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The employment and output of Nations: Theory and policy implications☆

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ABSTRACT

I build a dynamic general equilibrium model that is consistent with the trends in the participation, unemployment and employment rates for the US and major European economies over the last 50 years. I then use the model to study the interdependence of non-competitive labor and product markets in order to shed light on the effects of institutions and policies on employment and output. Unemployment harms output because it inserts a wedge between labor supply (participation) and employment. The distribution of income across wages and profits plays a central role in the economy's dynamics. The reason is that the wage share drives the labor market participation decisions of households, while the profit share drives the entry decisions of firms. Intuitively, one can think of entry decisions as another participation margin. I uncover feedback mechanisms linking the two markets that amplify the adverse effects on output of labor and product market frictions. These mechanisms have interesting policy implications.

1. Introduction

Figs. 1 and 2 display the evolution of the employment, unemployment and participation rates for the US and the EU15 economies.[1] One feature of these data is the steady rise of unemployment rates in Europe, although we observe a slight decline at the end of the sample period. The contrast with the US, which displays a hump-shaped profile of the unemployment rate, has led many to conclude that there is a "European unemployment problem" in that something prevents European unemployment from returning to its pre-1970s level.

A more remarkable feature of the data, however, is that the rise of European unemployment took place in the context of a smooth rise in participation. Apart from the slight dip ate the end of the sample period, the participation rate in the US has also been increasing smoothly. Moreover, the rise of the unemployment rate in Europe has not produced a fall of the employment rate, which instead has increased steadily. It appears, then, that to explain the long-term employment performance of the US and EU15 economies one must consider the participation margin. Unemployment matters, because it inserts a wedge between employment and participation, but it is not a sufficient statis-

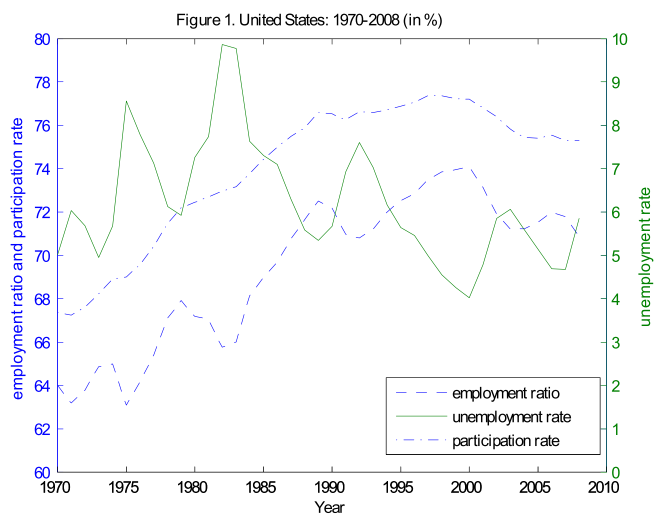

Fig. 1. The labor market in the USA.

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[1] The participation rate is the fraction of the population age 15–64 who claim to be in the labor market. These individuals are either employed or unemployed and actively seeking work. Accordingly, the employment rate is the fraction of the population age 15–64 who are employed, while the unemployment rate is the fraction of the participating population age 15–64 who are not employed.

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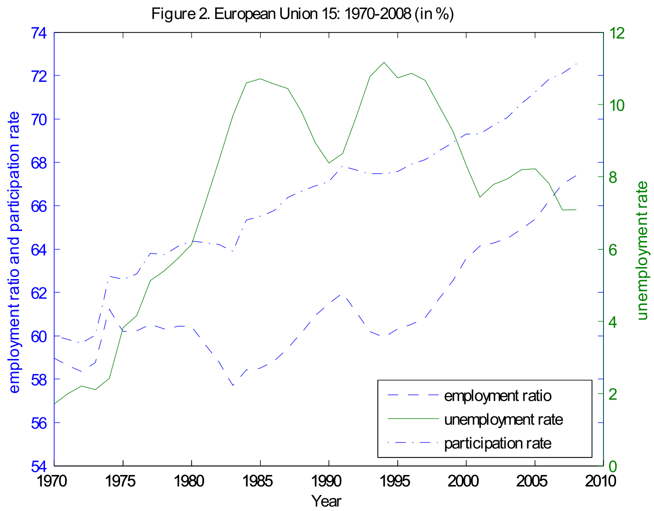

Fig. 2. The labor market in the EU15.

tic for the performance of the labor market.

In this paper I build a dynamic general equilibrium model that is consistent with these facts. I view employment as the outcome of actions taken on two margins. On one margin agents choose whether to participate to the labor market in the presence of individual unemployment risk. For simplicity, I model this margin as households that control the mass of members that supply labor but not their individual probability of employment. Accordingly, some of the participating members do not find employment even if at the going wage they wish to work. On the other margin, firms bargain with workers over wages and employment and thereby determine how many of the individuals willing to work find employment. There are thus three categories of individuals: those who participate and are employed, those who participate and are unemployed, and those who do not participate.

This representation allows me to study how in general equilibrium the rationing of jobs due to the imperfections of the labor market interacts with the creation, distribution and eventual dissipation of the rents due to the imperfections of the product market. The model is tractable and allows me to study analytically the dynamic effects of changes in institutions and policies. The explicit consideration of a labor force participation margin, in particular, sheds new light on the interdependence of labor and product markets. One reason is that participation is an important determinant of product market size and thereby of new firms' incentives to enter and compete away the rents earned by incumbent firms and their employees. Another is that it amplifies the effects of labor market frictions that generate unemployment through either a discouraged worker effect, whereby worse employment prospects induce the marginal individual to withdraw from the labor force, or an added worker effect, whereby worse employment prospects for the inframarginal individual induce the marginal individual to join the labor force. Whether the discouraged worker or the added worker effect prevails depends on the balance between substitution and income effects in households' decisions.

This mechanism highlights the central role of the distribution of income across wages and profits in driving the economy's dynamics: the wage share drives the labor market participation decisions of households, while the profit share drives the entry decisions of firms. Intuitively, one can think of entry decisions as another participation margin (the difference being that setting up a new firms entails a sunk cost while participation to the labor market does not). There is thus an inherent trade-off between participation of workers and participation of firms in that attempts at rising the wage share deter entry. On the other hand, participation of workers and firms must also feature a positive link in that firms employ workers to produce output so that ultimately higher participation of workers attracts participation of firms. The interplay of these forces generates interesting results.

Consider, for instance, the role of factors that raise labor costs and thus reduce employers' willingness to hire workers, resulting in lower employment and higher unemployment. Firms' entry decisions amplify these effects in that the fall in employment shrinks the size of the product market and thereby triggers a reduction in the number of firms. This produces a multiplier effect that amplifies the adverse effects of these factors because the fall in the number of firms reduces employment further than if one considers the labor market in isolation.

Similarly, regulations and frictions that raise the costs of entry and/or of operation for firms result in a larger reduction of the number of firms than if employment were held constant. There is thus a second multiplier effect that exploits the endogeneity of employment to amplify the adverse effects on output of interventions that worsen the product market.

Note that in both cases the fall in employment is larger if individuals withdraw from the labor force in response to a worsening of the labor market. In other words, endogenous participation potentially reinforces the multiplier effects linking the labor and product markets.

The analysis of these feedback mechanisms has two general policy implications. First, labor market reforms that reduce the cost of labor, like those advocated by the OECD in its Jobs Study (1994), and product market reforms that increase entry, like the pro-competitive reforms advocated by the McKinsey Global Institute (1995, 1997), are strongly complementary and reinforce each other. Moreover, their general equilibrium effects are stronger than any partial equilibrium analysis of the labor or product market would reveal.

The second implication stems from observing that some factors – e.g., the bargaining power of workers – have opposite effects on the long-run employment and participation rates. The reason is that a rise of workers' bargaining power redistributes income from profits to wages and thus attracts participation. The rise of the wage share, however, cannot persist because in the long run the shares of national income are pinned down by factors that regulate the entry decisions of firms. What eventually brings the wage share down is a rise of the unemployment rate that weakens workers' bargaining position. To accomplish this, however, the *wedge effect* of unemployment must be so strong that employment actually falls. Hence, an attempt at redistribution through a "wage push" (Bertola, 2001) succeeds only in the short run, and eventually results in rising participation, rising unemployment and falling employment, while the wage share falls back to its original level. For workers, this is the bad news part of the story.

The good news is that labor market reforms that worsen their bargaining position do not worsen their long-run share of income. On the other hand, reforms of the product market that reduce the costs of entry raise employment and output, lower unemployment, and *raise* the labor share of national income. They thus should appeal to workers from a redistributive viewpoint – a feature that makes them politically feasible as well as economically attractive. Taken together, these considerations suggest that workers, when asked for concessions that reduce its bargaining power, should make those concessions – and ask in exchange for reforms of the product market that reduce barriers to entry! While this suggestion appears to turn the traditional approach to labor-industry negotiations on its head, especially in Europe, its logic is straightforward. The concessions entail a short-run sacrifice of income share, but in the long run this is a win-win situation for labor in that unemployment falls, employment rises, and the reduction of barriers to entry ensures that the wage share rises as well.

I proceed as follows. In Section 2 I review the literature and place the paper in context. In Section 3, I set up the model. In Section 4, I study the instantaneous equilibrium of labor market. In Section 5, I study the economy's general equilibrium and show how the interaction of product and labor markets determines employment, unemployment and output. In Section 6, I discuss the effects of structural parameters and policy instruments. I conclude in Section 7.

2. Related literature

Economists agree that unemployment is high in economies where unemployment benefits are unrelated to the individual's effort to find work, the labor force is organized in sectoral (or firm-level) unions that do not coordinate their activities, and taxation raises the cost of labor.[2] Research undertaken in the 90s, reviewed in Nickell (1997) and Gersbach (1999), has augmented this view and emphasized that the characteristics of the product market matter as well. Consequently, recent research has focused on the role of product market factors, in particular the regulation of entry and competition, in determining macroeconomic performance (see, e.g., Boeri et al., 2000, Fonseca et al., 2001, Pissarides, 2001, Bertrand and Kramarz, 2002, Blanchard and Giavazzi, 2003, Spector, 2004). This literature indeed has grown so rapidly, and branched out in so many directions, that it is becoming difficult to keep track of all that is going on without the aid of surveys. A recent one that I found quite useful is Schiantarelli (2005).

Much of this literature focuses on unemployment and studies models where labor supply is inelastic so that employment and unemployment are forced to move in opposite directions. The mechanism giving rise to unemployment varies across models, but the logic that all that matters for labor market outcomes occurs on the demand side seems to go unchallenged. An exception is Rogerson (2001), who argues that we should rather focus on employment because it reflects more directly the resources allocation achieved by the economy. The data discussed above supports this view and emphasizes that to understand the long-run movements in employment we must look at participation.

Of all those mentioned above, the papers that come closer to what I do here are Blanchard and Giavazzi (2003) and Spector (2004). I depart from their setup in that I embed a static model of the labor market in a dynamic environment where households make a participation decision and a consumption-saving decision. One benefit of this approach is that it allows me to derive from the households' primitives a reservation wage that depends on unemployment and distortionary taxes, and that serves as the natural alternative in the bargaining problem (see below) since it measures the opportunity cost of labor market participation. The other benefit is that in general equilibrium endogenous participation amplifies the dynamic feedback effects linking the labor and product markets. (Aside from these changes, the conceptual representation of the labor market is basically the same.) Another difference of note is that those papers do not include a (sunk) entry cost. Together with the lack of a consumption-saving decision, this omission implies that the models do not have well-defined transitional dynamics. My model, in contrast, provides a very tractable characterization of transitional dynamics in response to policy and structural shocks.[3]

[2] In his review of the state of the art, for example, Nickell (1997, p. 72) concludes: "High unemployment is associated with the following labor market features: (1) generous unemployment benefits that are allowed to run indefinitely, combined with little or no pressure on the unemployed to obtain work and to low levels of active intervention to increase the ability and willingness of the unemployed to work; (2) high unionization with wages bargained collectively and no coordination between either union or employers in wage bargaining; (3) high overall taxes impinging on labor or a combination of high minimum wages for young people associated with high payroll taxes; and (4) poor educational standards at the bottom end of the labor market." Nickell et al. (2005) reinforce this view with updated data and conclude that "changes in labor market institutions explain around 55% of the rise in European unemployment from the 1960s to the first half of the 1990s, much of the remainder being due to the deep recession ruling in the latter period" (p. 22).

[3] A fourth difference is that they use endogenous markups – due to the assumption that the elasticity of product substitution is a function of the mass of firms – to generate interesting interactions between employment (market size) and entry, while my mechanism is based on firm size per se (see below).

3. The model

3.1. Production

A representative competitive firm produces a final good that can be consumed or invested by assembling differentiated intermediate goods according to the technology

$$Y = N^{-\frac{1}{\epsilon-1}} \left[\int_0^N x_i^{\frac{\epsilon-1}{\epsilon}} di \right]^{\frac{\epsilon}{\epsilon-1}}, \epsilon > 1 \tag{1}$$

where ϵ is the elasticity of product substitution, x_i is the final producer's use of each differentiated good, and N is the mass of intermediate goods (also the mass of intermediate firms; see below).

The final good is the *numeraire*. The final producer thus maximizes profits subject to the budget constraint $Y = \int_0^N p_i x_i di$, where p_i is the price of intermediate good i. This yields the demand schedule for good i,

$$x_i = \frac{Y}{N} \left(\frac{p_i}{P} \right)^{-\epsilon}, \tag{2}$$

where

$$P = \left[\frac{1}{N} \int_0^N p_j^{1-\epsilon} dj \right]^{\frac{1}{1-\epsilon}}$$

is the price index for intermediate goods.

Each intermediate good is produced by one firm with the technology

$$x_i = (l_i - \varphi)^{\theta}, \quad 0 < \theta < 1, \ \varphi > 0 \tag{3}$$

where x_i is output and l_i is the firm's employment. This technology exhibits diminishing returns to labor and a fixed labor requirement.[4] The latter implies a fixed operating cost that justifies the assumption that each good is produced by one, and only one, firm. Since intermediate firms are atomistic, moreover, they take the price index P at the denominator of (2) as given and face demand curves that feature constant elasticity ϵ.

In equilibrium the profit of the competitive final producer is zero. It follows that the price index of intermediate goods equals the price of the final good, $P = 1$, and without loss of generality can be omitted from (2) in the rest of the analysis.

3.2. Consumption, saving and labor market participation

There is one representative household with a continuum of mass $\Lambda(t) = \Lambda_0 e^{\lambda t}$ of members.[5] Each member is endowed with one unit of labor. The household maximizes

$$U(0) = \int_0^{\infty} e^{-\rho t} \Lambda \log u(t) dt, \rho > \lambda > 0, \tag{4}$$

where

$$\log u = \log \left(\frac{C}{\Lambda} \right) + \psi \log \left(\frac{\Lambda - L^s + \delta u L^s}{\Lambda} \right), \psi > 0, \ 0 \le \delta \le 1 \tag{5}$$

subject to the flow budget constraint

$$\dot{A} = rA + L^s [W(1-\tau)(1-u) + Bu] + T - C, 0 \le \tau < 1 \tag{6}$$

[4] One can rationalize this assumption by positing that upon its birth the firm sets up an exogenously given stock of capital $\kappa \equiv 1$ (i.e., it builds a plant). It then follows that in this economy the mass of firms stands for the aggregate capital stock, while entry stands for aggregate capital accumulation.

[5] The words "one representative household" have the usual meaning that there is a unit mass of identical, atomistic households all behaving in the same manner. This rationalizes why the (atomistic) representative household does not internalize general equilibrium effects in the participation and bargaining problems that I characterize below.

where ρ is the individual discount rate, C is consumption, L^s is the mass of household members that offer their labor for a wage (participate in the labor market), A is assets holding, T is a lump-sum transfer from the government, τ is income tax, and B is the after-tax unemployment benefit. (To simplify the notation I omit the time argument whenever confusion does not arise.) The assets available to the household are ownership shares of firms. Hence, r is the rate of return on stocks. The assets market is competitive. The rest of the variables deserve a more detailed explanation that I outline below.

Three features of this setup are important. First, the household controls the mass of members that supply labor but not their probability of employment. This is where the assumption that there is a continuum of agents within the household becomes very useful. By the law of large numbers I can equate the individual probability of unemployment to the economy's unemployment rate

$$u \equiv 1 - \frac{L}{L^s},$$

where $L = \int_0^N l_i di$ is aggregate employment. Similarly, with a continuum of firms the law of large numbers allows me to equate an employed worker's probability of being assigned to firm i with the firm's share of aggregate employment l_i/L.[6] It follows that the pre-tax wage that the employed member earns is the weighted average

$$W = \int_0^N w_i \frac{l_i}{L} di,$$

where w_i is the wage paid by firm i.

This approach implies a job rationing mechanism that takes the form of assigning job seekers at random to the unemployment pool and to the employment pool; those assigned to the employment pool are then assigned at random across the N existing firms and negotiate the terms of employment. Its main advantage is that it allows me to think of the term $1 - u$ in the budget constraint (6) as the fraction of the household members that participate to the labor market and earn the after-tax wage $W(1 - \tau)$, while u is the fraction that earn the after-tax unemployment benefit B. One could think of this as a particular type of matching mechanism. With respect to the traditional approach in search theory (e.g., Pissarides, 2002), it has two advantages. First, it does not imply unfilled vacancies and thus allows me to focus only on the supply side of the labor market as subject to rationing. Second, it does not require time and thus does not force me to model unemployment as a state variable, thereby reducing the dimensionality of the general equilibrium system.

The second feature captures the basic trade-off that governs labor supply and thus determines workers' wage demands. The household's instantaneous utility contains a term that captures the role of home production or other related activities the output of which is shared by all household members. This determines the opportunity cost of labor market participation, and thus contributes to determine the wage demands of employed workers. An employed member cannot participate in household production. An unemployed member, in contrast, recovers a fraction δ of his time endowment if he goes unemployed. Accordingly, the term $(1 - \delta u) L^s$ in (5) is the total amount of time subtracted from household production. Of this total, $L = (1 - u) L^s$ is spent on production of market goods. Therefore, $(1 - \delta) uL^s$ is the social cost of unemployment, the total amount of time that is lost to participation that does not result in employment.

The third feature is that the household insures its members participating in the labor market against individual unemployment risk. This simplifies the analysis because all household members get the same flow of utility regardless of the outcome of the job rationing mechanism.[7] More importantly, it implies that each individual worker is indifferent between employment and unemployment in the bargaining process (see below).

The maximization problem outlined above yields well-known results with some novel features. The household follows the usual saving rule

$$\frac{\dot{C}}{C} = r + \lambda - \rho \tag{7}$$

and equates the benefit from the marginal household member's participation to the cost. Formally,

$$W(1 - \tau)(1 - u) + Bu = \psi C \frac{1 - \delta u}{\Lambda - L^s (1 - \delta u)}. \tag{8}$$

On the left-hand-side of this expression there is the income from participation, on the right-hand-side there is the opportunity cost, the foregone contribution of the marginal individual to household production. Participation therefore can be written

$$L^s = \frac{\Lambda}{1 - \delta u} - \frac{\psi C}{W(1 - \tau) - [W(1 - \tau) - B] u}. \tag{9}$$

This is the economy's upward sloping labor supply curve.

The model's equilibrium conditions imply that the after-tax wage is higher than the after-tax unemployment benefit (see below) so that the second term in the labor supply curve is *decreasing* in the unemployment rate. This captures a discouraged worker effect whereby worse employment prospects lower a worker's anticipated income and thus reduce participation. This effect is strongest when $\delta = 0$, because the first term in (9) does not depend on u, and becomes weaker as the time cost of unemployment gets smaller, that is, the larger is δ.

3.3. Wages and prices at the firm level

The firm bargains with its workers over the wage and employment. Following the literature (e.g., Blanchard and Giavazzi, 2003), I model bargaining as

$$\max_{w_i, l_i} \left[(1 - \gamma) \log \pi_i + \gamma \log (w_i (1 - \tau) - W_a) l_i \right], \quad 0 < \gamma < 1$$

The parameter γ is the bargaining power of the workers. The firm and its workers maximize jointly the log-geometric average of profits and employees surplus.[8] The indifference condition (8) defines the appropriate alternative for this problem:

$$W_a \equiv W(1 - \tau)(1 - u) + Bu = \psi C \frac{1 - \delta u}{\Lambda - L^s (1 - \delta u)}.$$

This says that the worker receives at least the opportunity cost of participation for the marginal household member, that is, the marginal utility of staying out of the labor force and producing household goods. The alternative thus defined, moreover, is equal to a convex combination of employment elsewhere (i.e., in another randomly selected firm) at the after-tax average wage and the unemployment benefit – exactly as if the worker could reenter the rationing process if negotiations break down – because that is how the typical household makes participation decisions. The firm and the workers take the alternative W_a as given because it depends on aggregate variables that they do not control.

The firm has no outside option because unemployed workers do not underbid those who are negotiating with the firm. There are two reasons for modeling things this way, one explicit and one implicit. The explicit reason is that in this model the household insures workers against individual unemployment risk so that the unemployed worker obtains the same level of utility as the unemployed one. This eliminates the latter's incentive to underbid the former. Second, there exist real-world frictions (e.g., hiring and firing costs, search costs, institutional

[6] Since the equilibrium is symmetric (see below), it makes no difference whether the probability of being assigned to firm i is $1/N$ or l_i/L.

[7] Examples of previous work using this approach are Merz (1995) and Pissarides (2002).

[8] Recall that the efficient bargaining posited in the text gives the same results as assuming that firms bargain with workers over profit sharing only, and then set employment given the agreed upon wage.

restrictions, social norms) – that for the sake of simplicity I do not try to model explicitly – that prevent underbidding from taking place even when unemployed workers have an incentive to do so. Although the lack of an explicit mechanism capturing this feature is, arguably, a limitation of the model, it has the advantage that it keeps the general equilibrium dynamics tractable (see, e.g., Lindbeck, 1993 for a discussion of the limitations of models of unemployment that do not take an explicit stand on what prevents wage underbidding). In search theory, for example, the friction is explicit in that it takes time to fill the vacancy left by the worker if negotiations break down (see, e.g., Pissarides, 2002). This, however, comes at the cost of additional state variables. In the context of this model, I could argue that, in a fashion similar to the time cost of unemployment for workers – whereby the time available for household production of an unemployed worker is a fraction δ of his endowment – there is a time cost for employers in hiring unemployed workers at a lower wage. Namely, I could specify the alternative for the firm as producing with unemployed workers whose time available for production is only a fraction μ of their time endowment. (This could be interpreted as a reduced-form specification of lower productivity of replacement workers; see, e.g, Lindbeck, 1993). One can then interpret the model in the text as the outcome for $\mu \to 0$. The case $\mu > 0$ merely complicates matters without adding insight.

I now use the production function (3) and the demand curve (2) to write instantaneous profits as

$$\pi_i = p_i x_i - w_i l_i$$
$$= \left(\frac{Y}{N}\right)^{\frac{1}{\epsilon}} (l_i - \varphi)^{\theta\left(1-\frac{1}{\epsilon}\right)} - w_i l_i.$$

Let $\eta \equiv \theta\left(1-\frac{1}{\epsilon}\right) < 1$. This parameter combines diminishing returns to labor and the responsiveness of demand to price into a single number that, together with the fixed cost, regulates the curvature of the firm's revenue function with respect to employment l_i. Specifically, the elasticity of revenue with respect to employment is

$$\frac{\partial (p_i x_i)}{\partial l_i}\frac{l_i}{p_i x_i} = \frac{\eta l_i}{l_i - \varphi}.$$

This elasticity is smaller the more pronounced are diminishing returns to labor (low θ), the less elastic is demand (low ϵ), the smaller is the fixed operating cost (low φ), and the larger is the firm (large l_i).

The first-order conditions for the maximization problem are:

$$\frac{1-\gamma}{\gamma}\left[\frac{\partial (p_i x_i)}{\partial w_i} - l_i\right] + \frac{\pi_i}{w_i - \frac{W_a}{1-\tau}} = 0,$$

$$\frac{1-\gamma}{\gamma}\left[\frac{\partial (p_i x_i)}{\partial l_i} - w_i\right] + \frac{\pi_i}{l_i} = 0.$$

Observing that $\frac{\partial (p_i x_i)}{\partial w_i} = 0$ and substituting the first condition into the second, I obtain

$$w_i = \frac{W_a}{1-\tau} + \frac{\gamma}{1-\gamma}\frac{\pi_i}{l_i},$$

which says that workers get the reservation wage (adjusted for labor income taxation) plus a fraction of the firm's profit. Using this result, I can rewrite the condition for employment as

$$\frac{\partial (p_i x_i)}{\partial l_i} = \frac{W_a}{1-\tau},$$

which equates the marginal revenue from employment to the reservation wage. This yields

$$l_i = \frac{1-\tau}{W_a}\eta p_i x_i + \varphi. \tag{10}$$

Using this expression and the definition of profit, I can rewrite the equation for the wage as

$$w_i = \frac{W_a}{1-\tau}(1+m_i), \tag{11}$$

where

$$m_i \equiv \gamma\left(\frac{l_i - \varphi}{\eta l_i} - 1\right).$$

This says that the wage is set as a markup over the reservation wage and that larger firms pay higher than average wages since they operate in the less elastic region of their revenue curve.

4. Instantaneous equilibrium of the labor market

To characterize the labor market more sharply, I assume that the government cannot borrow and satisfies the budget constraint $T = \tau WL - B(L^s - L)$, which determines the lump-sum transfer, T, as the difference between tax revenues and net expenditure on benefits.[9] I also assume that the after-tax unemployment benefit is a constant fraction of the pre-tax wage, $B = \sigma W$.[10]

Next I make use of the fact that symmetry implies that all firms pay the same wage so that $w_i = W$. The wage equation (11) yields

$$1 = \frac{(1-\tau)(1-u) + \sigma u}{1-\tau}(1+m).$$

This can be solved for

$$u = \frac{1-\tau}{1-\tau-\sigma}\frac{m}{1+m}, \tag{12}$$

where

$$m = \gamma\left(\frac{l-\varphi}{\eta l} - 1\right). \tag{13}$$

Observe that unemployment is an increasing function of firm employment l that eventually becomes flat. To ensure $u < 1$, I impose

$$\gamma\left(\frac{1}{\eta} - 1\right) < \frac{1-\tau-\sigma}{\sigma},$$

which says that the upper asymptote of (12) is less than 1. This condition is surely satisfied if $\sigma = \tau = 0$.

An important property of this model is that the equilibrium of the labor market is not fully characterized by the unemployment equation (12) because labor supply is endogenous. Specifically, according to equation (9) participation is

$$L^s = \frac{\Lambda}{1-\delta u} - \frac{\psi}{1-\tau-(1-\tau-\sigma)u}\frac{C}{W}.$$

I can divide through by population size Λ and multiply and divide the ratio $\frac{C}{W}$ by L and Y so to obtain

$$\frac{L^s}{\Lambda} = \frac{1}{1-\delta u} - \frac{\psi}{1-\tau-(1-\tau-\sigma)u}\frac{\frac{C}{Y}}{\frac{WL}{Y}}\frac{L}{\Lambda}.$$

Observing that $L = L^s(1-u)$, I can solve explicitly for the participation and employment ratios:

$$\frac{L^s}{\Lambda} = \frac{\frac{1}{1-\delta u}}{1 + \frac{(1-u)\psi}{1-\tau-(1-\tau-\sigma)u}\frac{\frac{C}{Y}}{\frac{WL}{Y}}} \tag{14}$$

[9] This setup keeps to a minimum the effect of the government on economic activity. Only two distortions matter: taxation, which lowers labor supply and raises the pre-tax wage that workers demand, and the unemployment benefit, which raises both labor supply and the pre-tax wage that workers demand.

[10] The replacement ratio σ can be broken down into two components. Let τ_B be the tax rate on unemployment benefits and ω be the pre-tax replacement ratio. Then, $\sigma = (1-\tau_B)\omega$. This decomposition clutters the notation without adding insight. Notice that unemployment benefits are taxed more lightly than wages so that $\tau_B < \tau$; see Daveri and Tabellini (2000, pp. 58–59) for evidence on this point.

$$\frac{L}{\Lambda} = \frac{\frac{1-u}{1-\delta u}}{1 + \frac{(1-u)\psi}{1-\tau-(1-\tau-\sigma)u}\frac{c}{\frac{WL}{Y}}}. \tag{15}$$

where $c \equiv C/Y$ is the economy's consumption ratio and WL/Y is the wage share.

I now use the expression for firm employment (10), the wage setting equation (11) and aggregation across firms to obtain

$$L = \frac{(1+m)\eta}{W} Y + \varphi N.$$

I then use the relation $L = Nl$ to compute the wage share as

$$\frac{WL}{Y} = \gamma + (1-\gamma)\frac{\eta l}{l-\varphi}. \tag{16}$$

Observe that the wage share is decreasing in firm employment l.

Equations (12) through (16) provide a complete characterization of the labor market at a point in time once one knows firm employment l and the consumption ratio c. The evolution over time of these two variables depends on the entry process that provides the fundamental accumulation mechanism of this model. The next section discusses this process in detail. As an intermediate step toward that goal, I use (16) to rewrite the expression for the employment ratio as

$$\frac{L}{\Lambda} = nl = \frac{1}{\frac{1-\delta u}{1-u} + \frac{1-\delta u}{1-\tau-(1-\tau-\sigma)u}\frac{\psi c}{\gamma+(1-\gamma)\frac{\eta l}{l-\varphi}}}, \tag{17}$$

where $n \equiv N/\Lambda$ is the mass of firms per capita and symmetry implies $L = Nl$. I shall refer to this expression as the participation locus and to equation (12) above as the bargaining locus. The following lemma, proved in the appendix, provides a useful result.

Lemma 1. *Assume $1 - \delta \geq \frac{\sigma}{1-\tau}$. Then the participation locus (17) is decreasing in u.*

Intuitively, this says that the employment ratio is decreasing in the unemployment rate when the time cost of unemployment $1 - \delta$ is larger than the tax-adjusted unemployment benefit. In the following, I assume that this condition holds.[11]

The joint solution of equations (12) and (17)) characterizes the instantaneous equilibrium of the labor market in relation to the mass of firms per capita n and the consumption ratio c. Fig. 3 illustrates the mechanism and Proposition 2 summarizes the comparative statics.[12] A + on top of a variable denotes a positive partial derivative, a − denotes a negative partial derivative, while a ? denotes an ambiguous sign.

Proposition 2. *The instantaneous equilibrium of the labor market is characterized by the following two functions mapping the mass of firms per capita, n, and the consumption ratio, c, into firm employment, l, and the unemployment rate, u:*

$$l\left(\overset{-}{n}, \overset{-}{c}; \overset{+}{\eta}, \overset{+}{\varphi}, \overset{?}{\gamma}, \overset{-}{\tau}, \overset{?}{\sigma}, \overset{-}{\psi}, \overset{-}{\delta}\right);$$

$$u\left(\overset{-}{n}, \overset{-}{c}; \overset{?}{\eta}, \overset{?}{\varphi}, \overset{+}{\gamma}, \overset{?}{\tau}, \overset{+}{\sigma}, \overset{-}{\psi}, \overset{-}{\delta}\right).$$

Associated to these, there is the following function mapping the mass of firms per capita*, n, and the consumption ratio, c, into the economy's employment ratio, L/Λ:*

$$\frac{L}{\Lambda}\left(\overset{+}{n}, \overset{-}{c}; \overset{+}{\eta}, \overset{+}{\varphi}, \overset{?}{\gamma}, \overset{-}{\tau}, \overset{?}{\sigma}, \overset{-}{\psi}, \overset{-}{\delta}\right).$$

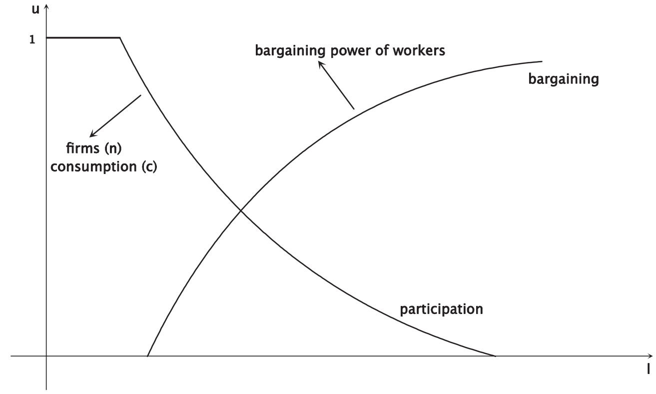

Fig. 3. Equilibrium of labor market.

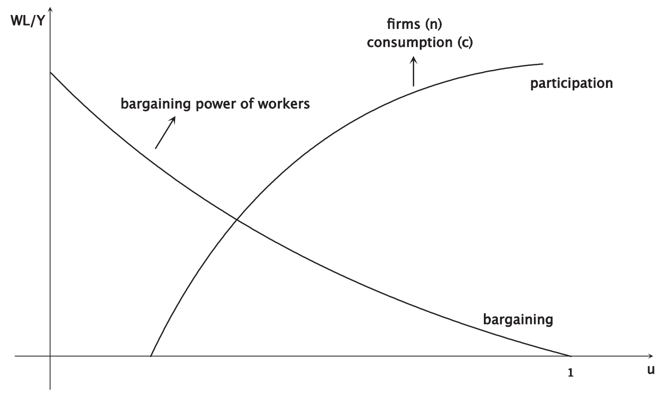

Fig. 4. The labor market in wage share, unemployment space.

Fig. 4 proposes a complementary illustration of the mechanism, an interpretation that stresses the role of the wage share. The idea is to use equation (16) to replace firm employment l with the wage share WL/Y. The resulting graphical analysis expresses the comparative statics properties effects stated in the proposition in wage share, unemployment space.

The mechanism explaining the comparative statics properties of this equilibrium is the following. Refer to Fig. 3. The bargaining locus is upward sloping because an increase in firm employment l yields an increase in the markup m. Restoring equilibrium requires a rise in unemployment u. The participation locus, in contrast, is downward sloping. The reason is that higher firm employment implies a lower wage (due to diminishing returns to labor in the firm production technology) and, holding constant n, higher aggregate employment. The latter implies a higher marginal cost of participation because diminishing returns in household activity imply that its marginal product rises. Restoring equilibrium then requires a fall in unemployment u that provides better job prospects to the marginal worker. The higher probability of employment raises the marginal benefit of participation while at the same time reduces the sacrifice of time needed for market participation and thereby rises the amount of time devoted to home activity, thus reducing its marginal product.

Now observe that an increase in n does not affect the bargaining locus while it implies higher aggregate employment and thereby a higher marginal product of home activity. The corresponding lower

[11] If it does not, the participation locus is upward sloping and the equilibrium is unstable. This is intuitive: if the tax-adjusted unemployment benefit is larger than the time cost of unemployment, it is always desirable for the individual to participate and be unemployed. But a situation where individuals wish to be unemployed cannot be sustainable in general equilibrium.

[12] Inspection of the figure suggests that is possible that the two curves fail to intersect so that in equilibrium $u = 0$. I show below that in steady state it is always the case that the intersection occurs and $u > 0$.

participation requires a compensatory fall in unemployment in order to satisfy equation (17). It follows that the participation locus shifts down. As a result, both firm employment and the unemployment rate fall. In contrast to firm employment, the employment ratio rises with n. To see why, imagine to apply the relation $L/\Lambda = nl$ to rewrite the bargaining and participation loci in $(L/\Lambda, u)$ space instead of (l, u) space. With this change of variable, the participation locus shifts up because the increase in n reduce firm employment l and raises the labor share. This attracts participation and for equation (17) to hold there must be a compensatory increase in unemployment u. The bargaining locus instead shifts down because the higher n spreads employment over more firms and makes them smaller, thus producing a smaller markup over the reservation wage. Consequently, unemployment falls and the employment ratio rises.

An increase in the consumption ratio c leaves the bargaining locus unaffected while reduces participation and thereby requires a compensatory fall in unemployment to satisfy equation (17). As a consequence, the participation locus shifts down and the new equilibrium exhibits lower firm employment and unemployment. Notice that since $L/\Lambda = nl$ and n is given, the employment ratio falls as well.

An interesting property of this equilibrium is that is captures the tension between the different effects of structural parameters on the employment and the participation margins. Ultimately this is because unemployment provides a wedge between labor supply and employment. For example, the reason why the effect of γ on firm employment is ambiguous is that the stronger bargaining power of workers results in a larger wage share – see (16) – and thereby in higher participation. This effect shows up in Fig. 1 as an upward shift of the participation locus. The expansion of labor supply should yield larger employment (aggregate and, holding constant n, per firm). However, the stronger bargaining power of workers also results in higher unemployment, an effect captured by an upward shift of the bargaining locus – see (12). The overall effect on unemployment is surely positive, while the overall effect on employment is ambiguous. Notice how this logic also explains the effects of the replacement ratio σ. Higher unemployment benefits raise both participation and unemployment – both the participation and bargaining loci shift up – so that the overall effect on employment is ambiguous.

In contrast, higher taxation of wages τ reduces participation and results in smaller employment (aggregate and per firm). This effect shows up as a downward shift of the participation locus. On the other hand, higher taxation of wages raises workers' demands and tends to raise unemployment, an effect captured by the upward shift of the bargaining locus. As one can see, if the fall in participation is sufficiently large employment and unemployment can both fall. If instead participation is not very sensitive to after-tax wages, employment falls and unemployment rises.

Similar reasoning explains the effects of the parameters η and φ that regulate the elasticity with respect to employment of the firm's revenue. An increase in either of them lowers the markup m and raises the wage share thereby shifting the bargaining locus down and the participation locus up. This results in higher employment and higher or lower unemployment depending on which force dominates.

5. General equilibrium

The previous analysis has provided a complete characterization of the labor market at a point in time given the consumption ratio c and the mass of firms per capita n. To characterize the evolution over time of these two variables and thereby of the whole economy I now need to characterize the entry process that provides the fundamental accumulation mechanism of this model. The construction of the general equilibrium of this economy is then straightforward. There is an Euler equation characterizing the equilibrium of the assets market, whereby all rates of return are equalized, and an equation characterizing the equilibrium of the goods market, whereby output is allocated to consumption and investment. The latter equation is where this model deviates from the standard setup because the state variable of this economy is the mass of firms per capita.[13]

5.1. Entry

The flow of dividends accruing to firm i's shareholders is π_i. Accordingly, the share price is

$$V_i(0) = \int_0^\infty e^{-\int_0^t r(v)dv} \pi_i(t)dt,$$

and satisfies the arbitrage condition

$$r = \frac{\pi_i}{V_i} + \frac{\dot{V}_i}{V_i},$$

where the characterization of firm behavior in Section 2 yields that the firm's profit is

$$\frac{\pi_i}{p_i x_i} = (1-\gamma)\left(1 - \frac{\eta l_i}{l_i - \varphi}\right).$$

According to this expression, the profit rate of firm i is increasing in firm employment.

I assume that entrepreneurs create new firms by sinking an entry cost $\beta p_i x_i$ in units of final output. Notice that this cost is proportional to the firm's initial revenue.[14] Entrants are active if the value of entry is equal to its cost, that is, if $V_i = \beta p_i x_i$. In symmetric equilibrium this condition becomes $V = \beta \frac{Y}{N}$. Taking logs and time derivatives, substituting into the arbitrage condition, and using the expression for the profit rate, I obtain the free-entry condition

$$r = \frac{1-\gamma}{\beta}\left(1 - \frac{\eta l}{l-\varphi}\right) + \frac{\dot{Y}}{Y} - \frac{\dot{N}}{N}. \tag{18}$$

This is the instantaneous rate of return on equity generated by firms.

5.2. The economy's dynamics

Assets market equilibrium requires $A = NV = \beta Y$. The government budget is $T + \sigma W(L^s - L) = \tau W L$. Therefore, the household budget constraint becomes

$$\frac{\dot{Y}}{Y} = r + \frac{WL - C}{\beta Y},$$

The saving schedule (7) and the definition $c \equiv C/Y$ yield

$$\frac{\dot{c}}{c} = r + \lambda - \rho - \frac{\dot{Y}}{Y}.$$

Substituting this expression into the one just derived and using equation (16) for the wage share yields

$$\frac{\dot{c}}{c} = \frac{1}{\beta}\left[c - \gamma - (1-\gamma)\frac{\eta l}{l-\varphi}\right] + \lambda - \rho,$$

where l is given by the function $l(n, c; .)$ characterized in Proposition 1.

The output market clearing condition requires

$$Y = C + \beta \frac{Y}{N}\dot{N}.$$

Since entry is non-negative, one has $\dot{N} > 0$ for $Y > C$ and $\dot{N} = 0$ otherwise. This condition identifies two regions: the entry region, where

[13] Recall, however, that the mass of firms per capita stands for capital per capita if I assume that upon birth each firm sets up one unit of capital (i.e., a plant).

[14] I have experimented with several specifications of the entry cost and concluded that this assumption yields the simplest and most tractable specification of the model. For example, if the cost of entry is β (i.e., independent of the firm's entry size), the qualitative results and the main message of the model do not change but the analysis is algebraically (much!) more complicated.

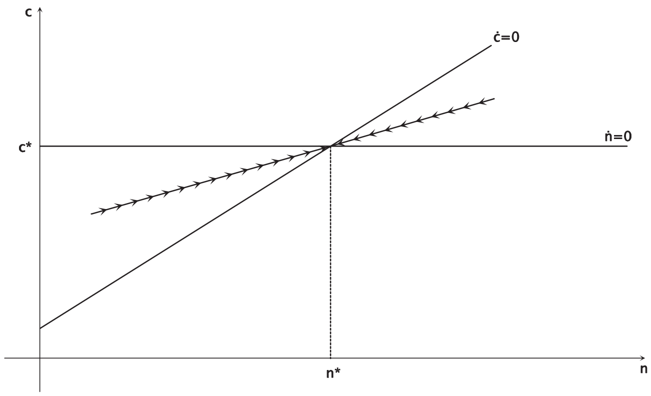

Fig. 5. Phase diagram.

entry is profitable, and the hysteresis region, where entry is not profitable and the mass of firms is fixed. For simplicity, I ignore the hysteresis region since population growth implies that the steady state of the dynamical system is inside the entry region. Dividing through by Y, and using the definition $n \equiv N/\Lambda$, the output market clearing condition reads

$$1 = c + \beta\left(\frac{\dot{n}}{n} + \lambda\right).$$

The analysis is now straightforward. The $\dot{n} = 0$ locus is simply $c = 1 - \beta\lambda$. The $\dot{c} = 0$ locus is

$$c = \beta(\rho - \lambda) + \gamma + (1-\gamma)\frac{\eta l(n,c)}{l(n,c) - \varphi}.$$

This equation defines an upward sloping locus $c(n)_{\dot{c}=0}$. Consider now the phase diagram in Fig. 5.

Paths above the saddle path eventually yield zero or negative n and thus cannot be equilibria. Paths below the saddle path eventually yield zero or negative c and similarly cannot be equilibria. Hence, I have:

Proposition 3. *There is a unique perfect-foresight general equilibrium: given initial condition n_0, the economy jumps on the saddle path and converges to the steady state (n^*, c^*).*

5.3. The steady state

The characterization of the steady state is extremely simple. Substituting $c^* = 1 - \beta\lambda$ into the $\dot{c} = 0$ locus and using (16) I obtain

$$\left(\frac{WL}{Y}\right)^* = 1 - \beta\rho = 1 - \left(\frac{N\pi}{Y}\right)^*. \tag{19}$$

This expression says that in the long run the wage and profit shares depend solely on the entry cost, β, and the discount rate, ρ. The intuition is straightforward. In steady state the free-entry condition reduces to

$$\beta\rho = \frac{\pi}{px} = \frac{N\pi}{Y},$$

which says that firms must deliver to savers the reservation interest rate ρ, and that to do so they must generate a profit ratio equal to $\beta\rho$. Accordingly, I can use (16) to solve for firm employment

$$l^* = \frac{\varphi}{1 - \frac{\eta}{1 - \frac{\beta\rho}{1-\gamma}}}. \tag{20}$$

Notice how taxes on labor and the replacement ratio do not enter this solution. Also, notice that l^* is increasing in $\varphi, \eta, \beta, \rho, \gamma$.

Substitution of l^* into the bargaining locus (12) yields

$$u^* = \frac{1-\tau}{1-\tau-\sigma}\widetilde{u}, \tag{21}$$

where

$$\widetilde{u} \equiv \frac{\gamma}{(1-\gamma)\left(\frac{1}{\beta\rho} - 1\right)}$$

is the unemployment rate that obtains absent fiscal distortions (i.e., for $\tau = \sigma = 0$). Notice how, differently from the instantaneous equilibrium discussed above, in steady state the effects of structural parameters on unemployment are no longer ambiguous. The reason is that taking into account the endogeneity of consumption and of the mass of firms allows me to resolve the tension between effects on participation and on bargaining. Higher taxes on labor, for example, lead workers to demand higher wages, which results in higher unemployment. This is the upward shift of the bargaining locus discussed above. The reason why the potentially offsetting downward shift of the participation locus is now not operational is that firm employment is pinned down by equation (20) independently of taxation. In other words, in the long run the mass of firms per capita adjusts endogenously and the participation locus in (l, u) becomes vertical and independent of taxation.

The value for the wage share obtained above yields

$$\frac{c^*}{\left(\frac{WL}{Y}\right)^*} = \left(\frac{C}{WL}\right)^* = \frac{1-\beta\lambda}{1-\beta\rho}. \tag{22}$$

Thus, expressions (14)-(15) for the participation and employment ratios become:

$$\left(\frac{L^s}{\Lambda}\right)^* = \frac{\frac{1}{1-\delta u^*}}{1 + \frac{(1-u^*)\psi}{1-\tau-(1-\tau-\sigma)u^*}\frac{1-\beta\lambda}{1-\beta\rho}}; \tag{23}$$

$$\left(\frac{L}{\Lambda}\right)^* = \frac{\frac{1-u^*}{1-\delta u^*}}{1 + \frac{(1-u^*)\psi}{1-\tau-(1-\tau-\sigma)u^*}\frac{1-\beta\lambda}{1-\beta\rho}}. \tag{24}$$

Using these expressions, I can prove the following proposition (the details are in the appendix).

Proposition 4. *The steady-state general equilibrium of the model is characterized by the following properties:*

1. *the unemployment rate u^* is increasing in γ, τ, σ, β, ρ;*
2. *the employment ratio $(L/\Lambda)^*$ is decreasing in ψ, γ, σ, τ, β, ρ, and increasing in λ, δ;*
3. *the participation ratio $(L^s/\Lambda)^*$ is decreasing in ψ, increasing in λ, δ, γ, σ, increasing in τ if*

$$\left(1 - \frac{\sigma}{1-\tau}\right)^2 < \widetilde{u},$$

and exhibits ambiguous effects of β, ρ;

4. *the mass of firms per capita n^* is decreasing in ψ, γ, τ, σ, β, ρ, φ, η and increasing in δ, λ.*

Equation (23) reveals a remarkable property: in steady state the participation ratio is *increasing* in the unemployment rate. Similarly, the proposition provides a sufficient condition for participation to be *increasing* in τ. It suggests that this happens when the tax rate τ is high, the replacement ratio σ is large and $\widetilde{u}$ is high. Intuitively, this says that participation is increasing in taxation in economies that are *already* heavily distorted.

To investigate what drives these results, recall that (23) comes from

$$\frac{L^s}{\Lambda} = \frac{1}{1-\delta u} - \frac{\psi}{1-\tau-(1-\tau-\sigma)u}\frac{C}{W\Lambda}.$$

This expression reveals that there are two effects of unemployment. First there is the direct negative effect of reducing the expected after-tax benefit of participation. How strongly this worsening of the marginal worker's job prospects – the discouraged worker effect discussed in Section 3 – reduces participation depends on the parameter δ: the higher δ, the lower the cost of participation that results in unemployment and the weaker the discouraged worker effect. Secondly, there is the effect on the ratio $C/W\Lambda$ that in steady state is

$$\left(\frac{C}{W\Lambda}\right)^* = \frac{\left(\frac{C}{Y}\right)^*}{\left(\frac{WL}{Y}\right)^*}\left(\frac{L}{\Lambda}\right)^* = \frac{1-\beta\lambda}{1-\beta\rho}\left(\frac{L}{\Lambda}\right)^* = \frac{1-\beta\lambda}{1-\beta\rho}\left(\frac{L^s}{\Lambda}\right)^*(1-u^*).$$

Hence, I have

$$\left(\frac{L^s}{\Lambda}\right)^* = \frac{1}{1-\delta u^*} - \frac{\psi(1-u^*)}{1-\tau-(1-\tau-\sigma)u^*}\frac{1-\beta\lambda}{1-\beta\rho}\left(\frac{L^s}{\Lambda}\right)^*.$$

This expression highlights how in general equilibrium unemployment has an additional effect: it reduces the consumption-wage ratio because it reduces the employment ratio. This is nothing else than a negative income effect that produces an additional worker effect similar to that discussed in the labor supply literature. In this model's specification, this effect dominates in the long run so that participation becomes increasing in unemployment.

The expression above also reveals that there are three effects of taxation. First there is the direct negative effect of reducing the expected after-tax benefit of participation. Then there is the indirect negative effect of raising unemployment. Finally there is the effect on the consumption-wage ratio. To see more clearly what is going on in this case, it is useful to set $\delta = 0$ to make the discouraged worker effect as strong as possible (and make the numerator of (23) independent of u^* exactly as the sufficient condition in the proposition does). Differentiating with respect to τ and rearranging terms, the balance of these three effects boils down to

$$\frac{d\left(\frac{L^s}{\Lambda}\right)^*}{d\tau} \gtrless 0 \Longleftrightarrow -\frac{d\left(\frac{L}{\Lambda}\right)^*}{d\tau}\frac{\tau}{\frac{L}{\Lambda}} \gtrless \frac{\tau}{1-\tau},$$

which says that higher taxation of labor results in higher participation when the elasticity of employment with respect to taxation is high. Using (24) to calculate the elasticity, I can write this condition as

$$\frac{d\left(\frac{L^s}{\Lambda}\right)^*}{d\tau} \gtrless 0 \Longleftrightarrow 1 - \frac{\sigma}{1-\tilde{u}^{\frac{1}{2}}} \gtrless \tau,$$

which shows explicitly that the participation ratio is a U-shaped function of taxation. The minimum of the function shifts to the left with σ and $\tilde{u}$. The interpretation therefore, is that the positive relation between taxation and participation – the dominance of the additional worker effect driven by the income effect – occurs in economies with heavily distorted markets (high σ, γ, β) and high taxation.

5.4. Output

In symmetric equilibrium, the production functions (1) and (3) yield

$$Y = N(l-\varphi)^\theta \text{ory} \equiv \frac{Y}{\Lambda} = n(l-\varphi)^\theta.$$

This reveals that there are competing effects of many parameters on steady-state output per capita due to the fact that n and l move in opposite directions. For example, l^* is increasing in φ, η, β, ρ, γ, while n^* is decreasing in φ, η, β, ρ, γ. Interestingly, ψ, τ, σ have an unambiguous negative effect because they do not affect l^* while they depress n^* through their negative effect on the employment ratio $(L/\Lambda)^*$. In contrast, δ, λ have a positive effect because they raise n^* while they do not affect l^*.

A related, and perhaps more interesting measure of performance, is the level of welfare. Specifically, in steady state one can compute

$$U^* = \int_0^\infty e^{-\rho t}\Lambda\left[\log\left(\frac{C}{Y}\frac{Y}{\Lambda}\right)^* + \psi\log\left(1-(1-\delta u^*)\left(\frac{L^s}{\Lambda}\right)^*\right)\right]dt$$
$$= \frac{\Lambda_0}{\rho-\lambda}\left[\log(1-\beta\lambda)y^* + \psi\log\left(1-(1-\delta u^*)\left(\frac{L^s}{\Lambda}\right)^*\right)\right].$$

This too exhibits competing effects that prevent unambiguous analytical statements concerning the role of many structural parameters. However, observe that (23) yields

$$1-(1-\delta u^*)\left(\frac{L^s}{\Lambda}\right)^* = \frac{1}{1+\frac{1-\tau-(1-\tau-\sigma)u^*}{(1-u^*)\psi}\frac{1-\beta\rho}{1-\beta\lambda}},$$

which is decreasing in u^*, σ and increasing in τ. Once again, then, fiscal distortions appear to be special. As argued, in highly regulated economies taxation of wages results in higher participation because of a dominant income effect. This means that overall the expression above is decreasing in τ. It follows that τ and σ unambiguously reduce welfare because they reduce consumption per capita of both market goods (since they reduce output per capita y^*) and household goods.

6. The role of labor and product market factors

In this section I discuss the dynamic effects of factors affecting the labor and product markets. I begin the analysis with a discussion of an important aspect of the interaction between labor and products markets. Namely that the endogenous participation rate produces a reinforcing mechanism that amplifies the effects on employment of structural changes that affect the labor market. To see this, consider equations (23) and (24) set $\psi = 0$. This removes from the model the opportunity cost of participation and yields $L^s/\Lambda = 1$. Accordingly,

$$\frac{L}{\Lambda} = 1-u$$

so that structural parameters affect employment only through the unemployment rate. If $\psi > 0$, instead, there are additional effects due to the endogeneity of participation. These effects are best seen by recalling the definition

$$\frac{L}{\Lambda} = (1-u)\frac{L^s}{\Lambda}.$$

In some cases, the effects due to participation work in the opposite direction of the direct wedge effect of unemployment and one needs to work out the balance. This is what equation (24) does, revealing for example that the negative effect of labor taxes τ and unemployment benefits σ on employment is larger because of the participation channel.

In the following analysis, I show how this feature of the model reinforces two important feedback mechanisms linking the labor and product markets. The first is due to the endogenous mass of firms and produces a *multiplier effect* that amplifies the role of structural changes that originate in the labor market. A second multiplier effect operates in the opposite direction. Namely, the endogenous market size due to the participation and unemployment margins amplifies the effects on entry decisions, and therefore on the mass of firms, of structural changes that originate in the product market.

6.1. Factors affecting the labor market

Consider Fig. 5. If τ increases, the $\dot{n} = 0$ locus is unchanged while the $\dot{c} = 0$ locus shifts to the left. The economy then jumps on the saddle path that converges to new steady state which features the same consumption ratio as the initial one and a lower mass of firms per capita. On impact, the mass of firms is given while the consumption ratio jumps up. According to Proposition 2, the rise in c and τ produces a fall in firm employment l and the employment ratio L/Λ, and possibly an increase in unemployment u. I say possibly because, as discussed in section 3, the direct effect of τ on unemployment is ambiguous due the endogeneity of the participation rate. According to (16) the fall in firm employment l produces a rise in the labor share WL/Y. According to (14), finally, the competing effects of the higher consumption ratio, wage share, and unemployment rate produce an ambiguous change in participation. One might conjecture that the direct negative effect of taxation of wages tilt the balance toward a fall of the participation ratio. Unfortunately, I have been unable to prove analytically that this is the case.

The transition features falling c and n. According to Proposition 2, then, it features rising firm employment l and unemployment u. The rising l in turn produces a falling labor share. The competing effects of the falling c and n produce an ambiguous change in the employment ratio. However, we know that at the end of the transition the employment rate must be lower so that eventually the rate must be falling. As to the participation rate, the competing effects of its determinants again result in an ambiguous change. Since the steady state effects are known, however, one can infer that if the tax increase occurs in a highly regulated economy it results in the participation rate eventually rising because of the dominant income effect (see Proposition 4). The reverse happens in a lightly regulated economy.

To see the role of the endogenous mass of firms, one simply compares what happens on impact, when the mass of firms is given, to the end-of-transition situation. There is a clear *multiplier effect* at work in that the gradual reduction of the mass of firms per capita drives unemployment up and employment down further than the initial tax increase warrants. The reason is that with higher taxation workers demand higher wages and the associated higher labor cost requires the market to become more concentrated in order to sustain firms' profitability and allow them to deliver to households the reservation interest rate ρ. Crucially, since firm employment l in the long run does not respond to taxation, the smaller mass of firms per capita must be produced by a combination of lower employment and higher unemployment. The latter margin is very important, because in highly regulated economies the participation rate goes up so that to produce a lower employment rate requires a large increase in the unemployment rate.

The replacement ratio has effects similar to those of the tax on wages with the important difference that the tax reduces participation (labor supply) while the replacement ratio raises it. Hence, the tax creates less unemployment than the replacement ratio.

A factor that has attracted much attention recently is the parameter γ that measures the bargaining power of workers. Consider again Fig. 4. If γ increases, the $\dot{n} = 0$ locus is unchanged while the $\dot{c} = 0$ locus shifts to the left. The economy jumps on the saddle path that converges to the new steady state, experiencing a falling consumption ratio and a falling mass of firms per capita along the transition. So far all this is quite similar to the effects of a rise in the tax on wages. The details, however, differ in some crucial aspect.

When γ rises, on impact the mass of firms is given while the consumption ratio jumps up. According to Proposition 2, the rise in c produces a fall in firm employment l and the employment ratio L/Λ, and an increase in unemployment u. However, the direct effect of γ on firm employment and the employment rate is now ambiguous. The different behavior of these variables with respect to the case of taxation is that higher bargaining power of workers attracts participation instead of discouraging it because it raises wages. If firm employment falls, it produces a rise in the labor share WL/Y. This effect is in fact stronger than in the case of taxation because γ redistributes rents from firms to workers (they capture a larger share of profits) and thus raises the wage share directly. Again the competing effects of the higher consumption ratio, wage share, and unemployment rate produce an ambiguous change in participation.

The transition features falling c and n. This produces a rising firm employment l and unemployment rate u. The rising l in turn produces a falling labor share. The competing effects of the falling c and n produce an ambiguous change in the employment ratio. However, we know that at the end of the transition the employment ratio must be lower so that eventually the ratio must be falling. As to the participation rate, again, the competing effects result in an ambiguous change. Since the steady state effect is positive, however, one can infer that the higher bargaining power results in the participation rate eventually rising. This fact is important. Contrary to the instantaneous equilibrium where the ambiguous effect of γ comes from the endogenous variables, c and u, in steady state the dominant factor driving participation up is the additional worker effect due to higher unemployment. To see this, observe that in equation (23) the consumption ratio and the labor share in the long run do not depend on γ, only u^* does.

One can again see the *multiplier effect* of the mass of firms per capita by comparing impact to steady state effects. Interestingly, γ has a permanent positive effect on firm employment and thus drives unemployment up further than taxation of wages. The reason is again that the higher labor cost requires the market to become more concentrated to sustain firms' profitability and allow them to deliver to households the reservation interest rate ρ. However, since firm employment now must rise, and the employment ratio falls, the fall in the mass of firms must be larger.

6.2. Factors affecting the product market

To consider the effects of changes in the toughness of price competition, ϵ, recall that $\eta = \theta\left(1 - \frac{1}{\epsilon}\right)$ and refer again to Fig. 4. When ϵ increases, the economy jumps on the saddle path that converges to a point located to the left of the initial one on the same $\dot{n} = 0$ locus. The associated transition features changes in c and n in line with the discussion of the previous subsection. The main difference concerns the long run effects. Perhaps surprisingly, in the long run ϵ does not affect unemployment and the employment and participation ratios. The reason why is in fact quite intuitive. In steady state firms must deliver to shareholders the reservation interest rate ρ, and this pins down the profit share according to the relation in (19). Consequently, changes in ϵ are absorbed by firm employment l in such a way that keeps the profit ratio constant. But this implies that the employment elasticity of revenue does not respond to ϵ. Consequently, both the unemployment rate and the labor share do not respond to ϵ. This in turn means the participation and employment ratios as well do not respond to ϵ.

Consider now the role of barriers to entry. Together with the population growth rate λ, this is the only factor that affects the consumption ratio in steady state. The reason is that it pins down the amount of "replacement investment" needed to keep constant the mass of firms per capita. Moreover, as discussed above, β determines the profit and labor shares. Consider Fig. 4. If β rises, the $\dot{n} = 0$ locus shifts down while the $\dot{c} = 0$ locus shifts to the left. The economy then jumps on the saddle path that leads to the new steady state, featuring lower n^* and c^*. The reason is that the higher β implies that steady-state incumbency is more costly and thus that the rate of return is equal to ρ only if the mass of firms falls. The smaller mass of firms reduces employment and raises unemployment. This captures the second multiplier effect. Higher barriers to entry ultimately raise the profit share and thus redistribute rents toward profits. This lowers the labor share and discourages participation. At the same time, it raises firm employment l and thus raises the wage markup, thereby raising unemployment. Accordingly, employment falls. Most importantly, *the reduction of the mass of firms* per capita *is larger than it would be if employment were held constant*. There is thus a reinforcing feedback mechanism whereby the redistribution of rents away from wages shrinks the size of the market and thus requires a further reduction of the mass of firms per capita.

6.3. Back to the data

It is now useful to go back to the data presented in the introduction and compare them to the model's dynamics. Observe that some factors – specifically, the bargaining power of workers – have opposite effects on the long-run employment and participation rates. This is where the notion of unemployment as a wedge becomes most clear. As I have just shown, a rise of γ redistributes income from profits to wages and raises the wage share, at least temporarily. This rise cannot persist because in the long run the shares of national income that go to profits and wages are pinned down by factors that regulate the entry decisions of firms.

The endogenous response that eventually brings the wage share down is a rise of the unemployment rate that weakens workers' bargaining position by worsening their alternative. The temporarily higher wage share, nevertheless, attracts workers so that participation increases. Therefore, an attempt at redistribution through a "wage push" (Bertola, 2001) results in rising participation, rising unemployment and falling employment.

This story fits the facts of Figs. 1 and 2 except for the predicted fall of the employment rate. To address this potential problem, observe that the secular rise of participation happened in both the US and the EU15, suggesting that a common supply-side factor affected both economies. The model suggests that this factor is a change in preferences (lower ψ) that makes people more willing to work in the market. The key is that a structural change of this type does not affect the long-run unemployment rate (see Proposition 3) and thus provides a force that can tilt the balance toward a long-run rise of the employment rate. Interestingly, it also produces a temporary rise in unemployment given that entry is costly and thus the economy takes time to adjust to the higher participation rate. In other words, the model produces a story consistent with the data if one imagines the EU15 as being subject to a "wage push" shock, that did not hit the US, in the context of a secular rise in participation due to a structural shift in preferences.

In a somewhat reduced form, therefore, the model captures the notion that in the post-war era in the US and Western Europe there has been a structural shift whereby activities that were performed within the household moved to the market domain. This move went hand in hand with the massive entry of women in the labor market, a fact that suggests that the we look carefully at household activity as the possible locus whence the shift originates. Of course, one could generate the shift without invoking a change in preferences by suitably designing a once-and-for-all change in technology that makes market activity relatively more productive than household activity. I did not pursue this specification because, while I used the facts documented in Figs. 1 and 2 to motivate inclusion of the labor force participation margin in the model, the focus of the paper lies elsewhere, namely on understanding employment as the outcome of interdependent labor and product markets. It is nevertheless reassuring that a model designed with a different purpose in mind seems capable of addressing some more subtle features of this very important set of facts. Exploring in more detail this issue is surely something worth doing in my future research.

7. Conclusion

In this paper, I studied the dynamic interdependence of non-competitive product and labor markets. I used a general equilibrium model based on a representation of the labor market where there are three categories of individuals: those who participate and are employed, those who participate and are unemployed, and those who do not participate. To my knowledge, this is the first paper that proposes a characterization of the joint determination of the participation, unemployment and employment rates in a tractable framework. The model produces dynamics broadly consistent with the experience of the US and EU15 economies over the last 40–50 years.

I uncovered the following feedback mechanisms:

- A fall in employment due to worse labor market conditions shrinks the size of the product market and thereby triggers a reduction in the number of firms. This produces a *multiplier effect that amplifies the adverse effects on output of labor market frictions because the fall in the number of firms reduces employment further than what would be warranted if one considered the labor market in isolation.*
- Similarly, *frictions that raise the costs of entry and/or of operation for firms result in* a *larger reduction of the number of firms than would obtain if employment were held constant.* There is thus another multiplier effect that exploits the endogeneity of employment to amplify the adverse effects on output of worse product market conditions.
- Since both these mechanism operate through the employment–market size linkage, *the adverse effects on output of labor and product market frictions are larger when one considers endogenous participation.* This reinforcing mechanism captures the fact that the induced fall in employment is larger when labor supply is elastic and individuals withdraw from the labor force in response to a worsening of the labor market.

An appealing feature of the model that I proposed here is that it reveals that fiscal variables like a proportional tax on wages and an unemployment benefit proportional to the market wage can have perverse effects that make them particularly harmful. Specifically, I found that in economies that display high unemployment independently of fiscal distortions – because, say, of high barriers to entry or high bargaining power of workers – the tax rate and the replacement ratio result in higher participation because the added worker effect dominates the discouraged worker effect. This means that these types of fiscal distortions reduce welfare because they reduce consumption per capita of both market goods, since they reduce the employment ratio, and household goods, since they increase the participation ratio. The welfare loss, in other words, stems from the fact that the *wedge effect* of unemployment becomes perversely strong. This finding illustrates quite vividly the advantage of working with a model that allows one to study the joint determination of the participation, unemployment and employment rates.

Declaration of competing interest

I have no conflict of interest to report concerning this paper.

Appendix

Proof of Lemma 1

The first term in the denominator of the right-hand side of (17) is increasing in u. Therefore, a sufficient condition for the denominator to be increasing in u is

$$\frac{\partial}{\partial u}\left(\frac{1-\delta u}{1-\tau-(1-\tau-\sigma)u}\right) \geq 0 \Longleftrightarrow 1-\delta \geq \frac{\sigma}{1-\tau}.$$

This is surely true if $\tau = \sigma = 0$ (i.e., no government).

Proof of Proposition 4

The employment ratio in (24) is decreasing in u^* by Lemma 1; the participation ratio in (23) is increasing in u^* because the numerator is increasing in u^* and the denominator is decreasing in u^*. Now notice that ψ, λ, δ do not affect u^* and so have only a direct effect on participation and employment. For both, the effect of ψ is negative and the effect of λ, δ is positive. Next, notice that γ has only an indirect effect through u^* on participation and employment. Since u^* is increasing in γ, I have that employment is decreasing and participation is increasing in γ. Finally, notice that the direct effect of β, ρ on participation and employment is negative. Since u^* is increasing in β, ρ the direct and indirect effects of β, ρ have the same sign so that overall the employment ratio is decreasing in β, ρ. In contrast, the direct and indirect effects of β, ρ on participation have opposite sign and thus there is, in principle, an ambiguity.

To study the effects of the fiscal parameters, I use (21) to rewrite the term

$$\frac{(1-u^*)\,\psi}{1-\tau-(1-\tau-\sigma)\,u^*} = \frac{(1-u^*)\,\psi}{(1-\tau)\left(1-\widetilde{u}\right)}.$$

Accordingly, (24)-(23) become:

$$\left(\frac{L^s}{\Lambda}\right)^* = \frac{\frac{1}{1-\delta u^*}}{1+\frac{(1-u^*)\psi}{(1-\tau)\left(1-\widetilde{u}\right)}\frac{1-\beta\lambda}{1-\beta\rho}}; \tag{25}$$

$$\left(\frac{L}{\Lambda}\right)^* = \frac{\frac{1-u^*}{1-\delta u^*}}{1+\frac{(1-u^*)\psi}{(1-\tau)\left(1-\widetilde{u}\right)}\frac{1-\beta\lambda}{1-\beta\rho}}. \tag{26}$$

These have the same properties with respect to u^* as the expressions used before. They have, however, the advantage that now σ has only an indirect effect through u^* on participation and employment (recall that $\widetilde{u}$ does not depend on σ). Since u^* is increasing in σ, I have that employment is decreasing and participation is increasing in σ. Similarly, since u^* is increasing in τ and the direct effect of taxation in both expressions is negative, I have that the employment ratio is decreasing in τ. In contrast, the effect of taxation on the participation ratio is ambiguous because the direct and indirect effects have opposite sign. To resolve the ambiguity, observe that the numerator of (26) is increasing in u^*, which is increasing in τ, so that participation in surely increasing in τ if the denominator is decreasing in τ, that is if, upon using (21),

$$\frac{\partial}{\partial\tau}\left(\frac{1-\frac{1-\tau}{1-\tau-\sigma}\widetilde{u}}{1-\tau}\right) < 0 \Longleftrightarrow \left(1-\frac{\sigma}{1-\tau}\right)^2 < \widetilde{u}.$$

Finally, the relation

$$n^* = \left(\frac{L}{\Lambda}^*\right)\frac{1}{l^*}$$

yields that n^* is decreasing in ψ, τ, σ because they do not affect l^* while they lower the employment ratio. Similarly, n^* is decreasing in φ, η because they do not affect the employment ratio while they raise l^*. β, ρ, γ lower n^* because they lower the employment ratio and raise firm employment. δ, λ raise n^* because they do not affect l^* while they raise the employment ratio.

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