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The (Ir)relevance of Limited Asset Market Participation for Monetary Policy: The Role of Union Wage-Setting Structures

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Abstract

This paper revisits the debate on whether limited asset market participation (LAMP) is relevant for the design of monetary policy. While LAMP can substantially alter the monetary transmission mechanism - potentially reinforcing or reversing the contractionary demand effects of interest rate increases and challenging standard policy prescriptions - its importance depends critically on labor market institutions. We develop a New Keynesian DSGE model with LAMP that incorporates sector-specific labor unions whose wage-setting behavior accounts for broader macroeconomic conditions. The analysis shows that when wage bargaining is sufficiently centralized, particularly under monopoly union structures, LAMP becomes largely irrelevant for monetary policy design, and the Taylor Principle once again ensures equilibrium determinacy. These findings highlight the structure of wage bargaining as a key determinant of how asset market participation shapes the effectiveness and conduct of monetary policy.

Keywords: Limited asset market participation; unions; monetary policy; Taylor principle; determinacy; centralized wage setting

JEL Codes: E52; E58; E44; E24

1. Introduction

Limited asset market participation (LAMP) is a well-documented feature of both developing and developed economies.[1] Households without assets live "hand-to-mouth," consuming most of their current wage income (e.g., Jappelli and Pistaferri 2014), making wage dynamics and wage policy central to aggregate demand. As labor income channels become as important as wealth effects in driving demand (Kaplan et al. 2018, Cloyne et al. 2020), they also shape the effectiveness of economic policy in LAMP economies (Gali et al. 2004, Bilbiie 2008, Auclert 2019, McKay et al. 2016).

There is an ongoing debate about the relevance of LAMP for the design of monetary policy, that is, the desirability of Taylor rules and the Taylor Principle.[2] A significant strand of the literature has shown that LAMP substantially alters the transmission mechanism of monetary policy in the canonical New Keynesian model (e.g., Gali et al. 2004, Bilbiie 2008). Depending on the fraction of non-asset holders (savers), LAMP can either reinforce or overturn the contractionary demand effect of a real interest rate increase. Importantly, for a certain fraction of non-asset holders, there is an inversion of the New Keynesian IS curve slope: higher real interest rates increase aggregate demand. Bilbiie (2008) calls this area 'Inverted Aggregate Demand Logic' (IADL) region. The emergence of the 'IADL' region hinges on the magnitudes of the profit channel and the labor income channel. Under LAMP, lower marginal costs boost profits more than wages fall, making interest rate hikes expansionary. Therefore, a LAMP economy may violate the Taylor Principle, the prima facie criterion for assessing monetary policy. In other words, passive policy or inverted Taylor principle now ensures a unique rational expectations equilibrium.

By focusing on labor market dynamics, Buffie (2013, 2014), Colciago et al. (2011), and Ascari et al. (2017) challenge previous claims about the significance of the LAMP hypothesis for monetary policy. They argue that the striking results of LAMP arise primarily from assuming highly flexible real wages. Once wage rigidity is introduced—an empirically relevant key in affecting macroeconomic responses to shocks and business cycle dynamics[3]— the expansionary effects of higher interest rates disappear, restoring the Taylor principle in ensuring a unique and stable equilibrium. These findings suggest that LAMP's policy relevance is limited.

However, the focus of the literature mentioned above has primarily been on wage stickiness versus flexibility, overlooking broader institutional features, such as wage-setting structures. Empirical evidence indicates that labor market institutions (e.g.,

[1] Krueger et al. (2016) find that 40% of the US households hold almost no net worth and Aguiar et al. (2025) similarly estimate that roughly 40% are hand-to-mouth, with substantially higher rates of financial exclusion in low- and middle-income countries. Euro Area exhibits a similar pattern as roughly half of Euro Area households have little to no financial wealth. In Appendix A we present the distribution of financial assets among Euro Area households utilizing the Eurosystem Household Finance and Consumption Survey-wave 2021 (Figure 6).

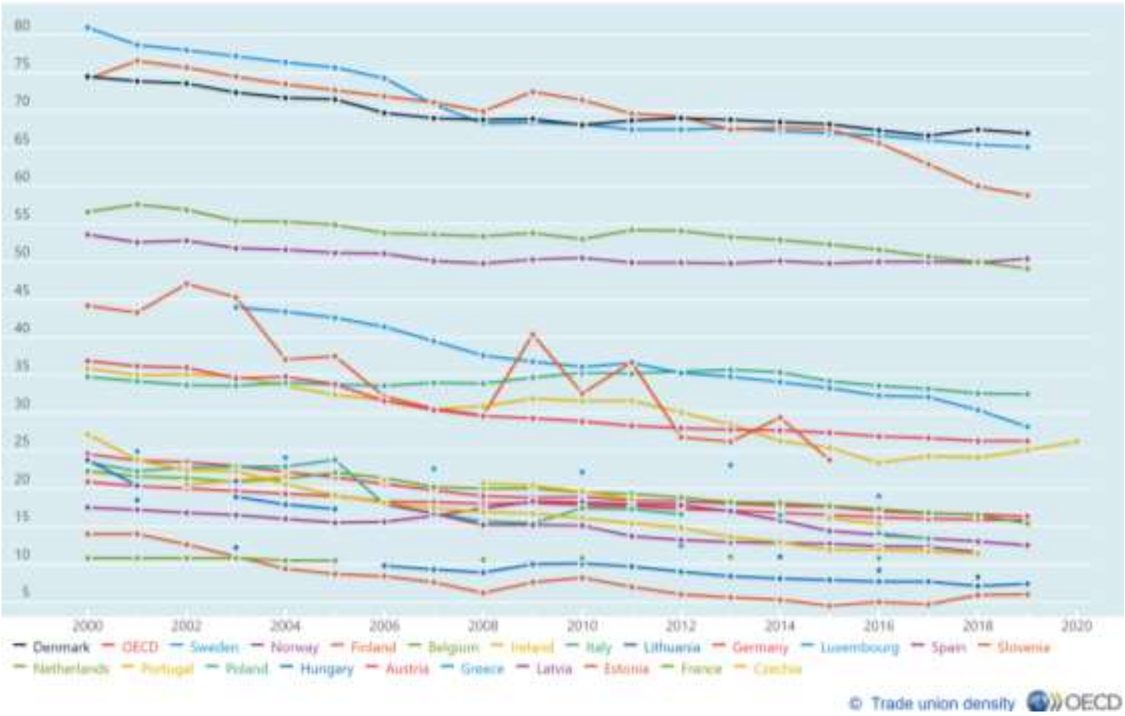
[2] The Taylor Principle states that for monetary policy to stabilize inflation, the central bank must raise the nominal interest rate by more than one-for-one in response to an increase in inflation, so that the real interest rate also rises and dampens demand.

[3] Labor market rigidities affect macroeconomic response to shocks and the business cycle dynamics. See, for example, Nickell, Nunziata, and Ochel (2005) and Morin (2017).

union density and bargaining systems) play a central role in shaping business cycle fluctuations (Gnocchi, Lagerborg, and Pappa 2015). A striking feature of European labor markets is that, despite union density decline, countries like Denmark, Sweden, and Finland still have very high union density (over 60%), far above both the OECD average and most other European economies (Figure 1, panel a). Another feature of European labor markets is the prevalence of collective wage bargaining, often at the sectoral or national level. As Figure 1 (panel b) illustrates, most European economies achieve broad bargaining coverage—typically above 60%—under centralized or coordinated systems, in sharp contrast to countries such as the United States, Japan, or Korea, where collective bargaining remains far less widespread. The institutional framework of wage bargaining—its coordination and degree of centralization—has remained broadly stable in recent years (Thelen 2014), with collective bargaining in most European countries occurring primarily at the industry (sectoral) level since the 1990s (Meyer 2017).

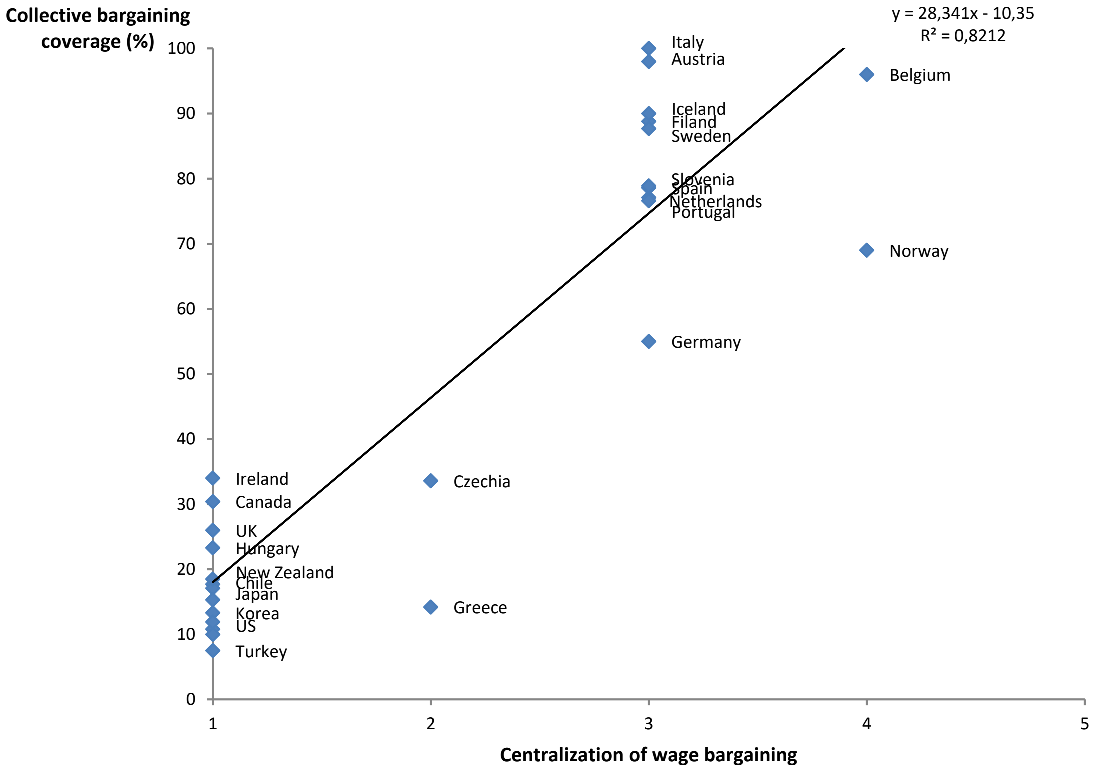
In most of these countries, a few large unions conduct negotiations, and their settlements significantly influence aggregate wages at both the sectoral and national levels (Nickell, Nunziata, and Ochel 2005; Visser 2019). For instance, countries like Germany, Sweden, and Norway typically have an export-led pattern of bargaining, where unions in the metalworking sector and the chemical sector set the path for wage increases in both private and public services (Bhuller et al., 2022). These sector-specific labor unions act strategically in wage negotiations by considering not only their own members' interests but also the impact of their wage settlements on the overall economy.

Figure 1: Labor market institutions characteristics



a) Trade union density for the period 2006-2020.

Source: OECD/AIAS, ICTWSS (Institutional Characteristics of Trade Unions, Wage Setting, State Intervention and Social Pacts) Database (2021). *Notes*: Trade union density is the share of workers belonging to trade unions



b). Centralization of wage setting and the coverage of workers by collective bargaining provisions in OECD countries for the period 2018

Source: OECD/AIAS, ICTWSS (Institutional Characteristics of Trade Unions, Wage Setting, State Intervention and Social Pacts) Database (2021). Authors' calculations. *Notes*: y = 28,341x - 10,35. R^2 = 0,8212.Wage setting (Level), i.e., the predominant level at which wage bargaining takes place (in terms of coverage).1 = Company and plant-level predominant; 2 = Combination of industry and company/plant level; 3 = Industry-level predominant; 4 = Predominantly industrial bargaining but also recurrent central-level agreements; 5 = Central-level agreements of overriding importance.

This 'internalization of aggregate effects' means they consider the broader macroeconomic consequences of their wage demands, influencing economic outcomes and policy making more significantly than smaller, less centralized unions. And this is exactly the rationale behind the famous Calmfors-Driffill U-shaped hypothesis (1988): in national-level wage bargaining, highly centralized unions coordinate and internalize the macroeconomic consequences of wage increases on economic outcomes.[4] Therefore, it is not the mere existence of unions that is decisive for economic performance but rather the specific mode of labor market organization (Haucap and Wey 2004, Calmfors and Driffill, 1988).

Many studies examine how wage-setting structures, i.e., centralized versus decentralized, interact with economic policy, but mostly in static or partial-equilibrium frameworks[5]—rather than in a fully microfounded Dynamic Stochastic General

[4] A large literature documents an inverted-u ("Calmfors–Driffill") relationship between wage-bargaining centralization and macroeconomic performance. Outcomes—especially inflation and unemployment—are best under either highly decentralized or highly centralized systems and worst at intermediate levels (Calmfors and Driffill, 1988, Iversen, 1999, Daniels, Nourzad, and VanHoose, 2006). Intuitively, at high centralization, unions coordinate and internalize the broader costs of wage hikes, at low centralization, competitive pressures restrain wages, and in between, coordination is weak and wage demands tend to be higher.

[5] For the typical strategic monetary policy literature in static models, see, Soskice and Iversen (2000), Lippi (2003), Di Bartolomeo et al. (2013), and Cuciniello (2011 and 2013).

Equilibrium (DSGE) framework[6]—and almost never in LAMP economies.[7] As a result, this literature largely overlooks the dynamic interaction between different unionization structures and monetary policy in a LAMP-DSGE economy, that is, in an economy where wage dynamics may invert aggregate demand. Conversely, the LAMP-DSGE literature largely assumes decentralized, atomistic wage setting—where individual wage setters or measure-zero unions take aggregate wages and prices as given—it does not capture coordinated, sectoral bargaining and broadly the institutional diversity of industry unionization. Consequently, the implications of more centralized wage-setting systems for the monetary policy in LAMP economy remain an open issue. This gap is notable given the continuing policy relevance of institutional wage coordination and ad-hoc social-partner agreements in several European countries, particularly during periods of economic stress (e.g., energy price shock, disinflation guidance) (Avdagic and Visser 2011, OECD 2023, Eurofound 2023).

Consistent with this policy relevance, recent empirical evidence suggests that wage outcomes and wage adjustment reflect not only nominal wage rigidity but also the institutional architecture of bargaining and labour-market power (Svarstad and Nymoen 2023; Matano, Naticchioni and Vona 2023; Reza and Rilstone 2024; Kumar and Mallick 2026). Taken together, these findings underscore that bargaining institutions are empirically consequential for wage dynamics. Yet this evidence has not been integrated into a fully microfounded New Keynesian DSGE framework with limited asset market participation, where wage-setting structures may also shape the monetary-policy transmission mechanism.

Motivated by this evidence, we address this gap by examining how unionization structures affect the design of monetary policy in LAMP economies. For this purpose, we develop a framework that allows us to analyze the effect of alternative unionization structures—that differ in the degree of wage centralization—on the desirability of Taylor rules. First, we examine the role played by the LAMP hypothesis under different labor structures for the aggregate dynamics. Then, we study determinacy properties of simple interest rate rules. That is, we examine the conditions under which a unique rational expectations equilibrium exists—thereby preventing multiple or unstable equilibria and enhancing policy effectiveness. To this end, we bridge the two popular strands of literature: the LAMP-DSGE literature and the typical strategic monetary policy literature, which has been largely developed in static models. We extend the standard LAMP-DSGE model of Bilbiie (2008) by incorporating different unionization structures, i.e., centralized (sectoral) level and decentralized wage setting.

Our key finding is that by considering the presence of centralized wage systems, and particularly when there is a monopoly union and wages are flexible, LAMP is irrelevant for the conduct of monetary policy. Therefore, the debate on the relevance of the LAMP hypothesis for monetary policy design is not related to whether wages are sticky or flexible but on the institutional structure of wage setting (centralized versus decentralized). The extent to which the monetary authority responds aggressively to inflation to prevent indeterminacy and explosive solutions is associated with central wage bargaining and LAMP parameters.

The present paper brings a new contribution to the literature by arguing that monetary policy design depends on the interplay between monetary policy, LAMP, and unions' wage-setting structures (centralized versus decentralized) structures.

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[6] To the best of our knowledge, only three papers explicitly incorporated the strategic interactions between large labor unions and policymakers into a DSGE model adopting a representative households framework: Coricelli et al. (2006), Gnocchi (2009), and Chrysanthopoulou and Sidiropoulos (2025).

[7] The only exception is Chrysanthopoulou and Sidiropoulos (2018) who analyse the interactions between 'Social pacts", government expenditures, and LAMP economy.

The reminder of the paper is organized as follows. Section 2 and 3 outline the model, the steady state, and the model's linearized version. Section 4 discusses the equilibrium dynamics. Section 5 explores the role played by the LAMP hypothesis under different union structures, namely centralized wage-setting versus decentralized wage-setting, for the aggregate demand and supply dynamics. Section 6 contains the main results regarding the determinacy analysis. Section 7 concludes.

2 The model

This section presents the theoretical setup. It builds upon the influential framework of the LAMP-DSGE economy model by Bilbiie (2008) and Ascari et al. (2017), incorporating the strategic monetary policy literature of Lippi (2003) and Gnocchi (2009). Therefore, the main differences with respect to the standard framework are in the structure of the labor market. [8]

We allow for alternative wage-setting structures, i.e., centralized versus decentralized, by varying a single parameter, $1/n$, the inverse of the number of unions, and by specifying union behavior accordingly. Under centralized, sector-level bargaining, a handful of large unions internalize the impact of their wage demands on aggregate wages, macroeconomic variables, and the wage policies of other unions. This is not the case with decentralized (atomistic) wage setting, the standard hypothesis in LAMP-DSGE literature. As atomistic unions are small, wages are determined without considering their impact on aggregate wages, and thereby on marginal costs and aggregate prices.

The model features two types of households, standard Ricardian households and an exogenous fraction of constrained households that do not have access to asset markets (non-Ricardian households). It also includes intermediate firms, final goods-producing firms, a monetary authority, a fiscal authority, and labor unions.

2.1 Households

There is a continuum of households indexed by $j \epsilon [0,1]$ all of which consume the final good and supply labour to firms. Households in the interval $[0, \lambda]$ do not hold assets and any profits and must consume out their available wage income in each period; these are referred to as Non-Ricardian households and are denoted by the superscript NR. The remaining households in the interval $(\lambda, 1]$ hold assets and smooth consumption over time, being able to trade in all markets for state-contingent securities. We use the superscript R to indicate standard Ricardian households. The instantaneous period utility function is common across both types of households and it has the following additively separable form[9]

$$U_t \equiv u\left(C_{jt}^S\right) - v\left(L_{jt}^S\right) \tag{1}$$

[8] Another difference from Ascari et al. (2017) is that we exclude productivity and preference (or taste) shocks. This simplification keeps the model transparent without sacrificing the mechanisms of interest.

[9] The function u is increasing and concave and the function v is increasing and convex.

where $S = NR, R$ stands for household type. Preferences are defined over consumption C_{jt}^{S} and hours worked L_{jt}^{S}. The aggregate consumption C_{jt}^{S} is obtained aggregating in the Dixit–Stiglitz form the quantities consumed of each good variety $i \epsilon [0,1]$,

$$C_{jt}^{S} = \left[\int_{0}^{1} C_{jt}^{S}(i)^{\frac{\theta_P - 1}{\theta_P}} di\right]^{\frac{\theta_P}{\theta_P - 1}} \tag{2}$$

where the parameter $\theta_P > 1$ represents the elasticity of substitution among goods varieties. For a given amount of aggregate consumption, equation (2), households minimize the expenditure $\int_0^1 P_{jt}(i) C_{jt}^{S}(i) di$ determining the optimal demand of good variety i . After integrating across households, the total demand of variety i equals

$$C_t^{S,*}(i) = \left(\frac{P_t(i)}{P_t}\right)^{-\theta_P} C_t^{S} \tag{3}$$

where P_t is the aggregate price index, given by equation (10), that represents the minimum cost of a consumption bundle C_t, denoted as $P_t C_t$ and $C_t^S = \int_0^1 C_{jt}^S dj$.

As hours worked are assumed to be determined by firms (instead of being chosen by households), given the prevailing wage, we do not report any relevant equilibrium condition. The hours worked for both households are determined in a non-Walrasian type labor market by strategic large unions above the marginal rate of substitution at all times. Therefore, households find it optimal to supply as much labor as firms demand.

Ricardian households

Given the optimal bundle of consumption goods, equation (3), the typical Ricardian household must choose the optimal consumption and nominal asset holdings vector that maximizes the lifetime utility function

$$E_0\left\{\sum_{t=0}^{\infty} \beta^t \left[\frac{\left(C_{jt}^{R}\right)^{1-\sigma}}{1-\sigma} - \frac{\left(L_{jt}^{R}\right)^{1+\varphi}}{1+\varphi}\right]\right\} \tag{4}$$

where $\beta \epsilon (0,1)$ is the discount factor and E_t is the rational expectations operator. The parameter σ denotes the coefficient of relative risk aversion and φ is the inverse of the Frisch elasticity of hours worked with respect to the real wage. Ricardian agents face the following sequence of budget constraints in nominal terms.

$$P_t C_{jt}^{R} + E_t\left(\Lambda_{t,t+1} B_{t+1}^{R}\right) \leq B_t^{R} + W_{jt}^{r} P_t L_{jt}^{R} + P_t D_t^{R} - P_t T \tag{5}$$

Ricardian agents can purchase any desired state-contingent nominal payment B_{t+1}^{R} in period $t+1$ at the dollar cost $E_t\left(\Lambda_{t,t+1} B_{t+1}^{R}\right)$. The variable $\Lambda_{t,t+1}$ represents the stochastic discount factor between period $t+1$ and t equal to $\Lambda_{t,t+1} = \beta(C_{t+1}^{R}/C_t^{R})^{-\sigma}(P_t/P_{t+1})$. The riskless interest rate, I_t, is associated with the stochastic discount factor, $1/I_t = E_t\left(\Lambda_{t,t+1}\right)$. We also assume that the nominal interest rate is positive at all times and no Ponzi schemes. W_{jt}^{r} is the real wage for the $j-$type hours worked. D_t^{R} denotes the real dividend payments for Ricardian households. We also assume that the government imposes a lump-sum tax T on Ricardian households equal to steady state Ricardian dividends D^R, i.e., $T = D^R$. Optimal allocation of Ricardian consumption over time implies the following standard Euler equation.

$$\beta E_t\{P_t (C_{t+1}^{R})^{-\sigma} / P_{t+1} (C_t^{R})^{-\sigma}\} = 1/I_t \tag{6}$$

Non-Ricardian households

The typical Non-Ricardian household consumes its current disposable income from labor and delegates wage decisions to unions. Therefore, there are no first-order conditions with respect to consumption or hours worked. Its level of private consumption is determined by its budget constraint.

$$P_t C_{jt}^{NR} = W_{jt}^{r} P_t L_{jt}^{NR} \tag{7}$$

2.2 Firms

As is standard in this class of models, we assume a continuum of monopolistically competitive firms who employ household labor of both types to produce differentiated intermediate goods. These goods are then used as inputs by a perfectly competitive firm producing a single final good.

Final goods firms

The representative perfectly competitive firm combines the intermediate goods using a standard Dixit-Stiglitz aggregator

$$Y_t = \left[\int_0^1 Y_t(i)^{\frac{\theta_P - 1}{\theta_P}} di\right]^{\frac{\theta_P}{\theta_P - 1}} \tag{8}$$

where $Y_t(i)$ is the quantity of intermediate good $i \in [0,1]$ used as an input. Profit $P_t Y_t - \int_0^1 P_t(i) Y_t\,(i) di$ maximization, taking as given the final goods price P_t and the prices for the intermediate goods $P_t(i)$, yields the following standard set of demand schedules.

$$Y_t(i) = \left(\frac{P_t(i)}{P_t}\right)^{-\theta_P} Y_t \tag{9}$$

Zero profits (due to perfect competition) provide the following aggregate price index condition.

$$P_t = \left[\int_0^1 P_t(i)^{1-\theta_P} di\right]^{\frac{1}{1-\theta_P}} \tag{10}$$

Intermediate goods firms

A continuum of monopolistically competitive firms indexed by $i \in [0,1]$ produces the differentiated intermediate goods. The production technology is simply linear in labor input, $L_t(i)$

$$Y_t(i) = L_t(i) \tag{11}$$

where $L_t(i)$ is a standard Dixit-Stiglitz aggregator index of labor input used by the i – firm

$$L_t(i) = \left[\int_0^1 L_t(i,j)^{\frac{\theta_W - 1}{\theta_W}} dj\right]^{\frac{\theta_W}{\theta_W - 1}} \tag{12}$$

and $L_t(i,j)$ represents the quantity of j - type labour employed by i – firm. We assume that $L_t(i,j)$ is uniformly distributed across the two different types of households. When making a decision on labor demand, the firm does not distinguish between different workers of type j (being indifferent between Ricardian and non-Ricardian workers and thus allocating labor demand proportionally). The parameter $\theta_w > 1$ indicates the elasticity of substitution among labor types.

The aggregate real wage has the property that the minimum cost of a unit of composite labor input L_t is $W_t^r L_t$ and is given by

$$W_t^r = \left(\int_0^1 \left(W_{jt}^r\right)^{1-\theta_w} dj\right)^{\frac{1}{1-\theta_w}}. \tag{13}$$

For a given quantity of aggregate labor required in the production, equation (12), firms minimize the cost $\int_0^1 W_{jt}^r L_t(i,j)dj$ determining the optimal demand of labor variety j for each firm. After integrating across firms, we obtain the total demand of labor variety j as follows

$$L_t^*(j) = \left(\frac{W_{jt}^r}{W_t^r}\right)^{-\theta_w} L_t \tag{14}$$

where $L_t = \int_0^1 L_t(i)di$. Since $\int_0^1 W_{jt}^r L_t(i,j)dj = W_t^r L_t(i)$, the common (due to the constant return of scale technology to all firms) real marginal cost is given by

$$MC_t^r = (1-\tau)W_t^r \tag{15}$$

where τ denotes a steady-state (time-invariant) employment subsidy. In this basic cashless model, we assume a Calvo (1983) pricing structure for intermediate goods to introduce a role for monetary policy in affecting the real allocation. Firms in any period get the opportunity to re-optimize prices with fixed probability $1-\xi_P$ and independently of the time elapsed since the last adjustment. Thus, ξ_P is a natural measure of the degree of price stickiness. In particular, a firm resetting its price in period t seeks to maximize the discounted sum of future nominal profits,

$$E_t \sum_{s=0}^{\infty} \left\{(\xi_P)^s \Lambda_{t,t+s} Y_{t+s}(i)[P_t^*(i) - P_{t+s}MC_{t+s}^r]\right\} \tag{16}$$

choosing the price $P_t^*(i)$ and using $\Lambda_{t,t+s}$ the relevant stochastic discount factor (pricing kernel) for nominal payoffs. The optimization is subject to a sequence of demand constraints $Y_{t+s}(i) = (P_t^*(i)/P_{t+s})^{-\theta_P} Y_{t+s}$, the technology production, and the Calvo price staggering hypothesis. The resulting first-order condition is

$$E_t \sum_{s=0}^{\infty} (\xi_P)^s \left\{\Lambda_{t,t+s} Y_{t+s}(i)[P_t^*(i) - \mu_P P_{t+s} MC_{t+s}^r]\right\} = 0 \tag{17}$$

where $\mu_P \equiv \theta_P/(\theta_P - 1)$ is the mark-up over the price that would prevail in the absence of nominal rigidities. At equilibrium, every firm opting for a new price $P_t^*(i)$ in period t will select identical prices and output levels, resulting in the price index being equal to

$$P_t^{1-\theta_P} = (1-\theta)(P_t^*)^{1-\theta_P} + \theta(P_{t-1})^{1-\theta_P}. \tag{18}$$

2.3 Union wage-setting regimes: centralized vs. decentralized

In this section, we explore how different unionization structures affect unions' wage changes incentives and employment, both under flexible and sticky wages. The economy is populated by unions indexed by $z \epsilon [1, \dots, n)$ with $n \geq 1$. Each union represents a continuum of workers (households) $j \epsilon (0,1)$, of which a fraction λ are Non-Ricardian households and the remaining $1 - \lambda$ are Ricardian households. Following the bulk of the literature (Soskice and Iversen 2000, Lippi 2003), we assume that all types of labour j (and independently of consumer behavior) are unionized and equally distributed among unions so that each union has mass n^{-1}. We interpret n^{-1} as the degree of wage-setting centralization.

We use n (or n^{-1}) to distinguish two wage-setting regimes. The first one is the centralized wage-setting, which corresponds to small n, as, e.g., in Nordic countries. In this case, unions have positive mass ($n^{-1} > 0$) and a few large unions do internalize the aggregate impact of their wage policy. Actually ($n^{-1} > 0$) denotes unions' ability to internalize the general equilibrium effects of their wage policy at time t on the aggregate wage and other aggregate variables (prices, dividends, labor income). This is a new aspect in the LAMP-DSGE literature.[10] The second regime, the decentralized (atomistic) wage-setting, is the benchmark regime in the LAMP-DSGE literature (Bilbiie 2008, Ascari et al. 2017). It assumes $n \to \infty$, thus unions have zero mass ($n^{-1} \to 0$) and there is no internalization of general-equilibrium effects, as e.g., in Japan and US. In what follows, we consider these union wage-setting regimes under both flexible and sticky wages.

2.3.1 Centralized wage-setting system

The centralized wage-setting assumption ($n^{-1} > 0$) has implications that are absent under decentralized wage setting. In particular, three features related to the unions strategic behavior emerge. First, under centralized wage-setting, the z-th union anticipates that a real wage W_{zt}^r hike increases aggregate real wage W_t^r in a way proportional to its size $n^{-1} \neq 0$. That is, the higher the number of unions, the lower their mass, then the lower the impact of unions' wage policy on the aggregate wage index. The elasticity of aggregate real wage to real wage perceived by z-th union, $\Sigma_w \equiv \left|\frac{\partial W_t^r}{\partial W_{zt}^r}\frac{W_{zt}^r}{W_t^r}\right|$, equals

$$\Sigma_w = \frac{dw_t^r}{dw_{zt}^r} = n^{-1} \tag{19}$$

where lower-case letters denote variables in logs, while a hat refers to a variable in log-deviation from the steady state.

Second, unlike the standard literature (Lippi 2003, Gnocchi 2009), we assume that unions consider the implications of their wage settlements for the Ricardian dividend income of their members. Hence, unions anticipate that a wage rise reduces total dividends D_{zt} and Ricardian dividends D_{zt}^R. This is an interesting assumption, as in a LAMP economy, union members' dividend income, through a wealth effect, may cause an inversion of the slope of the aggregate demand (Bilbiee, 2008). The elasticity of Ricardian dividend to real wage perceived by the z-th union $\Sigma_D \equiv \left|\frac{\partial D_{zt}^R}{\partial W_{zt}^r}\frac{W_{zt}^r}{D_{zt}^R}\right|$ is

[10] A notable exception is Chrysanthopoulou and Sidiropoulos (2018).

$$\Sigma_D = \frac{dd_{zt}^R}{dd_{zt}} \frac{dd_{zt}}{dw_t^r} \frac{dw_t^r}{dw_{zt}^r} = -\frac{1}{1-\lambda} \Sigma_w < 0 \tag{20}$$

Third, under centralized wage setting, the typical union internalizes the effect of its wage claim W_{zt}^r on aggregate labor demand L_t. In particular, the elasticity of aggregate labor demand to real wage perceived by the representative union, $\Sigma_L \equiv \left|\frac{\partial L_t}{\partial W_{zt}^r} \frac{W_{zt}^r}{L_t}\right|$, is given by

$$\begin{aligned} \Sigma_L &= \left(\frac{dl_t}{dw_t^r} \frac{dw_t^r}{dw_{zt}^r}\right)_{ISRC} + \left(\frac{dl_t}{dw_t^r} \frac{dw_t^r}{dw_{zt}^r}\right)_{NRDI} + \left(\frac{dl_t}{dw_t^r} \frac{dw_t^r}{dw_{zt}^r}\right)_{PD} \\ &= -\sigma(1-\xi_P)(1-\xi_P\beta)\Sigma_w + \frac{\lambda}{1-\lambda}\Sigma_w + (1-\lambda)\lambda\Sigma_D \end{aligned} \tag{21}$$

Interestingly, in a LAMP economy with centralized wage-setting ($n^{-1} > 0$), Σ_L is modified. Specifically, Σ_L takes place through three channels: i) the Intertemporal Substitution of Ricardian Consumption ($ISRC$) effect equal to $-\sigma(1-\xi_P)(1-\xi_P\beta)\Sigma_w$, ii) the Non-Ricardian Disposable Income (NRDI) effect given by $\lambda\Sigma_w/(1-\lambda)$, and iii) the Profit-Dividend (PD) effect equal to $(1-\lambda)\lambda\Sigma_D = -\lambda\Sigma_W$. According to the $ISRC$ effect, large unions perceive that their wage demands lead to higher marginal costs, effective prices, and an aggregate price level, thereby increasing the expected real interest rate and reducing Ricardian consumption, output, and employment (Gnocchi 2009, Chrysanthopoulou and Sidiropoulos 2018). The Non-Ricardian Disposable Income effect ($NRDI$) reflects unions' concern about their members who cannot smooth consumption, as in Chrysanthopoulou and Sidiropoulos (2018). Specifically, they anticipate that a wage rise will positively impact aggregate demand and employment by boosting non-Ricardian consumption. In a LAMP economy, this has a positive impact on output and employment. The profit-dividend effect (PD) is a new aspect in the literature and is due to unions' concerns for dividend (non-wage) income. According to this mechanism, unions consider that a wage rise reduces Ricardian dividend income, and thereby Ricardian consumption, output, and employment. Conditional on the relevant size of these channels, the sign of Σ_L differentiates. According to our baseline parameter values (see section 3) $\Sigma_L > 0$ for $\lambda \geq 0.25$ $(\sigma = 1)$ and $\Sigma_L < 0$, otherwise. The possibility of a positive Σ_L stands in contrast to the relative literature on strategic monetary policy in static and dynamic settings. Note that, in decentralized wage-setting systems, the elasticities Σ_w, Σ_D and Σ_L are zero.

Equation (21) implies the following elasticity of labor demand perceived by the $z-$th union for each of its members, $e_L \equiv \left|\frac{\partial L_{zt}}{\partial W_{zt}^r} \frac{W_{zt}^r}{L_{zt}}\right|$,

$$e_L = \left(\frac{dl_{zt}}{dw_t^r} \frac{dw_t^r}{dw_{zt}^r}\right)_{SE} + \frac{dl_{zt}}{dl_t}\Sigma_L = \theta_W(1-n^{-1}) + \Sigma_L \tag{22}$$

In centralized wage-setting systems, the incentive to moderate or not real wage claims is directly related to e_L. In our setting, this incentive depends on two effects. First, as real wages are negotiated, taking into account other unions' policies, each union anticipates inflationary pressures that will curb the other unions' real wages. This reduction enhances the competitiveness of labor services offered by other unions, thereby triggering labor substitution across firms as in the standard monopolistic competition framework. This effect is captured by the term $\theta_W(1-n^{-1})$ in equation (22) and is labelled as '*Substitution Effect*' (SE)(Lippi 2003). Second, in our setting, wage moderation is related to the elasticity of aggregate labor demand Σ_L, and thus it depends on the share of non-Ricardian workers or the level of financial exclusion λ.

Flexible wages

Real wages are fully flexible and set independently and simultaneously. Given the optimal real wage, households are willing to supply the quantity of labor required to clear the market. We also assume that each union takes as given the real wages set by the other unions W_{-zt}^{r} and the effects of wages on variables in the next period. In particular, the benevolent representative union sets the real wage W_{zt}^{r} to maximize the weighted sum of the utility function of their represented workers $j \epsilon z$[11]

$$E_0\left\{\sum_{t=0}^{\infty}\beta^t[\lambda U_t^{NR}(C_{zt}^{NR},L_{zt}^{NR})+(1-\lambda)U_t^{R}(C_{zt}^{R},L_{zt}^{R})]\right\} \tag{23}$$

subject to a sequence of labor demand schedules (equation (14)) and a sequence of flow budget constraints of its members, (equation (5) and equation (7)), thus taking the effect of the wage decision on the wage and non-wage income of its members into account.

In the case of a centralized wage-setting system, in the interaction with the economy, the typical union internalizes the general equilibrium effects of its real wage at time t. Thus, the representative union additionally internalizes the aggregate wage index (equation (13)), the marginal cost (equation (15)), the optimal price-setting equation (equation (17)), the aggregate price level (equation (18)), the Euler equation for Ricardian consumption (equation (6)), the equation linking Ricardian and Non-Ricardian consumption, the income identity (equation (30)), the production function (equation (11)), the Ricardian dividends equation (equation (29)). Unions also take into account that firms allocate labor demand uniformly across different household types and hence $L_{zt}^{NR}=L_{zt}^{R}=L_{zt}$ for all t and z, i.e., they work the same amount of hours.

The representative union's problem yields

$$\lambda MU_{C_t}^{NR}\left[\frac{\partial C_{zt}^{NR}}{\partial W_{zt}^{r}}+\frac{\partial C_{zt}^{NR}}{\partial L_{zt}^{NR}}\frac{dL_{zt}^{NR}}{dW_{zt}^{r}}\right]+(1-\lambda)MU_{C_t}^{R}\left[\frac{\partial C_{zt}^{R}}{\partial W_{zt}^{r}}+\frac{\partial C_{zt}^{R}}{\partial L_{zt}^{R}}\frac{dL_{zt}^{R}}{dW_{zt}^{r}}+\frac{\partial C_{zt}^{R}}{\partial D_{zt}^{R}}\frac{dD_{zt}^{R}}{dW_{zt}^{r}}\right] =\frac{dL_{zt}}{dW_{zt}^{r}}L_{zt}^{\varphi} \tag{24}$$

where $MU_{C_t}^{NR}=(C_{zt}^{NR})^{-\sigma}$, $MU_{C_t}^{R}=(C_{zt}^{R})^{-\sigma}$, and $MU_{L_t}=-L_{zt}^{\varphi}$ are the marginal utility of consumption for each household type and the marginal utility of hours worked, respectively. It is possible to interpret the typical union's first-order condition using the conventional variational argument. Assume that the union increases W_{zt}^{r} marginally. The left-hand side of the FOC expresses the marginal cost in terms of utility due to the induced change in consumption, which is negative. In fact, it can be easily shown that, under centralized wage setting,

$$\frac{dC_{zt}^{NR}}{dW_{zt}^{r}}=\frac{\partial C_{zt}^{NR}}{\partial W_{zt}^{r}}+\frac{\partial C_{zt}^{NR}}{\partial L_{zt}^{NR}}\frac{dL_{zt}^{NR}}{dW_{zt}^{r}}=L_{zt}^{NR}(1-e_L)<0$$

and

[11] We use the index z instead of j, as the representative union is interest for all the households $j \epsilon z$.

$$\frac{dC_{zt}^R}{dW_{zt}^r} = \frac{\partial C_{zt}^R}{\partial W_{zt}^r} + \frac{\partial C_{zt}^R}{\partial L_{zt}^R}\frac{dL_{zt}^R}{dW_{zt}^r} + \frac{\partial C_{zt}^R}{\partial D_{zt}^R}\frac{dD_{zt}^R}{dW_{zt}^r} = L_{zt}^R(1 - e_L) - \frac{1}{1-\lambda}\frac{D_{zt}^R}{W_{zt}^r} < 0,$$

A marginal increase in the real wage reduces real income, which in turn reduces consumption. Intuitively, for both types of union members, income contracts because labor demand is elastic ($e_L > 1$) for plausible parameter values. Additionally, for the typical union's Ricardian members the income drop is higher since the real wage hike restricts Ricardian dividend income. Similarly, the right-hand side of equation (24) represents the marginal benefit stemming from the induced change in hours worked. A marginal wage increase yields benefits for labor union members, enabling the same consumption with fewer work hours (reducing labor supply and increasing leisure). In fact,

$$\frac{dL_{zt}}{dW_{zt}^r} = -e_L\,\frac{L_{zt}}{W_{zt}^r} < 0$$

Note also that equation (24) differs from the standard one in the strategic monetary policy in that labor demand elasticity e_L is a function of the degree of asset market participation λ and the union's mass n^{-1} . A second difference is the appearance of the new term $\frac{\partial C_{zt}^R}{\partial D_{zt}^R}\frac{dD_{zt}^R}{dW_{zt}^r}$. This is because, in our setting, unions consider the impact of their wage policy on the Ricardian dividend income.

Condition (24) can be reformulated to align directly with the wage equation found in the LAMP-DSGE literature. Thus, in a symmetric equilibrium, i.e., $W_t^r = W_{zt}^r$, centralized wage-setting implies

$$W_t^r = \frac{e_L}{(e_L - 1)}\left[\frac{\lambda}{[MRS_{t+s}^{NR}]} + \frac{(1-\lambda)}{[MRS_{t+s}^{R}]}\right]^{-1} - \frac{(1-\lambda)(C_t^R)^{-\sigma} D_t^R L_t^{-1} \Sigma_D}{(e_L - 1)\left[\lambda MU_{C_t}^{NR} + (1-\lambda) MU_{C_t}^{R}\right]} \tag{25}$$

where $MRS_t^{NR} \equiv MU_{L_t}/MU_{C_t}^{NR} = L_t^{\varphi}/(C_t^{NR})^{-\sigma}$ and $MRS_t^{R} \equiv MU_{L_t}/MU_{C_t}^{R} = L_t^{\varphi}/(C_t^{R})^{-\sigma}$ are the marginal rate of substitution of consumption to hours worked for non-Ricardian and Ricardian workers, respectively.

The first-order condition (25) as well as (28) are the key equations for our results. Apart from the second term on the right-hand side, equation (25) has the same form as equation (28). In the context of the centralized wage-setting regime, however, a distinguishing feature lies in the dependency of the coefficient multiplying the marginal rate of substitution, $e_L/(e_L - 1)$, on the level of central wage bargaining n^{-1} and on the degree of limited asset market participation λ. Equation (25), is in fact increasing in λ: the more limited asset market participation is (higher λ), the higher is the incentive for unions to restrain wage demands. This result highlights how the functioning of financial markets may interact with market power in the labor market and influence unions' wage decisions. In contrast, this feature disappears under decentralized union wage setting, the standard LAMP-DSGE modeling assumption, as small unions do not internalize! Additionally, higher wage setting concentration (higher n^{-1}) leads to an aggressive wage policy.

The second term on the right-hand side of equation (25) is novel. It comes from the derivative of the utility consumption argument with respect to dividend payments for Ricardian households and captures the wealth effect of a wage change. This term is associated with the assumption that unions internalize the consequences of their wage policy on non-wage income (dividend payments and profits). When increasing the real wage, the typical union takes into account the subsequent reduction in households' real income. By contrast, as union size tends to zero (the decentralized regime), this internalization effect shuts down ($\Sigma_D = 0$) and the second term drops out.

Sticky wages

Nominal wage rigidities are modeled according to the Calvo (1983) mechanism. The $z-th$ union faces a constant probability $1-\xi_w$ of being able to re-optimize the real wage. Each period t, the representative union chooses $W_t^{r,*}$ to maximize a weighted average of households' lifetime utilities with weights attached to the utilities of Ricardian and non-Ricardian households $1-\lambda$ and λ, respectively.

$$E_t\left\{\sum_{s=0}^{\infty}(\xi_w\beta)^s[\lambda U_t^{NR}(C_{zt}^{NR},L_{zt}^{NR})+(1-\lambda)U_t^{R}(C_{zt}^{R},L_{zt}^{R})]\right\} \tag{26}$$

Under decentralized wage systems and sticky wages, the optimization takes place with respect to labor demand schedules (equation (14)) and flow budget constraints of its members, (equation (5) and equation (7)). The first-order condition is (Ascari et al. 2017)

$$E_t\sum_{s=0}^{\infty}(\beta\xi_w)^{t+s}\Phi_{t,t+s}\left\{\left[\lambda\frac{1}{[MRS_{t+s}^{NR}]}+(1-\lambda)\frac{1}{[MRS_{t+s}^{R}]}\right]W_t^{r,*}-\mu_w\right\}=0 \tag{27}$$

where $\Phi_{t,t+s}=L_{t+s}^{\varphi}L_{t+s}^{d}(W_{t+S}^{r})^{\theta_w}$, $L_t^d=\int_0^1 L_t(i)di$ is firms' aggregate demand for the composite labor input, and $\mu_w\equiv\theta_w/(\theta_w-1)$ represents the mark-up over the real wage in the absence of nominal wage rigidities . Variables MRS_{t+s}^{NR} and MRS_{t+s}^{R} are the marginal rates of substitution between hours and consumption of non-Ricardian and Ricardian agents, respectively, in period $t+s$, for a union resetting the wage in period t.

2.3.2 Decentralized wage-setting system

Flexible wages

At the other end of the spectrum, the representative union's problem under decentralization (standard case in a LAMP-DSGE economy) and flexible wages implies that

$$\frac{dC_{zt}^{NR}}{dW_{zt}^{r}}=\frac{\partial C_{zt}^{NR}}{\partial W_{zt}^{r}}+\frac{\partial C_{zt}^{NR}}{\partial L_{zt}^{NR}}\frac{dL_{zt}^{NR}}{dW_{zt}^{r}}=L_{zt}^{NR}(1-\theta_W)<0,$$

$$\frac{dC_{zt}^{R}}{dW_{zt}^{r}}=\frac{\partial C_{zt}^{R}}{\partial W_{zt}^{r}}+\frac{\partial C_{zt}^{R}}{\partial L_{zt}^{R}}\frac{dL_{zt}^{R}}{dW_{zt}^{r}}=L_{zt}^{R}(1-\theta_W)<0$$

and

$$\frac{dL_{zt}}{dW_{zt}^{r}}=-\theta_W\frac{L_{zt}}{W_{zt}^{r}}<0$$

The counterpart of equation (25) is

$$W_t^r=\frac{\theta_W}{\theta_W-1}\left[\frac{\lambda}{[MRS_{t+s}^{NR}]}+\frac{(1-\lambda)}{[MRS_{t+s}^{R}]}\right]^{-1} \tag{28}$$

In a decentralized wage-setting system $(n^{-1}\rightarrow 0)$, unions set the real wage as a mark-up over the marginal rate of substitution. In standard models with monopolistic competition and decentralized union, this mark-up (and thus the real wage) depends only on the elasticity of substitution among varieties θ_W .

$$\lim_{n\to\infty}\left(\frac{e_L}{e_L-1}\right)=\frac{\theta_W}{\theta_W-1}$$

Sticky wages

In the case in which not all unions are allowed to set their wages every period ($\xi_w \neq 0$), the first-order condition is given by equation (27) where W_t^r is determined by the equation (28).

2.4 Monetary policy

There are many plausible interest rate rules. For comparability with Bilbiie (2008), we restrict attention to the pure current rule and the forward-looking rule. Monetary policy is conducted according to a simple rule, whereby the nominal short-term riskless interest rate is set in response to variations in current or expected inflation, as follows:

$$I_t = IE_t\left(\frac{\Pi_{t+1}}{\Pi}\right)^{\varphi_\pi} \tag{29a}$$

$$I_t = I\left(\frac{\Pi_t}{\Pi}\right)^{\varphi_\pi} \tag{29b}$$

where $\Pi_t \equiv P_t/P_{t-1}$ is the inflation rate. The policy parameter φ_Π defines the responsiveness of the nominal interest rate to movements away from (zero) target rates of inflation. Monetary policy is called *active* (*passive*) if the nominal interest rate rises more (less) than one-for-one with the expected inflation rate, i.e. $\varphi_\Pi > 1$ ($\varphi_\Pi < 1$) (Leeper 1991). The condition $\varphi_\Pi > 1$ is the famous *Taylor Principle*. In standard sticky-price models (e.g.., Woodford 2011), the interest rate rule ensures local uniqueness of the Rational Expectations Equilibrium (REE) if it satisfies the Taylor Principle —without an upper under a current-looking interest rate rule and with an upper under a forward-looking rule (Lubik and Marzo 2007).

2.5 Aggregation, market clearing, and rational expectations equilibrium

We denote aggregate consumption, hours worked, and dividends by C_t, L_t, and D_t, respectively. Aggregate consumption and hours are given by a weighted average of the corresponding variables for each consumer type. Formally:

$$C_t = \lambda C_t^{NR} + (1-\lambda)C_t^R \tag{30}$$

and

$$L_t = \lambda L_t^{NR} + (1-\lambda)L_t^R = L_t^{NR} = L_t^R \tag{31}$$

Uniform allocation of labor demand across households, independently of their type, implies that $L_t = L_t^{NR} = L_t^R$. Market-clearing requires that all dividends be paid to asset holders

$$D_t = (1-\lambda)D_t^R \tag{32}$$

By Walras' law, the goods market also clears; all output must be consumed.

$$Y_t = C_t \tag{33}$$

Next, we define the rational-expectations equilibrium (REE) for the novel case of centralized wage setting with a few labor unions under flexible wages. Except for labor unions and monopolistic firms, all agents assume prices as given. A REE for the sticky price economy with nominal frictions, flexible wages, LAMP, and a centralized wage setting system with a few banks, consists of sequences for all endogenous prices and quantities such that each agent's optimality conditions are satisfied and all markets clear at any given time t. In other words, given price dispersion in period -1, Δ_{t-1}, and a value for the policy parameter φ_{π}, the REE is a process $\{Y_t,\ \Pi_t, F_t,\ K_t, \Delta_t,\ R_t, W_t^r, D_t^R, C_t^{NR}, C_t^R\}_{t=0}^{\infty}$ that satisfies equations (34)-(45), and (29).

The aggregate demand relationship is given by

$$Y_t = \frac{1}{\beta R_t E_t\left\{\dfrac{1-\lambda W_t^r}{1-\lambda W_{t+1}^r}\right\} E_t\{\Pi_{t+1}^{-1} Y_{t+1}^{-1}\}} \tag{34}$$

and the aggregate supply block of the model is described by

$$\left[\frac{1-\theta \Pi_t^{\theta_p - 1}}{1-\theta}\right]^{\frac{1}{1-\theta_p}} = \left(\frac{K_t}{F_t}\right)^{1-\theta_p} \tag{35}$$

where the auxiliary variables K_t and F_t are defined as

$$K_t = (1-\tau)W_t^r + \xi_p \beta E_t\left\{\Pi_{t+1}^{\theta_p - 1} F_{t+1}\right\} \tag{36}$$

and

$$F_t = 1 + \xi_p \beta E_t\left\{\Pi_{t+1}^{\theta_p - 1} F_{t+1}\right\}. \tag{37}$$

The FOC for the centralized wage setting under flexible wages is given by

$$W_t^r = \frac{e_L}{(e_L - 1)} \frac{L_t^{\varphi}}{[\lambda (C_t^{NR})^{-\sigma} + (1-\lambda)(C_t^R)^{-\sigma}]} - \frac{(1-\lambda)(C_t^R)^{-\sigma} D_t^R L_t^{-1} \Sigma_D}{(e_L - 1)[\lambda (C_t^{NR})^{-\sigma} + (1-\lambda)(C_t^R)^{-\sigma}]} \tag{38}$$

where

$$e_L = \ \theta_W (1 - n^{-1}) + \left[\sigma(1-\theta)(1-\theta\beta) - \frac{\lambda}{1-\lambda} + \lambda\right] n^{-1} \tag{39}$$

and

$$\Sigma_D = -\frac{\lambda}{1-\lambda} n^{-1} \tag{40}$$

Under centralized wage-setting regimes, both the demand and supply blocks of the model depend on unions' incentives to strategically change the real wage. These incentives are related to the elasticities e_L and Σ_D and rooted on the impact that such a wage has on the different components of unions' members utility, equation (23): hours worked and consumption levels for both types of workers.

Other equations of the non-policy block are the following:

$$C_t^{NR} = W_t^r L_t \tag{41}$$

$$C_t^R = \frac{1}{1-\lambda} L_t - \frac{\lambda}{1-\lambda} W_t^r\, L_t \tag{42}$$

$$D_t^R = \frac{1}{1-\lambda}(1 - W_t^r L_t) \tag{43}$$

$$Y_t = L_t \tag{44}$$

and

$$\Delta_t = (1-\theta)\left[\frac{1-\theta \Pi_t^{\theta_p - 1}}{1-\theta}\right]^{\frac{\theta_p}{\theta_p - 1}} + \theta \Pi_t^{\theta_p} \Delta_{t-1} \tag{45}$$

where the measure of relative price dispersion is defined as $\Delta_t = \int_0^1 \frac{Y_t(i)}{Y_t} di$.

The policy block is described by equation (29a) or (29b).

3 Steady state and linearized dynamics

For comparability with Ascari et al. (2017) and Bilbiie (2008), we assume an efficient steady state and adopt the same baseline calibration. To induce equality between the steady state marginal rate of transformation and the steady state marginal product of labor, we assume that the government imposes a lump-sum tax, T, on Ricardian households equal to steady state dividends, $T = D^R$. The latter assumption implies that $C^R = C^{NR} (= C)$ and thus, that agents have a common marginal rate of substitution between labor and consumption.[12] The steady state is not only efficient but also equitable: steady state shares of the two agents are equal, making aggregation much simplier. Moreover, the tax proceedings are then used by the government to subsidize steady state firm's labor demand at the constant rate τ. As a result, the government can perfectly offset the steady-state distortions associated with monopolistic competition in both the labor and product markets.

Time is measured in quarters. In the baseline parameterization, we set the discount factor β equal to 0.99, which implies a steady-state policy rate of roughly 4 percent (annualized). Following Ascari et al. (2017) and Bilbiie (2008), we set the risk aversion parameter equal to $\sigma = 2$, the labor-disutility curvature $\varphi = 3$, the Calvo price stickiness parameter, and the wage stickiness parameter $\xi_P = \xi_w = 0.75$ (implying an average price duration of one year). We target roughly 20% price and wage mark-ups, which corresponds to elasticities of substitution among good and labor types $\theta_p = \theta_w = 6$, respectively.

The model is solved by deriving log-linear approximations of the key optimality and market-clearing conditions, identities, and the policy rule around the non-stochastic (efficient) steady state with zero inflation (Table 1).

Table 1. Key equations

Euler equation, R	$\hat{c}_t^R = E_t \hat{c}_{t+1}^R - \sigma(\hat{\imath}_t - E_t \hat{\pi}_{t+1})$	(T.1)
Budget constraint, R	$\hat{c}_t^R = \widehat{w}_t^r + \hat{l}_t^{NR} + \hat{d}_t^R$	(T.2)
Budget constraint, NR	$\hat{c}_t^{NR} = \widehat{w}_t^r + \hat{l}_t^{NR}$	(T.3)

[12] Combining $C^R = C^{NR} (= C)$ with $L = L^{NR} = L^R$ means that, as long as the economy is on steady state, both types of households derive identical utilities.

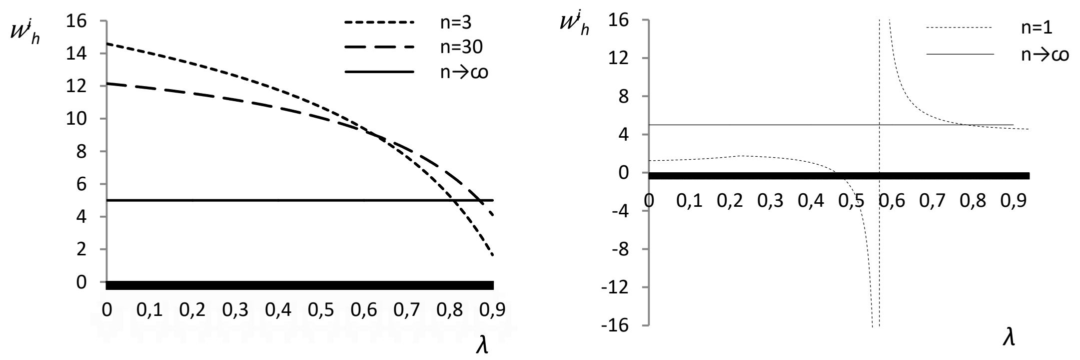
Wage-setting equation under centralization (cen) and flexible wages (fw)	$\hat{w}_t^r = w_{cen}^{fw}\hat{y}_t$	(T.4)
Parameter w_{cen}^{fw}	$w_{cen}^{fw} \equiv \frac{[\Phi(\varphi+\sigma+1)+2\sigma-1](1-\lambda)}{(1-\lambda)-(\Phi-1)(1-\sigma\lambda)}$	(T.5)
Composite parameter Φ	$\Phi = e_L(e_L-1)^{-1}$	(T.6)
Wage-setting equation under centralization (cen) and sticky wages (sw)	$\hat{w}_t^r = \frac{1}{1+\beta+\kappa_w}\hat{w}_{t-1}^r + \frac{\beta}{1+\beta+\kappa_w}E_t\hat{w}_{t+1}^r + w_{cen}^{sw}\hat{y}_t$	(T.7)
Parameter w_{cen}^{sw}	$w_{cen}^{sw} = \frac{\kappa_w}{1+\beta+\kappa_w}w_{cen}^{fw}$	(T.8)
Parameter κ_w	$\kappa_w \equiv \frac{(1-\beta\xi_w)(1-\xi_w)}{\xi_w}$	(T.9)
Wage-setting equation under decentralization (dec) and flexible wages (fw)	$\hat{w}_t^r = w_{dec}^{fw}\hat{y}_t$	(T.10)
Parameter w_{dec}^{fw}	$w_{dec}^{fw} \equiv \sigma+\varphi$	(T.11)
Wage-setting equation under decentralization (dec) and sticky wages (sw)	$\hat{w}_t^r = \frac{1}{1+\beta+\kappa_w}\hat{w}_{t-1}^r + \frac{\beta}{1+\beta+\kappa_w}E_t\hat{w}_{t+1}^r + w_{dec}^{sw}\hat{y}_t$	(T.12)
Parameter w_{dec}^{sw}	$w_{dec}^{sw} = \frac{\kappa_w}{1+\beta+\kappa_w}w_{dec}^{fw}$	(T.13)
Production function	$\hat{y}_t = \hat{l}_t$	(T.14)
Real marginal costs	$\widehat{mc}_t^r = \hat{w}_t^r$	(T.15)
Real profits/dividends	$\hat{d}_t = -\hat{w}_t^r$	(T.16)
Labor market clearing	$\hat{l}_t = \lambda\hat{l}_t^{NR} + (1-\lambda)\hat{l}_t^R$	(T.17)
Aggregate consumption	$\hat{c}_t = (1-\lambda)\hat{c}_t^R + \lambda\hat{c}_t^{NR}$	(T.18)
Aggregate hours	$\hat{l}_t = \hat{l}_t^{NR} = \hat{l}_t^R$	(T.19)
Monetary policy	$\hat{\imath}_t = i + \varphi_\pi\hat{\pi}_t$	(T.20a)
	$\hat{\imath}_t = i + \varphi_\pi E_t\hat{\pi}_{t+1}$	(T.20b)
Dividend market clearing	$\hat{d}_t = (1-\lambda)\hat{d}_t^R$	(T.21)

Before moving on, it is worthwhile to draw attention to real wage schedule. Figure 2 compares the coefficient on current output in the real wage schedule, w_h^i across economies with more versus less centralized wage bargaining systems, under both flexible and sticky wages, where $i \epsilon \{fw, sw\}$ denotes wage flexibility (fw = flexible, sw = sticky) and $h \epsilon \{dec, cen\}$ denotes the wage-setting regime (dec = decentralized, cen = centralized). Three points worth noting. First, in countries characterized by more centralized wage bargaining systems, the coefficient of current output is higher relative to the coefficient that emerges with decentralized wage bargaining systems. For example, under flexible wages with $\lambda = 0.35$, we obtain $w_{cen}^{fw} = 12.2$ for $n = 3$ and $w_{cen}^{fw} = 10.915$ for $n = 30$, whereas for $n \to \infty$ we find $w_{dec}^{fw} = 5$.[1]

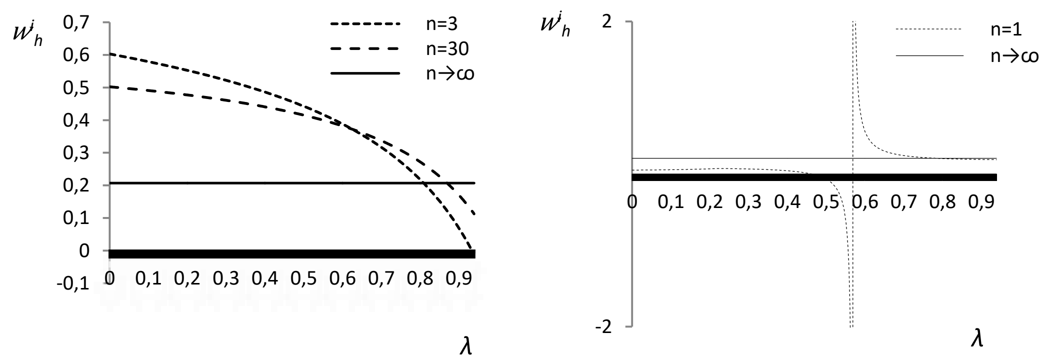
Second, this pattern does not hold for the monopoly union case. For $n = 1$ (monopoly union), we find $w^{fw}_{cen} = 1.41$. Indeed, with monopoly unionism, the coefficient of current output is lower, making the real wage less procyclical.

Third, under monopoly unionism, real-wage cyclicality varies non-monotonically with financial exclusion. Particularly, real wage is weakly procyclical at moderate financial exclusion, becomes countercyclical once exclusion exceeds $\lambda = 0.57$, and then—right of the threshold—turns strongly procyclical. The intuition is straightforward: For $\lambda < 0.57$, the Ricardian Intertemporal Substitution Effect and the Profit-Divident Effect dominate the Non-Ricardian Disposable Income Effect, leading to wage claims moderation. For $\lambda > 0.57$, the Non-Ricardian Disposable Income Effect dominates and monopoly union's wage hikes are more aggressive when labor demand (output) changes. However, note that $\lambda = 0.57$ is a very high value compared with typical empirical estimates of non-Ricardian shares around 0.35–0.40, so countercyclicality arises only under very high levels of financial exclusion. This pattern aligns with evidence suggesting that countries with stronger unions tend to have less pro-cyclical (or more counter-cyclical) real wages (see, for example, Messina et al. 2009). As we will see below, these are the main driving force behind our results.

Figure 2: Wage setting centralization and real wage schedule



a) flexible wages



b) sticky wages

Once all calculations have been performed, the general equilibrium model can be expressed through the policy and non-policy blocks, the latter of which can be represented by an aggregate demand condition and a New Keynesian Phillips curve.

4 Aggregate dynamics

The following equations summarize log-linear equilibrium dynamics around the non-stochastic efficient steady state with zero inflation. Percentage deviations from the steady state are denoted with small letters with a hat. Under flexible wages, equilibrium dynamics are summarized for price inflation, $\hat{\pi}_t$, and the output gap $\hat{x}_t = \hat{y}_t - \hat{y}_t^e$, i.e., the gap between the actual output and its efficient counterpart. Under sticky wages, one additional variable is added: wage inflation $\hat{\pi}_t^w$.

The two-equation dynamic system under flexible wages consists of the New Keynesian IS curve, equation (46) and the New Keynesian Phillips curve, equation (47).

$$\hat{x}_t = E_t\hat{x}_{t+1} - \delta_h^i E_t\left(\hat{\imath}_t - \hat{\pi}_{t+1} - \hat{r}_t^{eff}\right) \tag{46}$$

where $i = \{fw, sw\}$ with fw standing for flexible wages and sw for sticky wages and $h = \{dec, cen\}$ with dec standing for decentralized wage-setting regimes and cen for centralized wage-setting regimes. The composite parameter δ_h^i, the slope of the IS curve, denotes the elasticity of aggregate demand with respect to the real interest rate.[13]

$$\delta_h^i = \frac{1}{\sigma}\left(1 - \frac{\lambda}{1-\lambda} w_h^i\right)^{-1} \tag{47}$$

where $w_h^i \equiv \frac{d(\hat{w}_t^r)_h^i}{d\hat{y}_t}\frac{d\hat{y}_t}{d\hat{x}_t}$ is the slope of the labor supply curve under different wage centralization and flexibility regimes. This elasticity depends on the degree of asset market participation in a non-linear way. There exists a certain threshold for the parameter of financial exclusion λ beyond which the parameter δ_h^i becomes negative, thus changing the sign of the slope of the IS curve with respect to that in a conventional, full participation model. This critical value, denoted by $\lambda_h^{i,*}$, is given by

$$\lambda_h^{i,*} = \frac{1}{1 + w_h^i}. \tag{48}$$

For low enough participation rates, $\lambda > \lambda_h^{i,*}$, we are in the 'Inverted Aggregate Demand' (IADL) region, where increases in the real interest rate become expansionary (increase aggregate demand). In other words, the IADL region is realized when enough agents consume their wage income.

The New Keynesian Phillips Curve (NKPC) relates inflation to its one period ahead forecast, and the real marginal cost.

$$\hat{\pi}_t = \beta E_t\hat{\pi}_{t+1} + \gamma_h^i\hat{x}_t \tag{49}$$

The composite parameter γ_h^i is the slope of the NKPC and it denotes the elasticity of the marginal cost (real wage), from the firms' perspective, with respect to the output gap.

$$\gamma_h^i = \kappa_p w_h^i \tag{50}$$

[13] Since technology and preferences shocks are turned off, the efficient real interest rate is zero, $\hat{r}_t^{eff} = 0$.

where $\kappa_p \equiv (1-\beta\xi_P)(1-\xi_P)/\xi_P$.

The third-equation dynamic system that prevails under sticky wages consists of the IS curve, equation (51), the New Keynesian Phillips curve for price inflation, equation (49), and a wage inflation curve, equation (52). In the case of sticky wages, the counterpart of equation (46) is

$$\hat{x}_t = E_t\hat{x}_{t+1} - \delta_h^i E_t(\hat{\imath}_t - \hat{\pi}_{t+1}) + \frac{\lambda}{1-\lambda} E_t \Delta \widehat{w}_{t+1}^r \tag{51}$$

The wage inflation curve, is different from that in Erceg et al. (2000) and Ascari et al. (2017) and is given by

$$\hat{\pi}_t^w = \beta E_t \hat{\pi}_{t+1}^w + \kappa_w \left[\left(\frac{[\Phi(\varphi+\sigma+1)+2\sigma-1](1-\lambda)}{(1-\lambda)-(\Phi-1)(1-\sigma\lambda)} \right) \hat{x}_t - \widehat{w}_t^r \right] \tag{52}$$

5 Wage centralization and the slope of the New Keynesian IS curve and Phillips curve

In this section, we explore the role played by the LAMP hypothesis under different union structures, namely centralized wage-setting versus decentralized wage-setting, for the aggregate demand and supply dynamics (New Keynesian IS curve and Phillips curve). We compare our results to those in the traditional literature of LAMP, specifically with those in Bilbiie's (2008) results, which consider a model with flexible wages, and with Ascari et al.'s findings (2017), who introduce wage stickiness into a LAMP economy. In a rather impactful article, Bilbiie (2008) shows that, when asset market participation is restricted beyond a certain threshold, the slope of the New Keynesian IS curve may turn positive, leading to what he calls the '*Inverted Aggregate Demand Logic'* (IADL) region. In the parameter space where the IADL holds, aggregate demand increases with the real interest rate. This result, however, has been challenged by Ascari et al. (2017). By incorporating wage stickiness into a LAMP economy, they show that the IADL confines to extreme parameterizations. In the remainder of this section, we restore the relevance of the negatively sloped New Keynesian IS curve particularly when there is a monopoly union by considering the presence of centralized wage-setting regimes.

To clarify our point, we compare the elasticity of aggregate demand with respect to the real interest rate (the IS slope coefficient δ_h^i), across centralized and decentralized wag -setting, under both flexible and sticky wages.

Under decentralization with flexible wages, $w_h^i \equiv w_{dec}^{fw}$ (see equation T.11). Then, the slope of the IS curve (Bilbiie 2008)[14] equals

$$\delta_{dec}^{fw} = \frac{1}{\sigma}\left[1 - \frac{\lambda(\sigma+\varphi)}{1-\lambda}\right]^{-1} \tag{53}$$

and the threshold value for financial exclusion λ beyond which the IS curve turns positive is

$$\lambda_{dec}^{fw,*} = \frac{1}{1+\sigma+\varphi}. \tag{54}$$

[14] The expression is slightly different from Bilbiie (2008) and identical to Ascari et al. (2017).

Under decentralization with sticky wages and using $w_h^i \equiv w_{dec}^{sw}$ (see equation (T.13)), we obtain

$$\delta_{dec}^{sw} = \frac{1}{\sigma}\left[1 - \frac{\lambda(\sigma+\varphi)}{1-\lambda}\frac{\kappa_w}{1+\beta+\kappa_w}\right]^{-1} \tag{55}$$

and

$$\lambda_{dec}^{sw,*} = \frac{1}{1+(\sigma+\varphi)\frac{\kappa_w}{1+\beta+\kappa_w}} \tag{56}$$

We now turn to the centralized wage-setting regime. With flexible wages, $w_Y \equiv w_{cen}^{fw}$ (see equation (T.5)) the slope of the IS curve is defined by

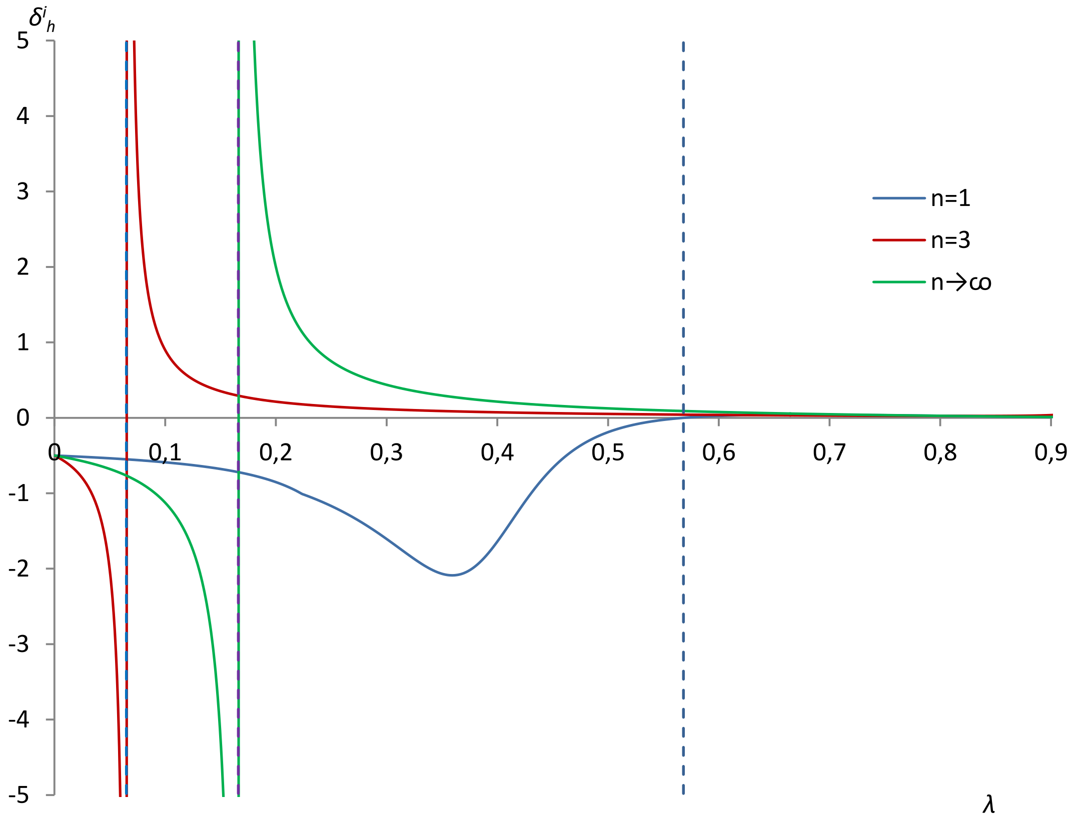
$$\delta_{cen}^{fw} = \frac{1}{\sigma}\left[1 - \frac{\lambda}{1-\lambda}\frac{[\Phi(\varphi+\sigma+1)+2\sigma-1](1-\lambda)}{(1-\lambda)-(\Phi-1)(1-\sigma\lambda)}\right]^{-1} \tag{57}$$

While under sticky wages and centralization with $w_Y \equiv w_{cen}^{sw}$ (see equation (T.8)), we obtain

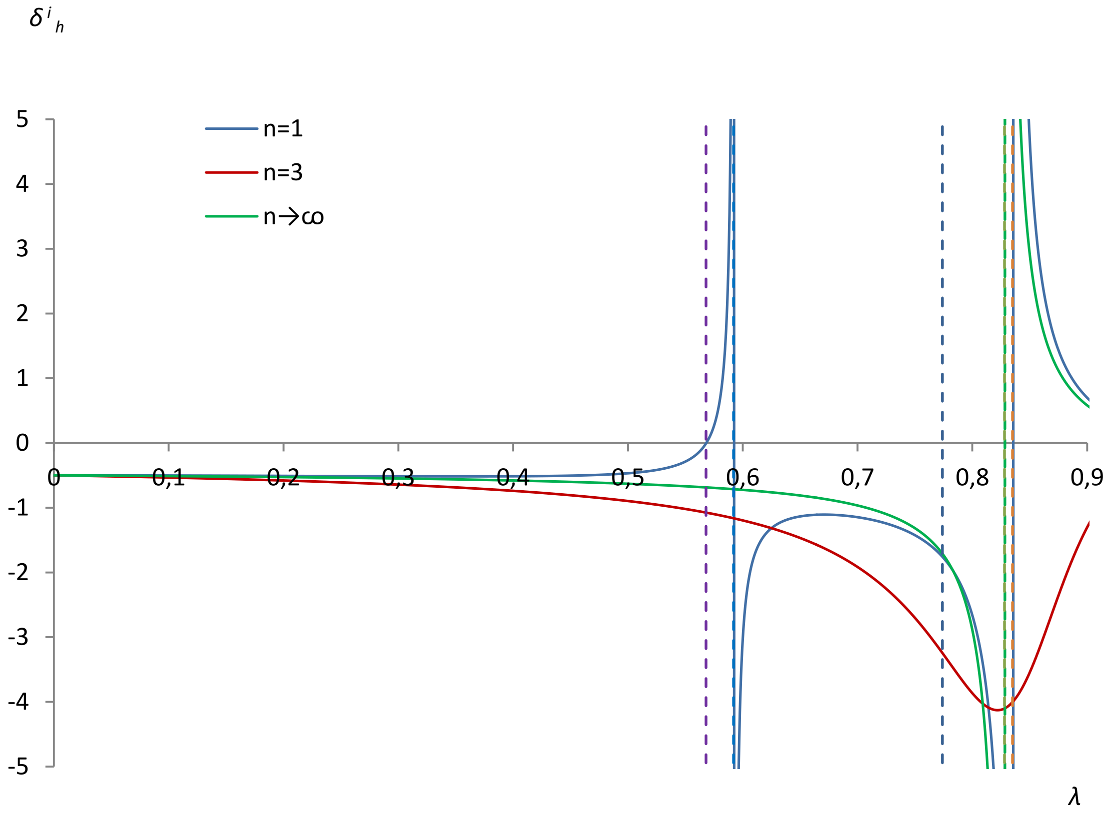
$$\delta_{cen}^{sw} = \frac{1}{\sigma}\left[1 - \frac{\lambda}{1-\lambda}\frac{[\Phi(\varphi+\sigma+1)+2\sigma-1](1-\lambda)}{(1-\lambda)-(\Phi-1)(1-\sigma\lambda)}\frac{\kappa_w}{1+\beta+\kappa_w}\right]^{-1} \tag{58}$$

It is worth stressing that, under the centralized regime, both the slope of the IS curve and its threshold are directly related to unions incentives to strategically change the real wage, via the composite parameter $\Phi = e_L(e_L-1)^{-1}$. This link between wage-setting structure with the IS slope and the IADL threshold is a novel aspect of our analysis.

Figure 3: Wage-setting centralization and the IS curve slope



a) Flexible wages



b) Sticky wages

Figure 3 plots the elasticity of aggregate output with respect to the real interest rate as a function of the degree of financial exclusion λ and the number of unions n (equivalently, the degree of centralization of the wage setting n^{-1}) for flexible wages (panel a) and sticky wages (panel b). Using the standard set of parameter values, we consider i) centralized wage setting with $n = 1$ (monopoly union) and $n = 3$, and ii) decentralized wage setting with $n \to \infty$.

Two points stand out: First, in both panels the impact of the real interest rate on output is nonlinear in the degree of asset market participation λ. Below a threshold value of λ, the link between the policy rate and output strengthens: monetary policy becomes more effective, so small increases in policy rates have pronounced contractionary effects. Once financial exclusion exceeds this critical threshold, the usual relationship between the interest rate and aggregate demand inverts—output responds positively to rises in the real interest rate. Following Bilbiie (2008), this is the Inverted Aggregate Demand Logic (IADL) region. The threshold values at which the IADL arises appear as vertical asymptotes of the elasticity for different values of λ. The IADL region is to the right of each vertical asymptote. Monetary policy becomes progressively less effective within the IADL as the level of financial exclusion λ increases above the threshold. Second, the threshold value for the IADL to occur is not fixed; it critically depends on the degree of wage-setting centralization. Table 2 reports the threshold value of λ under alternative wage-setting regimes and flexible and sticky wages for our baseline parameter values. We adopt the calibration of Ascari et al. (2017) to ensure comparability with their numerical results. With flexible wages, the threshold value of λ is low under decentralization $\to \infty$, i.e., about 0.17 as in Ascari et al. (2017) and even lower for $n = 3$. By contrast, under monopoly unionism $n = 1$, the threshold shifts far to the right, to $\lambda_{cen}^{fw,*} = 0.57$. With sticky wages, the pattern is more extreme. Wage rigidity shifts the thresholds further right to roughly 0.57-0.96 (depending on n).

Table 2: Critical value of λ under different modes of unionization and wage regimes

	Decentralized wage-setting	Centralized wage-setting	
	$n \to \infty$	$n = 3$	$n = 1$
Flexible wages	$\lambda_{dec}^{fw,*} = 0.17$	$\lambda_{cen}^{fw,*} = 0.065$	$\lambda_{cen}^{fw,*} = 0.57$
Sticky wages	$\lambda_{dec}^{sw,*} = 0.83$	$\lambda_{cen}^{sw,*} = 0.96$	$\lambda_{cen}^{sw,*} = \{0.57, 0.6, 0.83\}$

These findings lead us to the following proposition regarding the IS slope inversion.

PROPOSITION 1 (Centralization and the IS slope). *In wage centralized economies, the slope of the IS curve turns positive iff:*

$$\lambda > \lambda_{cen}^{fw,*} = \frac{1}{1 + w_{cen}^{fw}}, \qquad for\ flexible\ wages$$
$$\lambda > \lambda_{cen}^{sw,*} = \frac{1}{1 + w_{cen}^{sw}}, \qquad for\ sticky\ wages$$

We state several corollaries of Proposition 1 to collect further results on the IS curve slope.

COROLARY 1. *The threshold values beyond which IADL holds, $\lambda_{cen}^{fw,*} = g_1(n^{-1})$ and $\lambda_{cen}^{sw,*} = g_2(n^{-1})$, are increasing in the degree of wage-setting centralization. As wage setting becomes more centralized (smaller n, larger n^{-1}), the economy requires more financial exclusion for the IS curve to turn upward.*

COROLLARY 2. *Regardless of whether wages are flexible or sticky, under monopoly unionism, the IADL region is empty (it does not exist).*

Highly concentrated labor markets confine the IADL region to extreme calibrations. With a monopoly union, IADL requires financial exclusion above 57% under flexible wages and above 57% (60% and 83%) under sticky wages. These threshold values are substantially higher than empirical estimates of hump-to-mouth (around 40%) reported by Krueger et al. (2016) and Aguiar et al. (2025), implying that, under strong centralization, IADL is empirically less likely unless exclusion is unusually high. [15] This contrasts with the standard result that IADL is non-empty under flexible wages. Intuitively, monopoly unionism, fully internalizes the aggregate impact of its wage policy, altering the wage block (through e_L, hence $\Phi = e_L(e_L - 1)^{-1}$ and w_{cen}^{fw}), and thereby the IS slope and the threshold at which IADL would arise.

COROLLARY 3. *The slope of the IS curve under centralized wage bargaining regimes is increasing in the unions' incentive to strategically set their wage claims, as captured by the composite parameter Φ.*

[15] These thresholds are model- and calibration-dependent; while our baseline puts them above 0.57, alternative parameterizations could shift them. Nonetheless, relative to the 40% benchmark in the data, strong centralization robustly pushes the IADL region toward the extreme right tail of λ.

COROLLARY 4. *In a LAMP economy, the effectiveness of monetary policy is conditional on wage-setting centralization.*

Monetary policy is most effective near the threshold values of financial exclusion λ. In our setting, this efficient space shifts with n: under greater centralization (smaller n) it occurs at lower levels of financial exclusion (smaller λ), while under decentralization (smaller n) it moves to higher levels of λ, narrowing the parameter region where standard, contractionary rate hikes prevail.

Beyond its effect on aggregate demand dynamics, wage-setting centralization also affects the slope of the New Keynesian Phillips curve γ_h^i (equation 48). The next proposition provides a general result concerning LAMP, wage setting centralization, and the New Keynesian Phillips curve slope.

PROPOSITION 2 (Centralization and the New Keynesian Phillips curve slope). *In wage-centralized economies, the slope of the New Keynesian Phillips curve depends on the interaction between financial markets (e.g., the degree of financial exclusion) and unionized wage setting (e.g., the degree of wage setting centralization). This dependence is absent under decentralized wage setting, the standard case in the literature.*

As corollaries to proposition 2 we can state the following two.

COROLLARY 5. *Under centralized wage bargaining, the slope of the New Keynesian Phillips curve increases with unions' incentives for aggressive wage setting. In particular, greater financial exclusion and greater centralization both steepen the New Keynesian Phillips curve (i.e., raise γ_h^i).*

Recall that $\widehat{mc}_t^r = w_h^i \hat{x}_t$. Iterating forward equation (49) yields

$$\hat{\pi}_t = \gamma_h^i E_t \sum_{i=0}^{\infty} \beta^i \hat{x}_{t+i} \tag{59}$$

Price-setting decisions by firms (who can re-optimize), and thus inflation, are tied to current and anticipated cost conditions with sensitivity $\gamma_h^i = \kappa_p w_h^i$. This sensitivity is strictly increasing in the degree of wage setting centralization n^{-1} and financial exclusion λ. Highly centralized wage setting regimes implies a higher level of desired real wage, and thus marginal cost, leading re-optimizing firms to choose higher prices. In other words, with strong unions in place, the desired real wage is more sensitive to aggregate activity, i.e., they are better able to take advantage of a higher labor demand. A similar effect on the New Keynesian Phillips curve is generated by the degree of financial exclusion: the larger the fraction of the population that cannot smooth income through financial markets, the greater the pressure on the labor unions representing them to push for large wage increases. These outcomes distinguish our model from the standard New Keynesian model with or without LAMP, where labor markets are decentralized and there are no interactions between unionized labor markets and financial markets.

COROLLARY 6. *Centralized economies have a lower sacrifice ratio than decentralized ones. However, under monopoly unionism, larger output losses are needed to disinflate the economy.*

The intuition is straightforward. The steeper the New Keynesian Phillips curve, the smaller the output change Δx required to obtain a given reduction in inflation $\Delta \pi$ — hence, the lower the sacrifice ratio. In our framework we have

$$\Delta x = -\left(\gamma_h^i\right)^{-1} \Delta \pi,$$

so a higher γ_h^i implies a smaller $|\Delta x|$ for the same $\Delta \pi$. Under wage centralization ($n > 1$), unions' behavior—operating through e_L and Φ —raises γ_h^i relatively to the decentralized case (see Corollary 5), decreasing sacrifice ratio. This is consistent with the empirical finding that the output cost of disinflation declines with greater coordination among wage-setters (Bowdler and Nunziata 2010). Our model also delivers a theoretical counterpart to that evidence.

Besides our theoretical proof of this empirical result, our model delivers a theoretical counterpart to that evidence. By contrast, under monopoly unionism ($n = 1$) and for reasonable values of financial exclusion $\lambda < 0.57$, the monopoly union *fully* internalizes the aggregate effects of its wage decisions. This implies a lower γ_h^i, and thereby, a higher sacrifice ratio.

6 Determinacy and the Taylor Principle

The concepts of equilibrium uniqueness and multiplicity have been central in the monetary policy literature (Clarida et al. 2000, Bullard και Mitra 2002). Determinacy refers to the set of conditions under which a dynamic system converges to a single, well-defined rational-expectations equilibrium. When these conditions are not satisfied—most commonly because monetary policy reacts too weakly to inflation—the model becomes indeterminate: expectations are no longer uniquely anchored by fundamentals, and self-fulfilling (sunspot) fluctuations can arise, undermining the stabilizing role of policy and increasing macroeconomic volatility.

Monetary policy itself can be active or passive in the sense of Leeper (1991). Policy is active if the nominal interest rate rises more than one-for-one with current inflation, and passive if it rises by less. Which regime is stabilizing is not invariant to the structure of the economy. A strand of work shows that changes in the slope of the New Keynesian IS curve—driven, for example, by limited asset market participation (financial exclusion), or labor-market features such as the intertemporal elasticity of labor supply and wage stickiness—can reverse the usual determinacy results (Bilbiie 2008, Bilbiie and Straub 2004, Galí et al. 2004 and 2007, Rossi 2014). In such environments, policies that would deliver determinacy in the baseline NK model (active monetary policies that follows the Taylor principle) may no longer do so. Passive rules satisfying the inverted Taylor principle can restore uniqueness.

6.1 Wage-setting centralization and the Taylor principle

In what follows, we study the stability properties of our model under the two alternative monetary policy regimes, the current-looking and the forward-looking interest rate rules, eqs. (T.20a) and (T.20b). Recall that in highly centralized wage-setting regimes, unions' behavior affects the IS slope and can therefore change the determinacy conditions. We first analyze equilibrium determinacy in the flexible wage model and then turn to sticky wage model.

Flexible wages

Equations (46), (49), and (T.20a) imply the minimal state-space representation of the model involving two variables:[16] $AE_t\{z_{t+1}\} = B\{z_t\}$ where $z_t \equiv [\hat{x}_t,\ \hat{\pi}_t]'$ is the $2x1$ vector of the endogenous (non-predetermined) variables. The $2x2$ matrices of the coefficients are defined as

$$A = \begin{bmatrix} 1 & \delta_h^i \\ 0 & \beta \end{bmatrix},\ B = \begin{bmatrix} 1 & \delta_h^i \varphi_\Pi \\ -\gamma_h^i & 1 \end{bmatrix}$$

In order to study the determinacy of the system we need to analyze the eigenvalues of the matrix $J = A^{-1}B$. For determinacy, the number of eigenvalues of J outside the unit circle must equal the number of non-predetermined endogenous variables (Blanchard and Kahn, 1980). Therefore, using Woodford (2011), we derive Proposition 3.

PROPOSITION 3. *Under the interest rate rule (T.20a) and flexible wages, the necessary and sufficient conditions for a rational expectations equilibrium to be locally unique is that:*

Case I Under monopoly unionism ($n = 1$) the IS curve in a LAMP economy is always negatively sloped. Then,

$$\varphi_\Pi \in (1, \infty) \tag{60}$$

Case II Under both centralized wage setting ($n > 1$) and decentralized wage setting ($n \to \infty$), where the IS curve may change sign, $\delta_h^i \gtrless 0$, we obtain:

i) *for $\delta_h^i > 0$:*

$$\varphi_\Pi \in (1, \infty) \tag{61}$$

ii) *for $\delta_h^i < 0$:*

$$\varphi_\Pi \in [(0, min\{\varphi_1, 1\}) \cup (max\{1, \varphi_2\}, \infty)] \tag{62}$$

where

$$\varphi_1 \equiv \frac{(1-\beta)}{(-\delta_h^i)\gamma_h^i} \tag{63}$$

and

$$\varphi_2 \equiv \frac{2(1+\beta)}{(-\delta_h^i)\gamma_h^i} - 1 \tag{64}$$

with $(-\delta_h^i) > 0$, $\delta_h^i \equiv \delta_{dec}^{fw}$, and $\gamma_h^i \equiv \gamma_{dec}^{fw}$ (see eqs. (53), (50), and (T.11)) for the decentralized case and $\delta_h^i \equiv \delta_{cen}^{fw}$ and $\gamma_h^i \equiv \gamma_{dec}^{fw}$ (see eqs. (57), (50), and (T.5)) for the centralized one ($n > 1$).

According to Case I, LAMP becomes irrelevant for the conduct of monetary policy under monopoly unionism. The Taylor principle—without bounds—prescribes the necessary

[16] Given the focus of the paper on the equilibrium dynamics of the model we assume that non fundamental shocks hit the economy

and sufficient condition for equilibrium determinacy, as in the case with a full Ricardian economy $\lambda = 0$ (Woodford 2011, Lubik and Marzo 2007). The central bank has to increase its policy rate more than one-for-one in response to an increase in expected domestic inflation to avoid multiple equilibria. The determinacy region is independent of the model's structural parameters; it is pinned down by policy behavior alone. This feature—embodied in the Taylor principle—has become the hallmark argument for the preferability of inflation targeting (Lubik and Marzo 2007).

To build intuition for Case I, we suppose that the level of inflation starts increasing without fundamentals to justify it. The central bank, adhering to the Taylor principle, raises the nominal rate so the real rate increases and Ricardian households reduce their consumption. Due to lower demand, some firms will set a lower price, while those firms who cannot adjust their price will reduce labor demand, putting a downward pressure on the real wage. This generates a reduction in non-Ricardian households' consumption that further restricts aggregate demand. If φ is large enough, small changes in hours translate into large variations in the real wage. Consequently, real marginal costs decrease and, thus, there is a potential increase in (Ricardian) profits. The latter determines a positive wealth effect on Ricardian consumption. Note that if λ is sufficiently high, this wealth effect can partly offset the initial contraction and raise demand. In that case, the positive comovement of inflation and output implied by the New Keynesian Phillips curve can ex post rationalize the sunspot (i.e., make it compatible with a rational-expectations equilibrium).

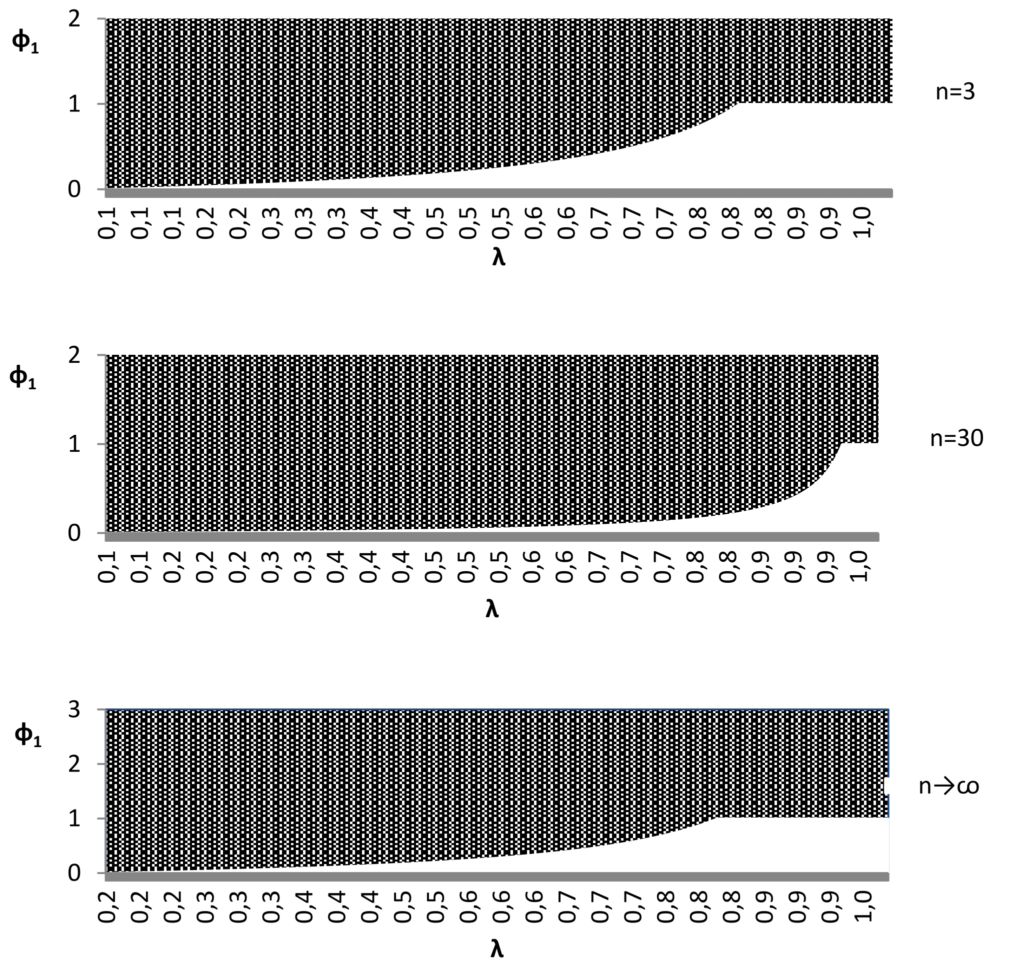
How does monopoly unionism alter this mechanism? A monopoly union fully internalizes the aggregate consequences of its wage choice. For non-extreme financial exclusion, the Ricardian intertemporal-substitution and profit–dividend channels dominate the non-Ricardian disposable-income channel, so the strong union moderates wage claims (weakly real wage procyclicality). By dampening the real-wage response to an increase in output (labor demand), it prevents a large fall in marginal costs and, therefore, a large rise in Ricardian profits. The resulting wealth effect is too small to offset the contractionary substitution effect exerted on Ricardian demand from the higher real rate. Thus, the central bank's Taylor-principle response, via Ricardian demand, suffices to ensure equilibrium uniqueness. In other words, we differentiated from previous work and show that monopoly unionism restores the Taylor Principle.

We now turn to Case II. Monetary policy must obey the Taylor principle in its strongest possible form in both centralized wage setting ($n > 1$) and decentralized wage setting ($n \to \infty$), as long as the IS curve is negatively sloped. This stops being true when $\delta_h^i < 0$. In this case, there are two determinacy regions, thereby, monetary policy must be hybrid as in Bilbiie (2008), Boerma (2014), and Rossi (2014), albeit for different reasons. In the first space, monetary policy has to adopt a passive role and satisfy the 'Inverted Taylor principle', i.e., $\varphi_\Pi < 1$. The central bank has to adjust its policy rate less than one-for-one in reaction to changes in inflation expectations. This conduct may have an upper limit represented by φ_1 that must be satisfied. In the other determinacy space, monetary policy needs to adopt an active role, with a potential downward limit represented by φ_2. For higher levels of financial exclusion, the 'Inverted Taylor principle' is too weak a criterion (figure 4) and determinacy requires the real interest rate to rise more aggressively in response to inflation (Bilbiie 2008).

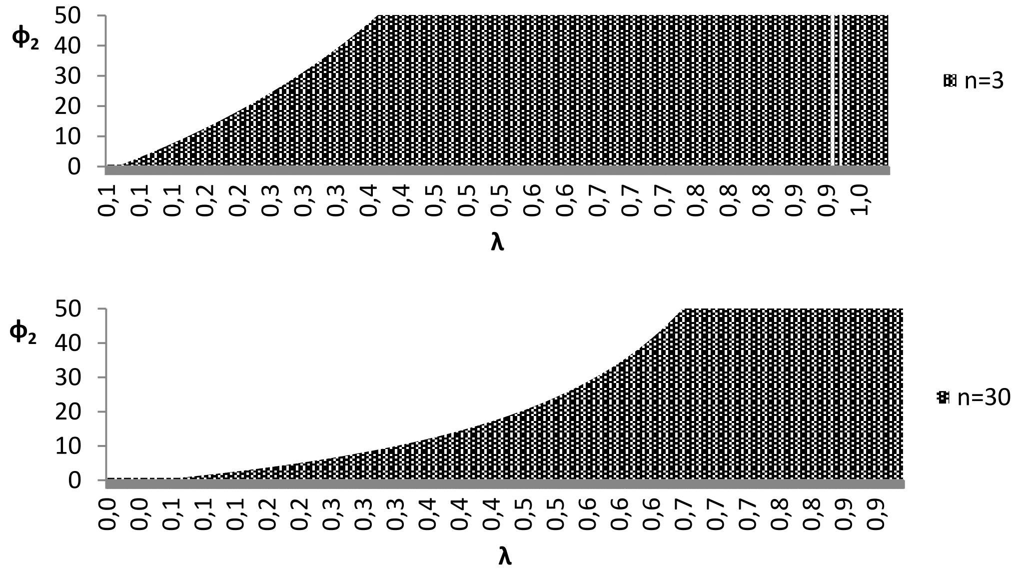
How tight are the bounds on the Taylor inflation coefficient? Are these bounds related to union policies that moderate wage setting? Remarkably, both limits, φ_1 and φ_2 depend, among other things, on w_h^i. We first consider the first stability region. Alternative wage-setting structures, i.e., centralized versus decentralized, have different implications for the degree of monetary policy aggressiveness required to ensure determinacy. Based on the adopted calibration, figure 4 (panel a) displays determinacy analysis in the (φ_1, λ)

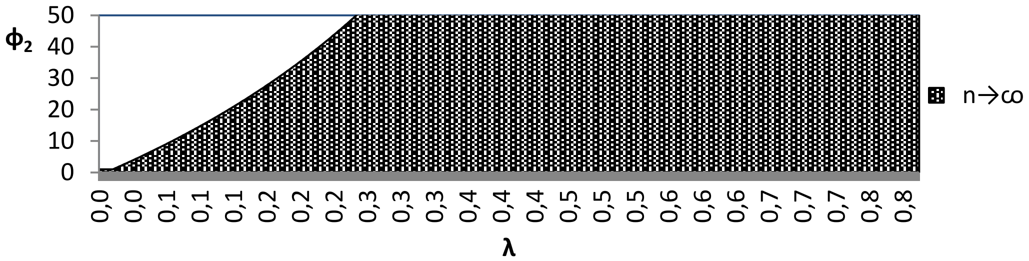
space for different parameter combinations of n in the Inverted Aggregate Demand region.

Figure 4. Determinacy, IADL, and wage setting centralization: Current-looking policy rule



a) first stability region





b) second stability region

Note: Determinacy (white areas) and indeterminacy (black areas).

Regarding the second stability region, it is the case (as in Gali et al 2004., Bilbiie 2008) that a policy rule responding to current inflation very strongly would insure equilibrium uniqueness. However, the lower bound on the inflation coefficient, φ_2 , is quite high. For $\lambda = 0.35$, we obtain $\varphi_2 = 30.39$, $\varphi_2 = 7.3$, and $\varphi_2 = 41.34$ for $n = 3$, $n = 30$, and $n \to \infty$ respectively which are far from any empirical estimates. This implies that there may exists a level of λ such that determinacy can be achieved by an interest rate peg, that is, by the policy rule $r_t = \rho$. Figure 4 (panel b) presents the second stability region in the Inverted Aggregate Demand in the (φ_2, λ) parameter plane and for various values of n.

The above observations leads us to Proposition 4.

PROPOSITION 4. *i) In centralized economies, ensuring determinacy within the IADL region requires a more aggressive hybrid monetary policy than in decentralized economies.*

ii) In centralized economies, a higher degree of financial exclusion λ and/or greater wage-setting centralization n^{-1} strengthens unions' incentives, leading to *more aggressive wage policies and shifts the determinacy regions outward.*

The mechanism explaining part (i) and (ii) of Proposition 4 is straightforward. More aggressive wage policies, steepen the labor supply (increase the output sensitivity of the real wage) and expand the bounds φ_1 and φ_2. Thus, the policy maker must react more forcefully (i.e., adopt a more aggressive hybrid monetary policy) to ensure the determinacy of the system.

Let's now proceed to the case of forward–looking interest rate rule (T.20b) with flexible wages. Then, after some algebraic substitutions, we obtain that the J matrix is

$$J = \begin{bmatrix} 1 - \dfrac{\delta_h^i(\varphi_\Pi - 1)\gamma_h^i}{\beta} & \dfrac{\delta_h^i(\varphi_\Pi - 1)}{\beta} \\ -\dfrac{\gamma_h^i}{\beta} & \dfrac{1}{\beta} \end{bmatrix}$$

The necessary and sufficient conditions for determinacy are presented at Proposition 5.

PROPOSITION 5. *Under the forward looking interest rate rule and flexible wages, equilibrium determinacy is achieved when:*

Case I Under monopoly unionism ($n = 1$) the IS curve in a LAMP economy is always negatively sloped. Then,

$$1 < \varphi_{\Pi} < \varphi_3 \quad (65)$$

Case II Under both centralized wage setting ($n > 1$) *and decentralized wage setting* ($n \to \infty$), *where the IS curve may change sign,* $\delta_h^i \gtrless 0$, *we obtain:*

i) *for* $\delta_h^i > 0$*:*

$$1 < \varphi_{\Pi} < \varphi_3 \quad (66)$$

ii) *for* $\delta_h^i < 0$*:*

$$\varphi_4 < \varphi_{\Pi} < 1 \quad (67)$$

where

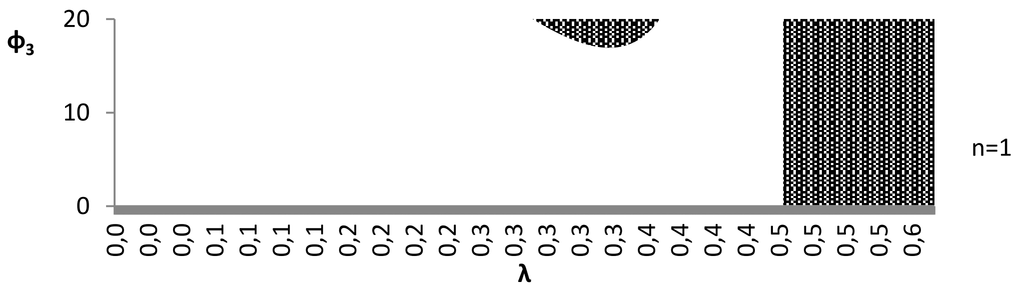
$$\varphi_3 \equiv 1 + \frac{2(1+\beta)}{\delta_h^i \gamma_h^i} \quad (68)$$

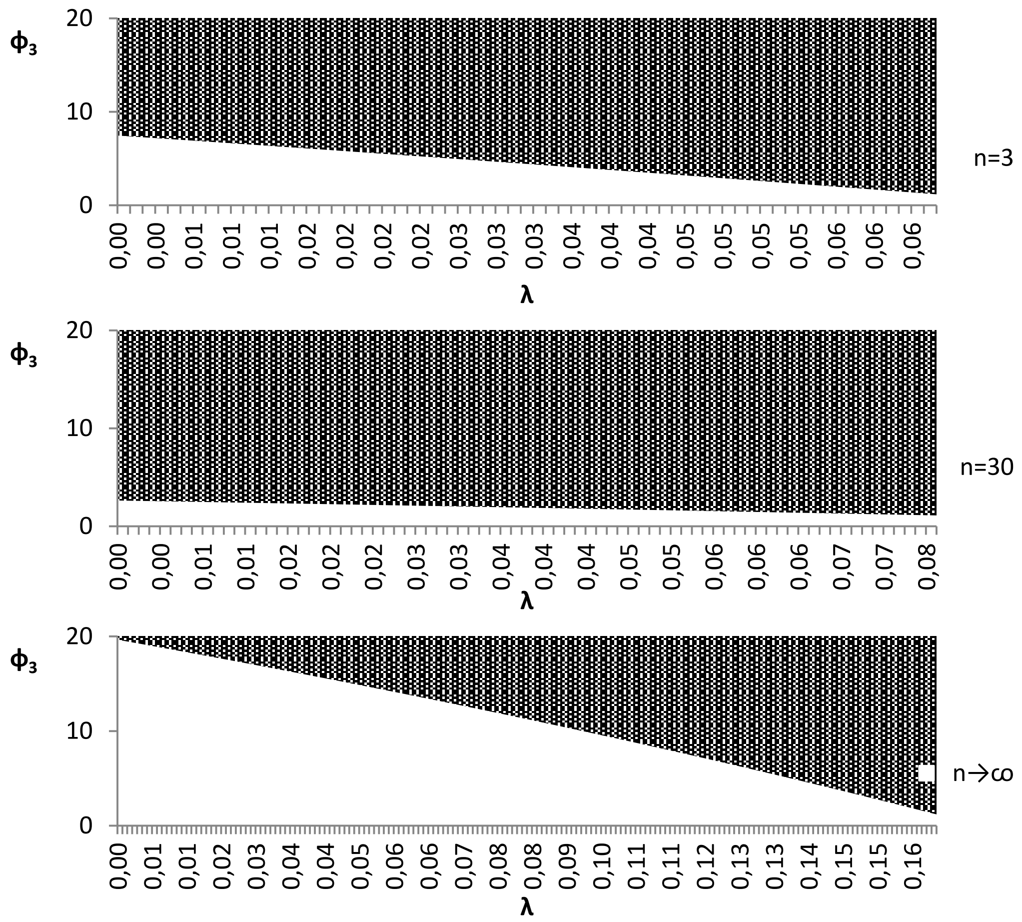
and

$$\varphi_4 \equiv 1 - \frac{2(1+\beta)}{(-\delta_h^i)\gamma_h^i} \quad (69)$$

Under monopoly unionism, monetary policy should be active and follow the Taylor Principle with an upper bound φ_3. The monetary authority should follow the same prescription for both centralized and decentralized wage setting as long as the IS curve is negatively sloped. A graphical inspection of determinacy can be found in figure 5. This stops being partly true when the economy is in the IADL. The monetary policy has to adopt a passive role and follow the Inverted Taylor principle, with a possible lower bound φ_4. If $\varphi_4 < 0$, then the monetary authority would have to follow an interest rate peg policy.

Figure 5. Determinacy, standard IS curve, and wage setting centralization: Forward-looking policy rule





Note: Determinacy (white areas) and indeterminacy (black areas).

PROPOSITION 6. *Under a forward-looking interest rate rule —regardless the slope of the IS curve— the determinacy region shifts outward monotonically with the aggressiveness of unions' wage claims.*

Sticky wages

As noted in the previous section, regardless of the unions' wage-setting structure, wage rigidity keeps the IS curve negatively sloped under empirically plausible parameterization. Consequently, the Taylor principle (with a possible upper bound) is re-established as the necessary and sufficient condition for equilibrium determinacy, with the possible bound depending on the union wage-setting regime and unions' incentive for aggressive wage claims. [17]

7 Concluding Remarks

In centralized wage bargaining systems, a few strong unions negotiate wages at the national or sectoral level (Visser 2019). However, general equilibrium models have typically assumed the presence of decentralized wage-setting regimes (atomistic

[17] Formal proofs are available upon request.

unions), thereby neglecting potential interactions between policy and labor union decisions under the presence of limited asset market participation.

In a non-fully Ricardian economy with sticky prices and wages, previous results challenge the substantially effect of the LAMP on the design of monetary policy. Under wage stickiness, the Taylor principle is always true irrespectively of the LAMP. By considering the presence of centralized wage bargaining structures, and particularly when there is a monopoly union, we argue for the irrelevance of LAMP for the conduct of monetary policy even in the presence of flexible wages. Therefore, the debate on the relevance of the LAMP hypothesis for monetary policy design is not related to whether wages are sticky or flexible but to the specific mode of unionization structure, namely, centralized versus decentralized unionization regimes. Wage bargaining structures are, thus, central to understanding how asset market participation shapes implementable monetary policy.

A natural extension of our work is to introduce a non-trivial policy problem and characterize optimal monetary policy in a fully micro-founded LAMP framework with unionized labour markets and sectoral wage bargaining. Such a setup would permit welfare-based policy rules and a systematic evaluation of the trade-offs between stabilization, and distributional objectives when wage setting is centralized. We also acknowledge that the real-world behavior of strong unions is influenced by political dynamics. Thus, embedding political-economy mechanisms that shape unions' behavior into the analysis will enrich the dialogue. Government ideology, tripartite arrangements, and broader trust conditions can affect the extent to which unions internalize macroeconomic constraints and, consequently, the slopes of the IS and NKPC blocks. Historical episodes of severe stress (e.g., the euro-area debt crisis, COVID-19) suggest that appeals to "wage moderation in the national interest" can be pivotal. Modeling these channels would enhance the empirical relevance of the framework and help reconcile cross-country differences in wage dynamics and policy transmission.

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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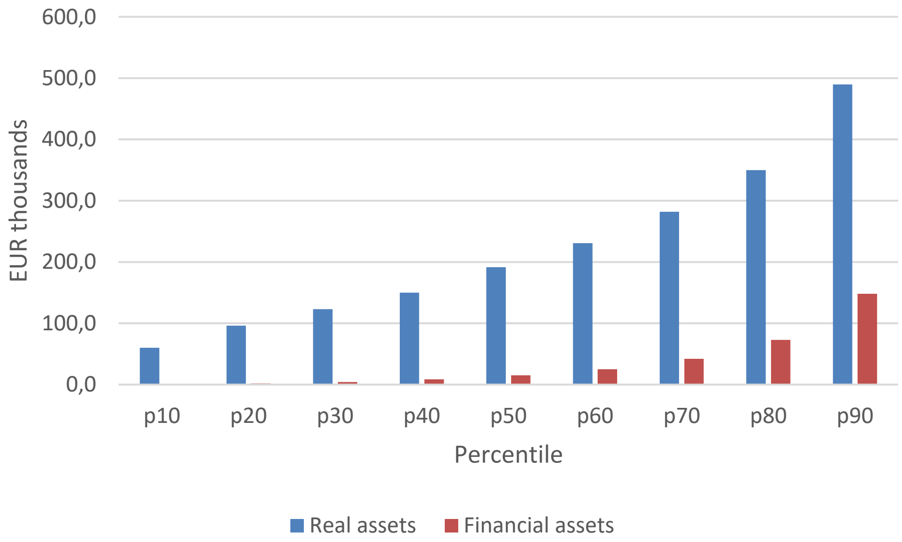
Appendices

Appendix A

Figure A.1 below shows that the Euro Area exhibits a similar pattern as roughly half of Euro Area households have little to no financial wealth.

Figure A.1: Financial and real assets among Euro Area households 2021 (eur thousands)



Source: Household Finance and Consumption Survey - wave 2021. *Note*: Real assets include the value of the household main residence for homeowners, other real estate property, vehicles, valuables (such as jewellery, works of art, antiques, etc.) and value of self-employment businesses. Real estate wealth includes household main residence and other real estate property. Financial assets include deposits (sight and saving accounts), mutual funds, bonds, shares, money owed to the households, value of voluntary pension plans and whole life insurance policies of household members and other financial assets item - which includes private non-self-employment businesses, assets in managed accounts and other types of financial assets.