Do increases in public sector wages affect inflation?

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Article**
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Abstract

After the pressures from rising energy and food prices subsided, wage increases became the primary risk to inflation. Given concerns that substantial wage growth in the public sector during Croatia's 2024 election year could create additional inflationary pressures, this paper estimates the potential impact of public sector wage growth on overall inflation using BVAR models. The analysis finds that while the direct impact of 0.15 pp is negligible, there may be a stronger indirect effect. Depending on the assumed (side) effects of public sector wage growth on aggregate demand and the extent of wage spillover to the private sector, the indirect effect of public sector wage growth on inflation could range from 0.34 to 0.88 percentage points. However, considering the double-digit wage growth, it can be concluded that the estimated total contribution of 0.5 to 1 basis points from public sector wage growth is relatively modest.

Keywords: public sector wage growth, inflation, transmission of wages to inflation, BVAR model, Croatia

1 INTRODUCTION

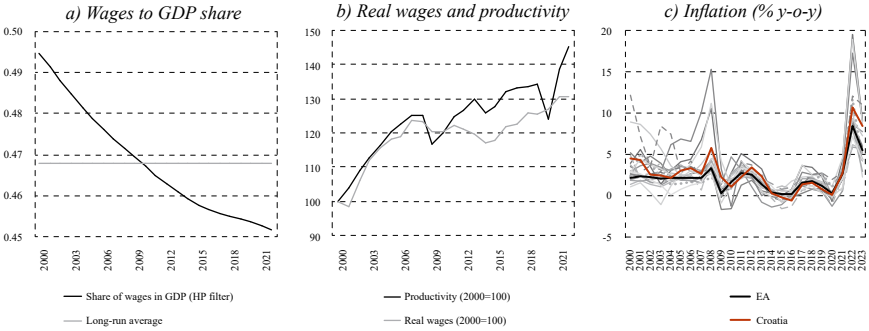
After a prolonged period of low and stable inflation, toward the end of 2021 inflationary pressures began to rise globally as well as in Croatia. These pressures, primarily driven by surges in global food, energy, and raw material prices, along with supply chain disruptions, peaked in the second half of 2022, when Croatia's annual inflation rate surpassed 12% – a level not seen since the implementation of the last stabilization program. Although this spike in inflation eroded real wages, they started to recover in 2023, as nominal wage growth began catching up with inflation. While such a recovery often follows a significant decline in real wages, the marked acceleration in wage growth has raised concerns about its potential impact on inflation, especially given that labour costs constitute a substantial portion of total production costs. Consequently, as external inflationary pressures have subsided, the unprecedented rise in nominal wages has emerged as a primary inflation risk (Ivanac, Kunovac and Nadoveza, 2024). This not only poses challenges for economic policymakers, particularly in the realm of monetary policy, but could also have broader social and economic impacts. While some have argued that the recent wage increases were merely compensating for prior losses in real wages[1], given that the share of wages in GDP has long trended below the long-term average (graph 1a) and that real wages have been growing more slowly than labour productivity (graph 1b). However, others were concerned that such a significant rise in wages could further accelerate the already high inflation rate[2], which is among the highest in the euro area (graph 1c).

[1] For instance Index argued that in 2022 labour costs (nominal wages) were increasing but that simultaneously real wages were decreasing (see Perković, 2022). From the context of the argumentation it is clearly implied that substantial nominal wage growth at the time (7.5% yearly) was not enough to offset inflation, the suggestion being that more nominal wage growth is required.

[2] During the periods of elevated inflation, particularly in the first half of 2023, concerns arose about the potential for a wage-price spiral. For instance, the Croatian Employers' Association cautioned that robust wage growth "raises the risk of a wage and retail price spiral" (---, 2024). This risk was taken seriously amid strong price increases, as reflected in remarks by key central bank figures. Notably, ECB President Christine Lagarde addressed the issue in a 2023 speech (ECB, 2023), and CNB Governor Boris Vujčić noted in 2024 that inflationary pressures had been contained before a wage-price spiral could take hold (CNB, 2024a).

Graph 1

Wages, productivity and inflation



Note: Prices are measured by the Harmonized Index of Consumer Prices (HICP). Wages are measured by compensation of employees per employee from national accounts statistics, productivity is calculated as the ratio of real GDP to the number of employees from national accounts.

Source: Eurostat.

Before the first estimates of the impact of the sharp rise in total wages on inflation and the inflation differential (which began to ease in late 2023 and early 2024) were published, the decision to implement a substantial wage increase as part of the civil and public service wage reform reignited discussions about the potential inflationary effects of rapid wage growth[3]. According to the government document titled Reform in Numbers (Government of RC, 2024), this reform affects 244,000 state and public service employees, aiming to streamline and equalize job classifications by merging roles of similar complexity based on evaluations and reducing the number of job titles. Of the five phases in this reform, the most relevant here is the 15% wage increase resulting from coefficient adjustments effective from March 2023.

Public sector wage growth can impact inflation through several channels. The direct effect stems from a possible rise in public service prices, driven by higher employee costs, as labour compensation accounts for over 80% of the gross value added (GVA) in the public sector[4], according to Eurostat's national accounts data. This is significantly higher than the average employee compensation share of approximately 50% in other sectors. However, this direct impact is likely small because (a) public sector prices are mostly set outside the market, making the pass-through of wage growth to public service prices lower than in other sectors, and (b) services that consumers purchase directly from the public sector represent a small portion of the overall consumer basket. Nonetheless, substantial wage increases in the public sector may create inflationary pressures indirectly by increasing the aggregate demand of public sector employees and potentially influencing private sector wages. The size of this indirect effect will depend on the proportion of public sector employment within the economy and the degree of wage spillover from the public to the private sector. Thus, a larger public sector could amplify these indirect inflationary effects.

[3] For instance in Lider (---, 2024b) and HRT (see: Kovaček, 2024).

[4] Which includes public administration and defence services; compulsory social security services (O), education services (P), and human health services (Q).

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This paper seeks to estimate both the direct and the indirect inflationary effects of public sector wage growth using a methodology based on Bayesian VAR models with sign and zero restrictions on impulse response functions, which approximate the standard wage-setting (WS) and price-setting (PS) model. By employing this established approach to analyse the impact of wage growth on prices, the paper contributes to academic literature by introducing a novel framework for identifying and examining the direct and indirect effects of public sector wage growth on inflation. Additionally, the paper adds to the ongoing policy and economic debate regarding the potential inflationary impact of exceptionally high wage increases in the public sector.

Analysis of the results of model estimates based on data for Croatia from 2004 to 2023 shows that wage growth in the public sector has a negligible direct but a relatively strong potential indirect impact on overall inflation. Thus, wage growth in the public sector increases the total inflation rate through the direct channel by approximately 0.15 percentage points. The negligible direct effect is mostly the result of the small share of public sector services in the consumer basket. On the other hand, it is estimated that the total indirect impact on inflation could be relatively strong and amount to between 0.34 and 0.88 percentage points, depending on the assumed contribution of wage growth in the public sector to total aggregate demand and the extent of spillover of wage growth in the public sector to the private sector. However, it is important to emphasize that considering the assumptions about the spillover of wage growth to the private sector and aggregate demand, bearing in mind that this wage growth is in the double digits, we can conclude that the estimated total contribution of wage growth in the public sector of 0.5 pp – 1 pp is relatively low. However, despite the relatively low estimated contribution of wage growth in the public sector to inflation, these results should be interpreted with caution, since empirical assessment of the impact of wage growth on inflation is inherently complex. That is, apart from the fact that the relationship between wages and prices is bidirectional (Conti and Nobili, 2019; Ivanac, Kunovac and Nadoveza, 2024), its strength and direction depend on the nature of the shocks affecting the economy (Bobeica, Ciccarelli and Vansteenkiste, 2019, 2021; Conti and Nobili, 2019; Ivanac, Kunovac and Nadoveza, 2024), so it is difficult to estimate empirically the real causal effect of wage growth on prices – even without additional assumptions regarding the potential effects of public sector wage growth on aggregate demand and private sector wages.

The remainder of the paper is organized as follows: section 2 provides a summary of the relevant theoretical and empirical literature. Section 3 outlines the data and methodology used to assess the effects of public sector wage growth on inflation. Section 4 presents the empirical results, and section 5 discusses the main conclusions and limitations of the estimates provided in the paper.

2 EXPLORING THE RELATIONSHIP BETWEEN WAGES AND PRICES: INSIGHTS FROM EXISTING LITERATURE

The impact of wages on inflation is one of the most widely researched topics in economics because of its relevance to economic policymakers and its significant effects on individuals' purchasing power, as well as on companies' production costs. However, studies specifically addressing the influence of public sector wages on inflation are rare. This scarcity likely reflects a common view that the direct impact of public sector wage growth on inflation is small – public sector service prices are largely non-market-based and represent only a small portion of the consumer basket (Whiteley, 2023). Nonetheless, public sector wage increases can indirectly affect inflation through heightened demand from public sector employees and by influencing private sector wages. The latter can lead to a rise in production costs across the economy, potentially increasing the prices of products and services not directly related to public sector wage growth (i.e., cost-push inflation). In such cases, theoretical and methodological tools that analyse the effects of broad wage growth on inflation become useful for examining the potential inflationary impact of public sector wage growth, particularly when such growth is substantial and in economies where the public sector is relatively large. We therefore review theoretical and empirical research that examines economy-wide wage-to-price transmission, while focusing on the effect of public sector wages on economy-wide prices.

2.1 THEORETICAL FRAMEWORK

The mechanism of the transmission of wage growth to inflation is often studied within the framework of macroeconomic theories summarized in various forms of the so-called Phillips curve, which essentially assumes an inverse relationship between the unemployment rate and inflation. According to this framework, a more favourable situation on the labour market, which manifests itself through a lower unemployment rate, leads to an increase in wages that can result in higher production costs that producers are able to pass on to consumers through an increase in the prices of their products and services (see for example Carlin and Soskice, 2014). Thus, in the basic neoclassical model of a closed economy under conditions of perfect competition where prices are set at the level of marginal cost, the prices of products and services grow according to the growth rate of wages minus labour productivity, that is, according to the growth rate of unit labour costs. In such conditions, it can be shown that in the long run the elasticity of price changes to wage changes, which is used to measure the transmission of wages to prices, is equal to the share of labour costs in the total costs.[5]

However, setting aside the empirical challenges of quantifying the causal impact of wage growth on prices – since wage dynamics itself is largely influenced by inflation

[5] See Deutsche Bundesbank (2019). It is important to note that consumers (and central banks) are primarily interested in the potential pass-through of wage growth to consumer prices measured by the Harmonized Index of Consumer Prices (HICP). In contrast, the conclusions of theoretical models generally refer to prices measured by the GDP deflator, which captures the prices of goods produced within the domestic economy. Since consumers also purchase imported goods and since a significant share of imported intermediates is used in the domestic production of consumer goods, the pass-through of wage growth to consumer prices will not necessarily correspond to the pass-through of wage growth to the prices of goods produced within the domestic economy.

trends – this theoretical conclusion faces several practical issues. The pass-through of wage growth to prices depends on a range of factors that vary between countries and can shift within a country over time. These include changes in profit margins[6], labour market conditions, the structure of the economy, and how workers formulate wage demands, which are influenced by anticipated inflation, current labour market conditions, and actual or expected productivity growth. As a result, we cannot simply deduce the extent of wage growth pass-through onto prices based solely on the share of labour costs, particularly in the short to medium term.

A formal framework for understanding the joint dynamics of wage and price movements is captured in a basic wage-setting (WS) and price-setting (PS) model, as outlined by Blanchard and Bernanke (2023).

The standard equation that describes the relationship among wage growth, inflation, and labour market conditions is known as the wage-setting (WS) relationship[7]:

$$\Delta w_t = \Delta p^e{}_t - \alpha\left(u_t - u^*\right) + \Delta a_{Lt} \tag{1}$$

where $\Delta w_t = w_t - w_{t-1}$ is the rate of change of nominal wages in time t, $\Delta p^e{}_t = p^e{}_t - p_{t-1}$ is the expected rate of inflation in time t, u_t is the unemployment rate in time t, and u^* is the natural rate of unemployment in time t, Δa_{Lt} is the real (or expected) labour productivity growth rate. Equation (1) indicates that workers' wage demands are driven by their inflation expectations and the current labour market conditions. When the unemployment rate is low, workers have greater bargaining power since employers face challenges in filling vacant positions, allowing workers to negotiate for higher nominal wages.

Also, when workers expect higher inflation, they demand higher wages to prevent real wages from falling. The way in which workers form inflation expectations can be described as follows:

$$\Delta p^e{}_t = \lambda \Delta p^*{}_t - (1-\lambda)\Delta p_{t-1} \tag{2}$$

Here, $\Delta p^*{}_t$ represents the long-term expected inflation rate, typically aligned with the central bank's target inflation rate. It is assumed that long-term inflation expectations are shaped by last year's long-term inflation and the inflation rate from the previous period.

$$\Delta p^*{}_t = \delta \Delta p^*{}_{t-1} - (1-\delta)\Delta p_{t-1} \tag{3}$$

[6] Markets are often not perfectly competitive, allowing companies to set prices above marginal costs, meaning they can charge markups. These markups do not necessarily remain constant, so companies can adjust them to mitigate (or amplify) the pass-through of higher wages to prices by reducing (or increasing) their markups.

[7] In describing the model, we abstract from the effect of so-called aspiration wages, which Blanchard and Bernanke (2023) consider in their highly influential paper. Specifically, while standard WS-PS models typically do not include aspiration wages (see, for example, Carlin and Soskice, 2014), integrating the concept of aspiration wages explicitly into the methodological approach underlying the empirical estimation would be challenging.

The parameter λ in equation (2) indicates the anchoring of short-term expectations, and the parameter δ in equation (3) indicates the anchoring of long-term expectations. When expectations are fully anchored, both parameters are equal to 1, and when expectations are completely unanchored, they are equal to 0[8].

In addition to expected inflation and labour market conditions, nominal wage growth described by equation (1) is also influenced by factors such as the actual or anticipated growth rate of labour productivity (Δa_{Lt}). In theory, prices increase according to the growth rate of unit labour costs rather than wages alone. Consequently, any changes or adjustments that affect labour productivity can mitigate the impact of wage growth on prices. For instance, companies may respond to wage increase demands by reducing their workforce, which might increase labour productivity. With higher labour productivity, unit labour costs may rise more slowly than wages, thereby reducing the sensitivity of prices to wage changes. Additionally, if layoffs lead to higher unemployment, total demand may decrease, potentially exerting downward pressure on prices.

The approach producers take to set prices is generally described by the price-setting (PS) relationship:

$$\Delta p_t = \Delta w_t - \Delta a_{Lt} + \Delta z_t \tag{4}$$

In equation (4), z_t represents all factors that influence pricing beyond unit labour costs – defined as wage growth (w) minus labour productivity growth (α_L). These factors include mark-ups and costs of intermediates, such as the prices of energy, food, and other raw materials. Together, these relationships form the basis of the standard Phillips curve, which is commonly used to analyse the mechanism through which wage increases translate into price changes.

$$\Delta p_t = \lambda \Delta p^*_t - (1-\lambda)\Delta p_{t-1} - \alpha\left(u_t - u^*\right) + \Delta z_t \tag{5}$$

The Phillips curve describes aggregate supply, illustrating how price levels move based on expected inflation, labour market conditions, and other factors. Assuming the Phillips relationship holds, equation (5) suggests that price dynamics are influenced by the anchoring of inflation expectations, labour market conditions which affect wage demands, and fluctuations in mark-ups and prices of important intermediates, such as energy and other raw materials.

A significant empirical challenge in assessing the impact of wages on prices (especially in the short and medium term) arises from the simultaneous determination of wages and prices, as evident in the WS-PS model (Conti and Nobili, 2019). The wage-price relationship is bidirectional, making it difficult to pinpoint and quantify

[8] In the empirical model, expectations are not explicitly modelled because the time series of short-term and long-term inflation expectations published by Consensus Economics for Croatia is too short and only available at a semi-annual frequency.

the causal impact of wages on prices. The co-movement of prices and wages can be driven by (a) demand shocks, (b) supply shocks, or (c) the attempts of workers or producers to increase their share in income distribution (Blanchard, 1986). The strength of the wage-price link depends on the nature of the shock. For instance, research shows that under a positive aggregate demand shock, the connection between wages and prices is much stronger than in the case of a supply shock[9].

A positive aggregate demand shock is characterized by rising prices and income, leading to increased demand for labour and a drop in the unemployment rate below its natural level. Companies respond to heightened demand for products by raising prices (demand-push), while workers, in response to increased demand for labour, push for higher wages. Wage growth raises production costs (cost-push), prompting further price increases unless mark-ups or input costs change. This cycle of rising prices and wages continues until income stabilizes at its potential level, or until unemployment returns to a level that does not accelerate inflation[10], as seen in equations (1) and (5).

Conversely, a negative aggregate supply shock is marked by rising prices alongside declining income. When such an inflationary shock occurs, workers seek wage increases to maintain their real purchasing power. However, a negative supply shock also raises the natural unemployment rate (or lowers the potential output), thereby weakening workers' bargaining power due to the availability of the involuntarily unemployed labour force in the market. As the economy adjusts to a higher equilibrium unemployment rate and lower potential output, aggregate demand declines, which puts a downward pressure on prices. Thus, in the case of a supply shock, wage growth impacts prices mainly through the cost-push channel, and this effect is mitigated (or even offset) by the reduction in aggregate demand.

2.2 EMPIRICAL FRAMEWORK

Due to its importance in economic theory and policy, numerous empirical studies examine the relationship and transmission of wage growth to inflation. The direction and significance of this relationship are often analysed using Granger causality tests (e.g., Hu and Toussaint-Comeau, 2010; Bidder, 2015) and by assessing the importance of wages in inflation forecasts (e.g., Stock and Watson, 2008; Knotek and Zaman, 2014; Jarocinski and Mackowiak, 2017) or through Phillips curve estimations (e.g., Stock and Watson, 2008; Tatierska, 2010; Galí and Gambetti, 2019). However, due to the simultaneity, these methods typically only reveal joint dynamics or correlation between wages and prices but generally inadequate for isolating the causal effect of wage growth on prices. While these approaches do not identify or quantify causation, they can be highly informative – particularly in the context of a potential wage-price spiral. On the other hand, analyses that try to quantify the pass-through of wage growth to inflation often use vector autoregressive (VAR) models (e.g., Bobeica, Ciccarelli and Vansteenkiste, 2019, 2021; Conti and Nobili, 2019; Hahn, 2020; Ivanac, Kunovac and Nadoveza, 2024),

[9] For instance, Gumiel and Elke (2018), Bobeica, Ciccarelli and Vansteenkiste (2019, 2021).

[10] The potential output is assumed to be the level of income achieved at the natural rate of unemployment, that is, the unemployment rate that does not accelerate inflation (Non-Accelerating Inflation Rate of Unemployment, NAIRU).

error correction models (e.g., Chang and Emery, 1996) or simultaneous equations (e.g., Blanchard and Bernanke, 2023; Arce et al., 2024).

The findings of various studies offer different assessments of the wage-to-price pass-through. While most research suggests a weak or partial transmission of wage increases to prices (Bobeica, Ciccarelli and Vansteenkiste, 2019, 2021; Conti and Nobili, 2019; Hahn, 2020; Blanchard and Bernanke, 2023; Arce et al., 2024), where only a portion of wage increases is passed on to prices due to competitiveness gains and changes in mark-ups (see, for instance, Deutsche Bundesbank, 2019; Bobeica, Ciccarelli and Vansteenkiste, 2019), some studies indicate that the extent of transmission varies across sectors and countries (Bobeica, Ciccarelli and Vansteenkiste, 2019).

More recent research typically analyses the wage-price nexus using structural VAR models similar to the approach taken in this paper. These models are able to account for shock-dependent wage-to-price relationship[11] (e.g., Gumiel and Hahn, 2018; Galí and Gambetti, 2019; Conti and Nobili, 2019; Bobeica, Ciccarelli and Vansteenkiste, 2019, 2021; Hahn, 2020), and offer a reasonable approximation of the WS-PS model. The results of these studies generally show that the wage-price relationship is strongest during aggregate demand shocks, but weaker during labour market shocks, and even negative in the case of aggregate supply shocks. Furthermore, Bobeica, Ciccarelli and Vansteenkiste (2019, 2021), and Ivanac, Kunovac and Nadoveza (2024) investigate the role of wages in transmission of various structural shocks to prices using a counterfactual scenario within a VAR framework[12]. These studies find that wages significantly amplify the effects of aggregate demand shocks on inflation, suggesting that, without wage growth, inflation would be considerably lower during aggregate demand shocks. In contrast, the role of wages in transmitting aggregate supply shocks to prices is much less significant.

In addition to the VAR model, Blanchard and Bernanke (2023) present a simple dynamic model of wages, prices (WS-PS), and short- and long-term inflation expectations, which was later replicated for the euro area by Arce et al. (2024). Their findings suggest that wage growth had a relatively low impact on inflation during the period of heightened inflation that began in late 2021 and that the surge in inflation during this period was primarily driven by shocks in raw material prices.

While this paper draws heavily on the literature that combines zero and sign restrictions on impulse response functions within the VAR framework to analyse the relationship between wages and prices, it makes two notable contributions. First, in addition to examining the conditional correlation between wages and

[11] The idea that the pass-through of wages to prices can vary depending on the shocks affecting an economy originates from the literature on exchange rate pass-through to inflation, as discussed in the papers of Kunovac and Communale (2017), and Forbes, Hjortsoe and Nenova (2018).

[12] The authors adopt the idea of identifying the effects of specific shocks using a hypothetical scenario from the literature related to isolating the role of confidence in the transmission of government spending shocks (Bachmann and Sims, 2012) and isolating the role of the credit channel in the transmission of monetary shocks (Ciccarelli, Maddaloni and Peydró, 2015).

prices under various structural shocks (wage-to-price multipliers), the paper explores time-varying correlations between wages and prices in both the public sector and in the overall economy. As in Ivanac, Kunovac and Nadoveza (2024) this analysis shows how the dynamics of wages and prices evolves over time even without a time-varying parameter. Second, the paper identifies the potential role of public sector wages in the transmission of various shocks to inflation, both across the economy and within the public sector, by using wage-to-price multipliers (Bobeica, Ciccarelli and Vansteenkiste, 2019, 2021; Conti and Nobili, 2019; Ivanac, Kunovac and Nadoveza, 2024). This approach is rarely applied in the literature on wage-price transmission but has proven to be a valuable tool for quantifying the indirect effects of public sector wage growth on overall inflation. Lastly, the paper makes a significant professional contribution by using the standard methodology in an analysis of the wage-price relationship in the public sector – a relatively large and crucial sector in most countries – in which no studies have attempted to quantify the transmission of wages to prices.

3 METHODOLOGY AND DATA

To examine the relationship between wage dynamics, consumer prices, and the transmission of wage growth to inflation, we approximate the WS-PS model using a standard Bayesian VAR model, applying zero and sign restrictions on the impulse response functions (see table 1)[13]. We estimate two models: one focused on the public sector, which evaluates the direct impact of public sector wage growth on public service price inflation, and another for the overall economy, which assesses the potential indirect effects of public sector wage growth on headline inflation.

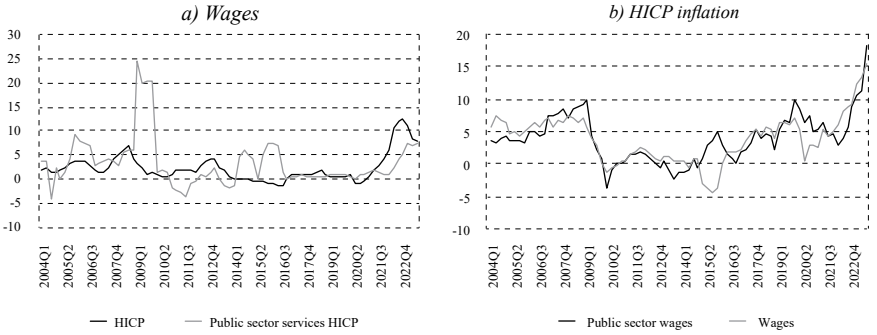
Prices and wages in both the public sector and the overall economy that are used in the empirical analysis are illustrated in graph 2[14]. The graph shows that wage trends in the public and private sectors are generally synchronised (graph 2a), with wage growth during the high inflation period of 2022 and 2023 (graph 3a) being exceptionally high. This surge can largely be attributed to the wage catch-up process aimed at preventing a significant decline in real wages during the high inflation period. On the other hand, inflation measured by the constructed HICP for public sector services (see appendix) did not always follow the dynamics of overall price growth, which is partly due to the role of administered prices in the price setting process for public sector services. The most notable divergence between total inflation and inflation in public sector services occurred in 2009, largely due to healthcare system reform, which introduced a new system of co-payments and supplementary health care insurance. Since, according to tables available in Cai and Vandyck (2020), healthcare spending accounts for a significant share (33.7%) of total consumer expenditure on public sector services, this reform had a marked impact on the constructed price index for public sector services.

[13] The identification scheme relies on sign restrictions on impulse response functions proposed by Canova and De Nicolò (2002), and Uhlig (2005), and further refined by Rubio-Ramírez, Waggoner and Zha (2010), and Arias, Rubio- Ramirez and Waggoner (2014).

[14] Data, data sources and their modifications are available in table A1.

GRAPH 2

Annual wage growth and HICP inflation in the public sector and the overall economy (%)



Source: CBS, Eurostat.

The model used to estimate the impact of wage growth (in the public sector) on inflation (of public sector services) includes five key variables for the period from 2004Q1 to 2023Q4: real GVA and GDP (with GVA from the services sector covering O-Q sections[15]), HICP inflation[16] (of public sector services, calculated using the CPA to COICOP conversion tables developed by Cai and Vandyck, 2020[17]), average wages (in the public sector)[18], labour productivity[19] and employment (in sections O-Q), and the unemployment rate. All variables are seasonally adjusted and expressed in quarterly growth rates, except for the unemployment rate, which is expressed in quarterly differences.

3.1 IDENTIFICATION OF THE EFFECTS OF PUBLIC SECTOR WAGE GROWTH ON INFLATION

The identification strategy we employ is outlined in table 1 and is primarily based on conventional macroeconomic theory and recent empirical literature. Aggregate demand and aggregate supply shocks are identified using standard sign restrictions found in the existing literature, while labour supply shocks are distinguished from wage mark-up shocks using the sign restrictions proposed by Foroni, Furlanetto and Lepetit (2018) and applied by Conti and Nobili (2019), as well as Bobeica, Ciccarelli and Vansteenkiste (2019, 2021) and Ivanac, Kunovac and Nadoveza (2024). The identification of shocks in the models for the overall economy and the

[15] According to the statistical classification of products by activity (CPA) section O includes public administration and defence services; compulsory social security services, section P includes education services, and section Q includes human health and social work services.

[16] Harmonised index of consumer prices.

[17] The HICP for public sector services is calculated as the share of consumption of a specific product by activity (CPA) in the public sector which is linked in the conversion tables to the corresponding category of consumption by purpose (COICOP) and the corresponding HICP index by purpose of consumption (COICOP). See explanation for table A2 and graph A1 for details.

[18] Calculated using Croatian Bureau of Statistics (CBS) data collected through regular monthly surveys on net and gross wages according to the classification of economic activities in the European community (NACE).

[19] Calculated as the ratio of GVA (gross value added of the O-Q sections) and the number of employees (in the O-Q sections).

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public sector – used to assess both the direct and indirect effects of public sector wage growth on inflation – is presented outside the parentheses. The identification using the unemployment rate, which is applicable only for the entire economy and which serves as a robustness check, is shown in parentheses. Namely, the existing literature usually uses the unemployment rate to identify shocks. Still, since there is no analogous indicator for the unemployment rate at the sectoral level, employment in the public sector is used as a proxy for the unemployment rate when identifying shocks within the public services sector. To ensure comparability, the model using employment and GVA is considered the baseline model for the overall economy. Models that use the unemployment rate and GDP to identify shocks are employed to test the robustness of the baseline model. This approach also aims to assess whether replacing the unemployment rate with employment is appropriate for the public sector, given that public sector employment is arguably more influenced by the political cycle than the business cycle. However, considering the absence of alternative indicators to identify shocks in the public sector since the correlation between annual employment growth rates in the public sector and the overall economy is moderately positive[20], we believe substituting employment for the unemployment rate may be justified if the results from the baseline and alternative models for the overall economy do not differ significantly.

Specifically, a positive demand shock is one that simultaneously boosts economic activity (measured by GVA and GDP), prices and wages. As economic activity rises, firms' greater demand for capital and labour leads to a reduction in the unemployment rate (i.e., increases employment). In the short run, following Okun's law, the effect on employment is smaller than the effect on economic activity, resulting in a rise in labour productivity. As a result, unit labour costs (wages adjusted for labour productivity) grow slower than wages. In addition to these short-run dynamics, it is assumed that economic activity does not respond to demand shocks in the long run, as standard macroeconomic theory assumes that demand shocks dissipate over time. Therefore, the long-term response of economic activity to demand shocks is assumed to be zero. On the other hand, a supply shock leads to increases in economic activity, labour productivity, and wages, while simultaneously reducing consumer prices and unemployment (i.e., increasing employment) (see, for example, Dedola and Neri, 2007; Peersman and Straub, 2009). In addition to these standard economic shocks, the model also identifies two shocks related to the labour market. A negative labour supply shock reduces labour force participation, which in turn lowers economic activity but also reduces the unemployment rate (increases employment). At the same time, wages and prices rise. This shock is differentiated from the aggregate demand shock by its distinct effect on economic activity. A wage mark-up shock, defined as an increase in the share of wages in the income distribution (wage growth[21]), raises wages while reducing producer profits (producer mark-ups). This increases marginal

[20] The correlation coefficient is 0.56.

[21] For example, structural reforms that lead to changes in wages regardless of the prevailing economic conditions (such as the 2024 public sector reform) or alter workers' bargaining power serve as good examples.

costs and inflation. Concurrently, the unemployment rate rises (employment decreases) as firms cut jobs due to higher hiring costs, and economic activity declines. In the case of labour market shocks in the economy-wide model, where we estimate the model using the unemployment rate, we remain neutral regarding the response of labour productivity. However, in the models estimated using employment, separating the two labour market shocks would not be possible without additional assumptions regarding the response of labour productivity to each shock. Thus, in the employment-based model, we assume that when wage mark-ups increase, GDP rises more slowly than employment, leading to higher productivity. Conversely, when a labour supply shock occurs, productivity declines. The fifth (and final) shock in the model remains unidentified. The short-term restrictions discussed above are summarized in table 1.

Table 1

Identification restrictions

Shocks/Variables	Demand	Supply	Labour supply	Wage mark-up	Other
GVA (GDP)	+	+	-	-	?
HICP	+	-	+	+	?
W	+	+	+	+	?
PROD	+	+	? (-)	? (+)	?
EMP (UR)	+ (-)	+ (-)	- (-)	- (+)	?

Note: GVA – gross value added, GDP – gross domestic product, HICP – harmonized index of consumer prices, W – wages, PROD – productivity, EMP – employment, UR – unemployment rate.

3.2 METHODOLOGY AND ASSUMPTIONS FOR ESTIMATING THE DIRECT AND INDIRECT EFFECTS OF PUBLIC SECTOR WAGE GROWTH ON INFLATION

To assess the direct effect of public sector wage growth on inflation, we treat wage growth resulting from the public sector coefficient reform as a wage mark-up shock in the public sector model. A key assumption is the exogeneity of public sector wage growth – meaning it is treated as a wage shock independent of other variables that typically influence wage dynamics, as outlined in the theoretical model in chapter 2.1.[22] This assumption is reasonable because the reform is exogenous by its nature, with the government making this decision independently of broader economic conditions. As a result, estimating the direct effect is straightforward, and the direct effect of public sector wage growth on inflation ($HICP_t^{direct}$) is:

$$HICP_t^{direct} = \sum_{h=1}^{4} IRF_h^{HICP_{O-Q}} \, shockW_t^{O-Q} \, HICP_t^{w_{O-Q}} \tag{6}$$

[22] It is important to note that this approach to analysing the effects of wages on inflation differs from cases where wage changes are the result of endogenous wage reactions to various economic shocks. In those situations, it is necessary to isolate the labour cost channel to evaluate its contribution to inflation at a specific point in time, considering the mix of shocks affecting the economy at that moment. It that case the focus is on the role of wages in amplifying the effects of economic shocks on inflation. The concept of studying "amplification" in a VAR model by constructing a hypothetical scenario – where wages do not respond to a specific shock – was employed by Ivanac, Kunovac and Nadoveza (2024), drawing on the methodology of Bachmann and Sims (2012) and Ciccarelli, Maddaloni and Peydró (2015).

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In equation (6), $IRF_h^{HICP_{O-Q}}$ represents the cumulative response of prices[23] to a one-standard-deviation public sector mark-up shock over a given horizon. In this paper, we set h=4, which corresponds to one year after the shock occurs. $shockW_t^{O-Q}$ indicates the magnitude of the public sector wage shock, expressed in standard deviations of the wage mark-up shock in the public sector model, while $HICP_t^{W_{O-Q}}$ refers to the share of public services in the consumer basket, based on the conversion tables from Cai and Vandyck (2020).

The estimation of the indirect effect of public sector wage growth on inflation that we propose in this paper is more complex and relies on a greater number of assumptions. To evaluate the indirect effect, we draw on the methodology used to calculate the wage-to-price multipliers (Bobeica, Ciccarelli and Vansteenkiste, 2019, 2021; Conti and Nobili, 2019; Ivanac, Kunovac and Nadoveza, 2024). The underlying idea is that exogenous, reform related, wage growth in the public sector, will stimulate aggregate demand and potentially spill over into wage growth in the private sector, creating shocks that could generate additional inflationary pressures. To estimate these effects, we first estimate a (B)VAR model for the entire economy, where we identify the same shocks as in the public sector model (demand, supply, and two labour market related shocks). This model allows us to examine the co-movements of prices and wages (labour costs) under the aggregate demand and wage mark-up shocks that could be triggered by exogenous public sector wage growth. We first estimate the strength of the wage mark-up shock resulting from the public sector wage growth shock at the economy-wide level. Then, using the wage-to-price multipliers for demand and wage mark-up shocks, we estimate the resulting effects on inflation.

To illustrate this approach, consider a positive demand shock that leads to higher prices. This happens because companies, benefiting from strong demand, have more incentives to raise prices. At the same time, as demand for inputs (labour and capital) increases, the cost of those inputs rises. Thus, wages increase endogenously, i.e. because of strong aggregate demand. To calculate the indirect effects of public sector wage growth on overall inflation through its impact on aggregate demand, we want to account for both channels (demand and cost) through which an exogenous wage increase in the public sector can influence inflation. Therefore, we need to examine the joint dynamics of prices and wages under aggregate demand and wage mark-up shocks, which is captured by the estimated (shock-dependent) wage-to-price multipliers. Hence, the indirect effect of public sector wage growth on inflation is represented by the product of the wage-to-price multipliers under aggregate demand and wage mark-up shocks, and the estimated size of the economy-wide wage mark-up shock related to public sector wage growth. As outlined in chapter 4.1, wage-to-price multipliers are defined as the ratio of the cumulative impulse response functions of HICP inflation and wages under identified economic shocks. The same methodology applies when assessing the potential

[23] The price response is measured by the impulse response function (IRF) of the public sector services HICP to a one-standard-deviation wage mark-up shock over a given horizon, *h*.

indirect effects of public sector wage growth on inflation through its potential spillovers to private sector wages.[24] Therefore, the indirect effect of public sector wage growth on overall inflation via the aggregate demand channel ($HICP_t^{AD\_indirect}$) is estimated using:

$$HICP_t^{AD\_indirect} = \frac{\sum_{h=1}^{4} IRF(HICP)_4^{AD}}{\sum_{h=1}^{4} IRF(WAGE)_4^{AD}} \Delta W_t^W \quad (7)$$

In equation (7), $\sum_{h=1}^{4} IRF(HICP)_4^{AD}$ represents the cumulative response of inflation to aggregate demand shocks in the overall economy model, while $\sum_{h=1}^{4} IRF(WAGE)_4^{AD}$ denotes the cumulative response of wages to an aggregate demand shock. ΔW_t^W refers to the change of wages under the wage mark-up shock resulting from the exogenous increase in public sector wages. It is calculated as a product of the cumulative impulse response function of wages to wage mark-up shock in the economy-wide model and the estimated size of wage mark-up shock expressed in standard deviations of the shock, i.e.:

$$\Delta W_t^W = \sum_{h=1}^{4} IRF(WAGE)_4^W \, shockW_t \quad (8)$$

We estimate the indirect effect of the public sector wage growth shock on inflation through its potential spillover to total wages in the same manner, specifically:

$$HICP_t^{W\_indirect} = \frac{\sum_{h=1}^{4} IRF(HICP)_4^{W}}{\sum_{h=1}^{4} IRF(WAGE)_4^{W}} \Delta W_t^W \quad (9)$$

In equation (9), $\sum_{h=1}^{4} IRF(HICP)_4^{W}$ represents the cumulative response of inflation to wage mark-up shock in the economy-wide model, while $\sum_{h=1}^{4} IRF(WAGE)_4^{W}$ denotes the cumulative response of wages to a wage mark-up shock. As in equation (7), ΔW_t^W is given by equation (8) and represents the estimated wage growth in the overall economy resulting from the exogenous wage increase in the public sector.

The total indirect effect of public sector wage growth on inflation is the weighted sum of these two indirect effects, specifically:

$$HICP_t^{indirect} = \alpha_{AD} HICP_t^{AD\_indirect} + \alpha_W HICP_t^{W\_indirect} \quad (10)$$

The equation (10) implies that we assume that the public sector wage growth, which indirectly impacts inflation through the aggregate demand channel, cannot concurrently affect inflation via a spillover to public sector wages, and vice versa. Therefore, $\alpha_{AD} + \alpha_W = 1$, or equivalently, $\alpha_W = 1 - \alpha_{AD}$, must always hold. Specifically, we assume that if some part of the increase in public sector wages spills over into the economy via the demand channel, we treat the rise in private sector wages as an endogenous result of the increased demand in the overall economy.

[24] In the case of wage spillover effects, the indirect effect can be calculated by using the impulse response function of inflation to wage mark-up shock and the estimated economy-wide wage mark-up shock.

Likewise, if some part of the increase in public sector wages spills over into the economy via private sector wages, we treat the increase in aggregate demand as an endogenous outcome of wage growth in both sectors. The total effect on inflation is calculated as the sum of the estimated direct effect and the total indirect effect.

4 RESULTS

4.1 THE RELATIONSHIP BETWEEN WAGE GROWTH AND INFLATION IN THE PUBLIC AND PRIVATE SECTORS

Before presenting the main results, this section briefly discusses key findings regarding the relationship between wage growth and inflation that can be compared with the results of existing research. The results presented are based on models that use gross value added and employment to identify shocks, with the estimated impulse response functions shown in graphs A2 and A3. The findings for the overall economy have proven to be relatively robust to the selection of variables in the model. Specifically, the key impulse response functions and the implied cumulative wage-to-price multipliers[25] (the ratio of cumulative impulse response functions of prices and wages) remain largely consistent across models that use different combinations of economic activity indicators (GDP and GVA) and labour market variables (unemployment rate and employment) for estimation and identification (see graphs A4-A15). The results are also consistent across models that are estimated using different periods (see graphs A16-A23).

Graph 3 illustrates the cumulative wage-to-price shock-dependent multipliers (CWPPT) for the public sector (graph 3a) and the entire economy (graph 3b). These multipliers, which we use to quantify the indirect effects of public sector wage growth on inflation, are calculated as the ratio of the cumulative impulse response functions of HICP inflation and wages in response to identified economic shocks in the public sector (graph A2) and the entire economy (graph A3), i.e.:

$$CWPPT_h^{k-th\ shock} = \frac{\sum_{h=1}^{H} IRF(HICP)_h^{k-th\ shock}}{\sum_{h=1}^{H} IRF(WAGE)_h^{k-th\ shock}} \tag{11}$$

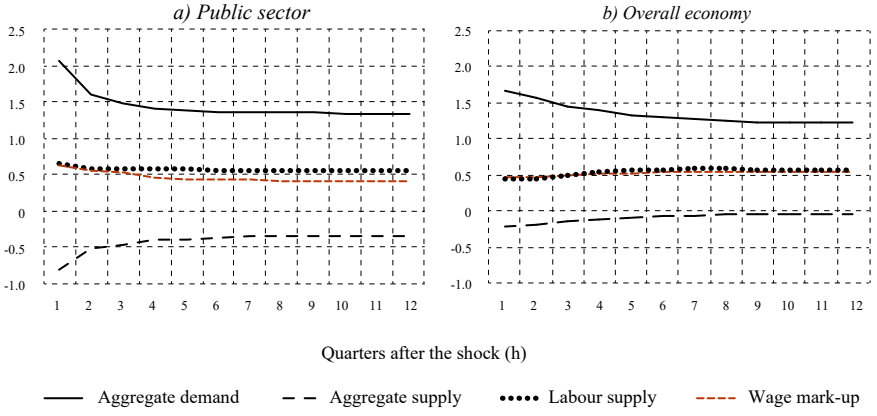
The results show that the positive relationship between wages and prices is particularly strong for aggregate demand shocks in both the public sector and the overall economy, wage growth being associated with 1.5 (economy-wide) to 2 (public sector) times stronger price growth in the short run (after one quarter, or h=1). This might suggest that public service prices tend to rise more significantly only during favourable economic conditions, such as periods of robust aggregate demand growth. The stronger relationship between wages and prices in the public sector during such times may be due to the higher share of labour costs (wages) in the public sector, which mainly produces services, compared to the other sectors in the economy. However, after a year (h>4), the relationship between wages and prices in the public sector closely resembles that in the overall economy.

[25] I.e., the relationship between wages and prices under different shocks, or the conditional correlations between wage growth and inflation.

However, the relationship remains relatively strong, which is consistent with findings from empirical studies (Bobeica, Ciccarelli and Vansteenkiste, 2019, 2021; Conti and Nobili, 2019; and Ivanac, Kunovac and Nadoveza, 2024). Additionally, under labour market related shocks, the wage-price relationship is only moderately positive in both the public and private sectors (cumulative wage-to-price shock-dependent multipliers are around 0.5). Conversely, in the case of aggregate supply shocks, the relationship between wages and prices is negative. This negative relationship is more pronounced in the public sector, in both the short run (-0.8 versus -0.2) and the long run (-0.35 versus -0.05). This may be due to public sector wage freezes during recessions, especially during the prolonged period when Croatia was under the Excessive Deficit Procedure (EDP), during which public sector wage growth was constrained regardless of inflationary pressures.

GRAPH 3

Shock dependent cumulative wage-to-price multipliers

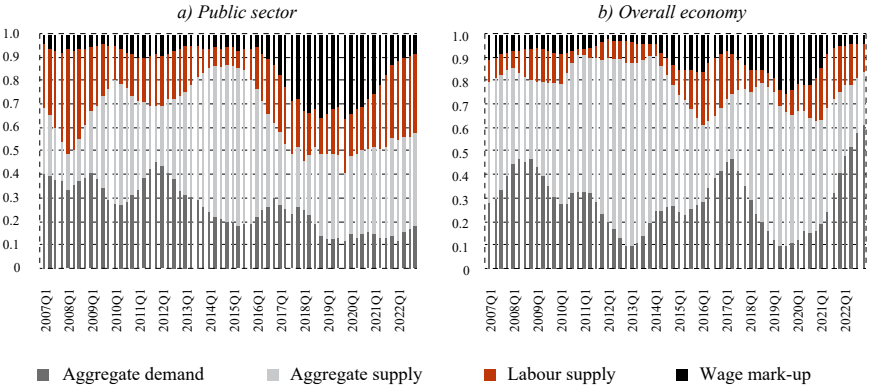


Source: Author.

The relationship between wage and price growth at any given point of time depends on the economic shocks that dominate wage dynamics, which in turn determine the ability of producers and service providers to pass on rising costs to consumers. This potential is clearly highest when wages are driven by aggregate demand shocks. Graph 4 shows that, after the first quarter of 2020, wage dynamics in the public sector were increasingly influenced by labour supply and aggregate supply shocks. This is likely related to technological changes and the digitalization of public services during the COVID-19 pandemic. In contrast, since 2022, wages in the entire economy have been primarily driven by exceptionally strong demand, which is probably at least partially related to the demand surge in tourism and the associated wage growth in the hospitality sector.

GRAPH 4

Relative importance of shocks in wage dynamics (2-year moving average)



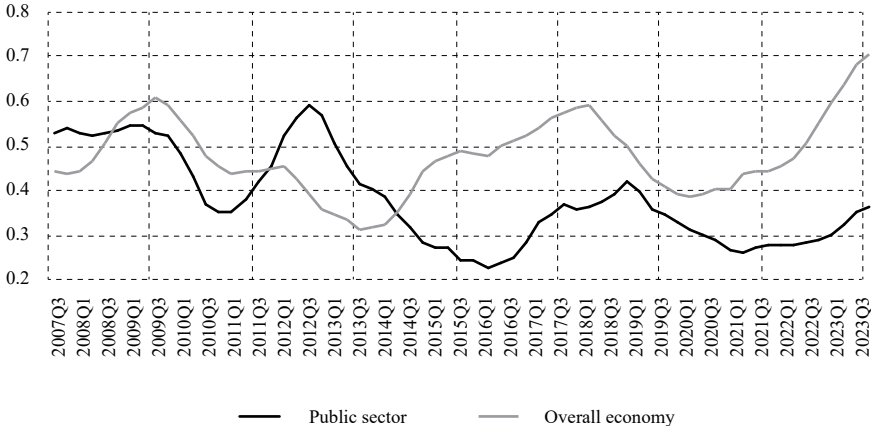
Note: The historical decomposition, used to calculate the relative importance of individual shocks in wage dynamics (see formulas A3 and A4 in appendix), is presented in appendix (graph A24) for both the public sector and the overall economy.

Source: Author.

As a result, the time-varying correlation between wage and price growth has been significantly higher in the overall economy than in the public sector in the recent periods (graph 5). This aligns with discussions on the potential effects of wage growth on inflation during periods of strong wage increases in Croatia, particularly in 2022 and 2023. It is also worth noting that the time-varying correlation between wage and price growth in the public sector is generally lower than in the overall economy. This is likely because public employees, when negotiating wage increases, do not typically take into account the rising prices of public services, but rather consider overall inflation during wage bargaining process.

GRAPH 5

Time-varying correlation between wage growth and inflation (2-year moving average)



Source: Author.

4.2 ESTIMATION OF THE EFFECT OF PUBLIC SECTOR WAGE GROWTH ON INFLATION

To estimate the potential direct, indirect, and total effects of public wage growth on inflation, we use the equations (6)-(10) developed and presented in section 3.2. We estimate the direct effect of public sector wage growth on inflation as the product of three components: the cumulative response of public sector services prices to a one-standard-deviation wage mark-up shock in the public sector (see the black mark on graph 6), the estimated size of the wage shock in the public sector and the share of public services in Croatia's consumer basket (based on matrices published in Cai and Vandyck, 2020). The wage mark-up shock in the public sector ($shockW_t^{O-Q}$) is calculated by subtracting last year's inflation rate (3.5%) and the long-term trend rate of labour productivity growth[26] in the public sector from the assumed annual growth in public sector wages due to the coefficient reform[27] (15%). This shock (10.85% year-on-year / 3.6% from Q2 2024) is 3.5 times larger than the standard wage mark-up shock in the public sector when expressed in quarterly growth rates. Taking into account the transmission of public sector wage growth to public sector prices, which is given by the response of public service inflation to public sector wage mark-up shock and equals 0.3 for a standard shock, the total annualized contribution to overall inflation (for the entire year of 2024) is estimated to be 0.15 percentage points[28]. Therefore, although the wage shock is substantial, the estimated contribution is modest mostly due to the small share of public services in the consumer basket (approximately 3.5%). It is important to note that this is likely the upper bound of the direct effect of public sector wage growth on overall inflation. Namely, the methodology we use assumes that the public sector can be modelled in the same way as the entire economy. However, the public sector prices are sometimes set administratively (as illustrated by the healthcare services price index in graph A1). As a result, the usual economic mechanisms observed in the price setting process in the entire economy may not always apply to the public sector. Since our approach does not take into account these specificities, it should be acknowledged that even this small effect might be overestimated.

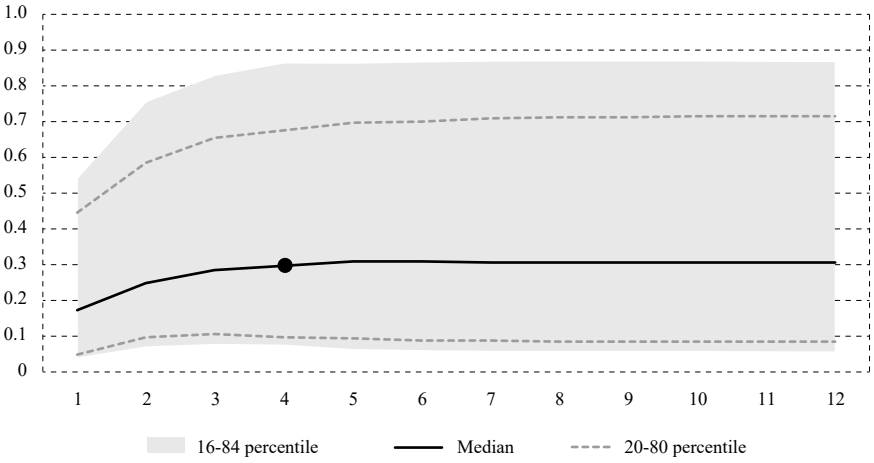
[26] As explained in the theoretical section, wages are endogenous and primarily driven by inflation in previous periods (wages catch-up to maintain real purchasing power) and labour productivity (if wage growth is offset by productivity gains it does not create additional production costs). To calculate the wage shock, the wage increase related to reform must be adjusted to account for last year's inflation and the anticipated labour productivity growth in the public sector. The expected annual productivity growth rate is 0.65%, which reflects the average of the annual growth rates derived from the Hodrick-Prescott trend of public sector labour productivity, based on the ratio of gross value added to employment in the O-Q sector.

[27] See: Government of RC (2024).

[28] $HICP_t^{direct} = \sum_{h=1}^{4} IRF_h^{HICP_{O-Q}} shockW_t^{O-Q} HICP_t^{W_{O-Q}} = 0.3 * (3.5 * 4) * 0.035 = 0.15.$

Graph 6

Cumulative response of public sector services HICP to a one-standard-deviation wage mark-up shock in public sector



Source: Author.

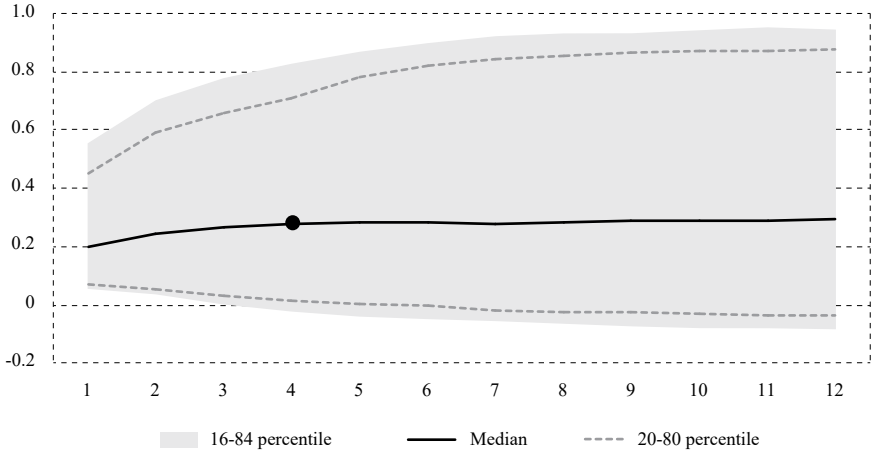
The indirect effect through the aggregate demand channel is given by equation (7). It is calculated as the product of the estimated wage-to-price multiplier for aggregate demand shocks in the model for the entire economy and the estimated economy-wide wage growth resulting from wage increases in the public sector. At a horizon of h=4 (one year), the wage-to-price multiplier is 1.4 (see graph 3b). The economy-wide wage growth due to public sector wage increases is estimated as the product of public sector wage growth (10.85% yearly / 3.6% quarterly starting in the second quarter of 2024), and the share of 244,000 employees[29] affected by the coefficient reform in total employment in Croatia (approximately 20%). In terms of standard deviations of the wage mark-up shock in the entire economy, this shock amounts to 56% of a standard wage mark-up shock. The change in wages related to a one-standard-deviation wage mark-up shock is given by the cumulative wage response to this shock in the economy-wide model and amounts to 0.28 after four quarters (see graph 7). Therefore, the annualized indirect effect of public sector wage growth through the aggregate demand channel could reach a maximum of 0.88 percentage points[30], but this would only occur if the wage growth in the public sector entirely spills over to the economy through the aggregate demand channel, which is likely to be an unrealistic assumption.

[29] See: Government of RC (2024).

[30] $HIPC_t^{AD\_indirect} = \frac{\sum_{h=1}^{4} IRF(HIPC)_4^{AD}}{\sum_{h=1}^{4} IRF(WAGE)_4^{AD}} \Delta W_t^W = 1.4 * 0.56 * 0.28 * 4 = 0.88.$

Graph 7

Cumulative response of wages to a one-standard-deviation wage mark-up shock



Source: Author.

The indirect effect through the public-to-private sector wage spillover channel is given by equation (8). It is calculated as the product of the estimated wage-to-price multiplier for wage mark-up shocks in the economy-wide model and the estimated wage growth across the entire economy, which results from the exogenous growth of wages in the public sector. At a horizon of h=4 (one year), this wage-to-price multiplier is 0.55 (see graph 3b). The increase in economy-wide wages due to rising public sector wages is the same as the one used to calculate the indirect effects of public sector wage growth on inflation through aggregate demand. Thus, the annualized indirect effect of public sector wage growth via the public-to-private sector wage spillover channel could come to as much as 0.34 percentage points[31], assuming that public sector wage growth fully spills over through this channel.

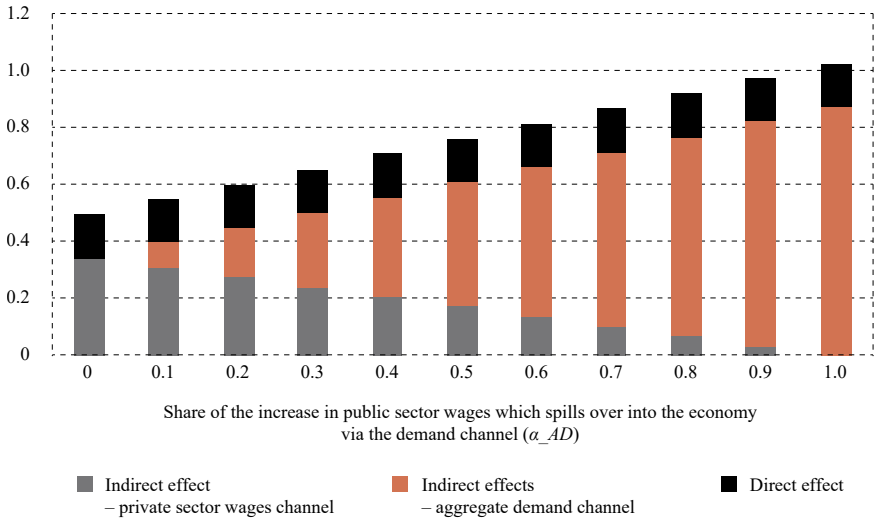
Our results indicate that the impact of public sector wage growth on headline inflation could range from 0.5 to 1 percentage point (see graph 8). Additionally, different model specifications (see graphs A4-A23) suggest that the lower bound of the estimated effect could range from 0.3 pp to 0.75 pp, while the upper bound could range from 0.6 pp to 1.6 pp (see graph 9). Graph 9 also illustrates that the results from the selected baseline model are very similar to those from models using GDP and employment data for the entire sample (2004Q1-2023Q4), as well as those using GDP and the unemployment rate for the period before the COVID-19 pandemic. Moreover, the selected baseline model results fall in the middle of the estimated effect range. Thus, despite the negligible direct effect of public sector wage growth on headline inflation, the indirect effects could be more significant, contributing between 0.34 pp and 0.88 pp to headline inflation. The strength of the estimated indirect effect depends on assumptions about the dominant public sector wage spillover channel (either through aggregate demand – α_{AD} or through public-to-private sector wage spillover – α_{w}).

[31] $HICP_t^{W\_indirect} = \frac{\sum_{h=1}^{4} IRF(HICP)_4^W}{\sum_{h=1}^{4} IRF(WAGE)_4^W} \Delta W_t^W = 0.55 * 0.56 * 0.28 * 4 = 0.34.$

Therefore, the overall effect will depend on which assumptions regarding the dominant channel through which public sector wage growth spills over to the economy best reflect the current situation. Since the role of wages in transmitting labour costs to inflation is weaker for the wage mark-up shocks, which is a typical cost-push shock, the potential for public sector wage growth to spill over into headline inflation decreases as a larger portion of the wage growth transmits into the economy through the public-to-private sector wage spillover channel.[32]

Graph 8

Estimated potential effect of public sector wage growth on headline inflation in 2024 (pp)



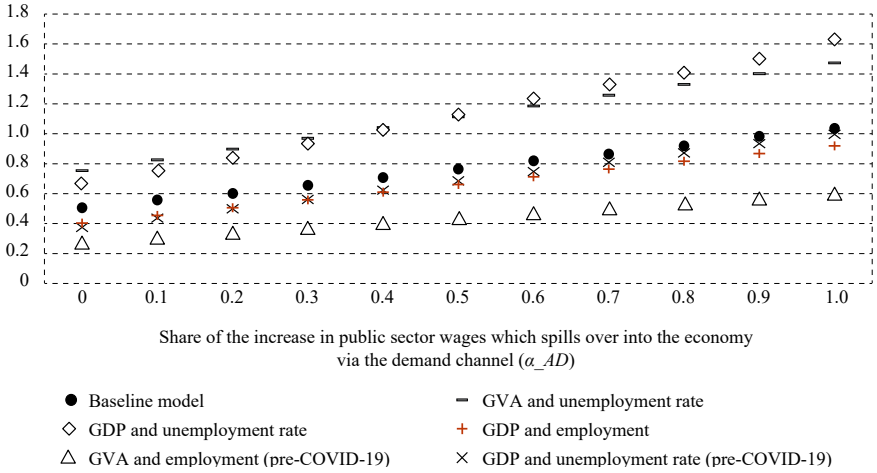
Note: The total effect was calculated using the formula: $HIPC_t^{total} = HIPC_t^{direct} + HIPC_t^{indirect}$, *where the total potential indirect effect is given by:* $HIPC_t^{indirect} = \alpha_{AD} HIPC_t^{AD\_indirect} + \alpha_W HIPC_t^{W\_indirect}$. *This was calculated under different, mutually exclusive assumptions related to* α_{AD}.

Source: Author.

[32] Although it may appear counterintuitive, it's important to note that any cost shock, by definition, negatively impacts production and leads to a reduction in employment (or an increase in unemployment). As a result, the pass-through of higher corporate wage bill to prices is moderated by the negative effects of reduced production and lower employment. In contrast, during demand shocks, the increase in costs due to wage growth further exacerbates price increases driven by strong demand.

Graph 9

Range of estimated effects across different economy-wide model specifications (pp)

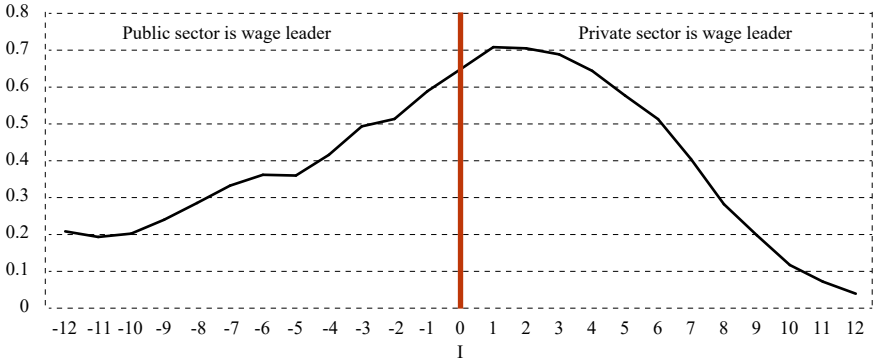


Source: Author.

Predicting which of these two channels will dominate in current situation is challenging. Based on the historical unconditional correlation of private and public sector wages growth shown in graph 10, we can observe a moderate to strong simultaneous correlation (l=0) of annual wage growth rates in the public and private sectors (0.65). While the private sector has typically been wage leader, implied by the fact that the highest correlation between public and private sector wages growth appears for l=1 (0.71) to l=4 (0.65), the moderate to relatively strong simultaneous correlation indicates that we can expect at least some public-to-private sector wage spillover. This suggests that the actual effect of public sector wage growth related to coefficient reform on inflation will probably fall within the middle of the estimated range of 0.5 pp to 1 pp.

Graph 10

Unconditional correlation between public and private sector wage growth



Note: The graph displays the unconditional correlation coefficients between public sector wages in period t and private sector wages in period t-l, where l represents a quarter and ranges from l = [-12, 12], corresponding to ±3 years.

Source: CBS, author.

5 CONCLUSION

Understanding the impact of public sector wage growth on inflation, especially during a period of high inflation and a strong labour market, is crucial for both monetary and fiscal policymakers. Of interest to monetary authorities, public sector wage increases could contribute to further inflationary pressures, potentially resulting in a higher inflation differential between Croatia and the countries with which it shares a common monetary policy. This could make the common monetary policy suboptimal for Croatia, in which case a more restrictive monetary policy would be more appropriate. From a fiscal policy standpoint, sustained inflation can lead to broader social challenges, increasing costs for the government, as seen during the inflationary episodes in 2022 and 2023.

Currently, there are no estimates of the potential effects of high public sector wage growth in 2024 on inflation. This gap in systematic estimates is partly due to the absence of a standard methodology for evaluating the impact of public sector wages on inflation. This is probably influenced by the prevailing view that the direct effect of public sector wage increases on inflation is small, given that public sector prices are non-market driven and make up a small share of the consumer basket (Whiteley, 2023). In this paper, we use the results of the methodology for analysing the wage to price pass-through to assess the potential impact of coefficient-reform-related public sector wage growth to headline inflation. We also provide an estimate of the overall impact that public sector wage growth in Croatia could have on inflation.

Using quarterly data for Croatia from 2004Q1 to 2023Q4 and (B)VAR models that approximate the WS-PS model, we identify key insights into the wage and price-setting dynamics in both the public sector and the broader economy. Additionally, we estimate the potential direct and indirect effects of public sector wage growth on headline inflation.

First, consistent with existing research, this paper confirms that the direction and strength of the wage-price relationship depend on the dominant shocks that drive economic and wage dynamics. The positive wage-price relationship is somewhat stronger in the public sector during aggregate demand shocks compared to the overall economy, but only in the short run. This suggests that public service prices typically rise significantly only during periods of economic growth, or "good" economic times, marked by aggregate demand expansion. In contrast, during aggregate supply shocks, the negative wage-price relationship is more pronounced in the public sector, both in the short and in the long run. This may be due to wage freezes in the public sector during recessions even when inflation remains positive, often driven by rising raw material prices. In the case of labour market shocks, the positive wage-price relationship is moderate and similar in the public sector and in the overall economy.

Second, since wage movements at any given point of time result from a unique combination of shocks affecting the economy, the (positive) correlation between wages and prices varies across sectors and changes over time. In this paper,

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we demonstrate that the time-varying correlation between wages and prices in the public sector is generally lower than in the overall economy. This is likely because public sector employees, when negotiating wage increases, do not consider the rise in public service prices as relevant information for wage demands; instead, they focus on overall inflation. Additionally, we show that in recent years, the correlation between wages and prices has not significantly increased in the public sector, while it has reached a historical peak at the economy-wide level. This suggests that exceptionally high wage growth in the public sector will not necessarily lead to substantial increases in the prices of public services. This finding supports the interpretation that the direct effect of public sector wage growth on headline inflation, as estimated in this paper, is likely its upper limit, considering the specific dynamics of wage and price setting in the public sector.

Third, even if high public sector wage growth were to significantly increase public service prices, the direct impact of public sector wage growth on headline inflation would remain limited and negligible. While the wage shock is exceptionally large (3.5 times stronger than a standard public sector wage shock), the wage pass-through to public sector prices – measured by the response of public service inflation to public sector wages in a standard wage shock – remains modest at 0.3. Given that public services make up only around 3.5% of the consumer basket, the total annualized contribution to inflation for 2024 is estimated at just 0.15 percentage points.

Finally, despite the negligible direct effect of public sector wage growth on total inflation, we show that indirect effects could be more significant. Depending on assumptions about the dominant channel of wage spillover – whether through aggregate demand or wage increases in the private sector – public sector wage growth could contribute between 0.34 and 0.88 percentage points to total inflation in 2024.

Our results suggest that the overall effect of public sector wage growth on headline inflation is likely to fall in the range of 0.5 to 1 percentage point, depending on the assumed channels of transmission. While this effect is relatively limited, especially considering the exceptional scale of public sector wage growth – which is assumingly expected to increase demand and wages in the private sector compared to a scenario with no public sector wage growth – it still can pose a challenge for both monetary and fiscal policy. This is particularly true in the context of strong demand, which could be further amplified by foreign demand during the tourist season.

Disclosure statement

The author has no conflict of interest to declare.

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APPENDIX

Estimation and analysis using the Bayesian Vector Autoregressive (VAR) model with sign and zero restrictions

To analyse the relationship between wages and prices in the public sector and the entire economy, we employ a Vector Autoregressive (VAR) model estimated using Bayesian techniques, based on data from Croatia spanning the period 2004Q1 to 2023Q4. Our estimation of the sign-restricted and zero-restricted Bayesian VAR model follows the methodology proposed by Arias, Rubio-Ramirez and Waggoner (2014). The procedure is outlined in detail by Deskar-Škrbić, Kotarac and Kunovac (2020), with their code adapted for the specific needs of this analysis.

The SVAR model with i lags can be expressed as:

$$A_0 y_t = \mu + A_1 y_{t-1} + \ldots + A_i y_{t-i} + \varepsilon_t, t = 1, \ldots, T \tag{A1}$$

where y_t is an $n \times 1$ vector of variables, A_j is an $n \times n$ matrix of fixed coefficients with an invertible A_0, μ is an $n \times 1$ vector of fixed coefficients, and ε_t represents structural economic shocks with an expected value zero and a covariance matrix I_n. i is the number of lags, which, following standard practice in models with quarterly data, is set to four ($i = 4$).

The SVAR model is used to compute the impulse response functions (IRFs):

$$\text{IRF}: \Psi_h = \frac{\partial y_{t+h}}{\partial \varepsilon_t}, h = 0, 1, 2, \ldots \tag{A2}$$

where $\psi_{jk,h}$ represents the median response of variable j to shock k after h periods.

In order to assess the relative importance of individual shocks (in absolute terms) in determining the dynamics of wages, or the historical decomposition of wages, which is necessary for calculating the time-varying correlation between wages and prices, we use the formula proposed by Deskar-Škrbić, Kotarac and Kunovac (2020):

$$\widetilde{y_{jt}^k} = \frac{\left| y_{jt}^k \right|}{\sum_{l=1}^{n} \left| y_{jt}^l \right|} \tag{A3}$$

In (A3), the contribution of shock k to variable j in period t, can be calculated as:

$$y_{jt}^k = \sum_{h=0}^{t-1} \psi_{jk,h} \varepsilon_{k,t-h}, h = 0, 1, 2, \ldots \tag{A4}$$

Unless otherwise specified in the results, we report the median and the 16th and 84th percentiles of the distribution of impulse responses over a horizon ranging from 1 to 12 or 24 quarters.

Following the approach of Deskar-Škrbić, Kotarac and Kunovac (2020), we apply the Gibbs sampling algorithm using the Independent Normal Inverse Wishart prior. At each step of the Gibbs sampler, with a given sample of VAR model parameters in

reduced form, we derive a set of structural models that satisfy the sign and zero restrictions used to identify the shocks. For the VAR model parameters to which no restrictions are applied, we use standard Minnesota priors, setting $\lambda_1 = 0.2$, $\lambda_2 = 0.5$, $\lambda_3 = 2$, and $\lambda_4 = 10000$. This choice reflects the use of a tight prior, in contrast to Deskar-Škrbić, Kotarac and Kunovac (2020), who employ loose priors.

Data

TABLE A1

Data and data sources, 2004-2023

Variable	Data	Source
Wages	Average wages based on regular monthly surveys of net and gross wages, classified according to the National Classification of Activities (NKD)	Croatian Bureau of Statistics (CBS), quarterly average, seasonally adjusted using X-12-ARIMA
Public sector wages	Average wages for sectors O, P, and Q based on regular monthly surveys of net and gross wages, classified according to the NKD	CBS, quarterly average, seasonally adjusted using X-12-ARIMA
HICP	Monthly Harmonized Index of Consumer Prices, seasonally adjusted using X-12-ARIMA, quarterly average	Eurostat, [prc_hicp_midx]
Public sector services HICP	See table A2 and graph A1	Eurostat, Cai and Vandyck (2020)
Gross domestic product (GDP)	GDP, constant prices, seasonally and calendar adjusted	Eurostat, [namq_10_a10]
Gross value added (GVA)	GVA, constant prices, seasonally and calendar adjusted	Eurostat, [namq_10_a10]
Gross value added (GVA) of public sector	GVA of O, P, and Q sectors, constant prices, seasonally and calendar adjusted	Eurostat, [namq_10_a10]
Employment	Employed individuals based on regular monthly surveys of employment by activity	CBS, seasonally adjusted using X-12-ARIMA
Employment in public sector	Employed individuals in of O, P, and Q sectors based on regular monthly surveys of employment by activity	CBS, seasonally adjusted using X-12-ARIMA
Unemployment rate	Unemployment rate, ages 15-74, percentage of the labour force, trend-cycle data	Eurostat, [une_rt_q_h]
Productivity	GDP/employment, GVA/employment	Eurostat, [namq_10_a10] and CBS
Productivity in public sector	GVA of O-Q sectors/employment of O-Q sectors	Eurostat, [namq_10_a10] and CBS

Source: Author.

Public sector services harmonized consumer price index calculation

The public sector services HICP is calculated by multiplying the share of spending on a specific product by activity (CPA) in the public sector, which is linked to the corresponding consumption category by purpose (COICOP) in the matrices from Cai and Vandyck (2020), with the relevant HICP index for that consumption purpose category. The columns of the matrices in Cai and Vandyck (2020) consist of the second-level hierarchical classification of products by activity, which can easily be mapped to the corresponding activities defined by the EU's statistical classification of economic activities (NACE). The rows in these tables represent consumption categories according to the COICOP classification at the second level (divisions). Each table cell contains data on spending for a specific COICOP category associated with a corresponding CPA product category. To calculate inflation for a given sector, the share of consumption allocated to that sector within the total consumption of a specific category is multiplied by the corresponding second-level HICP sub-index. A sample calculation for the health services sector (Q86) and the resulting HICP for health services is presented in table A2 and graph A1. In this case, the relevant COICOP consumption categories for the human health services are CP062 (out-patient services) and CP063 (hospital services). For each category, the share of total consumption is calculated, which is then multiplied by the HICP for outpatient and hospital services, and subsequently rescaled so that the index for the base year equals 100.

Table A2

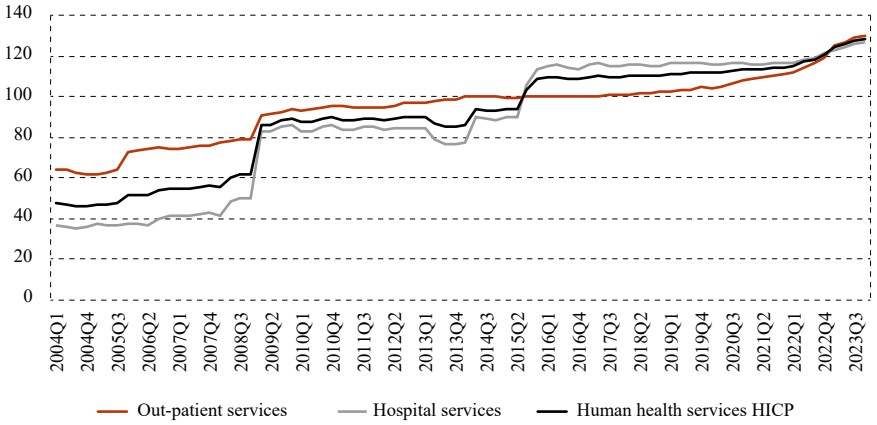
Part of the bridging matrices related to the human health services

Million euro, current prices	Out-patient services (CP062)	Hospital services (CP063)
Human health services (CPA_Q86)	386.5	80.4

Source: Cai and Vandyck (2020).

Graph A1

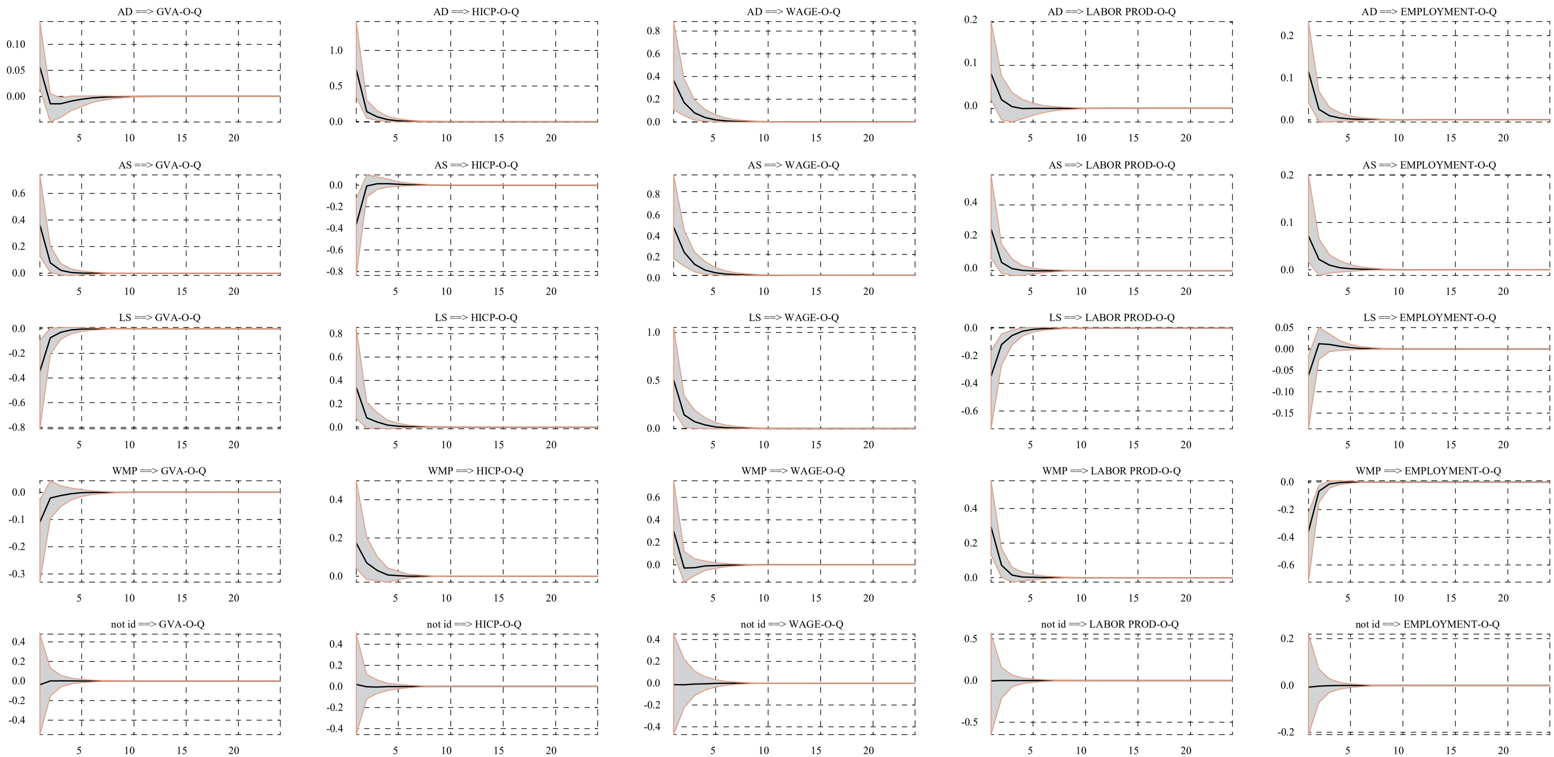
HICP for human health services and associated subcomponents



Source: Eurostat, Cai and Vandyck (2020), author's calculation.

Impulse response functions in the public sector model

GRAPH A2
Impulse response functions

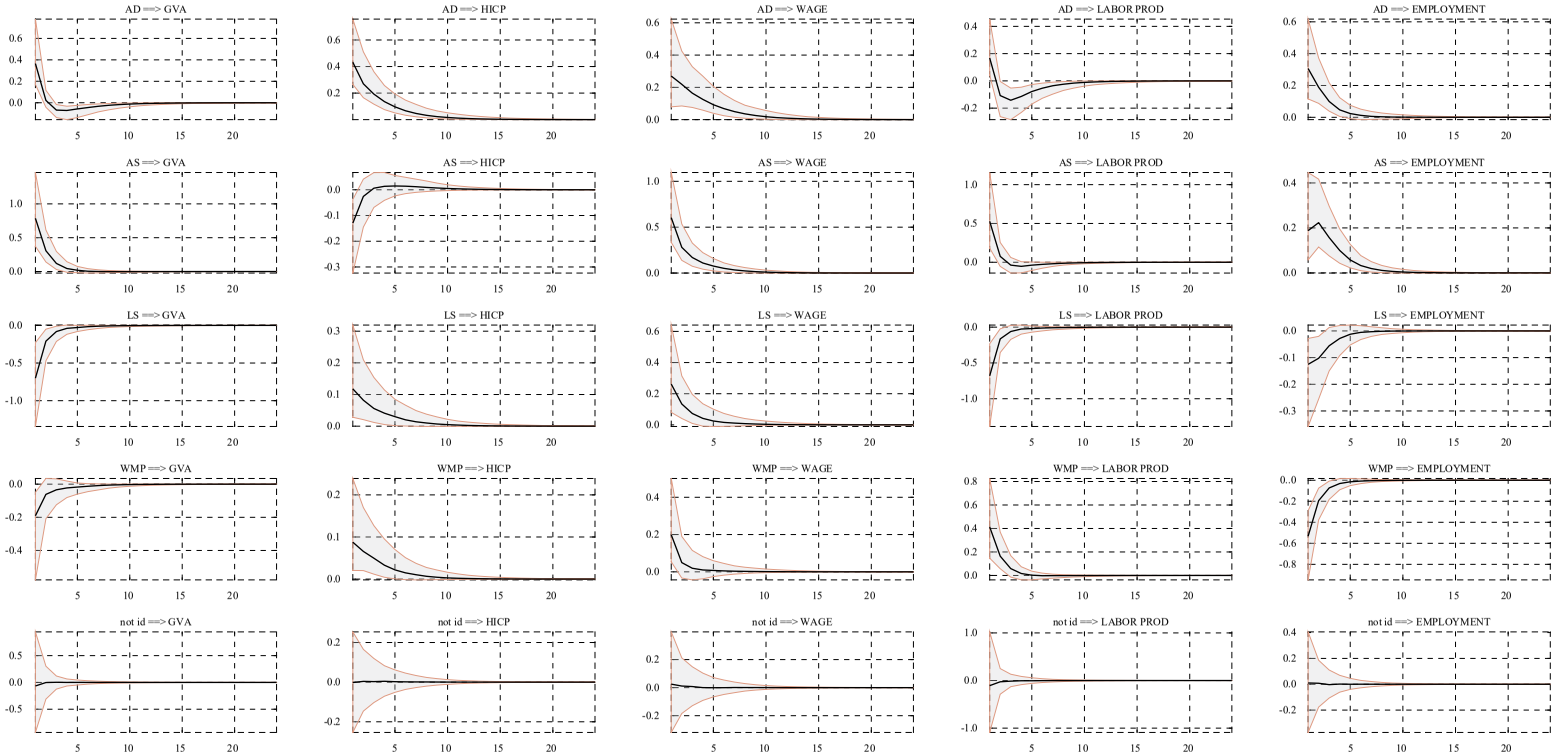


Source: Author.

Impulse response functions in the overall economy model

GRAPH A3

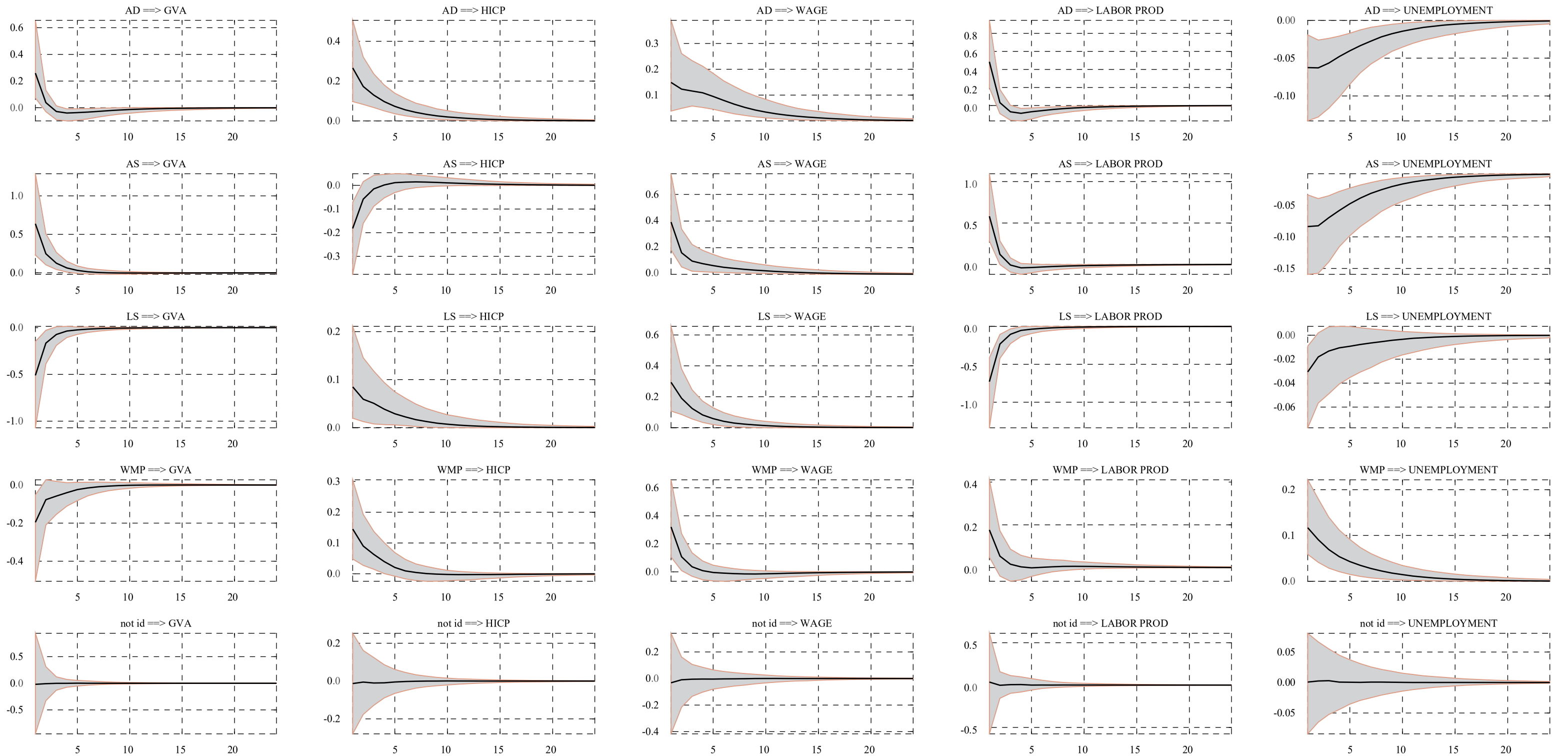
Impulse response functions



Source: Author.

Results from the model of the overall economy using gross value added and the unemployment rate

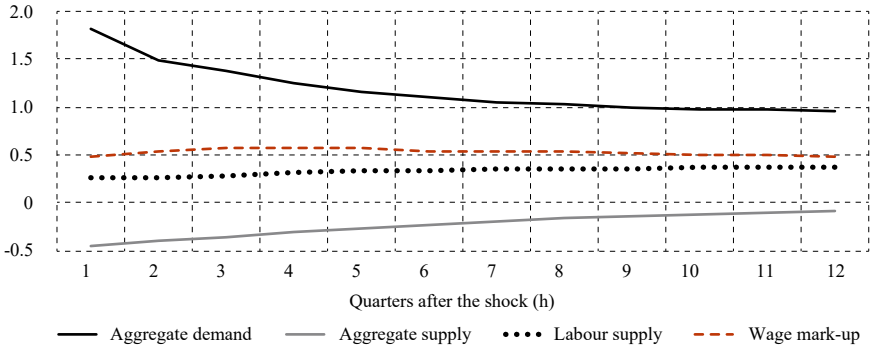
GRAPH A4
Impulse response functions



Source: Author.

GRAPH A5

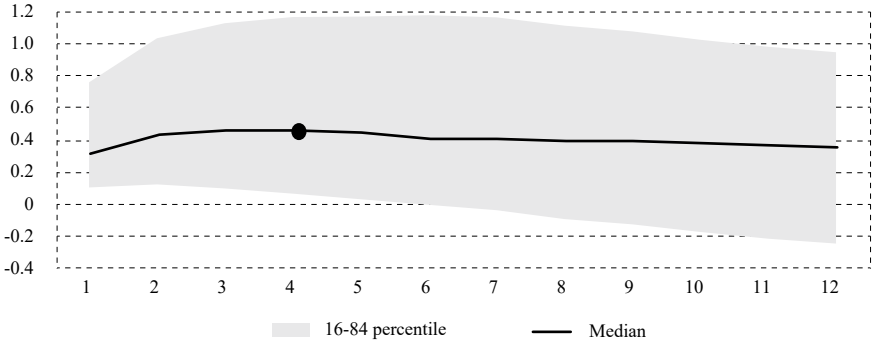
Shock dependent wage-to-price multipliers



Source: Author.

GRAPH A6

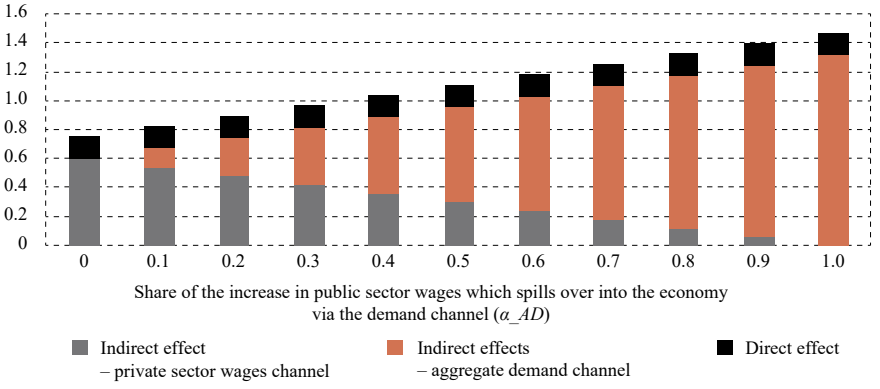
Cumulative response of public sector prices to a one-standard-deviation wage mark-up shock



Source: Author.

GRAPH A7

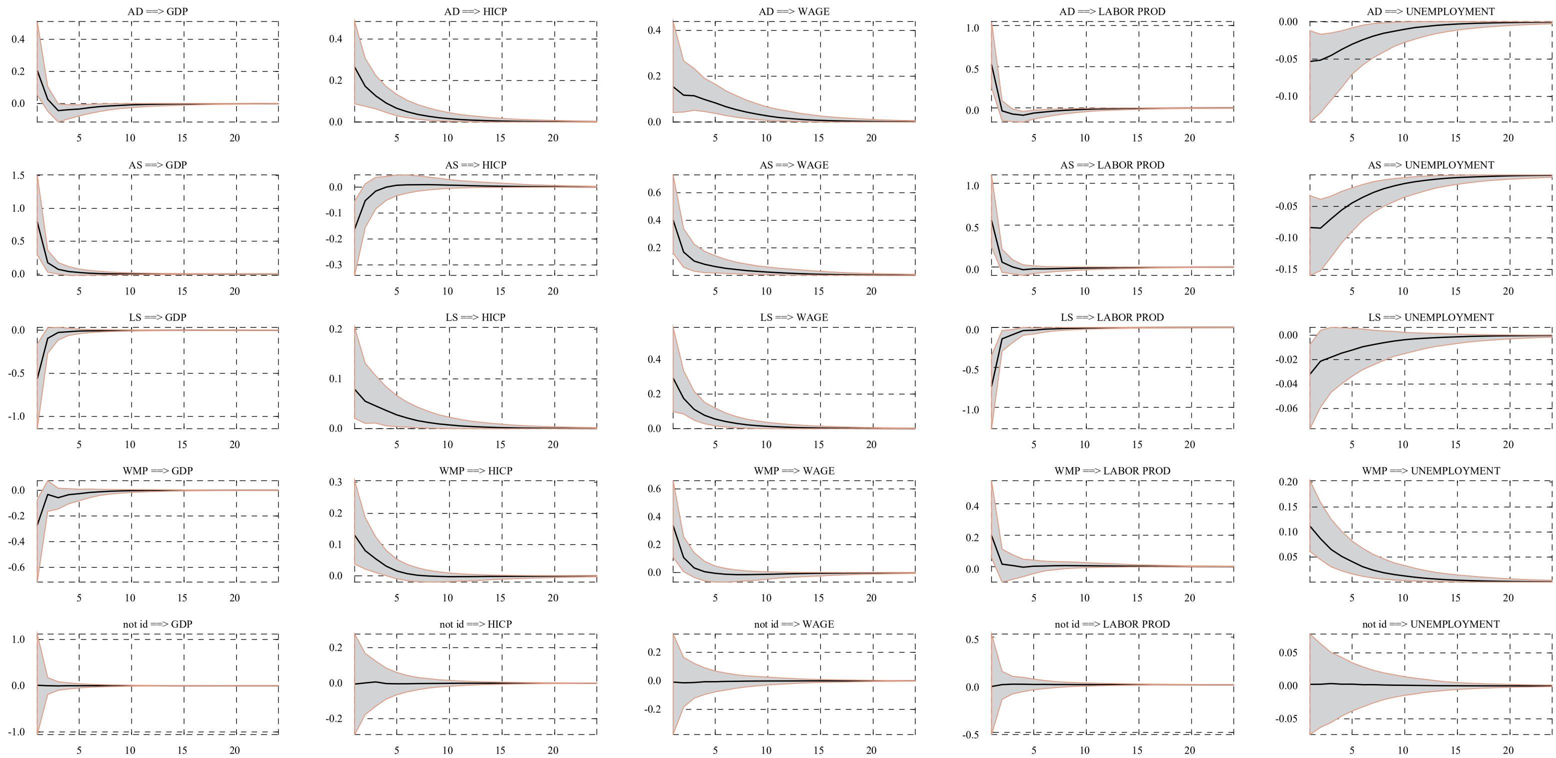
Estimated potential effect of public sector wage growth on headline inflation in 2024 (pp)



Source: Author.

Results from the model of the overall economy using gross domestic product and the unemployment rate

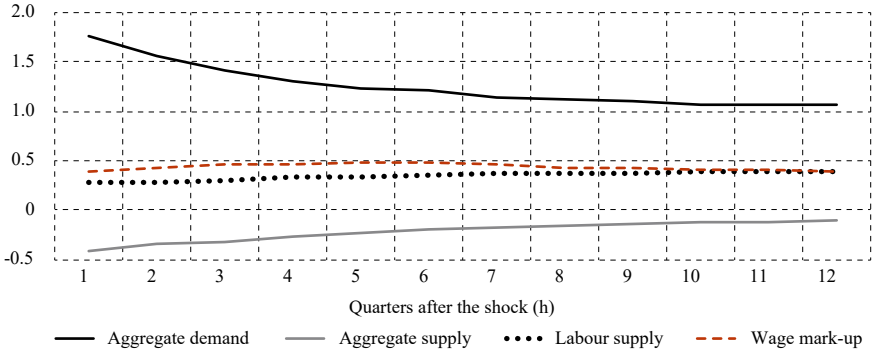
Graph A8
Impulse response functions



Source: Author.

GRAPH A9

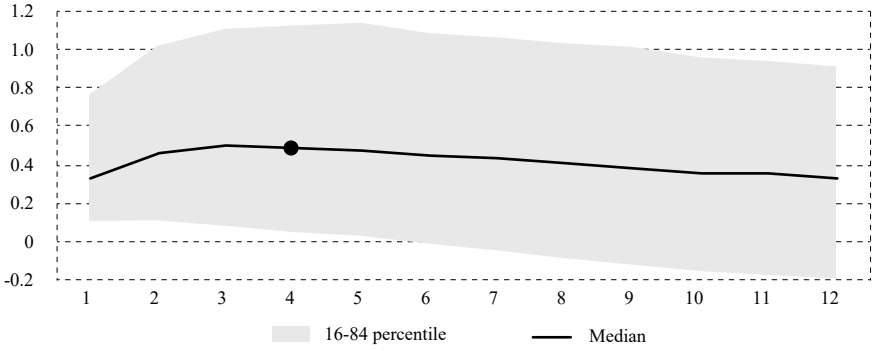
Shock dependent wage-to-price multipliers



Source: Author.

GRAPH A10

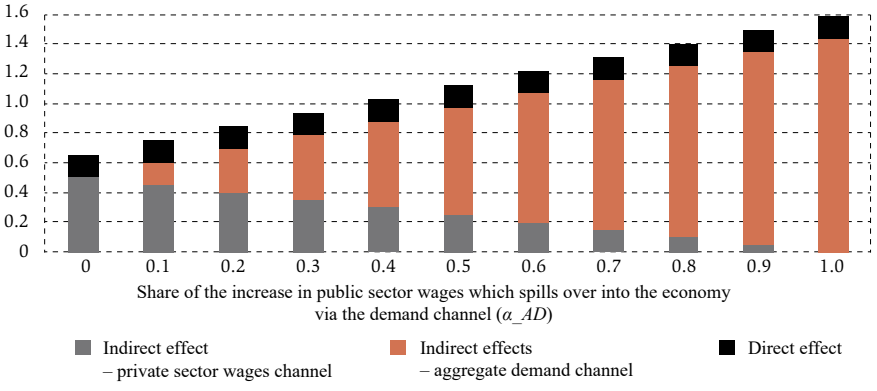
Cumulative response of public sector prices to a one-standard-deviation wage mark-up shock



Source: Author.

GRAPH A11

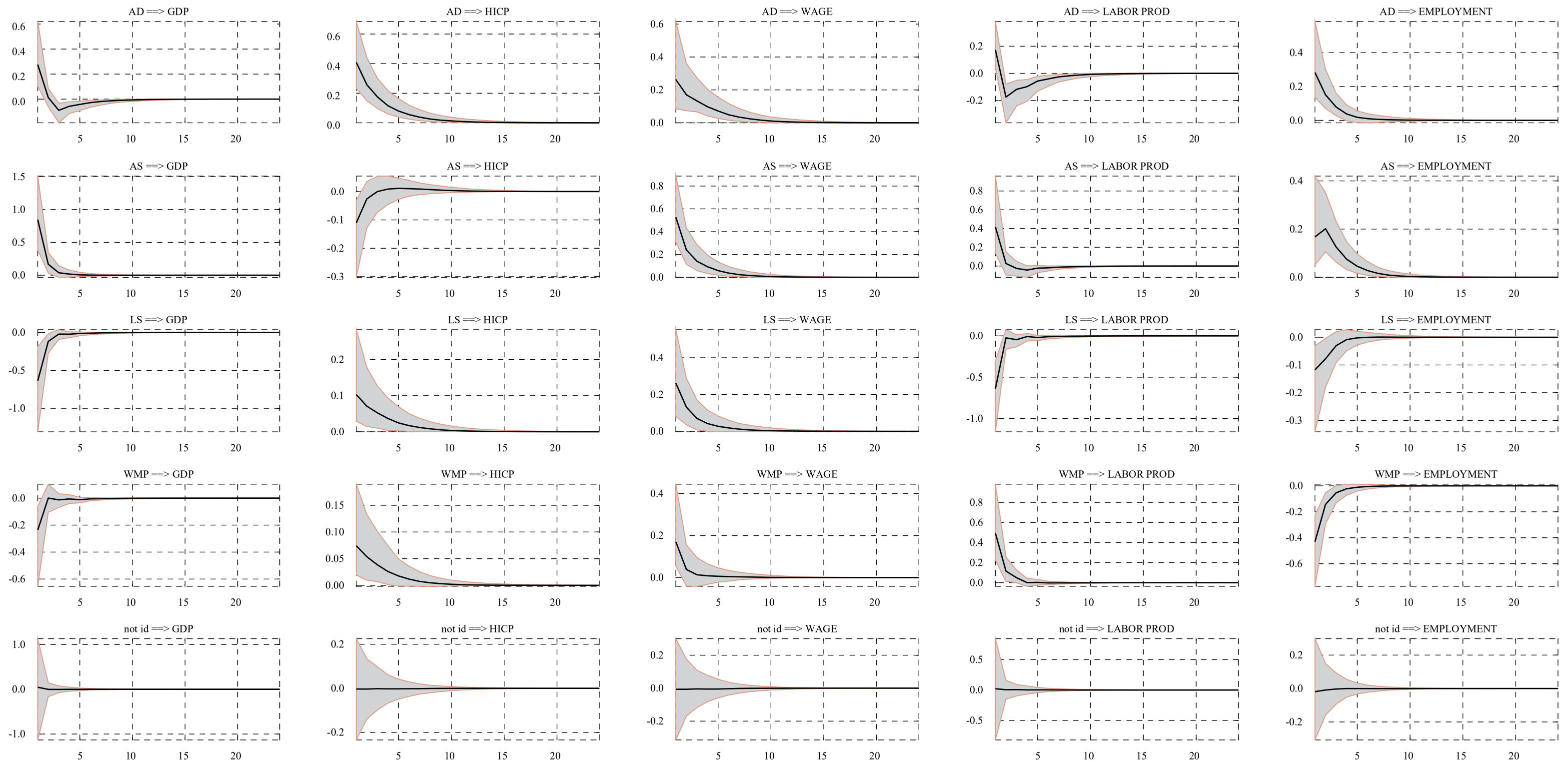
Estimated potential effect of public sector wage growth on headline inflation in 2024 (pp)



Source: Author.

Results from the model of the overall economy using gross domestic product and employment

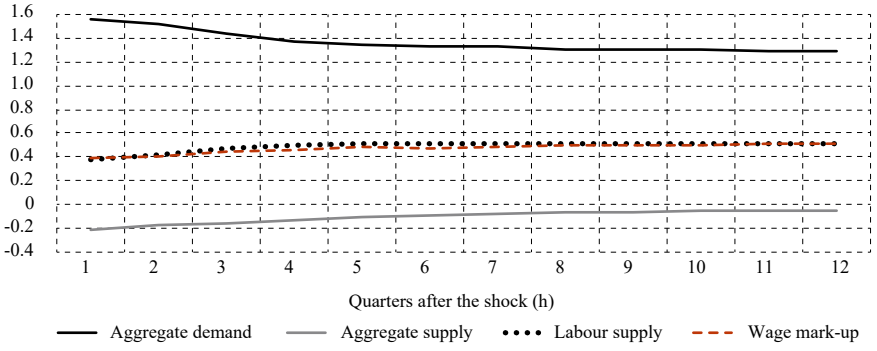
Graph A12
Impulse response functions



Source: Author.

GRAPH A13

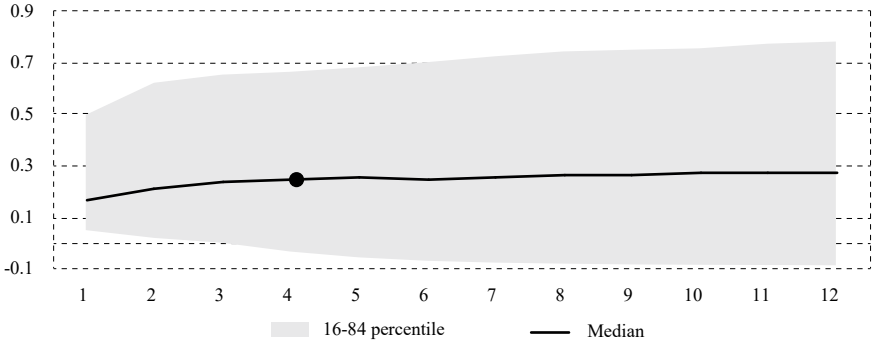
Shock-dependent wage-to-price multipliers



Source: Author.

GRAPH A14

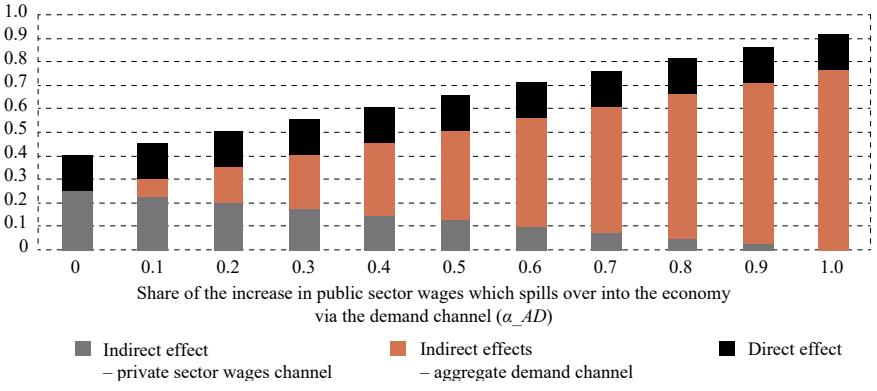
Cumulative response of public sector prices to a one-standard-deviation wage mark-up shock



Source: Author.

GRAPH A15

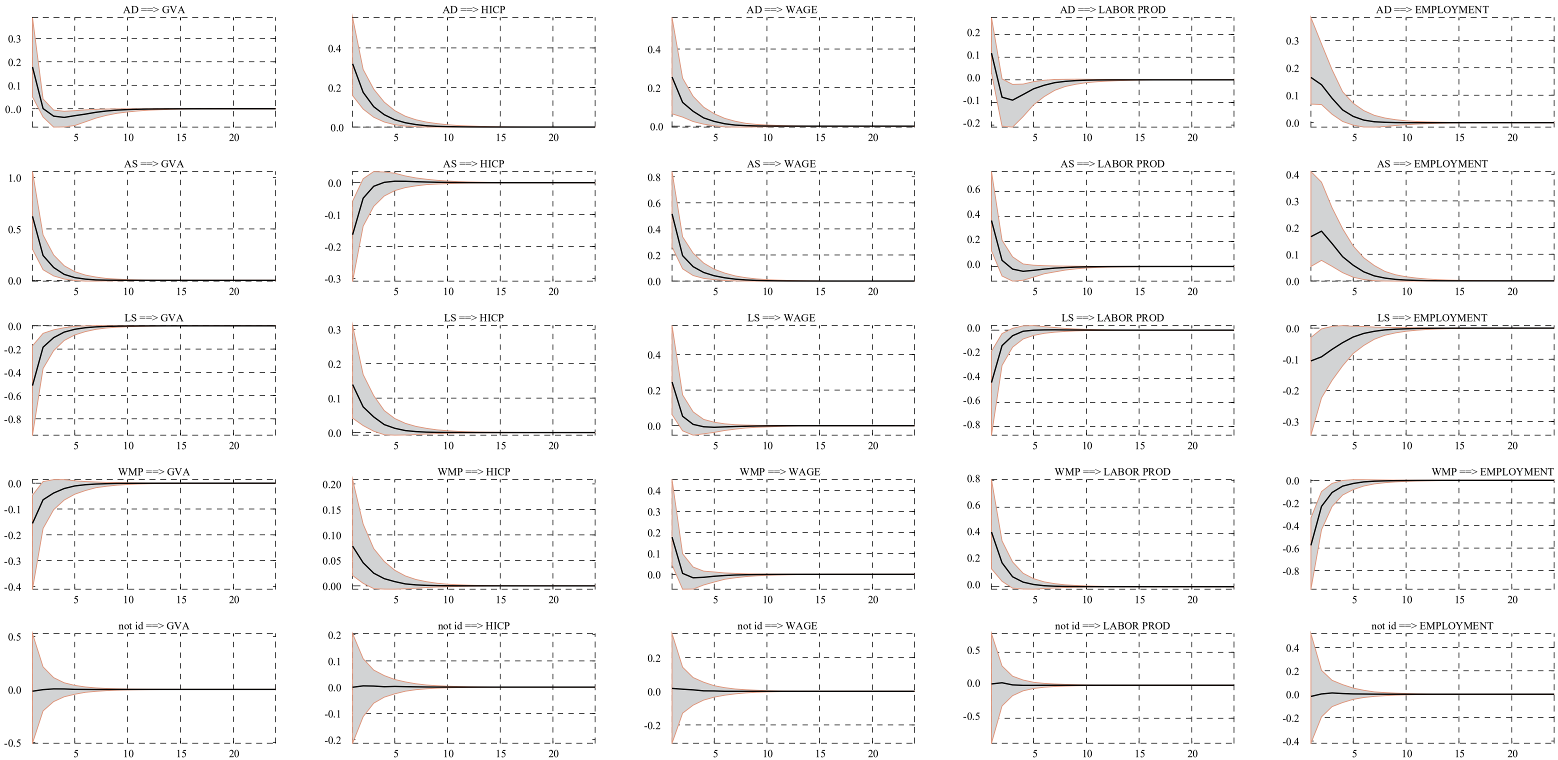
Estimated potential effect of public sector wage growth on headline inflation in 2024 (pp)



Source: Author.

Results from the model of the overall economy using gross value added and employment estimated before the COVID-19 pandemic (2004Q1-2019Q4)

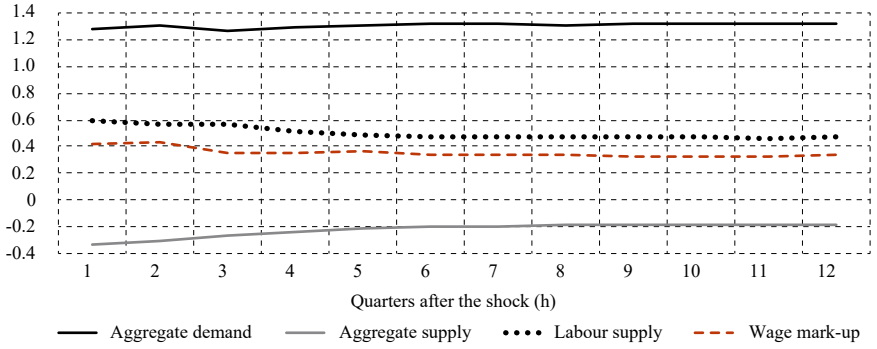
Graph A16
Impulse response functions



Source: Author.

GRAPH A17

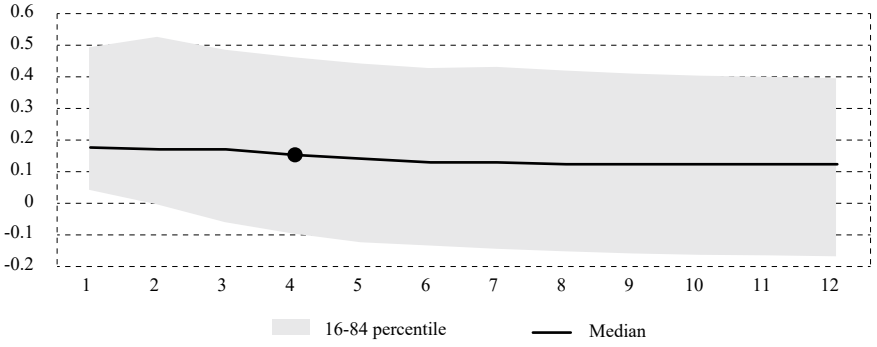
Shock-dependent wage-to-price multipliers



Source: Author.

GRAPH A18

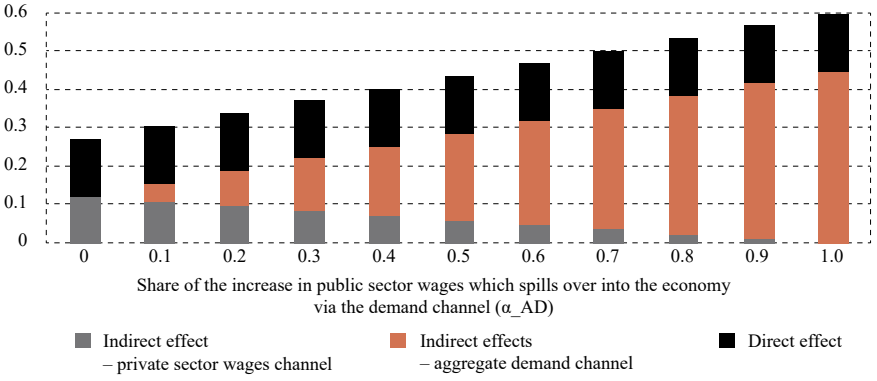
Cumulative response of public sector prices to a one-standard-deviation wage mark-up shock



Source: Author.

GRAPH A19

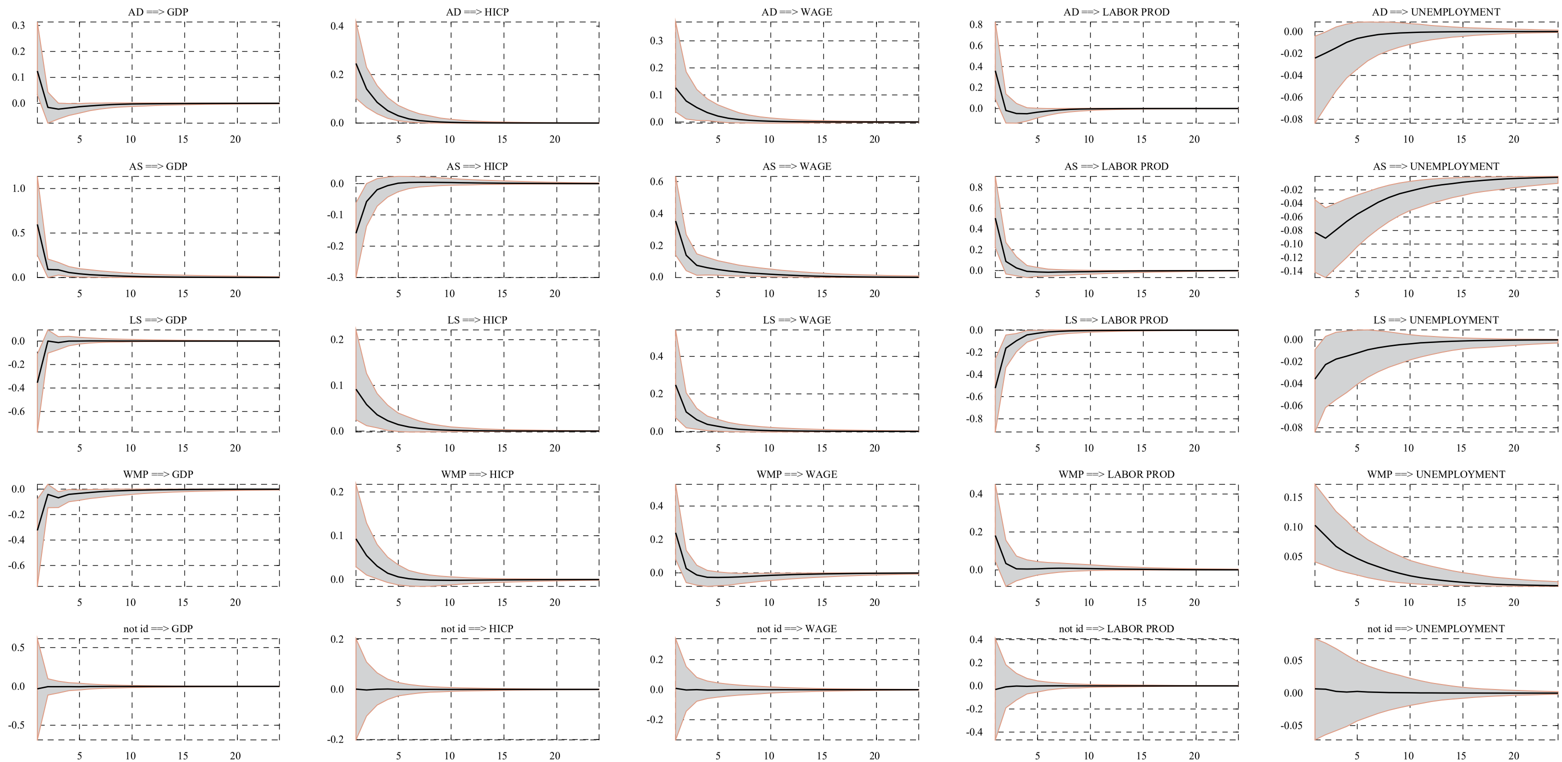
Estimated potential effect of public sector wage growth on headline inflation in 2024 (pp)



Source: Author.

Results from the model of the overall economy using gross domestic product and unemployment rate estimated before the COVID-19 pandemic (2004Q1-2019Q4)

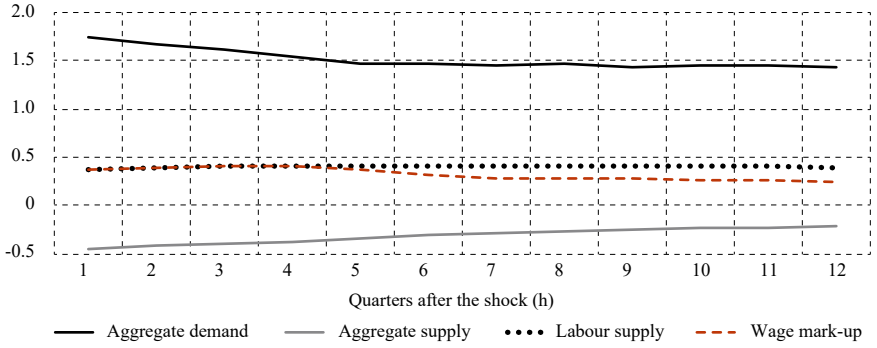
Graph A20
Impulse response functions



Source: Author.

GRAPH A21

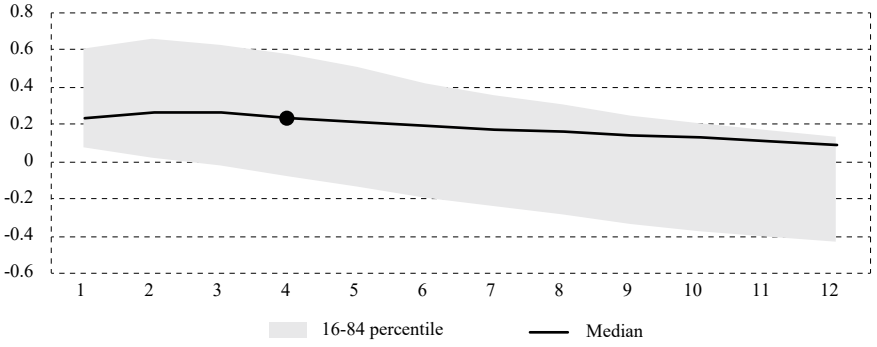
Shock-dependent wage-to-price multipliers



Source: Author.

GRAPH A22

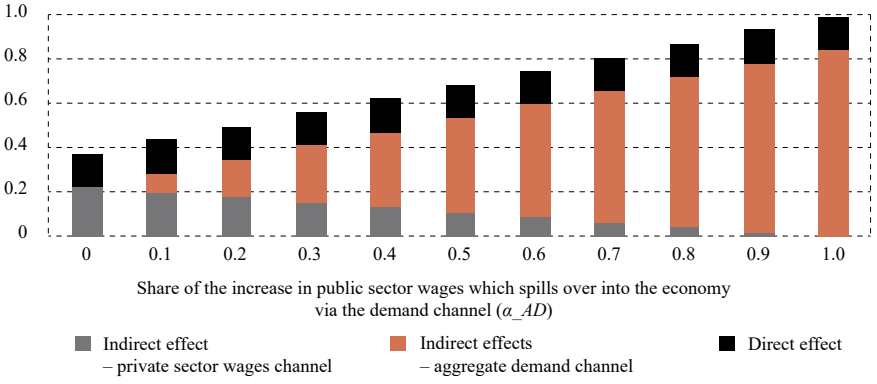
Cumulative response of public sector prices to a one-standard-deviation wage mark-up shock



Source: Author.

GRAPH A23

Estimated potential effect of public sector wage growth on headline inflation in 2024 (pp)

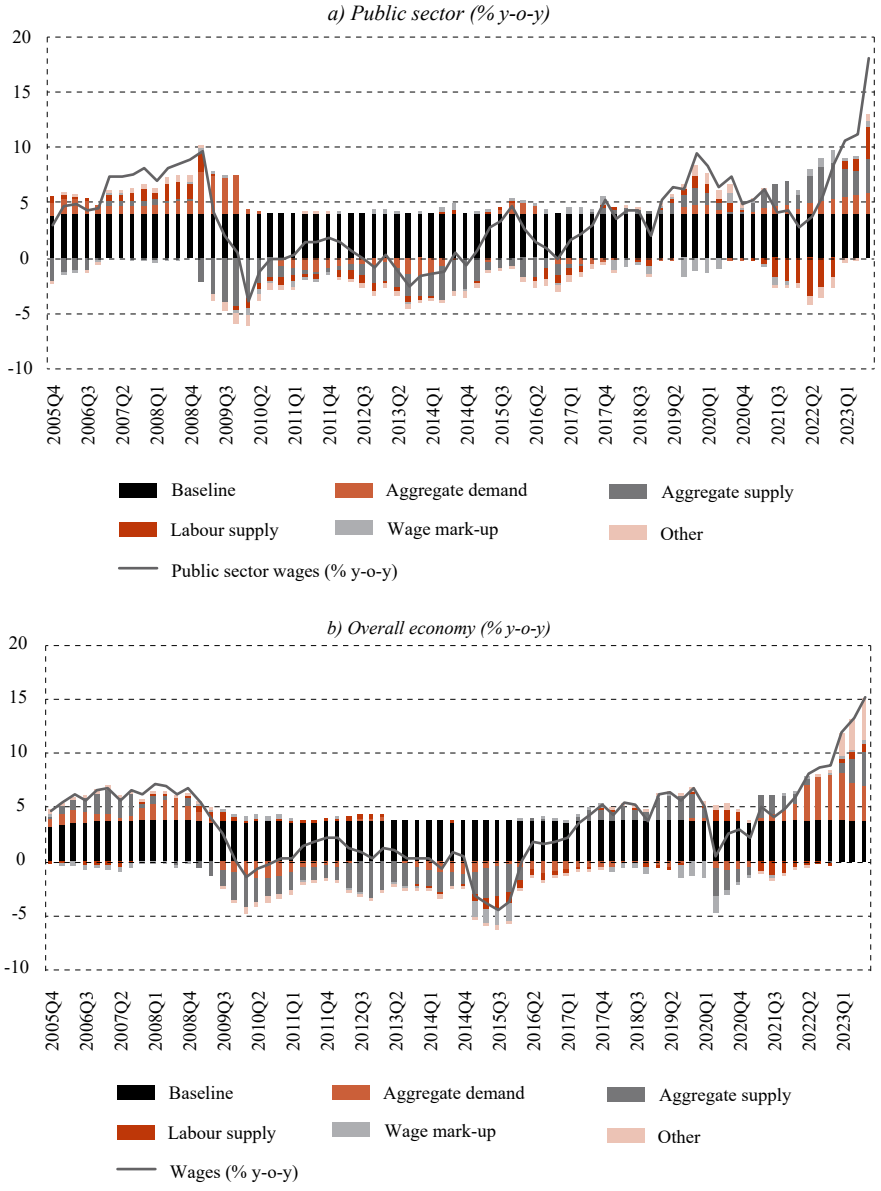


Source: Author.

Historical decomposition of nominal wages

GRAPH A24

Historical decomposition of nominal wages



Source: Author.