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Abstract

This paper investigates the effect of wage inflation on price inflation and vice versa, using industry-level data from Israel for identification. Various methodologies are employed to evaluate the wage inflationary effect, which yield consistent estimates of the pass-through from wage to price inflation. The findings suggest that a 10% increase in monthly wages is associated with a 1%-3% cumulative rise in prices a year ahead, an effect that gradually decreases in the following months. The analysis is extended to include the reversed effect of headline inflation on wages, thereby completing the wage-price spiral perspective. I find that within a year wages slowly adjust to catch up with an inflation shock. Lastly, the paper presents some evidence of a stronger relationship during the aftermath of the COVID-19 pandemic, albeit with considerable uncertainty. To a certain degree, the results indicate that labor market inflationary pressures may be higher than previously thought.

JEL Classification: E24, E31

Keywords: Wage-price spiral, pass-through, inflation dynamics.

אינפלציית שכר ומחירים: ניתוח ענפי

שירה בוזגלו-בריס

תקציר

מחקר זה בוחן את התמסורת מהשכר אל המחירים, ולהפך, תוך שימוש בנתונים ענפיים מישראל בשנים 2006-2022. שימוש במתודולוגיות שונות לזיהוי ההשפעה האינפלציונית של השכר מלמד על טווח אומדנים עקבי לתמסורת מהשכר אל המחירים: עליה של 10% בשכר, בהשוואה לחודש הקודם, תוביל לעליה מצטברת במחירים בהיקף של 1%-3% לאחר שנה. השפעה זו הולכת ודועכת בחודשים שלאחר מכן. בכיוון הנגדי, המחקר בוחן את התמסורת מהאינפלציה אל השכר ובכך משלים את התמונה של ספירלת שכר-מחירים. נמצא כי השכר מגיב באופן משמעותי לעליות בלתי צפויות במחירים, אך בפיגור של שנה. לבסוף, המחקר מצביע על עדויות אמפיריות לכך שהקשרים ההדדיים בין השכר והמחירים התחזקו בתקופה שלאחר היציאה ממשבר הקורונה, אולם ממצאים אלו מאופיינים ברמה גבוהה של אי ודאות לאור מגבלות הנתונים. במידה מסוימת, ממצאי המחקר מצביעים על הצורך לנקוט בגישה זהירה בהערכת הסיכונים האינפלציוניים משוק העבודה, שכן אלו עשויים להיות גבוהים מהערכות קודמות.

מילות מפתח: ספירלת שכר-מחירים, תמסורת, אינפלציה.

1 Introduction

This paper investigates the mutual effect between nominal wages[1] and prices, leveraging the availability of Israeli industry-level data from 2006 to 2022. Considering the two channels of a potential wage-price spiral, I examine how sectoral wage inflation affects sectoral price inflation and how headline inflation influences sectoral wage inflation. Using different methods and analyzing wage pressures from labor market competition and minimum wage policy, the results suggest an overall similar and consistent conclusion: a 10% increase in monthly wages is associated with a 1%-3% cumulative rise in prices a year ahead. Considering the reversed pass-through from headline inflation to wage inflation, I find that wages adjust, within a year, to catch up with an inflation shock. After accounting for different coefficients in the post-COVID-19 pandemic period, the estimated pass-throughs exhibit higher values in both directions, albeit with some uncertainty.[2] To a certain degree, these findings suggest that labor market inflationary pressures might be higher than previously thought.

The effect of wage inflation on price inflation comes from the dual role of workers in the economy. First, workers are a production factor. Hence, wage inflation puts pressure on firms' marginal cost. At the same time, workers are also consumers. Hence, higher income may lead to greater demand for goods and services, potentially affecting firms' optimal pricing. Accounting for labor productivity, both directions may lead to higher prices, following a wage shock. The industry-level analysis emphasizes the above distinction between cost-side and demand-side effect of wage inflation on price inflation. I follow Shapiro (2023) who concluded that labor cost affects inflation through the rise in marginal cost. That is, I specify an industry-level price equation and ask how industries' prices respond to an increase in the cost of employing their own workers. I carefully answer this question by using various methods and sources of exogenous variation in wages to draw similar conclusions, while discussing each method's advantages and limitations. The findings suggest that a 10% monthly increase in wages is associated with a 1%-3% cumulative rise in prices a year ahead, an effect that gradually decreases in the following months. In that sense, I contribute to the

[1] The paper studies the link between prices and wages in nominal terms. I will use the term "wages" as a shorthand for "nominal wages".

[2] That is, post-pandemic coefficients were estimated from a limited sample and should be interpreted with caution. Moreover, the null hypothesis that pass-through rates before and after COVID-19 are equal cannot be significantly rejected.

literature by providing a consistent range of estimates for the pass-through from wage to prices.

As a baseline, I estimate a reduced-form price Phillips curve with industry and time fixed-effects using local projection to examine the dynamic effect of wages on prices. Controlling for productivity growth and based on a 2006-22 sample, a 10% increase in wages leads to a less than 1% increase of price inflation a year ahead.

Wages are potentially endogenous if they respond to industry-level shocks that affect prices too. To account for such a possible endogeneity, I use two sources of exogenous variation in wages: (a) competition over workers, and (b) minimum wage legislations. First, I use the wages of competing industry (in terms of employment) as an instrument for wages in industry j, computed from rich micro-level data. This instrument is based on labor market competition for workers, triggering wage pressures. The cumulative price inflation response to a 10% monthly wage increase is approximately 2.5% one year later.

An additional way of assessing how wage increments translate into prices is through the lens of minimum wage legislations. I find that the response of industry prices to a minimum wage increase is proportional to the share of minimum wage workers in that industry.[3] That is, with approximately 20% miminum wage workers in the Israeli economy, a 10% increase in minimum wage will raise overall prices by 2%, a year after.

Completing the wage-price spiral perspective, the pass-through from inflation to wages is studied within the framework of a wage Phillips curve (Galí, 2011; Galí and Gambetti, 2019).[4] I find that, within a year, nominal wages are adjusted to catch up with an inflation shock. The analysis yields suggestive evidence that the mutual transmission effects - from wages to prices and from prices to wages - are more pronounced in the high-inflation environment following the pandemic. However, this conclusion is subject to a degree of uncertainty due to the limited sample size.

[3] Several papers in the literature found some positive effect of minimum wage increase on prices (Clemens, 2021; Luca and Luca, 2019; Allegretto and Reich, 2018; Lemos, 2008). Harasztosi and Lindner (2019) found that 75% of the cost of a large increase in Hungary's national minimum wage was passed on to consumers, with greater effect in non-tradable industries. Ashenfelter and Jurajda (2022) found near-full price pass-through of minimum wages using McDonald's restaurants data.

[4] A related study in the Israeli case is Brand (2024) who used information shock to obtain a pass-through of 0.1 from aggregate inflation expectations to aggregate nominal wage deviation from productivity trend during low and stable inflation periods.

1.1 Related Studies

Recent studies found a stable wage Phillips curve[5] (Beraja et al., 2019; Galí and Gambetti, 2019) along with a flattening price Phillips curve (Coibion and Gorodnichenko, 2015; Stock and Watson, 2019). The combination between these two findings is suggestive evidence of a limited pass-through from wages to inflation in a period of low and stable inflation (Bobeica et al., 2019; Peneva and Rudd, 2017). Heise et al. (2022) discuss potential explanations for the missing pass-through from wage to price inflation before the COVID-19 pandemic, focusing on local and foreign competition level. That is, negative markup shocks are likely to offset the rise in input cost and lead to negligible rise in prices.

The mutual effect of wage and price inflation is often referred to as a wage-price spiral. Lorenzoni and Werning (2023) suggest wage-price spiral is a result of a distributional conflict between workers and firms on the level of the real wage. That is, in response to an inflationary shock, workers demand a wage increase (for a given level of productivity). Then, second round effects come from a rise in labor cost and rise of demand through an income effect. If firms raise prices by more than what labor cost increased, it will generate an even accelerating behavior of prices. Blanchard (1986) links the length of the spiral to the degree of wage and price stickiness. Empirically, the limited pass-through found in recent literature, suggest a muted risk of a wage-price spiral (Alvarez et al., 2022).

The significant rise in inflation in the post-COVID-19 pandemic period, accompanied by a tight labor market, induced ongoing research on the mutual relation between wages and prices. In many countries, the stickiness of services inflation is assumed to be related to labor market pressures and wage inflation. Jorda and Nechio (2023) estimate a significant effect of the generous fiscal support in the pandemic on wages and price inflation with slightly faster response of prices and recent increase in the effect of inflation expectations on wage setting. Borio et al. (2023) suggest that the correlation between wage and price inflation is higher in a high-inflation regime, Blanchard and Bernanke (2023) claim that the effect of an overheated labor market has a more persistent effect than other shocks, and Amiti et al. (2023) show that joint shock to wages and input prices in the post-pandemic era have an amplified effect on price inflation by muting the substitution channel between the factors of production. Chin and Lin (2023) found a stronger pass-through from wage to price inflation in the COVID-19 pandemic recovery, using

[5] That is, a significant relation between activity or unemployment and wage inflation.

US sectoral data.

Contributing to the above ongoing research, this paper documents higher, albeit statistically insignificant, pass-through in the post-COVID-19 pandemic period while implementing various identification schemes to better account for the endogeneity of wages. The recovery from the pandemic was characterized by a debate over minimum wage increases in many countries. This paper also contributes by discussing the effect of minimum wage increases on prices, finding significant transmission in this direction. Completing the wage-price spiral perspective, the analysis also discusses the potential pass-through from inflation to wages.

The empirical analysis is based on industry-level panel data which is beneficial for several reasons. Unobserved macro-level shocks and industry effects are absorbed with the inclusion of time and industry fixed effects. It also makes it possible to identify which industries are driving the relationship and to what extent, which might be relevant for optimal policy design. However, the inclusion of time fixed effects leaves only cross-industries variation to study the effect of wages on prices. There might be reasons to believe that the response to an idiosyncratic wage increase is different (possibly smaller) from the response to a potentially wide increase in wages experienced by all industries. Acknowledging this limitation, I join many studies leveraging micro-level data to macro-level inference (McLeay and Tenreyro, 2020; Heise et al., 2022; Amiti et al., 2023).

The rest of the paper is organized as follows: Section 2 describes in detail the data used for the empirical analysis. Section 3 discusses the wage inflationary channel, specifies each model, and presents its estimation results. Section 4 examines the reverse direction - the pass-through from price to wage inflation, and Section 5 explores the post-COVID-19 period dynamics, discussing potentially higher transmission in both directions. Finally, Section 6 concludes.

2 Data

The analysis builds on industry-level data from the Israeli Central Bureau of Statistics (ICBS). I use data from different sources, combined by the one-digit industries classification.[6] Due to several reasons, as discussed below, I end up using 8 main industries[7] that account for 75%-80% of the Israeli private sector sales.

[6] See Central Bureau of Statistics (2015) for the 2011 industries classification.

[7] In fact, these are 10 industries (out of a total of 21 one-digit industries, each with different weights), with 'B' and 'C' grouped together, as well as 'R' and 'S'.

2.1 Prices and Productivity

Price indices by industries are composed of CPI components combined with surveys or administrative data on the industry activity. For example, the price index for Accommodation and Food Service Activities (industry I) is based on the "food away from home" CPI component and a survey of hotel revenues. The price indices for high-tech and scientific service industries (J, M) are often proxied by wage increases in these sectors, which makes them less suitable for analyzing the relationship between wages and prices, and hence they are excluded.[8]

The ICBS publishes each month a sales index by industry, based on administrative Value Added Tax (VAT) reports of businesses. These are published in nominal and real terms, adjusted to industry-level price indices, as described above.[9] The index is used as a proxy for activity by industry and has the advantage of monthly frequency and detailed industries data.[10] Growth of real sales divided by employee jobs is used as a proxy for real productivity growth. Several industries were omitted due to lack of comprehensive data. I omit the public sector industries (public administration, education, health and welfare) which have no sales data due to exemption from VAT.[11] The Insurance and Banking industry was omitted for the same reason. Agriculture industry is not included as some agriculture products are exempt from VAT. Lastly, Electricity and Water Supply industries are not included due to non-market-based prices. I end up using 8 main industries, that account for 75%-80% of the Israeli private sector sales. Table 1 reports characteristics by industry. Figure A.1 in the appendix shows large heterogeneity in the annual percentage change in price indices between 2006-2022, a variation the analysis leverages.

Figure 1 compares headline annual inflation and annual sectoral price inflation, weighted by industries' share in employment. A difference between the two

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[8] In fact, the activity of these industries is export-oriented and therefore their contribution to domestic prices is small.

[9] Note that the price indices used for the empirical analysis described above are not Producer Price Indices (PPI), but are more closely related to components of the Consumer Price Index (CPI).

[10] Compared with real output by industries, which is a quarterly series that is published with a significant lag and groups several industries together. In fact, sales indices are used, among other factors, for nowcasting Israeli GDP growth (Ginker and Suhoy, 2022).

[11] There are businesses in these industries that operate in the private sector (private healthcare clinics, etc.) and report their sales to VAT. Unfortunately, there is no wage data for private sector workers in these industries, hence they are excluded from the analysis. Prices of public sector services are hard to measure and are often set by the government.

Table 1: Industy Characteristics

Industry Name	Industry Code	Weight	Wage Growth		Min. Wage Earners
		%	2006-2019	2022	%
Mining and Manufacturing	B_C	15.4 (20.3)	2.94	3.38	13.87
Construction	F	7 (9.2)	3.31	4.85	17.65
Wholesale and Retail Trade	G	19.2 (25.2)	2.18	0.30	24.70
Transportation	H	5.3 (7)	2.01	6.18	12.65
Accommodation and Food Service Activities	I	8.4 (11.1)	2.38	6.69	34.93
Real Estate Activities	L	1 (1.3)	3.17	3.39	17.46
Administrative and Support Service Activities	N	12.3 (16.2)	4.03	9.91	30.19
Arts, Entertainment and Other Service Activities	R_S	7.2 (9.5)	2.43	3.14	19.81

Note: Note: Table 1 presents characteristics of one-digit industries. Weights are average (excluding COVID-19 months) employment weights, as a share out of private sector employees. In-sample industries account for 76% of total private sector employees, weights in parentheses are adjusted such that in-sample industries weights sum up to 100%. Wage growth is defined as the average of annual wage inflation at December of each year. Share of minimum wage earners is calculated using data from the Households Expenditure Survey.

series is due to the inclusion of services/products sold outside the local economy (e.g., manufacturing exports) and the exclusion of some industries as mentioned above. Some commodities are sold as input to other industries and not directly to households (again, mostly manufacturing), which is another source of difference between the series. However, I assume that prices that are likely to be affected by wages (domestic goods and services) are common for both series. Figure A.3 in the appendix shows the sectoral price inflation when the manufacturing industry is excluded, a modification that makes the two series closer. Results are qualitatively robust to this modification.[12]

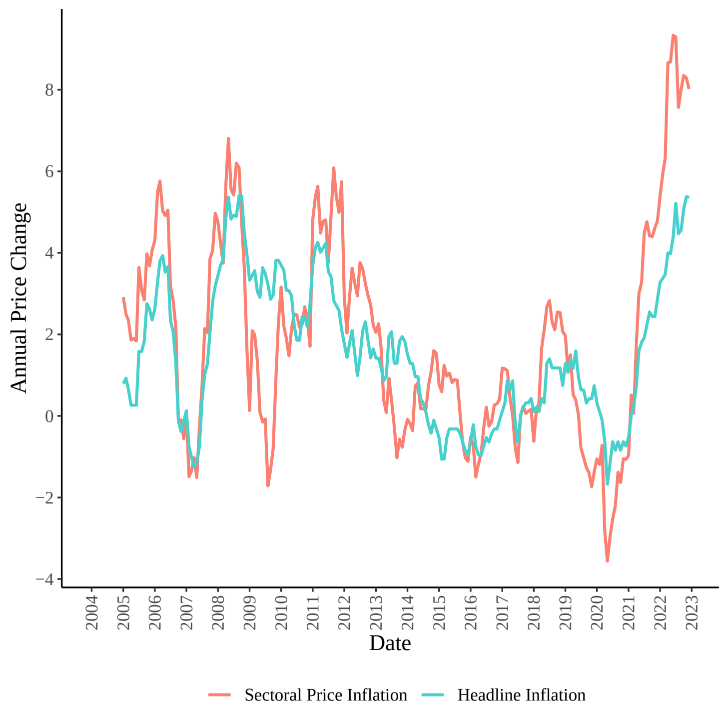


Figure 1: Sectoral Price Inflation and Headline Inflation (CPI)

Note: Figure 1 compares headline CPI annual inflation with the aggregate index based on all in-sample industries' price indices (weighted by industry's share in employment). Price indices by industry are comprised of CPI components, administrative data, and surveys.

[12]Excluding manufacturing (industries B, C), the pass-through from wage to price inflation is slightly lower and less significant compared to the main analysis. The minimum wage analysis yields very similar results, and the higher pass-through in the post-pandemic period remains robust—and even shows improved statistical significance—when excluding manufacturing.

2.2 Wages

The wage measurement I use is industry-level wage per employee job of Israeli workers, seasonally adjusted. Figure A.2 describes the annual percentage change of wage by industry during 2006-2022. The COVID-19 pandemic, which started in March 2020, led to a sharp increase in average wages, primarily because a large number of low-wage workers were laid off, altering the overall wage composition. Hence, in the empirical analysis, this period will be excluded.

2.3 Macro Variables

Allowing for a hybrid price Phillips curve, I include industry-level inflation expectations in some of the specifications examing the pass-through from wage to price inflation. Firms' inflation expectations, which are rarely available at a disaggregate level, are computed from the Israeli Businesses Tendency Survey.[13]

I complete the wage-price spiral perspective by estimating how CPI headline inflation affects wage inflation. Headline inflation is used because it is more commonly considered in wage negotiations. To mitigate the endogeneity of headline inflation, I use unexpected inflation, defined as the gap between actual inflation and professional forecasts made shortly before the monthly CPI release. To adjust for business cycle effects and labor market conditions, I include the ratio of job vacancies to the unemployment rate in the wage Phillips curve analysis.[14]

3 Wage Inflationary Effect

In this section, I aim to quantify the pass-through from wage inflation to price inflation, inferred from the industry-level analysis. The analysis employs several methods to identify the wage inflationary effect, discussing each method's advantages and limitations. I use (a) baseline panel Local-Projection, (b) Local-Projection with Instrumental-Variable (LP-IV) estimation based on labor market competition, and (c) identification using minimum wage increases. This approach provides a range of estimates for the pass-through from wage to price inflation that are fairly consistent, reinforcing the robustness of the findings.

[13] Before 2013, series is based on the quarterly Israeli Companies Survey.

[14] Unemployment was a quarterly series until 2012 when the frequency of the Labor Force Survey changed. To obtain a monthly series before 2012, I use cubic spline smoothing.

I begin with a simple reduced-form price Phillips curve by estimating a panel local projection (Jordà, 2005) with industry and period fixed effects:

$$\begin{aligned}\ln P_{j,t+h} - \ln P_{j,t-1} &= \alpha_h^w(\ln w_{jt}^n - \ln w_{jt-1}^n) + \beta_h(\ln Z_{jt} - \ln Z_{jt-1}) \\ &\quad + \theta_h \sum_{k=1}^{12} \ln X_{jt-k} - \ln X_{jt-k-1} + \gamma_j^h + \delta_t^h + \varepsilon_{jt+h}\end{aligned} \tag{1}$$

Where P_j, w_j^n, and Z_j are prices, nominal wages, and *real* productivity at the industry-level. α_h^w measures the cumulative effect on the price level, h periods ahead, from a 1% monthly increase in nominal wages at time t (compared to $t-1$).[15] Twelve lags of prices, productivity and wages (first differences), are included and denoted as X. The specification also controls for industry-level firms' inflation expectations.[16] γ_j is industry fixed-effect controlling for systematic differences in price inflation across industries and δ_t is time fixed-effect, absorbing macro-level shocks such as aggregate demand, exchange rate, and monetary policy stance. Observations are weighted by industry share in employment. Standard errors are clustered within period.[17]

Figure 2 shows the estimated cumulative response of prices to monthly wage change from equation 1. Pass through is limited - it is below 0.1 even a year ahead, then gradually decreases towards zero.

Under the above two-way (time and industry) fixed effect model, the only source of unobserved variation that is left unaddressed comes from industry-idiosyncratic shocks. That is, the effect of wage on price inflation estimated in Figure 2 is potentially biased due to the endogeneity of wages (e.g., industry-specific demand shock affecting both prices and wages) or model misspecification.[18] Pure exogenous variations in wages are difficult to be identified since wage and prices are often influenced by similar factors.[19] I address endogeneity by offering a potential

[15] Consider a Cobb-Douglas production fuction with $Y = L^\alpha K^{1-\alpha}$. In this case, α^w is bounded by α, the share of labor in production, around 0.45 for the private sector output.

[16] Headline inflation expectations of firms surveyed in the Businesses Tendency Survey. Firms' expectations are classified by groups of industries.

[17] Montiel Olea and Plagborg-Møller (2021) show that for LP with many lags there is no need to correct standard errors for autocorrelation.

[18] Due to greater wage stickiness (Grigsby et al., 2021; Nakamura and Steinsson, 2013), monthly changes in wage (as in the LP version) are less likely to respond to monthly price shocks, reducing the potential endogeneity problems at short-term intervals.

[19] Chin and Lin (2023) and Heise et al. (2022) used sectoral job-to-job transitions as an IV for wages. However, they both show that transitions are a weak instrument.

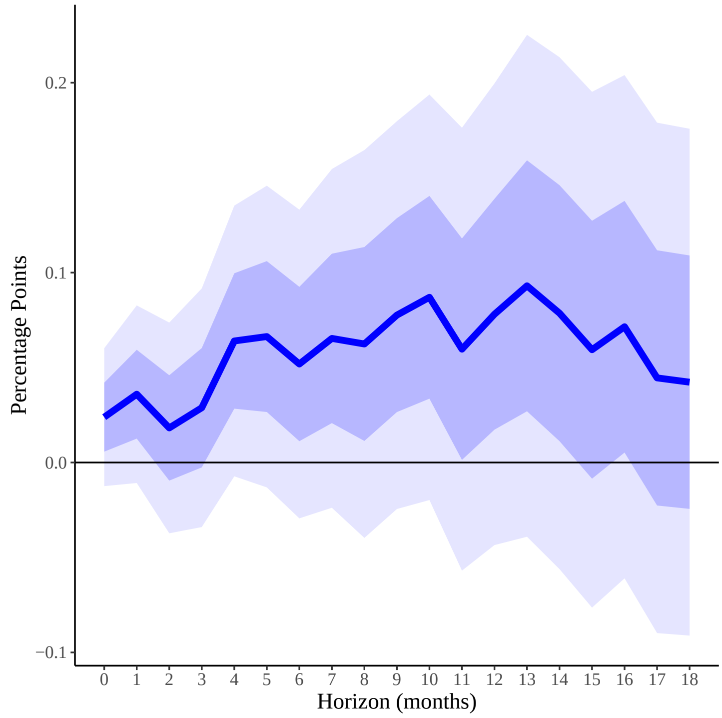


Figure 2: Cumulative Pass-Through from Wage Inflation to Price Inflation

Note: Figure 2 presents results of estimated Local Projection for the pass-through from wage inflation to price inflation, as described in equation 1. Twelve lags of prices, wage and productivity change are included along with inflation expectations and time and industry fixed effects. The coefficient on the y-axis represents the cumulative response of prices to a 1% increase in wage, h periods ahead. Each observation is weighted by each industry's weight in employment. Standard errors are clustered by time. Dark and light blue shaded areas correspond to 68% and 95% confidence interval (one/two standard errors, respectively). The estimation is based on a 2005-2022 sample, while COVID-19 observations are excluded.

instrumental variable from micro-data.

Within a two-stage least squares (TSLS) model, I instrument the wage inflation in industry j ($\ln w^n_{jt} - \ln w^n_{jt-1}$) with the wage inflation in its competing industry.[20] Competing industry (denoted as $j\prime$) was identified based on rich micro Employee-Employer data for Israel. I study workers' flows between industries and define a labor-market competing industry as the industry in which job changers, who moved from industry j, are more likely to be found next year. This instrument builds

[20] Defined as the average monthly change in competing industry's wages between $t-1$ to $t-12$. That is, no contemporaneous effect is included, to reduce possible simultaneity threats to identification.

on labor market competition that puts pressure to increase wages in response to an increase of the wages offered by competing employer. At the first stage, when wages (w^n_j) are regressed on competing industry wages ($w^n_{j'}$), I allow for competing wages to affect industry j's wages differentially, depending on whether w^n_j rose or declined, motivated by a more accurate prediction of w^n_j which improves the second-stage results.[21] First stage results (see Table 3, for $h = 10$) show positive correlation between changes of $w^n_{j'}$ and *increases* of wages in j, as higher wages in the competing industry put upward pressure on wages in industry j as workers demand higher wages to stay. Conversely, wages of workers in the competing industry are negatively correlated with wages in industry j when they *decrease*, which could be due to the mobility of skilled workers moving from industry j to industry $j\prime$ in search of better pay. Exogeneity is based on the assumption that industry-specific shocks in the competing industry are uncorrelated with industry-specific shocks in industry j affecting prices. I discuss and address some potential threats to the identification strategy:

- *Demand Channel:* An increase in the wage of industry j' might affect the price P_j through income effect of workers in j'. However, most industries are too small to affect the demand for products produced by industry j, while aggregate demand is controlled via δ^h_t. As mentioned earlier, Shapiro (2023) concludes that the effect of wages on prices is a result of cost pressures rather than demand.

- *Goods Market Competition:* If industry j' produces a product that is close to the product of industry j, then prices of both will move together and the exclusion restriction will be violated. The use of a one-digit industry classification is beneficial here, as each industry produces a broad and distinct category of products, leaving less room for complementary or substitution relationships.[22]

- *Production Inputs:* If industry j' product is an input in the production process of industry j, then $w^n_{j'}$ will affect the price P_j through components of

[21] Note that I do not refer to asymmetry in the effect of wage on prices. Loupias and Sevestre (2013) show asymmetry of price response is lower for wages compared with other costs.

[22] For example, industry G (Wholesale and Retail Trade) is the competing industry of industry N (Administrative and Support Service Activities). Since these two activities are quite distinct, I expect no significant good market relationship between them. Consumers are likely to assign weights on each consumption category in a way that do not immidiately react to relative price changes between categories.

marginal cost other than wage pressures. I use Input-Output tables to show that this channel is limited (see Table 2, column 3).

Table 2: IO Linkages Between Competing Industries

Industry	Competing Industry	Share of j' in the production of j	Share of other industries	Primary Inputs
A	I	0.0%	46%	54%
B_C	G	4.3%	26%	70%
D_E	N	2.1%	37%	61%
F	N	3.0%	46%	51%
G	N	2.4%	31%	67%
H	N	3.1%	37%	60%
I	G	4.9%	42%	53%
J	M	2.9%	27%	70%
L	N	0.6%	11%	88%
M	J	3.6%	25%	71%
N	G	2.5%	29%	69%
R_S	I	1.8%	43%	55%

Note: Table 2 presents the competing industry (j') of each industry and summarizes of I-O linkages between them (column 3). Most industries have limited production connections with their competing industry. Competing industry is identified using long-run flows of workers between industries, based on Israeli Employee-Employer micro data. Data is based on Input-Output tables for 2014. Primary inputs are compensation for jobs, imports, taxes and other value added components.

Acknowledging its limitations, at least some exogenous variation can be leveraged using this IV for estimation. Table 3 presents the first stage for peak cumulative response ($h = 10$) and suggests strong non-linear correlation between wages in industry j and the wages of its competing industry.[23] Figure 3 presents the cumulative effect of monthly increase in wages on prices along with one and two standard errors confidence intervals, based on an IV estimation. The pass-through is limited - following a 10% increase in wages, prices response with 2.65% increase after 10 months.

Finally, as an additional way to assess the wage inflationary effect, I estimate the dynamics of the direct effect of minimum wage increases on sectoral price

[23] A placebo test that matches each industry with an industry that is not connected by workers flows, yields weaker results.

Table 3: Wage to Price Inflation Pass-Through, h=10

Dependent Variables:	(First) $Wages_t$	(Second) $Prices_{t+10}$
Competing Industry's Wages × Positive	2.02***	
	(0.286)	
Competing Industry's Wages × Negative	-1.39***	
	(0.350)	
$Productivity_t$	0.081***	-0.060**
	(0.015)	(0.030)
Firm Expectations	-0.006**	0.022***
	(0.003)	(0.006)
$\hat{Wages}_t$		0.265*
		(0.147)
Fixed-effects		
Industry FE	Yes	Yes
Time FE	Yes	Yes
Observations	1,432	1,432
R^2	0.58160	0.57619
Within R^2	0.46610	0.03964
F statistic (first stage)	134.9	

*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Note: Table 3 presents the first and second stage of the estimated cumulative local projection (h=10) of wage to price pass-through. Wage growth is instrumented with wage changes in a competing industry, identified based on workers' flows from rich micro-data for Israel. I allow for nonlinear effect of the competing industry wages to improve prediction. "Positive" equals 1 if the wage in industry j at time t is higher than it was at t-1, "Negative" equals 1 when "Positive" is zero. Twelve lags of productivity, wage and price changes (first difference) are included as controls. Clustered (time) standard-errors are in parentheses.

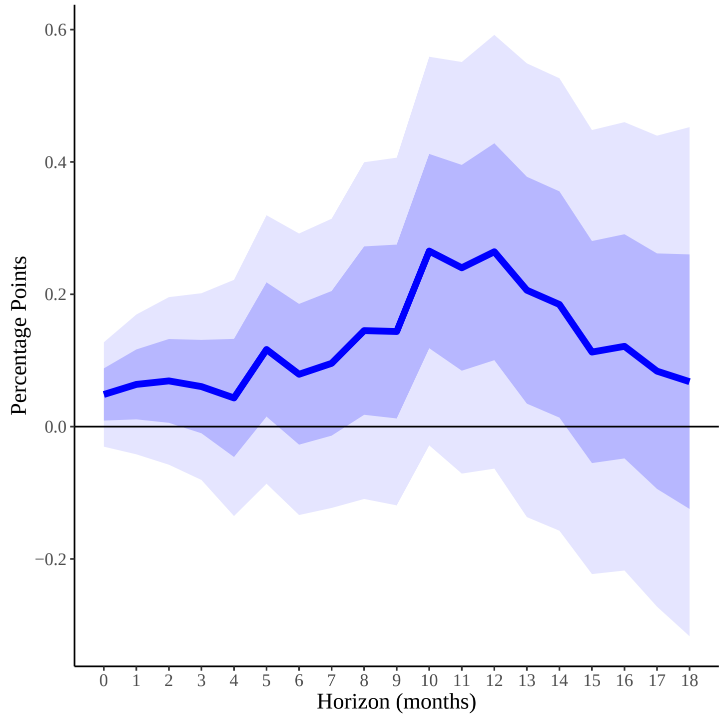


Figure 3: Cumulative Pass-Through from Wage Inflation to Price Inflation (IV Estimation)

Note: Figure 3 presents results of estimated Local Projection for the pass-through from wage inflation to price inflation, as described in equation 1. Twelve lags of prices, wage and productivity change are included along with inflation expectations and time and industry fixed effects. The coefficient on the y-axis represents the cumulative response of prices to a 1% increase in wage, h periods ahead. Wage change in industry j is instrumented with the wage growth in an industry competing for the same workers, identified from workers mobility between industries from a rich micro-data. Each observation is weighted by each industry's weight in employment. Standard errors are clustered by time. Dark and light blue shaded areas correspond to 68% and 95% confidence interval (one/two standard errors, respectively). Estimated based on 2005-2022 sample, while COVID-19 observations are excluded.

inflation using the share of minimum wage workers in the industry as the exposure to treatment proxy in a way similar to Harasztosi and Lindner (2019).

$$\ln P_{j,t+h} - \ln P_{j,t-1} = \alpha_h^w (mw\_earners_j \times \Delta mw_t) + \beta_h (\ln Z_{jt} - \ln Z_{jt-1}) + \theta_h \sum_{k=1}^{12} \ln X_{jt-k} - \ln X_{jt-k-1} + \gamma_j^h + \delta_t^h + \varepsilon_{jt+h} \quad (2)$$

$mw\_earners_j$ is the share of minimum wage earners in the industry, calculated based on the ICBS Household Expenditure Survey.[24] $\Delta mw_t \equiv \ln mw_t - \ln mw_{t-1}$ is the change in the statutory minimum wage. Figure 4 describes the statutory minimum wage and the percentage change implied by legislations.[25] Note that

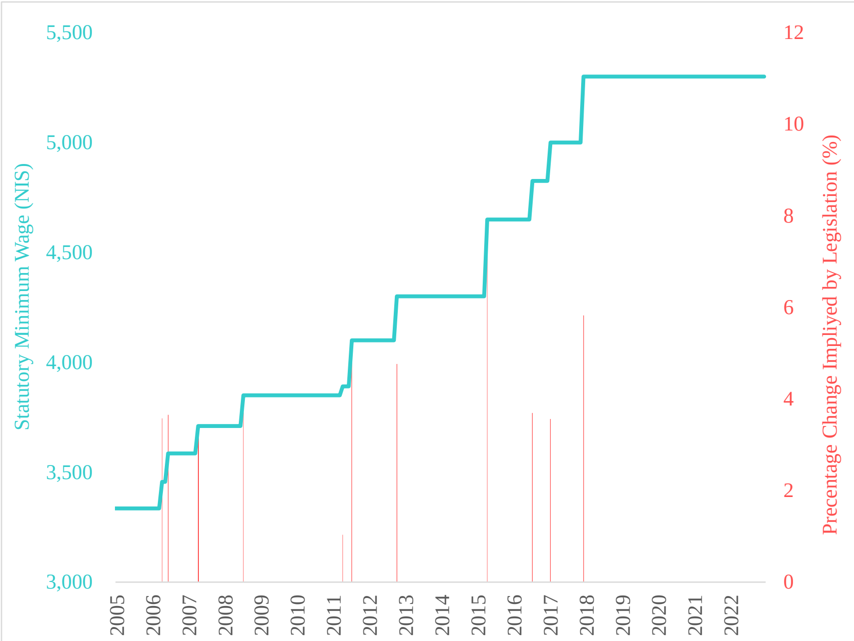


Figure 4: Minimum Wage Legislations, 2005-2022

Note: Figure 4 presents the level of the country-level minimum wage in Israel during 2005-2022 (main y-axis) and the implied percentage change in minimum wage (secondary y-axis). Minimum wage is updated mostly due to special legislations, following an agreement between labor unions and the goverment.

there is no variation in minimum wage across industries, as minimum wage is set at the country level. The above specification can be thought of as a DiD specification with α_h^w representing the *post* $\times$ *treated* treatment effect. That is, what is the direct effect on prices (h periods ahead) in industries that were heavily affected by the minimum wage increase, compared with industries with a small share of minimum wage earners. Then, the overall effect on prices is given by $\alpha_h^w \times mw\_earners_j$.

[24] See similar calculations in chapter 8 of the 2021 Bank of Israel Annual Report (2022).

[25] In many cases, this variable is actually zero. Minimum wage is updated also due to an automatic indexation to 47.5% of the average wage, rarely used in practice. Most of the minimum wage updates in the period covered in this study are due to specific legislations.

Figure 5 reports the estimated coefficients from equation 2. The interpretation is as follows: an industry will adjust its prices in response to a minimum wage increase, passing on the cost to the consumers proportionally to the share of minimum wage workers in the industry. Industries with higher share of minimum wage workers, experience higher pass-through from minimum wage increments to prices due to greater effect on marginal cost. The average effect, considering 20 percent of minimum wage workers (the Israeli private sector share of minimum wage earners in 2019), suggests that a 10% higher minimum wage translates into 1.1% higher price inflation on impact ($\sim 0.5 \times 0.2$), and 2% ($\sim 1 \times 0.2$) a year after. Note, however, that this estimate draws from a somewhat narrower view on

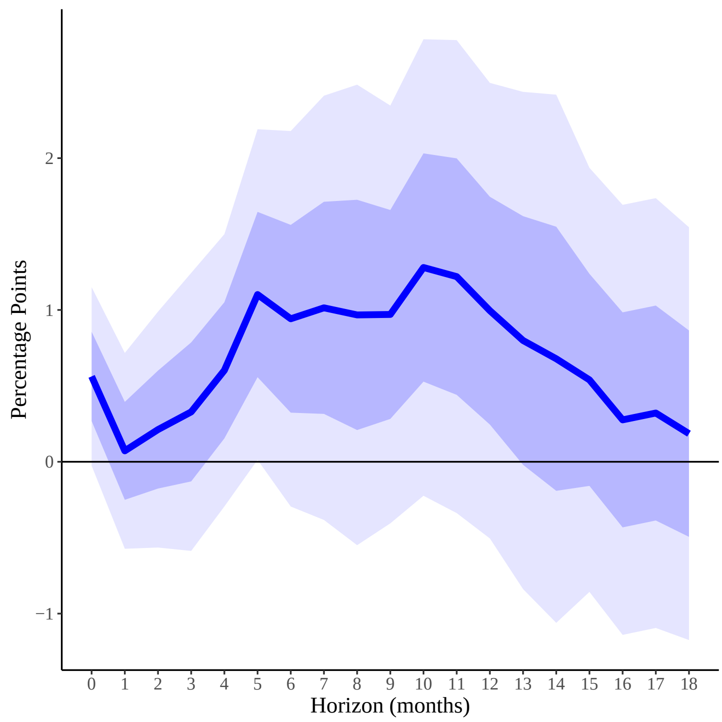


Figure 5: Cumulative Effect of Minimum Wage Increments on Price Inflation

Note: Figure 5 presents results of estimated Local Projection for the direct effect of minimum wage increments on prices, as described in equation 2. Twelve lags of prices and productivity change are included along with time and industry fixed effects. The coefficient on the y-axis represents the cumulative response of prices to a 1% increase in minimum wage, h periods ahead, while considering the share of minimum wage workers in the industry. Share of minimum wage workers identifies the extent to which an industry is exposed to minimum wage increments. Each observation is weighted by each industry's weight in employment. Standard errors are clustered by time. Dark and light blue shaded areas correspond to 68% and 95% confidence interval (one/two standard errors, respectively).

the wage inflationary channel since minimum wage increases are rare and generate a sudden and high increase in wages. Moreover, minimum wage hikes affect mostly low-wage industries which tend to be less concentrated, hence pass cost into prices to a large extent (Amiti et al., 2019).

4 Wage Sensitivity to Inflation

In this section, I examine the role of inflation in wage determination, thereby completing the wage-price spiral perspective. Historically, the Israeli economy has experienced significant wage indexation, both formal and informal, particularly during the 1980s and 1990s, following a period of hyper-inflation. While formal indexation mechanisms are less common in contemporary wage negotiations[26], wages may still exhibit sensitivity to inflation. Estimating this relationship provides a more comprehensive understanding of the wage-price spiral and contributes new insights to the existing body of literature.

The relationship between nominal wages and inflation is typically investigated through the wage Phillips curve framework (Phillips, 1958). Galí (2011) developed a New Keynesian Wage Phillips Curve that associates nominal wage growth with the unemployment gap and inflation. In my analysis, I employ a panel Local Projection method with industry fixed effects (γ_j) to measure the cumulative response of wages to a monthly 1% increase in headline CPI inflation (without industry distinction, hence no j index). To address endogeneity concerns, inflation is instrumented with inflation surprises, which are calculated as the difference between actual inflation and the average professional forecasts made shortly before the release of the monthly CPI. This exercise focuses on the period before the COVID-19 pandemic.[27] Specifically, I run the following local projection ($h = 0...12$):

$$\begin{aligned}\ln w^n_{j,t+h} - \ln w^n_{j,t-1} &= \alpha^p_h(\ln P_t - \ln P_{t-1}) + \beta_h(\ln Z^n_{jt} - \ln Z^n_{jt-1}) \\ &+\eta_h(\ln \frac{V_t}{U_t} - \ln \frac{V_{t-1}}{U_{t-1}}) + \theta_h \sum_{k=1}^{12}[\ln X_{jt-k} - \ln X_{jt-k-1}] + \gamma^h_j + \varepsilon_{jt+h}\end{aligned} \tag{3}$$

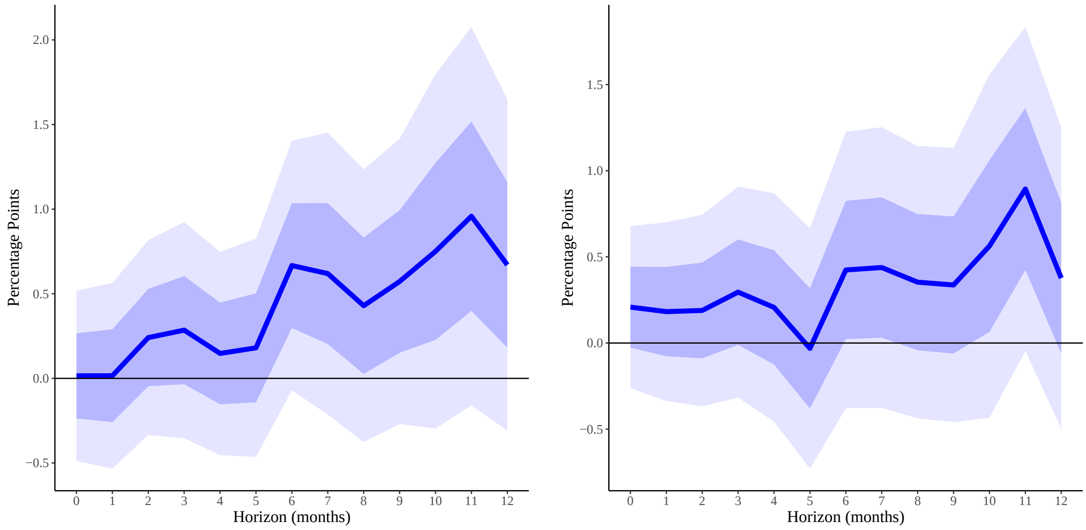
Equation 3 accounts for changes in nominal productivity (Z^n_j) and in labor

[26]The last formal wage adjustment linked to inflation indexation occurred in 2004.

[27]The results for a sample including post COVID-19 months are similar but measured with greater uncertainty for long-term horizons. Figure A.4 in the appendix shows the estimated response of wages to headline inflation for the full sample, with max horizon limited to 9.

market tightness $(\frac{V}{U})$[28] as explanatory factors for wage adjustments. The model controls for 12 lags of wages, productivity, labor market tightness, and prices, denoted by X. The parameter α_h^p quantifies the sensitivity of wages to monthly headline inflation, h periods ahead. Figure 6a plots the response of wages to a monthly unexpected increase in headline CPI. The findings indicate that wages gradually adjust to a monthly price increase over the course of a year. Figure 6b extends the above model to include market-based inflation expectations, incorporating elements of a hybrid wage Phillips curve. When inflation expectations are considered in workers' wage formulation, the impact of CPI unexpected inflation on wages appears to be slower and less certain.

[28] Although it might be endogenous, labor market tightness is included as a control variable. Moreover, labor market tightness may also capture some macro time effects.



(a) Baseline (b) Controlling for expectations

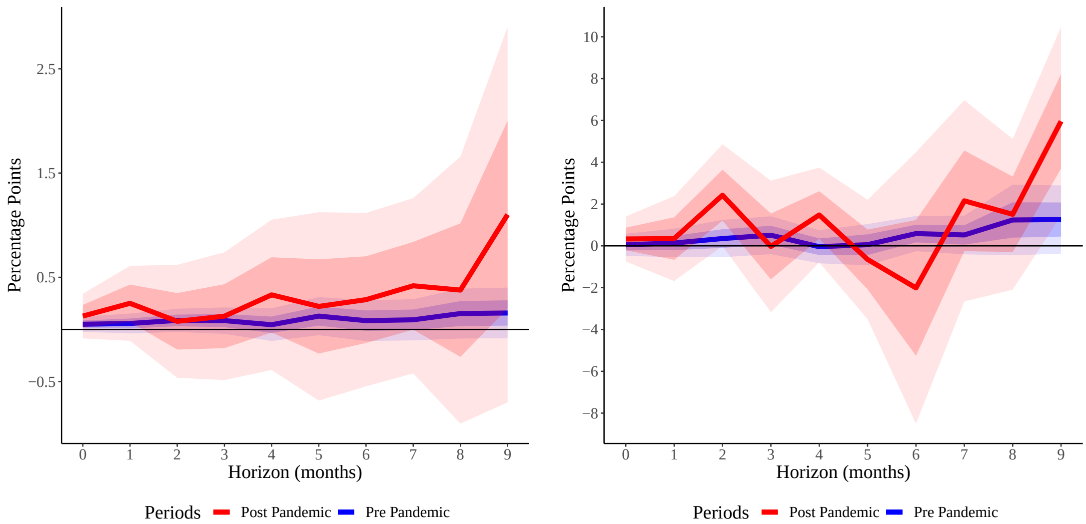
Figure 6: Cumulative Pass Through from CPI Inflation to Wage Inflation

Note: Figure 6 presents results of estimated Local Projection for the pass-through from headline CPI inflation to wage inflation, as described in equation 3. 12 lags of prices, wage, labor market tightness and productivity change are included along with industry fixed effects. Panel B added market based inflation expectation, allowing for a hybrid wage Phillips curve. The coefficient on the y-axis represents the cumulative response of wages to a 1% increase in CPI, h periods ahead. Changes in CPI are instrumented with inflation surprises based on the gap between actual inflation and professional forecasts made shortly before the monthly CPI release. Each observation is weighted by each industry's weight in employment. Standard errors are Driscoll-Kraay standard errors with a bandwidth of h periods. Dark and light blue shaded areas correspond to 68% and 95% confidence interval (one/two standard errors, respectively). Estimated based on 2006-2019 sample, pre-COVID-19 pandemic.

5 Post-COVID-19 Dynamics

As discussed in Section 1.1, existing research indicates different dynamics in the economic recovery following the COVID-19 pandemic, particularly with regard to the relationship between wage and price inflation. This section presents evidence that the period following the COVID-19 pandemic was characterized by higher transmissions in both directions - from wage to prices and from prices to wages. To test the hypothesis of increased pass-through in the post-COVID-19 period, equations 1 and 3 are modified to include period dummies interacted with all variables in the model.[29] In the revised equations, D_{PreCovid} is set to 1 for the period up to and including February 2020, while $D_{\text{PostCovid}}$ is a dummy variable that equals 1 beginning in May 2021. Months during the pandemic are excluded from this analysis. In that sense, I allow for a structural break in the relationship beween wages and prices following the pandemic. Due to limited sample in the post-pandemic period, reflected also through wide confidence intervals, I show estimated Local Projection response function up to $h = 9$. Figure 7a presents pre- and post-COVID-19 response of prices to wages, indicating an (insignificantly) stronger effect in the period following the pandemic. The wage response to inflation shocks, presented in Figure 7b, is considerably higher in the post-COVID-19 period. Appendix B estimate the relationship between *annual* price and wage inflation, documenting a structural break following the COVID-19 pandemic characterized by significantly higher transmissions in both direction.

[29] Lags variables (wage, prices, productivity, and labor market tightness) were not interacted with period dummies.



(a) Wages to Prices

(b) Prices to Wages

Figure 7: Cumulative Pass Through by Periods

Note: Figure 7 presents results of estimated Local Projection for the pass-through from wages to sectoral prices and from headline CPI inflation to wage inflation, seperated by periods. The coefficient on the y-axis of panel 7a represents the cumulative response of prices to a 1% increase in wages, h periods ahead. Twelve lags of prices, wage, and productivity change are included along with industry-level inflation expectations and industry and time fixed effects. Identification is based on competition over workers. See Figure 3 for details. The coefficient on the y-axis of panel 7b represents the cumulative response of wages to a 1% increase in CPI, h periods ahead. Twelve lags of CPI, wage, labor market tightness and productivity change are included along with industry fixed effect. Identification is based on inflation surprises. See Figure 6 for details. Each observation is weighted by each industry's weight in employment. Dark and light blue shaded areas correspond to 68% and 95% confidence interval (one/two standard errors, respectively). Estimated based on 2006-2022 sample while COVID-19 observations are excluded.

6 Conclusion

This study analyzes the relationship between wage and price inflation using Israeli industry-level data on wages, productivity, and prices from 2006 to 2022. It applies a range of methods, yielding consistent conclusions, and discusses each method's advantages and limitations. Beyond baseline panel-LP estimations, the research includes a micro-level instrumental variable for wages, based on labor market competition. The findings suggest that a 10% increase in wages is associated with a 1%-3% cumulative rise in prices, an effect that gradually decreases in the following months. The study also assesses the direct impact of minimum wage increases on prices, revealing a significant pass-through in affected industries. The response of industry prices to a minimum wage increase is proportional to the share of minimum wage workers in that industry. This paper contributes by providing a range of estimates for the wage inflationary effect, which are modest and consistent with literature from periods of mostly low and stable inflation.

The research also examines the effect of CPI inflation on wage inflation, covered less in prior studies. Wages tend to adjust to headline inflation with a lag of about a year. Notably, the post-COVID-19 period shows an increased sensitivity of inflation to wages and vice versa. Further research over a more extended period is needed to reinforce these findings. To a certain degree, the results indicate that labor market inflationary pressures may be more substantial than previously thought.

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Appendices

A Additional Figures

Figures A.1 and A.2 show annual price and wage inflation, between 2006-2022, for all industries included in the analysis.

As discussed in Section 2, sectoral price inflation used in the analysis is slightly different from CPI inflation, mostly due to manufacturing exports and intermediate good prices. Figure A.3 shows CPI inflation along with sectoral price inflation, when manufacturing is excluded. Excluding manufacturing, results are qualitatively robust (not presented). However, pass-through from wage to price inflation is slightly lower and less significant, compared with the main analysis.

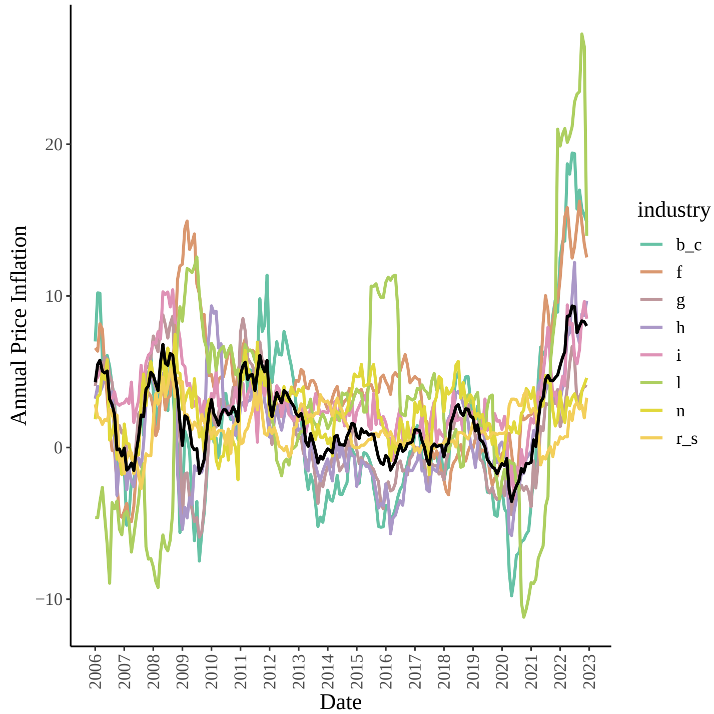


Figure A.1: Price Annual Percentage Change by Industries

Note: Figure A.1 presents 12 months percentage change in the price indices of in-sample industries during 2006-2022. Price indices were constructed by Israeli Central Bureau of Statistics from CPI components, administrative data and surveys. The black line represents weighted average of all in-sample industries' annual price inflation.

Minimum wage analysis shows similar results and the higher pass-through in the post-pandemic period is robust to the excluding of manufacturing.

Figure 6, in the main analysis, provided the response of wages to headline inflation, based on pre-pandemic sample. Figure A.4 below shows estimated cumulative response, including post-COVID-19 months, up to $h = 9$.

Section 5 discussed some evidence of increased pass-through from wages to prices in the aftermath of the COVID-19 pandemic. Figure A.5 shows the cumulative effect of wages on prices, a year ahead, estimated by rolling regression with window of 48 months.

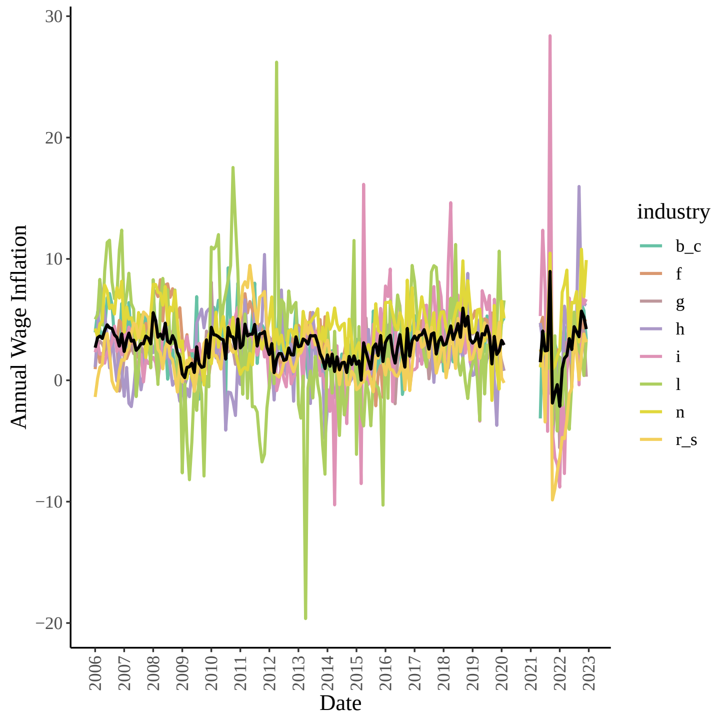


Figure A.2: Wage Annual Percentage Change by Industries

Note: Figure A.2 presents 12 months percentage change in the nominal wage of in-sample industries during 2006-2022. The black line represents weighted average of all in-sample industries' annual wage percentage change.

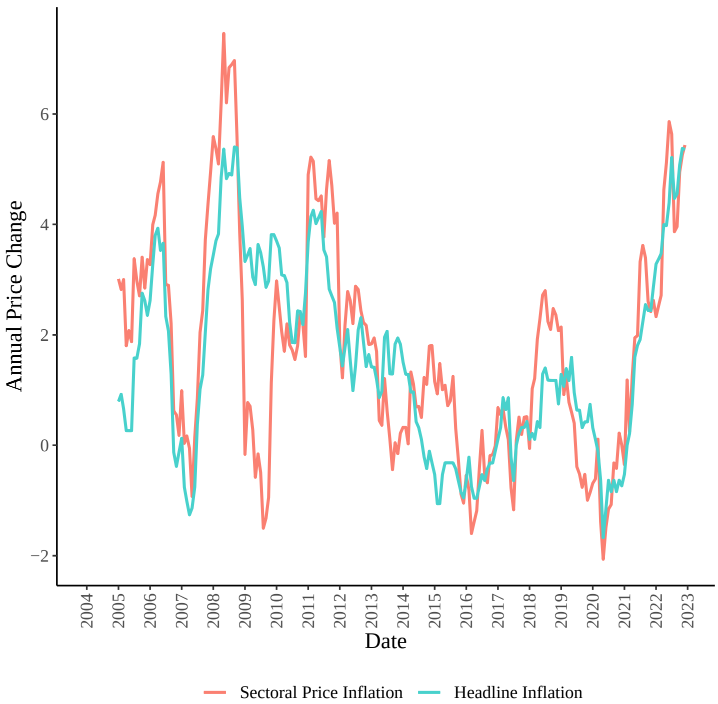
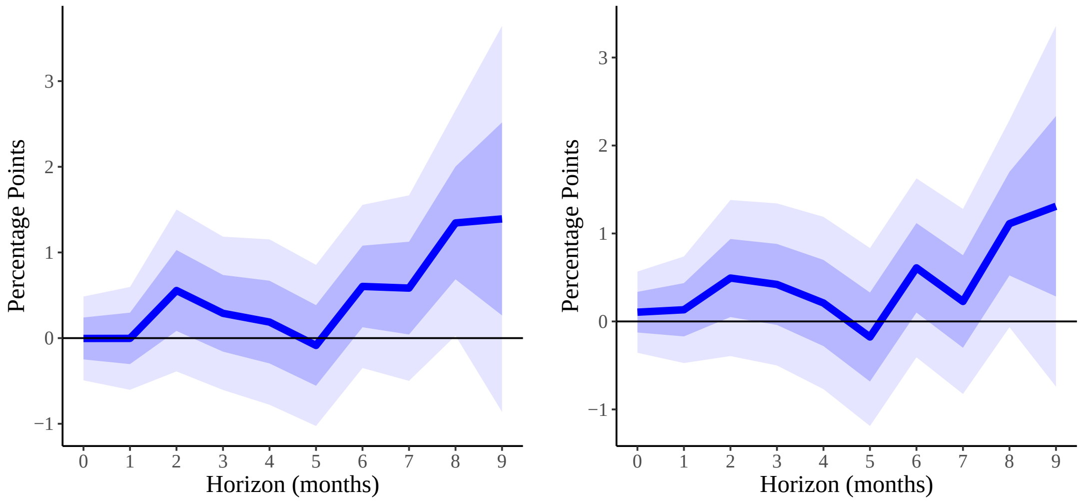


Figure A.3: Sectoral Price Inflation and Headline Inflation (CPI)

Note: Figure A.3 compares headline CPI annual inflation with the aggregate index based on all in-sample industries' price indices (weighted by industry's share in employment), excluding manufacturing (B_C). Price indices by industry comprise of CPI components, administrative data and surveys.



(a) Baseline (b) Controlling for expectations

Figure A.4: Cumulative Pass-Through from CPI Inflation to Wage Inflation

Note: Figure A.4 presents results of estimated Local Projection for the pass-through from headline CPI inflation to wage inflation, as described in equation 3. Twelve lags of prices, wage, labor market tightness and productivity change are included along with industry fixed effects. Panel B added market based inflation expectation, allowing for a hybrid wage Phillips curve. The coefficient on the y-axis represents the cumulative response of wages to a 1% increase in CPI, h periods ahead. Changes in CPI are instrumented with inflation surprises based on the gap between actual inflation and professional forecasts made shortly before the monthly CPI release. Each observation is weighted by each industry's weight in employment. Standard errors are Driscoll-Kraay standard errors with a bandwidth of h periods. Dark and light blue shaded areas correspond to 68% and 95% confidence interval (one/two standard errors, respectively). Estimated based on 2006-2022 sample while COVID-19 observations are excluded.

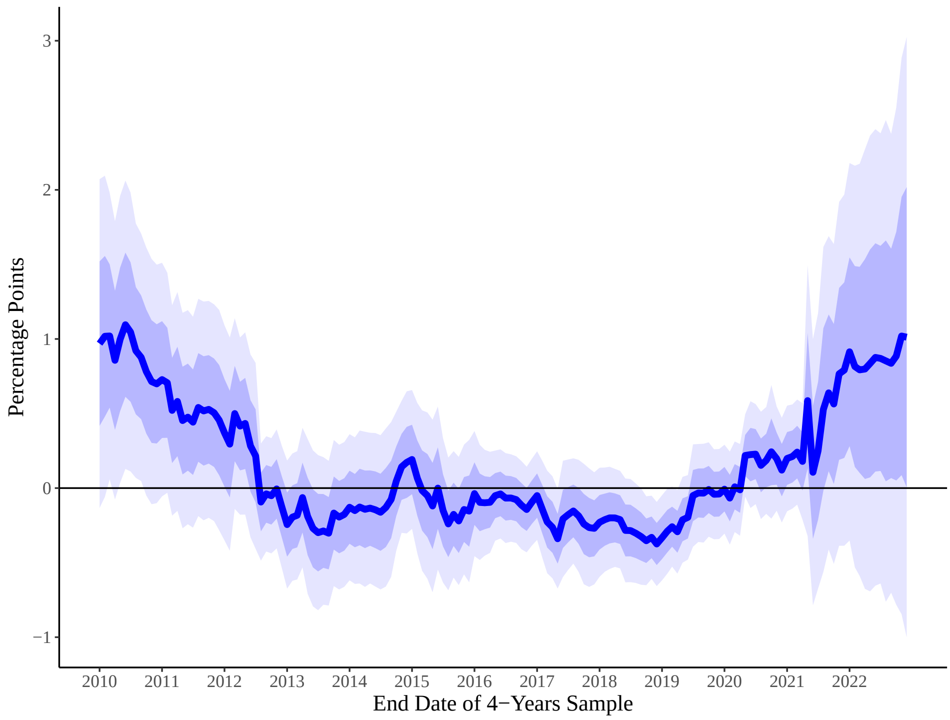


Figure A.5: Rolling Regression Analysis of Year-Ahead Wage to Price Pass-Through

Note: Figure A.5 presents results of estimated pass-through from wage inflation to price inflation a year ahead (h=11). The estimation is conducted using a rolling regression with a 48-month window. The X-axis indicates the ending date of each 48-month sample used in the estimation. The regression model includes twelve lags of prices, wages, and productivity changes, as well as inflation expectations, and both time and industry fixed effects. The coefficient on the y-axis represents the cumulative response of prices to a 1% increase in wage, a year ahead. Wage change in industry j is instrumented with the wage growth in an industry competing for the same workers, identified from workers mobility between industries from a rich micro-data. Each observation is weighted by each industry's weight in employment. Standard errors are clustered by time. Dark and light blue shaded areas correspond to 68% and 95% confidence interval (one/two standard errors, respectively).

B Annual Price and Wage Inflation Regressions

The main analysis presented the cumulative response of prices (h periods ahead) to a *monthly* 1% rise in wages and vice versa. I refer to the yearly cumulative response function to a *monthly* shock as the paper's main result, as it transparently shows intra-year dynamics with an increased cumulative effect (up to a year) since the shock is given. In this section, I document the overall relationship between *annual* price and wage inflation (YoY) using panel regressions.

B.1 Price Response to Wages

This part of the analysis examines the *annual* rise in prices following a corresponding 10% *annual* rise in wages, with a distinction between pre- and post-pandemic dynamics as discussed in Section 5. The following reduced-form Phillips curve was estimated using panel regression with industry and time fixed effect:

$$\Delta_{12} P_{j,t} = \sum_{\substack{i=\text{PreCovid,}\\ \text{PostCovid}}} D_i[\alpha^w \Delta_{12} w^n_{jt} + \beta \Delta_{12} Z_{jt} + \pi^{\text{exp}}_{jt}] + \gamma_j + \delta_t + \varepsilon_{jt} \tag{B.1}$$

Twelve-month price inflation in industry j, $\Delta_{12} P_{j,t}$, is therefore affected by *nominal* annual wage inflation, $\Delta_{12} w^n_{jt}$, and *real* productivity annual growth in industry j, $\Delta_{12} Z_{jt}$. γ_j is industry fixed-effect controlling for systematic differences in price inflation across industries and δ_t is time fixed-effect, absorbing macro-wided shocks such as aggregate demand, exchange rate and monetary policy stance. D_{PreCovid} is set to 1 for the period up to and including February 2020, while $D_{\text{PostCovid}}$ is a dummy variable that equals 1 beginning in May 2021. Months during the pandemic are excluded from this analysis. The parameter of interest, α^w is the response of annual price inflation to annual wage inflation, varies across pre- and post-pandemic periods.[30] Regression includes Driscoll and Kraay (1998) corrected standard errors to account for serial correlation and observations are weighted by industry share in employment.

Table B.1 shows a significantly higher pass-through from wage to price inflation

[30] To compare this *annual-on-annual* estimated pass-through with the Local Projection estimated pass-through, each monthly change will be multiplied by the corresponding pass-through from the LP main analysis, α^w_h: $\sum_{h=0}^{11}(\alpha^w_h \times (\ln w^n_{t-h} - \ln w^n_{t-h-1}))$.

in the post-COVID-19 period.[31] Inflation expectations played a significant role only before the pandemic, while the direct effect of wages on prices was insignificant during this time. This suggests that periods of low and stable inflation are marked by pricing that is primarily driven by inflation expectations.

Table B.1: Wage to Price Inflation Pass Through, by Periods

	Price Inflation
Pre-COVID-19	
Wage Inflation	0.061
	(0.047)
Real Productivity	-0.109***
	(0.028)
Industry Inflation Expectations	3.25***
	(1.22)
Post-COVID-19	
Wage Inflation	0.303***
	(0.053)
Real Productivity	-0.156***
	(0.055)
Industry Inflation Expectations	1.20
	(0.992)
Fixed-effects	
Time FE	Yes
Industry FE	Yes
Observations	1,520
R^2	0.58405
Within R^2	0.10409
P-value for $\alpha^{Post} > \alpha^{Pre}$	0.000

*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Note: Table B.1 presents estimation results for the pass-through from annual wage inflation to annual price inflation, allowing for a structural break characterized by different coefficients by periods. Annual percentage change (%) in productivity and industry inflation expectations are used as controls, along with time and industry fixed effects. COVID-19 observations are excluded from the analysis. Driscoll-Kraay (L=12) standard-errors are in parentheses.

[31] P value for the test $\alpha^{post} > \alpha^{pre}$ is reported in the last row of Table B.1.

B.2 Wage Response to Prices

Regarding the reverse direction, where prices increased by 10% annually, the analysis examines the corresponding rise in wages over the same 12-month period. Similar to the analysis of price response, this investigation differentiates between pre- and post-pandemic periods to assess potential shifts in how wages react to inflation.

I estimate the pass-through from annual headline inflation to wages using a panel regression with period dummies interactions:

$$\Delta_{12} w_{jt}^n = \sum_{\substack{i=\text{PreCovid,}\\ \text{PostCovid}}} D_i[\alpha^p \Delta_{12} P_t + \beta \Delta_{12} Z_{jt}^n + \eta \Delta_{12} \frac{V_t}{U_t}] + \gamma_j + \varepsilon_{jt} \tag{B.2}$$

$\Delta_{12} w_{jt}^n$, $\Delta_{12} Z_{jt}^n$, $\Delta_{12} \frac{V_t}{U_t}$ and $\Delta_{12} P_t$ are annual percentage change in wages, nominal productivity, labor market tightness and headline CPI, respectively. The parameter of interest is α^p, the sensitivity of annual wage inflation to annual CPI inflation, varies across pre- and post-pandemic periods.

Column 1 of Table B.2 displays the estimated results, by periods, treating inflation as if it were exogenous. Column 2 introduces estimates obtained when CPI inflation is instrumented with unexpected inflation, as described in the main analysis (Section 4). In Column 3, inflation is instrumented using weather anomalies in Europe, which is a key supplier of agricultural imports to Israel. All specifications indicate a weaker effect of prices on wages before the COVID-19 period, along with a significant positive impact of labor market tightness. This limited annual inflation-wage effect is consistent with findings in the literature for periods marked by low and stable inflation. Table B.2 indicates that the relationship between annual inflation and annual wages has notably strengthened in the aftermath of the pandemic.[32]

[32] P value for the test $\alpha^{post} > \alpha^{pre}$ is reported in the last row of Table B.2.

Table B.2: Pass Through from Inflation to Wages, 2006-2022

Dependent Variable:	Annual Wage Inflation		
Pre-COVID-19			
CPI Inflation	0.106	0.240*	0.046
	(0.070)	(0.129)	(0.186)
Nominal Productivity Growth	0.030**	0.028**	0.032**
	(0.012)	(0.013)	(0.014)
ΔLM Tightness	0.011***	0.012***	0.011***
	(0.003)	(0.004)	(0.003)
Post-COVID-19			
CPI Inflation	0.417***	0.637***	0.529***
	(0.074)	(0.190)	(0.116)
Nominal Productivity Growth	0.084***	0.076***	0.078***
	(0.010)	(0.011)	(0.010)
ΔLM Tightness	-0.022***	-0.025***	-0.025***
	(0.005)	(0.006)	(0.005)
Fixed-effects			
Industry FE	Yes	Yes	Yes
Observations	1,520	1,520	1,520
R^2	0.174	0.163	0.171
Within R^2	0.105	0.094	0.102
IV included	No	Yes	Yes
First Stage F statistic (Pre)		542.8	88.0
First Stage F statistic (Pre)		3791.4	1043.2
P-value for $\alpha^{Post} > \alpha^{Pre}$	0.000	0.067	0.001

*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Note: Table B.2 presents estimation results for the pass-through from annual headline (CPI) inflation to annual wage inflation, allowing for period-specific coefficients. Labor market tightness is defined as the ratio between vacancies and unemployment (country-level). The annual percentage change (%) in nominal productivity is included as a control variable, along with industry fixed effects. Column 1 treats inflation as if it were exogenous, column 2 instruments inflation with inflation surprises, and column 3 instruments inflation with weather anomalies in Europe, from which most agricultural imports to Israel originate. Driscoll-Kraay (L=12) standard errors are reported in parentheses.