\varepsilon_s})}}$$

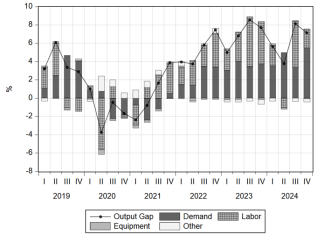
$$\widehat{OG}^{(F)}_{s,t} = \frac{\sigma_{CU_s}}{\sigma_{(\pi_s - \widehat{\varepsilon_s})}} \widehat{\beta}_F N^F_{s,t}$$

- The resulting output gap can be decomposed into demand, labour, equipment and other factors.

Constructing sectoral output gaps (V)

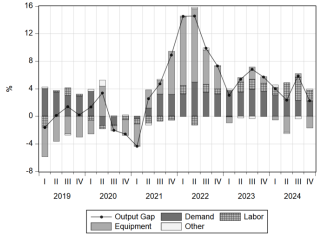
- Post-pandemic inflationary pressures in services remained elevated, reflecting strong demand and rising labour shortages.
- Manufacturing inflationary pressures peaked during 2021–2022 due to supply bottlenecks and equipment shortages, before gradually easing.

Figure 5 Output gap in services in HR



Source: authors

Figure 6 Output gap in manufacturing in HR

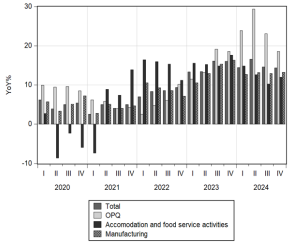


Source: authors

Underlying drivers of demand-supply shocks

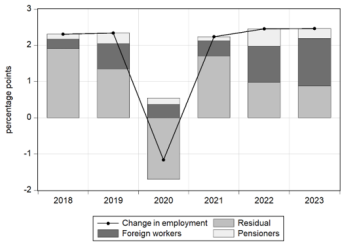
- Croatia experienced strong nominal wage growth after the pandemic, particularly in services and the public sector.
- Wage pressures emerged in an environment of tight labour markets and subdued productivity growth.

Figure 7 Average nominal gross wages



Source: CBS; authors

Figure 8 Employment dynamics



Source: CPII; authors

Conclusion

- Traditional output gaps struggled to capture post-pandemic inflationary dynamics in Croatia.
- Survey-based sectoral indicators provide a more informative measure of inflationary pressures.
- Demand dominated inflation developments in services, while manufacturing was more exposed to temporary supply-side shocks.
- Strong wage growth under tight labour market conditions and subdued productivity amplified inflationary pressures, particularly in services.
- The results highlight the importance of distinguishing between demand- and supply-driven inflationary pressures, because monetary policy operates primarily through the demand side of the economy.
- Future research could examine whether the effects of monetary policy are heterogeneous across services and goods sectors.

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Thank you for your attention