Economics Bulletin

Volume 44, Issue 3

Unpacking how wages cause changes in consumer prices by analyzing monthly data with long lags

Jarle Aarstad
HVL Business School, Western Norway University of Applied Sciences

Olav A. Kvitastein
HVL Business School, Western Norway University of Applied Sciences

Abstract

Previous studies have indicated that wages cause changes in consumer prices, but not all. To address the inconsistency, we compare US monthly data between Jan 2008 and Feb 2020 with Norwegian yearly data between 1955 and 2022. Our motive is that fine-grained monthly data with long lags may reveal a more nuanced picture than crude yearly data with short lags. By including 21 monthly lags, the US data showed that average wages caused changes in the consumer price index (CPI) with an alternating oscillatory pattern where positive and negative effects balanced each other out over time. The wage effect on the CPI was strongest after 13-15 months, illuminating the importance of including sufficient lags. The Norwegian data, conversely, using yearly data with a maximum of two lags, neither before, during, or after the oil crises, showed that average wage changes caused changes in the CPI.

Citation: Jarle Aarstad and Olav A. Kvitastein, (2024) "Unpacking how wages cause changes in consumer prices by analyzing monthly data with long lags", *Economics Bulletin*, Volume 44, Issue 3, pages 1018-1023
Contact: Jarle Aarstad - jarle.aarstad@hvl.no, Olav A. Kvitastein - olav.andreas.kvitastein@hvl.no.
Submitted: March 11, 2024. **Published:** September 30, 2024.

1. Introduction

Intuitively, one may assume that wage changes cause positive changes in consumer prices as the former affects unit labor costs (Nourzad, 2012) and demand in the overall economy, but while some studies grant the proposition empirical support (Hoxha, 2010; Ivanova, 2016; Mnqayi, 2021), others show non-significant or mixed results (Hess & Schweitzer, 2000; Knotek II & Zaman, 2014; Mills & Wood, 2002; Zanetti, 2007). Reasons for the inconsistency can be exogenous shocks in the economy (Mehra, 2000) or wages increasing the supply of goods and services (Majsterek & Welfe, 2010) that decrease consumer prices (Aarstad & Kvitastein, 2023). Another explanation can be methodological, as quarterly or yearly data applied in most studies may obscure nuances, which has motivated us in this study to examine monthly US data between Jan 2008 and Feb 2020, including long lags. Except for a brief decline in the consumer price index in the wake of the 2008 financial crisis, the series had modest fluctuations over the period, making it suitable for analysis.

For comparative reasons, we also analyze yearly Norwegian data from 1955, a few years after ending post-war consumer price controls (Store Norske Leksikon, 2022), to 2022. The series covers relatively stable and unstable periods with strong consumer price fluctuations due to exogenous oil shocks, and we analyze them combined and separately. Our motive for the comparison is that fine-grained monthly data with long lags may reveal information that crude yearly data with short lags lack.

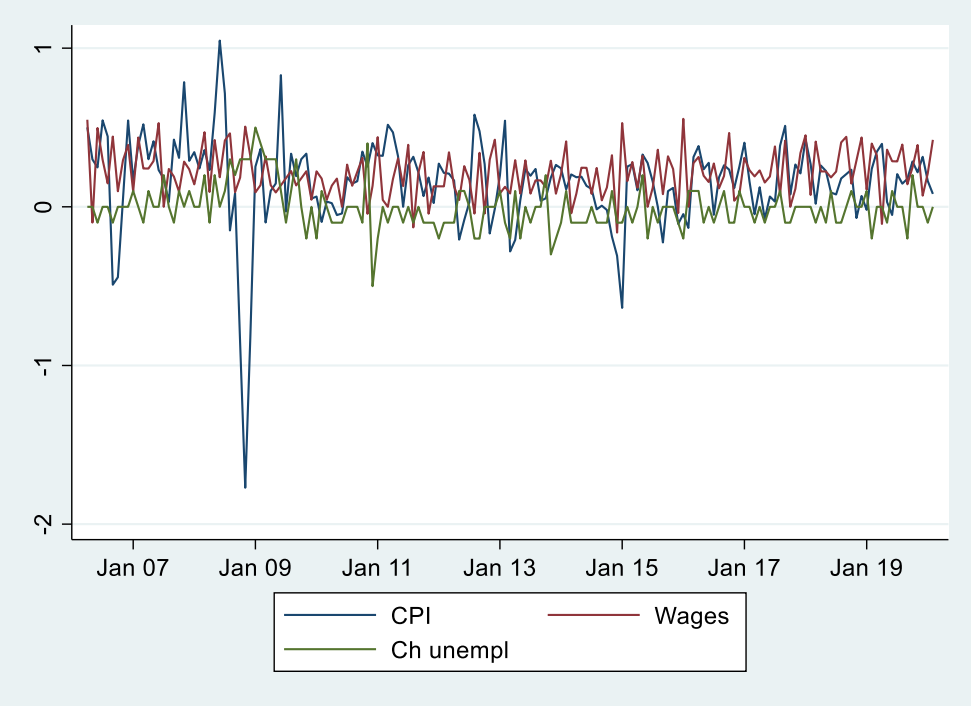
The study analyzes month-over-month and year-over-year percentage changes in the consumer price index (CPI) as dependent variables. Similarly, it analyzes changes in average wages as independent variables. Causality, formally Granger (1969) causality, is defined as "whether one [time] series is predictive of another: A series x_i is deemed not to be 'causal' of another series x_j if leveraging the history of series x_i does not reduce the variance of the prediction of series x_j" (Shojaie & Fox, 2022, p. 290).

2. Methods

We modeled month-over-month percentage change in the US CPI and average wages using FRED (2023a, 2023b) data, including data from overlapping years until Feb 2020, the last month before the COVID-19 pandemic. The analyses control for unemployment (FRED, 2023c), and Figure 1 illustrates the data.

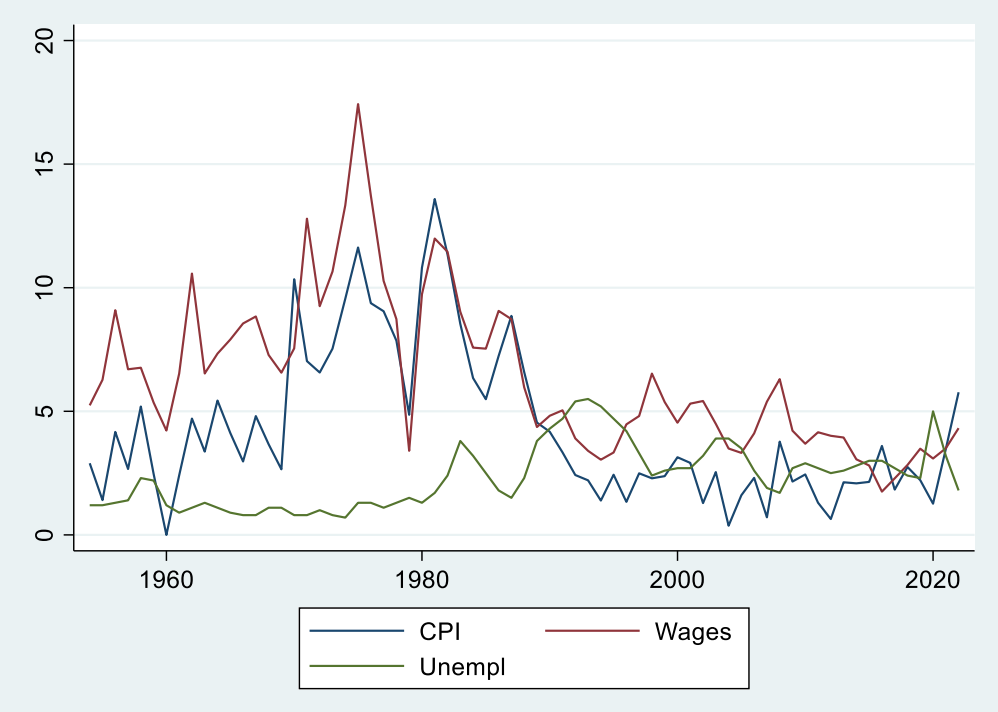
We modeled year-over-year percentage change in the Norwegian CPI using Statistics Norway (2023a) data. Average wage data were accessed from three sources. The first is from 1930-2002 (Statistics Norway, 2008), the second is from 1970-2021 (Statistics Norway, 2023c), and the third is from 2015-2022 (Statistics Norway, 2023b). In overlapping years, the data in the second divided by the first consistently took the value of about 1.035. To calibrate, from overlapping years, we calculated the average of the second divided by the first and then divided the observations in the first till 1969 by that number. Similarly, we applied the average of the third divided by the second in overlapping years, consistently taking the value of .990, to calibrate the 2022 data by dividing it by that number. Finally, we modeled year-over-year percentage wage change. The analyses control for unemployment (NAV, 2023), and Figure 2 illustrates the data.

Figure 1.



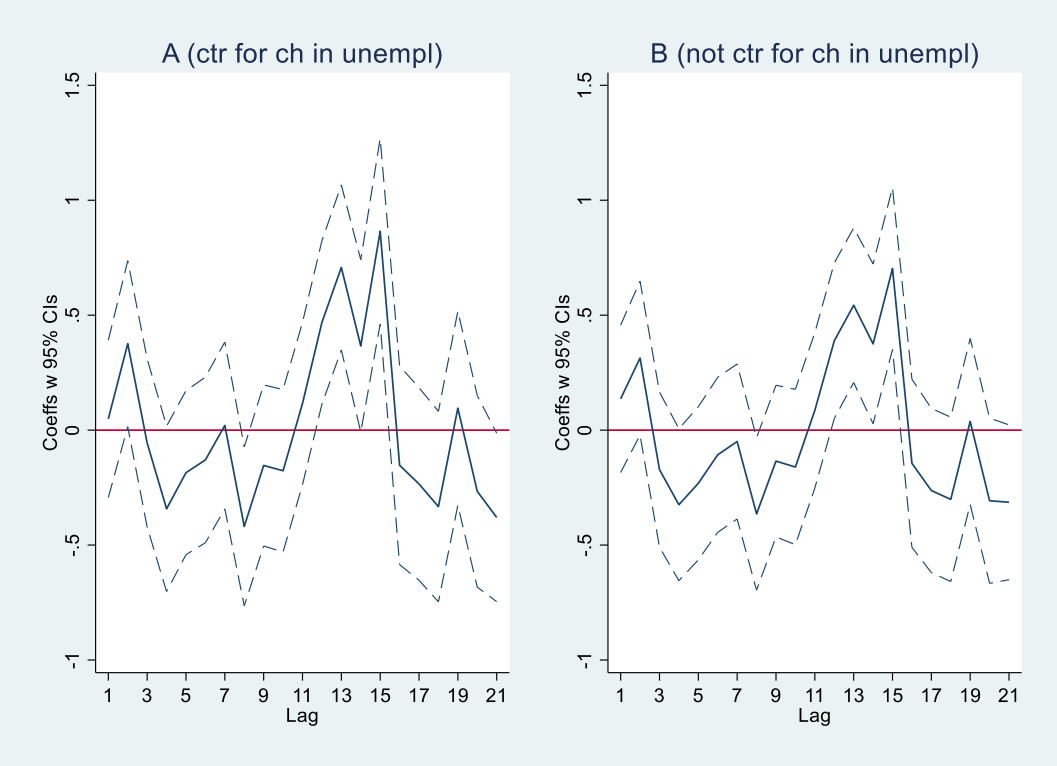
US data on month-over-month percentage change in the CPI, month-over-month percentage change in wages, and month-over-month change in unemployment. Month-over-month change in unemployment is measured by differentiating, i.e., percentage unemployment in month *t* minus percentage unemployment in month *t*–1.

Figure 2.



Norwegian data on the year-over-year percentage change in the CPI, the year-over-year percentage change in wages, and the percentage of unemployment.

Figure 3.



Vector autoregressions using US data with month-over-month percentage change in the CPI as dependent variable and month-over-month percentage change in wages as independent variable. Output in Graph A (Graph B) controls (does not control) for month-over-month change in unemployment. Using 21 lags generates significant Granger causality tests ($p<.001$) in both models concerning the independent variable. Increasing the number of lags to 24 in unreported models does not add more significant or borderline-significant associations. Time period analyzed is Jan 2008 - Feb 2020, 146 monthly periods.

Carrying out Dickey and Fuller's (1979) tests, all variables showed to be stationary, but the US unemployment data only after differentiation. Concerning the US data, the month-over-month percentage change in the CPI generated a test statistic value of -6.89, the month-over-month percentage change in average wages a value of -16.2, and the differentiated unemployment a value of -9.03 (N=146), all of which rejected the null-hypothesis of a random walk with drift ($p <.001$). Concerning the Norwegian data, the year-over-year percentage change in the CPI generated a test statistic value of -2.84, the year-over-year percentage change in average wages a value of -2.69, and the unemployment a value of -2.23 (N=68), all of which rejected the null-hypothesis of a random walk with drift ($p <.01$ concerning the two first variables and $p<.05$ concerning the last). Below, we address results from vector autoregressions (Lütkepohl, 2005), the Norwegian data with small-sample degrees-of-freedom adjustments, and Granger causality tests in Stata (2021).

Table 1. Vector autoregressions with small-sample degrees-of-freedom adjustments. Percentage year-over-year change in the CPI as a dependent variable using year-over-year Norwegian data. Granger causality p-values are reported to the right.

	Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 5*
CPI $_{t-1}$	.577***	.680***	.224	.610†	.339*
	(.154)	(.130)	(.286)	(.335)	(.165)
CPI $_{t-2}$	.194				
	(.162)				
	.970	.796	.890	.322	.899
Wages $_{t-1}$	-.004	.037	-.048	-.262	.024
	(.166)	(.145)	(.346)	(.264)	(.186)
Wages $_{t-2}$	-.034				
	(.162)				
	.065†	.070†	.075†	.043*	.966
Unempl $_{t-1}$	-.779†	-.416†	-2.44†	-1.32*	-.008
	(.409)	(.229)	(1.37)	(.655)	(.196)
Unempl $_{t-2}$	.296				
	(.412)				
χ^2	114.6***	113.7***	5.14 n.s.	7.81†	4.78 n.s.
R-sq	.656	.640	.269	.394	.138
Time period	1956-2022	1955-2022	1955-1972	1973-1988	1989-2022
Number of obs	67	68	18	16	34
Comment	Whole period	Whole period	Before oil crises	During oil crises	After oil crises

Standard errors in parentheses. † p < .10; * p < .05; ** p < .01; *** p< .001.

3. Results

To analyze month-over-month US data, we included 24 lags at the outset, as Beard et al. (2019) suggested, but reducing them to 21 did not alter any substantial conclusion. To ease the interpretation, we report the lagged effects of wage changes on changes in the CPI in Figure 3 with 95% confidence intervals, controlling (A) and not controlling for (B) change in unemployment, i.e., the differentiated unemployment variable. A and B show that wage changes caused changes in the CPI (p <.001) with an alternating oscillatory pattern taking positive and negative values. The wage effect on the CPI was strongest after 13-15 months.

Concerning the Norwegian data, including two lags (cf. Beard et al., 2019), yearly wage changes did not cause changes in the CPI (Table 1, Model 1), and including one lag only did not alter any conclusion (Model 2). The non-significant pattern was consistent before (Model 3), during (Model 4), and after oil crises (Model 5). Unemployment, on the other hand, tended to inversely cause changes in the CPI with a lag of one year (Model 1 and 2), but only before (Model 3) and during the oil crises (Model 4), not after (Model 5).

4. Conclusion

Previous studies have indicated that wages cause changes in consumer prices, but not all of them. To address the inconsistency, we compared US monthly data between Jan 2008 and Feb 2020 with Norwegian yearly data between 1955 and 2022 in this study. Our motive

for the comparison was that fine-grained monthly data with long lags may reveal a more nuanced picture than crude yearly data with short lags. By including 21 monthly lags, the US data showed that wages caused changes in the CPI with an alternating oscillatory pattern where positive and negative effects balanced each other out over time. Observing that the wage effect on the CPI was strongest after 13-15 months illuminates the importance of including sufficient lags in the analyses.

The Norwegian data, conversely, using crude yearly data with a maximum of two lags, neither before, during, or after the oil crises, showed that average wage changes caused changes in the CPI. Consistent with the Phillips (1958) curve, unemployment tended to inversely cause changes in the CPI, but only before and during the oil crises, not after.

Unreported models testing the Norwegian data for time-varying Granger causality, using an algorithm developed by Baum et al. (2022), showed that wage changes significantly affected changes in the CPI, countering the abovementioned findings. Having said that, other unreported models using the same algorithm, analyzing various variables, gave partly counterintuitive and conflicting statistical conclusions. Accordingly, we are somewhat cautious in concluding that wage changes cause changes in the CPI, as suggested by the algorithm developed by Baum et al. (2022). Another issue cautioning us to conclude as such is that the time-varying Granger causality tests counter the non-time-varying Granger causality tests, not showing that wage changes affect changes in the CPI. Therefore, we recommend further research to address the validity of different causality tests.

Taken together, this study contributes to the literature on how wages potentially cause changes in consumer prices as they have shown mixed results. Our study uncovered that fine-grained monthly data gave a more nuanced picture of how wages caused consumer price changes than crude yearly data did before, during, and after oil crises as indicators of external shocks. As some models had few observations, we encourage future studies to include more and longer time series.

References

Aarstad, J., & Kvitastein, O. A. (2023). Wage Inequality's Decreasing Effect on Enterprise Operating Revenues. *Economies*, *11*(7), 178. https://www.mdpi.com/2227-7099/11/7/178

Baum, C. F., Hurn, S., & Otero, J. (2022). Testing for time-varying Granger causality. *The Stata Journal*, *22*(2), 355-378. https://doi.org/10.1177/1536867x221106403

Beard, E., Marsden, J., Brown, J., Tombor, I., Stapleton, J., Michie, S., & West, R. (2019). Understanding and using time series analyses in addiction research. *Addiction*, *114*(10), 1866-1884. https://doi.org/https://doi.org/10.1111/add.14643

Dickey, D. A., & Fuller, W. A. (1979). Distribution of the Estimators for Autoregressive Time Series With a Unit Root. *Journal of the American Statistical Association*, *74*(366), 427-431. https://doi.org/10.2307/2286348

FRED. (2023a). *Average Hourly Earnings of All Employees, Total Private*. Retrieved Nov. 14, 2023 from https://fred.stlouisfed.org/series/CES0500000003

FRED. (2023b). *Consumer Price Index for All Urban Consumers: All Items in U.S. City Average* Retrieved Nov. 14, 2023 from https://fred.stlouisfed.org/series/CPIAUCSL

FRED. (2023c). *Unemployment Rate - Job Losers (U-2)*. Retrieved Nov. 14, 2023 from https://fred.stlouisfed.org/series/U2RATE#
Granger, C. W. J. (1969). Investigating Causal Relations by Econometric Models and Cross-spectral Methods. *Econometrica*, *37*(3), 424-438. https://doi.org/10.2307/1912791
Hess, G. D., & Schweitzer, M. (2000). Does wage inflation cause price inflation? *FRB of Cleveland Policy Discussion Paper*(1).
Hoxha, A. (2010). Causality between Prices and Wages: VECM Analysis for EU-12. *Theoretical & Applied Economics*, *17*(5), 27-48.
Ivanova, M. A. (2016). Analysis of the nature of cause-and-effect relationship between inflation and wage in Russia. *Studies on Russian Economic Development*, *27*(5), 575-584. https://doi.org/10.1134/S1075700716050051
Knotek II, E. S., & Zaman, S. (2014). On the relationships between wages, prices, and economic activity. *Economic Commentary*(2014-14).
Lütkepohl, H. (2005). *New introduction to multiple time series analysis*. Springer Science & Business Media.
Majsterek, M., & Welfe, A. (2010). Long-Run Price-Wage Relationships and the Role of the Tax System. *Ekonomista*(5), 677-700.
Mehra, Y. P. (2000). Wage-price dynamics: Are they consistent with cost push? *FRB Richmond Economic Quarterly*, *86*(3), 27-44.
Mills, T. C., & Wood, G. E. (2002). Wages and prices in the UK. *Applied Economics*, *34*(17), 2143-2149. https://doi.org/10.1080/00036840210135845
Mnqayi, N. S. (2021). *Review of the aggregate and sectoral relationship between wages and inflation in South Africa: 1980-2019*
NAV. (2023). *Historisk statistikk om arbeidsmarkedet*. Retrieved Nov. 14, 2023 from https://www.nav.no/no/nav-og-samfunn/statistikk/arbeidssokere-og-stillinger-statistikk/historisk-statistikk
Nourzad, F. (2012). Assessing the predictive power of labour-market indicators of inflation. *Applied Economics Letters*, *19*(10), 981-985. https://doi.org/10.1080/13504851.2011.610732
Phillips, A. W. (1958). The Relation Between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1861–19571. *Economica*, *25*(100), 283-299. https://doi.org/https://doi.org/10.1111/j.1468-0335.1958.tb00003.x
Shojaie, A., & Fox, E. B. (2022). Granger Causality: A Review and Recent Advances. *Annual Review of Statistics and Its Application*, *9*(1), 289-319. https://doi.org/10.1146/annurev-statistics-040120-010930
StataCorp. (2021). *Version 17*. StataCorp LP.
Statistics Norway. (2023a). *Konsumprisindeksen*. Retrieved Nov. 14, 2023 from https://www.ssb.no/priser-og-prisindekser/konsumpriser/statistikk/konsumprisindeksen
Statistics Norway. (2023b). *Lønn*. Retrieved Nov. 14, 2023 from https://www.ssb.no/statbank/table/11417/tableViewLayout1/
Store Norske Leksikon. (2022). *Norge i etterkrigstiden*. Retrieved Nov. 14, 2023 from https://snl.no/Norge_i_etterkrigstiden
Zanetti, A. (2007). Do Wages Lead Inflation? Swiss Evidence. *Swiss Journal of Economics and Statistics*, *143*(1), 67-92. https://doi.org/10.1007/BF03399234