Regimes of distributive conflict and inflation spirals*

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Abstract

In this paper, we assess the relationship between income distribution and price dynamics, focusing on the role of distributive conflict between labor and capital in the U.S. economy over the period 1960–2023. We employ a spectral decomposition in both the frequency and time–frequency domains to document how different distributive–inflation configurations have coexisted and shifted over these six decades. We complement the empirical analysis with a tractable nonlinear disequilibrium model in which inflation emerges endogenously from evolving wage–price and profit–price spirals. Structural parameters act as bifurcation triggers, determining whether inflationary pressures are wage-led or profit-led. By isolating the conflict channels and their dynamic feedback, we highlight how shifts in bargaining power and markup claims can sustain persistent inflationary regimes, with implications for policies addressing the structural roots of inflation.

JEL Codes: E31, E32, C61, D33, E24

Keywords: Income distribution, Inflation regimes, Bargaining power, Wavelet analysis, Nonlinear dynamics.

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1 Introduction

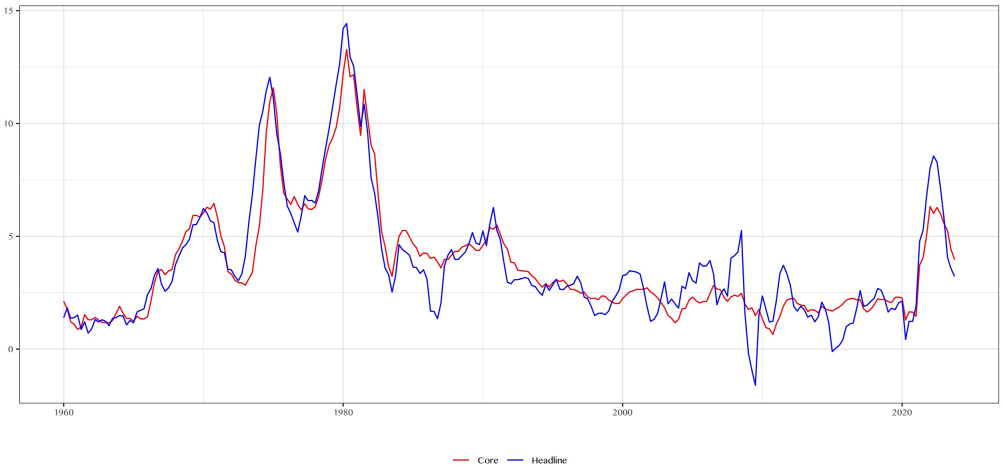
Inflation has re-emerged as a central macroeconomic concern after decades of price stability aligned with central bank targets (Carstens, 2022; Stiglitz, 2024). The recent surge, reminiscent of the 1970s (see Figure 1 and Table 1), calls for a deeper investigation of its structural drivers. Standard macroeconomic accounts separate demand-pull and cost-push factors, but this dichotomy overlooks the role of distributive conflict between workers' wage claims and firms' pricing power. In this paper, we argue that income distribution and labor-capital tensions are key to understanding inflationary episodes. Along the lines of Kaleckian theory of income distribution (Kalecki, 1971), we show how the balance of bargaining power shapes distinct inflationary regimes, generating either wage-price or profit-price spirals. Rather than a unique source and *mode* (i.e., mechanism) of inflation, we show that conflicting claims on output affect price dynamics and generate different inflationary-distributive regimes.

To identify these regimes– understood as the coevolution of inflationary modes (wage-led vs. profit-led) and historical phases– we investigate three questions: First, can we empirically document distinct wage-led and profit-led inflation regimes in U.S. data? Second, can a macro-dynamic conflict model reproduce the transitions between these regimes? Third, what structural conditions– bargaining power asymmetries and markup behavior– determine which regime emerges and persists?

We address these questions through complementary empirical and theoretical strategies. Empirically, we employ time–frequency spectral analysis (wavelet decomposition) on U.S. quarterly data (1960-2023) to isolate and quantify the competing inflationary channels. This reveals how the dominant distributive force has shifted historically. Theoretically, we develop a tractable nonlinear conflict model where inflation emerges endogenously from bargaining dynamics. Complementary to recent works on distributive conflict and markup-inflation channel (Lorenzoni and Werning, 2023a; van der Ploeg and Willems, 2025), we integrate markup expectations with a price-augmented wage Phillips curve within a disequilibrium framework. The model shows how parameter shifts governing bargaining power and markup claims can induce non-linear adjustments and phase transitions, characterizing the conditions under which the system shifts from locally stable equilibria to persistent endogenous fluctuations (limit cycles) or divergent spirals.

This paper contributes to the literature on inflation inequality and macroeconomic regime dynamics in two main ways. First, it provides new time and time–frequency domain evidence quantifying how distributive tensions between wages and profits have driven U.S. inflation from 1960 to 2023. The spectral decomposition isolates the intensity and direction of wage-led and profit-led inflationary channels across time-frequency horizons, identifying which regime dominates in each historical phase. Second, it develops a stylized nonlinear conflict model in which inflation emerges endogenously from distributive dynamics, not as a passive outcome of shocks but as an emergent property, with bifurcations triggered by structural parameter changes. This framework shows how inflation both results from and amplifies distributive conflict, with structural parameters governing regime shifts and the effectiveness of policy responses.

Figure 1: Quarterly CPI inflation rate, Year over Year



Source: U.S. Bureau of Labor Statistics, via FRED.

Historical Periods	Headline Inflation	Core Inflation
1965:Q1–1984:Q4	6.28	6.10
1985:Q1–2007:Q3	3.04	3.10
2007:Q4–2009:Q4	2.01	2.04
2010:Q1–2020:Q1	1.78	1.92
2020:Q2–2023:Q4	4.68	4.17

Table 1: Average Inflation Rates (YoY)

The remainder of the paper is structured as follows. Section 2 reviews the literature on wage–price and profit–price spirals. Section 3 provides our empirical analysis of the coexistence of different inflationary regimes, based on time–frequency decomposition. Section 4 introduces a stylized macroeconomic model representing these regimes through nonlinear dynamics. Section 5 explores the topological properties of, and transitions across, wage-led and profit-led configurations. Section 6 concludes and discusses limitations and policy implications.

2 Distributive conflict and inflation regimes

Theories of inflation are traditionally divided into demand-pull and cost-push explanations. While analytically useful, this dichotomy often neglects the core role of distributive dynamics: the opposite income claims of workers and firms. When these groups possess bargaining power, they can initiate feedback loops that sustain inflation, transforming it from a symptom of imbalance into a mechanism of income redistribution.

This perspective forms the core of the conflict inflation literature, which views price dynamics as the outcome of strategic interactions between capital and labor. The canonical model by Rowthorn (1977), recently rephrased by Lorenzoni and Werning (2023a), formalizes this idea: workers and firms target desired income shares, and misalignment between these targets triggers offsetting nominal adjustments (wage-wage, wage-price, price-price), generating persistent inflation. Recent contributions have microfounded these insights, showing how inflation can reflect unmet income aspirations of heterogeneous agents and how monetary policy can operate through an "aspirations channel" (Lorenzoni and Werning, 2023b; van der Ploeg and Willems, 2025). Hence, recent New Keynesian frameworks with nominal rigidities acknowledge that unresolved distributive tensions can be a source of endogenous inflationary pressure (Erceg et al., 2000).

The central insight is that inflation can be driven by two distinct, competing channels: wage-led and profit-led spirals. Their relative dominance defines the prevailing distributive-inflationary regime.

2.1 Wage-led inflation: channels and mechanisms

Wage-led inflation occurs when strong labor bargaining power translates into nominal wage growth that outpaces productivity, leading firms to raise prices to protect margins, which in turn triggers further wage demands. This generates a self-reinforcing wage–price spiral (Blanchard, 1986): workers, anticipating persistent inflation, demand higher nominal wages to preserve their purchasing power (i.e., real wages); firms, facing rising labor costs, raise prices to restore markups, workers then respond by revising wage claims upwards again, perpetuating the cycle. The literature emphasizes three interconnected channels:

1. **Aggregate Demand**. Expansionary fiscal policy can overheat the economy, reducing unemployment and strengthening workers' position. According to demand-driven inflation narratives, demand-side factors– amplified by expansionary fiscal policy– have played a central role in driving recent inflation, particularly its non-transitory components (Cerrato and Gitti, 2022; Crump et al., 2024). This demand-pull dynamic can reignite a wage-price spiral, echoing concerns raised during the post-pandemic recovery (Summers, 2021; Giannone and Primiceri, 2024).

2. **Inflation Expectations**. If expectations become de-anchored, agents begin to anticipate persistently high inflation, thus workers seek higher nominal wages to preserve real incomes, and firms preemptively raise prices, creating a self-fulfilling spiral where nominal wages claims and price-setting behavior reinforce each other (Corsello et al., 2021). Over the past four decades, central banks have in fact maintained anchored expectations through strong anti-inflationary credibility. This credibility has been crucial in preventing wage-price spirals, a marked contrast to the experience of Great Inflation (Carvalho et al., 2023; Coibion and Gorodnichenko, 2015).

3. **Labor Market Tightness**. Low unemployment increases workers' bargaining power (Phillips, 1958), leading to upward pressure on nominal wages and, in turn, on prices (Blanchard, 1986). Recent contributions have highlighted the role of labor demand

and supply indicators resulting from firm-worker interactions, particularly the job vacancy rate and the quit rate, as more reliable indicators of labor market tightness (Barnichon and Shapiro, 2024; Domash and Summers, 2022), relying upon the movements of the Beveridge curve (Figura and Waller, 2024). When the vacancy-to-unemployment ratio rises above one– signalling that job openings outnumber available workers– the relationship between labor market tightness and wage pressure becomes increasingly nonlinear, so that even moderate changes in slack can produce disproportionate movements in wages and inflation (Benigno and Eggertsson, 2023; Blanco et al., 2024). Post-pandemic, indicators like the quit rate ("Great Resignation") were seen as amplifying this channel (Faccini and Melosi, 2023).

While these factors can explain historical episodes like the Great Inflation, their relevance in the post-2020 surge is debated, as nominal wage growth often lagged behind price inflation (Adrjan and Lydon, 2022).

2.2 Profit-led inflation: market power and strategic pricing

Profit-led inflation stems from the ability of firms with (market) power to increase markups strategically, raising prices beyond cost increases. This channel operates even in the absence of strong wage pressure and highlights an asymmetry: firms can often adjust prices more swiftly and unilaterally than workers can secure compensating wage gains (Weber and Wasner, 2023).

Two primary mechanisms are identified:

1. **Supply Chain and Cost Shocks**. Disruptions (like those post-pandemic and during the Ukraine war) increase input costs. Firms with pricing power can pass through these costs more than fully, expanding their profit margins in the process (Bernanke and Blanchard, 2025; Hansen et al., 2023). This pass-through is asymmetric: prices can be raised quickly and substantially in response to cost shocks, whereas workers face slower and more uncertain adjustments in nominal wages, so that a larger share of the burden is shifted onto labor (Amiti et al., 2019; Corsello and Tagliabracci, 2023). This behavior represents a proactive profit-seeking strategy rather than a passive cost absorption.

2. **Cyclical Markup Behavior**. Beyond the price-cost pass-through, firms may raise markups opportunistically when demand is strong (Nekarda and Ramey, 2020), leveraging their market position to increase the profit share. Indeed, markup cyclicality can depend on underlying economic conditions: in periods of strong demand, limited spare capacity, and elevated inflation expectations, firms with market power can expand margins more aggressively than in slack periods. This behavior becomes especially pronounced following supply disruptions or when cyclical profits are already elevated, as firms exploit favorable conditions to shift income distribution toward capital (Cairó and Sim, 2024).

Recent extensions of New Keynesian models allow for pro-cyclical profits (Bilbiie and Känzig, 2023), as well as more general profit-driven price scenario (Kharroubi and Smets, 2024), solving the original counter-cyclical markups (Rotemberg and Woodford, 1999). Post-Keynesian models emphasize that rising profit shares can be inflationary (Lavoie, 2024), as a standard accounting framework predicts (Colonna et al., 2023), while agent-based models show how concentration can lead to profit-driven inflation under supply constraints (Ciambezi et al., 2025). Empirical evidence on this channel remains mixed (Alvarez-Blaser et al., 2025; Bijnens et al., 2023; Glover et al., 2023).

2.3 Synthesis and open questions

The wage-led and profit-led frameworks are not mutually exclusive but represent potential configurations of the same underlying dynamic distributive tension. Crucially, the dominance of one channel over the other can shift over time, suggesting the existence of distinct regimes or configurations with specific institutional and structural determinants.

However, the existing literature leaves key questions unanswered. First, there is limited empirical work systematically identifying and dating these regimes over long historical periods. Second, most models treat wage-price or profit-price spirals in isolation, lacking a unified framework that endogenously generates transitions between regimes based on evolving bargaining power and pricing strategies. This paper addresses these gaps by combining a novel empirical identification of regimes with a tractable nonlinear model of distributive conflict capable of reproducing such phase transitions.

3 Identifying distributive-inflation regimes

This section provides empirical evidence to characterize the modes and phases of inflation dynamics in the U.S. economy from 1960 to 2023. We employ two complementary approaches: (i) historical correlation analysis to document regime-specific relationships, and (ii) time-frequency spectral decomposition to isolate wage-led vs. profit-led channels at different frequencies. Together, these methods allow us to identify and characterize distinct *distributive-inflation configurations (regimes)* and trace their evolution across historical phases.

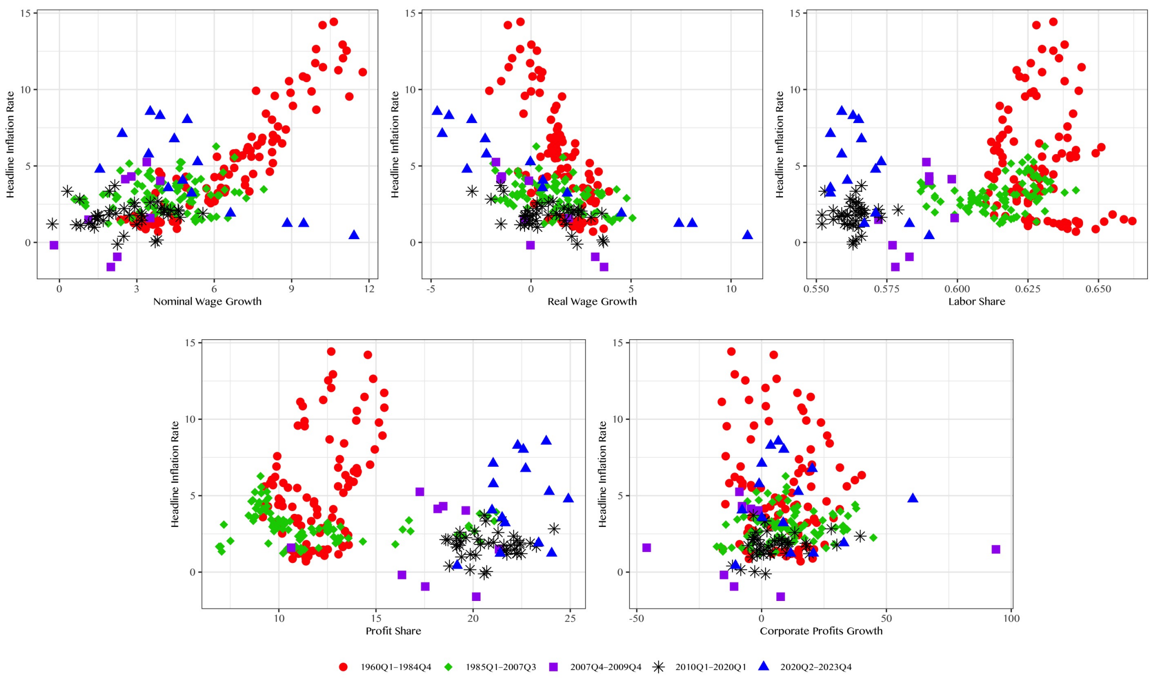
We focus on headline inflation, which includes food and energy components. Energy price spikes impose cost pressures that firms can either absorb (compressing margins) or pass through to consumers (preserving or expanding profit shares via markup). This markup adjustment reveals the underlying bargaining power dynamics and distributive conflict we seek to characterize (Burya and Mishra, 2022; Fierro and Martinoli, 2025; Manuel et al., 2024). Core inflation analysis is provided in Appendix D.4.

3.1 Preliminary evidence: static and time-varying patterns

The data we use concern US quarterly macroeconomic variables, mainly related to income distribution, and we report the complete table in Appendix A. Figure 2 reveals several stylized facts that challenge standard inflation hypotheses. The profit share co-moves positively with inflation in the 1970s and post-2020 (contrary to standard predictions), while nominal and real wage growth display weak or inconsistent Phillips-curve relationships with inflation. The labor share shows pronounced downward trends post-2008, decoupling from inflation dynamics in the Great Moderation yet reasserting some co-movement during the pandemic. These distributive patterns, where profits and wages move at different speeds and in different directions relative to inflation, highlight that the distribution-inflation nexus is historically contingent and highly nonlinear.

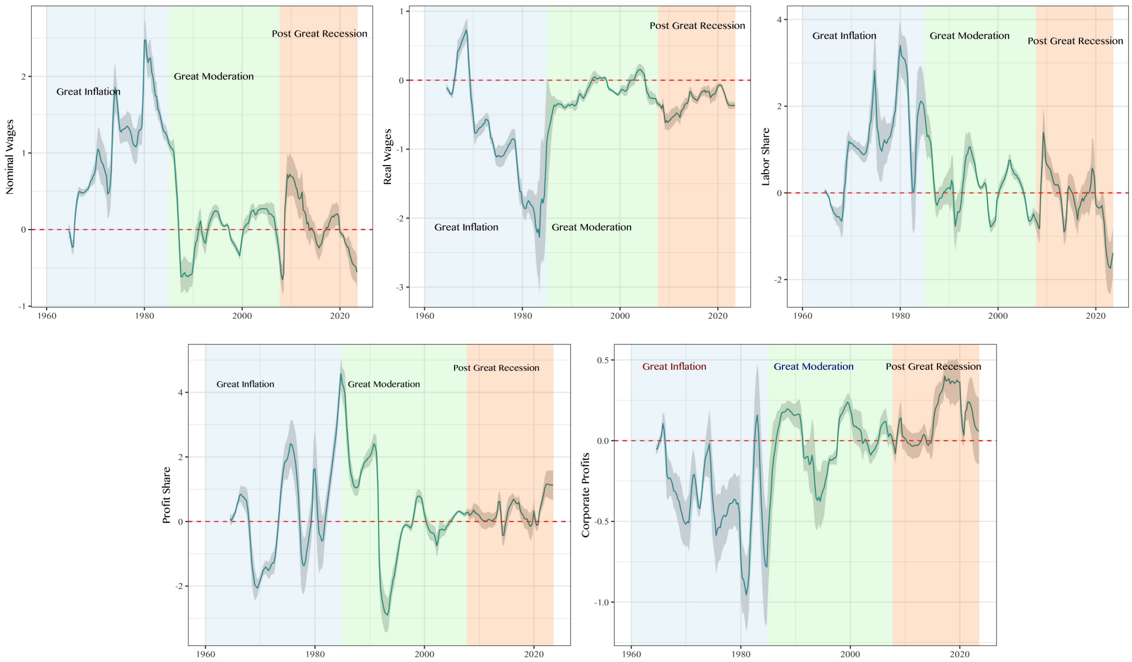
To examine how these relationships evolve over time, we segment the data into three periods: Great Inflation (1965-1984), Great Moderation (1985-2007), and post-Great Recession (2008-2023). Figure 3 presents rolling-window regressions (20 quarters window) showing time-varying coefficients for the inflation-distribution relationship. The results reveal a sharp increase in distributive variables' responsiveness to inflation during the Great Inflation, reflecting intense wage-profit conflict. By contrast, the subsequent decades show more muted responses, consistent with declining distributive tensions, until a new resurgence post-2020. This pattern points to distinct inflationary regimes defined by the dominance of wage-led versus profit-led channels.

Figure 2: Scatterplots w.r.t headline inflation rate across periods



Notes: Data are CPI Inflation Rate for All Urban Consumers: All Items in U.S. City Average; Nonfarm Business Sector: Labor Share for All Workers; Nonfarm Business Sector: Hourly Compensation for All Workers, Seasonally Adjusted; Nonfarm Business Sector: Real Hourly Compensation for All Workers, Seasonally Adjusted; Corporate Profits After Tax (without IVA and CCAdj), Seasonally Adjusted Annual Rate. Sources: U.S. Bureau of Labor Statistics and U.S. Bureau of Economic Analysis, via FRED.

Figure 3: Time-varying parameters regression w.r.t. headline inflation rate, with one-standard-deviation confidence interval



Sources: U.S. Bureau of Labor Statistics and U.S. Bureau of Economic Analysis, via FRED.

3.2 Cyclical Behavior in the Time-Frequency Domain

To capture both the timing and intensity of inflation-distribution co-movements while identifying regime shifts, we employ wavelet coherence analysis. Unlike traditional filtering techniques, wavelet methods provide a two-dimensional representation across time and frequency, enabling detection of transient dynamics and structural breaks in phase relationships (Proaño et al., 2025; Rua, 2010), which is precisely what is needed to characterize the transition from wage-led to profit-led regimes. A complementary analysis using the Christiano-Fitzgerald band-pass filter is provided in Appendix C. Technical details on wavelet decomposition analysis are in Appendix D.

This approach enables us to investigate not only the intensity of co-movement but also its direction (which variable leads) and phase structure (the timing of peaks and troughs), offering a richer characterization of how inflation and distributive variables evolve across distinct historical macroeconomic periods.

3.2.1 Coherence patterns between inflation and distributional variables

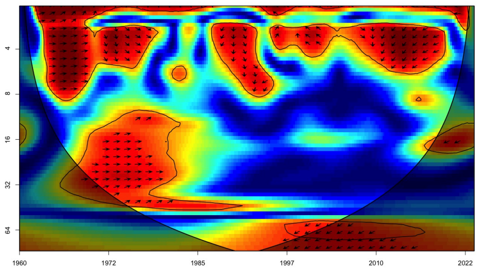
Wavelet coherency measures localized co-movement between two time series by normalizing their cross-wavelet power with the product of their individual power spectra. Unlike simple correlation or static spectral coherence, this approach captures both the intensity and evolution of co-movements over time and frequency, while identifying transient dynamics and changing phase relationships between inflation and distributive variables. We investigate both the local coherence amplitude and the phase to identify common frequencies and phase relations.

Figure 4 displays wavelet coherence between inflation and distributive variables across time and frequency. We identify shifts in phase relationships that may correspond to theoretical regime transitions– such as changes in the balance of bargaining power between capital and labor– while also capturing how the characteristic durations of these dynamics evolve over time. The horizontal axis displays time and the vertical axis frequency (in years). Warmer colors indicate stronger coherence; black contours mark regions that are statistically significant at the 5 percent level. Arrows indicate phase relationships: rightward (leftward) arrows denote in-phase (anti-phase) dynamics, with upward arrows indicating that the variable leads inflation by approximately 90 degrees.

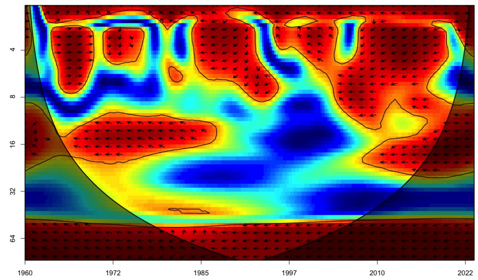
The results reveal distinct coherence structures at high frequencies (cycles shorter than 3-6 years). The Great Inflation shows strong, procyclical coherence between inflation and all wage-related variables, with real wages aligned with prices in the 2–7 year frequency range– a unique, wage-led dynamic. While nominal wages transitioned from moving in synchronization with prices to slightly lagging them, this pattern—combined with a labor share that moved consistently with prices in a context of high worker bargaining power—suggests that the acute and persistent inflation of these years was fundamentally driven by wage-pressure dynamics. By contrast, profit-related variables became more pronounced after 2008, with lagging but robust comovements suggesting that firms expanded margins while wages remained inert. The labor share moves anti-phase with prices, indicating that pricing strategies– not wage pressure– dominated income distribution. This pattern thus reflects a profit-led squeeze on the labor share. This supports the hypothesis of an emerging profit-led regime, a shift attributable to weakened labor power and broader structural economic changes. These historical shifts in coherence are not merely statistical artifacts but reflect substantive transformations in bargaining power. These short-run cycles appear especially informative for identifying regime-specific underlying interactions between income distribution *modes* and inflation *phases*, where the timing and strength of income claims (via wages or profits) exhibit distinct responses to inflationary pressures.

The strongest and most persistent coherency signals are concentrated in the high-frequency domain, suggesting that distribution–inflation coevolution is particularly active at business-cycle frequencies rather than at longer horizons. Our evidence complements Charpe et al. (2020)'s finding of a positive association between income distribution and high-frequency growth, but also repositions income distribution as a core business-cycle component of inflation dynamics, distinct from its role in long-run growth models (Growiec et al., 2018). Wage-led and profit-led distributive-inflation regimes emerge from the time-varying co-evolution of income distribution modes and price dynamics, with shifting lead–lag structures across cyclical frequencies (Aguiar-Conraria et al., 2023; Martins and Verona, 2023). This makes business-cycle frequency analysis essential for unpacking the distributive effects of inflation and underscores the need for context-sensitive policy responses, as both the origin of the inflationary impulse and the actors driving it differ across historical episodes.

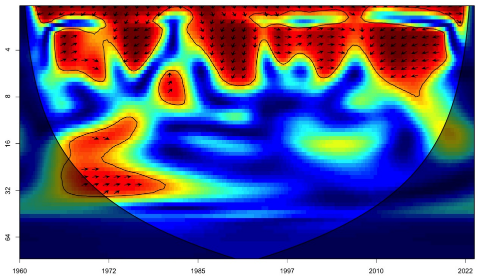
Figure 4: Wavelet Coherency w.r.t. headline Y.o.Y. Inflation Rate



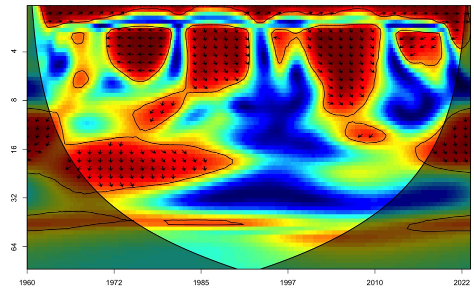
(a) Nominal Wages



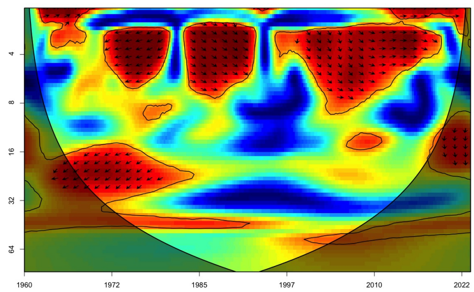
(b) Real Wages



(c) Labor Share



(d) Profit Share



(e) Corporate Profits

Notes: We obtain statistical significance areas using Monte Carlo randomizations. This involves generating a large set of surrogate data pairs with the same AR(1) as the data sets we are analyzing. We set the Monte Carlo randomization to 1000. The solid black curves represent regions of the time-frequency plane where coherence is statistically significant at the 5 percent level. The cone of influence, surrounding the entire region, identifies the areas affected by the edge effects of time series' signal. Sources: U.S. Bureau of Labor Statistics and U.S. Bureau of Economic Analysis, via FRED.

3.2.2 Cross-power spectra and the evolution of distributive regimes

To analyze the intensity and structure of the inflation–distribution nexus, we compute average cross-wavelet power spectra, which measure the strength of shared cyclical energy between inflation and distributive variables. Methodological details are provided in Appendix D.1.

Figure 5a and Table 2 reveal a stark hierarchy: profit share and corporate profits display substantially higher medians and means in cross-power with inflation, compared to wage-related variables. This reflects fundamentally different timing and persistence of distributive dynamics. Wage variables exhibit lower medians and wider dispersion, indicating episodic rather than persistent relevance. The combination of lower medians but higher means for wage variables reflects their concentration during the Great Inflation (generating high means) but decoupling thereafter (generating lower medians). The Kruskal–Wallis test confirms statistical significance ($p < 0.05$).

	Median	Mean	St. Dev.	25th Perc.	75th Perc.
Profit Share	0.1207	0.248	0.284	0.0232	0.2483
Corporate Profits	0.09166	0.232	0.279	0.02182	0.39299
Nominal Wages	0.03691	0.195	0.290	0.01636	0.23694
Real Wages	0.08456	0.189	0.238	0.02706	0.23314
Labor Share	0.04243	0.165	0.255	0.01561	0.20576
Kruskal-Wallis Test	Rank Sum=32.379, df=6, p=1.38e-05 ***				

Table 2: Descriptive statistics of average cross-power spectra for distributive variables.

We interpret these distributions by identifying phase-specific peaks in average cross-power spectra (Table 3, Panel 5b). To prevent inflating shared energy estimates due to asymmetric signal power, we implement the correction proposed by Veleda et al. (2012). This reveals a clear classification: wage-led configurations dominated the Great Inflation, while profit-led configurations emerged post-Great Moderation.

1. **Great Inflation**. Labor share dynamics peak before all other variables, reflecting the period's historically strong worker bargaining power. This lead-lag structure is consistent with a wage-led configuration: wage growth initiated price dynamics, to which firms responded with delayed margin adjustments. The average cross-power values during this phase reach their highest levels for all distributive variables, underscoring the intensity of this wage–price spiral.

2. **Great Moderation**. Cross-power values flatten markedly, with peaks concentrated at the period's beginning, reflecting institutional inertia from the preceding wage-led regime. Once these initial conditions dissipate, distributive variables decouple from inflation. The low and stable inflation environment, coupled with declining labor bargaining power, produces a weakly coordinated regime, where no distributive actor– neither workers nor firms– exerts consistent pricing influence. Structural shifts– labor market deregulation, union decline, globalization– fundamentally altered bargaining power, explaining why distributive dynamics that had dominated the Great Inflation became decoupled. This phase appears transitional, lacking a clearly dominant distributive anchor (or *distributive basin of attraction*).

3. **Post Great Recession**. This period exhibits a distinct bimodal cross-power structure, reflecting the Great Recession (2008–2009) and the COVID-19 pandemic (2020–2023),

sharing a common asymmetry: profit-related variables dominate while wage pressure remains subdued.

- **Financial Crisis**. Energy concentration shifts toward profit-related variables. Profit share and corporate profits exhibit strong coherence with inflation, moving in phase but lagging slightly (Ciambezi et al., 2025). Real wages decline more rapidly than prices, underscoring the asymmetric burden borne by labor.
- **Pandemic Inflation**. Profit share coherence reaches levels not observed since the Great Inflation. While nominal wages show some coherence with inflation, real wages display remarkably strong coherence in the opposite direction, indicating that workers' purchasing power declined sharply as inflation accelerated. This anti-phase relationship underscores a severe distributive squeeze: nominal wages failed to keep pace with price increases, enabling firms to expand margins while real labor compensation eroded systematically.

  This evidence complicates opportunistic pricing narratives (*greedflation*). Rather than episodic price gouging, the evidence points to a structural mechanism in which firms systematically exercise pricing power in response to cost shocks (Kharroubi et al., 2023). The behavior is not anomalous or temporary, but reflects persistent power-institutional asymmetries and institutional capacity to pass on cost shocks (Nikiforos et al., 2024), especially when supply shocks prevail (Shapiro, 2024). Wage growth contributed minimally to inflation during this phase (Boissay et al., 2022), marking a turning point where firm-level pricing power became the principal channel of inflation transmission.

  This configuration supports a structurally profit-led inflation regime, anchored in persistent asymmetries of bargaining power, institutional inertia, and cost pass-through capacity.

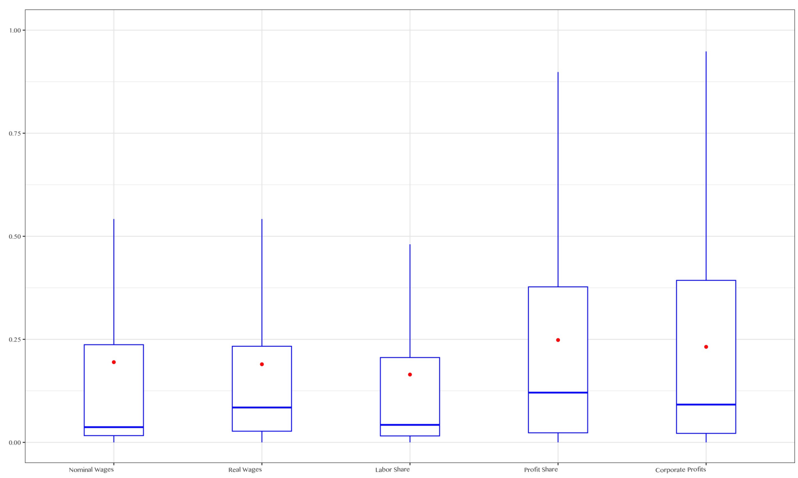
Average Cross-Power	**Great Inflation**	**Great Moderation**	**Post Great Recession**
Profit Share	1975:Q3	1985:Q1	$\boxed{2009:Q1--2021:Q2}$
Corporate Profits	1975:Q1	1985:Q1	$\boxed{2009:Q1--2021:Q2}$
Nominal Wages	$\boxed{1976:Q1}$	1985:Q1	2021:Q2
Real Wages	$\boxed{1975:Q1}$	1985:Q1	2021:Q3
Labor Share	$\boxed{1974:Q1}$	1985:Q1	2009:Q3 – 2021:Q1
Wage-led Regime	✓	**?**	✗
Profit-led Regime	✗	**?**	✓

Table 3: Peaks of average cross-power spectra: the empirical distributive-inflation configurations for the US economy.

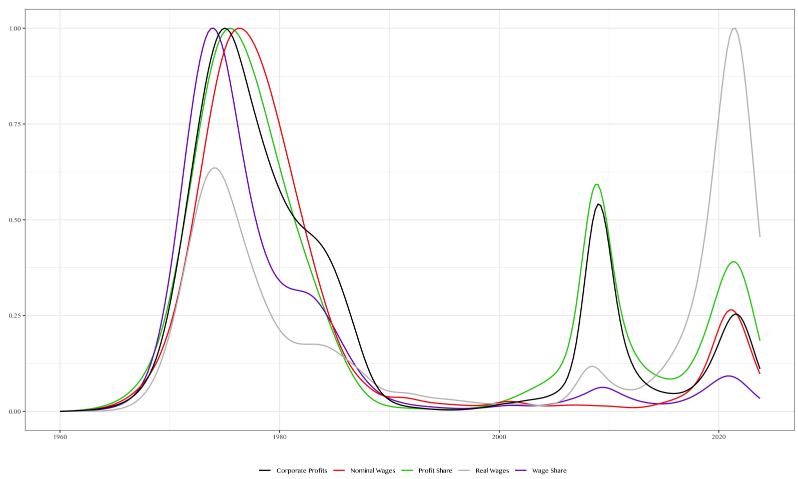
The timing of peak coherence reveals directionality in distributive-inflation nexus. During the Great Inflation, wage variables peak earlier than profit variables, indicating wage pressures actively initiated price dynamics– a wage-led configuration where workers' bargaining power secured nominal wage gains that firms accommodated through price increases (Blanchard, 1986). By contrast, in the post–Great Recession period– especially the pandemic—profit variables peak concurrently with or after inflation accelerates, indicating that firms actively captured inflationary gains rather than passively defending margins. This directional reversal is economically pivotal: inflation transitioned from being wage-driven to being profit-driven, with wage growth becoming subordinate to pricing power.

The empirical evidence points to a structural bifurcation in the inflation-distribution nexus: from labor-initiated wage-price spirals (Great Inflation) to firm-initiated profit-price spirals (post-2008), with the Great Moderation as structurally intermediate. This represents a regime transition requiring distinct analytical frameworks and policy responses, in line with Alvarez et al. (2024).

Figure 5: Average Cross-Power Spectra



(a) Boxplot of average cross-power spectra distribution: the red dots indicate the respective mean.



(b) Distributive Variables

Sources: U.S. Bureau of Labor Statistics and U.S. Bureau of Economic Analysis, via FRED.

Robustness: Discrete Wavelet Regression. The discrete wavelet regression results (Appendix D.3) corroborate the continuous wavelet coherence analysis and provide quantitative confirmation of the regime transition. At business-cycle frequencies, specifically D_1 but also D_2, wage variables (nominal and real wages, labor share) exhibit substantially higher coefficients (i.e., *regime elasticity*) during the Great Inflation, indicating their direct and statistically significant contribution to inflation at cyclical horizons. By contrast, during the post-Great Recession period, profit-related variables (profit share and corporate profits) show markedly elevated coefficients at the same frequency bands, while wage variables become statistically insignificant or weakly negative. This frequency-specific reversal provides rigorous quantitative evidence that the regime transition is not merely a change in correlation patterns, but reflects a fundamental shift in the *distributive transmission mechanism* of inflation: from wage-led to profit-led cycles at business-cycle frequencies. The medium- and long-run frequency bands (D_3 and S_3) show more modest effects across all variables, consistent with the hypothesis that distributive conflict primarily operates at cyclical, rather than medium-long horizons.

Link to the Theoretical Framework. The time–frequency evidence reveals that the U.S. economy has undergone multiple transitions in its distributive–inflation configurations. We develop a conflict-distribution-inflation model that endogenously reproduces these regime shifts through the interaction of distributive conflict, autonomous markup dynamics, learning-by-doing, and nonlinear price-wage feedback mechanisms. The model generates self-reinforcing wage or profit–price spirals and bifurcations, thereby explaining the observed spectral patterns and why transitions occur.

4 A stylized conflict distribution–inflation model

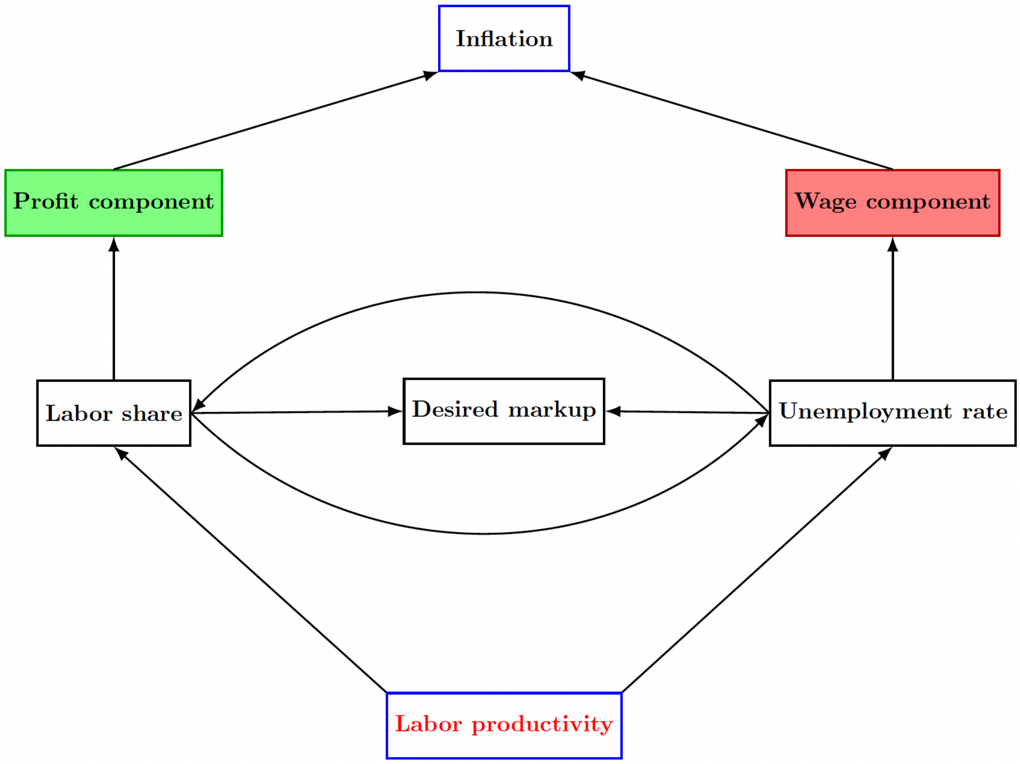
Building on the empirical evidence of shifting distributive–inflation configurations, we develop a stylized predator-prey framework (Dosi et al., 2024b), which captures the dynamic antagonism between wages and profits as the core engine of income distribution dynamics. When wages rise, profits decline, generating incentives for price increases; conversely, when firms expand markups, real wages decline, constraining purchasing power. The aim is to reproduce, in a reduced and tractable form, the coexistence of alternative inflationary-distributive mechanisms within a unified macroeconomic setting.

The model is designed to show how the relative bargaining power of workers and capitalists shapes price formation and income shares, giving rise to self-reinforcing wage–price or profit–price spirals, depending on the prevailing macroeconomic configuration. We integrate endogenous productivity growth via learning-by-doing and allow the desired markup to evolve endogenously with economic conditions and distributive pressures.

Figure 6 illustrates the general structure: a closed economy with two classes of agents (wages and capitalists) whose interactions over wages, markup expectations, and employment generate nonlinear feedback loops that drive both distributional shifts and inflation dynamics. The core state variables are the labor share, the (un)employment rate, and the desired markup, whose co-evolutionary dynamics determine whether the economy operates in a wage-led or profit-led regime. In this setting, firms use price increases as the primary adjustment mechanism to defend profitability against wage pressures and cost shocks.

We detail the production, the pricing-distribution, and the markup-formation blocks, then integrate them into the complete macrodynamic system. We examine equilibrium properties and stability conditions to show how different parameter configurations generate regime shifts and endogenous cycles consistent with Section 3. Numerical simulations illustrate how the model replicates wage-led and profit-led inflationary regimes.

Figure 6: Block Ddagram of the stylized conflict–inflation model



Notes: This figure provides the main stylized interactions among labor share, unemployment, markups, and productivity shape profit and wage channels, with inflation emerging endogenously from this feedback structure.

4.1 Supply-Production

We follow the structure of growth–cycle models à la Goodwin (1967). Labor productivity evolves via learning-by-doing process generating increasing returns (Dosi et al., 2024b), proportionally to employment pressure (high pressure economies incentivize productivity gains via demand):

$$\hat{a} = \alpha' \cdot e, \quad \text{with} \quad \alpha' = \begin{cases} > 0 & \text{Increasing returns} \\ < 0 & \text{Decreasing returns} \end{cases} . \qquad (1)$$

Firms' labor demand, assuming constant capacity utilization (Corrado and Mattey, 1997), is given by:

$$\hat{L}^d = \hat{y} - \hat{a} = \frac{1-\psi}{\sigma} - \alpha' e, \tag{2}$$

where $1-\psi$ is the profit share and σ is the capital–output ratio.
Labor supply grows exogenously at rate $\beta > 0$, so the employment rate dynamic follows:

$$\hat{e} = \hat{L}^d - \hat{L}^s = \frac{1-\psi}{\sigma} - \alpha' e - \beta. \tag{3}$$

The employment dynamics is governed by three forces: (i) output growth from profit accumulation, (ii) productivity improvements, and (iii) exogenous labor force growth. When $\hat{e} > 0$, unemployment falls and labor markets tighten, strengthening worker bargaining power, as a key feedback to the wage-setting mechanism.

This block provides the supply-side backbone, linking productivity, profit share, and employment dynamics in a tractable way. This analytical simplification, holding capacity utilization constant, allows us to focus on distributional dynamics without the added complexity of endogenous capital adjustment.

4.2 Pricing–Distribution

Inflation decomposes into competing components reflecting opposing income claims:

$$\pi = \underbrace{\mathcal{M}}_{\text{Profit Component}} + \underbrace{\mathcal{W}}_{\text{Wage Component}} .$$

The wage–price loop is formalized in two steps. First, firms set prices using a cost-plus pricing rule, originally introduced by Desai (1973) and Dutt (1992) and recently adopted in an original way by Lorenzoni and Werning (2023a) and van der Ploeg and Willems (2025), and gradually adjust prices toward their desired markup, μ^d, relative to the actual markup, where μ^a denotes the actual markup and ψ the labor share, so that $\mu^a = 1/(1-\psi)$.

$$\hat{p} = \lambda_p \left(\mu^d - \mu^a\right), \quad \lambda_p > 0, \tag{4}$$

where λ_p measures the speed of adjustment toward desired margins. This captures firms' responsiveness to margin pressures: when $\mu^d > \mu^a$ (desired markups exceed realized markups due to cost pressures or demand shocks), firms raise prices to restore profitability.

Second, nominal wages evolve according to employment conditions and the prevailing inflation rate:

$$\hat{w} = -\gamma + \rho e + \eta \hat{p}, \quad \gamma > 0, \quad \rho > 0, \quad \eta \in [0,1], \tag{5}$$

where γ captures secular decline in wage-setting capacity (Cairó and Sim, 2024), ρ the elasticity to labor market cyclicality, and η the degree of price indexation. Empirically, the U.S. has operated under weak indexation throughout the post-1980s period (Barattieri et al., 2014). This rigidity enables firms to shift inflation burden onto workers by letting inflation outpace sluggish nominal wage growth. Under partial indexation ($\eta < 1$), firms can expand profit margins as inflation outpaces wage growth– a mechanism central to profit-led inflation regimes (Guerreiro et al., 2024).

Combining the pricing rule (4), wage-setting equation (5), and productivity growth specification (1), we derive the law of motion for the labor share:

$$\hat{\psi} = -\gamma + (\rho - \alpha')e - (1-\eta)\lambda_p(\mu^d - \mu^a), \tag{6}$$

where for $\eta = 1$, the above equation returns to the distributive side of Dosi et al. (2024b).

This equation synthesizes the forces behind the income distribution dynamics: labor market conditions, technological change, nominal rigidities, and firms' markup ambitions.

4.3 Markup formation

We endogenize a behavioral rule of markup expectations or ambitions, μ^d, as a function of profitability conditions, labor market tightness, supply-side shocks and institutional determinants. Our specification is motivated by both theoretical considerations and recent empirical findings emphasizing the asymmetric role of market power in driving inflation dynamics. Firms adjust desired markup in response to four distinct forces:

- **Profit share pressure** (ε): When profit share $(1-\psi)$ rises, firms raise markup targets, reflecting how rising profitability and bargaining power feed back into price-setting (Ratner and Sim, 2022). This relationship is governed by ε, the elasticity of markup ambitions to profitability. When $\varepsilon > 0$, markups expand with rising profits, reinforcing profit-led dynamics; if $\varepsilon < 0$, rising profits do not translate into higher markups– either because of competitive constraints or because firms prioritize market share preservation. This heterogeneity can explain asymmetric inflationary responses (Bräuning et al., 2023; Kharroubi et al., 2023; Fierro and Martinoli, 2025).

- **Labor market pressure** (χ): Firms increase markups during expansions when employment is high and demand conditions are favorable (Harrod, 1936; Qiu and Ríos-Rull, 2022). This relationship is governed by χ, the elasticity of markups to demand: stronger labor markets allow firms to raise prices without eroding demand. Empirical studies support this mechanism by showing that markups respond positively to aggregate demand shocks (Nekarda and Ramey, 2020).

- **Supply-side turbulence** (δ): Temporary but severe shocks– such as global supply chain disruptions– affect firms' ability to raise prices (Franzoni et al., 2023). The exogenous component δ captures this mechanism, which can shift the distributive balance in favor of firms by constraining supply while demand remains inelastic.

- **Competitive anchor** ($\bar{\mu}$): To prevent unbounded markup ambitions' growth and ensure dynamic stability, we introduce a mean-reversion mechanism toward a benchmark satisfactory level $\bar{\mu}$. This captures institutional constraints (i.e., antitrust schemes, pricing regulations) or competition. Parameter κ governs adjustment speed.

The dynamic equation for desired markup is:

$$\hat{\mu}^d = \varepsilon(1-\psi) + \chi e + \delta - \kappa(\mu^d - \bar{\mu}), \quad \varepsilon, \chi > 0,\ \delta \geq 0,\ \kappa > 0. \tag{7}$$

This formulation closes the feedback loop in the conflict–inflation process: firms adjust their price-setting behavior in light of distributive tensions and macroeconomic signals, which in turn feed back into employment, wages, and labor share dynamics. Equations (4)-(6)-(7) form a closed-loop conflict–inflation system: wage pressures force firms to adjust markups, which feed into prices, which affect nominal wage growth, which evolves endogenously into labor share, which feeds back into markup expectations through profitability. This mutual reinforcement between distributive claims and pricing behavior is the core engine of regime shifts between wage-led and profit-led inflation.

4.4 Macrodynamic laws of motion

The full nonlinear three-dimensional system governing the coevolution of employment, labor share, and desired markup is:

$$\begin{cases} \dot{e} = \left(\frac{1-\psi}{\sigma} - \alpha' e - \beta\right) \cdot e \quad = h_1(e, \psi), \\ \dot{\psi} = \Big((\rho - \alpha')e - \gamma - (1-\eta)\big(\mu^d - \mu^a\big)\Big) \cdot \psi \quad = h_2(e, \psi, \mu^d), \\ \dot{\mu}^d = \big(\varepsilon(1-\psi) + \chi e + \delta - \kappa(\mu^d - \bar{\mu})\big) \cdot \mu^d \quad = h_3(e, \psi, \mu^d), \end{cases} \tag{8}$$

In this formulation:

- Equation h_1 describes employment dynamics: tight labor markets (e high) increase labor costs and pressure markups, but also reduce unemployment, which is a classic tension in growth models.
- Equation h_2 governs the evolution of the labor share, which depends on wage bargaining power, productivity dynamics, and the price–wage pass-through.
- Equation h_3 models the evolution of markup expectations, endogenously driven by profitability, labor market pressure, exogenous supply disturbances, and the mean-reverting competitive anchor.

These coupled equations form the conflict mechanism's backbone. They generate persistent cyclical behavior and wage-led or profit-led inflationary spirals depending on parameter configurations, aligning with Section 3's empirical patterns.

4.5 Characterisation of the (unique) interior stationary point

***Proposition* 1** (Interior stationary point & local stability)**.** *Let $\sigma, \kappa, \lambda_p > 0$, $\beta > 0$, $0 < \eta < 1$ and suppose the quadratic coefficients*

$$A_2 > 0, \qquad \Delta := B_2^2 - 4A_2C_2 > 0,$$

where[1]

$$A_2 = \alpha'^2\Big(\varepsilon\sigma^2 + \frac{\kappa\sigma}{1-\eta}\Big) + \alpha'\chi\sigma - \alpha'\frac{\kappa\rho\sigma}{1-\eta},$$
$$B_2 = 2\alpha'\beta\Big(\varepsilon\sigma^2 + \frac{\kappa\sigma}{1-\eta}\Big) + \alpha'\sigma\Big(\delta + \kappa\bar{\mu} + \frac{\kappa\gamma}{1-\eta}\Big) - \beta\chi\sigma - \frac{\beta\kappa\rho\sigma}{1-\eta} - \chi + \frac{\kappa\rho}{1-\eta},$$
$$C_2 = \beta^2\varepsilon\sigma^2 + \beta\sigma\Big(\delta + \kappa\bar{\mu} + \frac{\kappa\gamma}{1-\eta}\Big) - \delta - \frac{\kappa\gamma}{1-\eta} - \kappa\bar{\mu} + \kappa,$$

hold. Then system (8) admits a unique *interior equilibrium*

$$\boxed{e^* = \frac{-B_2 - \sqrt{\Delta}}{2A_2}}, \qquad \boxed{\psi^* = 1 - \sigma(\alpha' e^* + \beta)}, \qquad \boxed{\mu^{d*} = \frac{1}{\psi^*} + \frac{(\rho - \alpha')e^* - \gamma}{1-\eta}}.$$

1. ***Existence**: the inequalities* $0 < e^* < 1$, $0 < \psi^* < 1$, $\mu^{d*} > 0$ *are satisfied whenever* $A_2 > 0$ *and* $\Delta > 0$.

2. ***Uniqueness**: the alternative root* $e_+ = (-B_2 + \sqrt{\Delta})/(2A_2)$ *also lies in* $(0,1)$, *but corresponds to a saddle point: perturbations from this equilibrium grow along the unstable manifold, making it economically irrelevant for long-run dynamics.*

3. ***Stability**: the Jacobian at* (e^*, ψ^*, μ^{d*}) *has eigenvalues*[2]
   $\lambda_e = e^* F'(e^*) = -e^*\sqrt{\Delta} < 0$, *so the point is locally asymptotically stable.*

Economic Interpretation: The existence of a unique stable interior equilibrium means that the conflict–inflation system has a well-defined long-run attractor. Perturbations from this equilibrium die out over time, suggesting that transitory distributive tensions give way to long-run equilibrium configurations determined by structural parameters. The existence of an unstable equilibrium indicates that large perturbations from endogenous distributive tensions could trigger complex transient dynamics before convergence to the stable equilibrium.

5 Model simulations and regime analysis

Model parameters are calibrated to reflect stylized macroeconomic magnitudes consistent with growth-cycle and conflict inflation literature. We adopt a baseline configuration and explore deviations in key parameters to generate distinct distributive–inflation regimes. Table 4 summarizes the main parameters and their typical ranges. Parameter choices for each scenario are described in the relevant subsections.

[1] A full derivation is reported in Appendix E.1; $\rho, \gamma, \delta, \varepsilon, \chi, \bar{\mu}$ are strictly positive parameters.

[2] Because $\dot{\psi} = \psi G(e, \mu^d)$ and $\dot{\mu}^d = \mu^d H(e, \psi, \mu^d)$ satisfy $G(e^*, \mu^{d*}) = 0$ and $H(e^*, \psi^*, \mu^{d*}) = 0$ at equilibrium, the eigenvalues reduce to zero.

Parameter	Baseline Value	Typical Range
α'	0.00	[–0.05, 0.15]
σ	0.4	[0.25, 0.8]
β	1	[0.5, 1.5]
ρ	0.5	[0.1, 0.9]
η	1.00	[0.1, 1.5]
ε	0.3	[-0.99, 0.99]
χ	0.3	[-0.99, 0.99]
δ	0.4	[0.0, 0.99]
κ	0.4	[0.1, 0.99]
$\bar{\mu}$	1.2	[0.75, 1.6]
λ_p	0.001	[0.001, 0.99]

Table 4: Baseline calibration and parameter ranges for scenario S1. Scenarios S2 and S3 feature elevated values reflecting acute supply shocks, firm-pricing power and strong wage-setting power.

Scenario-specific variations We explore three archetypal scenarios:

S1: Stable limit cycle. Conservative baseline with balanced income claims and moderate markup expectations, corresponding to the Great Moderation historical period (1985–2007).

S2: Profit-led spiral. Weak wage indexation with elevated markup expectations, capturing post-2008 dynamics with energy shocks.

S3: Wage-led spiral. Over-indexation ($\eta > 1$) with strong worker bargaining power, approximating the Great Inflation (1960s–1980s).

Parameter	S1 (Conservative)	S2 (Profit-led)	S3 (Wage-led)
α'	0.00	0.001	0.001
ρ	0.50	0.50	0.10
γ	0.15	0.15	0.15
η	1.00	0.50	1.50
σ	0.4	0.4	0.4
β	1	1	1
χ	0.4	0.99	0.7
ε	0.4	0.99	0.7
δ	0.4	0.99	0.4
$\bar{\mu}$	1.2	1.2	1.2
λ_p	0.001	0.001	0.001

Table 5: Scenario-specific parameter configurations. S1 (Conservative) represents the baseline dynamics consistent with the Great Moderation period. S2 (Profit-led) elevates ε, χ and δ to 0.99, simulating market power. S3 (Wage-led) increases η to 1.50 and reduces ρ to 0.10, capturing strong labor bargaining and inelastic labor market.

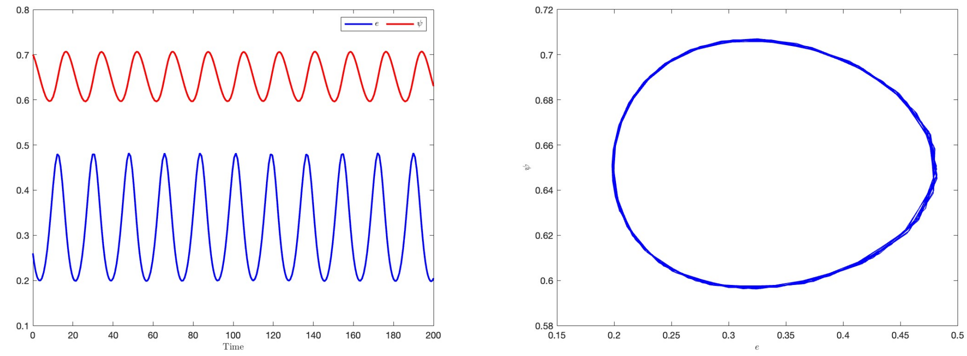
5.1 Baseline scenario S1: stable configuration

With no technological drift ($\alpha' = 0$) and full wage indexation ($\eta = 1$), any attempt by firms to expand their desired markup is exactly neutralized by the competitive pullback and workers' immediate wage catch-up. Wages rise one-for-one with prices, so the labor share ψ remains stationary, and markup expectations never produces a lasting profit squeeze on labor. The result is a perpetual tug-of-war: capitalists' margin-seeking and workers' indexation claims offset each other in a stable oscillatory pattern. The parameter η (wage indexation) acts as a *distributive picklock*: when $\eta = 1$, firms and workers' income claims are perfectly balanced, generating bounded limit cycles. Deviations break this symmetry and trigger bifurcations: $\eta < 1$ allows firms to expand profit shares (profit-led spirals); $\eta > 1$ compresses profit shares (wage-led spirals). The conservative case represents the equilibrium point where distributive conflict persists without cumulative advantage to either side.

In this scenario, employment e and labor share ψ form a classic predator–prey pair. When e increases, bargaining power shifts toward workers, raising ψ; this compresses the profit share $1 - \psi$, slowing job creation and eventually causing e to decline, restarting the cycle. The desired markup by firms, μ^d, evolves endogenously, with temporary surges gradually absorbed by the competitive anchor $\bar{\mu}$. Although μ^d does not amplify the core cycle, it introduces a three-dimensional dynamics in the phase-space trajectory.

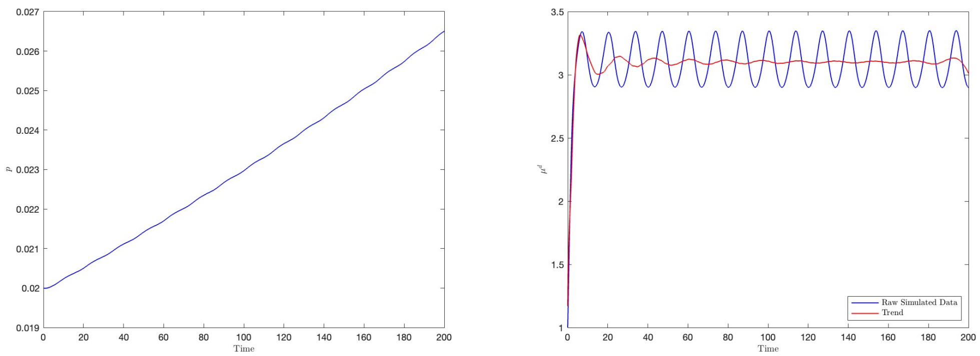
Unlike classic prey-predator dynamics where prices are abstracted, here the price level itself follows an endogenous dynamic driven by both profit and wage claims. A *Goodwinian cycle* persists even when capitalists attempt to push up prices to secure higher margins: any temporary profit gain is counterbalanced by workers' full indexation and competitive reversion. Prices and markups fluctuate (Figure 8), but the system maintains stable limit cycles close to the stationary point (Figure 7), and workers remain fully capable of defending their income share through unitary wage pass-through. This conservative setup demonstrates that the model reproduces sustained cyclical conflict with stable amplitudes and no net drift. Inflation and markup dynamics, while active, do not destabilize the system when indexation is complete and learning is absent. This qualitatively aligns with Great Moderation characteristics.

Figure 7: Conservative Configuration: $\alpha' = 0, \eta = 1$



(a) Trajectories of (e, ψ) (b) Phase portrait of (e, ψ) plane

Figure 8: Feedback Loop for Price and Markups



(a) Price Dynamics (b) Markup Dynamics

Notes: Feedback dynamics under the conservative configuration ($\alpha' = 0, \eta = 1$). The trend component is extracted using the Christiano–Fitzgerald band-pass filter with the same frequency bounds as in Section 3.

Definition: distributive–inflation configuration

A *distributive–inflation configuration* emerges from the endogenous co-evolution of price dynamics (*phases)* and the distributive conflict (*modes*) between firms and workers. It describes a macroeconomic regime in which the interplay between firms' pricing power, worker bargaining power, and wage-price pass-through allows one group to systematically appropriate a larger income share by translating inflationary pressures into asymmetric income redistribution.

In our framework, inflation is not merely a nominal phenomenon but an emergent outcome of conflicting income claims. Two configurations arise:

- In a **profit-led configuration**, firms exploit cost and demand shocks, supply chain disturbances, or heightened profit sensitivity to expand markups expectations, passing on rising costs to prices and eroding real wages.

- In a **wage-led configuration**, workers' bargaining power and indexation dominate, pushing nominal wages ahead of initial price increases and triggering a wage–price spiral.

Departing from the neutral conservative baseline, the following sections illustrate how changing key parameters reshape the system into these alternative configurations.

5.2 Scenario S2: profit-led configuration

In this configuration, inflationary pressures are primarily driven by the ability of capitalists to leverage their structural advantage in price-setting to protect and expand profit margins. When firms possess sufficient market power and institutional leverage, even moderate variations in profit shares, strong demand, or supply disruptions can be quickly transmitted into higher prices.

This mechanism reveals a sustained asymmetry: firms can readily pass on costs to prices through markups, while workers lack an equivalent ability to fully index wages. As a result, when profit-driven price hikes occur, real wages erode, labor share contracts, and profit share expands, reinforcing firms' pricing power in a self-sustaining loop. Even mild profit increases or supply shocks can ignite sustained inflationary spirals, whereas reversing these dynamics requires much larger countervailing forces, reflecting the inherent power imbalance between price-setters and wage-earners.

In our model, this asymmetry is captured by three channels: the profit elasticity of markups (ε), the demand-side pressure coefficient (χ), and the exogenous supply disturbance (δ). Their interaction determines whether profit-led inflation spirals can emerge and persist.

***Proposition* 2** (Necessary Conditions for a Profit-Led Spiral)**.** *Suppose $\eta < 1$ (incomplete wage indexation) hold. Then a profit-led distributive–inflation configuration arises when:*

$$\hat{\psi} < 0, \quad \hat{\mu}^d > 0, \quad \textit{and} \quad g = \mu^d - \mu^a > 0 \quad \textit{with} \quad \hat{p} > 0.$$

Intuitively, firms expand desired markups faster than labor share adjustments can offset, creating a self-reinforcing loop: higher desired markup $\rightarrow$ higher prices $\rightarrow$ eroded real wages $\rightarrow$ lower labor share $\rightarrow$ higher desired markup $\rightarrow$ (cycle restarts).

5.2.1 Channel 1: Profit elasticity

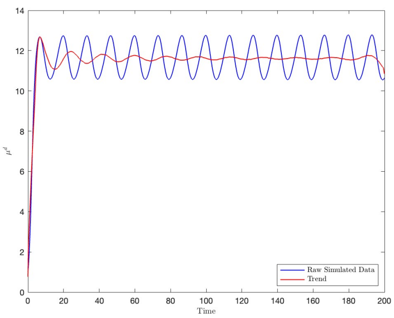
When firms respond aggressively to rising profit share, captured by parameter ε, even small improvements in $(1-\psi)$ trigger disproportionately large jumps in μ^d. This opens a wide aspirational gap $g = \mu^d - \mu^a$, feeding directly into the price rule $\hat{p} = \lambda_p g$. Since wages are only partially indexed ($\eta < 1$), workers cannot keep pace, real wages erode, and the labor share falls further. The erosion of ψ slightly raises employment e through the $(1-\psi)/\sigma$ channel[3], which in turn reinforces markup expectations via the χe term in the

[3]The erosion of ψ slightly raises employment e through the capital-utilization channel (as ψ falls, the profit share $(1-\psi)$ rises, boosting capacity utilization and job creation via $\dot{e} \propto (1-\psi)/\sigma$).

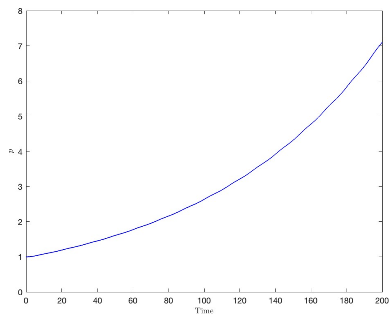
behavioral markup equation. This recursively amplifies markup desires via the $\varepsilon(1-\psi)$ term. A high ε locks the economy into a profit-led spiral: firms systematically enlarge their income share at labor's expense, sustaining inflationary pressures even without strong exogenous shocks. Figure 9 illustrates how $\varepsilon = 0.99$ generates persistent profit–price spirals.

This mechanism illustrates the structural asymmetry: a high ε locks the economy into a profit-led spiral where firms can quickly translate profit improvements into higher prices and markups, while reversing this process is slower and less certain. Firms systematically enlarge their income share at labor's expense, sustaining inflationary pressures even without strong exogenous shocks.

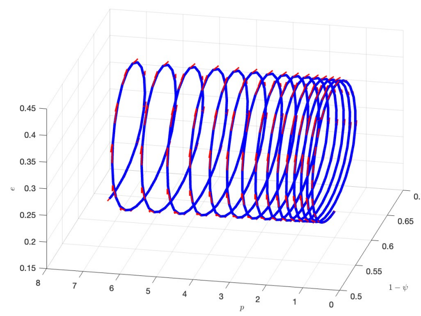
Figure 9: Profit elasticity channel



(a) Markup Dynamics under $\varepsilon = 0.99$



(b) Price Dynamics under $\varepsilon = 0.99$



(c) Phase portrait: profit–price spiral induced by $\varepsilon = 0.99$

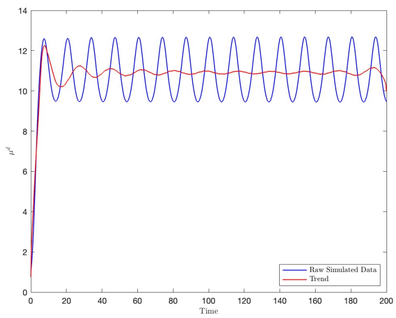
Notes: Impact of profit elasticity ($\varepsilon = 0.99$) on markup expectations, price adjustments, and the self-reinforcing profit–price spiral.

5.2.2 Channel 2: Demand elasticity

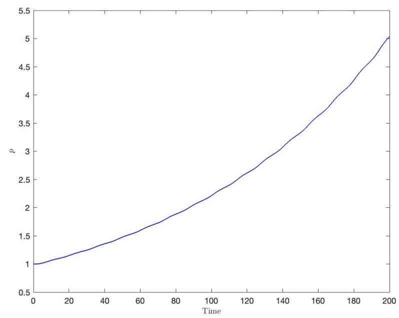
When firms raise markups in tight labor markets (high χ), employment gains trigger oversized markup expectations. The erosion of ψ from incomplete wage indexation feeds back into employment pressure via $(1-\psi)/\sigma$, reinforcing the cycle. When labor markets are tight, any employment gain immediately fattens the margin they aspire to charge because of large demand opportunities. This feeds into the price-adjustment rule $\hat{p} = \lambda_p g$ (Figure 10). When χ is large, price increases move upward more sharply in response to the same employment rise. Since wages are only partially indexed ($\eta < 1$), this further erodes real wages and shrinks the labor share ψ, boosting the profit share $(1-\psi)$. Through the $\varepsilon(1-\psi)$ term, it provides firms a further incentive to push μ^d even higher. Meanwhile, the erosion of ψ slightly lifts the employment driver $(1-\psi)/\sigma$, which pushes e up again, reinforcing the χe feedback. The result is an outward-spiraling trajectory: employment gains trigger oversized markup hikes, these hikes drive steeper inflation, inflation erodes wages, and the cycle intensifies.

Intuitively, high χ *steps on the accelerator* of profit-led spirals: moderate cyclical fluctuations transform into self-reinforcing inflationary dynamics, highlighting how firms exploit pro-cyclicality to protect and expand profit margins.

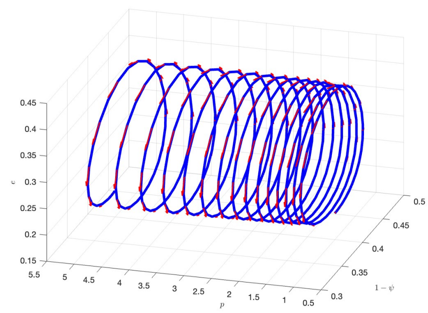
Figure 10: Demand elasticity channel



(a) Markup Dynamics under $\chi = 0.99$



(b) Price Dynamics under $\chi = 0.99$



(c) Phase portrait: profit–price spiral induced by $\chi = 0.99$

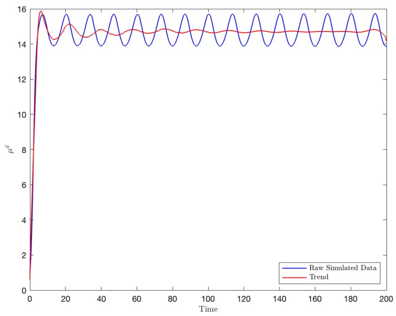
Notes: Impact of demand elasticity ($\chi = 0.99$) on markup, price adjustments, and the self-reinforcing profit–price spiral.

5.2.3 Supply disturbance channel

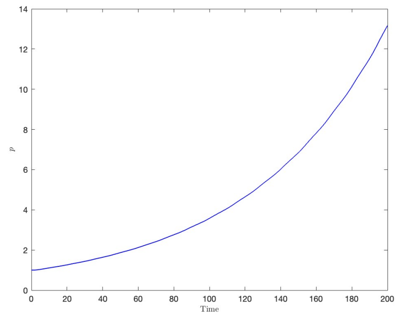
While a fully closed model cannot endogenously capture an international dimension, we incorporate δ in the behavioral equation of markup desires as a reduced-form proxy for external pressures. Our aim is to replicate how firms, having stronger power than workers, exploit supply disturbances as a pretext to increase their desired markup μ^d. A positive δ lifts μ^d, widening the aspirational gap and driving prices upward. As prices rise, incomplete wage indexation erodes real wages and the labor share. The lower $(1-\psi)$ activates both profit elasticity (ε) and demand-side (χe) channels, re-accelerating the spiral. Supply shocks thus enable firms to extract more surplus while sustaining inflationary pressures, with prices climbing swiftly while real wages absorb the loss.

Hence, even in a stylized closed setting, exogenous supply shocks shift the burden of adjustment onto workers, while preserving, if not expanding, firms' profit margins. The result is an asymmetrical pass-through effect (prices adjust immediately upward, but wages adjust downward only gradually): prices climb swiftly with supply chain stress, while real wages absorb the loss, reinforcing a profit-led distributive–inflation configuration (Figure 11), consistent with the empirical patterns discussed earlier.

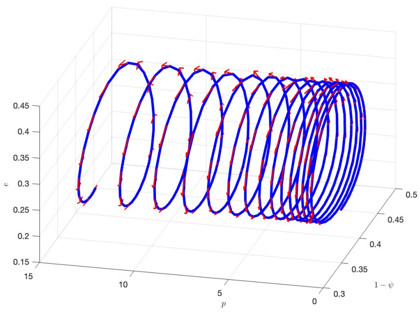
Figure 11: Exogenous supply shock



(a) Markup Dynamics under $\delta = 0.99$



(b) Price Dynamics under $\delta = 0.99$



(c) Phase portrait: profit–price spiral induced by $\delta = 0.99$

Notes: Impact of supply chain disturbance ($\delta = 0.99$) on markup, price adjustments, and the self-reinforcing profit–price spiral.

5.2.4 Competitive–pull-back channel

Two key parameters act as crucial 'brakes' that can contain profit–price spirals on runaway spirals: the mean-reversion strength (κ) and the markup ceiling ($\bar{\mu}$).

1. Markup Pull-Back (κ). Higher κ drags ambitious markups back toward their long-run anchor (reflecting competitive pressures or regulation). Intuitively, this stands for competitive pressures or regulatory constraints: the stronger they are, the more quickly firms must temper profit-seeking price hikes, narrowing the aspirational gap $g = \mu^d - \mu^a$ and damping inflationary impulses.

2. Markup Ceiling ($\bar{\mu}$). Lower $\bar{\mu}$ compresses the upper bound on sustainable markups (reflecting antitrust or bargaining limits): once μ approaches $\bar{\mu}$, the term $-\kappa(\mu - \bar{\mu})$ becomes large and negative, effectively shutting off further markup increases. Intuitively, it reflects antitrust regimes, competitive entry or bargaining limits that prevent firms from pushing prices– and thus profit shares– indefinitely higher.

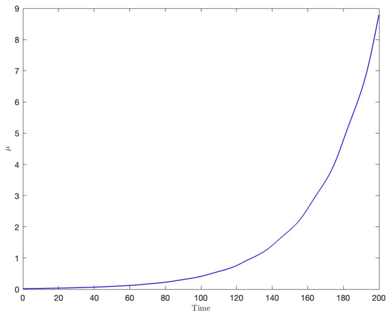
Together, these contain profit-led spirals into bounded cycles. Without them ($\kappa = 0$), markups spiral unbounded, highlighting the importance of institutional constraints in limiting predatory pricing behavior.

Absence of Competitive Anchor When $\kappa = 0$, firms face no institutional or competitive constraint on their markup ambitions. Therefore, μ^d evolves according to profit and demand pressures without reverting to a long-run anchor $\bar{\mu}$. The markup ambitions equation simplifies to

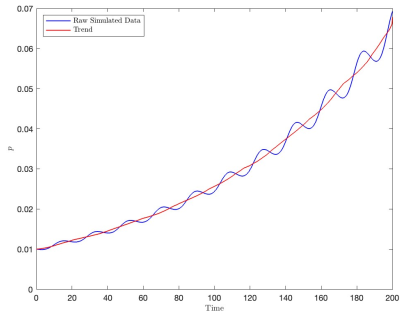
$$\hat{\mu}^d = \varepsilon(1 - \psi) + \chi e + \delta,$$

Any upswing in profits, employment, or supply disruptions feeds into markup expectations, creating unbounded aspirational gaps $g = \mu^d - \mu^a$. This drives prices upward in an accelerating spiral with no natural stabilizing mechanism. Figure 12 shows this scenario: markups and prices spiral outward without bound, reflecting an economy dominated by profit-seeking firms. This resembles recent evidence recalling increasing markups in some specific sectors of the economy (Davis, 2024) and highlights the importance of institutional constraints limiting predatory pricing behavior, which should act directly via strict control over price formation, specifically in profit-led inflation regimes (Stiglitz and Regmi, 2023; Weber and Wasner, 2023).

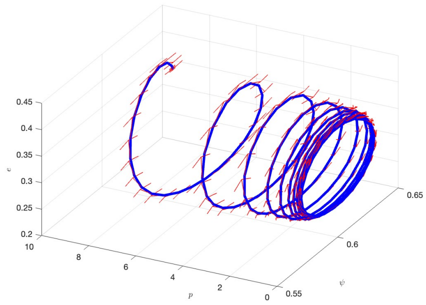
Figure 12: Absence of competitive anchor



(a) Markup Dynamics under $\kappa = 0$



(b) Price Dynamics under $\kappa = 0$



(c) Phase Portrait: Profit–Price Spiral Induced by $\kappa = 0$

Notes: No competitive anchor ($\kappa = 0$) on markup, price adjustments, and unbounded profit–price spiral.

5.2.5 Asymmetric adjustment: simulation evidence

In what follows, we illustrate this asymmetry with two representative scenarios, parameterized by the markup elasticities (ε, χ) and supply disturbance δ.

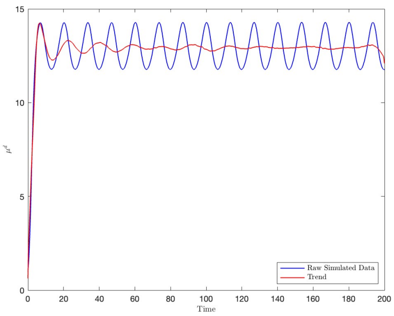
Scenario	**Key dynamics**
High Sensitivity $(\varepsilon > 0, \chi > 0, \delta > 0)$	Strong markup response: profit shocks quickly amplify prices and profits.
Low Sensitivity $(\varepsilon < 0, \chi < 0, \delta \approx 0)$	Weak markup response: even adverse profit shifts hardly lower prices; markups stick.

Table 6: Key features of representative scenarios illustrating profit-led distributive– inflation dynamics.

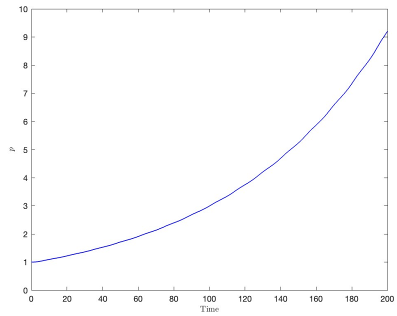
Figure 13 shows high and low sensitivity regimes. With high sensitivity, modest shocks rapidly ignite persistent spirals with escalating cycles. With low sensitivity, markup expectations adjust sluggishly and inflation softens but remains positive, reflecting downward price stickiness. This asymmetry stems from firms' structural advantage: they set prices directly and resist wage catch-up through incomplete pass-through. Hence, prices rise quickly when profit motives surge but descend only slowly when these motives weaken.

Our result supports recent empirical and theoretical findings on *state-dependent price response* and asymmetries in inflation dynamics (Ascari and Haber, 2022; Bobeica et al., 2025; Costain et al., 2022; De Santis and Tornese, 2025), underscoring that distributive power, not only nominal rigidities or expectations, is a fundamental driver of asymmetric inflation effects and macroeconomic dynamics.

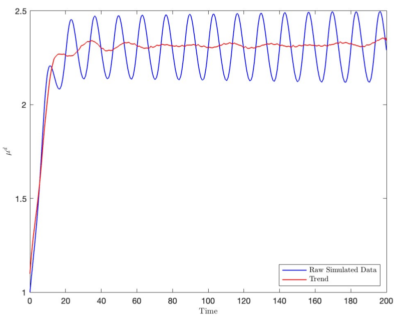
Figure 13: Asymmetric Price Adjustment under Contrasting Markup-Sensitivity Regimes



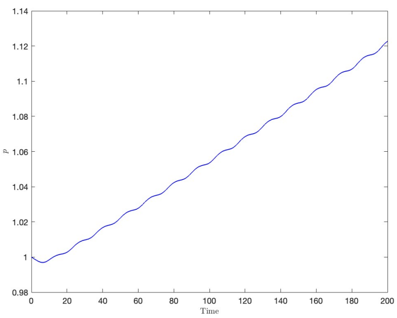
(a) Markup: high sensitivity



(b) Prices: high sensitivity



(c) Markup: low sensitivity



(d) Prices: low sensitivity

Notes: Top row: strong profit-seeking channels ($\varepsilon = 0.6$, $\chi = 0.6$, $\delta = 0.6$) generate rapid markup and price increases. Bottom row: weak or reversed channels ($\varepsilon = -0.2$, $\chi = -0.2$, $\delta \approx 0$) produce sluggish markup adjustment and sticky prices—inflation persists, though milder. The asymmetry highlights that price increases are easy but reversals are partial and slow.

5.3 Scenario S3: wage-led configuration

A wage-led distributive–inflation configuration arises when workers' bargaining power dominates, pushing nominal wages ahead of initial price increases due to a strong wage indexation. The key drivers are the degree of wage indexation (η), and the responsiveness of wages to employment conditions (ρ). When workers can over-index wages to price increases ($\eta > 1$) and labor markets are inelastic to cycle fluctuations (low ρ), real wages remain protected or even increase. This prevents erosion of labor share ψ and puts continuous upward pressure on unit labor costs. Each price increase feeds back into higher nominal wage demands. If wage claims persistently outpace productivity growth, firms must keep adjusting prices upward to defend profit margins, thereby sustaining a self-reinforcing wage–price spiral.

In this scenario, each nominal wage increase is perceived by firms as a threat to profitability. Rather than passively absorbing the cost, they react by pushing the desired markup μ^d above the cost-based margin μ^a, opening a positive aspirational gap $g = \mu^d - \mu^a$. This gap embodies the firm's defensive response to protect margins against perceived escalating wage threats. Through the price-adjustment rule, this gap directly accelerates inflation.

This configuration reveals a mirror asymmetry to the profit-led case: whereas firms exploit markup to appropriate income shares in profit-led regimes ($\eta < 1$), here workers leverage strong indexation ($\eta > 1$) and labor market rigidity to sustain wage-led inflation, forcing firms into a defensive pricing loop. Real wages stay constant or rise, so ψ remains stable or grows, creating a cycle where firms continually fear margin erosion, raising prices to defend profitability, and workers continually chase these prices, reinforcing inflation. The asymmetry between firms and workers reactions reflects an empirical reality: historical trends show a structural decline in worker bargaining power over the past 40 years, especially for the US economy (Stansbury and Summers, 2020). In scenarios with strong unions or coordinated wage-setting (as assumed under $\eta > 1$), workers can regain initiative and force firms into defensive responses.

***Proposition* 3** (Necessary Conditions for a Wage–Price Spiral)**.** *Suppose $\varepsilon > 0$, $\chi > 0$, $\delta > 0$ (high firms' markup responsiveness) and $\eta > 1$ (over-wage indexation) hold. Then a wage-led distributive–inflation configuration emerges when:*

$$\hat{\psi} \geq 0 \quad \textit{and} \quad g = \mu^d - \mu^a > 0 \quad \textit{with} \quad \hat{p} > 0.$$

Intuitively, workers' indexation and wage bargaining strength push the labor share up persistently, even as firms defend markups. The result is a positive feedback: wages chase prices, firms react defensively, and inflation becomes self-reinforcing.

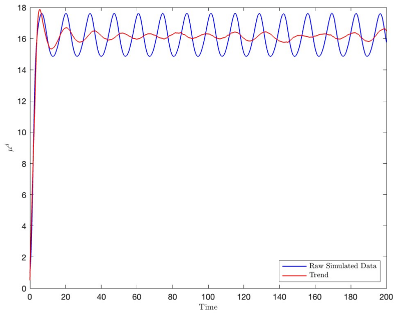
5.3.1 Channel 1: Over-Indexation

. When workers can over-index wages to prices, nominal wages immediately catch up and even outpace price inflation. Real wages remain protected or increase, preventing labor share erosion and sustaining upward pressure on unit labor costs. Firms perceive this as a wage threat and respond defensively by raising desired markups. Each price hike triggers wage demands again, amplifying the spiral. Figure 14a and 14b illustrate this mechanism: strong wage indexation ($\eta > 1$) generates rapid runaway wage–price sequences and persistent outward trajectories.

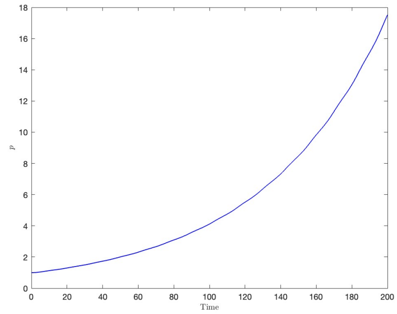
5.3.2 Channel 2: Labor Market Rigidity

. When wages do not adjust flexibly to slack employment (low ρ), a persistent wage floor emerges. Firms cannot suppress labor costs during downturns; any attempt to protect margins requires pushing prices higher. Real wages stay protected, so labor share remains stable or grows. This forces firms into continuous defensive responses: each wage claim generates a markup increase, which accelerates inflation, which triggers wage demands again. Figures 14c and 14d show this mechanism: inelastic labor markets produce sticky wages and defensive markup responses, sustaining wage–price spirals through institutional rigidity rather than high indexation alone.

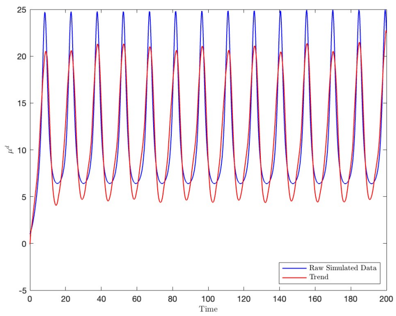
Figure 14: Wage-led regime



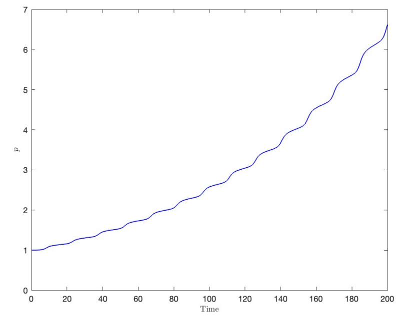
(a) Markup: strong indexation ($\eta > 1$)



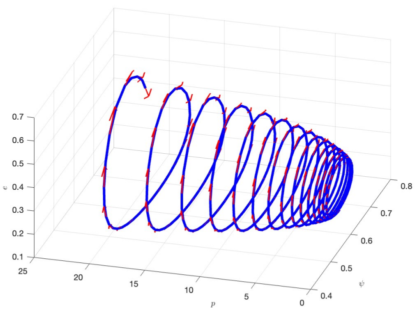
(b) Prices: strong indexation ($\eta > 1$)



(c) Markup: rigid labor market (ρ low)



(d) Prices: rigid labor market (ρ low)



(e) Wage-Price Spiral

Notes: Top row: strong wage indexation ($\eta > 1$) generates rapid wage–price escalation. Middle row: rigid labor market (ρ low) produces sticky wages and defensive markup responses. Bottom: phase portrait reveals outward trajectories indicating instability.

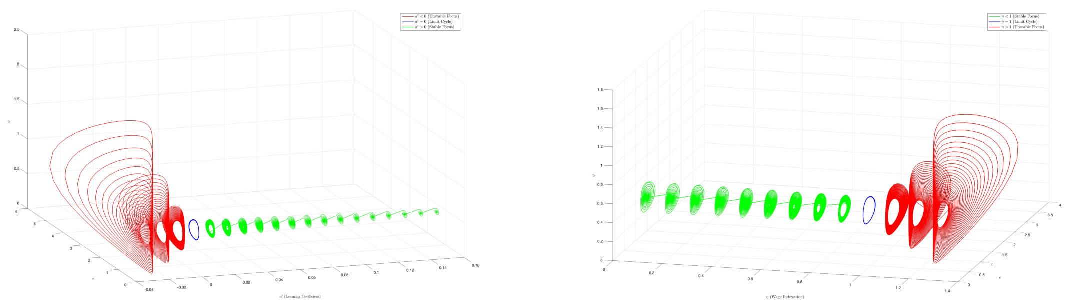
In both cases, firms respond defensively to perceived wage threats by raising markups and prices, sustaining wage–price spirals. The phase portrait (Figure 14e) reveals outward trajectories indicating instability, contrasting sharply with the stable limit cycle of S1. This analysis reveals a key institutional insight: wage-led spirals depend not only on indexation rules but on the institutional environment shaping wage-setting and firms' perceived threats to margins. Comparing S2 and S3 shows how the same firm behavior (raising markups to defend profits) can either amplify profit income share (profit-led, when workers lack indexation) or amplify labor income share (wage-led, when workers have strong indexation and labor market rigidity). This institutional dependence aligns with the historical regime transitions documented in Section 3.

5.4 Phase transition and regime shifts

Learning Regimes (α'). The parameter α' captures the economy's capacity for endogenous productivity growth via learning dynamics. As α' rises from zero, each upswing in employment and labor share feeds back into faster productivity improvements, easing distributive tensions. In the Jacobian of the linearized system, larger α' raises the trace, pushing eigenvalue real parts from non-negative to negative. When α' crosses its critical threshold α'_H, the system undergoes a Hopf bifurcation: the equilibrium switches from sustaining persistent cycles to becoming a stable focus. Oscillations still emerge but their amplitude shrinks, driving the economy toward steady state rather than allowing conflict-driven cycles to persist or explode.

Wage Indexation (η). The indexation coefficient η governs how nominal wages adjust to prices. When $\eta < 1$, firms' price increases outpace wage adjustments, eroding labor share ψ and fueling profit-led spirals. As η approaches unity, wage catch-up mechanisms stabilize ψ and dampen markup. At the critical value η_H, the system crosses a Hopf bifurcation: below η_H, the equilibrium is a stable focus with damped fluctuations; above it, a conservative limit cycle emerges, reflecting persistent wage–price oscillations typical of Goodwinian dynamics. When η exceeds 1, over-indexation destabilizes: each price increase triggers oversized wage claims, firms counter with further price hikes, and the equilibrium becomes unstable, producing runaway wage–price spirals.

Figure 15: Local bifurcation patterns and regime shifts



(a) Learning Coefficient (b) Wage Indexation to Inflation

Notes: This figure shows the Hopf bifurcation dynamics. Panel (a) shows the stabilization via learning (α'), while Panel (b) the destabilization via over-indexation (η). The figure confirms numerically the critical thresholds (see Appendix E.2 for the full Hopf bifurcation analysis).

These bifurcation parameters reveal the critical policy levers determining macroeconomic stability. Policies fostering learning diffusion and aligning wage indexation with inflation are essential to prevent distributive tensions from triggering persistent inflationary spirals. The framework thus shows how institutional and technological factors jointly determine whether the economy converges to stable equilibrium or drifts into self-reinforcing inflation-distribution regimes, directly connecting to the historical transitions documented in Section 3.

6 Conclusions

This study has investigated the relationship between income distribution and inflation by analyzing how different phases of distributive conflict shape *distributive–inflationary configurations*. Moving beyond conventional aggregate demand–supply perspectives, we have highlighted the central role of structural asymmetries in wage and price setting, showing how the balance of power between labor and capital critically determines whether inflationary dynamics become profit-led or wage-led.

Empirically, we provided new spectral evidence on income distribution and prices in the US from 1960:Q1 to 2023:Q4. Through frequency and time–frequency decomposition, we documented alternating regimes: periods in which firms' price-setting power dominated as the Post-Great Recession (profit–price spirals) and the Great Inflation, in which strong labor bargaining fueled wage–price spirals. These patterns highlight how shifts in distributive conflict and institutional context modulate inflation's behavior. Critically, they show that disentangling the correct sources of inflation is essential for accurate policy response (Stiglitz and Regmi, 2023). If inflation stems from profit-led spirals rather than wage-driven demand, monetary tightening alone may be insufficient and could amplify distributional inequalities.

To interpret these empirical regularities, we developed a stylized nonlinear model capturing the conflicting co-evolution of employment, labor share, and markup ambitions. The model demonstrates how key parameter settings– markup elasticity to profits, sensitivity to labor market tightness, wage indexation, and supply disruptions– push the economy through distinct phases: conservative limit cycles, profit-led spirals, or wage-led spirals. By formalizing necessary conditions for these spirals, we show that structural asymmetries in bargaining power and wage-price pass-through are critical for sustaining inflationary drift.

A key finding is that profit-led spirals emerge more easily and persist longer than wage-led spirals: firms can rapidly pass on shocks and protect markups, while wage-led spirals require exceptionally strong indexation and tight labor conditions to overpower firms' pricing leverage. This asymmetry helps reconcile recent debates on inflation's distributive origins, especially during supply chain stress or periods of weakened labor institutions. If labor markets are weak, contrary to Domash and Summers (2022), then the source of inflation cannot be attributed solely to excessive wage demands. Rather, if firms progressively exert pricing power via disproportionate markups (Caffarra et al., 2022), policy must counterbalance their market advantage rather than focus solely on wage restraint.

From a policy perspective, these findings underscore that managing inflation cannot rely only on demand management or monetary tightening (Mumtaz and Theophilopoulou, 2017; Lauper and Mangiante, 2024), especially when structural asymmetries empower firms to pass costs to prices more easily than workers can defend real wages. Addressing persistent profit-led spirals may require regulatory policy targeting high-market-power sectors and institutional frameworks that protect wage bargaining while avoiding excessive cost–push feedbacks (Weber and Wasner, 2023). Preventing wage–price spirals requires coordination between wage-setting institutions and productivity growth—currently limited by the concentration of productivity gains in capital incomes rather than worker compensation (Domash and Summers, 2022; Stansbury and Summers, 2020). A balanced distributive configuration emerges as the precondition for stable inflation dynamics.

Our analysis revives the importance of inflation as a mechanism constraining the bargaining power of both competing groups. In the current phase of structural weakness of worker bargaining power, profit-led inflation has further deteriorated the already eroded labor share, given that real wages growth have not kept pace with prices growth. This dynamic underscores how income distribution asymmetries can become self-reinforcing: weakened workers cannot fully protect real compensation, while strengthened firms exploit pricing power, perpetuating income concentration.

We have shown that a parsimonious nonlinear model can analytically capture the phases and regimes of macroeconomic dynamics, including endogenous inflation formation as the result of distributive conflict. The nonlinearity of our model allows us to account for alternative growth regimes of capitalist economies (Dosi et al., 2024a), linking macroeconomic dynamics to institutional settings (Dosi et al., 2015). Divorcing macroeconomic analysis from its institutional context risks losing a critical lens for understanding the system's structural evolution.

The study has limitations suggesting paths for further research. On the empirical side, aggregate data constrain our ability to identify markup dynamics at the micro level. Future work could exploit firm-level datasets to map sector-specific pass-through effects. On the modeling side, homogeneous representation of workers and firms is a key simplification; embedding agent heterogeneity and network interactions could illuminate how localized bargaining and supply chain asymmetries amplify distributive–inflation configurations.

In conclusion, this paper has provided both spectral evidence and a dynamic model showing how income distribution and inflation are deeply intertwined through conflict dynamics and structural asymmetries. By mapping the conditions under which wage-led or profit-led spirals emerge, we offer a coherent framework for interpreting past episodes and informing policy aimed at managing distributive tensions to safeguard price stability.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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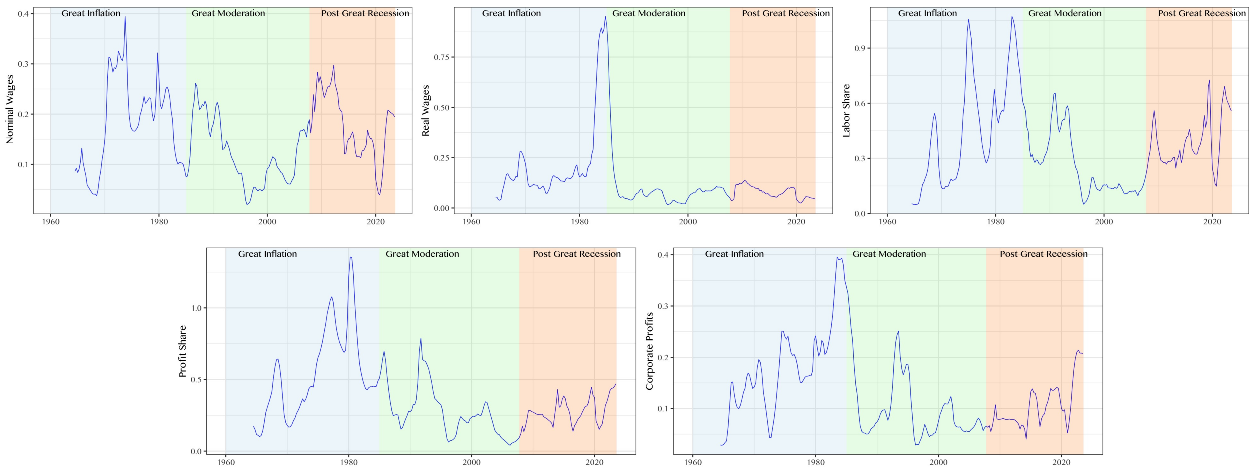
A Data summary

Variable	Description	Source	Sample
	Aggregate Variables		
P_t^H	U.S. CPI: All Items (Headline CPI)	FRED (CPIAUCSL)	1960Q1–2023Q4
P_t^c	U.S. CPI: All Items Less Food and Energy (Core CPI)	FRED (CPILFESL)	1960Q1–2023Q4
PS_t	Profit Share	(:= Corporate Profits After Tax/GVA)	1960Q1-2023Q4
CP_t	Corporate Profits After Tax (without IVA and CCAdj)	FRED (CP)	1960Q1-2023Q4
GVA_t	Gross value added of nonfinancial corporate business	FRED (A455RC1Q027SBEA)	1960Q1-2023Q4
LS_t	Nonfarm Business Sector: Labor Share for All Workers	BLS (PRS85006173)	1960Q1-2023Q4
NW_t	Nominal Wages (Hourly Compensation for All Workers, Nonfarm Business Sector)	FRED (COMPNFB)	1960Q1-2023Q4
RW_t	Real Wages (Real Hourly Compensation for All Workers, Nonfarm Business Sector)	FRED (COMPRNFB)	1960Q1-2023Q4
	Robustness Check		

Table 7: Summary of variables used in the analysis, including their definitions, sources, and sample periods.

B Time-varying regressions

Figure 16: Time-varying parameters regression w.r.t. headline inflation rate, with one-standard-deviation confidence interval



Sources: U.S. Bureau of Labor Statistics and U.S. Bureau of Economic Analysis, via FRED.

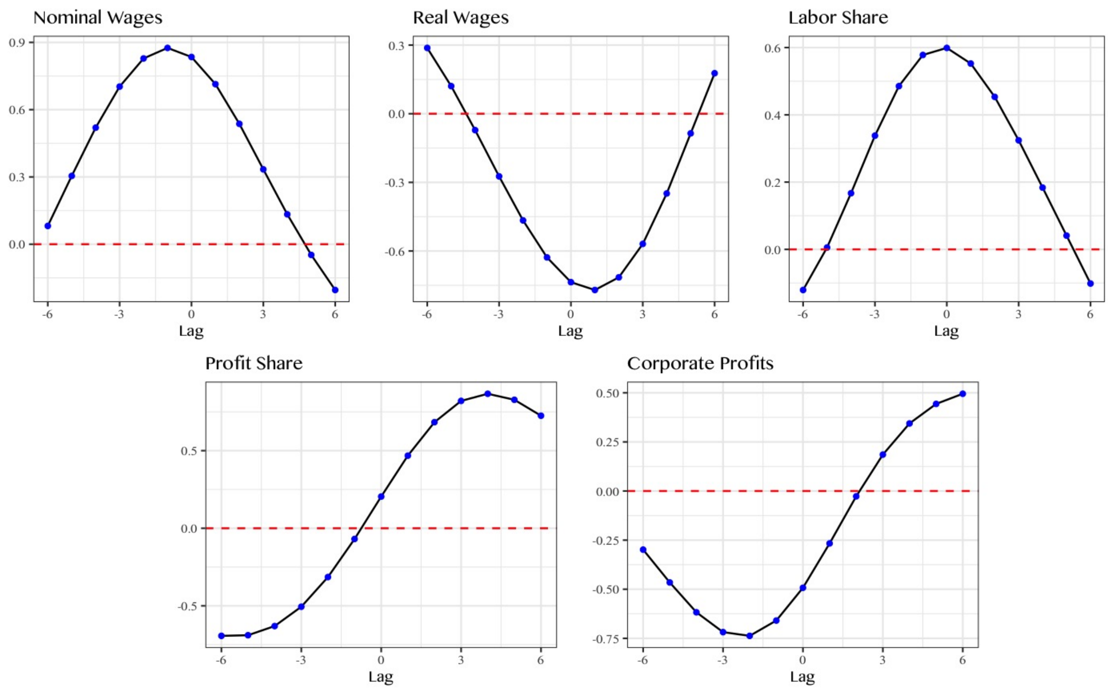
C Cyclical behavior in the frequency domain

Given the heightened volatility observed in distributive variables during the 1960s and 1970s (see Figure 16), we now investigate cyclical comovements between inflation and income distribution. We ask whether the relative influence of wage- and profit-related channels on inflation has shifted across historical regimes.

To isolate cyclical components at business cycle frequencies, all series are filtered using the Christiano-Fitzgerald band-pass filter (Christiano and Fitzgerald, 2003), which preserves cyclical variations while removing trend components. We then examine comovements between headline inflation and distributive variables (nominal wages, real wages, labor share, profit share, and corporate profits), separately for each of the three macroeconomic periods defined earlier (Great Inflation, Great Moderation, post-Great Recession). This temporal segmentation captures structural changes in bargaining power and institutional settings that can shape income distribution.

Great Inflation

Figure 17: Cross-correlation in the Great Inflation: 1965:Q1–1984:Q4



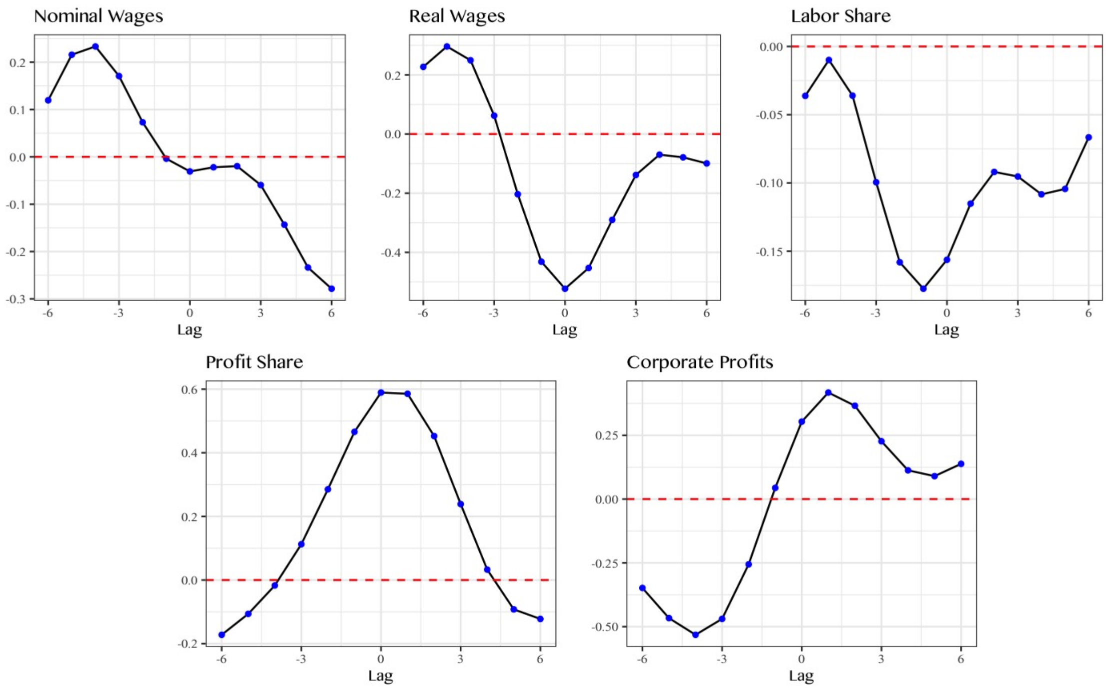
Sources: U.S. Bureau of Labor Statistics and U.S. Bureau of Economic Analysis, via FRED.

During the Great Inflation (1965-1984), nominal wages are procyclical, leading inflation by one quarter. These patterns reflect the considerable bargaining power of workers at that time, allowing them to secure wage gains that fed directly into price dynamics, which in turn trigger demands for wage increases and cost of living adjustments. This represents a classic wage–price spiral episode (Alvarez et al., 2024). In fact, real wages display a V-shaped pattern, showing a countercylical behavior. This reflects the fact that, although nominal wages rose rapidly, inflation initially eroded workers' purchasing power before real income recovered—a hallmark of wage-price spiral dynamics in which nominal adjustments lag behind price pressures (Blanchard, 1986). Nevertheless, the labor share displays a strongly procyclical and contemporaneous relationship with inflation.

In contrast, corporate profits are countercyclical and lead inflation by two quarters, indicating erosion of firm profitability amid rising wage demands. Profit share are procyclical but lag inflation by four quarters, suggesting that firms sought to restore margins following wage claims. Overall, the observed timing structure points to a distributive conflict dynamics, in which wage gains precede inflationary adjustments, while firms respond with delayed price increases.

Great Moderation

Figure 18: Cross-correlation for Great Moderation: 1985:Q1–2007:Q3



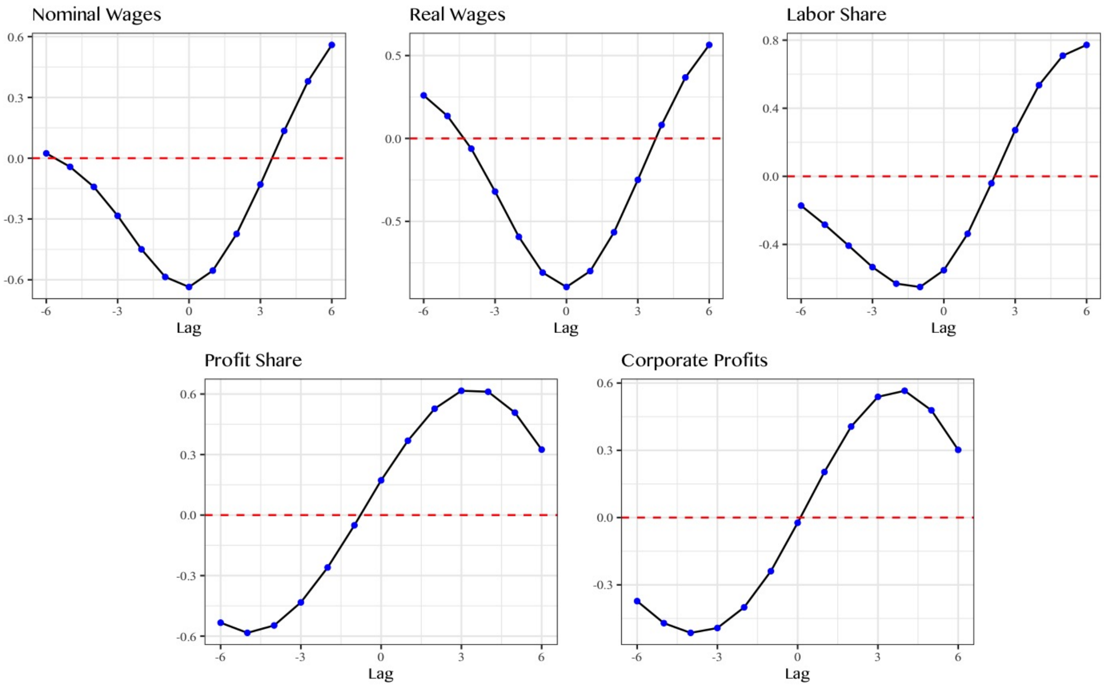
Sources: U.S. Bureau of Labor Statistics and U.S. Bureau of Economic Analysis, via FRED.

The Great Moderation (1985-2007) marks a structural shift in U.S. macroeconomic conditions and income distribution. Nominal wages are countercyclical, with a lagging behavior w.r.t inflation. Moreover, workers' purchasing power gains were eroded by subsequent price increases. This reflects the limited capacity of workers to defend real income against price movements pressures during this period. Hence, the labor share becomes mildly countercyclical, leading inflation by six quarters. Nominal wages also turn countercyclical, but lag inflation by the same interval. All these patterns are consistent with a weakening of worker bargaining power over the period (Mishel et al., 2012; Sabelhaus and Song, 2010).

Corporate profits remain procyclical but continue to lag inflation by four quarters. Profit share, by contrast, are procyclical and contemporaneous with inflation, suggesting that firms were able to sustain profitability without aggressive pricing strategies. The income distribution direction appears turned into favoring firms rather than workers, with attenuated feedback between wage dynamics and inflation.

Post–Great Recession

Figure 19: Cross-correlation for Post–Great Recession: 2011:Q1–2023:Q4



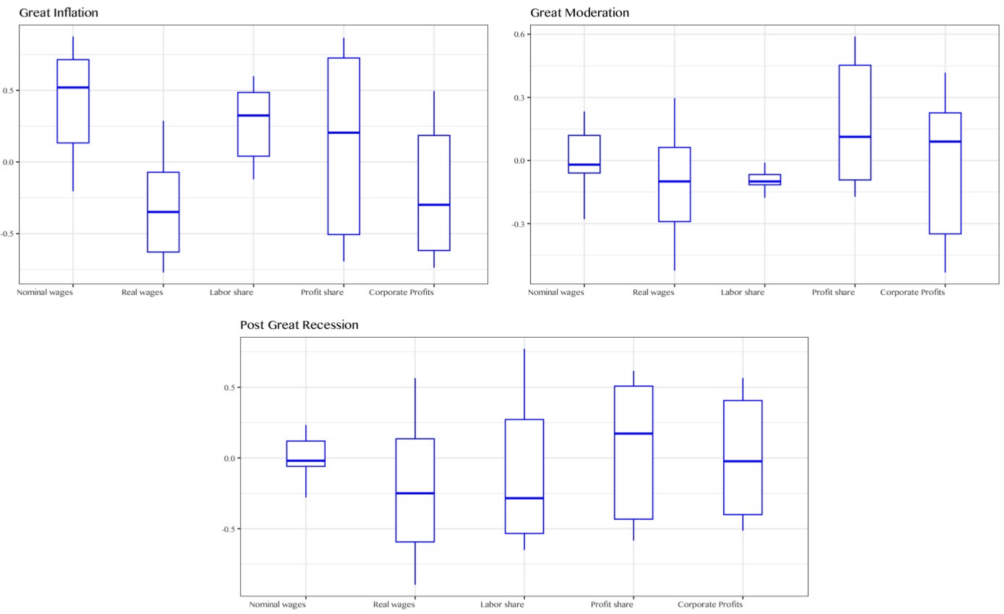
Sources: U.S. Bureau of Labor Statistics and U.S. Bureau of Economic Analysis, via FRED.

The post–Great Recession period (2011-2023) consolidates—and in some respects amplifies—the dynamics observed during the Great Moderation. On the wage side, nominal wages are countercyclical and contemporaneous with inflation, as well as real wages. This pattern reflects the persistent squeeze on workers' purchasing power during recent inflationary episodes—particularly post-2020—when nominal wages failed to keep pace with rapidly rising prices (Adrjan and Lydon, 2022). Hence, labor share becomes strongly countercyclical, leading inflation by one quarter.

On the profit side, profit share and corporate profits are procyclical, both lagging inflation by four quarters. This suggests that firms have increased their capacity to defend—or even expand—their share during inflationary episodes, especially in an environment of subdued nominal wage growth.

The current historical period exhibits a distinctive pattern in nominal variables and income distribution. Profits and wages show synchronized dynamics in their relationship to prices, but this synchronization systematically favors profit shares over wage shares. As a result, nominal wage growth fails to translate into real gains, consistently lagging behind cost-of-living adjustments. These patterns can be compatible with the erosion of worker bargaining power, reflecting both the limited responsiveness of wages to price pressures (Dosi et al., 2018) and viceversa (Peneva and Rudd, 2017).

Figure 20: Distributions of cross-correlation between distributive variables and headline inflation rate



Sources: U.S. Bureau of Labor Statistics and U.S. Bureau of Economic Analysis, via FRED.

Figure 20 summarizes the distribution of cross-correlations between inflation and key distributive variables across historical periods. A clear structural break is evident: the strong and volatile wage–inflation linkages that characterized the Great Inflation largely vanish during the Great Moderation and remain muted in the post-2008 period. By contrast, profit margins display increasing amplitude and variance in their correlation with inflation over time.

These findings point to a broader transition from a wage-led to a profit-led inflation regime. Although both the Great Moderation and post–Great Recession periods exhibit subdued wage–price dynamics, they differ fundamentally in profit behavior: while the Great Moderation saw constrained markups amid competitive pressures, the post-Great Recession era has witnessed rising market and pricing power, enabling firms to capture a larger share of income during inflationary episodes. In the next section, we investigate this evolution more closely using a time–frequency decomposition that captures the joint temporal and spectral characteristics of inflation–distribution linkages.

		Cross correlations with headline inflation rate: $\rho(x_t, y_{t+k})$												
Variable	**St. dev.**	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6
Nominal Wages	0.36	0.082	0.305	0.520	0.703	0.828	0.875	0.835	0.714	0.537	0.334	0.133	-0.048	-0.204
Real Wages	0.37	0.288	0.121	-0.072	-0.274	-0.466	-0.628	-0.736	-0.771	-0.715	-0.569	-0.349	-0.086	0.177
Labor Share	0.26	-0.121	0.006	0.167	0.338	0.485	0.578	0.599	0.552	0.453	0.324	0.184	0.041	-0.102
Profit Share	0.64	-0.694	-0.690	-0.630	-0.506	-0.315	-0.069	0.204	0.468	0.684	0.821	0.867	0.828	0.725
Corporate Profits	0.45	-0.298	-0.466	-0.617	-0.718	-0.737	-0.659	-0.493	-0.267	-0.027	0.185	0.344	0.443	0.495

Table 8: Cross-correlations between distributive variables and headline inflation during the Great Inflation (1965:Q1–1984:Q4)

	Cross correlations with headline inflation rate: $\rho(x_t, y_{t+k})$													
Variable	**St. dev.**	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6
Nominal Wages	0.16	0.120	0.216	0.233	0.171	0.073	-0.004	-0.031	-0.022	-0.020	-0.060	-0.143	-0.234	-0.279
Real Wages	0.27	0.227	0.296	0.249	0.062	-0.204	-0.432	-0.523	-0.453	-0.290	-0.139	-0.070	-0.079	-0.099
Labor Share	0.05	-0.036	-0.010	-0.036	-0.099	-0.158	-0.177	-0.156	-0.115	-0.092	-0.095	-0.108	-0.104	-0.067
Profit Share	0.28	-0.172	-0.106	-0.017	0.113	0.285	0.466	0.589	0.585	0.453	0.239	0.033	-0.092	-0.122
Corporate Profits	0.34	-0.348	-0.467	-0.532	-0.469	-0.256	0.044	0.304	0.418	0.366	0.227	0.113	0.090	0.138

Table 9: Cross-correlations between distributive variables and headline inflation during the Great Moderation (1985:Q1–2007:Q3)

	Cross correlations with headline inflation rate: $\rho(x_t, y_{t+k})$													
Variable	**St. dev.**	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6
Nominal Wages	0.37	0.024	-0.043	-0.141	-0.284	-0.450	-0.586	-0.636	-0.555	-0.374	-0.130	0.135	0.380	0.559
Real Wages	0.49	0.260	0.135	-0.062	-0.320	-0.593	-0.809	-0.896	-0.800	-0.566	-0.250	0.081	0.368	0.564
Labor Share	0.51	-0.172	-0.284	-0.408	-0.533	-0.630	-0.650	-0.551	-0.338	-0.041	0.272	0.536	0.709	0.772
Profit Share	0.47	-0.533	-0.584	-0.547	-0.433	-0.260	-0.051	0.172	0.369	0.527	0.616	0.611	0.508	0.325
Corporate Profits	0.43	-0.373	-0.471	-0.514	-0.493	-0.400	-0.239	-0.023	0.203	0.406	0.539	0.566	0.478	0.302

Table 10: Cross-correlations between distributive variables and headline inflation during the Post Great Recession (2011:Q1–2023:Q4)

D Cyclical behavior in time-frequency domain

D.1 Continuos Wavelet Transformations

We move beyond traditional filtering techniques such as the CF band-pass filter (Baxter and King, 1999), which can generate spurious periodicity or artificial comovements that lack foundations in the underlying data (Hamilton, 2018; Harvey and Jaeger, 1993). Fourier-based spectral methods offer an alternative by isolating dominant frequency components, but they suffer from a critical limitation: they abstract from time. Consequently, they are unable to detect transient relationships or regime shifts in comovement structures, which is a significant drawback for macroeconomic applications characterized by structural breaks (Gençay et al., 2001; Percival and Walden, 2000).

Hence, we adopt a continuous wavelet transform (CWT) framework. Wavelet analysis provides a two-dimensional representation of a time series across both time and frequency, allowing for the detection of evolving cycles and phase shifts. This makes wavelet analysis particularly well suited for studying macroeconomic dynamics characterized by structural breaks and shifting lead–lag relations, exactly what we observe in the evolution from wage-led to profit-led regimes—as well as nonstationary behavior. This technique employs a series of wavelet functions that are elongated and translated to elucidate the temporal and spectral characteristics of time series data. After shifting all of these wavelet functions with different amplitudes along the entire time scale, we are able to associate components with specific time horizons with the exact frequencies at which the signal occurs.

Let us consider a function $\psi(\cdot) \in L^2(\mathbb{R})$ (i.e., a Hilbert space of square integrable functions) satisfying the two following properties:

$$\int_{-\infty}^{+\infty} \psi(\cdot) = 0$$
$$\int_{-\infty}^{+\infty} \psi(\cdot)^2 = 1$$

The two above conditions tell us that any excursion above zero must be compensated by excursion below, such that $\psi(\cdot)$ resembles a *small wave*, i..e, a wavelet. Moreover, since wavelet functions belong to Hilbert space, they must respect the *admissibility condition*:

$$\int_{-\infty}^{+\infty} |\psi(\cdot)|^2 \leq \infty$$

Since the space $L^2(\mathbb{R})$ is known as the space of finite energy functions, then the squared norm of $\psi(x)$ is referred to as the *energy* of time series x.

Given a generic *mother* wavelet function ψ, a set of $\psi_{\tau,s}$ of wavelet *daughters* is obtained by scaling and shifting the original mother:

$$\psi_{\tau,s}(t) = \frac{1}{\sqrt{s}}\psi\left(\frac{t-\tau}{s}\right), \quad s \in \mathbb{R}_{\neq 0}, \quad \tau \in \mathbb{R} \tag{9}$$

where τ is the time position (translation parameter), s is the scale (dilation parameter)– which is related with the frequency– and $1/\sqrt{s}$ is a normalization factor to ensure that wavelet transforms are comparable across scales and time series.

Given a time series $x(t) \in L^2(\mathbb{R})$, its CWT (i.e., Continuos Wavelet Transformation) with respect to the wavelet ψ is a function of two variables: time (τ) and frequency (s).

$$W_x(\tau, s) = \frac{1}{\sqrt{s}} \int_{-\infty}^{\infty} x_t \psi^* \left(\frac{t-\tau}{s}\right) dt$$

where $*$ is the convolution operator between the signal $x(t)$ with and the family of stretched and translated child wavelets defined in (9). The wavelet transform, which maps the original series into a function of τ and s, provides information on both time and frequency simultaneously. The primary distinctions between the wavelet transform and the Fourier transform are that, in the Fourier case, there is no time localization parameter and the functions employed are cosine and sine, rather than a wavelet function.

In our work, we employ a specific mother wavelet: the Morlet wavelet function, depicted in the figure (21). The Morlet wavelets are a one-parameter family of functions (Goupillaud et al., 1984), given by:

$$\psi_{\omega_0}(t) = \pi^{1/4}\left(e^{i\omega_0 t} - e^{-\omega_0^2/2}\right) e^{-t^2/2}$$

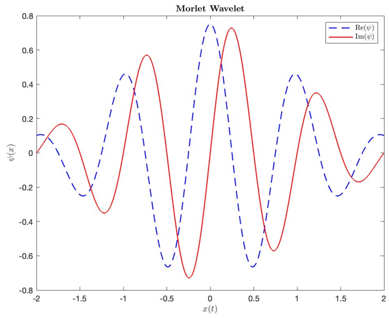


Figure 21: Morlet wavelet function with $\omega_0 = 6$

The objective of the analysis presented in section (3) was to identify and quantify the relationship between two time series, one of which was price dynamics. In this section, we present the formal descriptions of the calculations and representations that we have previously discussed. Our focus is on the notion of energy and local covariance.

The cross-wavelet transform of two time series, $x(t)$ and $y(t)$ is defined as:

$$W_{x,y}(\tau, s) = W_x(\tau, s) W_y^*(\tau, s) \tag{10}$$

By considering that when $x = y$ is equal to $W_x x = |W_x|^2$ (i.e, wavelet power spectra), then the *cross wavelet power spectra* is defined as:

$$|W_{x,y}| = |W_x(\tau, s) W_y^*(\tau, s)| \tag{11}$$

While the wavelet power spectrum can be interpreted as a representation of the local variance, the cross-wavelet power of two time series provides insight into their local covariance at each time and frequency. The computation of the expression (11) for the distributive variables, represented by figure (5b), is achieved by scaling the two signals in order to obtain a bias-corrected factor, following the normalization method proposed by Veleda et al. (2012).

Moreover, given two time series $x(t)$ and $y(t)$, we can define the wavelet coherency, depicted in figure (4), $R_{x,y}$, by

$$R_{xy} = \frac{|S(W_{xy})|}{\sqrt{[S(|W_x|^2) S(|W_y|^2)]}}, \quad \text{where} \quad R_{x,y} \in [0, 1] \tag{12}$$

Finally, since wavelet coherence captures only the strength of comovement (bounded between 0 and 1), it does not distinguish whether the relationship is positive, negative, or subject to temporal asymmetries. To address this, we compute the phase difference ϕ_{xy}:

$$\phi_{xy} = \text{Arctan}\left(\frac{\Im(S(W_{xy}))}{\Re(S(W_{xy}))}\right) \tag{13}$$

This measure reveals the relative timing of oscillations between two variables, indicating whether they move in phase, in opposition, or with a delay. In our visualizations (Figure **??**), this directional information is encoded by the orientation of arrows: rightward arrows imply in-phase comovement, leftward imply anti-phase, and upward/downward arrows indicate lead–lag structures.

D.2 Nonparametric test

While the Kruskal–Wallis test (Table 2) confirms the presence of statistically significant differences among the medians of the groups, it does not indicate which specific variables differ from one another. To address this limitation, we perform pairwise Mann–Whitney U tests to assess the distributional divergence between individual pairs of variables.

This test is particularly appropriate for our analysis– as it is nonparametric and robust to non-normality– making it suitable for identifying distributional asymmetries across key wage- and profit-related indicators.

	Corporate Profits	**Nominal Wages**	**Profit Share**	**Real Wages**	**Labor Share**
Corporate Profits	—	0.043*	0.419	0.564	0.0079**
Nominal Wages		—	0.0079**	0.014*	0.564
Profit Share			—	0.136	0.00071***
Real Wages				—	0.0041**
Labor Share					—

Table 11: P-values from pairwise Mann–Whitney U tests comparing average cross-power distributions. Significance levels: *$p<0.1$; **$p<0.05$; ***$p<0.01$.

The results show statistically significant differences– at conventional levels– between profit-related variables (especially profit share) and most wage-related indicators. This supports the view that the inflation–distribution coevolution differs structurally between the wage and profit sides, reinforcing the narrative of regime transitions highlighted in the main text.

D.3 Robustness checks: Discrete Wavelet Regression by Frequency Band

As a robustness check for the spectral analysis in the time–frequency domain, we implement a discrete wavelet decomposition of price and distributive dynamics via multiresolution analysis. Specifically, we apply the *Discrete Wavelet Transform* (DWT) to obtain an additive decomposition of each time series:

$$x_t = s_{J,t} + \sum_{j=1}^{J} d_{j,t}, \quad t = 0, \dots, N-1 \tag{14}$$

Each observation x_t is decomposed into:

- *Detail coefficients* $d_{j,t}$, which capture fluctuations at scale $\lambda_j = 2^{j-1}$, corresponding to periodicities in the $[2^j, 2^{j+1}]$ range;
- A *smooth component* $s_{J,t}$, reflecting long-run dynamics beyond 2^{j+1} periods.

To preserve temporal alignment with the original series and avoid information loss from downsampling, we adopt the Maximal Overlap Discrete Wavelet Transform (MODWT) (Percival and Walden, 2000). This approach maintains one coefficient per observation, enabling direct comparison across time periods. To enhance frequency discrimination and mitigate boundary effects, we choose a wavelet filter that closely approximates the ideal bandpass filter while ensuring adequate time localization.

To isolate short-, medium-, and long-run dynamics in the time series $\{x_t\}$, we define the following wavelet-based frequency bands:

$$\begin{aligned} \text{Short Run:} \quad & D_1 = \text{2–4 years}, \quad D_2 = \text{4–8 years} \\ \text{Medium Run:} \quad & D_3 = \text{8–32 years} \\ \text{Long Run:} \quad & S_3 = \text{more than 32 years} \end{aligned}$$

For each scale $j \in \{D_1, D_2, D_3, S_3\}$, we estimate the following regression:

$$y_{j,t} = \alpha_j + \beta_x x_{j,t} + \epsilon_t \tag{15}$$

Here, $y_{j,t}$ denotes the scale-specific component of the inflation rate, while $x_{j,t}$ represents the corresponding frequency band of each distributive variable—namely, profit share, labor share, nominal wages, real wages, and corporate profits. Each regression captures the contribution of distributive dynamics to inflation at different cyclical horizons.

We provide the wavelet regression results across the three macroeconomic historical periods for the US economy, which serve as the discrete-time counterpart to the continuous wavelet coherence patterns illustrated in Figure 4. This analysis evaluates both the strength and direction of the relationship between distributive variables and inflation across frequency bands, thereby shedding light on the temporal scale at which each variable exerts its greatest influence. We find different phases of conflict that are in tune with different price patterns. These patterns are referred to as distributive-inflation configurations.

Table 12: Regression across Frequencies: Great Inflation (1965-1984)

	D1	D2	D3	S3
Nominal Wages				
β	0.295***	0.261***	0.820***	1.630***
(SE)	(0.049)	(0.071)	(0.258)	(0.407)
R^2	0.305	0.174	0.265	0.832
Nobs		80		
Real Wages				
β	0.241***	0.147	-1.006***	-2.056***
(SE)	(0.106)	(0.136)	(0.192)	(1.092)
R^2	0.076	0.020	0.528	0.589
Nobs		80		
Labor Share				
β	0.323***	0.513***	0.783***	3.225***
(SE)	(0.148)	(0.094)	(0.643)	(5.669)
R^2	0.092	0.199	0.177	0.537
Nobs		80		
Profit Share				
β	-0.284***	-0.212*	0.080	0.565*
(SE)	(0.088)	(0.142)	(0.560)	(1.409)
R^2	0.160	0.035	-0.011	0.011
Nobs		80		
Corporate Profits				
β	-0.008**	-0.008	-0.030***	-0.170***
(SE)	(0.006)	(0.009)	(0.028)	(0.095)
R^2	0.043	0.013	0.089	0.478
Nobs		80		

Notes: This table shows the regressions results across each time scale and for each distributive variable across the Great Inflation (1965:Q1-1984:Q4). We estimate the equation (15). The estimation method is HAC-OLS. The weights follow Newey–West. Significance levels: $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$. Sources: U.S. Bureau of Labor Statistics and U.S. Bureau of Economic Analysis, via FRED.

Table 13: Regression across Frequencies: Great Moderation (1985-2007)

	D1	D2	D3	S3
Nominal Wages				
β	-0.021	-0.165**	-0.003	-0.061
(SE)	(0.081)	(0.064)	(0.166)	(0.324)
R^2	-0.010	0.057	-0.011	0.003
Nobs		90		
Real Wages				
β	-0.396***	-0.341***	-0.280***	-0.231***
(SE)	(0.052)	(0.056)	(0.119)	(0.226)
R^2	0.404	0.462	0.268	0.267
Nobs		90		
Labor Share				
β	0.360	-0.001	0.381*	0.088
(SE)	(0.267)	(0.312)	(0.475)	(0.719)
R^2	0.016	-0.011	0.026	-0.004
Nobs		90		
Profit Share				
β	0.362***	0.434***	0.394***	0.107*
(SE)	(0.074)	(0.100)	(0.514)	(0.334)
R^2	0.063	0.104	0.085	0.020
Nobs		90		
Corporate Profits				
β	0.035***	0.037***	0.028***	-0.013***
(SE)	(0.005)	(0.006)	(0.013)	(0.048)
R^2	0.278	0.308	0.179	0.026
Nobs		90		

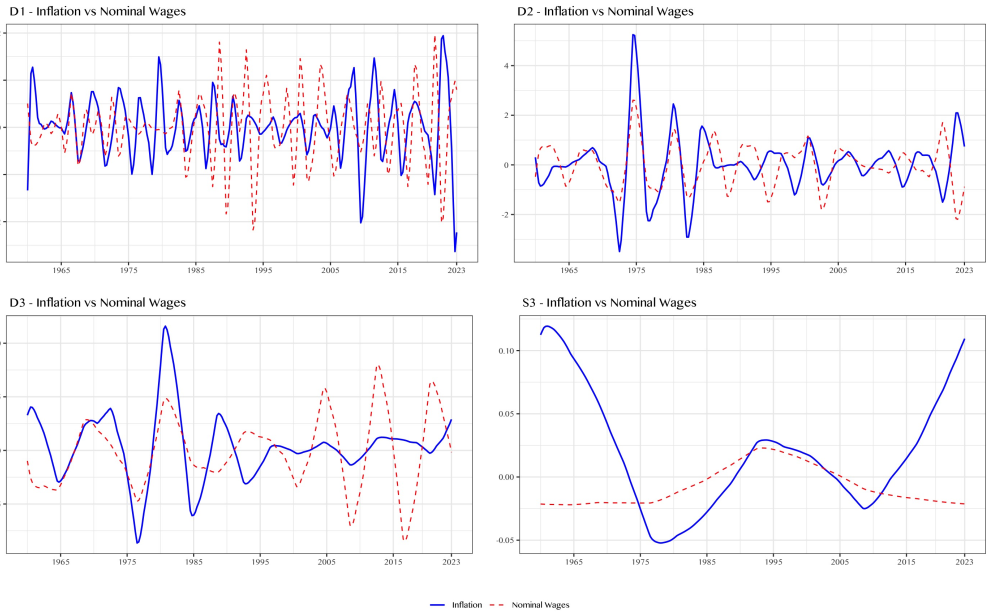
Notes: This table shows the regressions results across each time scale and for each distributive variable across the Great Moderation (1985:Q1-2007:Q3). We estimate the equation (15). The estimation method is HAC-OLS. The weights follow Newey–West. Significance levels: *p<0.1; **p<0.05; ***p<0.01. Sources: U.S. Bureau of Labor Statistics and U.S. Bureau of Economic Analysis, via FRED.

Table 14: Regression across Frequencies: Post Great Recession (2007-2023)

	D1	D2	D3	S3
Nominal Wages				
β	-0.174***	-0.159**	-0.577***	-0.430***
(SE)	(0.041)	(0.086)	(0.497)	(0.763)
R^2	0.089	0.045	0.250	0.179
Nobs		86		
Real Wages				
β	-0.284***	-0.332***	-0.556***	-0.519***
(SE)	(0.044)	(0.082)	(0.130)	(0.224)
R^2	0.423	0.437	0.775	0.729
Nobs		86		
Labor Share				
β	-1.396***	-1.803***	-1.966***	-0.545*
(SE)	(0.113)	(0.333)	(2.259)	(0.870)
R^2	0.474	0.422	0.180	0.060
Nobs		86		
Profit Share				
β	0.447***	0.411***	-0.152	0.292***
(SE)	(0.184)	(0.163)	(0.196)	(0.515)
R^2	0.102	0.139	0.004	0.116
Nobs		86		
Corporate Profits				
β	0.063***	0.044***	-0.030**	-0.006
(SE)	(0.012)	(0.009)	(0.017)	(0.050)
R^2	0.538	0.323	0.081	-0.013
Nobs		86		

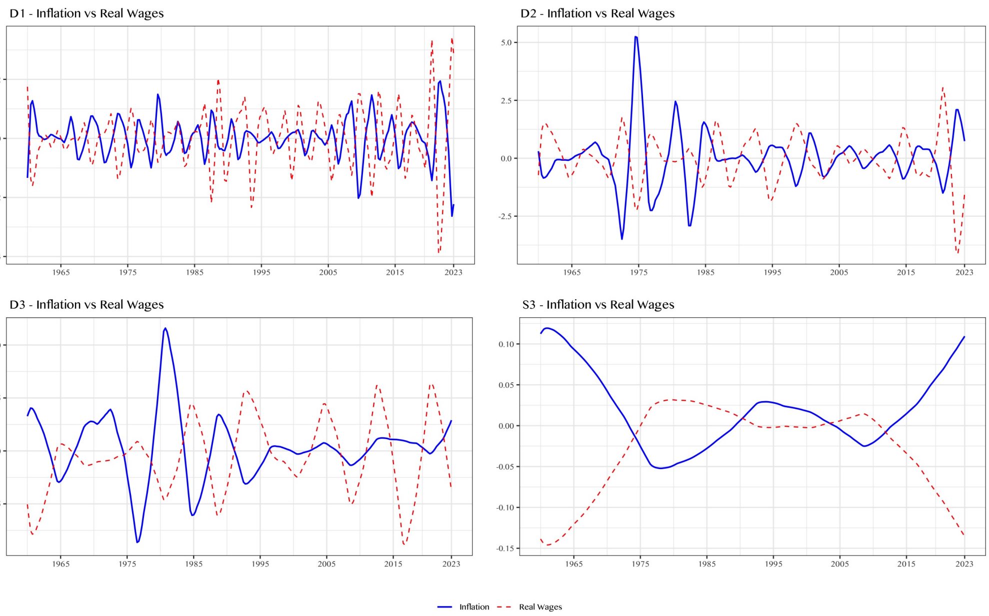
Notes: This table shows the regressions results across each time scale and for each distributive variable across the Post Great Recession period (2007:Q4-2023:Q4). We estimate the equation (15). The estimation method is HAC-OLS. The weights follow Newey–West. Significance levels: *p<0.1; **p<0.05; ***p<0.01. Sources: U.S. Bureau of Labor Statistics and U.S. Bureau of Economic Analysis, via FRED.

Figure 22: Discrete Wavelet Decomposition for Nominal Wages



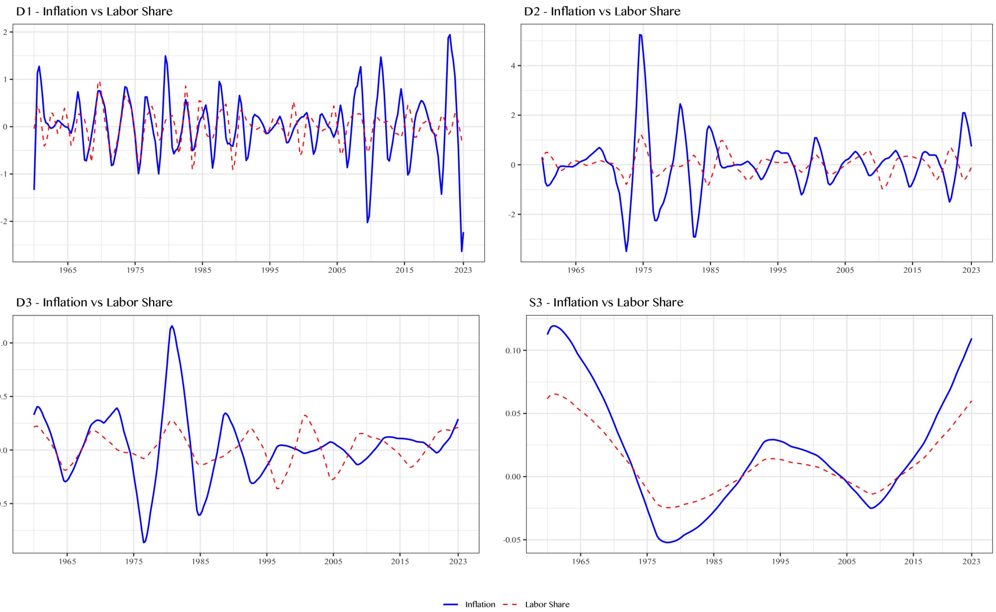
Notes: This figure displays the discrete wavelet filter for nominal wages and headline inflation for the following frequencies: D1: 2-4 years, D2 : 4 8 years, D3: 8-32 years and S3 beyond 32 years. Sources: U.S. Bureau of Labor Statistics, via FRED.

Figure 23: Discrete Wavelet Decomposition for Real Wages



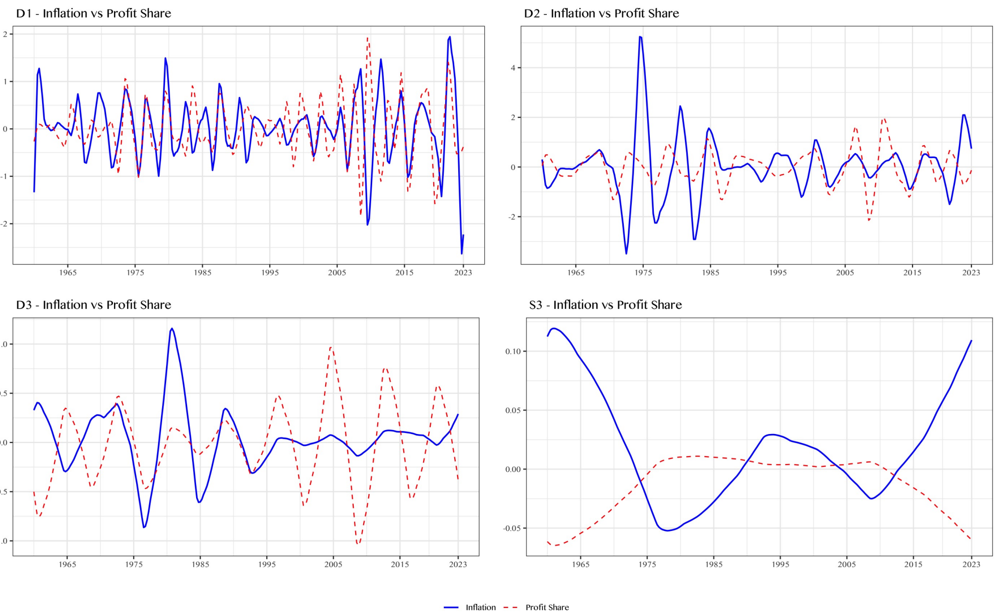
Notes: This figure displays the discrete wavelet filter for real wages and headline inflation for the following frequencies: D1: 2-4 years, D2 : 4 8 years, D3: 8-32 years and S3 beyond 32 years. Sources: U.S. Bureau of Labor Statistics, via FRED.

Figure 24: Discrete Wavelet Decomposition for Labor Share



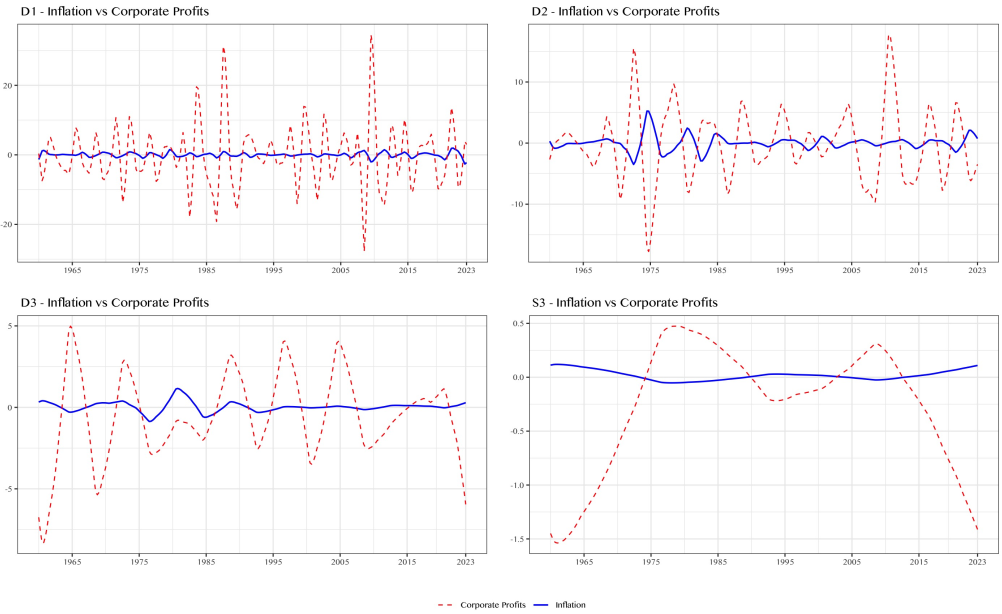
Notes: This figure displays the discrete wavelet filter for labor share and headline inflation for the following frequencies: D1: 2-4 years, D2 : 4 8 years, D3: 8-32 years and S3 beyond 32 years. Sources: U.S. Bureau of Labor Statistics and U.S. Bureau of Economic Analysis, via FRED.

Figure 25: Discrete Wavelet Decomposition for Profit Share



Notes: This figure displays the discrete wavelet filter for profit share and headline inflation for the following frequencies: D1: 2-4 years, D2 : 4 8 years, D3: 8-32 years and S3 beyond 32 years. Sources: U.S. Bureau of Labor Statistics and U.S. Bureau of Economic Analysis, via FRED.

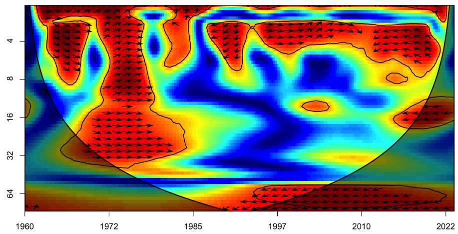
Figure 26: Discrete Wavelet Decomposition for Corporate Profits



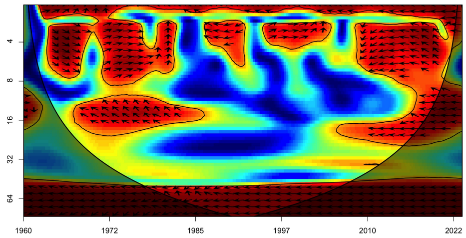
Notes: This figure displays the discrete wavelet filter for corporate profits and headline inflation for the following frequencies: D1: 2-4 years, D2 : 4 8 years, D3: 8-32 years and S3 beyond 32 years. Sources: U.S. Bureau of Labor Statistics and U.S. Bureau of Economic Analysis, via FRED.

D.4 Spectral Properties for Core Inflation Rate

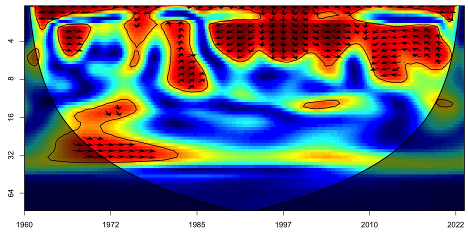
Figure 27: Wavelet Coherency w.r.t. Core Y.o.Y. Inflation Rate



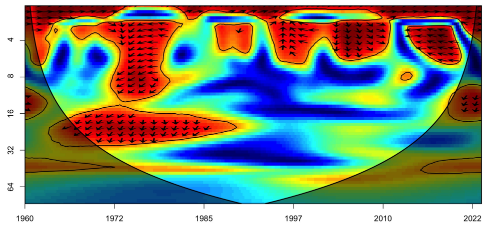
(a) Nominal Wages



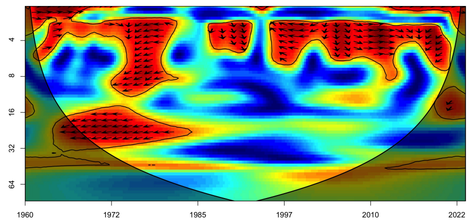
(b) Real Wages



(c) Labor Share



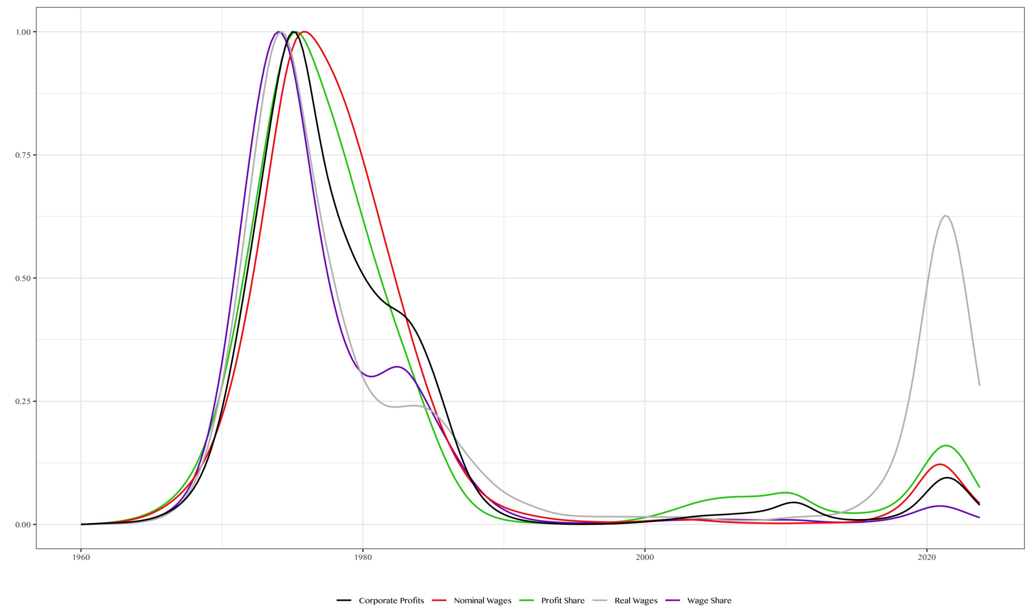
(d) Profit Share



(e) Corporate Profits

Notes: We obtain statistical significance areas using Monte Carlo randomizations. This involves generating a large set of surrogate data pairs with the same AR(1) as the data sets we are analyzing. We set the Monte Carlo randomization to 1000. Sources: U.S. Bureau of Labor Statistics and U.S. Bureau of Economic Analysis, via FRED.

Figure 28: Average Cross-Power Spectra between Core Inflation Rate and Distributive Variables



Sources: U.S. Bureau of Labor Statistics and U.S. Bureau of Economic Analysis, via FRED.

E The Model

E.1 Interior point existence

Proof. To find the interior equilibrium (e^*, ψ^*, μ^{d*}) we set each right-hand side in (8) to zero and proceed in three steps.

1. From $\dot{e} = 0$ to a quadratic in e. The condition

$$\dot{e} \;=\; \frac{1-\psi}{\sigma} - \alpha' e - \beta = 0$$

together with the steady-state expressions

$$\psi^* = 1 - \sigma(\alpha' e + \beta), \qquad \mu^{d*} = \frac{1}{\psi^*} + \frac{(\rho - \alpha')e - \gamma}{1-\eta}$$

allows one to eliminate ψ and μ^d, yielding a single scalar equation in e. After collecting terms, this equation can be written in the form

$$A_2 e^2 \;+\; B_2 e \;+\; C_2 \;=\; 0,$$

where A_2, B_2, C_2 are precisely the coefficients stated in the proposition.

2. Existence and uniqueness of the relevant root. Under the hypotheses $A_2 > 0$ and $\Delta = B_2^2 - 4A_2C_2 > 0$, the quadratic admits two distinct real roots

$$e_{\pm} = \frac{-B_2 \pm \sqrt{\Delta}}{2A_2}.$$

By inspection one checks that $e_+ = (-B_2 + \sqrt{\Delta})/(2A_2) > 1$ and hence lies outside the economically admissible interval. The other root

$$e^* = \frac{-B_2 - \sqrt{\Delta}}{2A_2}$$

satisfies $0 < e^* < 1$, $0 < \psi^* < 1$, and $\mu^{d*} > 0$, establishing both existence and uniqueness of the interior equilibrium.

3. Local stability via Routh–Hurwitz on the reduced one-dimensional dynamics. Because system (8) can be written in triangular form

$$\dot{e} = e\,F(e), \quad \dot{\psi} = \psi\,G(e), \quad \dot{\mu}^d = \mu^d\,H(e),$$

the Jacobian at (e^*, ψ^*, μ^{d*}) has eigenvalues

$$\lambda_e = e^* F'(e^*), \quad \lambda_\psi = 0, \quad \lambda_\mu = 0.$$

Differentiating the quadratic $F(e) = A_2 e^2 + B_2 e + C_2$ gives

$$F'(e^*) = 2A_2 e^* + B_2 = -\sqrt{\Delta},$$

so

$$\lambda_e = e^* F'(e^*) = -\,e^* \sqrt{\Delta} < 0.$$

Hence the single nonzero eigenvalue is strictly negative, and the interior equilibrium is locally asymptotically stable. □

E.2 Hopf Bifurcation

We now prove the emergence of phase transitions, as Figure 15 depicts.

Hopf bifurcation. Linearize the full three–dimensional system

$$\begin{cases} \dot{e} = \dfrac{1-\psi}{\sigma} - \alpha' e - \beta, \\ \dot{\psi} = -\gamma + (\rho - \alpha')\,e - (1-\eta)\,\lambda_p(\mu - 1/\psi), \\ \dot{\mu} = \varepsilon\,(1-\psi) + \chi\,e - \kappa\,(\mu - \bar{\mu}) \end{cases}$$

around its unique interior equilibrium (e^*, ψ^*, μ^*). Denote by $\mathcal{J}^*$ the Jacobian at that point:

$$\mathcal{J}^* = \begin{pmatrix} \partial_e \dot{e} & \partial_\psi \dot{e} & \partial_\mu \dot{e} \\ \partial_e \dot{\psi} & \partial_\psi \dot{\psi} & \partial_\mu \dot{\psi} \\ \partial_e \dot{\mu} & \partial_\psi \dot{\mu} & \partial_\mu \dot{\mu} \end{pmatrix} = \begin{pmatrix} -\alpha' & -\frac{1}{\sigma} & 0 \\ \rho - \alpha' & -(1-\eta)\,\frac{\lambda_p}{(\psi^*)^2} & -(1-\eta)\,\lambda_p \\ \chi & -\varepsilon & -\kappa \end{pmatrix}.$$

Its characteristic polynomial is

$$\mathcal{P}(\lambda) = \lambda^3 + a_1\,\lambda^2 + a_2\,\lambda + a_3 = 0,$$

with

$$a_1 = -\mathrm{tr}(\mathcal{J}^*) = \alpha' + \kappa + (1-\eta)\frac{\lambda_p}{(\psi^*)^2}.$$

By the Routh–Hurwitz criteria, local stability requires

$$a_1 > 0, \quad a_3 > 0, \quad a_1 a_2 > a_3.$$

A Hopf bifurcation occurs when a conjugate pair of eigenvalues crosses the imaginary axis, i.e.

$$a_1 = 0, \quad a_2 > 0, \quad a_3 > 0,$$

and the transversality condition $\frac{d}{dp} a_1 \big|_{p=p_H} \neq 0$ holds for $p \in \{\alpha', \eta\}$.

(i) Learning-driven Hopf (α'): Solving $a_1 = 0$ for α' gives

$$\alpha'_H = -\kappa - (1-\eta)\frac{\lambda_p}{(\psi^*)^2}.$$

(ii) Indexation-driven Hopf (η): Solving $a_1 = 0$ for η yields

$$\eta_H = 1 + \frac{(\psi^*)^2}{\lambda_p}(\alpha' + \kappa).$$

In both cases one checks $a_2(p_H) > 0$, $a_3(p_H) > 0$, and $\frac{d}{dp} a_1 \neq 0$, so the Hopf conditions are satisfied.

This completes the proof.

□