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Inflation and unemployment in Mexico: An asymmetric and non-linear relation

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Abstract. The relation between inflation and unemployment in the Mexican economy over the period 2005-2025 is assessed. We first review the debate on the Phillips curve argument; then, the hypothesis of a long-term non-linear and asymmetric relation between inflation and unemployment, put forth by Palley's Minimum Unemployment Rate of Inflation(MURI), is empirically tested. Our main contribution shows that inflation responds in a non-linear and asymmetric manner to unemployment intensity and to increases in the unemployment rate. Our econometric test supports Palley's contention regarding the existence of a more complex distributional relationship impacting price level changes. The above implies Central Banks can get a deeper understanding of the Phillips curve relation if their monetary policy framework includes employment and growth targets.

Key words: inflation; México, unemployment; Phillips curve; wages.

Inflación y desempleo en México: una relación asimétrica y no lineal

Resumen. Se analiza la relación entre la inflación y el desempleo en la economía mexicana durante el periodo 2005-2025. En primer lugar, se repasa el debate sobre la curva de Phillips; a continuación, se comprueba empíricamente la hipótesis de una relación no lineal y asimétrica a largo plazo entre la inflación y el desempleo, planteada por la "tasa de inflación que minimiza el desempleo" de Palley. La principal contribución muestra que la inflación responde de manera no lineal y asimétrica a la intensidad del desempleo y a los aumentos de la tasa de desempleo. La prueba econométrica respalda la tesis de Palley sobre la existencia de una relación distributiva más compleja que influye en las variaciones del nivel de precios. Lo anterior implica que los bancos centrales pueden comprender mejor la relación de la curva de Phillips si su marco de política monetaria incluye objetivos de empleo y crecimiento.

Palabras clave: inflación; México; desempleo; curva de Phillps; salarios.

Clasificación JEL: E31; E58; J3; J6.

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1. Introduction

The purpose of the present paper is to discuss the hypothesis that the relation between inflation and unemployment is asymmetric and non-linear in the long-term. In this connection, an econometric analysis is conducted to test our hypothesis for the case of the Mexican economy. The main contribution of the article, consequentially, confirms that inflation responds to increases in the rate of unemployment and, most importantly, it also reacts in a non-linear and asymmetric manner to changes in unemployment intensity, which seems to confirm the hypothesis of downward rigidity in the labour market.

The relation between inflation and unemployment has been a recurrent topic in the history of economic analysis (Laidler, 2003). Phillips (1958) is haughtily credited as the pioneer of the explanation of the negative relation between inflation and unemployment (u) –ever since known in the history of macroeconomics as the Phillips curve. The relation between money wages (w_m) and u and the related policy topics had been widely discussed long before Phillips (1958). Commenting tales of forgotten forerunners, Forder (2014) contends that "the basic relation was suggested by Hume" (1987 [1752], p. 286) and that Fisher (1926) pointed out a statistical relation between the change in prices, rather than wages, and unemployment.

Lipsey (1960), in turn, gave a demand-pull explanation of this relation in terms of the rate of change in nominal wages and the level of unemployment consequential from excess demand for labour; Samuelson and Solow (1960) continued the discussion, their contribution has been portrayed as the Phillips curve inflationism view which supplies a constellation of inflation-unemployment rates from which governments can choose, depending on the society's and the government's time-rate preferences. If such a trade-off exists between the Scylla of inflation and the Charybdis of unemployment, a remedy to such a callousness also exists: a social welfare function can be certainly found at an "optimal point of the Phillips curve" (Santomero and Seater, 1978, p. 502). Samuelson and Solow (1960) have been convicted of advocating inflationist policies, pursued under the assumption that the said trade-off is stable (Tobin, 1987a; Shaikh, 2016; *cf.* also Niehans, 1978). However, it is hard to sustain that they advocated inflationism and the idea of a stable Phillips curve. Instead, it is safe to argue that Samuelson and Solow (1960) were not that optimistic about attaining full employment and price stability simultaneously (*cf.* also Forder, 2014, chapter 2).

Yet Phelps (1967; 1968) and Friedman's (1968) Presidential Address to the American Economic Association critically argued that continuous infla-

tionist policies would eventually change agents' expectations and the Phillips curve, thereby inflation tends to accelerate; hence there was no systematic and exploitable long-run trade-off between inflation and unemployment but a vertical long-run relation corresponding to a natural rate of unemployment. Friedman (1968) is arguably taken as the first intellectual source for the analysis of the relevance of expectations –expected inflation, specifically– in workers' wage bargaining;[1] Friedman's expectations critique maintained that, because of the neglect of expectations in the Phillips curve literature, there was a confusion between money and real wages before him, a claim that is hard to sustain. Nonetheless, such a critique somehow managed to change the drift of the debate on a path against both inflationism and so-called Keynesian pro-employment policies. It can be argued that today's consensus on targeting inflation as the sole aim of monetary policy has its remote origin in Friedman's Presidential Address.

The "new" insight introduced by Friedman (1968) was amply discussed in the post-1968 literature on the Phillips curve.[2] Here we highlight Tobin's (1987a; 1987b) response for two main reasons. First, his reaction, which can be easily traced back to Keynes's ideas on inflation, is still relevant to understanding today's inflation-unemployment relation; secondly, the empirical test conducted in the present paper is based on Palley's (2003; 2009; 2012) rendition of the Phillips curve, which, in turn, follows Tobin's lubrication hypothesis.

The rest of the paper is structured as follows. The second section summarizes and disentangles the main issues at stake in Phillips's, Friedman's, Keynes's and Tobin's works on inflation; the third one discusses Palley's rendition of the Phillips curve. Palley's hypothesis is empirically tested in the fourth section for the case of the Mexican economy on grounds that Mexico's Phillips curve relation appears to be non-linear and asymmetric. The article closes with concluding remarks.

1 See Forder (2014) for a thorough discussion of the important role of expectations in the literature prior to Friedman's paper.

2 Blanchard (2016; 2018) contends that we are back to the original Phillips curve, albeit Friedman's non accelerating inflation rate of unemployment should not be hastily rejected.

2. A BRIEF REVIEW OF THE THEORETICAL DEBATE ON INFLATION AND UNEMPLOYMENT

Phillips's analysis of money wages and unemployment

Phillips (1958, p. 284) contended that there is statistical evidence supporting the hypothesis that the rate of change of money wage rates ($\dot{w}_m$) is determined by "the level of unemployment and the rate of change of unemployment". This relation can be formalized as follows:

$$\dot{w}_m = -\alpha(u - \bar{u}) \tag{1}$$

where $\bar{u}$ stands for the average unemployment rate over the business cycle; α gauges the adjustment response of nominal wages *vis-à-vis* the unemployment gap. This is a highly non-linear relation, as the lower (higher) the unemployment rate, the higher (lower) the average rate of increase of w_m.

Some misapprehensions related to interpretations of the Phillips curve need elucidation. First, Phillips emphasized labour market conditions as one of the most important institutional aspects affecting wages; contrary to marginalist analysis (Marshall, 1982 [1890]; Solow, 1956), in the Phillips curve technological factors –such as the marginal productivity of labour or offsetting effects of flexible substitutability among factors of production– do not appear to be relevant determinants of neither w_m nor u fluctuations. Second, open economy phenomena are not entirely neglected, international trade can also affect w_m –although on rare occasions– when a drastic rise in import prices trigger a wage-price spiral. Third, contrary to common opinion, the Friedman-Phelps expectations insight was not necessarily new, as Forder (2014) accurately points out, since Phillips assumed (constant) expectations in the wages-unemployment dynamics; he somehow came closer to a conflict theory of inflation (or wage-bargaining explanation of inflation) rather than to a marginalist theory of price changes. Fourth, there is no presumption of nominal wage fluctuations being a mechanism for bringing about full employment equilibrium over the business cycle, *i.e.*, wages do not move anti-cyclically. Fifth, there is no confusion between nominal and real wages, hence the shape of the Phillips curve is neither a sign of money illusion nor of irrational expectations either.

Adaptive expectations and inflation

Friedman (1968) emphasizes the role of inflation expectations in economic activities. Contrary to Phillips and Keynes (1964), he contends real wages ($w_r = w_m/\pi$), instead of w_m, is the key variable. Friedman introduced two major changes. First, now the Phillips curve is explained as an inverse relation between real wages and the unemployment gap as in the next equation:

$$\dot{w}_r = -\alpha(u - u_n) \tag{2}$$

where u_n stands for the natural rate of unemployment (NRU) which is taken to be a long-term equilibrium position. Secondly, money wage changes are replaced by price changes; under the assumption of a direct influence of the former on the latter, the short-run Phillips curve is understood as a correlation between the rate of price inflation (π) and the unemployment rate (u); adaptive expectations play a key role. In this connection, expected inflation (π^e) adjusts with a lag and w_r reacts accordingly:[3]

$$\pi^e = \pi^e_{t-1} + \beta(\pi_{t-1} - \pi^e_{t-1}) \qquad 0 \leq \beta \leq 1 \tag{3}$$

How great and during how long can real output and employment be increased? It hinges upon the size of β, *i.e.*, on the intertemporal speed of adjustment of wage and price expectations, in other words, the portion of both wage and price arrangements allocated in the short run and that part knotted down in long-run contracts. The slower expectations adjust, the longer a high level of real output can persevere. At this point Friedman makes his case for the instability of the Phillips curve: acceleration of aggregate demand will raise the inflation rate in the short run. Eventually, π tends to converge with π^e and so does u with u_n, thereby yielding a vertical long-run Phillips curve:

$$\pi = f(u - u_n) + \pi^e \tag{4}$$

Since ($u = u_n$), then $\pi = \pi^e$ in the long-term. Therefore, in the long-term there is no trade-off between inflation and unemployment, but acceleration of the rate of inflation.

[3] Friedman (1968) speaks of anticipations in lieu of expectations. Incidentally, it was Cagan (1956) who first used the concept "adaptive expectations" in macroeconomics.

Now, the question arises as to what is the mechanism that triggers inflation? Friedman (1968; 1975; 1977) tied inflation to excessive money supply growth. According to his famous dictum "inflation is always and everywhere a monetary phenomenon". Why is it not a fiscal phenomenon? Since fiscal stimulus is a real variable, it faces natural limits that prevent the government from continuously expanding and shifting aggregate demand.[4] Money supply injections by the central bank instead, Friedman believes, do not confront natural limits.[5] The Achilles's heel of Friedman's dictum is the institutional fact that the money supply is not exogenous but endogenous in modern capitalist economies (Wicksell, 1962; Minsky, 1975; Moore, 1988; Palley, 2018; Lavoie, 2015).

Keynes and Tobin on inflation

Harrod (1958, p. 66) maintains that "Keynes's theory of inflation was in essence a *demand* theory, and his policy recommendations were governed by that fact" (emphasis in the original). Indeed, in Keynes's diagnosis the demand for goods and services surpasses the economy's supply potential sometimes, leading to demand-induced inflation; and on occasion it falls short of supply, heading to unemployment. While rejecting the quantity theory of money, he put forth his analysis not in terms of the amount of money but in terms of wage units.[6]

Therefore, Keynes's theory of demand-induced inflation (deflation) has nothing to do with rising (falling) wages, nominal or real. The same is true of his explanation of cost-push inflation, albeit he did not elaborate much on the latter. The true dichotomy of the theory of a monetary economy, as opposed to a (Walrasian) barter economy, is the question of "what determines output and employment as a whole" (Keynes, 1964, p. 293) and inflation expectations, one may add. In his theory of prices, it is argued that the quantity theory of prices holds true only once full employment is reached (Keynes, 1964). The effect of a money supply expansion depends on the elasticities of

4 By definition, government expenditure cannot surpass an economy's production capacity.

5 By definition as well, the money supply is a nominal variable; Friedman maintains that the money supply is exogenous and, consequently, the central bank has the ability to expand it limitless. Hence inflation involves a monetary connection.

6 "We shall call the unit in which the quantity of employment is measured the labour-unit; and the money-wage of a labour-unit we shall call the wage-unit" (Keynes, 1964, p. 41).

both money-price expectations (e_p) and of output and employment *vis-à-vis* variations in (money) effective demand (ED). The latter speaks to the elasticity of money-wages (e_w) in respect to changes in ED. The sum of both elasticities yields Keynes's formula for inflation:

$$\Delta\pi = 1 - e_0(1 - e_w) \tag{5}$$

Thus we have two possible scenarios: first, a case of semi-inflation, with discontinuous money-wage changes; whenever $u > 0$ and $e_w < 1$, "*employment* will change in the same proportion as the quantity of money" and, second, a case of "absolute" or true inflation so long as $u = 0$ and $e_w = 1$: "*prices* will change in the same proportion as the quantity of money". Hence a central bank's monetary supply expansion will cause inflation if and only if $e_0 = 0$ or $e_w = 1$ (Keynes, 1964, pp. 285-286, 296 and 301). Keynes was mainly concerned with the troubles facing the propensity to invest and the prospect of profit posed by deficient ED. Since investment generates its own saving as income grows, inflation, up to a point, can improve profit expectations. In this context, in the General Theory Keynes is chiefly conversant with inflation to account for the determinants and treatment of involuntary unemployment (Harrod, 1958; Minsky, 1975).

Incidentally, Harcourt (1992) denied the Phillips curve can be found in Keynes (1964), and grumbled that Samuelson and Solow (1960) said society could freely choose any combination of inflation and unemployment. Yet, clearly, Keynes had in advance rejected Friedman's conclusion that there is no such a thing as a permanent trade-off between inflation and unemployment, thereby excluding Friedman's claim that in the long-run the Phillips curve is vertical at the NRU, a position where workers have rational expectations, money is neutral even in the short-run and economic equilibrium is indifferent to inflation (Lucas, 1972; Friedman, 1968; 1977).

Tobin (1987b, p. 37), like Keynes, considered that involuntary unemployment is possible in a "full-fledged neoclassical equilibrium". Involuntary unemployment is a "persistent disequilibrium" position within Keynes's equilibrium with no relation whatever with "money illusion" (*cf.* also Leijonhufvud, 1968). Along Keynes's reasoning, Tobin refutes Friedman's money illusion hypothesis arguing that "the resistance of money wage rates to excess supply is a feature of the adjustment process rather than a symptom of irrationality" (Tobin, 1987b, p. 38).

Tobin (1972, p. 45) contends that "zero-inflation unemployment is not wholly voluntary, not optimal", not even "natural" because "the economy has an inflationary bias […] perhaps accelerating inflation". It is worth quoting in full Tobin's rationalization of this stylized fact: it "might be termed a theory of stochastic macroequilibrium: stochastic because random intersectoral shocks keep individual labour markets in diverse states of disequilibrium; macroequilibrium, because the perpetual flux of particular markets produces fairly definite aggregate outcomes of unemployment and wages".

So, high levels of employment are likely to be associated with mild inflation without aggregate excess demand, because wages, employment and prices move imperfectly and randomly in heterogeneous markets, expanding and contracting at different speeds across the whole economy. All in all, Tobin and Keynes believed the relation between inflation and unemployment is nonlinear in character.

3. The backward bending Phillips curve and the Minimum Unemployment Rate of Inflation (MURI)

Palley (1994; 1997; 2003; 2009) developed a theory of the Phillips curve that reestablishes the long-term negative relationship between inflation and unemployment, which was displaced with the advent of the Non-Accelerating Inflation Rate of Unemployment (NAIRU) and its proposition that the Phillips curve is vertically-shaped in the long run and monetary policy is thereby ineffective to drive unemployment below the NRU, except at the cost of accelerating inflation (Friedman, 1968). Rooted in a structural Keynesian perspective, Palley's premise is that variations in aggregate demand are the underlying force in inflation and unemployment movements and are, therefore, the true cause of the relationship posed by the Phillips curve, thus "the long run Phillips curve is a locus of points in inflation-unemployment rate space rather than a causal relation" (Palley, 2009, p. 22). In parallel, unemployment is conceived as the result of low nominal demand relative to nominal wages. Palley's theory advocates for the re-emergence of monetary policy, arguing that a stimulus in nominal demand may fuel job creation (Palley, 1997; 2003).

The core of Palley's Phillips curve model relies on two fundamental assumptions (2003 and 2009). First, it resumes Tobin's (1987b) multisectoral analytical framework, composed by segmented labour markets that allow for the simultaneous existence of excess demand in some labour markets and

excess supply in others. Second, nominal wages in sectors with unemployment exhibit downward rigidity while nominal wages in sectors with full employment are perfectly flexible.[7] The impact that increased nominal aggregate demand produces on employment is captured by the grease effect; while it causes inflation in sectors with full employment, it generates more job creation in sectors with unemployment. The adjustment mechanism operates as follows:

> At any moment, the economy is subject to two distinct adjustment processes -one for sectors with unemployment, and one for sectors at full employment. In sectors with unemployment, nominal demand growth translates into increased employment and output, while prices and nominal wages are unchanged. In sectors at full employment, nominal demand growth translates into increased prices and nominal wages, while employment and output remain fixed. The aggregation of these two adjustment processes then produces a Phillips curve (Palley, 2003, pp. 43-44).

The existence of downward rigidity of nominal wages is explained by the mechanism for setting nominal wages in sectors with unemployment that reflects the critical distinction between "formation" and "incorporation" of inflation expectations (Palley, 2003; 2012; 2018).[8] Expectations formation refers to the debate between the existence of adaptive or rational expectations (Friedman, 1968; Lucas, 1972); only if the agents systematically predict inflation below the actual inflation rate nominal demand growth can have a persistent effect on unemployment. Expectation incorporation captures the way and the extent to which workers incorporate these expectations into their wage demands. Palley focuses on the latter issue and assumes that agents predict inflation rationally; however, they do not fully incorporate these inflation expectations into their nominal wage demands. The Friedman-Phelps model

[7] Incidentally, Keynes (1964, pp. 301-302) made a similar reasoning as he distinguishes between semi-inflation and absolute inflation. It is worth quoting in full the relevant passage: "In actual experience the wage-unit does not change continuously in terms of money in response to every small change in effective demand; but discontinuously. These points of discontinuity are determined by the psychology of the workers and by the policies of employers and trade unions [...] These points, where a further increase in effective demand in terms of money is liable to cause a discontinuous rise in the wage-unit, might be deemed, from a certain point of view, to be positions of semi-inflation, having some analogy to the absolute inflation which ensues on an increase in effective demand in circumstances of full employment. They have, moreover, a good deal of historical importance. But they do not lend themselves to theoretical generalisations".

[8] Relative wages and the concern for the nominal debt also explain downward rigidity of nominal wages (Palley, 2003).

assumes that all workers fully incorporate their inflation expectations into their nominal wage demands in the long-run, while in the short-term workers experience money illusion.

The incorporation of expectations works as follows (Palley, 2009): *1)* faced with the possibility of firms behaving opportunistically due to conflict and moral hazard, workers in sectors with unemployment reject nominal wage reductions. However, workers accept decreases in real wages through inflation, which is a variable beyond firms' direct control; *2)* as inflation rises, an increasing number of workers in sectors with unemployment begin to demand nominal wage increases that match inflation in order to protect their real wages. When inflation reaches a certain threshold, all workers fully translate inflation into nominal wage increases.

Consequently, the size of the grease effect provoked by changes in nominal demand is influenced by this rational expectations-incorporation mechanism (Palley, 2009). At low levels of inflation, workers in sectors with unemployment do not transfer it completely to nominal wages, causing a grease effect that increases job creation. Nonetheless, as inflation increases, some workers start demanding higher nominal wages, causing a decreasing grease effect. When nominal wages are completely indexed to inflation, the grease effect is eroded and the growth in nominal demand ceases to have an impact on unemployment.

According to Palley (2009), the previous mechanism provides microeconomic foundations to the relationship behind the Phillips curve. Also, by including conflict inflation that captures the capital-labour conflict, his approach to the Phillips curve enhances the theories of demand-pull inflation, providing a sound theoretical explanation of the incorporation of expectations (Palley, 1996; *cf.* also Myatt, 1986; Dalziel, 1990; Lavoie, 1992).

The preceding arguments can be formally expressed in the following four equations (Palley, 2009, pp. 20-21):

$$\pi = gd - gs \tag{6}$$

$$\pi^e = \pi \tag{7}$$

$$U = u\,(\sigma, gd - \lambda\pi^e); u_1 > 0, u_2 < 0$$
$$= 1\ if\ \pi^e \geq \pi^{MAX} \tag{8}$$

$$\lambda = \lambda(\pi^e, \psi) \; if \; \pi^e < \pi^{MAX};$$
$$0 \leq \lambda \leq 1, \lambda_1 > 0, \lambda_{11} > 0, \lambda_{12} < 0, \lambda_2 > 0 \quad (9)$$

Where π is the inflation rate, π^e is the expected inflation rate, π^{MAX} is the critical inflation rate at which all workers fully index nominal wages, gd is the growth in nominal demand, gs is the increase in productivity, U is the unemployment rate, σ is the dispersion of nominal demand shocks in specific sectors that have mean zero, λ is the aggregate coefficient on inflation expectations, and ψ is the worker militancy variable that affects the degree of resistance of real wages.

Equation 6 describes the inflation-generating process in the economy. Following a Keynesian approach, inflation dynamics depends on the rate of aggregate nominal demand growth and the rate of productivity growth. As shown in Palley (2009), productivity growth lowers inflation and unemployment for any given rate of nominal demand growth or, put differently, productivity growth generates space to increase demand and lower unemployment without causing inflation. Equation 7 sets expected inflation equal to actual inflation. Equation 8 describes the long-term unemployment-generating process in the economy. The second argument in equation 7, $gd - \lambda\pi^e$, captures the grease effect of nominal demand growth; when λ is low, the increase in nominal demand will have a large impact on employment, and when λ is high nominal demand growth will be neutralized by inflation. In Palley's model, in the low-inflation regime, λ is less than 1 since only some workers fully index their nominal wages. In a high-inflation regime, λ equals 1, since all workers in all sectors fully index their nominal wages. Equation 9 describes the determination of the aggregate coefficient on inflation expectations, which captures the measure of inflation resistance of real wages produced by the degree of worker militancy; the aggregate coefficient is a weighted average of the sectoral coefficients.

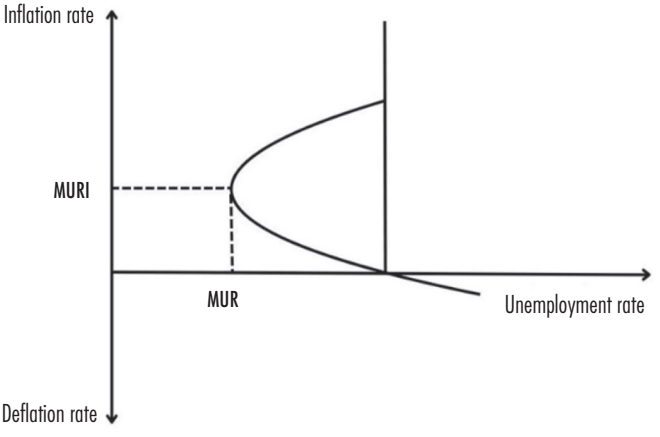
The explanation provided by Palley differs from the version of the backward bending Phillips curve presented by Akerlof *et al.* (1996; 2000). In the latter model λ equals 1, but workers have quasi-rational expectations, due to monetary illusion, they systematically underestimate inflation when it is low though correctly estimate it at higher levels. This allows for the existence of a grease effect of nominal demand growth when inflation is low, albeit this effect is completely eroded at high levels of inflation when expectations are correct; then, the Phillips curve becomes vertical, with the unemployment rate equal to the natural rate. According to Palley, Akerlof's argument fails to

explain the changing abilities of workers to accurately predict inflation under different inflation regimes.

Palley's long-run Phillips curve, depicted in figure 1, involves three segments: *1)* in the first segment, corresponding to low inflation rates, the curve slopes downward. In this case, the grease effect of aggregate demand is positive, since workers do not fully translate inflation expectations into their nominal wage demands, leading to reductions in unemployment; *2)* as inflation increases, there is a level of inflation, π^{MAX}, that marks an inflection point at which the Phillips curve turns backward and acquires a positive slope. At this point, the grease effect of aggregate demand begins to diminish, since more workers demand higher nominal wages, and unemployment increases as inflation rises; *3)* finally, at a sufficiently high level of inflation, all workers fully incorporate their inflation expectation, and the Phillips curve becomes vertical. Figure 1 represents a situation where the backward-bending Phillips curve is continuous since the inflation resistance threshold varies across sectors and workers; if this threshold is identical for all workers, the Phillips curve will display a discrete break and will become vertical at that point.

Figure 1 shows that, due to the grease effect, unemployment decreases as nominal demand, and the ensuing inflation grow. The Minimum Unemployment Rate (MUR) is achieved when the grease effect is maximized. The rate of inflation corresponding to this point is known as Minimum Unemployment

Figure 1. Backward bending Phillips curve



Source: Palley (2009, p. 26). MURI stands for Minimum Unemployment Rate of Inflation, the exact opposite of Friedman's NAIRU.

Rate of Inflation (MURI). These coordinates signal the inflection point where the Phillips curve turns backwards, generating a non-linear relationship between inflation and unemployment.

Palley's Phillips curve model establishes a link between the long-term downward-sloping Phillips curve and monetary theory and provides an alternative to the NAIRU regarding theoretical explanations and policy implications (Palley, 1994). While the NAIRU hypothesis has been invoked to justify the abandonment of the commitment to full employment, to promote labour market flexibility and weaken trade unions (Palley, 2018), in Palley's model the monetary authority can influence employment levels and, furthermore, is able to achieve the lowest possible sustainable unemployment rate by setting the MURI as the inflation target. It is worth noticing that the trade-off between inflation and unemployment is restored at low inflation levels, providing a sound argument for targeting low inflation as a policy recommendation. Nonetheless, estimates of the MURI usually found that it is located at higher levels than those fixed by monetary authorities (Palley, 2003).

Empirical tests of the MURI are scarce. Perrotini Hernández and Vázquez Muñoz (2025) provide the only analysis available for Latin American countries ruled by the inflation targeting model, namely Argentina, Brazil, Chile and Mexico. The authors found a non-linear relationship between inflation and unemployment and the presence of several inflation regimes in each country, supporting the MURI hypothesis. For the case of Mexico, the estimated minimum rate of unemployment is 2.8% and the MURI is 7.43%, substantially higher than the current official inflation target (3% ± 1%).

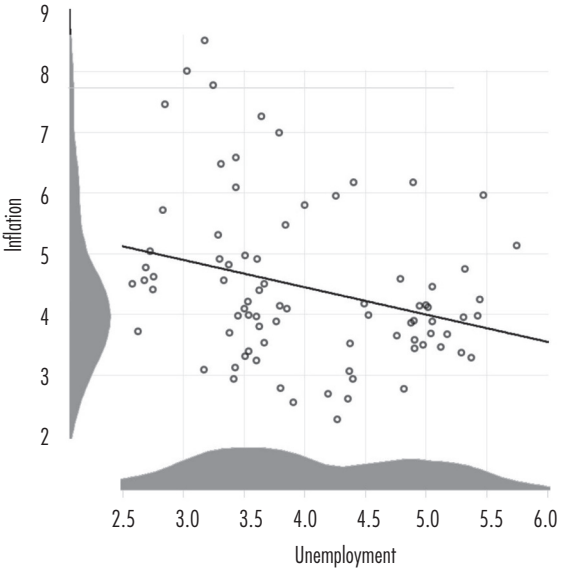
4. Econometric analysis

Let's inspect Mexico's data deeper. A negative trend can be observed at first sight between unemployment and inflation, resembling the Phillips curve (see figure 2). However, on closer inspection, the Kernel density indicates that the relationship between these variables is concentrated at the lowest values, which could indicate asymmetry. Therefore, seemingly an econometric analysis is necessary to gain a better understanding of this behaviour.

To test our hypothesis, we estimate a Palley-style non-linear and asymmetric statistical relationship between inflation and unemployment rates, economic growth, and labour productivity using equation 10.

$$\pi = \beta_0 - \beta_1 u + \beta_2 u^2 + \beta_3 g + \beta_4 gs + \varepsilon_t \tag{10}$$

Figure 2. Phillips curve. Mexico, 2005-2025



Source: own elaboration using data from Banxico (2025) and INEGI (2025).

According to the theoretical Phillips curve framework, inflation (π) is expected to be an inverse function of unemployment (u) –confirming the existence of a Phillips curve relationship–, and to be positively related to economic growth (g) and labour productivity (gs). The term u^2 suggests that the relationship between inflation and unemployment is not necessarily proportional and can capture hysteresis or nonlinearity effects, ε_t is the error term. Likewise, β_0 is a constant, and β_1, β_2 , β_3, and β_4 measure the sensitivity of the endogenous variables in respect to the exogenous ones. The data used to estimate the econometric model are quarterly frequency figures (sourced by Banxico and INEGI) of inflation, the unemployment rate, economic growth at constant 2018 prices, and the first difference of the labour productivity index of the global economy, respectively, for the period from 2005Q1 to 2025Q1.

Since we are dealing with time series information, a unit root test with structural break (Perron, 1990) is executed to determine the order of integration of the variables. Table 1 shows that, according to the Dickey-Fuller break, unemployment, quadratic unemployment, and productivity have unit roots, while inflation and economic growth do not. Furthermore, all variables are

Table 1. Unit root test with structural break

Variable	Model				Order of integration
	Intercept	Break date	Trend and intercept	Break date	
π	-6.08	2020Q4	-6.08	2020Q4	I(0)
u	-2.20	2015Q3	-4.02	2008Q2	I(1)
u^2	-2.24	2014Q3	-4.03	2008Q3	I(1)
g	-5.91	2021Q2	-6.20	2021Q2	I(0)
gs	-3.77	2007Q4	-4.46	2007Q4	I(1)
Δ π	-7.61	2008Q2	-7.56	2008Q2	I(0)
Δ u	-9.46	2020Q2	-9.47	2020Q2	I(0)
Δ u^2	-9.26	2020Q2	-9.28	2020Q2	I(0)
Δ g	-11.15	2006Q4	-11.07	2006Q4	I(0)
Δ gs	-16.47	2008Q1	-16.36	2008Q1	I(0)

Note: Δ denotes the first difference in the series. The significance level is 5%.

Source: own elaboration using data from Banxico (2025) and INEGI (2025).

stationary in first differences. Based on these results, a non-linear autoregressive distributed lag (NARDL) model is run to analyse the asymmetric long-term relationship shown in equation 10 and the dynamic multipliers are computed (Shin *et al.*, 2014). We then estimate a Vector Error Correction Model (VECM) to ensure the existence of a relationship in the short and long run.

NARDL Model and Results

Table 2 presents the results of the symmetry test, which verifies whether the effects of the positive and negative changes in each of the exogenous variables on inflation are statistically equal in the short and long term. According to the value of the Wald F statistics and its probability, there is statistical evidence of long-term asymmetry in u and the nonlinearity term u^2, while changes in g and gs are symmetric. Therefore, the model suggests that the effect of unemployment on inflation is asymmetric in the long term, but not in the short term, which is consistent with the MURI.

Table 2. Symmetry test

Variable	*Value*	*Probability*
	Long-run	
u	5.0534	0.0283
u^2	5.9640	0.0176
$g\ s$	0.9117	0.3435
g	2.1363	0.1491

Note: Ho indicates that the coefficient is symmetrical. The significance level is 5%.
Source: own elaboration using data from Banxico (2025) and INEGI (2025).

The estimation results of the NARDL model confirm that the components of the exogenous variables exhibit asymmetric behaviour. Table 3 shows that increases (+) in unemployment and the non-linear component are statistically significant in the long term, while reductions (−) in economic growth and productivity are also statistically significant. In this sense, inflation not only responds to increases in unemployment but also to changes in its intensity (u^2) in a non-linear and asymmetric manner, which appear to confirm the hypothesis of downward rigidity in the labour market. Furthermore, there is no conventional behaviour concerning *g* and *gs* in the long term, as expected in equation 10; in other words, in an economy like Mexico's, where exchange rate depreciations and cost pressures (imports and wages) significantly influence price dynamics, inflation may be a result of a distributional conflict (Palley, 1999; Lavoie, 2015; Perrotini Hernández, 2017).

To corroborate cointegration, we performed the limits test. Since the F-statistic exceeds the critical values of 10, 5, and 1% for the stationary and nonstationary variables, a stable and significant long-term relationship can be determined in equation 10. This fact validates the structural analysis of the model and justifies the asymmetry of the coefficients (see table 4).

We also performed a diagnostic of the model. Table 5 presents the correct specification of the NARDL residuals in terms of normality, homoscedasticity, and the absence of serial autocorrelation. The model was estimated with three residuals, no constant, and no dummy variables.

Table 3. Estimates of NARDL

Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Probability*
u^{+}	21.829	7.979	2.736	0.008
u^{-}	0.634	7.378	0.086	0.932
u^{2+}	-2.299	0.911	-2.522	0.014
u^{2-}	-0.389	0.769	-0.505	0.615
$g(-1)^{+}$	0.239	0.120	1.998	0.050
$g(-1)^{-}$	0.395	0.145	2.723	0.008
gs^{+}	0.243	0.206	1.182	0.241
gs^{-}	0.351	0.172	2.039	0.045

Note: The significance level is 5%.

Source: own elaboration using data from Banxico (2025) and INEGI (2025).

Table 4. Bounds test

	Test statistic			
Significance	*F-statistic*	*2.52*	*t-statistic*	*-3.31*
	I(0)	*I(1)*	*I(0)*	*I(1)*
10%	-1.00	-1.00	-1.62	-4.09
5%	-1.00	-1.00	-1.95	-4.43
1%	-1.00	-1.00	-2.58	-5.07

Source: own elaboration.

Table 5. Correct specification tests

Test	*Statistic*	*Probability*
Normality	0.2949	0.8628
Heteroscedasticity	1.0688	0.4043
Serial correlation LM	5.1759	0.1594

Note: based on the probability value, the null hypothesis is accepted in all cases.

Source: own elaboration.

In addition to the existence of nonsymmetric cointegration, it is necessary to study the speed of adjustment toward equilibrium. To do so, we estimate a VECM; the results show that, with an R-squared value of 0.41, the error term coefficient (ERC) is negative and statistically significant, implying that approximately 23% of the imbalance is corrected each quarter (see table 6). Furthermore, the coefficients of the lagged first differences are concentrated in the relationship between economic growth and inflation. In other words, these two variables appear to maintain a conventional and symmetric relation in the short term.

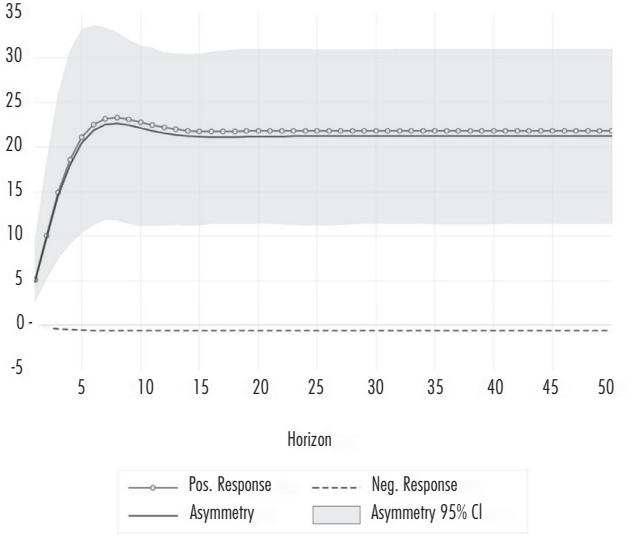
Table 6. VECM Model

Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Probability*
VECM	-0.2336	0.0461	-5.0713	0.0000
$D(\pi(-1))$	0.2120	0.1011	2.0960	0.0398
$D(\pi(-2))$	0.2023	0.1012	1.9990	0.0496
$D(g^{+})$	0.0769	0.0222	3.4726	0.0009
$D(g^{-})$	0.0618	0.0291	2.1262	0.0371
$D(g(-1)^{+})$	-0.0459	0.0251	-1.8292	0.0718
$D(g(-1)^{-})$	-0.0590	0.0249	-2.3733	0.0205

Source: own elaboration.

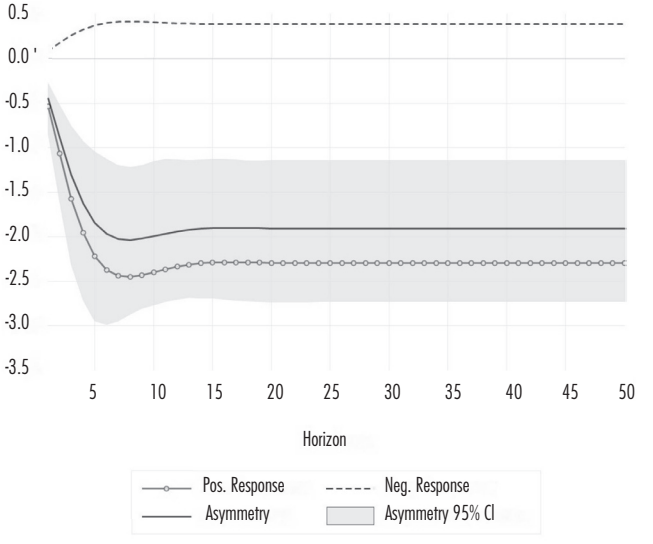
Figures 3, 4, 5, and 6 show the long-term dynamic multipliers for each of the exogenous variables. In general, there is a rapid adjustment to equilibrium after a positive or negative shock, as the case may be, and an error that tends to be corrected slowly. The difference in the magnitude and direction of the responses indicates that the effects are not symmetrical, validating the results of the NARDL model. In this connection, it is shown that unemployment imparts an expansionary and permanent impact on inflation; furthermore, a non-linear relationship exists, signalling that high and persistent levels of unemployment cumulatively reduce inflation. However, the difference between positive and negative u^2 shocks is not statistically significant, suggesting that, although the relationship is not linear, a robust asymmetry in this component cannot be confirmed (see figures 3 and 4).

Figure 3. Dynamic cumulative multiplier. Evolution of the asymmetric shock from unemployment to inflation



Source: own elaboration.

Figure 4. Dynamic cumulative multiplier. Evolution of the asymmetric shock of non-linear unemployment to inflation

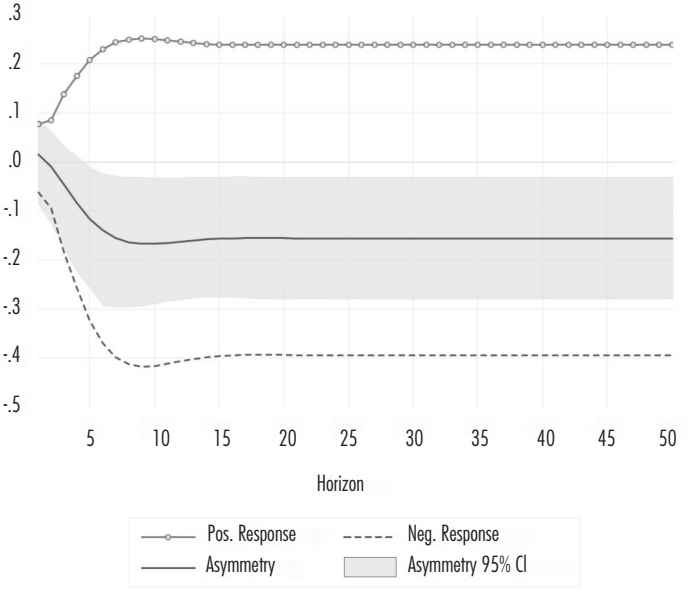


Source: own elaboration.

Regarding growth and labour productivity, the separate lines of the positive and negative shocks indicate that inflation responds asymmetrically to these exogenous variables. This behaviour could be associated with a deficient monetary policy transmission mechanism, where the contraction in aggregate demand is insufficient to reach the inflation target. Or even that price instability is due to supply-side issues indicated by the asymmetrical trajectory of productivity.

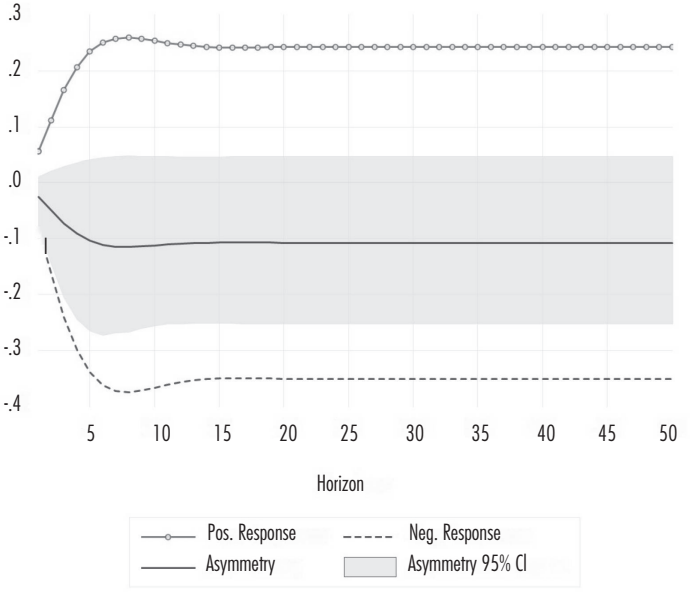
Taken together, the behaviours shown in the graphs confirm that the Phillips curve is neither symmetric nor linear, and that inflation cannot be understood simply as a linear outcome of aggregate demand. Our results empirically support Palley's argument about a more complex distributional relationship impacting price level changes, which the Central Bank should consider in its monetary policy framework.

Figure 5. Cumulative dynamic multiplier. Evolution of the asymmetric shock from non-linear economic growth to inflation



Source: own elaboration.

Figure 6. Dynamic cumulative multiplier. Evolution of the asymmetric shock from productivity to inflation



Source: own elaboration.

5. Concluding remarks

The present article looked at the inverse relation between inflation and unemployment described by the well-known Phillips curve. To that purpose, we summarily discussed the most salient features of Phillips's (1958) seminal article, the critique or expectations argument by Milton Friedman, Keynes's ideas on the aforementioned relation and James Tobin's rebuttal to Friedman's model of inflation and unemployment. Our theoretical review likewise includes an appreciation of Thomas Palley's rendition of the Phillips curve. Palley's hypothesis of the existence of a non-linear Phillips curve relation is then empirically tested for the case of the Mexican economy over the period 2005-2025Q1.

Our econometric analysis shows that the Phillips curve relation is asymmetric and non-linear relation in the long-term. Particularly, inflation re-

sponds to unemployment changes in a non-linear and asymmetric manner to changes, signalling downward rigidity in the labour market. Hence, inflation cannot be understood simply as a linear outcome of aggregate demand. Our results empirically support Palley's contention regarding the existence of a more complex distributional relationship impacting price level changes; the Phillips curve relation seemingly is best captured by the hypothesis of a non-linear correlation. If so, there seems to be space for a minimum-unemployment-rate of-inflation monetary policy framework (Palley's MURI). Needless to say, more research on this subject is required, for the case of Mexico and worldwide. Yet, we are afraid Central Banks might gain a deeper understanding of the Phillips curve relation if they were to open their monetary policy framework to alternative approaches such as the MURI.

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