



# CZECH REPUBLIC

## SELECTED ISSUES

January 2024

This paper on the Czech Republic was prepared by a staff team of the International Monetary Fund as background documentation for the periodic consultation with the member country. It is based on the information available at the time it was completed on December 15, 2023.

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## SELECTED ISSUES

December 15, 2023

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# INFLATION IN THE CZECH REPUBLIC: ANALYSIS USING AN ADAPTIVE LEARNING STRUCTURAL MODEL

**1. Since the start of 2023, both headline and core inflation rates have experienced a rapid decline.** After peaking at 18.0 percent and 14.7 percent (year-on-year) in September and October 2022, respectively, these rates have significantly decreased. The central bank responded to the acute inflation by tightening monetary policy, raising interest rates from 0.25 percent in June 2021 to 7 percent in June 2022, a level that has been maintained since.

**2. Various inflation forecast approaches indicate similar paths for inflation.** Due to uncertainties surrounding the modeling of both, headline and core inflation rates, multiple methods were employed for projections, including simulations from estimated structural models and bottom-up autoregression. Based on the staff's baseline assumptions, the projections generated using different methodologies suggest that headline inflation rates are expected to reach the inflation target range in early 2024 and the inflation target by early 2025.

## **Analysis Based On A Structural Model Indicates That Adaptive Expectations Can Affect the Duration of Inflationary Episodes in Czech Republic**

**3. A structural model incorporating adaptive learning features is well-suited to project inflation path in the Czech Republic.** In Czechia, inflation expectations are notably shaped by past inflation outcomes, creating a feedback loop where rapidly decreasing inflation contributes to a shorter duration of elevated inflation, and vice-versa.<sup>1</sup> Therefore—departing from the rational expectations assumption in the standard models—we employ a model with adaptive learning features that assumes that agents form their expectations by updating their beliefs using a simple AR(2) model with the most recent data. Within this model, the central bank influences inflation through three channels. The first is direct – tightening policy reduces demand, lowers the output gap, and thus decreases inflation. The other two channels operate through inflation expectations. Tightening policy not only reduces current inflation but also impacts future expectations. Importantly, in contrast to perfect foresight-rational expectations models, the central bank can shape agents' learning. Lower-than-expected current inflation leads to adjustments in how past inflation is perceived, influencing future inflation.<sup>2</sup>

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<sup>1</sup> See Czech Republic Staff Report for the 2022 Article IV Consultation.

<sup>2</sup> The workhorse model employed in this study is a semi-structural variation of the small open economy model developed by Galí, Smets, and Wouters (2012), as well as Berg and others (2006). This model is a conventional New Keynesian framework that incorporates wage and price Phillips curves (PC). We use the adaptation of the model developed by Dizioli and Wang (2022) and Dizioli (2022).

- The equilibrium equations for each country in the linearized system are as followed:

$$y_t = \alpha_{yL}y_{t-1} + \alpha_{yF}y_{t+1} + \gamma(\pi_{t+1} - r_t) + \varphi_Z Z_t + S_{yt} \quad (\text{IS Curve})$$

$$s_{yt} = \rho_\varepsilon s_{yt-1} + \varepsilon_{yt} \quad (\text{Demand Shock Process})$$

$$\pi_t = \alpha_{(\pi_L)}\pi_{(t-1)} + \alpha_{(\pi_F)}\pi_{(t+1)} + k_\pi w_t + \lambda z_t + \varepsilon_{\pi_t} \quad (\text{Price PC})$$

$$\pi_{wt} = w_t - w_{t-1} + \pi_t \quad (\text{Nominal Wage Definition})$$

$$\pi_{wt} = -\alpha_{wL}w_{t-1} + \alpha_{wF}\pi_{wt+1} + K_w y_t + \varepsilon_{wt} \quad (\text{Wage PC})$$

$$r_t = \rho r_{t-1} + (1 - \rho)(\rho_\pi \pi_{t+1} + \rho_y y_t) + \varepsilon_{rt} \quad (\text{Policy Reaction Function})$$

$$z_t = E_t[z_{t+1}] - (r_t - \pi_t - (r_t^F - \pi_t^F)) + \varepsilon_{zt} \quad (\text{UIP Condition})$$

where  $y_t$  is the output gap,  $\pi$  is the quarter-on-quarter annualized inflation rate,  $r_t$  is the nominal monetary policy interest rate,  $w_t$  is the constant composition real wage deviation from labor productivity growth,  $\pi_{wt}$  is the real wage inflation and  $z_t$  is the koruna bilateral real exchange rate with respect to the US dollar.

- The economic agents' expectation in this adaptive learning model follow an AR(2) process with coefficients vary over time. As discussed above, the agents in this model make out-of-sample forecast using learning algorithm, with a Kalman filter mechanism to update the coefficients of forecasting equation, follows the updating model developed in Slobodyan and Wouters (2012a; 2012b).
- The model described above is estimated with Bayesian methods with quarterly macroeconomic data from 2000: Q1 to 2023: Q3 for Czechia. The set of variables included are output gap (estimated by the IMF team), the real wage gap, annualized quarterly price inflation deviation from target, and the policy rate.

#### 4. The model suggests that the speed to reach the inflation target depends on the strength of the monetary policy stance.

- In the baseline scenario, year-on-year inflation falls within the tolerance band in early 2024 and reaches the target in early 2025. This requires a moderately tight policy stance during most of 2024, followed by a significant relaxation during 2025.
- Another simulation explores the impact of inflation of an earlier and sharper relaxation of the policy stance starting in 2023: Q4. In such a scenario, year-on-year inflation falls more slowly, getting within the tolerance band later in 2024 and approaching the target by the end of 2025. Note that the simulation assumes that in future periods, the policy stance is guided by the policy reaction function in the model, which implies that the policy deviation is only temporary. A more

pronounced effect on inflation will result if policy deviations are prolonged and agents start to doubt on the time consistency of the framework.

<b>Czech Republic: Policy Stance and Inflation Rate Under Different Scenario</b>				
	<b>Early Rate Drop</b>		<b>Baseline</b>	
	Policy Stance	CPI Inflation	Policy Stance	CPI Inflation
2023Q4	3.1	8.7	3.3	7.4
2024Q1	2.7	5.3	3.4	2.6
2024Q2	2.5	3.9	3.2	3.0
2024Q3	2.2	3.2	2.9	2.7
2024Q4	2.0	2.7	2.7	2.9
2025Q1	1.7	2.4	2.4	2.1
2025Q2	1.5	2.5	2.1	2.0
2025Q3	1.2	2.2	1.9	2.0
2025Q4	1.0	2.2	1.7	2.0

Source: IMF Staff Calculation

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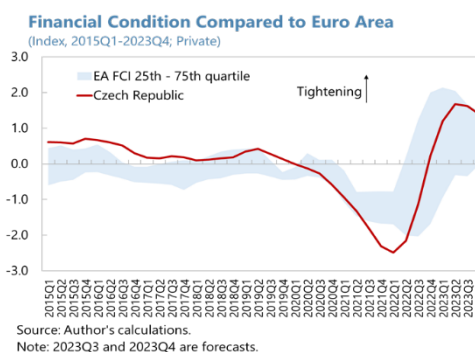
Slobodyan, Sergey and Raf Wouters, 2012, "Learning in a Medium-Scale DSGE Model with Expectation Based on Small Forecasting Models," *American Economic Journal: Macroeconomics*, Vol. 4, No. 2, pp. 65–101.

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## FINANCIAL CONDITIONS IN CZECH REPUBLIC

**1. Financial conditions in Czechia continue to tighten, albeit at a decreasing pace.** Our assessment is based on the IMF European Department financial conditions index (FCI), constructed to describe the state of financing conditions in the economy, encompassing both prices and quantities for households and nonfinancial corporations.<sup>1</sup> The overall economy FCI, encompassing all sectors under analysis, shows a significant tightening, starting in early 2022, and continuing through 2024, though the pace of tightening has slowed down.

**2. Financial conditions are concurrently tightening in European countries but at different paces.** Within the euro zone, the dispersion of tightening in financial conditions during the first half of 2023 is more pronounced than in previous periods of economic contraction episodes, indicating a possible stronger influence of idiosyncratic factors across countries.



**3. FCIs in all major economic sectors in the Czech Republic demonstrate varying degrees of tightening.** As the FCI for all sectors remain tightened, estimates indicate that the pace of tightening was stronger in the first half of 2023 for households but has started to decrease in the second half of the year, when compared to FCI for nonfinancial corporations.

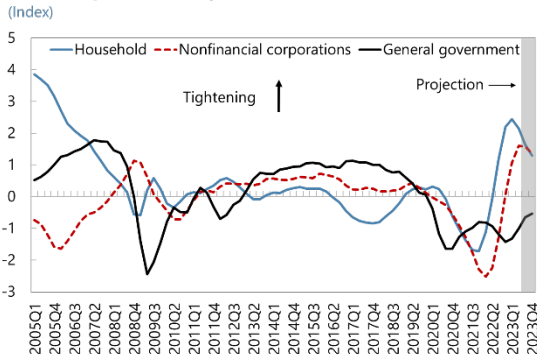
**4. A diverse set of factors explain the tight financial conditions, mainly the tight monetary policy stance, availability of credit, and higher price of risk.** According to the index, financial conditions started a tightening trend over the three years.

- Since the second half of 2021, the rate of financial conditions loosening, due to the relaxed pandemic-related measures, began to slow as the previously observed improvement in risk pricing started deteriorating, driven by worsening sentiment linked to the energy crisis and rising inflation from mid-2021.
- Financial conditions turned around in 2022, and started tightening as the price of risk, the tightening of the policy stance, and funding constraints became important drivers, amid deterioration of sentiment and increasingly high inflation.
- Although financial conditions remain tight, starting from Q1 2023, the pace of tightening has been slowing. This is due to the weakening impact of the price of risk and policy stance, along improved consumer sentiment, as real wages stabilize, the fading of the energy crisis, and the continuing disinflation.

<sup>1</sup> This is based on the IMF working paper "Financial Conditions in Europe: Dynamics, Drivers, and Macroeconomic Implications". V.Nguyen, R. Espinoza, V. Guzzo, R. Lafarguette, M. Segoviano, P. Wingender".

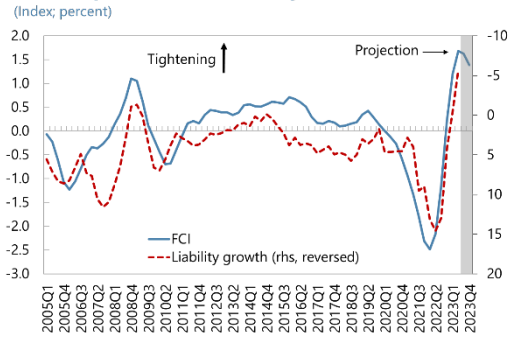
**Figure 1. Czech Republic: Financial Condition Index**

**Czech Republic: FCI by Sectors**



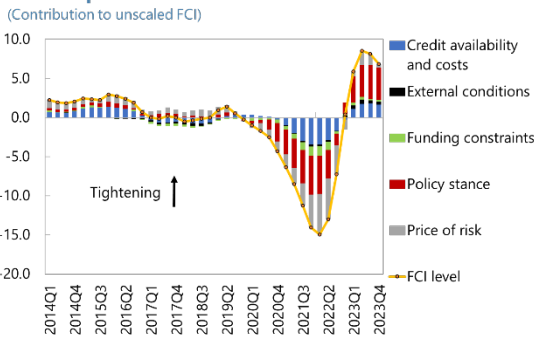
Sources: Author's calculations.

**Czech Republic: FCI and Liability Growth**



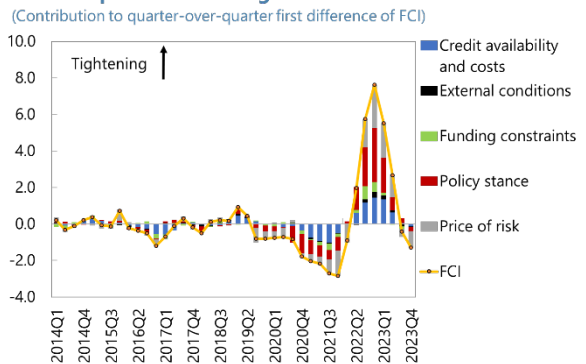
Sources: Author's calculations.

**Czech Republic: FCI level**



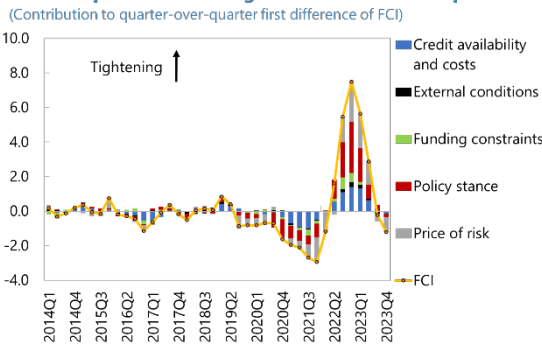
Sources: Author's calculations.  
Notes: FCI is not scaled. 2023Q3 and 2023Q4 are forecasts.

**Czech Republic: FCI Changes**



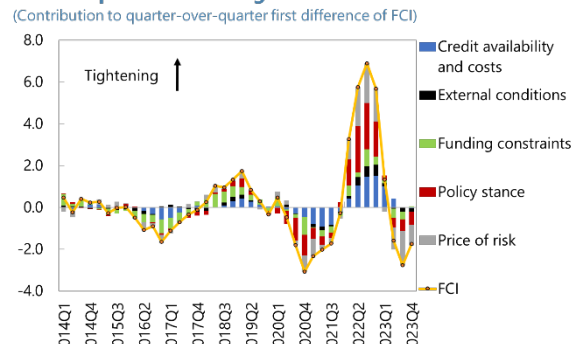
Sources: Author's calculations.  
Notes: FCI is not scaled. 2023Q3 and 2023Q4 are forecasts.

**Czech Republic: FCI Changes - Nonfinancial Corporations**



Sources: Author's calculations.  
Notes: FCI is not scaled. 2023Q3 and 2023Q4 are forecasts.

**Czech Republic: FCI Changes - Households**



Sources: Author's calculations.  
Notes: FCI is not scaled. 2023Q3 and 2023Q4 are forecasts.



# ENHANCING THE GREEN TRANSITION IN CZECH REPUBLIC

*Czechia has made progress towards reducing greenhouse gas emissions. Nonetheless, more efforts are needed to meet the goals in the EU's Fit-for-55 agenda by 2030. To meet longer-term climate targets, Czechia should follow through on its commitment to phase out coal from its energy mix by 2033. Planned reforms in the government's decarbonization strategy to diversify energy sources and rapidly scale up investment in renewables and low emissions energy sources should be prioritized to enhance energy security and steady the transition away from coal.*

## A. Overview

**1. Czechia has made progress in reducing GHG emissions, but more efforts are needed to facilitate the green transition.** GHG emissions were reduced by about 43 percent in 2021 relative to 1990, on the back of continued progress with the phase out of coal. Reaching the emission reduction goals for 2030 outlined in the EU's Fit-for-55 agenda will require stricter climate policies to achieve the longer-term targets of net zero. Despite the progress, the Czech Republic remains highly energy dependent and reliant on fossil fuels, with GHG-emission intensities among the highest in the EU ([OECD, 2023](#)). Energy intensity per unit of GDP is also considerably higher than in many other OECD countries, driven by the energy-inefficient stock of residential buildings, coal-fueled heating systems, and a large industrial sector. Fully achieving the EU-level climate related goals will require following through commitments to phase out coal by 2033 and accelerating transition to clean energy sources and higher energy efficiency.<sup>1</sup>

**2. Increasing the pace at which renewable energy is deployed is critical for supporting the transition away from coal, while also enhancing energy security.** Fossil fuels still play a major role in Czechia's energy mix. In 2021, solid fossil fuels accounted for 30 percent of Czechia's energy mix ([EC, 2023](#)). The share of renewable energy has been increasing but at a very slow rate. Deploying a broad range of alternative technologies especially renewables (e.g., solar, wind, geothermal, renewable hydrogen, and sustainable bio-methane) would help support the green transition and cover a large share of the natural gas shortfall.

## B. Czechia's Decarbonization Strategy

**3. The government has outlined a comprehensive decarbonization strategy aimed at supporting the green transformation of the economy.** The goals are to achieve a greener energy mix—by phasing out coal by 2033, while increasing the shares of renewable sources and nuclear energy—and enhancing overall energy efficiency.<sup>2</sup> This strategy includes raising the share of renewable energy (mainly photovoltaics and wind energy, with the contribution of biofuels and biomass) to 30 percent by 2030 (up from close to 18 percent in 2021). Czechia's 2030 goal for renewables is in line with the recently proposed level (31 percent) in the amendment of the

<sup>1</sup> [IMF Country Report No. 2022/2023](#).

<sup>2</sup> See the "[Update of the Czech National Plan of the Republics in the field of energy and climate](#)", October 2023.

Renewable Energy Directive ([EC, 2022](#)). Furthermore, the objectives involve raising nuclear power to 33 percent by 2040 (up from 15 percent in 2016). Reaching these goals is expected to assist Czechia in meeting its 2030 European climate and energy targets.<sup>3</sup>

**4. The necessary investment costs for decarbonization are expected to be distributed between both the public and private sectors.** Investment needs by 2050 are estimated at about CZK 3.5 trillion of which about CZK 1–1.2 trillion are identified from public support including EU funds.<sup>4, 5</sup> Making the best possible use of public funds available, while focusing on key priority projects with high impact and ensuring timely and efficient implementation will be of crucial importance to succeed in the green transformation of the economy.

### C. Supporting Policies to Facilitate the Green Transition

**5. To support the green transition while fostering private investment, various policies are envisaged:**

- Carbon prices under EU’s Emissions Trading System ETS1 and ETS2 (commencing in 2027), which together will cover most sources of emissions, will shift relative prices toward greener energy sources, while encouraging efficiency.
- Regulatory directives, such as prohibiting the registration of fossil-fuel vehicles within the next decade and establishing energy efficiency standards for buildings, among other measures, will further incentivize private investments in green sources.<sup>6</sup>
- Complementary strategies, as recommended by staff, might involve implementing feebates in the agricultural sector (and other non-covered sectors in the European Trading Systems), targeted subsidies to bolster R&D investments, and accelerated depreciation rates for machinery and equipment reliant on fossil fuels, provided they are replaced by cleaner fuel alternatives.

**6. Czechia’s commitment to the phase out of coal should also be supported by policies to address the socio-economic impacts.** Czechia’s coal regions (e.g., Ústí nad Labem and Karlovy Vary) face higher levels of unemployment and poverty, which could be exacerbated by the phase

<sup>3</sup> The authorities’ modelled scenario shows that in the sectors covered by EU ETS, Czechia is expected to reduce emissions by 63 percent in 2030 compared to the 1990 level—supporting the EU-wide target of at least 55 percent reduction in emissions by 2030. In the non-ETS sectors (under the Effort Sharing Regulation), Czechia is expected to reduce emissions by 32 percent in 2030, compared to its target of 26 percent.

<sup>4</sup> Public support includes funding from: Cohesion Funds, Recovery and Resilience Plan, ETS1 and ETS2 revenues, Modernization Fund, Social Climate Fund, and Loan from EIB-SFDI.

<sup>5</sup> See the “[Update of the Czech National Plan of the Republics in the field of energy and climate](#)”, October 2023.

<sup>6</sup> To incentivize the private sector, the Investment Incentive Act (amended by Act No. 89/2023 Coll.) offers: (i) Corporate income tax relief for a period of 10 years, (ii) Cash grant in the amount of CZK 200,000 for each newly created job, (iii) Cash grant for training employees in the amount of 50 percent to 70 percent of training costs, and (iv) Cash grant on capital investment in the amount of up to 20 percent of eligible costs (max. CZK 0.5 billion). The government should assess the effectiveness and flexibility of these programs to support private investment. See: [Are you interested in investment incentives in the Czech Republic? - CzechInvest](#)

out of coal-based jobs. Key activities to support the coal regions, in the context of the Operational Program Just Transition including investment in business start-ups and SMEs, up-skilling and retraining of workers would effectively support the transition. In line with the national energy and climate strategies, measures to support workers at risk of redundancy in coal regions should be swiftly implemented.

**7. Ensuring energy efficiency in the building and transport sectors would help to lower emissions and support energy security.** Investment in energy efficiency should be scaled up, while prioritizing the renovation of buildings connected to coal-based district heating ([EC, 2022](#)). New measures funded by REPowerEU, such as the subsidy program for the replacement of gas heating in low-income households, are steps in the right direction.<sup>7</sup> In parallel, promoting the introduction of low- and zero-emission vehicles and shifting individual road transport needs towards lower emissions modes like rail or public transport are critical to reduce CO<sub>2</sub> emissions in the transport sector. Measures to facilitate the use of electric vehicles, particularly charging infrastructure, and more public support for hybrid or electric vehicles would help improve the comparatively lower electric vehicles adoption in Czechia.<sup>8,9</sup> The Transport Policy of the Czech Republic is a key strategic document that aims to raise the CO<sub>2</sub>-efficiency of the vehicle fleet ([Ministry of Transport, 2021](#)). To achieve a faster replacement of the vehicle fleet, the government could also consider offering specific incentives to scrap old vehicles and replace them with newer models. The RRF also supports the decarbonization of transport through EUR 1.2 billion of investments in low-emission vehicles for the business sector, railway infrastructure, and to promote electric charging stations and cycling pathways.

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<sup>7</sup> See [Czechia's recovery and resilience plan](#), European Commission.

<sup>8</sup> The government aid to purchase electric vehicles (announced in June 2022) funded by the National Recovery Plan and targeting public entities, educational institutions, public institutions, NGOs is also a welcome step.

<sup>9</sup> A lack of infrastructure for electric vehicles, ineffectual incentives and comparatively weak public support for hybrid or electric vehicles have contributed to one of the oldest car fleets in the European Union (OECD, 2023).

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