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Unemployment insurance and self-fulfilling business cycles

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Abstract

We study the macroeconomic role of unemployment insurance in an economy with job search, labor force participation decisions, and involuntary unemployment. The framework allows labor market distortions to vary endogenously over the business cycle and, under certain conditions, to amplify economic fluctuations. We show that unemployment insurance can reduce the scope for such destabilizing dynamics and thereby act as an effective automatic stabilizer. Quantitative analysis indicates that while these dynamics may arise at unemployment benefit levels comparable to those observed in North America, they are unlikely at the higher replacement rates typical of European countries. Overall, our results suggest that unemployment insurance not only provides social insurance but can also contribute to macroeconomic stability, with important implications for the design of labor market policies over the business cycle.

Keywords labor wedge, indeterminacy, unemployment insurance
JEL classifications E32, E24, J64, J65

1. Introduction

Unemployment insurance not only provides timely welfare protection and social insurance to the short-term unemployed but is often also regarded as an important macroeconomic stabilizer. In fact, these two roles of unemployment insurance are often intertwined (Chodorow-Reich and Coglianese 2019). This is because the stabilizing effect of unemployment insurance is traditionally thought to be most effective in environments featuring incomplete opportunities for private insurance (McKay and Reis 2016). For example, unemployment insurance may dampen fluctuations in disposable income and thus stabilize the business cycle in environments with nominal rigidities and market incompleteness (Brown 1955). Similarly, unemployment insurance may redistribute income across individuals that have different marginal propensity to spend and, thus, contribute to aggregate demand stabilization when markets are incomplete (Blinder 1975). But in this paper, we present an additional channel through which unemployment insurance may have both an effective and desirable (welfare improving) stabilization role even in a setting with perfect private insurance markets and, consequently, no motivation for redistribution. Unemployment insurance may help eliminate inefficient self-fulfilling unemployment fluctuations.

To do this, we develop an equilibrium business cycle model with perfect insurance markets, but frictional labor markets. The market structure assumed generalizes Hansen (1985) indivisible labor supply model, using the same set-up developed by Merz (1997), which incorporates search frictions into the Hansen economy, and where individuals can fully insure themselves against differences in wealth arising from different labor market histories. Specifically, although in our economy individuals go through different labor market histories, featuring transitions across three states, including employment, unemployment, and non-participation, the model admits a representative agent representation with quasi-linear preferences as in Hansen (1985). The economic environment also features a positive link between the job-finding rate and economic activity resulting from agglomeration externalities in the labor market.

To obtain an active labor force participation choice, we assume there is an opportunity cost of job search in the form of forgone utility. Conditional on participation, unemployed workers search for jobs in frictional labor markets, and the transition rate from unemployment to employment is assumed to be procyclical: it is easier for unemployed workers to find jobs when output is above its long-run trend. We show that combining an active labor force participation choice with a procyclical job-finding probability yields an endogenous and countercyclical labor wedge.[1] The latter is defined as the gap between the marginal rate of substitution of consumption for leisure in the frictionless economy and the marginal product of labor.[2] The countercyclicality of the labor wedge has been shown to be an important feature of observed business cycle fluctuations (Galí et al., 2007; Hall 2009; Shimer 2009; Karabarbounis 2014).

In our model, the labor wedge is an outcome of search frictions because it is costly for the stand-in agent to move members into employment. Moreover, because there are transaction externalities (increasing returns to scale) in search activity (à la Diamond 1982), the labor wedge increases in downturns. We show that given the active participation margin, an endogenous countercyclical labor wedge can generate local equilibrium indeterminacy because of strategic complementarities in search. Specifically, the endogenous participation margin and the procyclical transition rate from unemployment to employment can generate a positive feedback loop leading to self-fulfilling unemployment fluctuations: when output and employment are high, the job-finding probability increases; this encourages higher labor force participation, in turn, raising employment and output even further.

Crucially, the labor wedge is also affected by unemployment insurance and, in particular, the unemployment insurance replacement rate: larger replacement rates lower the volatility of the labor wedge and make it less countercyclical. Because of this, a sufficiently large replacement rate is shown to restore determinacy and, therefore, can be a powerful automatic

[1] Recent empirical work attributes an important role to the participation margin for labor market transitions, e.g., Elsby et al. (2015) showed that the participation margin accounts for one-third of the cyclical variation in the unemployment rate.

[2] The frictionless economy is obtained by assuming away search frictions in the labor market, and corresponds to the Hansen (1985) and Rogerson (1988) indivisible labor model in which perfectly insured individuals purchase lotteries over employment and non-employment (yielding a two-states labor market without involuntary unemployment). In the frictionless economy's equilibrium, the marginal rate of substitution of consumption for leisure corresponds to the opportunity cost of employment in units of consumption and equals the marginal product of labor.

stabilizer. To obtain this result, we first characterize a necessary condition for local indeterminacy (multiple self-fulfilling rational expectations equilibria) by extending the methodologies of Benhabib and Farmer (1994), Aiyagari (1995), and Wen (2001) to economies with frictional labor markets. This necessary condition places restrictions on the employment elasticity of the labor wedge and, thus, on its countercyclicality. Since the labor wedge cyclicality is affected by the unemployment insurance (UI) replacement rate, the upshot is that by inverting the necessary conditions, we are able to obtain a sufficient condition on the size of the UI replacement rate required to restore equilibrium determinacy and, thus, eliminate inefficient fluctuations. Raising the replacement rate sufficiently smooths the labor wedge and, thus, eliminates belief-driven fluctuations by making the participation rate less sensitive to changes in the transition rate from unemployment to employment.[3]

We calibrate the model and show numerically that indeterminacy arises for replacement rate policies observed in the United States and Canada (North America), while the equilibrium is locally unique for the policy parameters observed in European countries. Allowing the replacement rate and the (steady state) job-finding probability to vary independently, we trace the regions of (in)determinacy of equilibrium across these two dimensions. European characteristics, namely, generous welfare states (high UI replacement rates) and sclerotic labor markets (low job-finding probabilities), fall within the determinacy region, while those of North America, fluid labor markets, and less generous policies compared to Europe, fall within the region of indeterminacy. Starting with the replacement rates observed in the United States, holding labor market frictions fixed and raising the replacement rate to European levels would be enough to restore the determinacy of equilibrium. This result is consistent with the common empirical finding that raising the replacement rate of unemployment insurance lowers business cycle volatility (see, for example, Di Maggio and Kermani 2016). Conversely, given a fixed replacement rate, more sclerotic labor markets are more likely to be associated with a unique equilibrium.[4] Crucially, our calibration captures the salient facts distinguishing European and North American labor markets, according to Ljungqvist and Sargent (2008), that displaced workers in Europe suffer smaller earnings losses but also face lower reemployment rates than in North American labor markets.

Finally, we study the business cycle dynamics produced by two alternative calibrations of our model, corresponding, in turn, to a high UI replacement rate that yields equilibrium uniqueness and a low replacement rate that yields equilibrium indeterminacy. Using this experiment, we show that raising the UI replacement rate can substantially lower consumption volatility through two channels: stabilizing the countercyclical labor wedge and eliminating self-fulfilling fluctuations.

1.1 Related literature

Our paper relates to the literature that studies search complementarities as a source of volatility, typically by introducing increasing returns in search activity across labor and other markets. Early precursors include Diamond (1982, 1984), Howitt and McAfee (1992), and

[3] This resonates with the result by Arseneau and Chugh (2012) regarding optimal taxation in models with frictional labor markets and endogenous participation (features that are also important in our model). In their framework, efficiency requires stabilizing the labor wedge over the business cycle.

[4] When we conduct these comparative static experiments, we are ignoring the possibility that the replacement rate affects the steady state job-finding probability. In doing this, we are following the approach in Krusell et al. (2017) in treating labor market frictions as exogenous. However, with an endogenous job creation channel, these two parameters may be codetermined.

Boldrin et al. (1993).[5] With a focus on labor market search frictions, there are a few papers investigating the possibility of equilibrium indeterminacy and self-fulfilling fluctuations due to externalities in search, employing equilibrium dynamic stochastic general equilibrium (DSGE) models with frictional labor markets. Two early examples are Hashimzade and Ortigueira (2005), who develop a neoclassical growth model with search frictions and show that inefficient self-fulfilling fluctuations can arise in this model, and Zanetti (2006), who considers instead a New Keynesian model with staggered prices and search frictions, and shows that labor market frictions may yield indeterminacy under monetary policy regimes that would deliver a unique equilibrium in the absence of the search externalities.[6]

Two other related studies are Krause and Lubik (2010) and Lazaryan and Lubik (2019) who investigate, in turn, local and global equilibrium dynamics in the canonical search and matching model of the labor market, showing the possibility of indeterminacy related to the job creation condition. In particular, the latter paper demonstrates the pervasiveness of periodic and chaotic solutions when global dynamics are considered. Instead, in our approach, it is the strategic complementarity in participation choice that may generate self-fulfilling unemployment fluctuations, justifying automatic stabilizers in the form of unemployment insurance to eliminate belief-driven fluctuations, even in environments with perfect insurance markets.

In such environments, there may be an important role for policy interventions. In particular, we contribute to the work examining automatic stabilizers in models of endogenous business cycles. Schmitt-Grohé and Uribe (1997) show that indeterminacy can arise in the neoclassical growth model if tax rates are determined by a balanced budget with a pre-set level of revenues. Guo and Lansing (1998) argue that progressive income tax schedules can restore saddle path stability and, in related work, Christiano and Harrison (1999) show that indeterminacy can be prevented if the tax rate is an increasing function of aggregate employment. Nakajima (2006) shows that indeterminacy can arise even in the absence of externalities in the neoclassical growth model with asymmetric information and incomplete markets because moral hazard generates a downward-sloping labor supply curve. However, unemployment insurance weakens this mechanism and, thus, may eliminate sunspot fluctuations.

More broadly, we contribute to the important literature on the impact of unemployment insurance and other labor market institutions on labor market and business cycle fluctuations. This work often considers environments combining search and matching frictions with nominal rigidities, a feature that we abstract from in this paper. Examples of such environments include Faia (2008), Christoffel et al. (2009), Thomas and Zanetti (2009), and Zanetti (2011*a*), which highlight the interaction between search and matching frictions and nominal rigidities, emphasizing the role of labor market institutions in shaping fluctuations. Within the Mortensen and Pissarides (1994), Pissarides (2000) and Zanetti (2011*b*), study how labor policy instruments such as unemployment benefits, firing costs, and payroll income taxes, affect the profitability of forming a match and, thus, the cyclical volatility of job creation. In particular, Zanetti (2011*b*), shows that both taxes and unemployment benefits lower the joint surplus of job matches and, therefore, yield a more volatile job creation margin. Also within

[5] Although our focus is the labor market, search externalities are more general and can generate self-fulfilling fluctuations. For example, Kaplan and Menzio (2016) develop a theory of self-fulfilling unemployment fluctuations driven by shopping-time externalities, and Fernández-Villaverde et al. (2025) document the important role played by strategic complementarities in search effort by firms seeking to form trading relationships along supply chains.

[6] In contrast to this strand of the literature, a large body of work on labor market business cycle fluctuations focuses, instead, on environments where volatility arises from the transmission and amplification of fundamental shocks rather than from self-fulfilling beliefs. Examples of such amplification channels include real wage rigidities (Hall 2005*a*), fixed matching costs (Pissarides 2009) and, more recently, cyclical markups (Kokonas 2023).

the Mortensen and Pissarides (1994) framework but including endogenous search effort by the unemployed and moral hazard considerations, Jung and Kuester (2015) study state-contingent optimal labor market policies and, in particular, show that fiscal support for vacancy creation and unemployment insurance should adjust countercyclically in response to large business cycle shocks.[7]

The stabilizing effect of automatic stabilizers, in particular unemployment insurance, is traditionally thought to be potent in environments featuring missing insurance opportunities (Flodén 2001; Alonso-Ortiz and Rogerson 2010; Challe and Ragot 2016; McKay and Reis 2016). More recently, Kekre (2023), Gorn and Trigari (2024) and Ferriere and Navarro (2024), in environments with incomplete markets, nominal rigidities, and labor market frictions, assess, both theoretically and quantitatively, the stabilizing effect of unemployment insurance. Ferriere and Navarro (2024) model unemployment risk with a similar externality, assuming a procyclical transition rate from unemployment to employment. Instead, we use the model developed in this paper to study the role of unemployment insurance in a setting with perfect private insurance markets and, consequently, no motivation for redistribution. Still, unemployment insurance is shown to have the potential to eliminate local indeterminacy and, therefore, is a powerful automatic stabilizer that can also have beneficial welfare effects by eliminating inefficient fluctuations driven by extrinsic uncertainty. Although there are other models in which automatic stabilizers reduce business cycle volatility despite the existence of perfect private insurance markets (for example, by lowering the aggregate labor supply elasticity, as in Janiak and Santos Monteiro 2016), this is in general not efficient. In contrast, in the model with search and agglomeration externalities that we propose, unemployment insurance may both lower aggregate volatility and improve welfare in a set-up with perfect private insurance market, by preventing inefficient beliefs-driven fluctuations.[8]

The rest of the paper is organized as follows. In Section 2 we introduce the general equilibrium model. In Section 3 we obtain necessary conditions for local indeterminacy to arise. In Section 4, we consider the stabilization role of unemployment insurance and, specifically, show that sufficiently high replacement rates can eliminate indeterminacy. In Section 5, we consider the calibrated model and study quantitatively how labor markets with either European or North American characteristics compare through the lenses of our model. In Section 6 we investigate the business cycle dynamics generated by the model under two alternative calibrations, in turn, with equilibrium indeterminacy and with an unemployment insurance replacement ratio sufficiently high to eliminate indeterminacy. Finally, Section 7 offers some conclusions.

2. Model

In our model, labor market adjustments occur only along the extensive margin and there are three possible labor market states: employment, unemployment, and nonparticipation. Adjustments along the extensive margin are determined by individuals' indivisible choice over labor force participation in frictional labor markets. To overcome the resulting

[7] There also exists a large empirical literature, well surveyed in Bettarelli et al. (2025), that investigates the relationship between labor market institutions and business-cycle volatility. The substantial variation in both the sign and magnitude of the estimated effects across studies highlights the value of complementary theoretical work to clarify the underlying mechanisms.

[8] Other earlier related research includes Andolfatto and Gomme (1996) who, like us, also develop a general equilibrium model with endogenous participation, but with incomplete markets. They embed in the model an unemployment insurance system calibrated to the Canadian economy and obtain substantial welfare gains from a reform that raised the generosity of the unemployment insurance system in Canada.

non-convexity, we consider the Hansen (1985) and Rogerson (1988) lottery mechanism, but with individuals purchasing lotteries over labor market participation and, conditional on participation, searching for jobs in frictional labor markets, as in Alvarez and Veracierto (1999, 2012) and Kokonas and Santos Monteiro (2021, 2025).

Individuals derive flow utility from consumption, c, and incur a disutility cost from participation in the labor market. The flow utility at each date is given by

$$\mathcal{U}_t = \begin{cases} \ln C_t, & \text{if non-participant} \\ \ln C_t - \xi, & \text{if participant} \end{cases}, \tag{1}$$

where $\xi > 0$ is the opportunity cost of labor market participation due to forgone home production, which is incurred irrespective of whether the individual is employed or unemployed. As in Hansen (1985) and Rogerson (1988), individuals purchase lotteries where, with probability $\pi \in (0, 1)$, they participate in the labor force and, thus, sacrifice utility ξ. But in our model, not all labor market participants are employed.

There are frictional labor markets and, conditional on participation, an individual may either be employed or unemployed. An individual who participates in the labor market but begins period t without a job finds employment with probability $f_t \in (0, 1)$. As in Blanchard and Galí (2010), and Michaillat (2012), newly hired workers become productive immediately. Conditional on participation, unemployment is involuntary, and any equilibrium with unemployment is not Pareto optimal.

Individuals who fail to find a job are eligible for unemployment insurance, receiving a fraction $\zeta \in [0, 1]$ of the total hourly wage rate. Unemployment insurance (UI) is financed with lump-sum taxes $T \geq 0$ levied on every individual. Each job is destroyed with constant probability $\lambda \in (0, 1)$. Upon destruction, an individual is allowed to choose between searching for another job or staying out of the labor force. If the existing job is not destroyed, then the individual continues with the existing employment relationship.

Frictions restrict workers' access to employment. However, conditional on employment, the labor market is competitive, and wages reflect the marginal product of labor.[9] Goods and capital markets are competitive. There is no aggregate uncertainty (perfect foresight equilibria), but frictional labor markets generate idiosyncratic risk. Competitive firms have (identical) Cobb-Douglas technology which turns labor and capital into output, $Y = F(K, N) = K^{\alpha} N^{1-\alpha}$, $\alpha \in (0, 1)$, and (K, N) denote the demand for capital and hours of work. Firms pay wages w to hire workers, r to rent capital, and maximize their flow of profits, $F(K, N) - rK - wN$.

2.1 Stand-in agent's problem

Time is discrete and the horizon is infinite, $t = 0, 1, 2, \ldots$; the measures of individuals at the end of date $t-1$ in employment, unemployment, or out of the labor force, in turn, N_{t-1}, U_{t-1}, O_{t-1}, are all pre-determined variables. Agents face three salient sources of idiosyncratic risk: the outcome of the lottery over labor force participation, the risk of job loss conditional on employment, and the risk of not finding work conditional on labor force participation. However, as in Andolfatto (1996), despite the random matchings and separations that occur in the labor market inducing different individual employment histories, this heterogeneity

[9] The assumption of competitive markets in coexistence with search frictions has a long tradition and follows, for example, Lucas and Prescott (1974), Alvarez and Veracierto (1999, 2012) Alvarez and Shimer (2011), and Krusell et al. (2008, 2010, 2011).

does not lead to wealth dispersion because of perfect insurance markets, and all individuals enjoy the same level of consumption no matter their labor force status. This market structure yields a stand-in agent representation, with lifetime utility given by

$$\mathbf{V} = \sum_{t=0}^{\infty} \beta^t (\ln C_t - \xi \Pi_t), \tag{2}$$

with $\beta \in (0, 1)$ the discount factor, and where Π_t is the labor force participation at date t, given by

$$\Pi_t = \pi_{e,t}(1-\lambda)N_{t-1} + \pi_{u,t}U_{t-1} + \pi_{o,t}O_{t-1} + \pi_{\lambda,t}\lambda N_{t-1}, \tag{3}$$

with $\pi_{e,t}$, $\pi_{\lambda,t}$, $\pi_{u,t}$, $\pi_{o,t} \in [0, 1]$, the probabilities of labor force participation at date t chosen by individuals that start date t, in turn, matched to a job that survives, a job that is destroyed, in unemployment, and out of the labor force.[10] The stand-in agent must choose state contingent allocations to maximize (2) subject to the budget constraint

$$C_t + I_t = r_t K_t + w_t[N_{t-1}(1-\lambda)\pi_{e,t} + f_t H_t] + b_t(1-f_t)H_t - T_t, \tag{4}$$

where H_t is the measure of individuals searching for jobs at date t, given by

$$H_t = \pi_{u,t}U_{t-1} + \pi_{o,t}O_{t-1} + \pi_{\lambda,t}\lambda N_{t-1}. \tag{5}$$

Thus, the job searchers at date t include all the individuals who were not in employment at date $t-1$ and choose to participate in date t, and also the individuals who were employed at date $t-1$, but who see their job destroyed at date t and choose to remain in the labor force. A proportion $(1-f_t)$ of the job searchers fail to find a job and, thus, earn unemployment benefits, given by $b_t = w_t\zeta$, with ζ the unemployment replacement rate.

Finally, the capital accumulation equation is given by

$$K_{t+1} = I_t + (1-\delta)K_t, \tag{6}$$

where I_t denotes investment, K_{t+1} is the end of period capital stock holdings and $\delta \in (0, 1)$ is capital depreciation.

2.2 Equilibrium

The optimality conditions solving the stand-in agent's problem are

$$\xi \leq \frac{f_t w_t + (1-f_t)b_t}{C_t}, \tag{7}$$

[10] As in the Hansen (1985) indivisible labor supply model, individuals purchase lotteries that specify their participation probabilities, $\pi_{e,t}$, $\pi_{\lambda,t}$, $\pi_{u,t}$, $\pi_{o,t}$, and therefore determine their labor market histories. We depart from Hansen by assuming that the lotteries are over labor force participation and not employment. Conditional on participation, individuals may still stay unemployed because of labor market frictions. However, no matter the history of labor market outcomes, all individuals enjoy the same consumption and, thus, as in Hansen (1985), the model admits a representative agent representation with quasi-linear preferences. In Supplementary Appendix A we describe carefully how the aggregation result is obtained.

$$\xi \le \frac{w_t}{C_t}, \tag{8}$$

$$1 = \beta R_{t+1}\left(\frac{C_t}{C_{t+1}}\right), \tag{9}$$

where (7) and (8) are the intratemporal optimality labor supply conditions. Condition (9) is the standard Euler equation with $R_{t+1} = 1 - \delta + r_{t+1}$.

Conditions (7) and (8) determine the participation choices made by individuals. They are written as inequalities because we allow for corner solutions, where some individuals participate with certainty. In the sequel, we restrict attention to equilibria in which some individuals choose not to participate in the labor force. For this to be the case, we must have that (7) holds as equality, meaning that there is an interior solution for the tuple $(\pi_{\lambda,t}, \pi_{u,t}, \pi_{o,t})$. The upshot is that (8) holds as an inequality and, hence, all individuals holding a job choose to participate, $\pi_{e,t} = 1$.

Recalling that $b_t = \zeta w_t$, the intratemporal optimality condition (7) can be written as follows

$$w_t = \tau_t\left(\frac{\xi}{1/C_t}\right), \qquad \text{with} \qquad \tau_t = \frac{1}{f_t + (1-f_t)\zeta}, \qquad \text{the labor wedge}, \tag{10}$$

where w_t corresponds to the marginal product of an employed worker, and ξC_t corresponds to the worker's opportunity cost of employment in the frictionless economy. Efficiency requires the marginal product of employment to be equal to the opportunity cost of employment and, therefore, the wedge between these two quantities, $\tau_t \geq 1$, corresponds to the labor wedge. The frictionless economy is achieved when $f_t = 1$ for all t, in which case we obtain the original Hansen (1985) economy, in which there is no involuntary unemployment and the equilibrium is efficient. It is easy to verify that in the frictionless economy there is no labor wedge, $\tau_t = 1$ for all t. Thus, the labor wedge in our economy results from labor market search frictions. This is because conditional on participation, inactivity is socially wasteful: in other words, involuntary unemployment is suboptimal in our economy.

The model equilibrium conditions correspond to those of the canonical neoclassical growth model with indivisible labor, augmented with an endogenous labor wedge, as follows

$$1 = \beta R_{t+1}\left(\frac{C_t}{C_{t+1}}\right), \tag{11}$$

$$w_t/C_t = \tau_t \xi, \tag{12}$$

$$C_t + K_{t+1} = K_t^{\alpha} N_t^{1-\alpha} + (1-\delta)K_t, \tag{13}$$

$$w_t = (1-\alpha)\left(\frac{K_t}{N_t}\right)^{\alpha}, \tag{14}$$

$$R_t = 1 - \delta + \alpha\left(\frac{N_t}{K_t}\right)^{1-\alpha}, \tag{15}$$

where (11) and (12) are the intertemporal and intratemporal optimality conditions discussed above, condition (13) is the goods' market clearing condition, and (14) and (15) are obtained from the firm's optimal decisions. The motion equations for the aggregate labor market variables are

$$N_t = (1-\lambda)N_{t-1} + H_t f_t, \quad (16)$$
$$U_t = (1-f_t)H_t, \quad (17)$$
$$\Pi_t = N_t + U_t, \quad (18)$$

where we impose $\pi_{e,t} = 1$ to obtain (16). Lastly, the government budget is given by

$$T_t = b_t U_t, \quad (19)$$

where proceeds from lump-sum taxation finance UI benefits.

The system of equilibrium conditions (11–19) fully determines the equilibrium path for a given sequence of job-finding probabilities $\{f_t\}_{t\geq 0}$. It determines a unique steady state equilibrium up to a choice of steady state job-finding probability, as shown in Supplementary Appendix C.

3. Search frictions and indeterminacy

As is clear from (10), the labor wedge, τ_t, is endogenous and determined by the job-finding probability, f_t. Next, we show that if the job-finding probability is procyclical (and, thus, the labor wedge is countercyclical), then the equilibrium dynamics around the steady state may feature local indeterminacy, enabling inefficient self-fulfilling fluctuations. We extend the method of Wen (2001) to analyze economies with labor market frictions and determine necessary conditions for local indeterminacy. Our focus is to provide an intuitive explanation for the emergence of inefficient self-fulfilling fluctuations through necessary conditions for local indeterminacy.

3.1 The job-finding probability

The job-finding probability, which measures the ease of matching job seekers with jobs, has been found to be procyclical in empirical studies. Specifically, during economic expansions, the job-finding probability tends to increase, and during recessions, it tends to decrease (Shimer 2005; Hall 2005*b*). To align our model with this empirical evidence, we impose the following restriction on the equilibrium sequence of job-finding probabilities, $\{f_t\}_{t\geq 0}$.

Assumption 1. *(procyclical job-finding probability)*

$$\widehat{f}_t = \sigma \widehat{Y}_t, \ \forall t,$$

where $\sigma > 0$ denotes the output elasticity of the job-finding probability and hat variables, $\widehat{f}_t$ and $\widehat{Y}_t$, denote log-deviations from the steady state.

Assumption 1 posits that the job-finding probability is procyclical. Crucially, this assumption creates an externality in the model with endogenous participation. This externality embeds the Diamond (1982, 1984) transaction externalities into the labor market, in the sense that the probability that an unemployed worker is able to find employment depends on the overall level of economic activity. Ferriere and Navarro (2024) model unemployment risk under assumptions similar to ours, specifically by postulating procyclical job-finding rates, and they further evaluate the effectiveness of various labor market policies. In

Supplementary Appendix B, we provide explicit micro-foundations that derive an equilibrium relationship consistent with Assumption 1, combining standard economic agglomeration effects with undirected search by unemployed workers.

However, regardless of the specific micro-foundations, all that matters in the sequel is the procyclical nature of the job-finding probability, which leads to a positive feedback loop: when output and employment are high, the job-finding probability increases, which in turn encourages more individuals to participate in the labor force, further raising employment and output. This externality implies inefficiency in competitive equilibrium and the possibility of sunspot equilibria. Next, we obtain necessary conditions for local indeterminacy and, thus, the emergence of inefficient sunspot equilibria.

3.2 Necessary conditions for local indeterminacy

Substituting the motion equation (16) into the stand-in agent's flow budget (4) allows us to express it in terms of the household's labor income, $w_t N_t$. In this setup, the stand-in agent consumes a constant fraction $(1-\beta)$ of her permanent income, as follows:

$$C_t = (1-\beta)\left[R_t K_t + w_t N_t + b_t U_t - T_t + \sum_{j=1}^{\infty}\left(\prod_{i=1}^{j} R_{t+i}^{-1}\right)\left(w_{t+j}N_{t+j} + b_{t+j}U_{t+j} - T_{t+j}\right)\right]. \quad (20)$$

Therefore, indeterminacy in consumption requires indeterminacy in permanent income. Following Wen (2001), we express (20) as a function of the equilibrium path of employment $\{N_t\}_{t=0}^{\infty}$. Once the equilibrium path of employment is determined, then we can also determine the equilibrium path of output, consumption, and capital. The task of characterizing the local dynamics of the model around the steady state is, therefore, reduced to the examination of the indeterminacy of the equilibrium path of employment.

Iterating the Euler equation (11) forward yields:

$$\left(\prod_{i=1}^{j} R_{t+j}^{-1}\right) C_{t+j} = \beta^j C_t. \quad (21)$$

In turn, substituting the intratemporal condition (10), the government budget (19), and the iterated Euler equation (21) into (20), yields

$$C_t = R_t K_t \left[\sum_{j=0}^{\infty} \beta^j \left(1 - \xi \tau_{t+j} N_{t+j}\right)\right]^{-1}. \quad (22)$$

Substituting (10) into (22), yields

$$\sum_{j=0}^{\infty} \beta^j \left(1 - \xi \tau_{t+j} N_{t+j}\right) = \frac{\xi \tau_t R_t K_t}{w_t}, \quad (23)$$

where the right-hand side of (23) is the value of wealth in utility terms. Log-linearizing (23) around the steady state yields

$$\Gamma \sum_{j=0}^{\infty} \beta^j (\widehat{N}_{t+j} + \widehat{\tau}_{t+j}) = \widehat{\tau}_t + \widehat{R}_t - \widehat{w}_t + \widehat{K}_t, \tag{24}$$

with $\Gamma = -(1-\beta)\xi\bar{\tau}\bar{N}(1-\xi\bar{\tau}\bar{N})^{-1}$, and where $\bar{X}$ denote the steady state of variable X, and $\widehat{X}$, the log-deviation from steady state.

The task of the remaining part of this section is to derive a necessary condition for local indeterminacy. The key point is to show that the current employment elasticity of both sides of (24) must be negative. This turns out to be the case if and only if the employment elasticity of the labor wedge, defined in (26), lies within an appropriately constructed open interval. Before presenting the detailed arguments leading up to the necessary condition, we first outline the main building blocks. We begin by establishing two lemmas that allow us to rewrite both sides of (24) as functions of the sequence $\{\widehat{N}_{t+j}\}_{j=0}^{\infty}$. This, in turn, makes it possible to apply the method of Wen (2001), which derives necessary conditions for local indeterminacy by requiring that the current employment elasticity of both sides be negative.[11]

Proposition 1 shows that for there to be multiple equilibrium paths, it must be that the equilibrium employment dynamics follow an AR (2) process around the steady state. Using this result, Proposition 2 establishes that the employment elasticity of the left-hand side of (24) is negative if and only if the employment elasticity of the labor wedge is bounded above, providing the first building block toward the construction of the necessary condition. Next, Proposition 3 shows that without fluctuations in the labor wedge, the equilibrium is locally unique. Proposition 4 clarifies why obtaining necessary and sufficient conditions for local indeterminacy is more demanding: it requires not only that the employment elasticities on both sides of (24) share the same sign but also that they be exactly equal. Finally, Proposition 5 establishes the main result of this section: local indeterminacy arises only if the employment elasticity of the labor wedge lies within an open interval. In particular, the elasticity must be bounded below to ensure that the employment elasticity of the right-hand side of (24) is negative. This guarantees that the employment elasticity of both sides of (24) is negative, which is the key requirement for local indeterminacy. The economic intuition for this condition is discussed in the following paragraphs.

The following two lemmas allow us to rewrite both sides of (24) as functions of the sequence $\{\widehat{N}_{t+j}\}_{j=0}^{\infty}$.

Lemma 1. *The log-deviation of the labor wedge from the steady state is given by*

$$\widehat{\tau}_t = -\bar{\tau}\bar{f}(1-\zeta)\widehat{f}_t, \ \forall t. \tag{25}$$

Proof. Follows immediately from the log-linearization of the labor wedge (10) □

Given (25) and Assumption 1, we can define the employment elasticity of the labor wedge, which is given by

[11] Wen (2001) applies this methodology to the model of Schmitt-Grohe and Uribe (1997), where the labor wedge follows from distortionary labor income taxes and, thus, is exogenous. However, in our setup, the labor wedge is an outcome of labor market frictions and is endogenous. Thus, we generalize the method of Wen (2001) for deriving necessary conditions for local indeterminacy in an economy with endogenous labor wedge fluctuations. More generally, (23) characterises the equilibrium of an RBC economy with indivisible labor and time-varying labor income taxes financed with lump-sum subsidies.

$$\varepsilon_\tau \equiv \frac{\partial \widehat{\tau}_t}{\partial \widehat{N}_t} = -\bar{\tau}\bar{f}(1-\zeta)(1-\alpha)\sigma, \tag{26}$$

where we made use of the log-linear production function, $\widehat{Y} = \alpha\widehat{K}_t + (1-\alpha)\widehat{N}_t$. Thus, the labor wedge reacts countercyclically to output. Subsequently, (25) implies that the left-hand side of (24) depends on $\sum_{j=0}^{\infty}\beta^j\widehat{f}_{t+j}$, which, in turn, after taking into account Assumption 1 and $\widehat{Y} = \alpha\widehat{K}_t + (1-\alpha)\widehat{N}_t$, is determined by $\sum_{j=0}^{\infty}\beta^j\widehat{K}_{t+j}$ and $\sum_{j=0}^{\infty}\beta^j\widehat{N}_{t+j}$, as follows.

Lemma 2. *The infinite sum $\sum_{j=0}^{\infty}\beta^j\widehat{\tau}_{t+j}$ reduces to*

$$\sum_{j=0}^{\infty}\beta^j\widehat{\tau}_{t+j} = \omega\widehat{K}_{t-1} + \chi\widehat{N}_{t-1} + \varphi\sum_{j=0}^{\infty}\beta^j\widehat{N}_{t+j}, \tag{27}$$

where ω, χ, φ are functions of structural parameters and ε_τ and $\varphi < 0$.

Proof. See Supplementary Appendix D. □

Substituting (25) and (27) into (24), and substituting for the equilibrium factor prices, yields

$$\sum_{j=0}^{\infty}\upsilon_j\widehat{N}_{t+j} = \psi_0\widehat{K}_t + \psi_1\widehat{K}_{t-1} + \psi_2\widehat{N}_{t-1}, \tag{28}$$

where the right-hand side depends on predetermined variables at date t, and υ_j and ψ are elasticity parameters.[12] This leads us to the following equilibrium characterization.

Proposition 1. *If the equilibrium transition path for N_t around the steady state follows a stationary AR(1) process, then the equilibrium is locally unique. If the equilibrium path is not unique, then it must follow a stationary AR (2) process around the steady state.*

Proof. The proof follows similar ideas from Wen (2001). We discuss the key points.

First, if $\widehat{N}_t$ is AR (1), then the equilibrium is unique. Let

$$\widehat{N}_{t+1} = \rho\widehat{N}_t,\ \rho \in (0,1).$$

Substituting it into (28) and iterating forward, we obtain that $\widehat{N}_t$ is pinned down by the right-hand side predetermined variables at date t. The equilibrium is unique.

Thus, under indeterminacy, $\widehat{N}_t$ must follow an autoregressive process with an order higher than one. Consider, first, an AR (2), as follows:

$$\widehat{N}_{t+2} = \rho_1\widehat{N}_{t+1} + \rho_2\widehat{N}_t,\ \rho_1 + \rho_2 < 1. \tag{29}$$

Under repeated iteration, (28) implies

[12] See Supplementary Appendix E for detailed derivations of these parameters.

$$\widehat{\rho}_1\widehat{N}_{t+1}+\widehat{\rho}_2\widehat{N}_t=\psi_0\widehat{K}_t+\psi_1\widehat{K}_{t-1}+\psi_2\widehat{N}_{t-1},$$

where $\widehat{\rho}_1,\widehat{\rho}_2$ are functions of the two stable roots. Given the predetermined variables, $\widehat{N}_t$ is indeterminate unless $\widehat{N}_{t+1}$ is known. Since $\widehat{N}_{t+1}$ cannot be solved by backward iteration using (29), it is unknown at time t. The equilibrium is not unique.

Finally, $\widehat{N}_t$ cannot follow an autoregressive process of a higher order than two, because the state space of the model has a dimension of at most two, including one state variable and one co-state variable □

Next, through a series of steps, we characterize necessary conditions for local indeterminacy.

Proposition 2. *The employment elasticity of the left-hand side of (23) is negative if and only if*

$$-\varepsilon_\tau<\bar{\varepsilon}\equiv\frac{\alpha\beta(\bar{Y}/\bar{K})-\alpha\beta\delta}{\alpha\beta(\bar{Y}/\bar{K})}, \tag{30}$$

where $\bar{Y}/\bar{K}$ is the output-capital ratio in steady state.

Proof. Log-linearizing the left-hand side of (23) yields

$$\Gamma\sum_{j=0}^{\infty}\beta^j(\widehat{N}_{t+j}+\widehat{\tau}_{t+j}). \tag{31}$$

Substituting (25) into (31) and ignoring predetermined variables yields

$$\Gamma(1+\varphi)\sum_{j=0}^{\infty}\beta^j\widehat{N}_{t+j},$$

with $\Gamma=-(1-\beta)\xi\bar{\tau}\bar{N}(1-\xi\bar{\tau}\bar{N})^{-1}<0$, because intratemporal optimality and labor market clearing imply

$$\xi\bar{\tau}\bar{N}=\frac{\bar{w}\bar{N}}{\bar{C}}=\frac{1-\alpha}{\bar{C}/\bar{Y}}=\frac{1/\beta-1+\delta-\alpha\delta-\alpha(1/\beta-1)}{1/\beta-1+\delta-\alpha\delta}<1,$$

where $\bar{C}/\bar{Y}$ is the steady state consumption-output ratio (see Supplementary Appendix C). Thus, $\Gamma(1+\varphi)$ is negative if and only if $\varphi>-1$. In Supplementary Appendix F we show that $\varphi>-1$ is true if and only if (30) holds.

To complete the argument we need to show that

$$\text{sign}\left\{\sum_{j=0}^{\infty}\beta^j\widehat{N}_{t+j}\right\}=\text{sign}\{\widehat{N}_t\}. \tag{32}$$

The proof is identical to the proof of Proposition 2 in Wen (2001). The key point is as follows. The equilibrium employment path $\{\widehat{N}_t\}_{t=0}^{\infty}$ is converging with an autoregressive order of at most two (see Proposition 1). Solving the second order system and then substituting into $\sum_{j=0}^{\infty}\beta^j\widehat{N}_{t+j}$ satisfies (32) □

The emergence of belief-driven fluctuations arises from a positive feedback loop between current actions and beliefs about the behavior of current and future aggregate variables.

Proposition 2 shows that the current employment elasticity of the present value of labor income in utility terms is positive, providing the first building block toward the necessary conditions for local indeterminacy. To see this, substitute the intratemporal condition (10) into the left-hand side of (23) and rearrange to obtain:

$$\frac{1}{1-\beta} - \sum_{j=0}^{\infty} \beta^j \left(\frac{1}{C_{t+j}} w_{t+j} N_{t+j} \right), \tag{33}$$

which represents the opposite, ignoring constants, of the present discounted value of labor income in utility terms. Condition (30) is necessary and sufficient for the employment elasticity of the latter value to be positive. Intuitively, higher current employment increases the stand-in household's permanent income, as measured by the present value of labor income in utility terms. To complete the positive feedback loop and establish the necessary conditions for local indeterminacy, it remains to show how beliefs about higher permanent income feed back into higher current employment, closing the loop between current actions and expectations about the path of permanent income.

Before stating the necessary condition formally, we prove two useful results.

Proposition 3. *If the labor wedge is constant, then the equilibrium is locally unique.*

Proof. If $\sigma = 0$, then the labor wedge is constant. Then, it suffices to show that given the steady state level of $\bar{K}$ there is no N_t other than the steady state $\bar{N}$ that satisfies (23). We prove this by contradiction. Suppose there is $N_t > \bar{N}$ such that (23) is satisfied, then

$$\sum_{j=0}^{\infty} \beta^j (1 - \xi\tau N_{t+j}) = \frac{\xi\tau R(\bar{K}, N_t)\bar{K}}{w(\bar{K}, N_t)}. \tag{34}$$

By Proposition 2, expression (30) is satisfied, and the left-hand side of (34) satisfies

$$\sum_{j=0}^{\infty} \beta^j (1 - \xi\tau N_{t+j}) < \sum_{j=0}^{\infty} \beta^j (1 - \xi\tau \bar{N}).$$

Next, the gross interest rate R is increasing in N_t, and the real wage is decreasing in N_t. The right-hand side of (23) satisfies

$$\frac{\xi\tau R(\bar{K}, N_t)\bar{K}}{w(\bar{K}, N_t)} > \frac{\xi\tau R(\bar{K}, \bar{N})\bar{K}}{w(\bar{K}, \bar{N})},$$

which implies that

$$\sum_{j=0}^{\infty} \beta^j (1 - \xi\tau N_{t+j}) < \sum_{j=0}^{\infty} \beta^j (1 - \xi\tau \bar{N}) = \frac{\xi\tau R(\bar{K}, \bar{N})\bar{K}}{w(\bar{K}, \bar{N})} < \frac{\xi\tau R(\bar{K}, N_t)\bar{K}}{w(\bar{K}, N_t)}.$$

This is a contradiction. □

Proposition 4. *A necessary and sufficient condition for indeterminacy is that the employment elasticities on both sides of Equation (23) are the same.*

Proof. Starting from an equilibrium path, a small deviation of N away from this path will not violate equation (23) if and only if the changes on both sides of (23) brought about by the deviation in N exactly offset each other. In such a case, N is indeterminate given the state K. This is the same as saying that the labor elasticities on both sides of (23) are the same □

Finally, we obtain necessary conditions for local indeterminacy. This result is key, since it allows us to subsequently obtain sufficient conditions for local stability that are implementable through a judicious design of unemployment insurance.

Proposition 5. *(Necessary condition) Suppose* $\alpha < \bar{\alpha} \equiv 1/[1+\delta\left(\alpha\beta(\bar{Y}/\bar{K})(1-\delta)\right)^{-1}]$. *Then, a necessary condition for local indeterminacy is*

$$-\varepsilon_{\tau} \in (\underline{\varepsilon}, \bar{\varepsilon}), \tag{35}$$

where $\underline{\varepsilon} = \varepsilon_R - \varepsilon_W$, $\varepsilon_W < 0$ *is the employment elasticity of real wages,* $\varepsilon_R > 0$ *is the employment elasticity of gross interest and* $\alpha < \bar{\alpha}$ *ensures that* $\bar{\varepsilon} > \underline{\varepsilon}$.

Proof. From Proposition 2 we show that the employment elasticity of the left-hand side of (23) is negative if, and only if, $-\varepsilon_{\tau} < \bar{\varepsilon}$. A necessary condition for local indeterminacy requires that the employment elasticities of the left and right-hand sides of (23) have the same sign. A necessary and sufficient condition for the employment elasticity of the right-hand side of (23) to be negative is that $-\varepsilon_{\tau} > \varepsilon_R - \varepsilon_W \equiv \underline{\varepsilon}$, which, in turn, reduces to $-\varepsilon_{\tau} > \alpha\beta(\bar{Y}/\bar{K}) + \alpha\beta(1-\delta)$. The upshot is that a necessary condition for local indeterminacy is that $-\varepsilon_{\tau} \in (\underline{\varepsilon}, \bar{\varepsilon})$, which is a well-defined interval as long as $\alpha < \bar{\alpha}$ □

The restrictions on primitive parameters that ensure $\alpha < \bar{\alpha}$, such that (35) is a well-defined interval, are satisfied by common calibrations in the literature and, in that sense, it is a weak restriction.[13]

The necessary condition (35) involves two bounds. Satisfaction of the upper bound, $\bar{\varepsilon}$, as discussed after Proposition 2, ensures that higher employment raises permanent income. The lower bound, $\underline{\varepsilon}$, ensures that current actions reinforce initially held beliefs: expectations of higher permanent income feed back into higher current employment. This condition can also be interpreted in terms of the restriction it places on the equilibrium employment-wage loci defined by (10), specifically in terms of the slopes of the left- and right-hand sides, which correspond to the employment demand and supply elasticities. In particular, both aggregate labor demand and aggregate labor supply are downward sloping, since $\varepsilon_W < 0$ and $\varepsilon_{\tau} < 0$. The lower bound of the necessary condition for local indeterminacy requires that aggregate labor supply is steeper than aggregate labor demand, i.e., $-\varepsilon_{\tau} > -\varepsilon_W + \varepsilon_R > -\varepsilon_W$, where the first inequality corresponds exactly to the satisfaction of the lower bound in the necessary condition stated in Proposition 5.[14]

[13] In our calibration $\bar{\alpha} \approx 0.61$ and common parameterisations of the capital income share fall below this threshold.

[14] Similar to us, the mechanisms in Bennett and Farmer (2000) and Nakajima (2006) rely on downward-sloping labor supplies to generate self-fulfilling fluctuations. The former approach augments the one-sector neoclassical growth model with non-separable preferences between consumption and leisure and increasing returns in production. Indeterminacy requires that the labor supply curve is downward sloping and steeper than the (standard) downward-sloping labor demand curve. While Nakajima (2006) considers a variation of the neoclassical growth model with unobservable effort, efficiency wages, and limited unemployment insurance for unemployed workers. The labor supply is replaced by the relevant no-shirking condition (NSC). Under partial income insurance, the NSC is downward-sloping and steeper than the downward-sloping labor demand, and indeterminacy obtains. Instead, our framework does not require increasing returns or moral hazard considerations, but simply frictional labor markets.

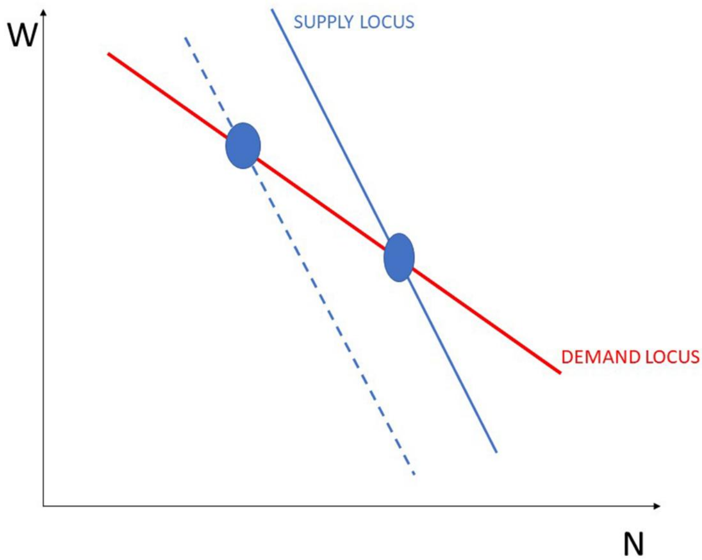

Figure 1 Equilibrium employment-wage loci.

It is important to clarify how the countercyclicality of the labor wedge generates a downward-sloping labor supply. To that end, consider again the equilibrium employment-wage locus defined by (10):

$$w_t = \tau_t \left(\frac{\xi}{1/C_t} \right), \tag{36}$$

where the countercyclicality of the labor wedge ($\varepsilon_\tau < 0$) implies that an increase in current employment N_t, holding consumption C_t constant, reduces the right-hand side of (36). To satisfy the condition, wages w_t must fall, which generates a downward-sloping labor supply curve. Allowing consumption to vary shifts the position of the labor supply curve (see Fig. 1) and enables us to study how changes in households' expectations about permanent income feed back into current employment decisions, creating a positive feedback loop that can generate self-fulfilling unemployment fluctuations.

For example, beliefs of a forthcoming recession shift the labor supply schedule to the left (following a drop in current consumption given beliefs of a lower permanent income), which, in turn, is consistent with lower current labor force participation and employment, confirming the initially held beliefs (satisfaction of the lower bound). Furthermore, satisfaction of the upper bound in (35) ensures that the drop in current employment reduces permanent income further (satisfaction of the upper bound), which, in turn, reduces current consumption and employment even further, closing the positive feedback loop between actions and beliefs.

4. Unemployment insurance

The main result of the paper characterizes sufficient conditions regarding optimal replacement rates that restore saddle path stability. The key insight is that by inverting the necessary condition for local indeterminacy we obtain sufficient conditions for saddle path stability. (For common calibrations of technology and preference parameters, existence of a stable equilibrium path can be verified for any nonnegative employment elasticity of the labor wedge.)

More formally, we establish the following result.

Proposition 6. *It is always possible to design a UI policy to guarantee a unique equilibrium path around the steady state. In particular, there exists replacement rates* $\zeta \in [\bar{\zeta}, 1]$*, with*

$$\bar{\zeta} = \frac{\sigma(1-\alpha) - \underline{\varepsilon}}{\sigma(1-\alpha) + (1/\bar{f} - 1)\underline{\varepsilon}}, \tag{37}$$

for which there is a unique saddle path stable equilibrium.

Proof. Follows immediately by setting $-\varepsilon_\tau = \sigma(1-\alpha)\bar{f}\bar{\tau}(1-\zeta) = \underline{\varepsilon}$, and using the expression of the labor wedge $\bar{\tau} = 1/[\bar{f} + (1-\bar{f})\zeta]$ at steady state, we construct the bound $\bar{\zeta}$. Then, for all $\zeta \in [\bar{\zeta}, 1]$, the (lower bound of the) necessary condition is violated, and there is a unique path converging to the steady state □

To inspect the mechanisms further, consider the intratemporal optimality (10) rearranged as follows:

$$\xi = \frac{w_t f_t}{C_t} + \frac{(1-f_t)\zeta w_t}{C_t}, \tag{38}$$

which equates the exogenous cost of participation, ξ, to the expected return received by a non-employed individual who searches for a job. Beliefs about the state of the economy affect current labor market conditions via externalities through the job-finding probability *f*. If $\zeta = 1$, then the job-finding probability cancels from the right-hand side of (38) and there is no feedback loop between current actions and beliefs. The result of Proposition 6 states that if replacement rates exceed bound $\bar{\zeta}$, then the positive feedback loop between current actions and beliefs is weakened substantially, and inefficient belief-driven fluctuations are eliminated.[15]

5. Calibration

We consider a range of calibrations for the model economy to reproduce the quarterly job-finding probabilities and unemployment insurance replacement rates found in a cross-section of OECD economies. The countries considered are Belgium (BE), Canada (CA), France (FR), Germany (GE), the Netherlands (NL), Spain (ES), the United Kingdom (UK), and the United States (US). Crucially, this set of countries spans two different labor market environments with distinct characteristics (something highlighted in Ljungqvist and Sargent 2008). The countries in continental Europe are characterized by sclerotic labor markets (meaning a low job-finding probability, *f*), and generous welfare states (meaning high unemployment

[15] Notice that $\bar{\zeta} < 1$, generically. Thus, it is always possible to design unemployment insurance policies that eliminate self-fulfilling fluctuations. What is interesting to observe is that setting a 100% replacement rate, $\zeta = 1$, in our model also implements an efficient equilibrium outcome. With 'thick market externalities' as in Diamond (1982, 1984), efficiency is generically not achieved because these externalities are akin to increasing returns to scale. Indeed, the implementation of an efficient market allocation in the Diamond (1982) model is explicitly discussed in Hosios (1990) and shown to only be achievable in the knife-edge case in which there are no externalities. In our model, this corresponds to the result that efficiency is only achievable when the elasticity of the job finding rate to output is zero, $\sigma = 0$, or if the replacement rate of unemployment insurance is 100%, $\zeta = 1$, in which case the equilibrium is both unique and efficient.

Table 1 UI replacement rates and job-finding probabilities across countries.

	BE	CA	FR	GE	NL	ES	UK	US
ζ	79.7%	26.6%	69.6%	59.5%	69.6%	62.9%	54.6%	25.0%
$\bar{f}$	9.8%	58.0%	18.1%	18.9%	13.1%	11.3%	28.7%	81.5%

Source: OECD and Hobijn and Sahin (2009).

insurance replacement rate, ζ), whilst countries in North America are the opposite. Perhaps appropriately, the UK stands more or less between this North Atlantic divide.

A period in our model corresponds to 3 months, but the effective replacement ratio earned on average by the typical unemployed worker in each country is contingent on the country's cross-sectional distribution of unemployment duration, and for the majority of the countries in our sample the average unemployment duration exceeds 6 months with a very high incidence of unemployment durations in excess of 12 months (Hobijn and Sahin 2009). Thus, we consider an unemployment duration of 12 months in the computation of the replacement rates. Specifically, to calibrate the unemployment replacement ratio, ζ, for each country, we make use of OECD statistics on the unemployment insurance net replacement rates, available between 2001–2021, for single households with no children and previous earnings at 67% of the average wage, and unemployment duration of 12 months. Next, turning to the calibration of the steady state job-finding probabilities in each country, $\bar{f}$, we make use of the estimated unemployment hazard rates documented in Hobijn and Sahin (2009) for several OECD countries.[16] The calibrated UI replacement rates and job-finding probabilities for each country are shown in Table 1.[17]

Next, to calibrate the output-elasticity of the job-finding probability, σ, we target the conditional volatility of unemployment and, specifically, the Okun coefficient corresponding to the correlation coefficient between unemployment and the output gap. We choose to target the Okun coefficient because there is ample evidence that this coefficient is stable over time and across countries (Ball et al., 2017). The Okun relationship is derived by log-linearizing the system of equations describing the labor market aggregate dynamics, as follows[18]

$$\begin{aligned} u_t - \bar{u} &= \underbrace{(1-\bar{u})\left[\left(\frac{1}{1-\alpha} - \lambda\sigma\right)\cdot\frac{1}{\lambda+\bar{f}(1-\lambda)} - \frac{1}{1-\alpha}\right]}_{\text{Okun's coefficient} \simeq -0.5} \widehat{Y}_t + \cdots, \\ &= \mathcal{O}\widehat{Y}_t + \cdots, \end{aligned} \tag{39}$$

where the remainder term $(\cdots)$ includes predetermined variables. The Okun coefficient, $\mathcal{O}$, is jointly determined by the job-finding probability, $\bar{f}$, the job-destruction probability, λ, the unemployment rate $\bar{u}$, the capital income share α, and, lastly, the parameter controlling the output elasticity of the job-finding rate, σ. Thus, the same Okun coefficient can be associated with different labor market characteristics. We choose to calibrate σ to match the labor market characteristics of the US and, in particular, target an unemployment rate of 5% following

[16] Hobijn and Sahin (2009) estimate average monthly instantaneous job-finding rates, $\widehat{f}_m$, based on a continuous-time model of unemployment duration. We make use of their estimated hazard rates and obtain discrete time job-finding probabilities using the formula $f = 1 - \exp(-3\widehat{f}_m)$.

[17] Our results extend to alternative calibrations where we consider an unemployment duration of 6 months in the computation of the replacement rates. The replacement rate for the US and CA are equal to 43% and 64% respectively, while the replacement ratio for the remaining countries coincides with the values in Table 1.

[18] Detailed derivations are presented in Supplementary Appendix G.

Table 2 Calibrated parameters (time unit of model: quarterly).

Parameter	Value	Target (and source)
α	0.283	Capital's income share of 28.3% (Gomme and Rupert 2007)
δ	0.014	Annual investment/capital ratio of 7.6% (Cooley and Prescott 1995)
β	0.992	Annual rate of return on capital of 5.16% (Gomme et al., 2011)
λ	0.232	US unemployment rate of 5% (Blanchard and Galí 2010)
σ	2.80	Okun's Law coefficient, $\mathcal{O} = -0.5$ (Ball et al., 2017)

Blanchard and Galí (2010). Making use of the model's equilibrium formula for the unemployment rate

$$\bar{u} = \frac{\lambda(1-\bar{f})}{\lambda(1-\bar{f})+\bar{f}} \rightarrow 5\% = \frac{\lambda(1-0.815)}{\lambda(1-0.815)+0.815}, \tag{40}$$

we obtain the US job-destruction probability, $\lambda = 0.232$.

Given the US quarterly job-finding probability in steady state, $\bar{f} = 0.815$, the job-destruction probability, $\lambda = 0.232$ and the steady state unemployment rate, $\bar{u} = 0.050$, targeting an Okun's coefficient of $\mathcal{O} = -0.5$, yields $\sigma = 2.80$. The target for Okun's coefficient, $\mathcal{O} = -0.5$, is taken from Ball et al. (2017) and is a robust feature of the data which holds for both annual and quarterly periodicity, and for various methods of measuring short-run movements in output and unemployment. Finally, the calibration of the technology and preferences parameters, α, δ, and β is standard in the literature and is reported in Table 2.

5.1 Labor market and (in)determinacy: a quantitative assessment

We are now in a position to assess quantitatively how different countries in the OECD, with contrasting labor market characteristics, perform in relation to the criteria for local indeterminacy we have derived above. Specifically, building on Proposition 6, we are able to rule out local indeterminacy for those countries that have a sufficiently high unemployment insurance replacement rate, ζ, given the fluidity of their respective labor markets, which is controlled by the job-finding rate probability, $\bar{f}$. This exercise is illustrated in Fig. 2, which plots the locus of job-finding probabilities and UI replacement rates, $(\bar{f}, \zeta)$. The curve separates regions in the graph: the *yellow* region above the curve indicates where the sufficient condition for ruling out local indeterminacy is satisfied. Thus, countries located above this curve exhibit a unique perfect-foresight equilibrium, ruling out self-fulfilling fluctuations.[19]

Figure 2 uncovers significant differences between North America and Europe when looking at the generosity of the welfare state and labor market conditions. Europe is characterized by generous welfare states and sclerotic labor markets (jobs are hard to find), while North America (US and CA) is characterized by less generous welfare states and fluid labor markets. As it turns out, labor markets with European characteristics, except the UK, rule out self-fulfilling fluctuations (all European countries, with the exception of the UK, are comfortably in the region satisfying the sufficient condition for local uniqueness), whilst labor

[19] To be clear, the figure is constructed only making use of the sufficient condition for local uniqueness obtained in Proposition 6. Consequently, a country below the curve (the *orange* region), where the sufficient condition is not satisfied, may still satisfy the Blanchard-Kahn conditions for local determinacy.

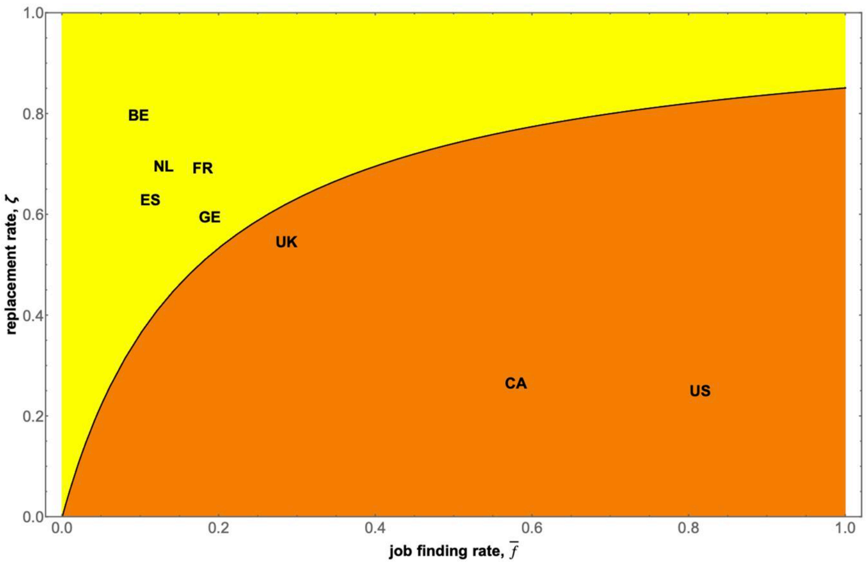

Figure 2 Labor market characteristics and (in)determinacy.

markets with North American characteristics, including the UK, are susceptible to inefficient, belief-driven fluctuations. This characterization of two different labor market environments in North America and Europe is evocative of the analysis by Ljungqvist and Sargent (2008), who show that since the 1980s European workers, compared to their North American counterparts, face lower hazard rates of gaining employment and increased unemployment duration (sclerotic labor market), whilst at the same time suffering a lower drop in earnings conditional on job loss due to more generous unemployment compensation.

Figure 2 highlights the contrasting characteristics of European and North American labor markets and shows that these differences matter for business cycle fluctuations. It also reveals that, holding the replacement rate fixed, the economy exits the indeterminacy region as labor markets become more sclerotic ($\bar{f} \longrightarrow 0$). To see this, recall the intratemporal condition

$$\xi = \frac{w_t f_t}{C_t} + \frac{(1 - f_t)\zeta w_t}{C_t}.$$

As $\bar{f} \longrightarrow 0$, the replacement income receives more weight in the expected return to search, weakening the effect of beliefs about f_t on current actions. This dampening effect breaks the feedback loop between beliefs and employment, thereby ruling out indeterminacy.[20]

[20] We have assumed that the unemployed do not engage in home production. However, in previous work (Kokonas and Santos Monteiro 2025), we consider similar preferences but generalize the model to include also disutility from working, in addition to a participation cost, incurred only by the employed individuals. This additional cost is interpreted as the forgone home production of the employed (the opportunity cost of employment conditional on participation). In the model with forgone home production for the employed, the opportunity cost of participation is procyclical (consistent with Chodorow-Reich and Karabarbounis 2016). This feature of the model will work in the opposite direction as the countercyclicality of the labor wedge and, thus, the indeterminacy region becomes smaller.

6. Business cycles and indeterminacy

Next, we examine a version of the model that includes fundamental shocks and study the macroeconomic response to these shocks when, in turn, there exists a unique rational expectations equilibrium and when, instead, the unemployment insurance replacement rate is too low, meaning that there is equilibrium indeterminacy and, thus, a sunspot (non-fundamental) shock is required to pin down the transition path, conditional on the fundamental shock. The log-linear equilibrium conditions of the version of the model that includes fundamental shocks are given by

$$\widehat{w}_t = \widehat{C}_t + \widehat{\tau}_t, \tag{41}$$

$$\widehat{\tau}_t = -\bar{\tau}\bar{f}(1-\zeta)\sigma\widehat{Y}_t, \tag{42}$$

$$\mathbb{E}_t(\widehat{C}_{t+1}) - \widehat{C}_t = \alpha\beta(\bar{Y}/\bar{K})\mathbb{E}_t[(1-\alpha)(\widehat{N}_{t+1} - \widehat{K}_{t+1}) + z_{t+1}], \tag{43}$$

$$\widehat{R}_t = \alpha\beta(\bar{Y}/\bar{K})[(1-\alpha)(\widehat{N}_t - \widehat{K}_t) + z_t], \tag{44}$$

$$\widehat{w}_t = \alpha(\widehat{K}_t - \widehat{N}_t) + z_t, \tag{45}$$

$$(\bar{C}/\bar{K})\widehat{C}_t + \widehat{K}_{t+1} = (\bar{Y}/\bar{K})\widehat{Y}_t + (1-\delta)\widehat{K}_t, \tag{46}$$

$$\widehat{Y}_t = \alpha\widehat{K}_t + (1-\alpha)\widehat{N}_t + z_t, \tag{47}$$

$$z_{t+1} = \rho_z z_t + \varepsilon^z_{t+1}, \tag{48}$$

where $\mathbb{E}_t(\cdot)$ is the date t conditional expectations operator, and ε^z_t is a fundamental technology shock that raises total factor productivity z_t.

The model corresponds to the standard RBC model, except for the endogenous labor wedge $\widehat{\tau}_t$, which, as we have seen, may lead to equilibrium indeterminacy if σ, which controls the strength of the externalities in search, is sufficiently large. However, if the unemployment replacement rate $\zeta \in [0, 1]$ is sufficiently large, the indeterminacy disappears. In particular, when $\zeta = 1$, we have that the labor wedge no longer fluctuates, as $\widehat{\tau}_t = 0$ for all t, and the model collapses to the canonical RBC model with a unique rational expectations equilibrium.

We consider two versions of the model, one with $\zeta = 43\%$ (the US unemployment replacement ratio for the 6-month horizon—see footnote 17), and a second calibration that is identical in everything, except that $\zeta = 100\%$, thus ensuring a unique rational expectations equilibrium. To solve the model with indeterminacy, we follow the method in Farmer et al. (2015), which amounts to introducing sunspots in the form of rational expectation errors, as follows:

$$\varepsilon^s_t = \hat{C_t} - \mathbb{E}_{t-1}(\widehat{C}_t). \tag{49}$$

As in Farmer et al. (2015), we model expectations formation by specifying how the forecast error, ε^s_t, covaries with the fundamental innovation, ε^z_t. Specifically, we assume the sunspot is perfectly correlated with the fundamental shock, $\varepsilon^s_t = \varsigma\varepsilon^z_t$, and calibrate ς such that the TFP shock generates the same percentage increase in output on impact in both the indeterminate economy and the economy with a unique rational expectations equilibrium. This approach keeps the stochastic dimensionality of the two economies the same, and the calibration is disciplined by restricting the response of output to TFP shocks on impact to be the same across the two economies.

Figure 3 shows the impulse response functions for output, consumption, employment and investment to a TFP shock causing output to increase on impact by 1%, in both the economy

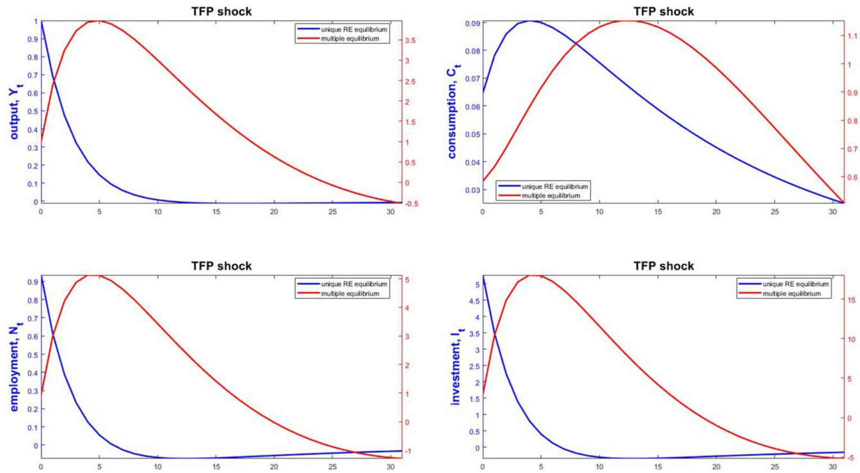

Figure 3 Response to a TFP shock in the two economies (blue lines—unique RE equilibrium; and red lines economy with multiple equilibria). The response of the model corresponding to the unique RE equilibrium is measured in the left vertical axis, and the response of the economy with multiple equilibria is measured in the right vertical axis.

Table 3 Business cycle volatility.

Variable	**Rel. std. dev. (to $\widehat{Y}$)**		**Std. dev. across calibrations**
	Unique equilibrium ζ =**100**%	**Multiple equilibria** ζ =**43**%	$\sigma_x^{\zeta=43\%}/\sigma_x^{\zeta=100\%}$
Y	1.0000	1.0000	9.2783
C	0.2600	0.4171	14.8806
N	0.9087	1.2579	12.8430
I	5.1257	4.4241	8.0082

Source: Authors' calculations.
The first two columns report σ_X/σ_Y. The third column reports the relative standard deviation of each variable across the two model calibrations ($\sigma_x^{\zeta=43\%}/\sigma_x^{\zeta=100\%}$).

with an unique RE equilibrium (the high replacement rate economy), and the economy with multiple equilibria and, thus, where we introduce a sunspot as in equation (49), taking the form of a rational expectation error correlated with the TFP shock. Although the volatility and persistence of the TFP shocks are the same in the two economies, in the economy with indeterminacy, the macroeconomic volatility is much higher as we report in Table 3. This higher volatility results in part from the volatility associated with the sunspot shock, and, in particular, the response of consumption on impact to a TFP shock is entirely determined by the volatility of the sunspot shock and is given by $\varepsilon_t^s = \varsigma\varepsilon_t^z$. We discipline the calibration by choosing the volatility coefficient, ς, such that in response to a one standard deviation TFP

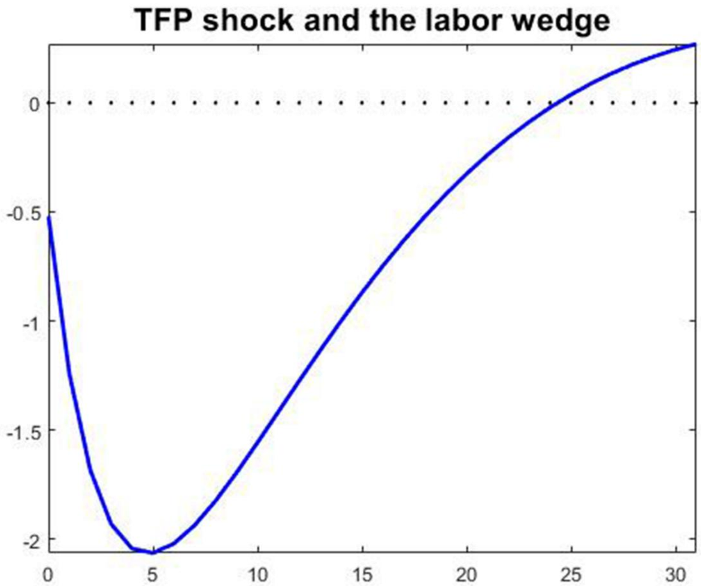

Figure 4 Labor wedge and TFP in the economy with multiple equilibria.

shock, output increases on impact by exactly 1% in both economies. However, to be sure, the volatility in the sunspot economy is arbitrarily high, as it increases with the volatility of the rational expectations error. Because of this, precise welfare statements are difficult to make. Still, given the volatility obtained in the sunspot economy, if we increased the replacement rate of unemployment insurance to 100%, all else equal, the volatility of consumption would fall by a factor of 14.88, suggesting very large welfare gains.

The second factor contributing to the higher volatility of the sunspot economy is the strong internal propagation mechanism resulting from the endogeneity of the labor wedge. This is illustrated in Fig. 3, and also in Fig. 4, which plots the response of the labor wedge to a TFP shock in the economy with indeterminacy. A positive TFP shock lowers the labor wedge, resulting in an internal propagation mechanism that delivers a hump-shape with a delayed peak response of investment, and other macroeconomic aggregates such as the job finding rate. This is a feature of the business cycle that conventional models struggle to obtain without imposing implausible adjustment costs in flow variables such as investment and vacancy creation (a problem discussed in, for example, Van Rens and Vukotić 2023). Therefore, the endogenous labor wedge we obtain, resulting from transaction externalities in search and endogenous labor force participation, can lead to empirically more plausible conditional business cycle dynamics.[21]

[21] Of course, the endogenous labor wedge fluctuations also lead to stronger internal propagation in an economy with a unique rational expectations equilibrium, as long as the replacement rate of the unemployment insurance is less than full. However, when $\zeta = 1$, it is immediate to see from equation (42) that $\widehat{\tau}_t = 0$, for all t, and thus the labor wedge becomes constant. Obtaining a hump shaped response of output and, thus, positive serial correlation in output growth echoes a similar result in Hashimzade and Ortigueira (2005), who also construct a model with labor market frictions and search externalities and argue that the increased internal propagation of shocks is a feature of models with such externalities.

7. Conclusion

This paper embeds frictions in the labor market and an endogenous participation choice in an otherwise standard neoclassical growth model and shows that the interaction of these features can generate self-fulfilling fluctuations. Unemployment insurance is shown to make indeterminacy less likely and is a powerful automatic stabilizer. Calibrated versions of the model suggest that this source of instability, and hence, the need to use unemployment insurance as an automatic stabilizer, is not just a theoretical possibility but occurs for empirically plausible values of the parameters. Given a fixed set of labor market characteristics (controlled by the labor market fluidity, $\bar{f}$), the results give support to generous unemployment insurance, similar to Europe, which eliminates self-fulfilling fluctuations.

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Supplementary material

Supplementary material is available at the *Oxford Economic Papers Journal* online. These include the replication files and the online appendix.

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References

Aiyagari, S. R. (1995), Comments on Farmer and Guo's 'The Econometrics of Indeterminacy: An Applied Study', Staff Report 196, Federal Reserve Bank of Minneapolis.

Alonso-Ortiz, J., and Rogerson, R. (2010) 'Taxes, Transfers and Employment in an Incomplete Markets Model', *Journal of Monetary Economics*, 57: 949–58.

Alvarez, F., and Shimer, R. (2011) 'Search and Rest Unemployment', *Econometrica*, 79: 75–122.

Alvarez, F., and Veracierto, M. (1999) 'Labor-Market Policies in an Equilibrium Search Model', *NBER Macroeconomics Annual*, 14: 265–304.

Alvarez, F., and Veracierto, M. (2012) 'Fixed-Term Employment Contracts in an Equilibrium Search Model', *Journal of Economic Theory*, 147: 1725–53.

Andolfatto, D. (1996) 'Business Cycles and Labor-Market Search', *American Economic Review*, 86: 112–32.

Andolfatto, D., and Gomme, P. (1996) Unemployment Insurance and Labor-Market Activity in Canada. *Carnegie-Rochester Conference Series on Public Policy*, 44: 47–82.

Arseneau, D. M., and Chugh, S. K. (2012) 'Tax Smoothing in Frictional Labor Markets', *Journal of Political Economy*, 120: 926–85.

Ball, L., Leigh, D., and Loungani, P. (2017) 'Okun's Law: Fit at 50?, ', *Journal of Money, Credit and Banking*, 49: 1413–41.

Benhabib, J., and Farmer, R. E. (1994) 'Indeterminacy and Increasing Returns', *Journal of Economic Theory*, 63: 19–41.

Bennett, R. L., and Farmer, R. E. (2000) 'Indeterminacy with Non-separable Utility', *Journal of Economic Theory*, 93: 118–43.

Bettarelli, L. et al. (2025) 'Labor Market Reforms and Unemployment Fluctuations', *Oxford Economic Papers*, 77: 919–37.

Blanchard, O., and Galí, J. (2010) 'Labor Markets and Monetary Policy: A New Keynesian Model with Unemployment', *American Economic Journal: Macroeconomics*, 2: 1–30.

Blinder, A. S. (1975) 'Distribution Effects and the Aggregate Consumption Function', *Journal of Political Economy*, 83: 447–75.

Boldrin, M., Kiyotaki, N., and Wright, R. (1993) 'A Dynamic Equilibrium Model of Search, Production, and Exchange', *Journal of Economic Dynamics and Control*, 17: 723–58.

Brown, E. C. (1955) 'The Static Theory of Automatic Fiscal Stabilization', *Journal of Political Economy*, 63: 427–40.

Challe, E., and Ragot, X. (2016) 'Precautionary Saving over the Business cycle', *The Economic Journal*, 126: 135–64.

Chodorow-Reich, G., and Coglianese, J. M. (2019) 'Unemployment Insurance and Macroeconomic Stabilization,' In: **Heather Boushey**, Nunn, R., and Shambaugh, J. (ed.) *Recession Ready*, pp. 153–79. Washington, DC: Brookings Institution.

Chodorow-Reich, G., and Karabarbounis, L. (2016) 'The Cyclicality of the Opportunity Cost of Employment', *Journal of Political Economy*, 124: 1563–618.

Christiano, L. J., and Harrison, S. G. (1999) 'Chaos, Sunspots and Automatic Stabilizers', *Journal of Monetary Economics*, 44: 3–31.

Christoffel, K., Kuester, K., and Linzert, T. (2009) 'The Role of Labor Markets for Euro Area Monetary Policy', *European Economic Review*, 53: 908–36.

Cooley, T. F., and Prescott, E. C. (1995) 'Economic Growth and Business Cycles', *Frontiers of Business Cycle Research*, 1: 1–38.

Di Maggio, M., and Kermani, A. (2016) *The Importance of Unemployment Insurance as an Automatic Stabilizer, Technical Report*. Cambridge, MA: National Bureau of Economics.

Diamond, P. A. (1982) 'Aggregate Demand Management in Search Equilibrium', *Journal of Political Economy*, 90: 881–94.

Diamond, P. A. (1984) *A Search-Equilibrium Approach to the Micro-Foundations of Macroeconomics*, Vol. 1982. Cambridge, MA: MIT Press.

Elsby, M. W. L., Hobijn, B., and Şahin, A. (2015) 'On the Importance of the Participation Margin for Labor Market Fluctuations', *Journal of Monetary Economics*, 72: 64–82.

Faia, E. (2008) 'Optimal Monetary Policy Rules with Labor Market Frictions', *Journal of Economic Dynamics and Control*, 32: 1600–21.

Farmer, R. E., Khramov, V., and Nicolò, G. (2015) 'Solving and Estimating Indeterminate DSGE Models', *Journal of Economic Dynamics and Control*, 54: 17–36.

Fernández-Villaverde, J. et al. (2025) 'Search Complementarities, Aggregate Fluctuations, and Fiscal Policy', *Review of Economic Studies*, 92: 2502–36.

Ferriere, A., and Navarro, G. (2024) *Fiscal Management of Aggregate Demand: The Effectiveness of Labor Tax Credits, Technical Report*. London: CEPR.

Flodén, M. (2001) 'The Effectiveness of Government Debt and Transfers as Insurance', *Journal of Monetary Economics*, 48: 81–108.

Galí, J., Gertler, M., and Lopez-Salido, J. D. (2007) 'Markups, Gaps, and the Welfare Costs of Business Fluctuations', *Review of Economics and Statistics*, 89: 44–59.

Gomme, P., Ravikumar, B., and Rupert, P. (2011) 'The Return to Capital and the Business Cycle', *Review of Economic Dynamics*, 14: 262–78.

Gomme, P., and Rupert, P. (2007) 'Theory, Measurement and Calibration of Macroeconomic Models', *Journal of Monetary Economics*, 54: 460–97.

Gorn, A., and Trigari, A. (2024) 'Assessing the Stabilizing Effects of Unemployment Benefit Extensions', *American Economic Journal: Macroeconomics*, 16: 387–440.

Guo, J.-T., and Lansing, K. J. (1998) 'Indeterminacy and Stabilization Policy', *Journal of Economic Theory*, 82: 481–90.

Hall, R. (2009) 'Reconciling Cyclical Movements in the Marginal Value of Time and the Marginal Product of Labor', *Journal of Political Economy*, 117: 281–323.

Hall, R. E. (2005a) 'Employment Fluctuations With Equilibrium Wage Stickiness', *American Economic Review*, 95: 50–65.

Hall, R. E. (2005b) 'Job Loss, Job Finding, and Unemployment in the US Economy Over the Past Fifty Years', *NBER Macroeconomics Annual*, 20: 101–37.

Hansen, G. D. (1985) 'Indivisible Labor and the Business Cycle', *Journal of Monetary Economics*, 16: 309–27.

Hashimzade, N., and Ortigueira, S. (2005) 'Endogenous Business Cycles with Frictional Labour Markets', *The Economic Journal*, 115: C161–75.

Hobijn, B., and Şahin, A. (2009) 'Job-finding and Separation Rates in the OECD', *Economics Letters*, 104: 107–11.

Hosios, A. J. (1990) 'On the Efficiency of Matching and Related Models of Search and Unemployment', *The Review of Economic Studies*, 57: 279–98.

Howitt, P., and McAfee, R. P. (1992) 'Animal Spirits', *American Economic Review*, 82: 493–507.

Janiak, A., and Santos Monteiro, P. (2016) 'Towards a Quantitative Theory of Automatic Stabilizers: The Role of Demographics', *Journal of Monetary Economics*, 78: 35–49.

Jung, P., and Kuester, K. (2015) 'Optimal Labor-market Policy in Recessions', *American Economic Journal: Macroeconomics*, 7: 124–56.

Kaplan, G., and Menzio, G. (2016) 'Shopping Externalities and Self-fulfilling Unemployment Fluctuations', *Journal of Political Economy*, 124: 771–825.

Karabarbounis, L. (2014) 'The Labor Wedge: Mrs VS, Mpn', *Review of Economic Dynamics*, 17: 206–23.

Kekre, R. (2023) 'Unemployment Insurance in Macroeconomic Stabilization', *Review of Economic Studies*, 90: 2439–80.

Kokonas, N. (2023) 'A Note on the Unemployment Volatility Puzzle', *Oxford Economic Papers*, 75: 55–74.

Kokonas, N., and Santos Monteiro, P. (2021) 'Aggregation in Economies with Search Frictions', *Journal of Mathematical Economics*, 96: 102521.

Kokonas, N., and Santos Monteiro, P. (2025) 'Equilibrium Labour Force Participation and the Business Cycle', *Economica*, 92: 783–822.

Krause, M. U., and Lubik, T. A. (2010) 'Instability and Indeterminacy in a Simple Search and Matching Model', *SSRN Electronic Journal*, 96: 259.

Krusell, P. et al. (2008) 'Aggregate Implications of Indivisible Labor, Incomplete Markets, and Labor Market Frictions', *Journal of Monetary Economics*, 55: 961–79.

Krusell, P. et al. (2010) 'Aggregate Labor Market Outcomes: The Roles of Choice and Chance', *Quantitative Economics*, 1: 97–127.

Krusell, P. et al. (2011) 'A Three State Model of Worker Flows in General Equilibrium', *Journal of Economic Theory*, 146: 1107–33.

Krusell, P. et al. (2017) 'Gross Worker Flows over the Business Cycle', *American Economic Review*, 107: 3447–76.

Lazaryan, N., and Lubik, T. A. (2019) 'Global Dynamics in a Search and Matching Model of the Labor Market', *Economic Theory*, 68: 461–97.

Ljungqvist, L., and Sargent, T. J. (2008) 'Two Questions about European Unemployment', *Econometrica*, 76: 1–29.

Lucas, R. E., and Prescott, E. C. (1974) 'Equilibrium Search and Unemployment', *Journal of Economic Theory*, 7: 188–209.

McKay, A., and Reis, R. (2016) 'The Role of Automatic Stabilizers in the US Business Cycle', *Econometrica*, 84: 141–94.

Merz, M. (1997) 'A Market Structure for an Environment with Heterogeneous Job-matches, Indivisible Labor and Persistent Unemployment', *Journal of Economic Dynamics and Control*, 21: 853–72.

Michaillat, P. (2012) 'Do Matching Frictions Explain Unemployment? Not in Bad Times', *American Economic Review*, 102: 1721–50.

Mortensen, D. T., and Pissarides, C. A. (1994) 'Job Creation and Job Destruction in the Theory of Unemployment', *The Review of Economic Studies*, 61: 397–415.

Nakajima, T. (2006) 'Unemployment and Indeterminacy', *Journal of Economic Theory*, 126: 314–27.

Pissarides, C. A. (2000) *Equilibrium Unemployment Theory*, 2nd edn, Vol. 1 of MIT Press Books. Cambridge, MA: The MIT Press.

Pissarides, C. A. (2009) 'The Unemployment Volatility Puzzle: Is Wage Stickiness the Answer?', *Econometrica*, 77: 1339–69.

Rogerson, R. (1988) 'Indivisible Labor, Lotteries and Equilibrium', *Journal of Monetary Economics*, 21: 3–16.

Schmitt-Grohé, S., and Uribe, M. (1997) 'Balanced-budget Rules, Distortionary Taxes, and Aggregate Instability', *Journal of Political Economy*, 105: 976–1000.

Shimer, R. (2005) 'The Cyclical Behavior of Equilibrium Unemployment and Vacancies', *American Economic Review*, 95: 25–49.

Shimer, R. (2009) 'Convergence in Macroeconomics: The Labor Wedge', *American Economic Journal: Macroeconomics*, 1: 280–97.

Thomas, C., and Zanetti, F. (2009) 'Labor Market Reform and Price Stability: An Application to the Euro Area', *Journal of Monetary Economics*, 56: 885–99.

Van Rens, T., and Vukotić, M. (2023) 'Delayed Adjustment and Persistence in Macroeconomic Models', *Journal of Money, Credit and Banking*, 55: 1325–56.

Wen, Y. (2001) 'Understanding Self-fulfilling Rational Expectations Equilibria in Real Business Cycle Models', *Journal of Economic Dynamics and Control*, 25: 1221–40.

Zanetti, F. (2006) 'Labor Market Frictions, Indeterminacy, and Interest Rate Rules', *Journal of Money, Credit and Banking*, 38: 1959–70.

Zanetti, F. (2011a) 'Labor Market Institutions and Aggregate Fluctuations in a Search and Matching Model', *European Economic Review*, 55: 644–58.

Zanetti, F. (2011b) 'Labour Policy Instruments and the Cyclical Behaviour of Vacancies and Unemployment', *Economica*, 78: 779–87.

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