Equilibrium search unemployment, endogenous participation and labor market flows*

Pietro Garibaldi
Bocconi University, and CEPR

Etienne Wasmer
UQAM, ECARES, IZA and CEPR

July 15, 2004

Abstract

The sustainability of Welfare States requires high employment and high participation to raise the tax base. To analyse labor supply in a world with market frictions, we propose and solve a macro model of the labor market with unemployment and labor force participation as endogenous and distinct states. In our world, workers' decisions of participating are determined by an entry decision and an exit decision. A calibration of the model improves the usual representations of labor markets, since it quantitatively accounts for the observed flows between employment and non participation. The paper investigates also the effect of payroll taxes and unemployment benefits on participation decisions. Taxes reduce entries and increase exits while unemployment benefits, at given job finding rate, raise entries and have ambiguous effects on exits.

*This paper is the new version of CEPR dp. 3896 and of IZA dp 406. We thank two anonymous referees and the Editor, R. Perotti, as well as seminar participants at ECARES-ULB, Bank of Italy (Ente Einaudi), Humboldt Universität, Berlin, Lausanne (DEEP-HEC), Geneva (IUHEI) Séminaire Fourgeaud in Paris, CEMFI (CEPR Workshop on Unemployment, Redistribution and Inequality), LSE, the CEPR European Summer Symposium in Labour Economics (ESSLE) and the EEA and ESEM 2002 meetings in Venice. We are also indebted to Robert Shimer who kindly provided us with the gross US flows data.

1 Introduction

Given demographic pressures in Western economies, the sustainability of many welfare state programs requires high employment and high labor force participation to raise the tax base and avoid distortions. However, most economic analysis understands the determinants of labor supply only in a world without market frictions, and workers' participation to the labor market is often described by a neoclassical labor supply function. In the four chapters of the *Handbook of Labor Economics* devoted to labor supply, there are very few references to the role of search frictions[1]. Participation decisions in imperfect labor markets are not yet fully understood. Further, in a macroeconomic perspective, we know little about the interactions between workers' participation decisions and firms' incentives to create jobs.

To better understand the functioning of an imperfect labor market with endogenous labor supply, our paper investigates a three-state macro model of the labor market, in which the following decisions by agents are endogenous: job creation decisions by firms; job destruction by pairs worker/employer; entry and exit decisions in the labor market by workers; and in extensions, search effort margins. Our modelling approach is based on the observation that people spend simultaneously a large amount of time in both market and home production, a feature of the data that has been already exploited in the macroeconomic literature.

Recently, the business cycle literature has improved the calibration of various aspects of the data by enriching the time allocation problem on the part of the household, so as to explicitly consider the choice between leisure, home production and market work[2]. But the existing business cycle literature studies home production within frictionless labor markets. Our goal, conversely, is to study the border between market and home production in an *imperfect labor market.*[3] In our world, heterogenous workers face idiosyncratic shocks to

[1] The most advanced paper in this direction is Blundell and MacCurdy (1999) who discuss intertemporal decisions (pp.1672+), notably human capital decisions and habit persistence, with no explicit role for stochastic arrival of job offers. They conclude page 1686 in saying that "There remain a number of big issues that we have not touched on in this chapter but that are important for labour market analysis. (...) Another issue relates to the process of job search and job matching."

[2] Notably, output volatility, the correlation between hours and productivity and the correlation between investments in home and market capital (Benhabib et al. 1991, Rios-Rull 1993, Mc Grattan et al. 1991, Gomme et al. 2001)

[3] An important exception is Nosal et al. (1992), who show that in an indivisible labor model with home

home productivity, but market frictions impose a cost to labor market participation. Since we work with a technologically fixed number of hours, our analysis abstracts from the intensive margin of labor supply, and concentrates on the extensive margin.

In the paper, we explore in details the effects of time consuming search, a market friction into employment that has attracted a great deal of attention in the macro literature (Hall, 1999 and Mortensen and Pissarides, 1994 and 1999). Our paper shows that job search costs lead the decisions to participate and stop participating to be *dynamic* decisions and to differ: labor supply is described by two margins, an entry margin and a quit margin. The two decisions differ all the more when frictions are important, and conversely coincide when frictions vanish. The gap between the two decisions is due to employed workers hoarding on-the-job, since quitting involves the loss of irreversible search investment when frictions are positive. Similarly, this employment-hoarding effect does not exist in the absence of frictions.[4]

The paper then explores the positive and normative implications of this setting. From the positive standpoint, we account for a labor market with three states, whereby people spend time in employment, unemployment and full time home production. The two labor supply margins also rationalize the recent important work of Jones and Ridell (1999) and Sorrentino (1993, 1995) who emphasize the difficulty to define the frontier between non-participation and unemployment. Notably, they show that there exist agents reporting that they would like a job but do not search, which is one of the main insights of the model. This allows to define a broader concept of unemployment which takes this population into account. Second, the model can quantitatively account for the large flows between the three labor market states, and we present a calibration aiming at replicating the monthly flows for the U.S. in the 90's.

From the normative standpoint, we argue that the existence of two different labor supply margins has some policy implications. We show under which conditions the decentralized

production, involuntary unemployment arises in equilibrium without assuming that leisure is an inferior good.

[4] To our knowledge, the irreversibility of investments developed in Dixit and Pindyck (1994) has not been transposed to the analysis of labor supply.

unemployment rate is too high and the vacancy-unemployment ratio is inefficiently low due to taxes, even when wages internalize search frictions. The paper also discusses the conditionality of unemployment benefits and examine their entitlement effects, i.e. the fact that an increase in unemployment insurance increases the attractiveness of market participation among non eligible non-employed (Mortensen, 1977 and Fredriksson and Holmlund, 2001). Our theoretical analysis highlights the existence of a participation hoarding effect, which we define as the additional incentive to hold on to market participation induced by conditional eligibility.

Our work is not the first attempt to incorporate endogenous labor market participation features to standard models of search. On the *microeconomic* side, Seater (1977), Burdett-Mortensen (1978), Burdett (1979), Burdett-Kiefer-Mortensen-Neuman (1984), Swaim-Podgursky (1994) have successfully investigated the relations between search frictions and labor supply, with a fixed supply of jobs. Our theoretical distinction between inactivity and unemployment, empirically consistent with Flinn and Heckman (1983), is inspired by Burdett and Mortensen (1978). In the *macro-search* literature, Bowden (1980), Mc Kenna (1987); Pissarides (1990), chap. 6; Sattinger (1995) have introduced a labor demand side and endogenous participation, in a way that brings few new insights as compared to the standard (two state) model of matching. Individuals have a heterogenous value of non-market time and decide in a static (though intertemporal) way about their participation to the labor market. It follows that the flows between activity and inactivity are driven by macroeconomic changes (in productivity, in unemployment) and are thus mainly cyclical or conjunctural flows. In contrast, our theory, building on both macroeconomic factors and individual (household) shocks, is able to account for permanent, structural flows between activity and inactivity, even when macro-conditions are unchanged. Pries and Rogerson (2002) is another recent attempt to incorporate labor market participation in a macroeconomic framework[5].

The paper proceeds as follows. Section 2 defines the main properties of the labor supply margins in a partial equilibrium context, when the job finding rate is exogenously fixed.

[5] Footnote 7 discusses the specific differences between our theory and that proposed by Pries and Rogerson (2002).

Section 3 derives the general equilibrium of the model and proves its existence. Section 4 analyses the two policy dimensions of the paper, namely the role of taxation and unemployment benefits. It highlights also the counterfactual empirical predictions, and it discusses how these can be dealt with in the context of our theory. Section 5 presents a calibration of the baseline model and shows how our framework can rationalize most flows across the three labor market states. We also discuss quantitatively the role of conditional unemployment benefit. Section 6 concludes.

2 Labor supply with search frictions

2.1 Framework

Time is continuous and there is a mass 1 of risk-neutral individuals who are allocated one unit of time. They derive linear utility from home production (leisure) and from market activity. We consider a given skill segment of the labor force in which the marginal productivity is homogenous, at a level y. Individuals are paid a wage w determined later on and produce x units of utility per unit of time if they are engaged in home production.

Workers wanting to participate to the labor market undertake time-consuming search. The time allocation problem of the worker is defined as follows: h_w is the number of hours actually worked, h_s is the search intensity necessary to obtain a job and h_h is the choice of hours spent in leisure/home production. The time constraint is thus

$$\begin{aligned} 1 &= h_w + h_s + h_h \\ \text{with } h_w &\in \{0, e\} \\ h_s &\in \{0, s\} \end{aligned}$$

where e is the inelastic number of hours worked and s is the inelastic number of hours spent to find a job (we discuss and relax this assumption later on). There is no on-the-job search, thus job search and employment are mutually exclusive activities. It follows that in the three states W, U, H, where W is employment, U is unemployment and H is full-time home production, the flow utility of agents is given by

$$\begin{aligned} v^W &= (1-e)x + w \\ v^U &= (1-s)x \\ v^H &= x \end{aligned}$$

where x is home productivity and w is the total wage received for the e hours worked. Throughout this section, we assume $1 \geq e \geq s$. It is important to note that, following Becker (1965), home production or leisure consumption are formally expressed in the same way (raising individual's utility).[6] Hereafter, we keep the home production interpretation of x but interpretations in terms of time-varying marginal utility of leisure are possible.

We assume that there is some heterogeneity in the valuation of non-market activities. Concretely, home productivity x is *heterogeneous and stochastic*, and its value changes according to a Poisson process at rate λ. Conditional on the arrival rate of a shock, the value of home productivity takes a value from a continuous distribution $f(x)$ and c.d.f. $F(x)$ defined over the support $x \in [x^{\min}, x^{\max}]$.[7] For a non-employed individual, the key decision is whether to spend 0 or s hours in the labor market, while for an employed worker, the key decision is whether to work e or 0 hours: our model is an *extensive margin* model.[8] We further assume $x^{\min} \leq 0$ to insure that there will be market participants in equilibrium.

Labelling W, U, H the present-discounted value of the utility of workers in each state and using W for $W(x)$, $W' = W(x')$ etc... for simplicity of exposition, the Bellman recursive

[6] The simplest interpretation is Becker's (1965) one. Utility is the consumption of bundles, representing a combination of time and money. Here, home production is intensive in time, market activity is intensive in money. Gronau (1977, p. 1100) states that "[the distinction between home production and leisure], so common in everyday language disappeared in Becker's more general formulation. The omission is partly due (...) to the large number of borderline cases (eg. is playing with a child leisure or work at home?)".

[7] Changes in x are thought as individual and family shocks with large variance and low frequency. We have explored the alternative assumption in which x is fixed but heterogeneous and y is time-varying. Even in the simplest case in which y takes two values only, this framework gives twice as many margins as in our specification. We think that our modelling choice is more adapted analytically, and the time-variations in the value of non-participation (disease, children education or changes in the income of the household, etc...) are sufficiently large for driving a significant part of transitions between activity and non-participation. Pries and Rogerson (2002) have made the opposite modelling choice and have to keep track of the wage distribution.

[8] This is why we ignore hereafter issues such as the intertemporal elasticity of substitution, bargaining over hours or work sharing.

equations in the three states read:

$$(r+\lambda)W = v^W + \lambda \int_{x^{\min}}^{x^{\max}} Max(W', U', H')dF(x') + \delta[Max(U,H) - W] \quad (1)$$

$$(r+\lambda)U = v^U + \lambda \int_{x^{\min}}^{x^{\max}} Max(U', H')dF(x') + p[Max(W,U) - U] \quad (2)$$

$$(r+\lambda)H = v^H + \lambda \int_{x^{\min}}^{x^{\max}} Max(U', H')dF(x') \quad (3)$$

where δ is the Poisson parameter of a process of exogenous destruction of the job and p is the Poisson job finding rate for workers (treated as a parameter in partial equilibrium and endogenized in general equilibrium). The first equation states that the equity value of employment is the sum of the utility flow, of the capital gain (or loss) from a home production shock after which workers reoptimize (they decide whether to hold on the job W', look for another job U' or leave activity H') and of the capital loss of being hit by a destruction shock δ in which case workers decide whether to search for a new job or to return to full-time home production. The second and the third equations have similar interpretation for the λ shocks. In addition, upon getting a job offer with arrival rate p, unemployed individuals decide whether or not to accept it in considering $Max(U, W)$.

To solve for wages, we need to introduce firms. A firm has either 0 or one worker. As long as there are frictions, i.e. when p has finite value, successful matches yield a pure economic rent. As is conventional in the search-matching literature, those rents are split in fixed proportion between firms and workers. Formally, the value of a filled position for the firm depends on x if the wage does depend on x. We have

$$(r+\lambda)J(x) = y - w(x) + \delta(V_V - J) + \lambda \int_{x^{\min}}^{x^{\max}} Max(J', V_V)dF(x') \quad (4)$$

where y is the marginal product of the worker and V_V is the value of a job vacancy (treated in partial equilibrium as a parameter). The equity value of a job is the sum of flow profit, the capital loss following exogenous job destruction and the capital gain after a change in workers' characteristics possibly leading to job destruction if the worker quits.

Nash-bargaining over w follows the usual rule

$$w = ArgMax[W - Max(U,H)]^{\beta}[J - V_V]^{1-\beta} \quad (5)$$

and it follows that wages split the surplus in shares β and $1-\beta$. It can be guessed that there are two wage rules, depending on the sign of $U-H$. If $U \geq H$, then workers hit by an exogenous destruction shock (δ) look for another job. If $U < H$, then workers hit by this type of shock exit from the labor market and are engaged full-time in home production. The expression for wages is in Appendix 7.1, in equations (20) and (21). They conventionally appear as a weighted average (with weights respectively β and $1-\beta$) of the marginal product net of the firm's outside option (in equity value) and of a term reflecting the threat point of workers, i.e. either U or H.

2.2 Reservation strategies and definitions

We can now derive the slopes of the value functions W, U and H with respect to x. With linear utility, the value functions are piecewise linear functions of x, as proved in Appendix 7.2. Let us introduce the cut-off points x^{ν} and x^{q}, defined by

$$U(x^{\nu}) = H(x^{\nu}) \tag{6}$$

$$W(x^{q}) = H(x^{q}) \tag{7}$$

The ordering of the slopes implies the following ordering of intersections: $x^{q} \geq x^{\nu}$. This is always the case in a viable labor market with $W > U$. This is illustrated in Figure 1 showing these value functions as a function of x. $W(x)$ has a kinked point at the cut-off value of home production x^{ν}, corresponding to the change in the outside option of workers.

We are now in position to clarify a few labor concepts. Above x^{q} one finds only workers engaged in full-time home production, or non-participants. Between the two cut-off points x^{ν} and x^{q}, one finds two categories of workers. First, some of them are non-participants but do not search for a job: this corresponds to a well identified group of agents in labor statistics: there are indeed persons willing to work, but not ready to pay the search cost, i.e. non-employed agents whose home productivity belongs to the interval $[x^{\nu}; x^{q}]$. In Jones and Ridell (1999), those workers are called *marginally attached* to the labor market. These workers would accept a job if offered one, but do not wish to pay the search cost. We can thus define a broader concept of unemployment, adding up the unemployed job seekers and

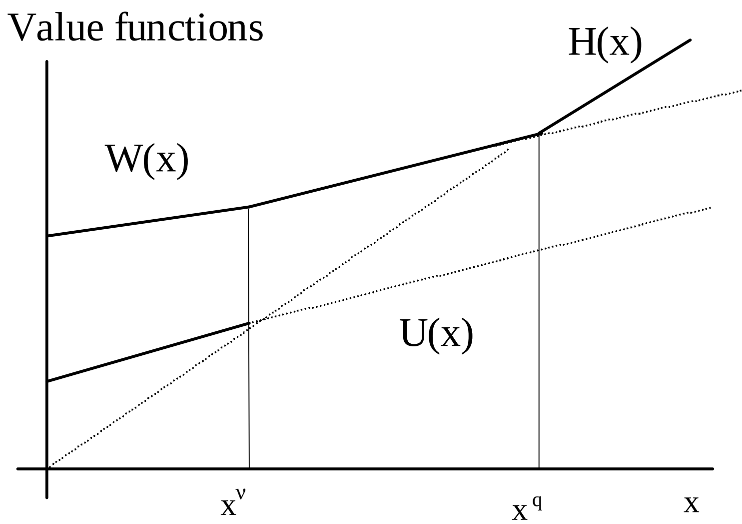

Figure 1: Value functions of home productivity x

the marginally attached to the labor market. We call it the extended unemployment rate. Second, there are employed workers. These workers had at a time a low value of $x < x^{\nu}$ in their individual history, and searched and found a job in the past. We call them *unattached employed workers* since they would leave the labor market after a job destruction shock δ. Finally, below x^{ν}, one finds both *unemployed job seekers* and employed workers. We label the latter *attached employed workers*, since they are willing to search for a new a job if hit by a job destruction shock δ.

2.2.1 Entry margin

The first indifference condition (6) defines an **entry-margin,** a level of home productivity **at** which the worker is indifferent between being full time in home production or being in search unemployment. Formally, the entry margin reads $sx^{\nu} = p(W - U)(x^{\nu})$. This states that the forgone value of home production in the job search activity sx^{ν} has to be compensated by an equivalent gain in expected surplus $p(W - U)$ given search frictions. In using equations

(30) in Appendix 7.3, we obtain:

$$\beta \frac{e(x^q - x^\nu)}{r + \lambda + \delta} = \frac{sx^\nu}{p} \tag{8}$$

where the term $\frac{sx^\nu}{p}$ stands as the expected value of foregone home production during search and the left-hand side is the worker's share of the total surplus of the match. This is thus clearly a free-entry condition into the labor market. At a given p, this equation defines a positive link between x^ν and x^q. The higher the quit cut-off point x^q, the higher the surplus on the job, thus the more attractive the labor market is, inducing further entries and a larger x^ν.

2.2.2 Quit margin and employment-hoarding

The second indifference condition (7) defines a **quit-margin,** a level of home productivity at which a worker is just indifferent between working in the market or being full time in home production. Using (17) in Appendix 7.1, we have

$$ex^q = w^{na}(x^q) + \lambda\beta\overline{S}, \tag{9}$$

where $\overline{S} = \int_{x^{\min}}^{x^q}[J' - V_V + W' - Max(U', H')]dF(x') > 0$ is the average value of a match net of the firm and the worker's outside option. Equation (9) states that the forgone value of home production on the job is larger than the wage from market activity, by a term reflecting the future expected surplus of the job given stochastic transitions in x. This is an *employment-hoarding* effect. It is the exact counterpart of the labor hoarding effect for a firm that face hiring and firing costs and expects higher productivity from labor in the future: it thus pays a wage above marginal productivity on a temporary basis in order to save on turnover costs (see e.g. Bertola and Caballero 1994). Note that the employment hoarding effect disappears as the surplus on the job $\overline{S}$ goes to zero, which is in particular the case when frictions disappears (see sub-section 2.3).

Further, given (21) in Appendix 7.1, we obtain

$$ex^q = y - rV_V + \lambda\overline{S} \tag{10}$$

The intuition of this equation is similar to the previous one. This equation states that the marginal worker at the quit margin has home productivity equal to the neoclassical reservation productivity y/e minus a term reflecting the bargaining power of the firm, plus the employment-hoarding term. In other words, under free entry of firms ($rV_V = 0$), the sacrifice of home production for the marginally indifferent worker would be above market productivity by a quantity reflecting future, anticipated gains of being on the job, given that quitting involves time spent to search. After straightforward calculations of the value of $\overline{S}$ in Appendix 7.3, (equation 31), we finally obtain $x^q = y/e - rV_V/e + \frac{\lambda}{r+\lambda+\delta}\int_{x^\nu}^{x^q} F(x)dx + \frac{\lambda(e-s)/e}{r+\lambda+\delta+\beta p}\int_{x^{min}}^{x^\nu} F(x)dx$. At a given p, this equation defines a negative link between x^ν and x^q.[9] The larger x^ν, the smaller the employment-hoarding term and thus, the less conservative employed workers are in their quit decision.

2.3 Existence and properties of labor supply in partial equilibrium

In partial equilibrium, p is treated as a parameter as well as V_V.[10] The two labour supply margins can be usefully analyzed in the space (x^q, x^ν). Figure 2 illustrates. It shows that there is a unique equilibrium in (x^q, x^ν). The proof of this statement is in Appendix 7.4.

Note also that the quit margin is vertical when $\lambda = 0$, with x^q at a level $(y - rV_V)/e$. This deserves a comment. When $\lambda = 0$, i.e. when there is no stochastic change in x, we have a 'static participation model', as opposed to dynamic participation when $\lambda > 0$. In the former case, the quit margin is latent, while it is activated in the latter case. Indeed, if $\lambda = 0$, people are permanently, either in or out the labor force. The quit cut-off point is still defined at $ex^q = y - rV_V$, but above x^ν there are only non-employed workers, and since $x^q > x^\nu$, the quit margin is not active. In contrast, when $\lambda > 0$, x evolves in time, and as a

[9] A differentiation shows that the sign of the derivative of dx^q/dx^ν is the sign of $-1 + (1 - s/e)(r + \lambda + \delta)/(r + \lambda + \delta + \beta p) < 0$. One can also comment this expression of the quit margin. An increase in s has a direct negative effect on the reservation value x^q because it negatively affects the surplus of being employed, reducing the value of participation. See equation (16) in Appendix 7.1 for instance. There is another indirect effect with the opposite sign, through the entry margin: a higher s reduces the entry cutoff point x^ν which increases x^q. This is easy to verify from equation (10): the intuition of this effect is that a higher s increases the value of being employed by saving on future search cost.

[10] We study x^ν and x^q for a given worker in a given firm, while rV_V, which is formally derived later on, may be a function of $x^{\nu'}$ and $x^{q'}$ in *other* firms.

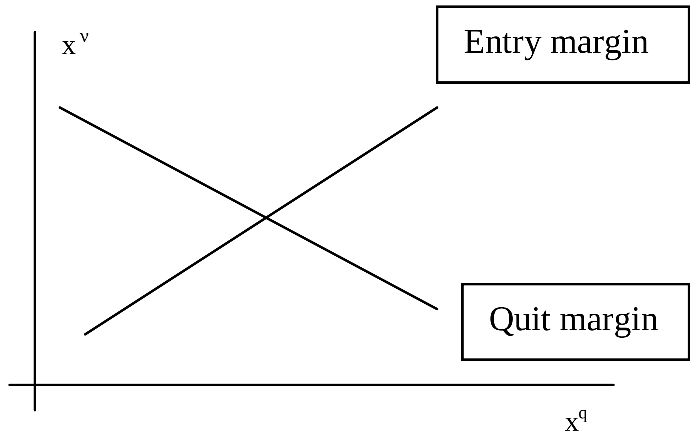

Figure 2: Entry and Quit Margins in Partial Equilibrium

result, employed workers quit the labor force when $x > x^q$: the quit margin is active.

Why does it matter? To see this, consider a positive shift of the entry margin in Figure 2 due to policy or technology. This leads in partial equilibrium to more entries, but with an active quit margin, i.e. with a downwards sloping (Quit) curve, x^ν increases less than if the quit curve was vertical; and second, x^q decreases. Thus, the positive entry shift will have opposite effects on participation along each margin. What is at work here is that the shift $dx^\nu > 0$ at constant x^q implies a decline in the surplus of the job. This reduces the size of the *employment-hoarding* effect, so that workers quit more frequently, i.e. x^q falls.

As an illustration, consider for instance an increase in p, still treated as a parameter here. This affects the (Entry) curve but not the (Quit) curve: the larger p, the easier it is to find a job, and thus the larger the incentive to participate in the labor market (higher x^ν at a given x^q). Put otherwise, the opportunity cost of searching, sx^ν/p is lower, raising incentives to participate. The role of frictions on labor supply can thus be understood: in an efficient labor market with large p, workers quit more easily since eventually they can come back to the labor market. In the limit $p \to +\infty$, the difference $x^q - x^\nu$ tends to zero, both quantities tend to the neoclassical entry point y/e. This sub-section has illustrated the role of dynamic participation decisions in a frictional labor market.

3 Labor demand and general equilibrium

The labor supply margins have in turn a general equilibrium effect which we now explore.

3.1 Labor demand

The general equilibrium is derived by adding a free-entry condition on firms which endogenizes V_V and p. In line with the traditional matching literature, an additional vacant position for a firm is established at no fixed cost, but at a flow cost c. It thus writes

$$rV_V = -c + \chi(J^e - V_V)$$

where χ is the job contact intensity for the firm and J^e is the expected value of the job given wage bargaining. J^e takes into account the density of workers actively looking for a job in the market. Thanks to the assumption of inelastic search effort s, workers actively looking for a job, in the interval $[x^{\min}, x^{\nu}]$, are met by firms with identical probabilities. Further, the density of those workers is the conditional density of $x's$ in the population.[11] It follows that $J^e = \left(\int_{x^{\min}}^{x^{\nu}} J(x')dF(x')\right) / F(x^v)$.

To obtain the third margin, we assume that there is free-entry of firms, i.e. all vacancy opportunities are exhausted, which leads to $V_V = 0$ and thus to $J^e = c/\chi$. The issue is thus to determine the value of J^e which depends on the expected wage faced by the firm.

So far we have assumed that $e \geq s$ and have solved for the partial equilibrium properties of the model. However, at the stage of introducing the labor demand equation, we found it very convenient to assume as a limit case that $e = s$ with $e \leq 1$ for reasons carefully detailed below. On the one hand, the assumption that $e = s$ is inconsistent with empirical works indicating that job search activity is a small fraction of the hours worked.[12] On the other hand, we may view such an assumption as an extreme form of indivisibility of labor. That s is as large as e may actually capture the fact that the decision to enter the labor market involves a new organization of individual's life, in an irreversible way (which is what

[11] This is not assumed, but was proved in Garibaldi-Wasmer (2001). The proof is omitted here but can be supplied on request.

[12] That $e > s$ is documented for instance in Layard et al. (1991), pages 237-41.

our modelling choice is precisely about). Given this new organization, unemployed workers must, at least temporarily, be immediately available for a job, which reduces the extent to which they can produce domestic good or services. So, we define a *fully indivisible labor supply* as one in which entering the labor market involves a sacrifice of home production regardless of the employment status: $e = s \leq 1$. This assumption implies that, when $V_V = 0$, the **job-creation margin** is

$$\frac{c}{\chi} = (1-\beta)\frac{e(x^q - x^\nu)}{r+\lambda+\delta} \tag{11}$$

Given the simplification, the general equilibrium is solved in assuming a fully indivisible labor supply $e = s$ and further, to avoid unimportant constant terms but without implication for the results, $e = 1$.[13]

Equation (11) makes clear how the labor supply margins affect the entry decisions of firms. It simply says that the surplus from a job for the firm is equal to the expected search/recruitment costs. It then determines χ as a function of x^q and x^ν. The model is then simply closed by the assumption of a matching process between workers and firms. The total number of contacts per unit of time is denoted by $M(u,v)$ where u is the number of unemployed job seekers in the population and v is the number of job vacancies. We denote by $\phi = v/u$ their ratio, traditionally called market tightness. We have, under the usual constant returns to scale assumption in M, that $\chi = M/v = \chi(\phi)$ with $\chi' < 0$. In addition the meeting probability p becomes also endogenous, and can be expressed as a simple function of market tightness ϕ. Formally, p is defined as a function $p = M/u = p(\phi)$ with $p' > 0$; and thus p is uniquely obtained from χ by the job-creation margin.

[13] To see the simplification brought by $e = s$, consider the wage equation (20) and asset values of $W - U$ in Appendix 7.1. They shows that whenever $e = s$, both the wage of the attached workers and $(W-U)(x)$ are independent of x for $x < x^\nu$. It follows that $J(x)$ is itself a constant for all $x \in [x^{\min}, x^\nu]$. Therefore, by assuming $e = s$, $J(x)$ is constant for all newly hired workers, i.e. for $x < x^\nu$, and is equal, by continuity to $J^e = J(x^v) = (1-\beta)\frac{x^q - x^\nu}{r+\lambda+\delta}e$. The equality $e = s = 1$ is totally innocuous and calibrations are actually carried out with $e = s$ different from 1.

3.2 General equilibrium

Denote by n the non-participation rate, i.e. the ratio of the number of inactive workers to the total population (normalized to 1). Then,

Definition: *A market equilibrium is a n-uple* (x^ν, x^q, ϕ, u, n) *and two wage rules (one for the attached, one for the unattached workers) satisfying: the entry margin for workers; the quit margin for workers; the job creation margin for firms; the steady-state condition for unemployment flows; the steady-state condition for inactivity flows.*

The derivation of the general equilibrium involves the three equations solving for three endogenous variables: x^q, x^ν, ϕ. Then comes the derivation of the stocks (unemployment and non-participation) from steady-state conditions on flows.

The three equations are the following:

$$\frac{c}{\chi(\phi)} = (1-\beta)\frac{x^q - x^\nu}{r+\lambda+\delta} \tag{JC}$$

$$\frac{x^\nu}{p(\phi)} = \beta\frac{x^q - x^\nu}{r+\lambda+\delta} \tag{Entry}$$

$$x^q = y + \frac{\lambda}{r+\lambda+\delta}\int_{x^\nu}^{x^q} F(z)dz. \tag{Quit}$$

Equation (JC) was obtained from the labor demand equation (11). Equations (Entry) and (Quit) are just derived from the definitions of entry and quit in equations (8) and (10) when $e = s = 1$ and $V_V = 0$. Note also that in the quit margin, the second term of $\overline{S}$ has disappeared in a fully indivisible economy ($s = e$).

Proposition 1 *A sufficient condition for existence and uniqueness is* $y > 0$.

The proof is derived in Appendix 7.5.

3.3 Stocks

In this sub-section, we derive the equilibrium stock of workers in different states. With the steady-state assumption, one obtains the unemployment rate which is defined as the ratio of the number of unemployed to the active population (employed + unemployed):

$$u_r = \frac{\delta + q}{p + \delta + q} \tag{12}$$

with $q = \lambda[1 - F(x^q)]$. The steady-state stocks of the other states are too complicated for being reported here, but can be calculated (see proofs in Appendix 7.6).

In the general case, equilibrium unemployment is determined by a whole new set of parameters linked to inactivity and non-market production, through the quantity q appearing in equation (12). Those parameters are absent from the classical two state analysis of the labor market. Second, the effect of the quit rate is in steady-state exactly the same as an increase in the job destruction rate: it increases the inflows into unemployment, because the number of people leaving a job for inactivity will be matched by an equivalent number of workers entering activity through unemployment. Equation (12) has also the implication that unemployment is affected by q through an indirect effect affecting p: the quit rate is anticipated by firms along the job creation margin, and a higher q reduces vacancy posting at a given x^ν and leads to a lower job finding rate p, raising unemployment.

4 Further issues

We now explore several additional questions raised by the model: first, the efficiency of participation margins in a decentralized equilibrium; second, the distorsive role of taxes on the allocation of time; third, the role of unemployment benefits in attracting and keeping workers in the labor force; fourth, the role of heterogeneity of market productivity in wage and employment differences across groups. And fifth, the existence of a search effort margin that extends our model. Most of these extensions will be used in the last section of the paper devoted to a quantitative exercise and a calibration of US flows.

4.1 Welfare and efficiency

As in Section 3, we assume in the next four subsections that $e = s = 1$ so as to get rid of unimportant constant. Only the equality $s = e$ has important consequences, as discussed before. Let us first consider the central planner problem. The central planner is maximizing the sum of market and non-market production. The general program of the central planner reads

$$\underset{N_U, x^\nu, x^q}{Max}\ \Omega(z) = y(1-n-N_U) - c\phi N_U + \mathcal{H}$$

under constraints (42) and (43) in Appendix 7.7

where $\mathcal{H}$ is total home production, n is the number of non-participants and N_U is the mass of unemployed workers (total population is normalized to 1). After some involving intermediate steps detailed in Appendix 7.7, one can show that the optimal values of x^q, x^ν and ϕ (the latter being obtained from optimal N_U) are jointly determined by the following expressions.

$$\frac{c}{\chi(\phi)} = (1-\eta)\frac{x^q - x^\nu}{\lambda+\delta} \quad \text{(JC*)}$$

$$\frac{x^\nu}{p(\phi)} = \eta\frac{x^q - x^\nu}{\lambda+\delta} \quad \text{(Entry*)}$$

$$x^q = y + \frac{\lambda}{\lambda+\delta}\int_{x^\nu}^{x^q} F(x)dx \quad \text{(Quit*)}$$

where $-\eta$ is the elasticity of χ with respect to ϕ.[14] Comparing these results with the decentralized equilibrium described by equations (JC), (Entry) and (Quit), we immediately obtain the Hosios condition $\eta = \beta$. In this case, the decentralized equilibrium is efficient: it reaches a labor market allocation that is identical to the social planner allocation with optimal taxation. This result might have been expected, since it is a synthesis of the efficiency results obtained in Pissarides (2000, § 6&8) with either endogenous destruction but fixed participation or exogenous destruction but endogenous participation (though static, with $\lambda = 0$). In what follows, we assume that the Hosios condition is satisfied.

4.2 Taxation and welfare

Things are very different when taxes affect wage earnings. Let us introduces a proportional tax on wages at rate t. In this case, all participation margins are distorted. The reduced

[14] Formally, $\eta = \eta(\phi) = -\phi\chi'(\phi)/\chi(\phi)$.

form of the model reads (Appendix 7.8):

$$\frac{c(1-t)}{\chi(\phi)} = (1-\beta)\frac{x^q - x^\nu}{r+\lambda+\delta} \quad \text{(JC}(t))$$

$$\frac{x^\nu}{p(\phi)} = \beta\frac{x^q - x^\nu}{r+\lambda+\delta} \quad \text{(Entry}(t))$$

$$x^q = y(1-t) + \frac{\lambda}{r+\lambda+\delta}\int_{x^\nu}^{x^q} F(x)dx \quad \text{(Quit}(t))$$

Inspecting equations (JC(t)), (Entry(t)) and (Quit(t)) it immediately follows that payroll taxes influence the equilibrium.

Proposition 2 *When the quit margin is active ($\lambda > 0$), a marginal increase in payroll taxation reduces the two cut-off points and labor market tightness to an inefficiently low level: $\frac{\partial \phi}{\partial t} < 0$; $\frac{\partial x^q}{\partial t} < 0$ and $\frac{\partial x^\nu}{\partial t} < 0$. It also raises the unemployment rate and reduces the employment rate compared to socially optimum levels.*

The proof is left to Appendix 7.8. The intuition is that taxation of wages reduces the payoff from labor market activity and thus reduces the incentives to participate (effect on the two participation margins, x^ν and x^q). It also raise labor costs compared to market and home productivity and discourages job creation (effect on ϕ). The clarification we thus bring here is that taxes distort the economy along two dimensions, while the literature tends to consider one or the other at a time, and further, these distortions are fairly independent on each other.

In fact, in the standard and simplest matching model with exogenous job destruction (Pissarides, 1987), payroll taxes do increase equilibrium unemployment if one interprets the unemployment income as a non taxable home production. This is well known. Yet, in such models the size of the labour force is fixed, and the only endogenous variable that may respond to changes in taxation is market tightness. As Pissarides (1998) as shown, such effect is present as long as unemployed income is not taxed. But in our economy both the entry and the quit margins would also be affected.[15]

[15] Taxation with home production was also studied by Holmlund (2002), but in his paper the effect on the quit margin was not considered. Other papers, such as Sandmo (1990), Frediksen et al. (1995), Sorensen

To see the relative independence of the two distortions, consider a special case of our model when $\lambda = 0$, i.e. when home production is constant over time and the quit margin is latent. In this special case, the three equations above simplify to

$$\begin{aligned} \frac{y(1-\beta) - c\beta\phi}{r+\delta} &= \frac{c}{\chi(\phi)} \\ x^\nu &= \frac{c(1-t)\phi\beta}{1-\beta} \\ x^q &= y(1-t) \end{aligned} \tag{13}$$

In this special economy there are only attached workers since workers with x above the entry cut-off point x^ν never participate. The quit margin is thus latent. In this special case all wages are independent of home production and labour costs are equal to $w = \beta(y + c\phi)$. As a result, firms create the appropriate number of jobs, so that vacancy and unemployment are at the efficient level. Yet, the overall returns to market participation are distorted and fewer people enter the labour market. This is a pure labour supply effect. As shown in equation (13), the entry margin is only affected by taxation through t , since ϕ is unchanged when $\lambda = 0$. In the general case $\lambda > 0$, a lower ϕ brings an additional distortion of x^ν.

We can finally bring two additional results. First, in the general case of our model, with $\lambda \geq 0$, taxes tends to reduce the employment hoarding effect, by decreasing the distance between x^q and x^ν.[16] Since taxes increase the relative value of home production, a larger tax rates clearly reduces the dynamic incentive to hold on on the job. The second result concerns a reverse causality: the larger is the difference between x^q and x^ν, the larger is the distorsive effect of taxation on market tightness.[17] Using the results of section 2.3 notably that the gap between x^ν and x^q was larger when search frictions increase, this implies that taxation reduces job creation quantitatively all the more, the more frictions there are in the economy. *A contrario*, the adverse marginal effect of taxation on unemployment disappears

(1997) and Kolm (2000) have studied taxation with home production, but these latter models do not focus on job search, and are mainly concerned with tax differentials between market an home production. There exists also an extensive empirical literature on the effects of taxes on labor costs. The results of that literature are mixed. See, for example, Tryvänen (1995) or Gruber (1997).

[16] JC(t) shows that $x^q - x^\nu$ decreases both because of a lower ϕ (proposition 2) and because of the denominator (a lower $1-t$).

[17] $\frac{\partial \phi}{\partial t}$ is proportional to $-\lambda \int_{x^\nu}^{x^q} zf(z)dz$ as shown by equation (44) in Appendix 7.8.

as frictions vanish.

4.3 Unemployment benefits in partial equilibrium

We now discuss the effect of the level and the eligibility of unemployment benefits. Their insurance role is often put forwards, at the cost of reducing search efforts of the unemployed, with additional adverse effects on wages. Overall, unemployment is increased by a lower labor demand. Beyond such disincentive effects on the insured workers, the existing literature has also emphasized a positive link between unemployment benefits and market participation, since an increase in unemployment insurance reinforces the attractiveness of market participation among non eligible non-employed in general, and among people who are out of the labor force in particular. This is called the *entitlement effect*.[18] In this section, we briefly discuss the implications of an extension of our model to unemployment benefits when p is fixed with a focus on the entitlement effect.

Let us assume here that a benefit b is available to workers under two conditions: they have a significant job search activity and have been previously employed (i.e. they do not come from non-participation, see Fredriksson and Holmlund 2001 for a similar assumption).[19] Unemployed workers coming from full-time home production then differ from those who were previously employed. We refer to the latter as covered and to the former as uncovered. The present-discounted value of unemployment is denoted by U^c and U^u respectively. The x^υ cut-off point is thus doubled and we can defined x^ν and $x^{\nu c}$ such that $U^c(x^{\nu c}) = H(x^{\nu c})$ and

[18] It was firstly pointed out by Mortensen (1977), it was mentioned by Atkinson and Mickelwright (1991) in an influential survey, and has recently received a lot of attention. Notably, Fredriksson and Holmlund (2001) studied such effects in their analysis of optimal sequencing of unemployment benefit. Related papers are Cahuc and Lehmann (2000) and Lehmann and Vanderlinden (2002).

[19] We ignore issues of imperfect monitoring from the public service providing the benefits, since s is assumed to be exogenous.

$U^u(x^{\nu u}) = H(x^{\nu u})$. Straightforward calculations (in Appendix 7.9) lead to

$$x^q = y + \frac{\lambda}{r+\lambda+\delta}\int_{x^{\nu c}}^{x^q} F(x)dx + \widetilde{b} \quad \text{(Quit')}$$

$$\frac{x^{\nu u}}{p} = \beta\frac{x^q - x^{\nu c}}{r+\lambda+\delta} + \frac{\widetilde{b}+b}{r+\lambda+p} \quad \text{(Entry')}$$

$$\frac{x^{\nu c}}{p} = \beta\frac{x^q - x^{\nu c}}{r+\lambda+\delta} + \frac{\widetilde{b}+b}{p} \quad \text{(Entry}^{c}\text{')}$$

$$\frac{c}{\chi(\phi)} = (1-\beta)\frac{x^q - x^{\nu c}}{r+\lambda+\delta} \quad \text{(JC')}$$

with

$$\widetilde{b} = \lambda/(r+\lambda)\int_{x^{\nu u}}^{x^{\nu c}} F(x)dx$$

being a key additional terms which reflects the gain in surplus for workers due to the existence of unemployment benefits. We have that $\widetilde{b} > 0$ and goes to zero when $b = 0$. One can further show that U^u and U^c do not depend on x, and that the following inequalities hold, $U^c > U^u$ and $x^{\nu c} > x^{\nu u}$ i.e. covered unemployed are better off than uncovered unemployed, and the decision of covered unemployed to return to full-time home production is reached for higher values of home productivity than for the uncovered. Thus, unemployment benefits attract and retain more active job seekers. Finally, from the perspective of the firm, there are now two different types of job seekers, the new entrant ones with $x < x^{\nu}$ and the laid-off unemployed workers, with $x < x^{\nu c}$, as displayed in Figure 3.

The novelty of our analysis compared to the literature is the existence of a *participation-hoarding* effect, which adds up to the employment hoarding effect described in section 2.2.2.

Definition 1 *The participation-hoarding effect is the additional incentive to participate to the labor market induced by conditional eligibility to benefits and is accounted for by the term* $\widetilde{b}$*, i.e. the loss of eligibility in case of a withdrawal from market activity.*

Eligible unemployed individuals and employed workers, in order to keep eligibility, hold on to market participation in anticipation of future changes in the value of home production. Note that all three cut-off points are affected: $\widetilde{b}$ directly raises $x^{\nu c}$ and x^q by one to one, but it also affects intertemporally by $p/(r+\lambda+p)$ the cut-off point $x^{\nu u}$. The participation

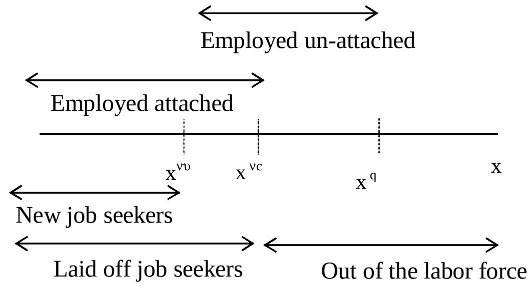

Figure 3: Employed workers (attached and unattached), unemployed workers (covered and uncovered) and non-participants as a function of home productivity.

hoarding effect exists only when $b > 0$ and when b is strictly conditional to a previous employment spell. A higher b makes $\widetilde{b}$ larger, i.e. it is more costly to quit, since it also involves losing eligibility. The increase in x^q can be shown to be exactly equal to $\widetilde{b}$. Hence, this effect parallels the employment-hoarding effect in (Quit) which was the additional term $\lambda/(r+\lambda)\int_{x^\nu}^{x^q} F(x)dx$ compared to the neo-classical labor supply rule.

One can also formally establish the partial equilibrium comparative static of the model over the three labor supply cut-off points x^q, $x^{\nu c}$ and x^ν, holding fixed market tightness ϕ.

Proposition 3 *At fix $p(\phi)$, the effect of benefits is such that $\partial x^{\nu c}/\partial b > 0$, $\partial x^\nu/\partial b > 0$ and if δ is sufficiently low $\partial x^q/\partial b < 0$*

The proof is omitted here (see Garibaldi - Wasmer 2003 for details). This proposition suggests that the effect of an increase in b on $x^{\nu c}$ and x^ν is the standard eligibility effects of benefits, which induces an increase in the entry cut-off points of both eligible and non-eligible unemployed. The effect of an increase in b on the quit cut-off point is now more complicated. In the quit margin there are now both the *employment-hoarding* effect and the *participation-hoarding* effect. While the increase in b reduces the employment-hoarding effect, causing a potential reduction in x^q, it also increases the participation-hoarding effect, since with larger benefits workers lose more from a voluntary quit into inactivity. The overall effect is then ambiguous, and depends on the size of δ. For low values of δ the employment-hoarding effect prevails, and a larger b reduces the quit margin. For sufficiently large values of δ the second effect dominates, since larger δ reduces the size of the employment-hoarding effect. To sum up, in the four state model, the presence of the quit margin mitigates the entitlement effect, however only at low values of δ.

The general equilibrium results of benefits are more complex and is explored in the calibration exercise next section.

4.4 Discussions and counterfactual predictions

The model rationalizes five of the six flows in the labor market and allows for a series of tractable extensions developed above. It however seems to fail in two dimensions. First, it does not account for the sixth flow ne, and second, it generates a seemingly counterfactual prediction on wages. In this section we discuss how our model can be consistent with both phenomena.

4.4.1 Wages

In our model the wage of unattached workers is above the wage of the attached workers. To see this consider the general equilibrium value of the wages as

$$w_a = \beta y + \beta c\phi \tag{14}$$

$$w_{na}(x) = \beta y + (1-\beta)x \tag{15}$$

Equation (Entry) implies that if $x > x^{\nu}$ then $(1-\beta)x > \beta c\phi$. In other words the wage of unattached workers is always above the wage of the attached workers, with equality in the entry margin $x = x^{\nu}$. This result is theoretically sound, since unattached workers have a higher threat point and may capture the intuition that the reservation wage of workers with a stronger preference for leisure is higher, *ceteris paribus*. However, this result does not fit with the intuition that in a cross-section of workers, higher attachment is positively associated with wages and participation. The reconciliation of the two intuitions is obtained in removing *ceteris paribus* above.

Let us consider some dispersion in market productivity y. For instance, consider n class of workers, with $y^1 < y^2 < ...y^n$ so that the index $i = 1...n$ is positively related to market productivity. Most productivity differences in the cross-section can be attributed to observable differences in education, experience or demographic characteristics such as age or gender so that one can, as a benchmark, argue that it is relevant to consider a full segmentation between the n categories of workers. The logic of our argument is based on the following three cross sectional correlation

$$\begin{aligned} corr(y^i, a^i) &> 0 \\ corr(y^i, w^i) &> 0 \\ corr(w^i, a^i) &> 0 \end{aligned}$$

where $a^i = \frac{e_a^i}{e_a^i + e_{na}^i}$ is the share of attached employment in the $i-th$ class of workers. Consider the first correlation. Larger market productivity is associated with larger attachment. In our model, higher market productivity reduces the relative value of home production, so that following an adverse shocks, non-employed workers are more likely to be interested in finding a new job, and are thus more attached to the labour market. The second correlation is also straightforward. Consider the expressions for wages given in equations (14) and (15) above. Market productivity enters directly in both expressions, so that a group of workers with higher market productivity is also a group of workers with higher wages. The third correlation follows directly from the first two, and represents the solution to the apparent counterfactual prediction discussed above: in a cross section, individuals with larger attachment have larger wages, simply because they have higher market productivity on average. In the quantitative section below, we show that this is the case with just two class workers.

A very similar argument would run if the heterogeneity across groups lies home productivity parameters such as λ. Indeed, in a segment in which workers are more frequently hit by positive shocks on x, firms face higher turnover rates and are thus reluctant to open job vacancies, thus reducing tightness and accordingly the average wage. We thus still have a positive correlation in wages and labor market attachment. Those claims will be more fully documented in the calibration exercise that follows.

4.4.2 Flows from N to E and continuous job search

Our model accounts for five flows out of six flows between employment, unemployment and out of the labor force (see Figure 4). We do not properly account for workers flows from N to E, while in reality, as detailed in next section, a significant number of workers flows directly from non-employment to employment. Those workers thus make no transition to unemployment, which was, in our theoretical definition, a state in which workers actively look for a job.

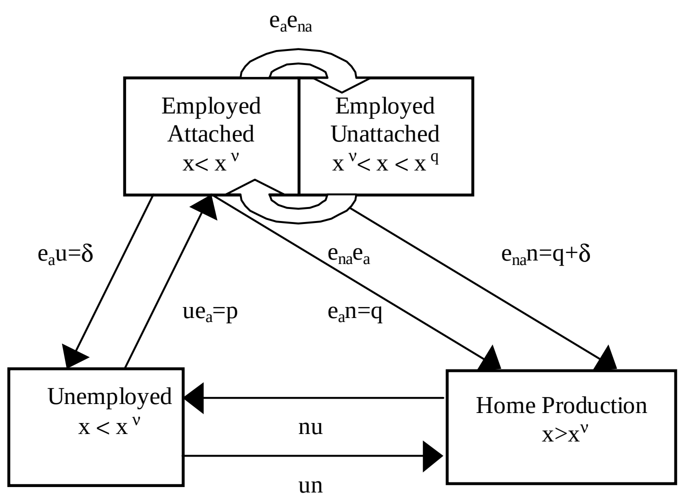

Figure 4: Labor market flows between three labor market states and internal flows.

Several authors in the literature, and Petrongolo and Pissarides (2002) in particular, have however argued that the direct flows from inactivity to employment are due to an additional mis-classification problems, technically known as a time aggregation bias. Any person having a job had to make a minimal effort (going to an interview or negotiating the wage or working conditions), which cannot be detected by labor force surveys. The working hypothesis is that en flows in the data are a pure mis-classification problem, due to undetected infra-monthly transitions. The time aggregation bias is the basic route we follow.

However, there are additional rationalizations. An interpretation similar to the time aggregation bias is that search effort is continuous, while we took it to be inelastically set to either 0 or s. Thus, some workers with low search effort are mis-classified as inactive while their search effort is strictly positive but below the detection point of the statisticians.[20] These people get jobs, despite low search effort, and the transition is recorded as part of the ne flows. The last interpretation, which we did not allow for so far, is that 'jobs bump into people', even though they make no search effort, so that truly inactive workers obtain job offers.

As we argued in the previous section, our model already rationalizes the existence of such 'marginally attached workers'. To go beyond however, one can relax the assumption that s, the fraction of time devoted to search, is inelastic. This will make the model consistent with all possible interpretations of data and offer a synthesis between the empirical findings of Jones and Ridell (1999) and our model. Indeed, even with endogenous search effort the two margins still emerge in equilibrium. Such a model is derived in Appendix 7.10. The hazard rate of non-employed workers is $\sigma(s)p(\phi)$ where σ is job search efficiency. The main insight is that search effort s can be shown to depend continuously and negatively on x and becomes equal to zero at some cut-off point x^*. We can thus easily incorporate the various explanations of ne flows in this analysis. The 'jobs bump into people' explanation is simply that $\sigma(0) > 0$. The 'statistical misclassification' explanation is simply that workers with s below some positive detection point are classified as non-participants, while $\sigma(s)$ can be positive for these workers.

4.4.3 Dynamics

An additional possible extension concerns the dynamic implications of the model. Is it possible that accounting for participation improves the quality of macroeconomic models of the business cycle? The answer is a priori ambiguous. On the one hand, Veracierto (2002) argues that including leisure-work choices into the RBC models generates counter-factual implications notably with too low volatility of employment fluctuations. Shimer (2003a and

[20] See Frijters and Van Der Klaauw (2003) for a recent empirical paper on the intensity of search and changes in transitions from U to N where there is a discussion of the impact of personal characteristics on the arrival rate of offers.

b) and Hall (2003) have also argued that the standard search model was predicting too high volatility of wages and too low volatility of employment and vacancies. At a first glance, our model has a feature that is not present in Veracierto, the fact that employment and participation are determined by two margins, the new one being the quit margin. Indeed, a positive productivity shock would reduce workers' incentives to quit and thus additionally raise employment. Further, as we noticed in Section 3.3, a lower quit rate further raises vacancy creation as firms anticipate longer periods of profits. The bottom line is that potentially, our model generates a higher employment response to productivity shocks.[21] Extending our model to investigate its dynamic properties is therefore important. Faraglia (2003) has made some progress in this direction, with indications that there are however difficulties associated with accounting the dynamics of distribution of workers across states.

5 A quantitative analysis

5.1 The stylized facts

Let us first start with a description of the facts we want to illustrate here. Following Abraham and Shimer (2001) and Faraglia (2003), we use the gross monthly flows of workers between the three ILO market states E, U and N. As it is well known in the labor literature, all flows tabulated from labour force surveys suffer from serious misclassification problems. Indeed, there are two major problems with the unadjusted gross flows data derived from the CPS. First, imperfect matching of labour force data leaves approximately 15% of the eligible observation with labor force status missing in one month or the other. Second, the measurement of changes in labor-force status may be biased because of random respondent, interviewer or coding errors even when these classifications errors do not generate bias in the measurement of the levels. Abowd and Zellner (1985) have proposed a procedure resolving these issues. We apply their adjustment under the assumption that these biases are time invariant (as in Abraham and Shimer, 2001). We only consider the post-June 1995 period

[21] All these interesting points were made clear to us by a referee.

(since there are missing data between June and September 1995) for two groups of workers: the 15-64 population (hereafter referred to as 'total') and the 25-54 population ('prime-age'). When the flows are deflated by the origin population, they are called transition rates. When they are deflated by the total (or prime-age) population, they are called 'flow rates'. Table 1 indicates the sample averages for the different flows and stocks.

Table 1 shows that there are large flows to and from inactivity, even when we take away the extreme of the age distribution, as we do in considering the sample 25-54. It is notably the case that exits from employment to unemployment are less frequent than exits from employment to inactivity. The other flows have standard values. Table 1 also indicates that there are important direct flows from inactivity to employment. To be consistent with the time-aggregation interpretation developed in sub-section 4.4.2, any *ne* transition may mask two infra-month transitions *nu* and *ue*. Our calibration strategy will account for this correction.

Table 1: Average Monthly Flows in the US Labor Market.

	Flows [a]					
	eu	*en*	*ue*	*un*	*nu*	*ne*
15-64 Population						
Transitions	1.02	1.62	25.90	16.59	3.46	4.43
Flow Rates	0.74	1.18	0.90	0.58	0.81	1.04
Stocks [b]	E/P	U/P	N/P	U/L		
	72.90	3.50	23.60	4.58		
25-54 Population						
Transitions	0.83	1.01	25.61	13.28	4.61	3.38
Flow Rates	0.68	0.82	0.76	0.40	0.71	0.52
Stocks	E/P	U/P	N/P	U/L		
	81.58	3.00	15.42	3.55		

[a] The first (second) letter refers to the source (destination) population e.g. *eu* is the employment unemployment flow.
[b] E is employment, N is out of the labor force, U is unemployment and L is the labor force.
Averages 1995:10 2001:12. Abowd Zellner correction (Abowd and Zellner (1985), Table 5).
Source: Gross CPS data provided by Robert Shimer and Elisa Faraglia and Authors' calculation.

Table 2: Calibration to the US Labor Market

Parameters	Notation	Value	US Economy
Fixed Parameters			
Matching Elasticity	η	0.5	
Average Home Production [a]	Λ^{-1}	2.00	
Unemployed Income	b	0.00	
Discount Rate	r	0.005	
Idiosyncratic Shock Rate	λ	0.06	
Workers' Surplus Share	β	0.5	
Code Determined Parameters			
Separation Rate	δ	0.01	
Productivity	y	3.93	
Matching Function Constant	x_o	0.71	
Search Costs	c	6.30	
Equilibrium Values			
Entry Margin	x^{ν}	3.15	
	$F(x^{\nu})$	0.79	
Quit Margin	x^q	4.08	
	$F(x^q)$	0.87	
Market Tightness	ϕ	0.50	
Calibrated Statistics			
Unemployment Rate	u	3.55	3.55
Non Participation Rate	n	15.40	15.42
Implied statistics			
Share Household GDP		0.30	0.33
eu Flow Rate	eu	0.83	0.68
en Flow Rate	en	0.67	0.82
$(ue)^{TA}$ Flow Rate	$(ue)^{TA}$	1.50	1.47
un Flow Rate	un	0.04	0.40
$(nu)^{TA}$ Flow Rate	$(nu)^{TA}$	0.18	1.23
Extended Unemployment		5.41	4.97
Attached Employed	E_a	76.31	
Non-Attached Employed	E_{na}	5.29	
Employment Hoarding [b]		0.14	
Attached Wage	w_a	3.54	
Non-Attached Wage	w_{na}	3.77	
Diagnostic statistics			
Absolute Fit	R^{abs}	0.62	1
Relative Fit	R^{dev}	0.56	1

[a], Distribution is Exponential with parameter $\Lambda = 0.50$
[b], As a fraction of market productivity
Source: Authors' calculation

5.2 Calibration: Baseline model

As displayed in Table 1, there are six flows to consider, and the model endogenizes five of them. Consistent with the model and the discussion above on the infra-month transitions, the calibration will be based on the modified rates: $(nu)^{TA} = nu + ne$ and $(ue)^{TA} = ue + ne$ where the superscript TA refers to the correction for the time aggregation bias, which implies that workers flowing from N to E are assumed to have made two transitions, from N to U and from U to E.

The spirit of the calibration exercise is to see how the model performs in accounting for

Table 3: Calibration to the US Labor Market: Extensions

Parameters	Notation	Heterogeneity[a]			4 states	US
		l	a	h		
Productivity	y	3.53	3.93	4.33	4.13	
Matching Elasticity	η		0.5		0.4	
Discount Rate	r		0.01		0.01	
Idiosyncratic Shock Rate	λ		0.058		0.06	
Workers' Surplus Share	β		0.5		0.4	
Average Home Production	Λ^{-1}		2.0		2.0	
Time in Market Activity	e		0.90		0.85	
Matching Function Constant	x_o		0.71		0.74	
Separation Rate	δ		0.01		0.01	
Search Costs	c		6.30		6.03	
Eligible Unemployed Income	b		0.00		1.149	
Calibrated statistics						
Unemployment Rate	u	4.10	3.61	3.12	3.55	3.55
Non Participation Rate	n	19.02	15.76	12.50	15.40	15.42
Market Tightness	ϕ	0.44	0.50	0.56	0.50	
Implied statistics						
eu Flow Rate	eu	0.78	0.83	0.87	0.78	0.68
en Flow Rate	en	0.78	0.68	0.57	0.69	0.82
$(ue)^{TA}$ Flow Rate	ue^{TA}	1.56	1.6	1.44	1.47	1.47
un Flow Rate	un	0.05	0.04	0.03	0.04	0.40
$(nu)^{TA}$ Flow Rate	nu^{TA}	0.27	0.20	0.13	0.19	1. 23
Share of Covered Unemployed		0.00	0.00	0.00	0.52	0.33
Replacement Rate		0.00	0.00	0.00	0.32	0.2
Attached Employed	E_a	71.92	75.95	79.98	77.24	
Non-Attached Employment	E_{na}	5.74	5.27	4.79	4.36	
Employment Hoarding [b]		0.14	0.14	0.14	0.11	
Participation Hoarding [b]		0.00	0.00	0.00	0.02	
Average Wage	$\overline{w}$	3.17	3.55	3.93	3.56	
Diagnostic statistics						
Absolute Fit	R^{abs}		0.63		0.65	1
Relative Fit	R^{dev}		0.57		0.59	1

[a] l, a and h refer respectively to the low average and high segment of the economy
[b] As a fraction of market productivity
Source: Authors' calculation

the labour market flows, once the stocks, determined in steady-state from these flows, are calibrated to replicate the U.S. economy quantities, for the 25-54 population in the second half of the nineties. Notably, we want to replicate an unemployment rate of 3.5 percent and a non-participation rate of 15.4 percent. The target for market tightness is set at 0.5, the latter being a reference value for most of the matching literature. The calibration code searches the parameter space for values of y, δ, c, x_0.[22]

Table 2 reports the assumptions (upper part) and the outcome of calibration (lower part). We find that 8% of the total working age population is between x^ν and x^q, among which 5.6

[22] The total number of contacts is $x_0\psi^{-\eta}v$ (i.e. x_0 is a scale parameter; and $-\eta$ is the elasticity of $\chi(\psi)$, the finding rate of workers by firms). The pure monthly discount rates r is 0.005, $\beta = \eta = 0.5$ so as to satisfy the Hosios efficiency condition with standard values. The distribution of home productivity is exponential with parameter $\Lambda = 0.5$. The arrival rate of the idiosyncratic shock λ is set to 0.06.

percent are employed unattached. This means that 2.4% of the population corresponds to the marginally attached defined by Jones and Ridell (1999) with reference to the Canadian Labour market. For the US Sorrentino (1993 and 1995) has established several definitions of unemployment, ranking from 1 (the most conservative) to 7 (the broadest one), on the basis of answers of respondents to individual surveys such as their willingness to have a job, the desired number of hours and the duration of the current unemployed spell. The ILO definition corresponds to definition 4, while definition 5 includes part-timers reporting the desire to be full-time and definition 6 includes workers reporting wanting a job but not searching for the job. Using the estimates of Sorrentino (1993) without considering the issue of part-time, *extended unemployment* in the United States (including the marginally attached workers) is 40 percent larger than the conventional definition. This implies that extended unemployment in the United States is around 4.97 percent of the working age population. As Table 2 shows, in our calibration extended unemployment is 5.41 percent, which is just half a percentage point larger than the corresponding US estimates.

Household production is approximately 30 percent of market production (GNP), a statistic which appears to be in line with existing estimates on the size of the informal sector (Eisner 1988 finds 33%). Table 2 presents also a quantitative measure of the employment hoarding effect, and shows that the incentive to hold on the job amounts to 14 percent of market productivity.

In order to assess the goodness of fit of our calibration exercise, we rely on two quantitative indicators, which measure the distance of our calibration to the US economy. The first indicator is R^{abs} and its expression reads

$$R^{abs} = 1 - \frac{\sum_{i=1}^{5} |flow_i^{US} - flow_i^{Model}|}{\sum_{i=1}^{5} flow_i^{US}}$$

where $flow_i^{US}$ $flow_i^{Model}$ refer to one of the five labour flows calculated for the US economy and for the artificial economy. The value of the indicator R^{abs} refers the average fit of our flows from the US statistics, where the fit is measured in absolute value. A perfect match would yield a value of R^{abs} equal to 1 while a value of 0 would indicate an average deviation of an order of magnitude. The indicator R^{rel} is constructed in a similar way, but with the distance calculated in percentage terms.

Remarkably, Table 2 shows that the model economy calibrated to the US stocks can match between 56 and 62 percent of the flows, depending on which of the two indicators are being used. Nevertheless, as it is clear from Table 2, the actual degree of resemblance of the various statistics varies across flows. In particular, our model economy matches very well three of the five target flows (eu, ue^{TA} and en) while fall shorts of accounting for the flows un and nu. Further, our economy implies that non attached workers enjoy a higher wage than the attached workers. As discussed in Section 4.4.1, albeit theoretically sound, this result is somewhat controversial. In the next section, we assess whether a more accurate accounting of the structure of the unemployment benefits, as well as relaxing the representative agent assumption can improve various dimensions of the calibration.

5.3 Calibration: Extensions

In this section we present two extensions to our baseline calibration. The first extension deals with market productivity differences in the population while the second extension deals with unemployment benefits. The results are displayed in Table 3.

In the first simulation we assume that there are two types of agents in the population: individuals with high market productivity and individuals with low market productivity. The former have productivity equal to y^h while the latter have productivity equal to y^l with $y^h > y^l$. For simplicity, we assume that both populations have identical size. We assume that the aggregate economy is the superposition of the high productivity and low productivity segments. The spirit of the exercise is to start from the parameters of the three state model and to set y^l and y^h so that the average values of endogenous stock variables match the US economy. Once done, we uncover the underlying properties which are the result of an aggregate composition effect. Table 3 highlights several important implications. First, it is clear that high productivity individuals are high wage individuals. Second, it is clear that low wage individuals have larger flows to and from inactivity. Notably, the en

flows for the high productivity group is just 0.1 percent while it is ten times larger for low productivity workers. The same is true of other flows to and from inactivity. This suggests *that low wage individuals (and hence low productivity) account for most transitions to and from inactivity.* Third, the table shows that a larger share of unattached workers is made up of low productivity workers.

The second extension presented in Table 3 provides a better description of the unemployment benefit system, in line with the model presented above. The calibration is based on the aggregate statistics used in Table 2. The parameters are similar to those used in the baseline calibration, with the only notable exception being the Hosios condition, which is now satisfied for value of $\beta = \eta = 0.4$. The results are as follows. First, our aggregate indicators of fits increase to 59 and 65 percent respectively, suggesting that improving the specification of the unemployment benefit system goes in the direction of explaining a larger share of the flows. Second, the calibration of the unemployment benefits is fairly accurate, since it implies a replacement rate of 30 percent and a coverage of 50 percent, statistics which are in line with the US market. Finally, Table 3 presents also a quantitative measure of the participation hoarding effect, and suggests that it amounts to (almost) 10 percent of the level of unemployment benefits.

6 Conclusions

Our model allows for a rather precise description of the labor market. It includes several categories of individuals: attached employed workers, unattached employed workers, unemployed workers, marginally attached non-employed workers and true non-participants. All this is delivered with a tractable model of endogenous job creation and the solution is characterized with three equations only, solving for two reservation values for workers and one job creation rate. Five of the six usual labor market flows are accounted for in the benchmark model, the sixth requires specific assumptions about flows from inactivity to employment. Policy implications are explored: the role of taxation and unemployment benefits is different and more complex than with inelastic labor supply or static participation, due to the emergence of the quit margin.

Beyond dynamic issues, extensions of this work include policy simulations of the impact of workfare policies and subsidies towards activity, a better accounting for firms' heterogeneity and the introduction of several classes of workers. The present paper is a first step in the direction of an accurate calibration of frictional labor markets.

7 Appendix

7.1 Wage determination

The proof involves the computation of the average surplus of workers, firms and the match. Denote by $\overline{S}_w = \int_{x^{\min}}^{x^{\max}} Max(W', U', H') - Max(U', H')dF(x')$, by $\overline{S}_f = \int_{x^{\min}}^{x^{\max}} Max(J' - J^V, 0)dF(x')$ and by $\overline{S} = \overline{S}_f + \overline{S}_w$. Thanks to (5), we have that $\overline{S}_f = (1-\beta)\overline{S}$ and $\overline{S}_w = \beta\overline{S}$. Note first that, given that $v^H > v^U$, we have that, for all x such that $H(x) > U(x)$, necessarily Max(W-U,0)=W-U. This is easily seen from Bellman equations (2) and (3). Taking differences of the Bellman equations (1) to (3), we obtain:

$$(r+\lambda+\delta)(W-U)(x) = w(x) + (s-e)x - p(W-U)(x) + \lambda\beta\overline{S} \text{ if } H(x) \leq U(x) \quad (16)$$
$$(r+\lambda+\delta)(W-H)(x) = w(x) - ex + \lambda\beta\overline{S} \text{ if } H(x) \geq U(x) \quad (17)$$
$$(r+\lambda+\delta)(J-J^V)(x) = y - w(x) + \lambda(1-\beta)\overline{S} - rJ^V \quad (18)$$

Using (5) and simplifying for discount factors $(r+\delta+\lambda)$, we have the sharing rule

$$(1-\beta)(W - Max(U,H)) = \beta(J - J^V) \quad (19)$$

Further noting that that terms in $\overline{S}$ cancel out in the above equality, the expression for wages comes easily: we obtain

$$w^a(x) = \beta(y - rV_V) + (1-\beta)[(e-s)x + p(W-U)(x)] \text{ if } H(x) \leq U(x) \quad (20)$$
$$w^{na}(x) = \beta(y - rV_V) + (1-\beta)ex \text{ if } H(x) \leq U(x) \quad (21)$$

where a refers to attached workers while na refers to unattached workers.

7.2 Slopes of value functions and reservation strategies

Recall from Appendix 7.1 that for all x such that $H > U$, we also have $W > U$. It is thus sufficient to prove that asset values are increasing, linear or piecewise linear and continuous and that $U(x)$ is less steep than $H(x)$ so that for all $x < x^\nu$, where x^ν is defined as $U(x^\nu) = H(x^\nu)$, we necessarily have $W > U > H$. Now, if $x^{\min} > x^\nu > x^{\max}$ which we will assume, then we have $x^q > x^\nu$.

Let's prove this. Using the wages derived in Appendix (7.1), one can rewrite Bellman equations of the employed according to $H-U$:

$$(r+\lambda)W = (1-e)x + w^a(x) + \lambda \int_{x^{\min}}^{x^{\max}} Max(W',U',H')dF(x') + \delta(U-W)(x) \text{ if } H \leq U$$
$$(r+\lambda)W = (1-e)x + w^{na}(x) + \lambda \int_{x^{\min}}^{x^{\max}} Max(W',U',H')dF(x') + \delta(H-W)(x) \text{ if } H \geq U$$

Let us denote by a_W^a, a_W^{na}, a_U and a_H the slopes of these two asset values and of H and U, all multiplied for convenience by the constant $r+\lambda$. We have thus, differentiating the equations above with respect to x and introducing the expression for wages, that:

$$a_W^a = (1-\beta)\left[(e-s) + p/(r+\lambda)(a_W^a - a_U)\right] + \delta/(r+\lambda)(a_U - a_W^a) \quad (22)$$
$$a_W^{na} = (1-\beta)e + (1-e) + \delta/(r+\lambda)(a_H - a_W^{na}) \quad (23)$$
$$a_U = (1-s) + p/(r+\lambda)(a_W^a - a_U) \quad (24)$$
$$a_H = 1 \quad (25)$$

By difference of (22) and (24), we have

$$(a_W^a - a_U)[1 + \beta p/(r+\lambda) + \delta/(r+\lambda)] = -\beta(e-s) \leq 0 \quad (26)$$

By difference of (23) and (25), we have

$$(a_W^{na} - a_H)[1 + \delta/(r+\lambda)] = -\beta e \leq 0 \quad (27)$$

Then, by difference of (24) and (25), we have

$$a_U - a_H = -s + p/(r+\lambda)(a_W^a - a_U) \leq 0$$

using inequality (26). Overall, we have proved that

$$a_H \geq a_U \geq a_W^a$$
$$a_H \geq a_W^{na} \geq a_W^a$$

Given $W(x) > U(x) > H(x)$ for $x < x^\nu$ and $a_H \geq a_U$, the intersection of $W(x)$ with $H(x)$ denoted by x^q is thus necessary to the right of the intersection of $U(x)$ and $H(x)$. Thus $x^q \geq x^\nu$. This is represented in Figure 1. Note that one can also prove that $a_W^{na} \geq a_W^a$.[23]

7.3 Determination of the surplus $S(x)$ and $\overline{S}$

Let us first define $S(x) = J(x) + V_V + W(x) - Max(U(x), H(x))$. One remarks that $\frac{\partial S}{\partial x} = \frac{-e}{r+\lambda+\delta}$ for $x^q \geq x \geq x^\nu$ and $\frac{\partial S}{\partial x} = \frac{-e+s}{r+\lambda+\delta+\beta p}$ for $x^\nu \geq x \geq x^{Min}$. Given that $S(x^q) = 0$ and $S(x)$ is continuous in x^ν with a discontinuity in slopes, we have

$$S(x) = \frac{e(x^q - x)}{r+\lambda+\delta} \text{ for } x^q \geq x \geq x^\nu$$
$$\text{and notably } S(x^\nu) = \frac{e(x^q - x^\nu)}{r+\lambda+\delta}$$

[23] By difference of (22) and (23), and using inequalities (26) and (27).

By Nash-bargaining, we obtain that for any $x \geq x^{\nu}$ the surplus of the worker and the firm can be written as

$$J(x) - V_V = (1-\beta)e\frac{x^q - x}{r+\lambda+\delta} \quad (28)$$

$$W(x) - H(x) = \beta e\frac{x^q - x}{r+\lambda+\delta} \quad (29)$$

$$W(x^{\nu}) - U(x^{\nu}) = \beta e\frac{x^q - x^{\nu}}{r+\lambda+\delta} \quad (30)$$

We can also determine the value of $\overline{S}$ defined in Appendix 7.1. An integration by part leads to

$$\begin{aligned} \overline{S} &= \int_{x^{min}}^{x^{\nu}} S(x)dF(x) + \int_{x^{\nu}}^{x^q} S(x)dF(x) \\ &= F(x^{\nu})S(x^{\nu}) - 0 + \frac{e-s}{r+\lambda+\delta+\beta p}\int_{x^{min}}^{x^{\nu}} F(x)dx \\ &\quad + F(x^q)S(x^q) - F(x^{\nu})S(x^{\nu}) + \frac{e}{r+\lambda+\delta}\int_{x^{\nu}}^{x^q} F(x)dx \end{aligned}$$

which brings equation (31):

$$\overline{S} = \frac{e-s}{r+\lambda+\delta+\beta p}\int_{x^{min}}^{x^{\nu}} F(x)dx + \frac{e}{r+\lambda+\delta}\int_{x^{\nu}}^{x^q} F(x)dx \quad (31)$$

7.4 Existence and uniqueness in partial equilibrium with finite p

The proof for uniqueness of x^{ν}, x^q for a given p is simple to obtain. First, the expression of the quit margin in equation (10) is downward sloping, the expression for the entry margin in equation (8) is upward sloping.It is also easy to see that the intersections with the horizontal axis ($x^{\nu} = x^{\min}$) are such that the intercept of the entry margin is below $x^{\min}$ while the intercept of the quit margin is given implicitly by $x^q = y/e - (r/e)V^V + \frac{\lambda}{r+\lambda+\delta}\int_{x^{\min}}^{x^q} F(x)dx$. A sufficient condition for uniqueness is that the latter is above $x^{\min}$ which is the case when y is sufficiently large.

7.5 Existence and uniqueness of the general equilibrium

Proof of Proposition 1. The existence (and uniqueness) of the equilibrium described by (Entry), (Quit) and (JC) can be shown in eliminating x^{ν} from those equations, in noting that (Entry) and (JC) jointly imply

$$x^{\nu} = \frac{\beta}{1-\beta}c\phi. \quad (32)$$

This states, in a reduced form, that higher shares of the surplus and better labor market prospects induce further entry of workers into the labor market. Using (32), one obtains two relations between ϕ and x^q that have opposite slopes. One thus can express the equilibrium in the space $[\phi, x^q]$. The modified JC curve is positively sloped and states that more stable workers (higher x^q) raise job creation. The modified (Quit) equation is downward sloping and states that, with better labor market tightness, the surplus of a job is lower and the capital loss of quitting is lower, reducing x^q. Comparing the intercepts of the two modified (JC) and (Quit) i.e. when $x^\nu = \phi = 0$, we can show existence and uniqueness. The intercept of the JC curve is $x^q = 0$ and the intercept of the quit margin curve, denoted by q_0 is defined by $q_0 = y + \frac{\lambda}{r+\lambda+\delta} \int_0^{q_0} dF(x) \geq y > 0$ as long as $y > 0$.

7.6 Stocks and flows

We first define a few notations: let's denote with capital letters the stocks of workers E_a, E_{na}, N_U and $N = n$ respectively the employed attached, employed unattached, unemployed and the non-participants (in full-time home production), and by small letters $e_a n$, etc... the flows between those stocks. One can write the evolution of the stocks of workers in the four categories by:

$$dE_a/dt = -(e_a n + e_a u + e_a e_{na})E_a + ue_a N_U + e_a e_{na} E_{na} \tag{33}$$
$$dE_{na}/dt = -(e_{na} n + e_{na} u + e_{na} e_a)E_{na} + e_a e_{na} E_{na} \tag{34}$$
$$dN_U/dt = -(ue_a + un)N_U + e_a u E_a + nuH \tag{35}$$
$$dN/dt = -nuN + e_{na} n E_{na} + unN_U + e_a n E_a \tag{36}$$

In steady-state and replacing the rates of transition by their values, one obtains:

$$N\lambda F(x^\nu) - \lambda N_U(1 - F(x^\nu)) = \lambda E_a(1 - F(x^q)) + E_{na}(\delta + \lambda - \lambda F(x^q)) \tag{37}$$
$$N_U(\lambda - \lambda F(x^\nu) + p) = N\lambda F(x^\nu) + E_a\delta \tag{38}$$
$$E_a(\delta + \lambda - \lambda F(x^\nu)) = pN_U + E_{na}\lambda F(x^\nu) \tag{39}$$
$$E_{na}(\delta + \lambda - \lambda F(x^q) + \lambda F(x^\nu)) = \lambda E_a(F(x^q) - F(x^\nu)) \tag{40}$$
$$E_{na} + E_a + N_U + N = 1 \tag{41}$$

Take (39) + (40), and denote by $E = E_a + E_{na}$. One gets:

$$E(\delta + \lambda - \lambda F(x^q)) = pN_U$$

which immediately leads to

$$u_r = \frac{N_U}{E + N_U} = \frac{\delta + q}{\delta + p + q}$$

where

$$q = \lambda(1 - F(x^q))$$

Then, using (40), one has that

$$\frac{E_a}{E} = \frac{\delta + q + \lambda F(x^\nu)}{\delta + q + \lambda F(x^q)} = \frac{\delta + q + \lambda F(x^\nu)}{\delta + \lambda}$$

and thus $\frac{E_{na}}{E} = \frac{\lambda(F(x^q) - F(x^\nu))}{\delta+\lambda}$. Finally, using (38), one has:

$$N\lambda F(\theta^\nu) = (\lambda - \lambda F(x^\nu) + p)N_U - \delta\left(\frac{\delta + q + \lambda F(x^\nu)}{\delta + \lambda}E\right)$$

but the value of N which cannot be easily simplified.

7.7 Welfare analysis

The proof of the social planner problem is as follows. The social planner maximizes over N_U, x^ν, x^q

$$\Omega = y(1-n-N_U) - c\phi N_U + \mathcal{H}$$

where $\mathcal{H}$ is home production of inactive workers, n are the non-participants and N_U is the mass of unemployed workers (total population is normalized to 1) implying that $\phi N_U = v$ the vacancy rate. NB, $u_r = N_U/(E+N_U)$. Denoting by $f^H(x)$ the density of inactive workers, home production is

$$\mathcal{H} = n\int_{x^\nu}^{+\infty} x f^H(x) d\theta$$

We can prove that f^H is proportional to f and the problem thus rewrites

$$\begin{aligned} \underset{u,\theta^\nu,\theta^q}{Max}\,\Omega &= y(1-N_U-n) - c\phi u + \int_{x^\nu}^{+\infty} x f(x)dx \\ & -(1-N_U-n)\frac{\lambda}{\lambda+\delta}\int_{x^\nu}^{x^q} x f(x)dx, \end{aligned}$$

subject to constraints

$$pN_u - (\delta+q)(1-N_U-n) = 0 \tag{42}$$

$$(1-N_U-n)\left[\frac{\delta}{\delta+\lambda}(\delta+q) - \frac{\lambda}{\lambda+\delta}\lambda F(x^\nu)\right] - N_U(\lambda+p) + \lambda F(x^\nu) = 0 \tag{43}$$

This immediately leads to (Entry*), (Quit*) and (JC*).

7.8 Taxation in the decentralized economy

If t is the marginal tax rate on wages the labor cost can be found to be:

$$\begin{aligned} w^a &= \beta(y + c\phi) \\ w^{na}(x) &= \beta y + x(1-\beta)/(1-t) \end{aligned}$$

The model with taxes is summarized by equations Entry(t), Quit(t) and JC(t) in section 4.2. Combining (Entry(t)) and (JC(t)) we have an equivalent of equation (32) in Appendix 7.5, i.e. we have that $x^\nu = c(1-t)\phi\beta/(1-\beta)$ with $\partial x^\nu/\partial t = -\beta\phi c/(1-\beta) = -x^\nu/(1-t) < 0$ and $\partial x^\nu/\partial\phi = \beta c(1-t)/(1-\beta) > 0$ so that the equations become

$$\begin{aligned} x^q - y(1-t) - \frac{\lambda}{\lambda+r+\delta}\int_{x^\nu(\phi,t)}^{x^q} F(z)dz &= 0 \\ \frac{x^q - x^\nu(\phi,t)}{r+\lambda+\delta}(1-\beta) - \frac{c(1-t)}{\chi(\phi)} &= 0 \end{aligned}$$

Taking the total differential we have $Adx^q + Fd\phi = -Hdt$ and $Cdx^q - Dd\phi = -Kdt$ with $A = [\frac{r+\lambda(1-F^q)+\delta}{r+\lambda+\delta}]; F = \frac{\lambda F(x^\nu)}{\lambda+r+\delta}\frac{\partial x^\nu}{\partial\phi}; H = [y + \frac{\lambda F(x^\nu)}{\lambda+r+\delta}\frac{\partial x^\nu}{\partial dt}]$ $C = \frac{1-\beta}{r+\lambda+\delta}; D = -[-\frac{1-\beta}{r+\lambda+\delta}\frac{\partial x^\nu}{\partial\phi} +$

$\frac{c(1-t)\chi'(\phi)}{\chi^2(\phi)}]$; $K = [-\frac{1-\beta}{r+\lambda+\delta}\frac{\partial x^\nu}{\partial t} + \frac{c}{\chi(\phi)}]$. All letters A, F, C, D and K are defines so as to be positive. We can also prove that $H > 0$[24]; applying Kramer's rule it follows that $\frac{dx^q}{dt} = \frac{HD+FK}{-AD-FC} < 0$, while $\frac{d\phi}{dt} = \frac{-AK+HC}{-AD-FC} < 0$. To see the latter effect note that substituting from the definition of A, K, H, C one obtains that

$$-AK + HC = -\lambda \int_{x^\nu}^{x^q} F(z)dz + \lambda(F(x^q)x^q - F(x^\nu)x^\nu) = \lambda \int_{x^\nu}^{x^q} zf(z)dz > 0. \tag{44}$$

Further note that with $\lambda = 0$, $\frac{d\phi}{dt} = 0$, since $A = 1$, $K = \frac{\beta\phi c}{r+\delta} + \frac{c}{\chi(\phi)}$; $H = y$ and $C = \frac{1-\beta}{r+\delta}$ so that

$$(-AD - FC)\frac{d\phi}{dt} = \frac{y(1-\beta)}{r+\delta} - \frac{c}{\chi(\phi)} - \frac{\beta\phi c}{r+\delta} = 0$$

7.9 Unemployment benefits

New entrants are uncovered by benefits. Employed workers are covered by unemployment benefits as soon as they have worked for a period of time τ. For reasons that will become clear later on, we only study the limit cast $\tau \to 0$. We still have the present discounted value of utility W which writes as a function of the value of covered unemployment:

$$\begin{aligned} rW(x) = w(x) + \delta\{Max[U^c(x), H(x)] - W(x)\} + \\ \lambda \int_{x^{\min}}^{x^{\max}} \{Max[W', U^{c\prime}, H'] - W\}dF(x'), \end{aligned} \tag{45}$$

As before, we shall assume that, for every x such that $W(x) > H(x)$, then $W(x) > U^c(x)$. This corresponds to a restriction on parameters which is ex-post shown to be $y > b$. The value of covered unemployment writes:

$$\begin{aligned} rU^c(x) &= b + p[W(x) - U^c(x)] \\ &+ \lambda \int_{x^{\min}}^{x^{\max}} \{Max\,[U^{c\prime}, H'] - U^c\}dF(x'), \end{aligned} \tag{46}$$

while the value of uncovered unemployment writes:

$$\begin{aligned} rU^u(x) &= p[W(x) - U^u(x)] \\ &+ \lambda \int_{x^{\min}}^{x^{\max}} \{Max\,[U^{u\prime}, H'] - U^u\}dF(x'), \end{aligned} \tag{47}$$

[24] We have that

$$\begin{aligned} x^\nu &= x^q - (x^q - x^\nu) = y(1-t) + \frac{\lambda}{r+\lambda+\delta}\int_{x^\nu}^{x^q} F(z)dz - (x^q - x^\nu) \\ x^\nu &< y(1-t) + \frac{\lambda}{r+\lambda+\delta}(x^q - x^\nu) - (x^q - x^\nu) < y(1-t) - \frac{r+\delta}{r+\lambda+\delta}(x^q - x^\nu) \\ x^\nu &< y(1-t) \text{ thus } x^\nu/(1-t) < y. \end{aligned}$$

Thus $H = y - \frac{\lambda F(x^\nu)}{r+\lambda+\delta}x^v/(1-t) > 0$.

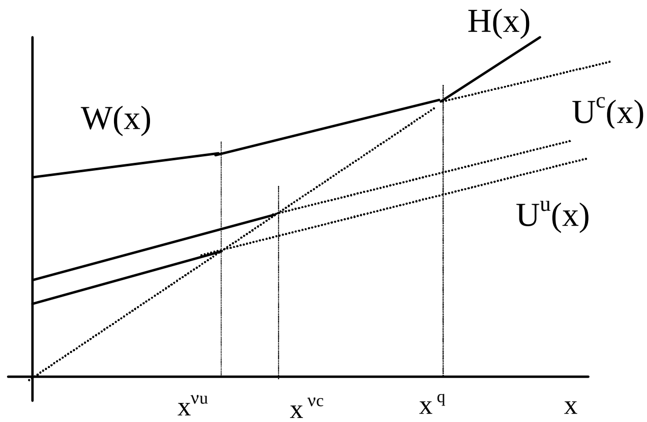

Figure 5:

The value of home production writes

$$rH(x) = x + \lambda \int_{x^{\min}}^{x^{\max}} \{Max\,[U^{u\prime}, H'] - H\} dF(x'), \tag{48}$$

7.9.1 The entry and quit margins

We still assume that a reservation strategy exists and determines three threshold values $x^q, x^{\nu u}$ and $x^{\nu c}$ above which, respectively, workers quit because they prefer inactivity to employment, and are indifferent between uncovered (respectively covered) unemployment and inactivity. A graphical representation of the asset values can be seen in Figure 5.

The equality $W(x^q) = H(x^q)$ implies the new quit margin,

$$\lambda \overline{S_w} = x^q - w(x^q), \tag{49}$$

with the quantity $\overline{S_w}$ defined as :

$$\overline{S_w} = \int_{x^{\min}}^{x^q} \{W(x') - Max[U^u(x'), H(x')]\} dF(x') \geq 0. \tag{50}$$

The new entry margin is defined by $H(x^{\nu u}) = U^u(x^{\nu u})$ and implies:

$$x^{\nu} = p\,[W(x^{\nu u}) - U^u(x^{\nu u})]\,. \tag{51}$$

Finally, the new margin, determined by $H(x^{\nu c}) = U^c(x^{\nu c})$, is denoted by the 'covered' entry margin margin (which is rather an exit margin for the covered unemployed workers) and implies:

$$x^{\nu c} = b + p\,[W(x^{\nu c}) - U^c(x^{\nu c})] + \int_{x^{\nu u}}^{x^{\nu c}} (U^c - U^u)(x') dF(x'). \tag{52}$$

Using the Bellman equations for the covered and uncovered unemployment, we further show that, for all $x^{\nu u} < x < x^{\nu c}$,

$$(r+\lambda+p)(U^c-U^u)(x) = b+\lambda\int_{x^{\min}}^{x^{\nu u}}(U^c-U^u)(x')dF(x')+\lambda\int_{x^{\nu u}}^{x^{\nu c}}(U^c-H)(x')dF(x') \quad (53)$$

and it is easy to check that this quantity is constant, independent of x. For positive benefits b, as displayed in Figure 5, this quantity is positive.

7.9.2 Firms

The value of a job $J(x)$ when the worker has home-productivity x is unchanged :

$$rJ(x) = y - w(x) + (q+\delta)(V_V - J(x)) + \lambda\int_{x^{\min}}^{x^q}\left[J(x') - J(x)\right]dF(x'), \quad (54)$$

where $q = \lambda(1-F(x^q))$ is the quit rate.

The value of a vacancy is

$$rV_V = -c + \chi(\phi)[J^e - V_V], \quad (55)$$

where

$$J^e = p_c\frac{\int_{x^{\min}}^{x^{\nu c}} J(x')dF(x')}{F(x^{\nu c})} + (1-p_c)\frac{\int_{x^{\min}}^{x^{\nu u}} J(x')dF(x')}{F(x^{\nu})}$$

with p_c is the probability to meet a covered employed worker.

7.9.3 Wages

To simplify the analysis, we make a useful assumption about wage determination : we consider that all employed workers are covered by unemployment benefits when they bargain over wages, even previously uncovered unemployed workers, i.e. new entrants. This assumption is a limit case of a more realistic assumption in which the entry wage of uncovered unemployed workers is determined conventionally as ArgMax $J^{1-\beta}(W-U^u)^{\beta}$for a initial period, but is renegotiated as soon as the worker is covered, after a period τ, according to ArgMax $J^{1-\beta}(W-U^c)^{\beta}$. Our assumption is thus the limit when τ goes to zero. Accordingly, the wage rule of all workers satisfies

$$W(x) - Max(U^c(x), N(x)) = \beta\mathcal{S}(x) \quad (56)$$

with $S(x) = W(x) - Max(U^c(x), N(x)) + J(x)$. This leads, as a straight extension of GW, to

$$w_A = \beta\,(y+\phi c) + (1-\beta)b \qquad \forall x \leq x^{\nu c}, \quad (57)$$

$$w_{NA}(x) = \beta y + (1-\beta)x \qquad \forall x \geq x^{\nu c}. \quad (58)$$

7.9.4 General equilibrium

The wage rules notably implies that the quit margin rewrites

$$x^q = y + \lambda \overline{S_w}/\beta$$

which looks similar to the quit margin in the previous sections. However, we can no longer use $\overline{S_w} = \beta\overline{S} = \beta\frac{\int_{x^\nu}^{x^q} F(x)dx}{r+\lambda+\delta}$ from equation (31) with $e = s$. In fact, we have now

$$\overline{S_w} = \beta\overline{S} + \int_{x^{\min}}^{x^{\upsilon u}} (U^c - U^u)(x')dF(x') + \int_{x^{\nu u}}^{x^{\nu c}} (U^c - H)(x')dF(x') > \beta\overline{S}$$

We denote by $\widetilde{b} = \lambda\int_{x^{\min}}^{x^{\nu u}} (U^c - U^u)(x')dF(x') + \lambda\int_{x^{\nu u}}^{x^{\nu c}} (U^c - H)(x')dF(x')$ the additional terms which reflect the gain in surplus for workers due to unemployment benefits. Of course, $\widetilde{b} > 0$ and goes to zero when $b = 0$. From equation (53) we have that

$$(U^c - U^u)(x^\nu) = \frac{\widetilde{b} + b}{r + \lambda + p}$$

To solve for this system, one needs to obtain an expression for $\widetilde{b}$. This can be obtained in observing that

$$\partial(U^c - H)/\partial x = -(r + \lambda)^{-1}$$

which implies that, after an integral by part,

$$\lambda\int_{x^{\nu u}}^{x^{\nu c}} (U^c - H)(x')dF(x') = -\lambda F(x^\nu)(U^c - H)(x^\nu) + \frac{\lambda}{r + \lambda}\int_{x^{\nu u}}^{x^{\nu c}} F(x)dx \qquad (59)$$

Using the Bellman equations, we obtain after simplification (notably using Exit') one obtains

$$(U^c - H)(x^{\nu u}) = (U^c - U^u)(x^{\nu u}) \qquad (60)$$

$$= \frac{b + \widetilde{b}}{r + \lambda + p} \qquad (61)$$

We can then derive the three main equations of the labor supply side and the demand side (Quit', Entry', Entryc' and JC'. A quite involving analytical proof of the proposition on the partial equilibrium effects of b can be found in Garibaldi-Wasmer (2003).

7.10 A model with endogenous search effort

With one additional variable in the model, i.e., how much effort is made in equilibrium by workers, we need to simplify wage determination: wage are assumed to be constant over time, and posted by firms so that they maximize the value of a job vacancy. This notably implies that inefficient separation will occur. However, as we will show, the structure of the model, namely the existence of two separate margins, will be preserved.

Let us denote by $\overline{w}$ the value of the wage. The asset values of the state employment and non-employment (unemployment no longer exists) is as follows:

$$
\begin{aligned}
(r+\lambda)W(x) &= \overline{w}+ex+\delta(N(x)-W(x))+\lambda\int Max(W(x'),N(x'))dF(x') \\
(r+\lambda)N(x,s) &= x(1-s)+p(\phi,s)[Max(W(x)-N(x,s);0]+\lambda\int N(x',s')dF(x')
\end{aligned}
$$

with $p(\phi,s)=\phi\chi(\phi)\sigma(s)$ is the product of an aggregate component and of the efficiency of search time, with $\sigma'>0$ and $\sigma''<0$. We make the following assumptions: $\sigma'(0)<+\infty$ and $\sigma(0)\geq 0$.[25]

Workers' search efforts are determined such as to maximize $N(x,s)$: the first order condition states that the marginal cost of search, namely home productivity, has to equal the marginal return in terms of expected surplus gained:

$$x=\sigma'(s)\phi\chi(\phi)(W(x)-N(x,s)) \text{ for } s>0$$

It is easy to show that the optimal search effort, $s^*=s(x)$ is decreasing with x. At some point, s^* is at a corner solution zero. Hereafter, we denote by $N(x)$ the indirect value of non-employment. We can formally define $\widetilde{x}^q$ and $\widetilde{x}^\nu$ in this context:

$$
\begin{aligned}
N(\widetilde{x}^q) &= W(\widetilde{x}^q) \\
s(\widetilde{x}^\nu) &= 0
\end{aligned}
$$

In words, $\widetilde{x}^q$ is the value of home production leading workers to quit, while $\widetilde{x}^\nu$ is the value of home production making workers indifferent between full-time home production and marginal search effort. Formally, $\widetilde{x}^\nu$ is the solution to:

$$\widetilde{x}^\nu=\sigma'(0)\phi\chi(\phi)(W(\widetilde{x}^\nu)-N(\widetilde{x}^\nu)) \tag{62}$$

This equation implies that, for finite $\sigma'(0)$, $W(\widetilde{x}^\nu)-N(\widetilde{x}^\nu)>0$, implying $\widetilde{x}^\nu<\widetilde{x}^q$. In other words, we still have two distinct entry and exit margins.[26]

Now, the important parameter here is $\sigma(0)$: when this quantity is equal to zero, only active job seekers (a statistician would call them unemployed) access to jobs, and ne flows are only a matter of statistical illusion. On the other hand, when $\sigma(0)>0$, there are truly non-active individuals that get job offers. Among them, as explained above, only those between $\widetilde{x}^\nu$ and $\widetilde{x}^q$ would accept the offers, consistent with Jones and Ridell's findings. Workers with x above $\widetilde{x}^q$ would instead reject them. Each alternative assumption about $\sigma(0)$ rationalizes one aspect of the discussion on ne flows.

[25] The assumption $\sigma(0)=0$ means that getting a job is impossible without a minimum search effort, while $\sigma(0)>0$ implies that some jobs are offered to individuals. In both cases, when hit by a job offer, workers decide whether to accept the job offers. They do so only when the value of the job exceeds the value of non-employment.

[26] Above $\widetilde{x}^\nu$, workers would like to make negative search efforts, i.e. to raise home production. At the extreme, when $x>\widetilde{x}^q$, workers reject any job offer and would like to have a zero arrival rate of offers $\sigma(s)=0$, which happens with negative search. However, since time cannot be borrowed, these individuals hit the corner solution $s=0$.

References

[1] Abraham K.G. and Shimer, R. (2001). “Cha nges in Unemployment Duration and Labor Force Attachment”, NBER Working Paper 8501

[2] Abowd, J. and Zellner, A. (1985) “Estimating Gross Labor Force Flows”, Journal of Economics and Business Statistics 3, no. 3: 254-83.

[3] Atkinson, A.B. and Micklewright J. (1991). “Unemployment Compensation and Labor Market Transitions: A Critical Review”, Journal of Economic Literature, Vol. XXiX, pp. 1679-1727

[4] Becker G.S.. (1965). “Theory of the Allocation of Time”, The Economic Journal, No 299(LXXV), pp493-517

[5] Benhabib J., Rogerson R., and R. Wright (1991) “Homework in Macroeconomics: Household Production and Aggregate Fluctuations”, Journal of Political Economy, 99: 1166-87.

[6] Bertola, G. and Caballero, R. (1994). ”Cross-Sectional Efficiency and Labor Hoarding in a Matching Modelof Unemployment”, Review of Economic Studies 61(3) July 1994, 435-456

[7] Blundell R. and MacCurdy, T. (1999). “Labor Supply: a Review of Alternative Approaches”, Handbook of Labor Economics, Vol. 3A, chapter 27.

[8] Bowden, R. J. (1980), “On the Existence and Secular Stability of $u - v$ Loci”, Economica 47, pp35-50, February

[9] Burdett K., (1979), “Search, leisure and individual labor supply”, chapter 8 in Studies in the Economics of Search, Contributions to Economic Analysis, Tinbergen, Jorgenson and Waelbroeck eds., North-Holland

[10] Burdett K. and Mortensen D.T., (1978), “Labor Supply Under Uncertainty”, in Research in Labor Economics, Ehrenberg R.G. ed.

[11] Burdett K., Kiefer N., Mortensen D., Neumann G. (1984), “Earnings, Unemployment, and the Allocation of Time Over Time”, Review of Economic Studies LI, pp559-578

[12] Cahuc, P. and Lehmann, E. (2000). “Should Unemployment Benefits decrease with unemployment spell?”, Journal of Public Economics, vol 77, 135-53, July 2000.

[13] Dixit, A. K. and R. S. Pindyck (1994). Investment under Uncertainty. Princeton University Press, New Jersey

[14] Eisner, R. (1988). “Extended Accounts for National Income and Product” Journal of Economic Literature 1611-84.

[15] Faraglia, E. (2003). “Search intensity, US gross worker flows and the business cycle”, in progress, New York University.

[16] Flinn C.J. and Heckman J.J., (1983), "Are Unemployment and Out of the Labor Force Behaviorally Distinct Labor Force States", Journal of Labor Economics, vol.1(1), pp28-42

[17] Frediksen, F., Hansen, P, Jacobsen, H and P. B. Sorensens (1995). "Subsidising Consumer Services: Effects on Employment, Welfare and the Informal Economy, Fiscal Studies, 16, 271-293.

[18] Fredriksson, F. and B., Holmlund (2001). "Optimal Unemployment Insurance in Search Equilibrium, Journal of Labor Economics, April

[19] Frijters, P. and Van Der Klaauw, B. (2003), "Job search with nonparticipation", paper presented at the CEPR-DAEUP conference in Berlin

[20] Garibaldi, P. and Wasmer, E. (2001). "Labor Market Flows and Equilibrium Search Unemployment", IZA dp 406

[21] Garibaldi, P. and Wasmer, E. (2003). "Equilibrium search unemployment, endogenous participation and labor market flows", CEPR dp 3986, july

[22] Gomme, P., Kydland, F., Rupert, P. (2001). "Home Production Meets Time to Build" Journal of Political Economy

[23] Gronau, R. (1977). "Leisure, Home Production, and Work. The Theory of the Allocation of Time Revisited", Journal of Political Economy, Vol. 85, Issue 6, (Dec.), 1099-1124.

[24] Gruber, J. (1997). "The Incidence of Payroll Taxation: Evidence From Chile", Journal of Labor Economics, 72-101.

[25] Hall, R. (1999). "Labor-Market Frictions and Employment Fluctuations" Ch. 17 in Handbook of Macroeconomics, Vol. 1 J.B. Taylor and M. Woodford eds.

[26] Hall, R. (2003). "Wage Determination and Employment Fluctuations", mimeo Stanford

[27] Holmlund, B. (2002). "Labor Taxation in Search Equilibrium with Home Production", German Economic Review, December.

[28] Jones, S. R.G. and Ridell W. C. (1999). "The Measurement of Unemployment: an Empirical Approach", Econometrica, Vol. 67, n°1,pp. 147-162

[29] Kolm, SA (2000). "Labour Taxation in a Unionised Economy with Home Production", Scandinavian Journal of Economics, Vol. 102, 4.

[30] Layard R., Nickell S., and Jackman R., (1991). "Unemployment", Oxford, Basil Blackwell

[31] Lehmann, E. and Vanderlinden, B. (2002). "On the optimality of search matching equilibrium when workers are risk averse", mimeo Paris II.

[32] Mc Grattan, E. R., R. Rogerson, and R. Wright, (1992). "Estimating the Stochastic Growth Model with Household Production" Mimeo, Federal Reserve of Minneapolis.

[33] McKenna, C.J. (1987), “Labour Market Participation in Matching Equilibrium”, Economica 54, pp325-333

[34] Mortensen, D.T. (1977). “Unemployment Insurance and Labor Supply Decisions” Symposium on the Economics of Unemployment Insurance”, Industrial Labor Relations Review, 30, pp. 505-517

[35] Mortensen, D.T. and Pissarides, C.A. (1994). “Job Creation and Job Destruction in the Theory of Unemployment”, Review of Economic Studies, 64, 397-415

[36] Mortensen, D.T. and Pissarides, C.A. (1999). “Job Reallocation, Employment Fluctuations and Unemployment”, Handbook of Macroeconomics, vol 3B, Ch. 39

[37] Nosal, E., Rogerson, R.; Wright, R. (1992). “The Role of Household Production in Models of Involuntary Unemployment and Underemployment” Canadian Journal of Economics, Vol. 25, No. 3, pp. 507-520.

[38] Petrongolo, B. and C., Pissarides (2002). “Inside the Black Box: A Survey of the Matching Function”, Journal of Economic Literature.

[39] Pissarides, C.A. (1987). ”Search, Wage Bargain and Cycles”, Review of Economic Studies 54, (July), 473-83

[40] Pissarides C.A. (1990), Equilibrium Unemployment Theory, Oxford, Basil Blackwell

[41] Pissarides C.A. (1998). “The impact of employment tax cuts on unemployment and wages; the role of unemployment ebenfits and tax structure”, European Economic Review, vol. 42, pp. 155-83.

[42] Pissarides, C. (2000), Equilibrium Unemployment Theory, Cambridge (MA.): The MIT Press.

[43] Pries, M. J. and R. Rogerson (2002). ”Search Frictions and Labor Market Participation”, mimeo, Univ. of Maryland

[44] Rios-Rull (1993). “Working in the Market, Working at Home and Acquisition of Skills: A General Equilibrium Approach.” American Economic Review” 83:893-907

[45] Sandmo, A. (1990). “Tax Distortions and Household Production”, Oxford Economic Papers 42, 78-90.

[46] Sattinger M. (1995). “General Equilibrium Effects of Unemployment Compensation with Labor Force Participation”, Journal of Labor Economics, vol.13(4), pp623-652

[47] Seater J.J., (1977). “A Unified Model of Consumption, Labor Supply, and Job Search”, Journal of Economic Theory 14, pp349-372

[48] Shimer, R. (2003a). “The Consequences of Rigid Wages in Search Models”, prepared for the Journal of the European Economic Association Papers and Proceedings, 2003

[49] Shimer, R. (2003b). “The Cyclical Behavior of Equilibrium Unemployment and Vacancies: Evidence and Theory”, NBER Working Paper 9536

[50] Sorensen, P. B. (1997). “Public Finance Solutions to the European Unemployment Problem”, Economic Policy, October, 223-264.

[51] Sorrentino C., (1993). “International comparisons of unemployment indicators“, Monthly Labor Review, March.

[52] Sorrentino C. (1995). “International unemployment indicators, 1983-93“, Monthly Labor Review, August.

[53] Swaim P. and Podgursky, M. (1994). “Female Labor Supply following Displacement: A Split-Population Model of Labor Force Participation and Job Search”, Journal of Labor Economics, vol.12(4), pp640-656

[54] Tryväinen, T. (1995). “Real Wage Resistance and Unemployment”. The OECD Jobs Study, Working Paper Series No. 10, OECD

[55] Veracierto, M. (2002). ”On the Cyclical Behavior of Employment, Unemployment and Labor Force Participation”