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NON-LINEARITY BETWEEN PRICE INFLATION AND LABOR COSTS: THE CASE OF CENTRAL EUROPEAN COUNTRIES

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Non-Linearity between Price Inflation and Labor Costs: The Case of Central European Countries

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Abstract:
This article explores the relationship between labor costs and price inflation under two conditions. Firstly, with linear assumption and classical techniques. Secondly, without assuming linearity, by a novel non-parametric machine learning method, namely gradient boosting. With quarterly data from 1996 to 2022 for V4 countries, we find linear and non-linear dependency between labor cost and price inflation. However, the magnitude of the connection is country-specific and changes over time. Our findings indicate that a significant linear relationship between considered variables does not lead to the higher predictability power of labor cost in a non-parametric model, which predicts inflation. Even opposed, the Czech Republic, the country with the highest correlation between unit labor cost(ULC) and deflator, shows better prediction in a case when the ULC is not in the set of independent variables. This fact highlights the importance of non-linearity for the inflation model.

JEL: E24; E31; E37
Keywords: inflation, labor cost, non-linear model, V4 countries

1. Introduction

The study of inflation remains a hot topic of economic research. One of the most popular chunks of the studies in this area explores the relationship of changing prices with different economic variables. For example, many papers discuss the relationship between the movements of labor costs and inflation (Lucas Jr and Rapping 1969, Stock and Watson 2008, Bobeica et al. 2019). These studies have reached common conclusions, yet there is still room for investigation. In this paper, we contribute under-researched questions on the relationship between labor cost and price inflation and try to fill the existing gaps.

According to the cost-push view: wage increases over productivity are seen as putting upward pressure on prices, and wages are the exogenous variable determining the future direction of inflation. Ghali (1999) proves this theory by reporting Granger-causality test results, which indicate that wage growth does indeed predict inflation. However, other papers employing the same method show an opposite result, namely that there is no causal link between labor cost and price inflation (Sbordone 2002, Bidder et al. 2015, Hess and Schweitzer 2000). A different method of exploring the connection, namely out-of-sample forecasting, also shows indefinite results. Stock and Watson (2008), Knotek II and Zaman (2014) conclude, that it is difficult to ascertain whether labor cost brings useful information to inflation forecast or not.

From a theoretical point of view, there should be a significant positive correlation between changes in labor cost and inflation. That is why policymakers and financial market analysts pay close attention to the dynamics of labor costs to gauge inflationary pressures. However, as mentioned above, the empirical studies show inconclusive and inconsistent results. For example, several authors have examined whether movements in labor costs lead to changes in price inflation for the US. The inferences vary with the different methodology and data definitions. For example King and Watson (2012) study two decomposition of inflation, motivated by the standard New Keynesian pricing equation of Sbordone (2002). They conclude that real factors influence labor costs in ways largely unrelated to inflation. Another study (Mehra 2000) came to the opposite result, that wage inflation helps predict price inflation.

Nevertheless, there is also consensus on several questions regarding the discussed connection. Different literature concludes the same result: that the link is heterogeneous across countries and sectors (Dees and Guntner 2014, Bobeica et al. 2019). In

addition, the magnitude of the relationship depends on the inflation regime, the state of the economy, and the nature of the shock that hit the economy. Namely, the connection is becoming weaker after the crisis. Also, researchers suggest that improved anchoring of inflation expectations potentially can weaken the relationship between labor cost inflation and price inflation over time (Peneva and Rudd 2017, Knotek II and Zaman 2014, Bobeica et al. 2019).

In this paper, we examine the relationship between price inflation and labor costs by using quarterly data from 1996 to 2022 for Visegrad Four (V4) countries, namely the Czech Republic, Hungary, Poland, and Slovakia. The contribution to the literature is twofold. First of all, we explore countries that are poorly present in similar literature. Secondly, we go beyond standard approaches, where researchers consider only linear dependency between variables.

To explore possible connections more broadly, we check for both linear dependency and non-linear. For it, we use parametric and non-parametric methods. Our analysis shows that, even though for several countries, there is no statistically significant linear dependence between movements of wages and price inflation, labor cost can still affect inflation in a non-linear way. We prove it by the fact that labor cost has strong predictive power for the inflation forecast. So considering changes in labor costs, we can more accurately predict inflation.

The remained part of the paper organizes as follows. Section 2 connects the article to the existing literature. Section 3 describes the data used for the analysis, plots the time series, and makes inferences about the statistical relationship between unit labor cost (ULC) and GDP deflator. Section 4 presents the results of the cross-correlation analyses and the Granger causality test. Section 5 explores non-linear dependency by using out-of-sample forecast evaluation based on a gradient boosting algorithm. Section 6 summarizes and concludes.

2. Related Literature

Since the introduction of the Phillips curve (Phillips 1958), it was uncovered that there is a negative relationship between the unemployment rate and the wages movements, and the study of price inflation started to focus on the labor market Since then, researchers have begun to explore the link between price inflation and market development. A sig-

nificant share of such studies focusing on the connection between price and labor cost inflation. One part of this research attempts to find the relation between the two, using empirical evidence, and to show whether movements in labor costs precede dynamics in price inflation or vice versa. Another part is proving the presence of the connection between variables by showing that one variable has predictability power for predicting another one.

The first bunch of research, which examines whether movements in labor costs lead to changes in price inflation, shows an inconsistent result, so there is still a debate about this question. For example Peneva and Rudd (2017) research this question by using US data and time-varying parameter/stochastic volatility VAR framework. The baseline VAR model includes four variables: core price inflation, unemployment gap, a measure of trend in unit labor cost growth, and weighted relative import price inflation. As a result, they do not find significant evidence that independent dynamics of labor costs have affected price inflation. Nevertheless, they find that the pass-through of labor cost growth to core price inflation has diminished over time.

The reason for lower pass-through of labor cost is dipper research in another paper from Bobeica et al. (2021). In that paper, the authors check four potential explanations for the decline in pass-through from labor cost to price inflation: improved anchoring of inflation expectations, the changing constellation of shocks hitting the economy, increased trade integration, and rising firm market power. Researchers find that the improvement in anchoring the inflation expectations has played a particularly important role, as did the last two reasons, but to a lesser extent.

Another similar to Peneva and Rudd (2017) work were done by Knotek II and Zaman (2014). They also explore the passthrough of labor costs to price inflation for the USA. However, they do this by looking at the role, that wages play in some medium-scale macroeconomic models. Namely, they use a Bayesian vector auto-regression that includes eight variables: real GDP, real personal consumption expenditures (PCE), core PCE inflation, PCE inflation, productivity, one measure of wages, the unemployment rate, and the federal funds rate. As a result, authors find a limited effect of changes in labor costs on aggregate price inflation.

Nonetheless, studies based on European data show a different result. Recent literature in the European context finds wage-price linkages to be robust. For instance,

Bobeica et al. (2019) systematically documents the link between labor cost and price inflation for the euro area, namely Italy, France, Germany, and Spain. They not only prove a strong wage passthrough to inflation but also explain how the state of the economy and the nature of the shock affect this link. The results show that the link between labor cost and price inflation is explicit and relatively strong during demand shock, but for supply shock, it is not the case, and the relationship is inconclusive.

Some other research based in EU countries also find that the passthrough is sizable (Bundesbank 2019, Boranova et al. 2019, De Luigi et al. 2019). De Luigi et al. (2019) explore eight Central, Eastern, and Southeastern European EU Member States. They find a positive relationship between labor costs and price inflation and also show that the results are country-specific, and the connection is weakening after the global financial crisis.

There can be several explanations for such deviation from the theory. Firstly, components of the consumption basket are not equally sensitive to changes in labor cost. For example, food prices change with the weather condition, energy prices fluctuate mainly because of the global market. That is why changes in the production cost do not equally affect the prices for different types of goods. Secondly, as we mentioned, the production cost is a significant part of the total cost, but not the only one. Hence, the changes in the expenses of other tangible and intangible production inputs may interfere with wage developments. Lastly, it can be the case that firms want to avoid costs associated with changing prices or/and retain market share, for doing it, they compensate for an increase in labor cost by lowering their profit margin. All these discussed reasons can lead to a situation where in the short term, the changes in labor cost do not translate into moves in the inflation rate. However, in the long run, an insistent wage increase should, at some point, increase the price level.

All described papers explore the connection between the dynamics of wages and inflation by using parametric models, so they consider only linear relationships. In our research, we go beyond this approach, and in addition to standard linear methods, we exploit a novel machine learning technique - gradient boosting. This method lets us catch non-linear relationships between variables. To the best of our knowledge, there is no article that would use this method for exploring the pass-through of labor costs to price inflation, so we are going to fill this gap.

3. Data description

We explore the link between unit labor cost and price deflator for V4 countries. For this purpose, we collect quarterly data over the period from Q1 1996 to Q4 2021 [1]. For a measure of labor cost, it is common to use employee compensation or unit labor cost (ratio of labor cost to labor productivity). We choose to use ULC because economic theory suggests that only wage increases that exceed productivity growth should exert upward pressure on prices. As a measure of inflation, we use the GDP price deflator. Seasonally adjusted GDP Implicit Price Deflator and Unit Labor Costs obtained from Federal Reserve Economic Data (FRED).

As we mentioned in the introduction, in addition to exploring linear dependencies between wage and price inflation, we test the non-linear connection. For this purpose, we build a predictive non-parametric model using the gradient boosting method. To do this, we need additional variables, such as the real exchange rate and uncertainty index. An explanation of why we chose these particular variables is in the fifth chapter - Pseudo-out-of-sample forecast evaluation. The uncertainty index is defined using the frequency of the word "uncertainty" in the quarterly Economist Intelligence Unit country reports (Ahir et al. 2022). The data for both variables, real exchange rate, and uncertainty index, were taken from FRED.

[1] Due to the availability of the data, some time series are shorter. However, no series covered less than 21 years. The shortest series is ULC for Poland (Q4 2020 - Q4 2021).

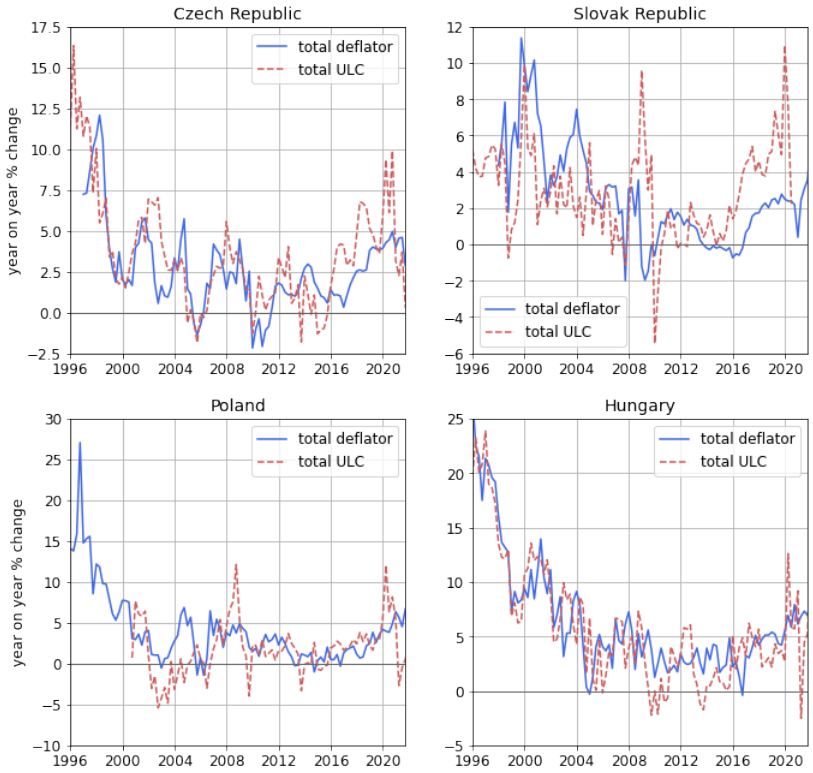


Figure 1: Unit Labor Cost and GDP deflator, year on year % change

The figure above shows the year-on-year percentage change of the measure of inflation (total GDP deflator) and unit labor cost for V4 countries. The two-time series significantly positively correlated for the Czech Republic and Hungary (0.67 and 0.87, respectively). Not significant, but still positively correlated for Slovakia and Poland (0.31 and 0.27 respectively). Also, all countries share the same trend: the peak in 1996, then they decline approximately till 2004 (the year when all V4 countries and other six countries joined the EU), and slightly grow after that.

The drop in the time series after 1996 can be explained by the improvements in the inflation anchoring expectations. The literature (Dräger, Lamla, et al. 2018) shows that inflation expectations have become more firmly anchored since the middle of the 1990s, and the mean forecasts of inflation across agents became more stable and close to the central bank's inflation target. Consumers became more trusting of the Federal Reserve in setting the appropriate interest rate.

To get rid of the trend based on the improvements in the inflation anchoring expectations to lower levels, we adjust both time-series (ULC and GDP deflator) by subtracting the consensus survey-based long-run inflation expectations. This method

is based on Knotek II and Zaman (2014). That paper itself was inspired by the forecasting literature (Kozicki and Tinsley 2001, Meyer et al. 2013). These papers discover that the accuracy of inflation forecast increases by specifying inflation in gap form as the deviation from a slow-moving long-run trend. The adjusted time series are present in Figure 2.

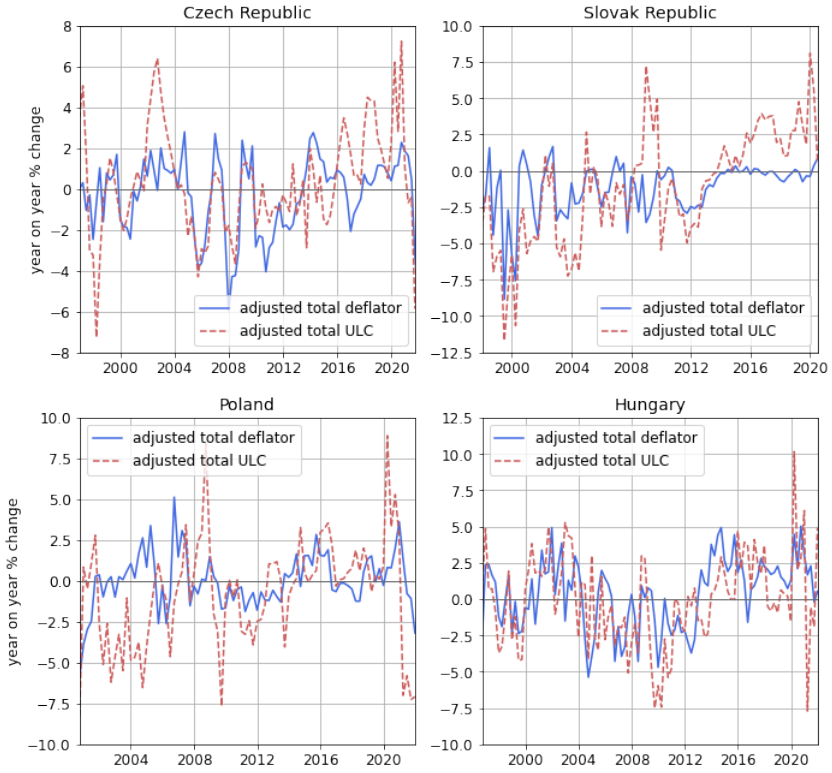


Figure 2: Adjusted Unit Labor Cost and the adjusted GDP deflator, year on year % change

After adjustment, we get stationary series, which is visible in picture 2. Stationarity is also proved by the augmented Dickey-Fuller (ADF) unit root test. In addition to stationarity, adjustment makes the connection between variables more independent of whether it was a pre-crisis period (before 2007) or a period after the crisis. We show this in figure 3, in the example of the Czech Republic and Slovakia. There we can see that, for unadjusted data, the connection between changes in inflation and labor cost is different before and after the crisis. However, for the adjusted data, there is no dramatic difference. The graphs of adjusted and not adjusted data for Poland and Hungary are present in appendix 1.

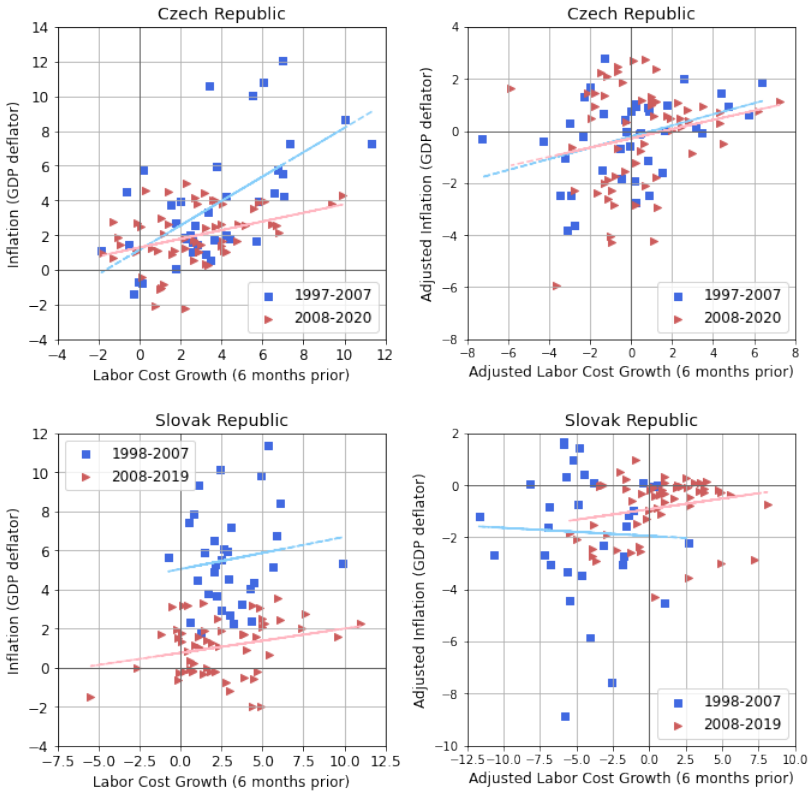


Figure 3: Adjusted and not adjusted ULC growth (6 months prior) and GDP deflator in the Czech Republic and Slovakia

The data described in this chapter already allows us to make some inferences. First of all, wage inflation and price inflation positively correlated with each other. The correlation value is country-specific: the magnitude is the highest for Hungary and the smallest for Poland. Secondly, deflator and ULC follow the general trend, which is less clear (noisier) for Slovakia. Time series reaches the peak value at 1996, then graph decreases till 2004, and slightly grow after this. Lastly, adjustment lets us make the data independent of whether it is the time before or after the crisis.

4. Cross-correlation and Granger causality test

As was discussed in a previous section, for some countries, there is a strong connection between labor cost and the measure of price inflation. However, it is unclear from the analysis whether the ULC comes before inflation or the other way round. To clarify this, we study the cross-correlation between these two series. The resulting graph is in Figure 4.

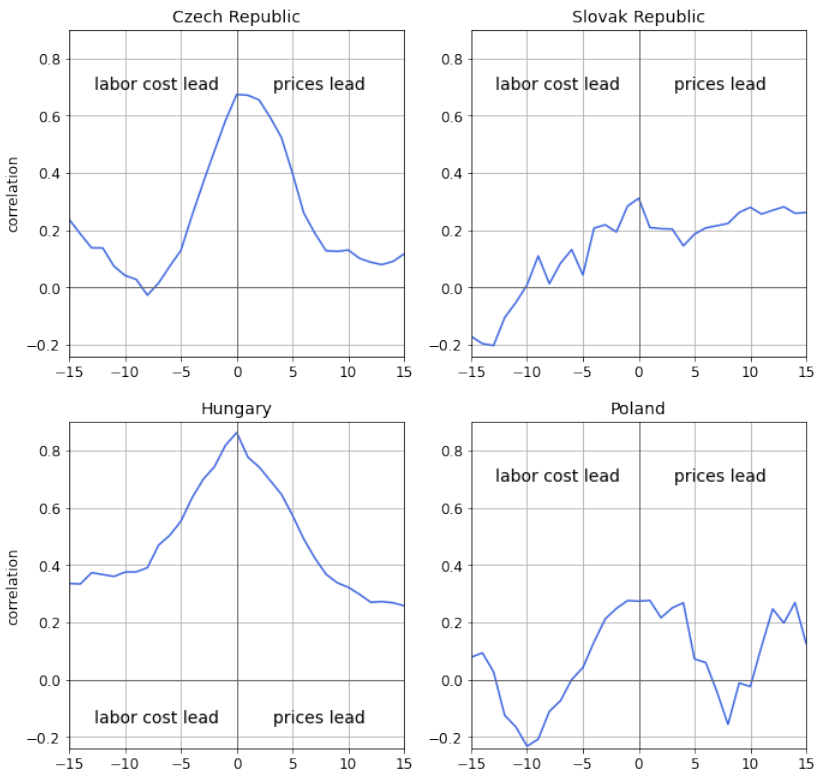


Figure 4: Cross-correlation between adjusted labor cost and price inflation for V4 countries

A plot of cross correlation enables a simple examination of the lead-lag structure of the correlations. The resulting charts show a heterogeneous picture of the lead-lag structure, connecting ULC, and price inflation. While, in Hungary, changes in labor costs seem to lead to price movements, in the Czech Republic, the situation is opposed: price dynamics leading to changes in labor costs. However, for both these countries, the difference between the case when the ULC or inflation leads is insignificant. Consistently with the time series shown earlier, the cross-correlation plot one more time shows that, in the case of Slovakia and Poland, there is no significant correlation between ULC and inflation. For any leads and lags, the correlation for these countries is less than 0.3.

Even though the cross-correlation results show a heterogeneous outcome, there is also a common tendency for all countries: the single strongest correlations appear in a specification with no lag or a specification with only a moderate lag. Obtained findings are consistent with the literature (De Luigi et al. 2019, and Bobeica et al. 2019). For example, De Luigi et al. (2019) consider eight different countries, and they also faced the heterogeneous picture of the lead-lag structure connecting ULC growth and price inflation.

To investigate the relationship between ULC growth and inflation further, we also use one more generally used approach - The Recursive Granger causality test. It is a statistical hypothesis test for determining whether one-time series is helpful in forecasting another. The result of the Recursive Granger causality test is present in figure 5.

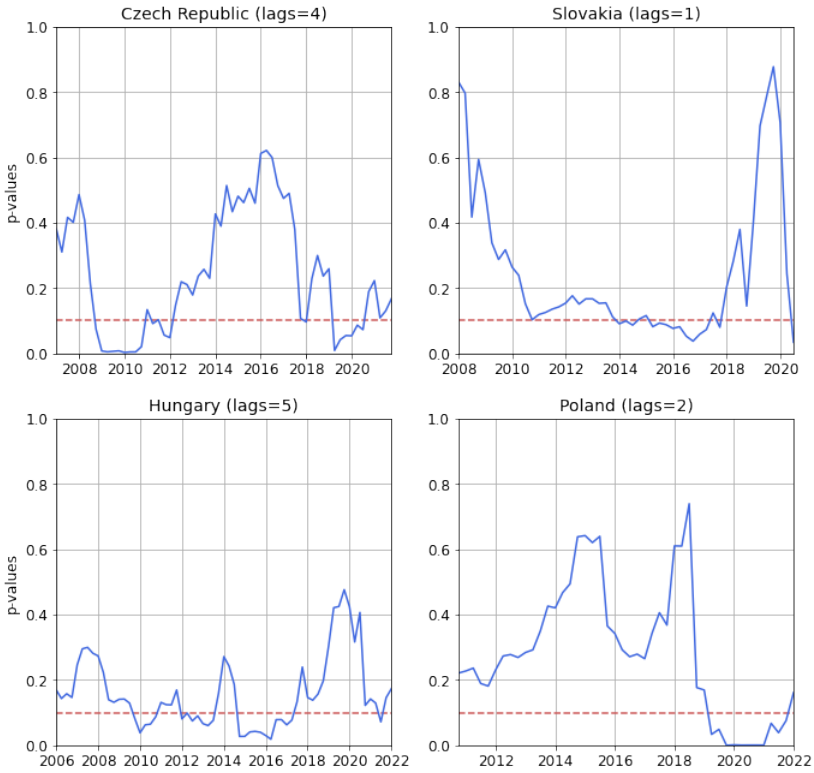


Figure 5: Recursive Granger causality test results (p-values)

In our case, the Recursive Granger causality test checks whether lagged values of ULC have significant in-sample explanatory power for price inflation. More formally, we estimate a single equation model, where price inflation regressed on p lags of inflation and ULC. After modeling, we test the exclusion of ULC lags. The test is performed on a recursive basis: it starts by estimating the equation for the first ten years of the time series and then subsequently adding one quarter at a time. Lags are chosen optimally by grid search in a way that minimizes the p-values of the tests.

The results show that for all considered countries, there are some periods where there is Granger causality from ULC to price inflation at 10% and sometimes even 5% significance, the causality is less evident for Slovakia. However, it can be the case that both time series "Granger-cause" each other. In this scenario, we can conclude only

that both economic series are determined simultaneously, but not that one variable has an independent causal effect on the other. To exclude this case and to avoid incorrect inferences, we also consider another approach - pseudo-out-of-sample forecast evaluation.

5. Pseudo-out-of-sample forecast evaluation

In the previous section, we analyze the linear relationship. We find that for some countries, indeed, there is a strong connection between the movements of the unit labor cost and price inflation, but for some countries, the relationship is not significant. In this chapter, we will go further in exploring connections and will check non-linear dependency. For this purpose, we use a commonly adopted approach: a pseudo-out-of-sample forecast evaluation (e.g. Stock and Watson 2007, Ang et al. 2005).

For a forecasting model we choose non-parametric method - gradient boosting (Chen and Guestrin 2016). It is a scalable decision tree ensemble technique that is a reliable and efficient machine learning challenge solver. We choose this method because it is powerful enough to find any nonlinear relationship between the target variable and features. Also, gradient boosting has great usability as it handles outliers without any special processing.

For implementing the chosen method, we use the CatBoost library - a high-performance open-source implementation of the Gradient Boosting Decision Tree (GBDT) algorithm. CatBoost outperforms many existing library based on GBDT, such as XGBoost (Chen and Guestrin 2016) and LightGBM (Ke et al. 2017). We tune the hyper-parameters by using the grid search method. We regulate the most important parameters: the tree depth, learning rate, and the number of iterations. To estimate the model performance, we split the data into test and train parts, the last four years of available data is the testing, and all previous data is training.

Pseudo out-of-sample forecast evaluation helps us to estimate the predictability power of the labor cost dynamic. For this purpose, we compare the performance of two models. Both models predict the GDP deflator using the first five lag values, broad effective exchange rate, unemployment rate, and uncertainty index. However, one model also includes ULC as an independent variable and second one is not.

The exchange and the unemployment rates are commonly used variables for inflation prediction. According to the Phillips Curve (Phillips 1958), when unemployment goes down, people tend to spend more money, which leads to more pressure on prices, so inflation is rising. For the exchange rate, the dependency is the opposite: the increase in the foreign exchange price raises the inflation rate. It happens because a higher exchange rate makes domestic goods cheaper for foreign consumers, which increases exports, total demand, and prices. A broad effective exchange rate is a weighted average of a foreign currencies basket. We take this type of exchange rate in order to have an overall measure of the country's external competitiveness.

As a potential explanatory variable, we also choose the uncertainty index because the index can be used as a proxy for the state of the economy, hence uncertainty affects the price movements. The literature supports this argument. Research shows that the uncertainty index effect both: inflation expectation and inflation itself. In the paper of Arce-Alfaro and Blagov (2021), for example, the authors show it by using US data and stochastic volatility-in-mean structural VAR mode.

The evaluation of the models' performance is based on the different metrics: mean square error (MSE), mean absolute error (MAE), and R squared score (R^2). The result shows that based on all three presented metrics for Poland and Hungary the models with ULC perform better than without them. For the Czech Republic and Slovakia, the opposite is true, models without ULC show better quality.

We can conclude that the result is heterogeneous. For Poland and Hungary, the ULC has predictability power to inflation, for the Czech Republic and Slovakia it has not. Interesting that Poland has the smallest correlation between ULC and inflation, and despite this, the ULC improves the accuracy of the model. It gives us another result: when we take ULC into the model, the effect of non-linear dependence should not be neglected. All statistics are presented below in Table 1.

Table 1 - Performance of the model with ULC variable and without it for Czech Republic (CZ), Slovakia (SK), Poland (P), and Hungary (H)

	CZ with ULC	CZ without	SK with ULC	SK without	P with ULC	P without	H with ULC	H without
MSE	0.661	0.505	1.684	1.243	1.040	1.332	0.853	1.368
MAE	0.702	0.573	1.263	1.061	0.862	0.953	0.688	0.806
R^2	0.583	0.681	-0.210	0.107	0.359	0.179	0.413	0.058

For a better visibility, we also plot the prediction of the deflator for both models and the real deflator value in figure 6. In addition to this, we calculate the correlations between predicted values and the real deflator (all the correlations are present in Appendix 2). If we examine these correlations between predicted values and real deflator, we can see that the statistical relationship is high for all countries. Moreover, for every country except the Czech Republic, the correlation is bigger for a model with labor cost than without it.

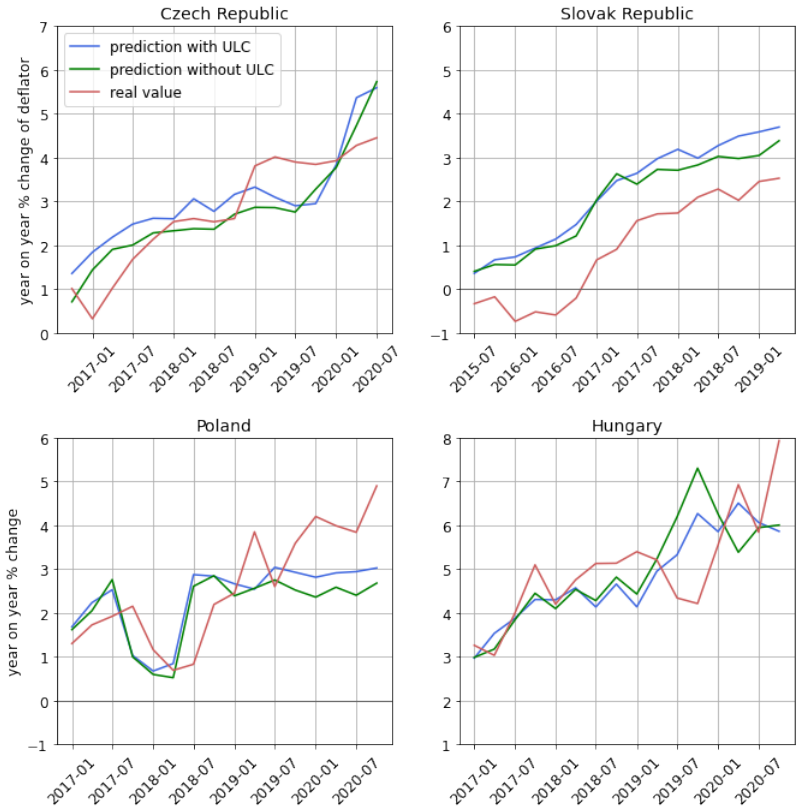


Figure 6: The prediction of deflator for V4 countries for a model with ULC(blue) and without ULC(green) and the real value of the deflator(red)

For Slovakia, the difference between the two models is the lowest (the correlation is 0.967 for a model with ULC and 0.962 without it). For Poland, the difference is also not so big (0.628 with labor cost, 0.550 without it). For Hungary, the correlation in a model with labor cost is significantly stronger than without it (0.677 with labor cost, 0.510 without it). Surprisingly, for the Czech Republic, the correlation is stronger without the ULC variable (0.769 with labor cost, 0.832 without it), even though, in the second chapter, we find that ULC is strongly correlated with deflator.

6. Conclusion

Understanding the signal in the labor cost changes that affect the inflationary process is substantial for politicians and financial market analysts. However, the empirical connection between wage inflation and price inflation is usually analyzed within the scope of linear assumption. In this paper, we document the link not only for a classic linear case but also for a non-linear one.

Using quarterly data from 1996 to 2022 for Visegrad Four countries, we reveal the numbers of facts. First, we find the common trend in the development of the time series. Time series peak at 1996, then it decreases till 2004, and slightly grow after. This trend is explained by the anchoring process and eliminated by using adjustment by subtracting the consensus survey-based long-run inflation expectations.

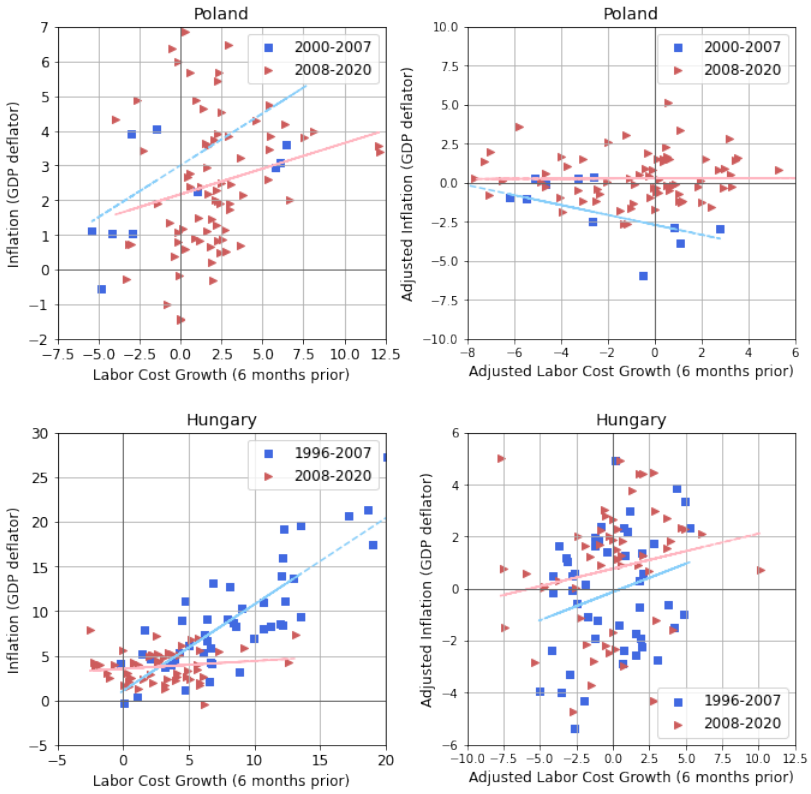
Second, we document the heterogeneous nature of the correlation between labor cost and price inflation. The Czech Republic and Hungary show a high positive correlation (0.67 and 0.87, respectively). A positive but less strong correlation is for Slovakia and Poland (0.31 and 0.27, respectively). We can explain this difference in findings by various reasons. For example, the result can be heterogeneous because the distribution of the sectors' shares (manufacturing, service, and construction) are different for considered countries. It can be a reason for heterogeneity because, as it was shown in Bobeica et al. (2019), the link between labor cost and inflation is diverse for various sectors. Another reason can be that the state of the economy and shocks hitting the economy is significantly different for considered countries, which is why the link between ULC and inflation also varies. To confidently answer the question of why the result is so heterogeneous, additional research is needed.

Third, we make a pseudo-out-of-sample forecast evaluation with the non-parametric

model. It lets us estimate whether the labor cost is a good variable for the prediction of inflation in a non-linear model or not. The results show that for all countries (except the Czech Republic), even with the low correlation between ULC and deflator, the ULC helps predict inflation.

The most important conclusion of this work is that even if there is no linear dependency between labor cost and price inflation, it is still beneficial to consider labor cost for the inflation prediction with a non-linear model.

Appendix 1



Adjusted and not adjusted ULC growth (6 months prior) and GDP deflator in Poland and Hungary

Appendix 2

Correlations between different variables

	Czech Republic	Slovakia	Poland	Hungary
ULC and deflator	0.67	0.31	0.27	0.87
real and predictive value of deflator (model with ULC)	0.797	0.968	0.628	0.677
real and predictive value of deflator (model without ULC)	0.832	0.962	0.550	0.510

References

Ahir, Hites, Nicholas Bloom, and Davide Furceri (2022). *The world uncertainty index*. Tech. rep. National bureau of economic research.

Ang, Andrew, Geert Bekaert, and Jun Liu (2005). "Why stocks may disappoint". In: *Journal of Financial Economics* 76.3, pp. 471–508.

Arce-Alfaro, Gabriel and Boris Blagov (2021). *Monetary policy uncertainty and inflation expectations*. Tech. rep. Ruhr Economic Papers.

Bidder, Rhys et al. (2015). "Are wages useful in forecasting price inflation?" In: *FRBSF economic letter* 33, pp. 1–5.

Bobeica, Elena, Matteo Ciccarelli, Isabel Vansteenkiste, et al. (2019). *The link between labor cost and price inflation in the euro area*. Tech. rep. Central Bank of Chile.

Bobeica, Elena, Matteo Ciccarelli, and Isabel Vansteenkiste (2021). "The changing link between labor cost and price inflation in the United States". In.

Boranova, Vizhdan, Raju Huidrom, Sylwia Nowak, Petia Topalova, Mr Volodymyr Tulin, and Richard Varghese (2019). *Wage Growth and Inflation in Europe: A Puzzle?* International Monetary Fund.

Chen, Tianqi and Carlos Guestrin (2016). "Xgboost: A scalable tree boosting system". In: *Proceedings of the 22nd acm sigkdd international conference on knowledge discovery and data mining*, pp. 785–794.

De Luigi, Clara, Florian Huber, Josef Schreiner, et al. (2019). "The impact of labor cost growth on inflation in selected CESEE countries". In: *Focus on European Economic Integration Q* 4.

Dees, Stephane and Jochen Guntner (2014). "Analysing and forecasting price dynamics across euro area countries and sectors: A panel VAR approach". In.

Dräger, Lena, Michael Lamla, et al. (2018). *Is the Anchoring of Consumers' Inflation Expectations Shaped by Inflational Experience?* Tech. rep. CESifo.

Ghali, Khalifa H (1999). "Wage growth and the inflation process: A multivariate cointegration analysis". In: *Journal of Money, Credit and Banking*, pp. 417–431.

Hess, Gregory D and Mark Schweitzer (2000). "Does wage inflation cause price inflation?" In: *FRB of Cleveland Policy Discussion Paper* 1.

Ke, Guolin, Qi Meng, Thomas Finley, Taifeng Wang, Wei Chen, Weidong Ma, Qiwei Ye, and Tie-Yan Liu (2017). "Lightgbm: A highly efficient gradient boosting decision tree". In: *Advances in neural information processing systems* 30.

King, Robert G and Mark W Watson (2012). "Inflation and unit labor cost". In: *Journal of Money, credit and Banking* 44, pp. 111–149.

Knotek II, Edward S and Saeed Zaman (2014). "On the relationships between wages, prices, and economic activity". In: *Economic Commentary* 2014-14.

Kozicki, Sharon and Peter A Tinsley (2001). "Shifting endpoints in the term structure of interest rates". In: *Journal of monetary Economics* 47.3, pp. 613–652.

Lucas Jr, Robert E and Leonard A Rapping (1969). "Real wages, employment, and inflation". In: *Journal of political economy* 77.5, pp. 721–754.

Mehra, Yash P (2000). "Wage-price dynamics: Are they consistent with cost push?" In: *FRB Richmond Economic Quarterly* 86.3, pp. 27–44.

Meyer, Brent, Guhan Venkatu, and Saeed Zaman (2013). "Forecasting inflation? Target the middle". In: *Economic Commentary* 2013-05.

Peneva, Ekaterina V and Jeremy B Rudd (2017). "The passthrough of labor costs to price inflation". In: *Journal of Money, Credit and Banking* 49.8, pp. 1777–1802.

Phillips, Alban W (1958). "The relation between unemployment and the rate of change of money wage rates in the United Kingdom, 1861-1957". In: *economica* 25.100, pp. 283–299.

Sbordone, Argia M (2002). "Prices and unit labor costs: a new test of price stickiness". In: *Journal of Monetary economics* 49.2, pp. 265–292.

Stock, James H and Mark W Watson (2007). "Why has US inflation become harder to forecast?" In: *Journal of Money, Credit and banking* 39, pp. 3–33.

— (2008). "Phillips curve inflation forecasts". In.

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