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Wage and Price Inflation: Evidence with Asymmetric Methods for Türkiye

Ücret ve Fiyat Enflasyonu: Asimetrik Yöntemlerle Türkiye'den Kanıtlar

Serhat Alpağut[1]

Abstract

The relationship between wages and inflation has retained its importance since the early economists. In particular, during periods of high inflation, the discussion that wages are the main source of inflation is back on the agenda. In contrast to the linear relationships presented in previous studies, this study addresses the issue with a non-linear econometric approach (NARDL). Linear models deal only with the impact of wage increases on inflation. The purpose of choosing a non-linear method is to determine the effects of both positive and negative shocks to wages on inflation. Knowing the asymmetric effects while designing a policy can provide significant advantages in estimating the results of the policy. In this study on Türkiye, quarterly data for the years 2012-2023 have been used. The first result obtained shows that there is an asymmetric relationship between wages and inflation. The second result is that a positive shock to wages has a positive effect on inflation. This result is in consistency with previous studies. The third result is that inflation is strongly negatively affected by a negative shock that can occur in wages. The effect of a negative shock in wages on inflation is stronger than that of a positive shock. This result is quite remarkable. In addition, the applied cumulative dynamic multiplier effect analysis shows that in the case of a negative shock to gross wages, the decrease in inflation will continue for 3 periods (9 months) and this effect will reach equilibrium at the end of 5 periods (15 months).

Keywords: *Inflation, Wage, Nonlinear ARDL.*

Öz

Ücret ve enflasyon ilişkisi ilk dönem iktisatçılardan bugüne önemini korumaktadır. Özellikle enflasyonun yüksek seyrettiği dönemlerde, enflasyonun temel kaynağının ücretler olduğu yönündeki tartışmalar yeniden gündeme gelmektedir. Bu çalışma önceki çalışmalarda sunulan doğrusal ilişkilerin aksine doğrusal olmayan bir ekonometrik yaklaşımla (NARDL) konuyu ele almıştır. Doğrusal modeller sadece ücretlerdeki artışın enflasyona etkisini ele almaktadır. Doğrusal olmayan bir yöntem seçilmesindeki amaç, ücretlerde hem pozitif hem de negatif şok etkilerinin enflasyona etkisini tespit etmektir. Bir politika tasarlanırken asimetrik etkilerin bilinmesi, politikaların sonuçlarının tahmin edilmesinde önemli avantajlar sağlayabilir. Türkiye üzerine olan bu araştırmada 2012-2023 yılları çeyreklik verileri kullanılmıştır. Elde edilen ilk sonuç ücret ve enflasyon arasında asimetrik bir ilişkinin var olduğunu göstermektedir. İkinci sonuç ücretlerde bir pozitif şokun enflasyonu pozitif etkilediği yönündedir. Bu sonuç geçmiş çalışmalarla uyumludur. Üçüncü sonuç ücretlerde oluşabilecek bir negatif şok karşısında enflasyonun güçlü bir şekilde negatif etkilendiğidir. Ücretlerin enflasyona negatif şok etkisi pozitife göre daha güçlüdür. Bu sonuç oldukça dikkat çekicidir. Ayrıca uygulanan kümülatif dinamik çarpan etki analizi brüt ücretlere bir negatif şok gelmesi durumunda enflasyonda yaşanacak düşüşün 3 dönem boyunca (9 ay) sürdüğünü ve bu etkinin 5 dönem sonunda (15 ay) dengeye geldiğini göstermektedir.

Anahtar Kelimeler: *Enflasyon, Ücret, Nonlinear ARDL.*

JEL Codes: *C32, E31, E5, E64*

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[1]Asst. Prof. Dr., Agri Ibrahim Cecen University, Eleskirt Vocational School, Finance-Banking and Insurance Department, Ağrı, Türkiye, salpagut@agri.edu.tr, ORCID: https://orcid.org/ https://orcid.org/0000-0001-7326-4048.

Introduction

In Türkiye, wages are indexed to past inflation. Measuring inflation at a lower level than it should be will cause wages to be below inflation. This is a factor that reduces aggregate demand in terms of expenditures and increases aggregate supply in terms of costs. If inflation is measured at a higher level than it should be, it will cause wages to be above inflation. This is a factor that increases demand in terms of aggregate expenditures and decreases aggregate supply in terms of costs. In a situation where wages increase in line with money supply and inflation, there will be no monetary deterioration in the general economic balance. M. Friedman, one of the pioneers of monetarist economics, states that macroeconomic disorders are caused by the deterioration of the monetary balance. Since wage increases expand the monetary base, Friedman recommends indexing wages to inflation (Friedman, 2021: 9; Hetzel, 2012: 36). The issues mentioned here clearly reveal the relationship between gross wages and inflation.

Inflation in Türkiye has risen rapidly recently. The causes and consequences of this rapid rise in inflation are currently the subject of debate among economists. In addition, policymakers believe that the source of inflation may be the increase in wages. This situation intensifies the debate among economists as to whether wages are the source of inflation. This study aims to provide a scientific basis for such current debates.

A review of the literature reveals that several studies have investigated the cointegration relationship between inflation and wages. Among them, Mehra (1991), Saatcioglu (2005), Korkmaz and Coban (2006), Sunal and Alp (2015), Islatince (2017) and Eryilmaz and Bakir (2018) found that there is a long-run relationship between inflation and wages. In some studies, the relationship has been analysed using an autoregressive econometric approach. Among them, Festić (2000) and Tuleykan (2019) found that the source of inflation shocks is wages. Contrary to these results, Agenor and Hoffmaister (1997) conclude that the source of wage shocks is inflation. Some studies have examined the relationship between wages and inflation using static and dynamic regression analysis. Jorda and Nechio (2023) concluded that inflation has a positive effect on wages, while Jacobsson and Lindbeck (1969); Lucas Jr. and Rapping (1969); Akgul and Bukey (2020) concluded that inflation has a negative effect on wages. Gumus and Akgunes (2020) find that the effect of inflation on wages is insignificant. When analyzing the studies that investigate the effect of wages on inflation, Lemos (2003); Sahinoglu, Ozden, Basar and Aksu (2010); Agayev (2012); Baskaya and Ozmen (2013); Ahmed, Muzib and Roy (2013); Majchrowska (2022) found that wages have a positive effect on inflation. Cuong (2011) and Campos-Vazquez, and Esquivel (2020) show that wages do not have a significant impact on inflation. Some studies in the literature have analyzed the wage-inflation relationship using causality tests. Thus, the question has been whether inflation is the cause of wages or wages are the cause of inflation. Bulut-Cevik and Macit (2017) found unidirectional causality from wages to inflation. Mehra (1991); Islatince (2017); Eryilmaz and Bakir (2018); Ozyigit, Celik and Petek (2019); Kara, Kanberoglu and Oguz (2020) found a unidirectional causality from inflation to wages. The studies of Korkmaz and Coban (2006) and Abdioglu (2013), Sunal and Alp (2015) and Sevinc (2022) found bidirectional causality for the variables.

The available literature has focused on econometric approaches that treat the relationship between wages and Inflation linearly. The results obtained from linear models express the effects of positive changes in one variable on another. However, in non-linear models, the effects of negative changes in one variable can be seen in addition to the results of linear models. For this reason, this study aims to analyze the issue using a non-linear econometric approach. Thus, as a result of the established model, the effect of inflation against a negative shock in wages for Türkiye should be known. It is believed that the econometric method used in the study and the results obtained will contribute to the literature.

The following sections of the study discuss the relationship between wages and inflation using economic approaches. Then, the available studies in the literature are analyzed. The econometric method to be used is then briefly explained. Finally, tests are carried out on the basis of the established model and the results are presented. The last section presents a general evaluation.

1. Theoretical Background

Inflation refers to a cumulative and continuous increase in the general price level. The increase in prices can cause deviations in the production-expenditure-income balance. Inflation is generally divided into two main categories: demand inflation and cost inflation. Demand inflation is recognized by Keynesian economists as a short-run imperfection in the goods market. Keynesian economists define inflation as the sum of domestic production and imports being less than the sum of domestic expenditure and exports. This implies excess demand. As mentioned above, excess demand is the situation where expenditure is higher than production. In this case, the Keynesian perspective argues that the inflationary effect can be eliminated by controlling expenditure. When analyzing the structure of domestic expenditure, Keynes argues that consumption expenditure depends on income. Increases in income can increase aggregate demand and compensate for the lack of demand. However, this does not reduce existing inflation. On the contrary, according to

Keynes, it is not possible to fight inflation by reducing incomes. This is because Keynes accepts that nominal wages are downwardly rigid (Tarhan and Kara, 2011: 228). Although wage policy is generally accepted as cost inflation, Keynes accepts wages as a way to achieve general equilibrium in the economy through aggregate spending. The main determinant of investment spending is firstly profit appetite and secondly interest rates. It is not easy to stimulate both consumption and investment spending in the short run. For this reason, Keynes proposed the way to control aggregate spending through public spending, which is considered autonomous. The Keynesian view assumes aggregate supply with zero price elasticity. Moreover, the fact that there was no inflationary phenomenon in the countries during the period of its dominance did not prepare the ground for the formation of an anti-inflationary wage policy within the Keynesian view. The problem of insufficient aggregate demand was tried to be solved by an expansionary fiscal policy.

Another important view of inflation is the monetarist approach. According to this view, which was brought to the fore by M. Friedman, the source of inflation is the excess of money in the market. He argues that if the money supply can be controlled, it is possible to control inflation. This view is not very far removed from neoclassical economics. In fact, the view known as "quantity theory" assumes that the amount of money in circulation is equal to the amount of goods in the market. When the quantity of money exceeds the quantity of goods, inflationary effects occur. Neoclassics believe that there is no inflation in the long run under the assumption of an aggregate supply curve with infinite price elasticity (Aktan, 2010: 175). This is because the idea is that markets are constantly being cleared. If there is an excess of money, inflation will occur first (Bilir, 2017: 190). After that, the prices of goods will adjust, and all prices will be equal in real terms. This view is based on A. Smith's theory of the "invisible hand" and the Walrasian price movement. However, the orthodox monetarist view recognizes that short-term fluctuations may occur in the economy (Kucukefe and Demiroz, 2018: 77). According to the monetarist approach, labor market agents are aware that wages are real. However, due to the "monetary illusion" of workers and the fact that labor contracts bind workers to certain periods of time, it takes time for inflation to be reflected in wages. Eventually, inflation will be realized first and then wages will rise. However, if the money supply cannot be controlled, there will be an increase in inflation and a situation where wages and prices feed each other (Abidoglu, 2014: 246). Monetarist economists emphasize the importance of monetary policy in the impact of wages on inflation. It is stressed that monetary policy should be implemented strictly in order to keep inflation under control. Central banks should tightly control the money supply and adjust monetary policy to reduce inflation. In addition, monetarist economists stress the importance of flexibility and competition in the effect of wages on inflation. In a competitive market environment, wages and prices can be set flexibly. This can reduce the impact of inflation and help maintain economic equilibrium.

The orthodox monetarist view, like other classical economists, assumes that wages are determined in the labor market. When the demand for labor is high, wages will rise. When the supply of labor is high, wages will fall (Parasiz, 1991: 47). Since the wage structure is not fully flexible in the short run, there may be both temporal and quantitative disruptions in wage and price adjustment. In order to avoid these disruptions, M. Friedman has proposed that wages should be indexed to inflation. This indexation refers to the readjustment of wages according to past inflation (Bocutoglu, 2012: 175). It is assumed that if the indexation is correct, there will be no difference between wages and prices. Therefore, providing employees with an increase above inflation will increase the demand for goods and services. Since this situation will increase aggregate demand, it will in turn have an accelerating effect on inflation. Otherwise, not increasing wages at the rate of inflation will reduce the demand for goods and services. Since this situation will reduce aggregate demand, an increase in unemployment and an increase in economic growth may occur. For these reasons, the relationship between wages and prices is very important for the economy.

The factors mentioned so far are related to demand inflation. Wages are an important cost for producers. An increase in costs for producers means a decrease in their possible profits. Producers reflect costs in prices after a certain level of profit reduction. This is cost inflation. Although wages play an important role in cost inflation, there are also macroeconomic factors other than wages that increase cost inflation. These are the relative value of international prices, exchange rate increases, tax increases and broad money supply (Bal, 2019: 546).

In terms of macroeconomic theory, there is an indirect intervention in nominal wages to increase aggregate supply, even if not to reduce inflation. Both orthodox monetarists and new classical economists have argued that nominal wages can be reduced by reducing the power of trade unions. Unions seek to increase the wages of their members at all costs. In an economy where unions are strong enough, wage increases cannot be prevented. This situation may not provide suitable conditions for firms to increase labor demands. In this case, a reduction in nominal wages can be achieved through the unions. If these recommendations for aggregate supply are implemented, aggregate supply will increase. In this case, even if aggregate demand remains constant, inflation will fall. This situation can ultimately be seen as having an indirect effect on inflation through wages.

In the new classical economic view, money is neutral. It is not possible for expected changes in the money supply to affect real variables (Oguz, 2020: 167). Thus, even if an increase in the money supply reduces real wages, the labor

market will rebalance according to the new situation because workers are subject to "intertemporal labor substitution". In this case, it will not be possible to fight high inflation with wage policy (Bocutoglu, 2012: 256).

The New Keynesian view of the economy assumes that wages are rigid. Collective bargaining is the cause of wage rigidity based on approaches such as the efficient wage hypothesis, the insider-outsider hypothesis and the hysteresis effect (Bocutoglu, 2012: 351). The New Keynesian view also argues that prices are rigid due to menu costs. New Keynesians accept that the macroeconomic damage caused by economic fluctuations is less due to rigidities in both wages and prices (Kablamacı, 2011: 56; Saydam, 2010: 243). Thus, according to the New Keynesian view, controlling inflation through wages is not considered a reasonable method.

It is also necessary to assess the impact of a change in wages on prices in terms of price elasticity. This is because, when wages change, it is important whether or not prices adjust in line with wages. First of all, the classical economic view assumes that prices are perfectly flexible in the long run. Keynesians, on the other hand, assume that prices are rigid in the short run. In the orthodox Keynesian view, there is a scenario in which prices are both rigid and flexible. In the monetarist view, prices are sufficiently flexible. In the new classical view, prices are perfectly flexible so that markets are in equilibrium in both the short and the long run. In the new Keynesian view, prices are rigid because of menu costs. In summary, ideas based on the classical view have price elasticities, while ideas based on the Keynesian view have price rigidity. The classical, orthodox monetarist and new classical schools accept the effect of wage differentiation on prices.

In summary, for the Classics and New Classics, who accept that the price elasticity of the aggregate supply curve is high, the reflection of wages in prices is high. The monetarists have proposed a less elastic aggregate supply curve in the short run. For the New Classical and New Keynesians, it is less flexible in the short run but fully flexible in the long run. This suggests that an increase in wages will be reflected in prices. Conversely, while the Classical, Monetarist and New Classical schools might suggest a decline in real wages due to wage and price elasticities, this suggestion is not accepted by the Keynesian and New Keynesian schools due to the rigidity of wages. Nominal wage rigidity prevents real wages from reaching equilibrium. Thus, it is not possible for wages to pass through to inflation (Altıok, 2009: 85).

2. Literature

The available studies in the literature that examine the relationship between wages and prices are summarized in Table 1. An examination of the studies shows that cointegration tests are used as an econometric method. Mehra (1991); Saatcioglu (2005); Korkmaz and Coban (2006); Sunal and Alp (2015); Islatince (2017) and Eryilmaz and Bakir (2018) found a cointegration relationship between wages and inflation. These results provide evidence that there is a long-run relationship between wages and inflation.

Another method used in the literature is the causality test. The study of Bulut-Cevik and Macit (2017) found a one-way causality from wages to inflation. Mehra (1991); Islatince (2017); Eryilmaz and Bakir (2018); Ozyigit et al. (2019); The studies of Kara et al. (2020) found a one-way causality from inflation to wages. The studies of Korkmaz and Coban (2006) and Abdioglu (2013) Sunal and Alp (2015); Sevinc (2022) found bidirectional causality for the variables.

In some studies, the autoregressive model is established by including the lagged value of the dependent variable in the model. The results of the variance decomposition analysis applied in the studies of Festić (2000) and Tuleykan (2019) show that the source of inflationary shocks is wages. In the study of Agenor and Hoffmaister (1997), the next important source of wage shocks was found to be inflation. As a result of the impulse response analyses of the three studies mentioned, inflation was found to respond positively to a wage shock.

Other studies have carried out regression analysis, creating static and dynamic approaches to short- and long-term relationships between variables. Some studies have examined the impact of inflation on wages. The study by Jorda and Nechio (2023) concludes that inflation has a positive effect on wages. The studies of Jacobsson and Lindbeck (1969); Lucas Jr. and Rapping (1969); Akgul and Bukey (2020) concluded that inflation has a negative effect on wages. The study by Gumus and Akgunes (2020) found statistically insignificant results on the effect of inflation on wages. Some studies have examined the effect of wages on inflation. Lemos (2003); Sahinoglu et al. (2010); Agayev (2012); Baskaya and Ozmen (2013); Ahmed et al. (2013) and Majchrowska (2022) study showed that wages have a positive effect on inflation. The studies of Cuong (2011) and Campos-Vazquez and Esquivel (2020) obtained statistically insignificant results on the effect of wages on inflation. Thus, it was interpreted that wages have no effect on inflation.

Apart from the aforementioned studies, there are also studies that find remarkable results. In the study of Korkmaz (2017), the effect of wages on inflation has been examined in two different ways: consumer prices and producer prices. The study concluded that wage increases have a negative effect on consumer inflation, but no effect on producer prices. However, the study by Baskaya and Ozmen (2013) finds that wage increases have a positive effect on producer

inflation. Two studies on wage-induced producer inflation find different results. In their study, Deniz, Tekce and Yilmaz (2016) examined the effect of wages on inflation, differentiating between developed and developing countries. The study concluded that wages have a positive effect on inflation in developing countries, and a negative effect in developed countries. The study by Lemos (2003) found that the positive effect of wages on inflation was stronger in poor regions. In his study on the wage and price spiral, Yildiz (2022) applied two models, first with two variables and then with macroeconomic variables. As a result of the two-variable model, it was concluded that each inflation has a positive effect on wages and wages have a positive effect on inflation. However, when the model was extended to include macroeconomic variables, the results were not statistically significant.

The studies available in the literature, especially on Türkiye have examined the relationship between wages and inflation using generally linear econometric methods. It is important to detect and identify a possible asymmetric relationship between two variables. It is believed that this study will contribute to the literature by examining the asymmetric relationship between the relevant variables based on the difference in econometric methods.

Table 1. Literature Summary

Studies	Country and Period	Models	Variables	Conclusion
Jacobsson and Lindbeck (1969)	Sweden 1955-1967	OLS	CPI, wages, unemployment, open positions in the workforce	The effect of inflation increases on wages is negative. This shows that wages do not rise as much as inflation. The reason for this is probably the Swedish government's pressure on wages and prices during the period.
Lucas Jr and Rapping (1969)	U.S. 1930-1965	Dynamic OLS	CPI, wages, unemployment, GDP	Rising inflation has a negative impact on wages.
Mehra (1991)	U.S. 1959: Q1-1989: Q3	Engle- Granger Co. and Granger cas.	CPI, wages, output gap	A co-integration relationship was found between wages and inflation. There is also a one-way causality from inflation to wages.
Agenor and Hoffmaister (1997)	Chile, Korea, Mexico and Türkiye 1979: Q4-1982: Q1	VAR	CPI, wages, output gap, exchange rate, money supply	As a result of the variance decomposition, the source of wage shocks in Mexico and Chile was found to be inflation. In the generalized impulse response analysis, a positive shock to nominal wages increases inflation in all countries. In all countries, a positive shock to the money supply tends to increase rather than decrease real wages, ultimately leading to an increase in output.
Festić (2000)	Slovenia 1992-1998	VAR	CPI, wages, money supply, import price	The variance decomposition shows that a significant part of the shocks to inflation is related to wages, and the next important source of shocks to wages is the money supply.
Lemos (2003)	Brazil 1982-2000	OLS	CPI, minimum wage, average minimum wage, employment, GDP, nominal interest	Minimum wage increases increase inflation (a 10% increase in wages increases prices by 0.5% to 3%). This effect is lower in periods of low inflation and higher in periods of high inflation. In addition, the impact of the minimum wage on prices is greater in poorer regions.
Domac (2003)	Türkiye 2001: M05-2002: M12	ARDL	CPI, wages, exchange rate	Rising wages lead to higher inflation in the long run.
Saatcioglu (2005)	Türkiye 1988:M01-2004:M05	Johansen co. and VAR	CPI, exchange rate, bond interest, wages, loans, monetary base, public sector WPI	In the study carried out to determine the determinants of inflation, wages are the explanatory variable. It was found that there is a cointegration relationship between inflation and wages. In the short-term VAR-based impulse response analysis, no significant results were obtained between inflation and wages.
Korkmaz and Coban (2006)	Türkiye 1969-2006	Johansen co. and Granger cas.	Minimum wage, WPI, unemployment rate	There is a long-run relationship between the minimum wage and inflation. There is also a bidirectional causality between inflation and the minimum wage.
Sahinoglu et al. (2010)	Türkiye 1998:M01-2015:M04	ARDL	CPI, wages, output gap, budget deficit, money supply, crises	In the study conducted to identify the determinants of inflation, wages are the explanatory variable. While wages have a positive and significant effect on inflation in the long run, the current value and the first lag of wages are positive in the short run. As the lags increase, the effect becomes negative.
Cuong (2011)	Vietnam 1994-2008	OLS, FGLS	CPI (food), minimum wage, GDP, public revenues, exchange rate, money supply	It has been found that increases in the minimum wage do not have an impact on inflation (the results were not statistically significant).
Agayev (2012)	23 Transition economies 1998-2008	Panel data (fixed random effect)	CPI, wages, money supply, exchange rate	The study of the determinants of inflation found a strong positive relationship between wages and inflation.

Abdioglu (2013)	Türkiye 1997-2012	Todo-Yamamoto cas.	Nominal wages, CPI	Bidirectional causality has been found between nominal wages and inflation.
Baskaya and Ozmen (2013)	Türkiye 2003-2012	Difference-in-differences (DiD) method	PPI, minimum wage, employer cost	Minimum wage increases raise the PPI. This effect comes from sectors that do not use skilled labor.
Ahmed, et al. (2013)	Bangladesh 1975-2010	ARDL	CPI, wages, GDP, exchange rate, credit	Wages and credit have a positive and significant impact on inflation.
Sunal and Alp (2015)	Türkiye 1987-2012	Johansen co. and Granger cas.	CPI, minimum wage, GDP	A long-term relationship has been determined between inflation and minimum wage. Additionally, a bidirectional causality relationship between nominal minimum wages and inflation was determined.
Deniz et al. (2016)	40 countries (developed and developing) 2002-2012	Dynamic and Statik Panel data	CPI, GDP, wages, exchange rate, money supply, budget balance	The study of the determinants of inflation finds that the effect of wages on inflation is positive in developing countries, while it is significant and negative in industrial countries.
Bulut-Cevik and Macit (2017)	Türkiye 1988-2016	Engle-Granger	Minimum Wage, CPI, Unemployment Rate, GDP, Trade	A one-way causality from the minimum wage to inflation has been established.
Islatince (2017)	Türkiye 1988-2016	Johansen co. and Granger cas.	CPI, wages, money supply	A cointegration relationship was found between the variables. The study of the relationship between money supply and inflation found a unidirectional causality from prices to wages.
Korkmaz (2017)	Türkiye 1998: M01-2015: M04	OLS	CPI, PPI, nominal wages GDP, money supply, interest rate	As a result of the study on the determinants of inflation, the effect of nominal wages on the CPI was found to be negative and significant, while the effect of nominal wages on the PPI was found to be statistically insignificant.
Eryilmaz and Bakir (2018)	Türkiye 1988-2012	Johansen co. and Granger cas.	Productivity, real wage, CPI	A cointegration relationship has been found between the variables. One-way causality was found from inflation to wages.
Tuleykan (2019)	Türkiye 1988: Q1 – 2018: Q1	VAR	CPI, minimum wage, unemployment rate	While the effect of the minimum wage on inflation is positive in the first period, it continues to fluctuate positively and negatively in the remaining periods and has a significant effect in 6 periods. In the variance decomposition, the impact of inflation shocks due to the minimum wage was high.
Ozyigit et al. (2019)	Türkiye 1980-2016	Todo-Yamamoto cas.	Minimum wage, CPI, GDP, productivity	A one-way causality from inflation to the minimum wage has been established.
Akgul and Bukey (2020)	Türkiye 1987-2018	ARDL	Minimum wage, CPI, structural breaks (dummy)	While inflation has a positive effect on the minimum wage in the long run, it has a negative effect in the short run.
Gumus and Akgunes (2020)	Türkiye 1982-2018	ARDL	Minimum wage, CPI, GDP, unemployment rate	As a result of the study investigating the relationship between the minimum wage and macro variables, it was concluded that only growth has a negative and significant effect on the minimum wage in the long run.
Kara et al. (2020)	9 Developing Countries 1995-2018	(Panel Data) Dumitrescu and Hurlin cas.	CPI, wages	A one-way causality from inflation to wages has been established.
Campos-Vazquez and Esquivel (2020)	Mexican 2015-2018	RMSPE	CPI, minimum wage, taxes	Minimum wage increases have little or no impact on prices.
Sevinc (2022)	Türkiye 2005: Q1-2022: Q1	Bootstrap Todo-Yamamoto cas.	CPI, PPI, Gross minimum wage, net minimum wage, minimum wage employer cost	While the net minimum wage and the rate of increase in the minimum wage are not the cause of consumer inflation, other variables have been found to be causally related to each other.
Yildiz (2022)	Türkiye 2009: Q1-2021: Q3	ARDL	CPI, wages, GDP, exchange rate, credit	Several models of the relationship between wages and inflation have been examined. In the two-variable model, where inflation and wages are included in the first model, it was concluded that wages have a positive effect on inflation and inflation has a positive effect on wages. In the results of the large model, in which macroeconomic variables were included, no statistically significant results could be obtained for wages on inflation and inflation on wages. The main determinant of inflation was found to be the exchange rate.

Majchrowska (2022)	16 regions of Poland 2003-2020	Dynamic panel data	Minimum wages, CPI, GDP, unemployment, oil prices	The minimum wage has a significant and positive effect on inflation. This effect is higher when the dependent variable is food inflation. In addition, the effect of the minimum wage on inflation is higher in periods of high inflation.
Jorda and Nechio (2023)	Australia 1980-2020	Difference-in-differences (DiD) method	Lagged CPI, inflation expectations, lagged nominal wages, unemployment gap	The effect of past inflation values on nominal wages is positive but insignificant. However, in the post-pandemic period, inflation expectations have a significant and positive effect on nominal wages.

3. Methodology

The nonlinear ARDL test was developed by Shin et al. (2014). NARDL is similar to the ARDL test developed by Pesaran et al. (2001). Shin et al. (2014) proposed a new cointegration test by adding a procedure that includes separating the independent variables into positive and negative shocks.

$$\delta_t^+ = \sum_{j=1}^{q} \max(\Delta\delta_j, 0)\ ,\ \delta_t^- = \sum_{j=1}^{q} \min(\Delta\delta_j, 0)\ ,\ \delta_t = (\delta_0 + \delta_t^+ + \delta_t^-) \quad (1)$$

An independent variable contains constant terms, negative and positive shocks. Equation (1) expresses the situation of the independent variable separated into positive and negative shocks.

$$y_t = \sum_{j=1}^{p} \Phi_j\, y_{t-j} + \sum_{j=0}^{q} (\vartheta_j^{+\prime}\, \delta_{t-j}^+ + \vartheta_j^{-\prime} \delta_{t-j}^-) + u_t \quad (2)$$

Equation (2) represents the long-run asymmetric regression model of the NARDL model: y, dependent variable; δ+, positive shocks to the independent variable; δ-, negative shocks to the independent variable; Φ, autoregressive parameter; u, error term with zero mean and constant variance; p, appropriate lag of the dependent variable; q, appropriate lag of the independent variable (Shin et al., 2014: 10).

$$\Delta y_t = \sigma y_{t-1} + \alpha_j^{+\prime} \delta_{t-j}^+ + \alpha_j^{-\prime} \delta_{t-j}^- + \sum_{j=1}^{p-1} \omega_j\, \Delta y_{t-j} + \sum_{j=0}^{q-1} (\psi_j^{+\prime}\, \Delta\delta_{t-j}^+ + \psi_j^{-\prime} \Delta\delta_{t-j}^-) + u_t \quad (3)$$

Equation (3) represents the error correction model of the NARDL approach. The coefficient representing the lagged value of the dependent variable is denoted by the symbol ω. Δ represents the difference operator. The short-term coefficient values of the independent variables are represented by the symbol ψ. The long-term lagged values are reduced by one (Shin et al., 2014: 11).

$$Wald\colon \sum_{j=0}^{q-1} \psi_j^{+\prime}{}_2 = \sum_{j=0}^{q-1} \psi_j^{-\prime} \quad (4)$$

The existence of asymmetric relationships is examined using a Wald test, which tests whether the sum of the negative and positive shock values of the independent variables is equal to each other.

$$m_h^+ = \sum_{j=0}^{h} \partial y_{t+j} \Big/ \partial \delta_t^+\ ,\qquad m_h^- = \sum_{j=0}^{h} \partial y_{t+j} \Big/ \partial \delta_t^-\ ,\qquad h = 0,1,2 \ldots \infty \quad (5)$$

Equation (5) is the asymmetric dynamic multiplier equation. Asymmetric dynamic multipliers are calculated to monitor the effects of positive and negative changes, where m_h^+ and m_h^- represent the effects of positive and negative shocks, respectively. The dynamic multipliers are related to the long-run parameters of the model (Shin et al., 2014: 15).

4. Empirical Evidence

This research examines the impact of wages on inflation, taking into account the macroeconomic factors that influence inflation. By evaluating the working principles of the studies in the literature and the theory of the subject, the dependent and independent variables in the study were determined and a regression equation was created. Since inflation is affected by changes in both the goods and money markets, both market variables are included in the selection of independent variables. The resulting function is shown in equation (6).

$$Inflation_t = f(Economic\ Growth_t, Money\ Supply_t, Exchange\ Rate_t, Credits_t, Wage_t) \quad (6)$$

One of the most fundamental determinants of inflation is national income. Even the neoclassical economic view is based on the equivalence of inflation and output. Assuming that there is no change in the money supply in response to an increase in the amount of goods and services produced in a country, prices are expected to rise. Based on the so-called neoclassical "quantity theory", there is a direct link between output and inflation. In the literature, Lucas Jr. and Rapping (1969); Agenor and Hoffmaister (1997); Lemos (2003); Sahinoglu et al. (2010); Cuong (2011); Ahmed et al. (2013); Sunal and Alp (2015); Deniz et al. (2016); Bulut-Cevik and Macit (2017); Korkmaz (2017); Ozyigit et al. (2019); Gumus and Akgunes (2020); Yildiz (2022) and Majchrowska (2022) studies accepted the level of output as a determinant of inflation and included it as an explanatory variable in the model they constructed. In line with the literature, we include the national income variable in the model. The variable named *Economic Growth* refers to the annual level value of GDP. It is adjusted for both calendar and seasonal effects.

Holding other variables constant, increases in the money supply have a positive effect on aggregate demand. Increases in aggregate demand increase inflation. Therefore, a positive relationship between money supply and inflation is expected. In the literature, Agenor and Hoffmaister (1997); Festić (2000); Saatcioglu (2005); Sahinoglu et al. (2010); Cuong (2011); Agayev (2012); Deniz et al. (2016); Islatince (2017) and Korkmaz (2017) include money supply as a determinant of inflation in their models. In line with the literature, we include the money supply variable in the model. The money supply variable, denoted as MS, represents the M1 money supply, which is the sum of cash, the total amount of money in demand deposit accounts and cheques. The logarithm of the variable is taken.

Changes in exchange rates are seen as an indicator of international purchasing power. In particular, the high import ratios of developing countries and the dependence of exports and domestic consumption on imports are directly related to the impact of exchange rate changes on inflation. The expected effect is that as exchange rates rise, inflation also rises. In the literature, the studies of Agenor and Hoffmaister (1997); Domac (2003); Saatcioglu (2005); Cuong (2011); Agayev (2012); Ahmed et al. (2013); Deniz et al. (2016) and Yildiz (2022) included the exchange rate in the model as a determinant of inflation. The *Exchange Rate* represents the selling rate of the US dollar. The logarithm of the variable is taken.

Banks bring deposits back into the monetary system by making loans. The amount of money offered to the economy through loans is greater than total deposits. This is called "bank money creation". Each deposit brought into the banking system leads to a greater expansion of money in the banking system. This results in an expansion of the monetary base. An increase in credit in a country is expected to have a positive impact on inflation as it expands the monetary base. The studies of Saatcioglu (2005); Ahmed et al. (2013) and Yildiz (2022) used credit as a determinant of inflation. The *Credits* refers to the sum of consumer, vehicle and housing loans granted by banks, including overdraft accounts, in Turkish lira. The logarithm of the variable was taken.

Wages represent the rent paid for the supply of labor. As such, it is a factor affecting aggregate supply. As an increase in wages raises costs, it can lead to a reduction in labor demand and aggregate supply. On the other hand, wages increase the money stock of individuals and are directly related to aggregate spending. The increase in wages has a positive effect on aggregate demand through its effect on spending. The sum of these two opposing effects is the impact of wages on inflation. Wages, which are the main subject of the study, are represented by the abbreviation *Wage*. Taken from the data source as gross wage index. Both calendar and seasonal effects are used.

Economic Growth, *Money Supply, Exchange Rate*, *Credits* variables were obtained from the EVDS database within CBRT (Central Bank of the Republic of Türkiye). The *Wage* variable was obtained from the Labor Force Indices database within TSI (Turkish Statistical Institute). The data set covers the period 2012Q3-2023Q3. The fact that the data starts from 2012 is due to the fact that the credits variable is presented from the data source as of this date.

Table 2. Descriptive Statistics of the Variables

	Inflation	*Wage*	*Credits*	*Exchange Rate*	*Economic Growth*	*Money Supply*
Mean	5.524	4.467	21.50	1.569	20.75	20.22
Median	5.494	4.467	19.87	1.339	20.61	19.92
Maximum	6.105	5.385	38.91	3.289	22.76	22.22
Minimum	5.082	3.612	12.26	0.580	19.77	18.88
Std. Dev.	0.298	0.524	5.352	0.765	0.773	0.955
Observations	45	45	45	45	45	45

The study analyses 6 different variables. A time series of 45 observations was created for each variable. The descriptive statistics of the variables are presented in Table 2. *Inflation* and *Wage* are index variables. The variables *Credits*,

Economic Growth and *Money Supply* are monetary variables. The variable *Exchange Rate* is a US dollar/Turkish lira value. All variables' logarithms are taken. There is no scale difference in the final state of the variables.

Table 3. Unit Root Test Results

	DF-GLS				PP			
	Level		Difference		Level		Difference	
	Cons.	Cons. + Trend	Cons.	Cons. + Trend	Cons.	Cons. + Trend	Cons.	Cons. + Trend
Inflation	1.35	-0.77	-3.75***	-5.01***	4.05	-0.33	-5.68***	-6.54***
Wage	1.26	-3.94***	-3.41***	-5.35***	2.14	-5.19***	14.28***	-14.30***
Credits	-1.69	-2.24	-2.90***	-3.20**	-1.80	-2.47	-2.66*	-2.72***
Exchange Rate	2.05	-0.82	-3.67***	-4.66***	5.02	0.19	-4.84***	-5.36***
Economic Growth	2.40	-0.53	-6.19***	-7.48***	5.24	1.31	-5.66***	-6.57***
Money Supply	2.09	-0.79	-3.53***	-4.07***	3.58	-0.13	-5.67***	-7.40***
Critical 1%	-2.6198	-3.7700	-2.6211	-3.7700	-3.5885	-4.1809	-3.5924	-4.1864
values 5%	-1.9486	-3.1900	-1.9488	-3.1900	-2.9297	-3.5155	-2.9314	-3.5180
10%	-1.6120	-2.8900	-1.6119	-2.8900	-2.6030	-3.1882	-2.6039	-3.1897

Note: The symbols *, ** and *** indicate significance levels of 10%, 5% and 1% respectively.

The assumptions of the nonlinear ARDL test are the same as those of the ARDL test. The first is that the dependent variable is stationary at the I(I) level and the explanatory variables are stationary at the I(0) and I(I) levels, regardless of their order. The important and striking point is that the variables are not stationary at I(II) order. To meet these requirements, DF-GLS and Phillips-Perron (PP) tests were applied to the variables. The DF-GLS test was created by combining the Dickey-Fuller (DF) test with the Generalized Least Squares (GLS) method, which is a semi-parametric approach. This method is used to better model the autoregressive structure of the series and the stationarity of the series. The results of the two tests are similar. It is found that the variables *Inflation, Credits, Exchange Rate, Economic Growth, Money Supply* are stationary at the I(I) level and the variable *Wage* is stationary at the I(0) level. Thus, it appears that the NARDL model is applicable.

Table 4. Cointegration Test Results

		F-Bounds 4.26***		*t-Bounds* -5.09**	
		I(0)	I(I)	I(0)	I(I)
Critical Values	1% ***	2.54	3.86	-3.43	-5.68
	5% **	2.06	3.24	-2.86	-5.03

Note: The symbols ** and *** indicate significance levels of 5% and 1% respectively.

Table 4 presents the results of the cointegration test to test for the existence of a long-run relationship between the variables. The result of the F bounds test presented in the table indicates the existence of possible cointegration above the upper band I(I) level. Accordingly, the value of 4.26 in the F bounds test indicates that there is cointegration at the 1% significance level. The t bounds test tests the reliability of the statistical significance of the long-run and short-run results. The results of the t bounds test indicate that the t statistic is reliable at the 5% significance level.

Table 5. Asymmetry Test Results

	Wage	*Credits*	*Exchange Rate*	*Economic Growth*	*Money Supply*
Long-run asymmetry (Wald)	4.01**	20.42***	6.87**	1.14	7.48**

Note: The symbols ** and *** indicate significance levels of 5% and 1% respectively.

The existence of non-linear relationships in a constructed model is based on the difference between positive and negative shocks in the variables. In the asymmetry test presented in Table 5, the Wald test was used to test whether the coefficients of the long-run positive and negative effects of each variable were equal. Since the asymmetric relationships of all variables, not just the variable of interest, were used in the model built, the results of the asymmetry test for each

variable are shown in Table 5. There is an asymmetric relationship for all variables except *Economic Growth*. Every variable except *Economic Growth* has an asymmetric relationship with inflation.

Table 6. Co-Integration Test Result Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Wage^{pos}	0.221***	0.068	3.24	0.003
Wage ^{neg}	-3.929*	2.040	-1.92	0.065
Credits^{pos}	-0.003**	0.001	-2.77	0.010
Credits^{neg}	0.003***	0.000	3.61	0.001
Exchange Rate^{pos}	0.003	0.003	1.04	0.306
Exchange Rate^{neg}	-0.056**	0.022	-2.50	0.018
Economic Growth ^{pos}	0.058	0.037	1.52	0.138
Economic Growth ^{neg}	-0.019	0.069	-0.27	0.786
Money Supply^{pos}	0.132***	0.032	4.01	0.000
Money Supply^{neg}	-0.230*	0.125	-1.83	0.078

Note: The symbols *, ** and *** indicate significance levels of 10%, 5% and 1% respectively.

Table 6 shows the results of the long-run estimation. It shows that positive and negative wage shocks are statistically significant. In the case of a positive wage shock, inflation rises. A negative wage shock reduces inflation. Although these results clearly show the inflationary effect of wage increases, they also show that inflation will fall sharply in the case of a wage decrease. Another result is the relationship between credit and inflation. Both positive and negative shocks are statistically significant. While positive shocks to credit cause inflation to fall, negative shocks to credit cause inflation to rise. Another result is the relationship between the exchange rate and inflation. In this relationship, negative shocks to the exchange rate are statistically significant, while positive shocks are insignificant. Accordingly, negative exchange rate shocks have a downward effect on inflation. Another result is the relationship between national income and inflation. Both positive and negative shocks are statistically insignificant. In the asymmetry research, it was also found that there is no asymmetric relationship between inflation and national income. The final result is the relationship between money supply and inflation. Both positive and negative shocks are statistically significant. It was found that positive shocks to the money supply have an inflationary effect, while negative shocks have no an inflationary effect.

Table 7. Error Correction Model Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Cons.	4.227***	0.521	8.11	0.0000
Δ *Inflation*$_{t-1}$	0.143*	0.073	1.95	0.0609
Δ *Wage*^{pos}	-0.001	0.055	-0.01	0.9847
Δ *Exchange Rate*^{neg}	-0.022	0.014	-1.56	0.1291
Δ *Economic Growth* ^{neg}	0.062**	0.028	2.21	0.0359
Δ *Money Supply*^{pos}	0.035**	0.017	2.07	0.0481
ECT	-0.833***	0.103	-8.05	0.0000

Note: The symbols *, ** and *** indicate significance levels of 10%, 5% and 1% respectively.

Table 7 shows the short-run results. The indicator that the error correction model is working correctly is that the error correction coefficient is negative and statistically significant. According to Table 7, since both conditions are met, it can be said that the error correction model is working correctly. The error correction coefficient indicates that errors disappear in the long run. This coefficient of 0.83 indicates that 83% of the errors were corrected in a single period. It was therefore concluded that short-term errors were corrected in approximately 4 months. The evaluation of the coefficients shows that a one-period lag in inflation has a positive effect on current inflation. This shows that one of the causes of inflation is inflation itself in the short run. The effects of wages and exchange rates are not statistically significant. Increases in the level of output and the money supply seem to increase inflation in the short run.

Table 8. Diagnostic Tests Used to Check the Accuracy of the Model

Diagnostics tests	Stat.	Prob.	Status
Heteroskedasticity test: Breusch-Pagan-Godfrey	9.74	0.879	Heteroskedasticity does not exist.
Breusch-Godfrey Serial Correlation	5.12	0.077	There is no autocorrelation problem.
Jarque-Bera normality	4.26	0.118	A normal distribution exists.

Ramsey RESET	0.04	0.966	There are no excluded variables in the model. There is no specification error in the model.
Cusum and Cusum^2	Consistent, Graphs are in Appendix 1		There is no structural break in the model.

It is necessary to test the accuracy of the model created and the tests applied. Table 8 lists these tests and their results. The Ramsey reset test is used to test whether there is an excluded variable in the model. The result of this test is that the model has been built correctly and no specification errors have been made. The results of other tests indicate that there is no autocorrelation and no heteroskedasticity. It also appears that there is a normal distribution. In addition, Cusum tests were used to check whether there is a structural break in the model. There is no structural break in the model.

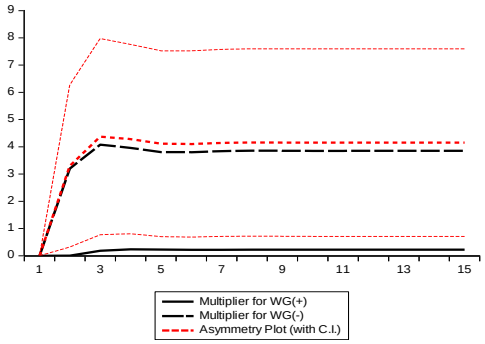

Figure 1. Cumulative Dynamic Multiplier Effect

The thin red dashed lines in Figure 1 represent the 95% confidence interval. The fact that the black dashed lines, representing negative shocks to gross wages, lie within the confidence interval indicates that they are statistically significant. Accordingly, the effect of negative shocks to gross wages on inflation occurs over 3 periods (9 months), being very strong in the 1st and 2nd periods and relatively weak in the 3rd period. It takes 5 periods to reach long-run equilibrium.

Conclusion

Inflation in Türkiye has risen rapidly recently. This rapid rise in inflation is a matter of debate among economists. In addition, policymakers are expressing the opinion that the source of inflation may be the increase in wages. This situation intensifies the debate among economists as to whether wages are the source of inflation. This study aims to provide a scientific basis for such current debates. In this study on Türkiye, a model was created by considering the macroeconomic factors that determine inflation for the data period 2012Q3-2023Q3. In the literature review, it was found that the studies used econometric methods that examined linear relationships. Therefore, the Nonlinear Autoregressive Distributed Lag Bound Test (NARDL) analysis was used, considering that an asymmetric examination of the wage-inflation relationship would contribute to the literature.

According to the results of the empirical analysis, the short-term determinants of inflation in Türkiye are national income, money supply and the lagged value of inflation. In the long run, they are wages, credit, money supply and exchange rate. Among these determinants, wages are the most important.

The result of the asymmetry test applied was those wages, credit, money supply and the exchange rate have an asymmetric effect on inflation, but that national income has no asymmetric effect.

One of the results is the relationship between credit and inflation. The analysis shows that positive shocks to credit have a negative effect on inflation, and negative shocks to credit have a positive effect on inflation. However, the coefficients are quite small. Such low coefficients indicate effects that need not be considered in the relationship between credit and inflation. In the literature, the study of Saatcioglu (2005) shows that loans affect inflation positively, while the studies of Ahmed et al. (2013) and Yildiz (2022) show that loans affect inflation negatively.

Another result is related to the relationship between national income and inflation. As a result of the study, it was found that both positive and negative shocks to national income have no statistical significance on inflation. In the literature, the studies of Korkmaz (2017) and Yildiz (2022) found that the effect of inflation increases on national income is statistically insignificant. In addition, Majchrowska (2022) provides evidence that the effect is low enough to be insignificant, although it is positive.

When examining the effect of exchange rates on inflation, it is concluded that a positive shock in exchange rates will increase inflation, but there is no statistical significance. It is concluded that a negative shock in exchange rates will reduce inflation. The effect of a negative shock is stronger than a positive shock in the effect of exchange rates on inflation asymmetrically. Among the studies that have examined the effect of exchange rates on inflation with linear regression models in the literature, Agenor and Hoffmaister (1997); Domac (2003); Saatcioglu (2005); Agayev (2012) and Yıldız (2022) have concluded that an increase in exchange rates will increase inflation. Cuong (2011); Ahmed et al. (2013); Deniz et al. (2016) have concluded that an increase in exchange rates will reduce inflation. The effect of positive exchange rate shocks on inflation is consistent with the literature.

When the effect of money supply on inflation is examined, it is concluded that positive shocks to money supply increase inflation and negative shocks decrease inflation. The effect of negative shocks in money supply on inflation is stronger than that of positive shocks. This situation shows that monetary tightening can have a decreasing effect on inflation. The studies of Sahinoglu et al. (2010) and Deniz et al. (2016) found that the increase in money supply has an increasing effect on inflation. The results are consistent with the literature.

As a result of the cointegration test, it is found that the positive shock to gross wages has a positive effect on inflation in the long run coefficients. This result is consistent with the literature of Domac (2003); Lemos (2003); Sahinoglu et al. (2010); Agayev (2012); Baskaya and Ozmen (2013); Ahmed et al. (2013); Tuleykan (2019) and Majchrowska (2022). In the literature that investigates the relationship between wages and inflation, econometric approaches that test linear relationships have been used as much as possible. This situation has led to the fact that only the effect of wage increases on inflation is known in the wage-inflation relationship. What happens to inflation when wages fall has become a new research question. This question is the basic research hypothesis of this study.

What is striking about the asymmetric effect of wages is that the negative shock to gross wages has a much stronger negative impact on inflation. Negative shocks to gross wages are stronger than positive shocks. This shows that inflation can fall significantly in the event of a negative wage shock.

In addition, the applied cumulative dynamic multiplier effect analysis shows that the reduction in inflation due to a negative shock to gross wages lasts for 3 periods (9 months) and this effect reaches equilibrium at the end of 5 periods (15 months).

The power of the negative effect on gross wages to reduce inflation and the duration of the effect are very important results for economic units struggling with inflation. As a result of the study, we conclude that fighting inflation through wage policy is macroeconomically important. We present this as a policy recommendation with the warning that wage policy and the fight against inflation may lead to a shortfall in aggregate demand. Although this suggestion is not a method of fighting inflation in orthodox economic policy, it has applications in heterodox policy. We are aware that wages are an important macroeconomic factor affecting both aggregate demand and aggregate supply. We believe it is important to explore this issue further in future studies using different econometric models and methods to test the accuracy of our policy recommendations.

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Appendix 1: Cusum Tests