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Abstract

This study explores a novel policy for stimulating investment in training within the standard labor market by implementing a transfer system similar to that used in soccer. We develop a life-cycle search model with on-the-job search in which investment in training is endogenous. We estimate the model's parameters using the French Labor Force Survey and simulate the impact of implementing a transfer system. Our simulations indicate that a time-limited entitlement to compensation upon poaching can significantly enhance access to training and employment at no cost, and is more effective than an unlimited entitlement to compensation. Overall, our results suggest that the standard labor market would benefit from a transfer system similar to that used in soccer.

JEL Classification: E24, J21, J24, J64

Keywords: on-the-job search, training, transfer fees

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1 Introduction

Since the 1960s, investment in human capital has been the subject of many studies. The work of Becker (1962) laid the foundation for human capital theory. Becker introduces a crucial distinction between investments in general human capital, which increase worker productivity in any firm, and investments in specific human capital, which increase worker productivity only in training firms. In the case of specific training, it may be in the employer's interest to contribute to training financing if a sharing rule enables the company to obtain a return on investment. In the case of general training, the firm's investment is much riskier: once trained, the employee may leave (or threaten to leave) his/her employer to obtain a higher wage and thus capture the full return on training. According to Becker, employers that anticipate this risk of *"hold-up"* (Grout, 1984) thus have little incentive to contribute to the financing of general training.

Interestingly, this prediction is not consistent with observations from the data. Acemoglu (1997) and Acemoglu and Pischke (1998, 1999b,a) show that firms invest massively in general training. The authors point out that asymmetric information and labor market frictions limit workers' ability to hold up. Therefore, the employer can capture some of the gains from training, even when the training is general. The authors also highlight a key finding: when firms invest in general human capital, they internalize the fact that this will increase workers' productivity in the current job, but they do not consider the fact that it will also increase workers' productivity in future jobs. This is what the authors call the *"poaching externality"*. When making investment choices, firms do not account for this positive social externality of training. Consequently, the private return on training is lower than the social return. The result is that firms underinvest in training relative to what is socially optimal, thus justifying state intervention.

One method of solving this problem is to implement a training subsidy (Chéron and Terriau, 2018). The latter is particularly effective when modulated according to workers' age and level of education, which conditions access to training (and the size of the poaching externality). However, such a policy is costly and may complicate an already confusing training system. An alternative policy suggested by Acemoglu (1997) involves the introduction of a clause involving compensation for the training firm in the event of poaching, thereby securing employers' training investments. Prior studies analyze two clauses that induce compensation for the poached firm. On the one hand, Amand et al. (2023) analyze the role of the transfer system in the soccer labor market. In such a system, every player's transfer results in the payment of a transfer fee from the buying club to the incumbent club. The authors show that in the absence of such a system, equilibrium training investment decisions would be far removed from what a planner would do, and that the introduction of a transfer system allows restoring the optimality of training investments. On the other hand, Shi (2023) explores the impact of non-compete employment contracts and shows that such clauses generate a trade-off between restricting worker mobility and encouraging firm investment.

Transfer fees offer two advantages over non-compete clauses. First, non-compete clauses are generally negotiated *ex ante* before the firm invests in training and before the impact of training on worker productivity became apparent. In contrast, transfer fees can be negotiated *ex post* once training has taken place and the impact on productivity has been revealed. This difference, which may seem small, is crucial. In most countries, non-compete clauses are strictly regulated; they must be limited in time and space, and must target a specific activity (Kinsey, 1991). In addition, the compensation to be paid in the event of noncompliance must be defined *ex ante* (depending on the date of separation and expected loss for the firm) or determined by the labor courts. As pointed out by Kafker (1993), such clauses are difficult to draft and are often challenged in court. This explains why these clauses are rare and are concentrated among a very limited number of employees (generally managers in very specific sectors). In contrast, in the soccer market, transfer fees are negotiated *ex post*: the player, selling club, and buying club sit down together and agree on a price. This process, which can be viewed as three-agent Nash bargaining, is generally mutually advantageous, does not necessarily restrict worker mobility, can be applied to any type of player, and is rarely challenged in court[1].

[1] See Amand et al. (2023) for more details.

In this paper, we assess the impact of implementing a transfer system similar to that used in soccer to the standard labor market. To this end, we develop a life-cycle search model with on-the-job search in which investment in training is endogenous. We first present a simplified version of the model to underline some theoretical properties and then develop a more sophisticated model for quantitative investigation. We estimate the model's parameters using the French Labor Force Survey (FLFS), which provides information on labor market flows, employment, and access to training over the life cycle. We then use the model to simulate the impact of a transfer system comparable to that used in soccer; that is, a time-limited entitlement to compensation for the current employer in the event of poaching. We demonstrate that such a policy secures investments in human capital and substantially increases access to training and employment. Additionally, this policy is more effective than unlimited entitlement to compensation. Overall, our results suggest that the transfer system used in soccer is a promising tool for stimulating investments in training and employment.

The rest of the paper is organized as follows. Section 2 presents a simplified version of the model to highlight some theoretical properties. Section 3 presents a more sophisticated version of the model that enables a quantitative investigation. Section 4 evaluates the effects of setting up a time-limited or unlimited entitlement to compensation upon poaching. The final section concludes the paper.

2 Theory and Analytical Insights

2.1 Agents

We consider a frictional labor market. Workers search for jobs both on- and off-the-job. The economy comprises three types of agents:

- ◇ *hiring firms*, which employ individuals coming from the pool of nonemployed workers
- ◇ *poaching firms*, which employ individuals coming from the pool of employed workers
- ◇ *workers*, who can be employed or nonemployed, trained or untrained

Firms are characterized by their technology $p \in [\underline{p}, \overline{p}]$, distributed according to a distribution function $G(p)$.

Workers are characterized by a deterministic age $t \in [1, T]$. Workers enter the labor market at age 1 as nonemployed (and can, therefore, be employed from age 2) and retire from the labor market at age T (and can, therefore, be employed until age $T - 1$). Workers are also differentiated by their human capital, which can vary at different levels and in different compositions. At this stage, we consider that individuals can be heterogeneous only in terms of their general human capital. We will introduce specific human capital in Section 3.

When matched with a p-firm, workers without human capital[2] produce p. At the time of hiring (and only at this time), the employer may decide to pay a training cost z to increase workers' production from p to $(1 + \Delta)p$. Therefore, training decisions are characterized by an age-dependent productivity threshold, denoted by F_t. If $p \geq F_t$, then a worker of age t who has never been trained and who gets a job offer from a p-firm, is trained.

[2] In Section 3, we propose a more sophisticated model in which workers can lose general human capital during periods of nonemployment and can accumulate specific human capital during periods of employment as a result of a learning-by-doing process.

Consequently, we can distinguish the following three types of workers:

- ◇ *untrained workers* ($j = 0$), who have never been trained by a firm
- ◇ *trainees* ($j = 1$), who have no general human capital at the time of hiring but who are capable of being trained by their incumbent firm
- ◇ *trained workers* ($j = 2$), who have general human capital and thus do not need training

Let $S_{j,t}(p)$ denote the joint surplus of a match between a p-firm and a worker of type j and age t. This value corresponds to the net value of the match for the worker (the value of employment minus the value of nonemployment) plus the net value of the match for the firm (the value of a filled job[3]). The training productivity threshold F_t solves $S_{0,t}(F_t) = S_{1,t}(F_t)\ \forall t$. This condition implies that at the training productivity threshold F_t, the firm is indifferent to continuing the employment relationship with an untrained worker or training the worker (and paying the related training cost).

2.2 Bargaining without and with transfer fees

2.2.1 Model intuitions

Before introducing the model, we provide the main intuitions. At first glance, representing all agent decisions (match acceptance, training, job-to-job mobility, and separation decisions) may appear daunting. This task may seem even more difficult when viewed within a life-cycle framework. For example, training decisions depend on the expected duration of the job, which in turn depends on the worker's age and the external offers he or she may receive. The probability of accepting an external offer depends on the current wage (which depends on the history of all past external offers, as the salary can be renegotiated in each period) and on the external offer received in the current period (depending on the distribution of firms).

However, the model can be written in a very tractable manner using joint surplus representation. As in Bilal et al. (2022), Amand et al. (2023) and Jarosch

[3]As in Jarosch (2023), this definition implies that the value of a vacant job is zero.

(2023), we do not need to determine equilibrium wages. What matters in determining the agents' decisions and labor market flows is the value of the joint surplus, not the exact way in which the worker and firm share it. All allocations (match acceptance, training, job-to-job mobility, and separation decisions) are uniquely determined by the dynamics of joint surpluses. The initial match is formed if the joint surplus is non-negative; the worker is trained if the joint surplus is higher with than without training; the worker moves from job to job if the surplus of the new match is greater than the surplus of the current match; and the job is destroyed endogenously if the joint surplus becomes negative. Thus, all agents' decisions can be determined based on surpluses, and the model's parameters can be estimated based on labor market flows and access to training. Then, it is possible to find *a posteriori*, a bargaining set consistent with the observed flows.

2.2.2 Model assumptions

Workers search for jobs both on- and off-the-job. Wages are restricted to fixed-wage contracts and can be renegotiated only when either party faces a *credible threat*. Employed workers may receive outside offers at the arrival rate λ_e. The latter event may lead to a job-to-job transition and wage renegotiation if $p' \geq p$ or to wage renegotiation without job-to-job mobility if $p' < p$ but if the outside offer improves the worker's threat point. Nonemployed workers may receive a job offer at the arrival rate λ_u. We further denote $R_{j,t}$ as the productivity threshold for a match between a p-firm and a worker of type j and age t, which solves $S_{j,t}(R_{j,t}) = 0$. This condition implies that a match can be formed only if a nonnegative surplus is generated. Consequently, if $p < R_{j,t}$, new matches are not formed, whereas existing matches are endogenously destroyed.

We follow Cahuc et al. (2006) by considering Bertrand competition between employers. Following Jarosch (2023), we consider that wages are fixed and can be renegotiated only if either party faces a credible threat. Thus, wages depend on the worker's negotiation benchmark, denoted by NB, which corresponds to the maximum between the value of nonemployment and the value of the highest outside offer received while employed.

Bargaining power is α for hiring firms, β for poaching firms, and γ for workers. In fact, Cahuc et al. (2006) (implicitly) assume that $\alpha = \beta$; that is hiring firms have the same bargaining power as poaching firms. A recent study by Shi (2023) also considers such a simplification. However, Amand et al. (2023) work on the soccer labor market emphasizes that the bargaining power of poaching employers may differ (be higher) from that of incumbent employers. Accordingly, we allow for $\beta \neq \alpha$. We show in Section 2.4 that this assumption is crucial for the age dynamics of the labor market equilibrium.

Our study shows how the introduction of a transfer system modifies wage bargaining and labor market flows in the standard labor market by switching from the auction framework developed by Cahuc et al. (2006) to a three-agent Nash bargaining model in which new wages and transfer fees are negotiated simultaneously in the spirit of Amand et al. (2023)[4].

2.2.3 Bargaining without transfer fees

First, we examine wage bargaining in the context of Bertrand competition without a transfer system. We begin by describing the wage determination process for nonemployed workers. Let $E_{j,t}(p, NB)$ be the value of employment (for the worker), $U_{j,t}$ be the value of nonemployment (for the worker), and $J_{j,t}$ be the value of a filled job (for the firm).

Let $S_{j,t}(p) = E_{j,t}(p, NB) - U_{j,t} + J_{j,t}(p, NB)$ be the joint surplus; that is, the private net value of an employment relationship between a p-firm and a worker of type j and age t. Note that the value of the joint surplus does not depend on the threat point; NB affects the way the firm and worker share the joint surplus, not the value of the joint surplus. In the remainder of this paper, we will use the following notation:

$$S^+_{j,t}(p) = \max\{S_{j,t}(p), 0\}$$

Obviously, for a nonemployed worker, the threat point is the value of nonemployment. Thus, the worker's negotiation benchmark is type-0 nonemployment for untrained workers (either type 0 or type 1) and type-2 nonemploy-

[4] Amand et al. (2023) show that three-agent Nash bargaining allows an accurate reproduction of wages and transfer fees in the soccer market, characterized by a transfer system. See Thomson et al. (2006) for more details on asymmetric Nash bargaining with N agents.

ment for nonemployed workers that were previously trained. The relative bargaining power of the nonemployed worker with respect to the hiring firm is $\gamma/(\gamma+\alpha)$, so the sharing rules that characterize the hiring wages of the nonemployed are:

$$\begin{aligned}
E_{0,t}(p,u) - U_{0,t} &= \frac{\gamma}{\alpha+\gamma} S_{0,t}(p);\ \forall p \geq R_{0,t} \\
E_{1,t}(p,u) - U_{0,t} &= \frac{\gamma}{\alpha+\gamma} S_{1,t}(p);\ \forall p \geq R_{1,t} \\
E_{2,t}(p,u) - U_{2,t} &= \frac{\gamma}{\alpha+\gamma} S_{2,t}(p);\ \forall p \geq R_{2,t}
\end{aligned}$$

where $E_{j,t}(p,u)$ is the expected value of employment for a worker of type j and age t who is currently nonemployed and gets a contract with a p-firm. $U_{j,t}$ is the worker's value if he or she stays nonemployed.

We now examine the wage determination process for a worker employed in a p-firm that receives a job offer from a p'-firm. In particular, if $p' > p$, then the negotiation benchmark for the worker is no longer nonemployment. In this case, the current employer and the outside firm enter a Bertrand competition to attract the worker, and this auction framework continues until the worker captures the entire surplus of the less-productive firm; that is, the current employer. Consequently, the worker's new threat point is the surplus value in the current firm. The worker can use this new threat point to claim a share of the surplus differential between its current employer and new employer according to its relative bargaining power with respect to the poaching firm, that is, $\gamma/(\gamma+\beta)$. More generally, we can write the following sharing rules for workers who move from p-firms to p'-firms:

$$\begin{aligned}
\text{if } S_{0,t}(p') > S_{0,t}(p) \,\&\, S_{0,t}(p') > S_{1,t}(p') : E_{0,t}(p',p) - U_{0,t} &= S_{0,t}(p) + \frac{\gamma}{\beta+\gamma}[S_{0,t}(p') - S_{0,t}(p)] \\
\text{if } S_{1,t}(p') > S_{0,t}(p) \,\&\, S_{1,t}(p') \geq S_{0,t}(p') : E_{1,t}(p',p) - U_{0,t} &= S_{0,t}(p) + \frac{\gamma}{\beta+\gamma}[S_{1,t}(p') - S_{0,t}(p)] \\
\text{if } S_{2,t}(p') > S_{2,t}(p) : E_{2,t}(p',p) - U_{2,t} &= S_{2,t}(p) + \frac{\gamma}{\beta+\gamma}[S_{2,t}(p') - S_{2,t}(p)]
\end{aligned}$$

First, it is worth emphasizing that despite the type-1 situation lasting only one period by definition, we introduce the possibility for type-0 employed workers to become type-1 if they contact a firm with a productivity p' high enough. This case corresponds to the value $E_{1,t}(p',p) - U_{0,t}$. Second, owing to Bertrand competition, the worker's surplus is given by the total surplus captured from the incumbent firm and the share $\gamma/(\beta+\gamma)$ of the surplus gain from moving to the poaching firm.

2.2.4 Bargaining with transfer fees

We now consider the case in which a transfer system allows a firm to receive compensation in the event of poaching. Following Amand et al. (2023), we consider that in this situation, the worker's new wage w and transfer fees T paid by the poaching firm to the current employer are solutions to three-agent Nash bargaining. Again, our objective here is not to determine the distribution of wages but to examine how sharing rules, expected joint surpluses, and labor market flows are impacted if we would implement a transfer fee system. Accordingly, we must restate the bargaining process of employed workers.

We first consider Nash bargaining for a worker initially untrained (type 0) in a p-firm, who can either stay type-0 or becomes type-1 if p' is sufficiently high. For $j \in \{0,1\}$, we define:

$$\underset{T_{j,t},\, w_{j,t}}{\text{argmax}} \Big(\underbrace{T_{j,t}(p',p)}_{\substack{\text{Tranfer}\\ \text{fees}}} - \underbrace{J_{0,t}(p,u)}_{\substack{\text{Current firm's}\\ \text{outside option}}} \Big)^{\alpha} \Big(\underbrace{J_{j,t}(p',p) - T_{j,t}(p',p)}_{\substack{\text{Poaching firm's}\\ \text{net surplus}}} - \underbrace{0}_{\substack{\text{Poaching firm's}\\ \text{outside option}}} \Big)^{\beta} \Big(\underbrace{E_{j,t}(p',p)}_{\substack{\text{New value}\\ \text{of employment}}} - \underbrace{E_{0,t}(p,u)}_{\substack{\text{Player's}\\ \text{outside option}}} \Big)^{\gamma}$$

where $\alpha+\beta+\gamma=1$ and where $J_{j,t}(p',p)$ and $E_{j,t}(p',p)$ depend on $w_{j,t}$.

This problem is thus a weighted average of the respective net surplus of the transfer for both firms and the worker. Each party trades off the benefit of a transfer versus the status quo.

Similarly, for type-2 employed workers, we have:

$$\underset{T_{2,t},\, w_{2,t}}{\text{argmax}} \Big(\underbrace{T_{2,t}(p',p)}_{\substack{\text{Tranfer}\\ \text{fees}}} - \underbrace{J_{2,t}(p,u)}_{\substack{\text{Current firm's}\\ \text{outside option}}} \Big)^{\alpha} \Big(\underbrace{J_{2,t}(p',p) - T_{2,t}(p',p)}_{\substack{\text{Poaching firm's}\\ \text{net surplus}}} - \underbrace{0}_{\substack{\text{Poaching firm's}\\ \text{outside option}}} \Big)^{\beta} \Big(\underbrace{E_{2,t}(p',p)}_{\substack{\text{New value}\\ \text{of employment}}} - \underbrace{E_{2,t}(p,u)}_{\substack{\text{Player's}\\ \text{outside option}}} \Big)^{\gamma}$$

From these optimization problems, we obtain the following sharing rules that characterize the renegotiation process for wages and transfer fees:

$$\begin{aligned}
\text{if } S_{0,t}(p') > S_{0,t}(p) \;\&\; S_{0,t}(p') > S_{1,t}(p') &: \\
E_{0,t}(p',p) - U_{0,t} &= E_{0,t}(p,u) - U_{0,t} + \frac{\gamma}{\alpha+\beta+\gamma}\left[S_{0,t}(p') - S_{0,t}(p)\right] \\
T_{0,t}(p',p) &= J_{0,t}(p,u) + \frac{\alpha}{\alpha+\beta+\gamma}\left[S_{0,t}(p') - S_{0,t}(p)\right] \\
\text{if } S_{1,t}(p') > S_{0,t}(p) \;\&\; S_{1,t}(p') \geq S_{0,t}(p') &: \\
E_{1,t}(p',p) - U_{0,t} &= E_{0,t}(p,u) - U_{0,t} + \frac{\gamma}{\alpha+\beta+\gamma}\left[S_{1,t}(p') - S_{0,t}(p)\right] \\
T_{1,t}(p',p) &= J_{0,t}(p,u) + \frac{\alpha}{\alpha+\beta+\gamma}\left[S_{1,t}(p') - S_{0,t}(p)\right] \\
\text{if } S_{2,t}(p') > S_{2,t}(p) &: \\
E_{2,t}(p',p) - U_{2,t} &= E_{2,t}(p,u) + \frac{\gamma}{\alpha+\beta+\gamma}\left[S_{2,t}(p') - S_{2,t}(p)\right] \\
T_{2,t}(p',p) &= J_{2,t}(p) + \frac{\alpha}{\alpha+\beta+\gamma}\left[S_{2,t}(p') - S_{2,t}(p)\right]
\end{aligned}$$

Notably, these rules show that the transfer fees $T_{j,t}(p',p)$ correspond to the hiring firm's outside option plus the share α of the net transfer surplus. Recalling that $J_{j,t}(p,u) = \frac{\alpha}{\alpha+\gamma}S_{j,t}(p)$, $E_{j,t}(p,u) - U_{j,t} = \frac{\gamma}{\alpha+\gamma}S_{j,t}(p)$, and that $\alpha+\beta+\gamma = 1$, we can rewrite:

$$\begin{aligned}
T_{j,t}(p',p) &= \frac{\alpha}{\alpha+\gamma}S_{0,t}(p) + \alpha\left[S_{j,t}(p') - S_{0,t}(p)\right], \text{for } j \in \{0,1\} \\
T_{2,t}(p',p) &= \frac{\alpha}{\alpha+\gamma}S_{2,t}(p) + \alpha\left[S_{2,t}(p') - S_{2,t}(p)\right]
\end{aligned}$$

2.3 Match surplus

We now state the definition of match surplus. The latter depends not only on the external opportunities available to the worker (which may depend on the training status) but also on the possibility of transitioning to nonemployment. The valuation of these opportunities is closely related to the sharing rules and existence (or absence) of a transfer fee system. Let $\zeta \in [0,1]$ be the discount factor. We introduce $\Psi \equiv \{1-\beta/(1-\alpha); 1-\beta\}$ for the cases with and without transfer fees, respectively.

Proposition 1 : Equilibrium matches surplus satisfy, for $t = [1, T-1]$:

$$\begin{aligned}
S_{0,t}(p) &= p - b + \zeta S^{+}_{0,t+1}(p) \\
&+\zeta\Psi\lambda_e \int_{p' \in M^{E_0}_{t+1}(p)} \left(S^{+}_{0,t+1}(p') - S^{+}_{0,t+1}(p)\right) dG(p') \\
&+\zeta\Psi\lambda_e \int_{p' \in M^{E_1}_{t+1}(p)} \left(S^{+}_{1,t+1}(p') - S^{+}_{0,t+1}(p)\right) dG(p') \\
&-\frac{\gamma}{\alpha+\gamma}\zeta\lambda_u \left(\int_{p' \in M^{U_0}_{t+1}} S_{0,t+1}(p')\, dG(p') + \int_{p' \in M^{U_1}_{t+1}} S_{1,t+1}(p')\, dG(p') \right) \\
S_{1,t}(p) &= (1+\Delta)p - b - z + \zeta S^{+}_{2,t+1}(p) + \left(U_{2,t+1} - U_{0,t+1}\right) \\
&+\zeta\Psi\lambda_e \int_{p' \in M^{E_2}_{t+1}(p)} \left(S^{+}_{2,t+1}(p') - S^{+}_{2,t+1}(p)\right) dG(p') \\
&-\frac{\gamma}{\alpha+\gamma}\zeta\lambda_u \left(\int_{p' \in M^{U_0}_{t+1}} S_{0,t+1}(p')\, dG(p') + \int_{p' \in M^{U_1}_{t+1}} S_{1,t+1}(p')\, dG(p') \right) \\
S_{2,t}(p) &= (1+\Delta)p - b + \zeta S^{+}_{2,t+1}(p) \\
&+\zeta\Psi\lambda_e \int_{p} \left(S^{+}_{2,t+1}(p') - S^{+}_{2,t+1}(p)\right) dG(p') \\
&-\frac{\gamma}{\alpha+\gamma}\zeta\lambda_u \left(\int_{p' \in M^{U_2}_{t+1}} S_{2,t+1}(p')\, dG(p') \right)
\end{aligned}$$

$$\begin{aligned}
\text{with } U_{2,t} - U_{0,t} &= \left(U_{2,t+1} - U_{0,t+1}\right) + \frac{\gamma}{\alpha+\gamma}\zeta\lambda_u \Bigg[\int_{p' \in M^{U_2}_{t+1}} S_{2,t+1}(p', \underline{s})\, dG(p') \\
&- \int_{p' \in M^{U_0}_{t+1}} S_{0,t+1}(p')\, dG(p') - \int_{p' \in M^{U_1}_{t+1}} S_{1,t+1}(p')\, dG(p') \Bigg]
\end{aligned}$$

where sets M are defined as follows:

- $p' \in M_t^{E_0}(p)$: $p' \geq p$ and $p' < F_t$, with $S_{0,t}(F_t) = S_{1,t}(F_t)$
- $p' \in M_t^{E_1}(p)$: $p' \geq p$ and $p' \geq F_t$, with $S_{0,t}(F_t) = S_{1,t}(F_t)$
- $p' \in M_t^{U_0}$: $p' \geq R_{0,t}$ and $p' < F_t$, with $S_{0,t}(R_{0,t}) = 0$ and $S_{0,t}(F_t) = S_{1,t}(F_t)$
- $p' \in M_t^{U_1}$: $p' \geq R_{0,t}$ and $p' \geq F_t$, with $S_{0,t}(R_{0,t}) = 0$ and $S_{0,t}(F_t) = S_{1,t}(F_t)$
- $p' \in M_t^{U_2}$: $p' \geq R_{2,t}$, with $S_{2,t}(R_{2,t}) = 0$

Proof. See Appendix B for more details.

Note that $S_{2,t}(p) > S_{0,t}(p)$ $\forall p$ and that F_t determines the productivity threshold above which $S_{1,t}(p) \geq S_{0,t}(p)$. In addition, it is worth emphasizing that transfer fees unambiguously increase the match surplus because, by definition, $1 - \beta/(1-\alpha) < 1 - \beta$.

2.4 Age-dynamics of matching and training, and the role of transfer fees

Our objective is now to characterize certain labor market equilibrium properties. We can derive the first set of properties by abstracting training issues, and thus focusing on the age dynamics of $R_{0,t}$ which determine the shape of job creation and job destruction with age.

Corollary 1 :

Assuming no training, if $\frac{\alpha+\gamma}{\gamma}\Psi > \frac{\lambda_u}{\lambda_e}$, then $R_{0,t+1} > R_{0,t}$ $\forall t$; that is, job creation (destruction) decreases (increases) with age. Without transfer fees, $\Psi = \frac{\gamma}{\beta+\gamma}$, and the condition can be rewritten $\frac{\alpha+\gamma}{\beta+\gamma} > \frac{\lambda_u}{\lambda_e}$.

Proof. For the sake of exposition, we consider here that $\zeta = 1$. Considering the equilibrium match surplus without training (S_0) and without transfer fees ($\Psi = \frac{\gamma}{\beta+\gamma}$), we have:

$$S_{0,t}(p) = p - b + S^+_{0,t+1}(p) + \Psi\lambda_e \int \left(S^+_{0,t+1}(p') - S^+_{0,t+1}(p)\right) dG(p') - \frac{\gamma}{\alpha+\gamma}\lambda_u \int_{R_{0,t+1}} S_{0,t+1}(p')\, dG(p')$$

As $S'_{0,t}(x) = 1 + [1 - \Psi\lambda_e(1-G(x))]S'_{0,t+1}(x)$, it follows that the equilibrium match surplus is of the form $S_{0,t}(x) = \nu_{t,x}(x - R_{0,t})$ with $\nu_{t,x} \equiv \sum_{j=0}^{T-(t+1)}[1 - \Psi\lambda_e(1-G(x))]^j$.

The job creation/destruction decision rule depends on the productivity threshold $R_{0,t}$, which solves $S_{0,t}(R_{0,t}) = 0 \; \forall t$. The age dynamics for $R_{0,t}$ can be solved recursively starting from $t = T-1$. At the end of their working life, we have:

$$\begin{aligned} R_{0,T-1} &= b \\ R_{0,T-2} &= b - \tilde{v}_{T-1} \max\left\{[1-\Psi\lambda_e(1-G(R_{0,T-2}))][R_{0,T-2}-R_{0,T-1}], 0\right\} \\ &\quad + \tilde{v}_{T-1}\left\{\Psi\lambda_e \int_{\max(R_{0,T-2},R_{0,T-1})} (x-R_{0,T-1})dG(x) - \lambda_u \frac{\gamma}{\alpha+\gamma}\int_{R_{0,T-1}} (x-R_{0,T-1})dG(x)\right\} \end{aligned}$$

where $\tilde{v}_{T-1} = \tilde{v}_{T-1}$ if $R_{0,T-2} > R_{0,T-1}$, and $\tilde{v}_{T-1} = v_{T-1,R_{0,T-1}}$ if $R_{0,T-2} < R_{0,T-1}$.

From this, it is straightforward to see that $\frac{\lambda_e}{\beta+\gamma} > \frac{\lambda_u}{\alpha+\gamma}$ is a sufficient condition for $R_{0,T-1} - R_{0,T-2} > 0$. This implies in particular that $\max\{S_{0,T-1}(R_{0,T-2}), 0\} = 0$; therefore, in $T-2$, the productivity threshold is ultimately written as:

$$R_{0,T-2} = b - \tilde{v}_{T-1}\left\{\Psi\lambda_e - \lambda_u \frac{\gamma}{\alpha+\gamma}\right\}\int_{R_{0,T-1}} (x-R_{0,T-1})dG(x)$$

From backward induction and using the properties $\max\{S_{0,t+1}(R_{0,t}), 0\} = 0$ and $\tilde{v}_{t+1} < \tilde{v}_t$, we can show that:

$$sign(R_{0,t+1} - R_{0,t}) = sign\left(\left\{\Psi\lambda_e - \lambda_u\frac{\gamma}{\alpha+\gamma}\right\}\left\{\int_{R_{0,t+1}} (x - R_{0,t+1} - \int_{R_{0,t+2}} (x - R_{0,t+2})\right\}\right).$$

Therefore, $\Psi\lambda_e > \lambda_u \frac{\gamma}{\alpha+\gamma}$ is consistent when $sign(R_{0,t+1} - R_{0,t}) > 0$. *QED.*

Corollary 1 illustrates the key role of on-the-job search and the bargaining power of the poaching firm in the age dynamics of job creation/destruction. This can be observed first by considering the case where $\lambda_e \rightarrow 0$. At some point, if matched with a low-productivity job/firm, it can be worthwhile for a worker to become nonemployed, and hence expect to draw a new job opportunity (over the entire set of possibilities) at probability λ_u. For instance, in the case where $\lambda_e \rightarrow 0$, we have $R_{0,T-2} > R_{0,T-1}$ (decreasing job destruction with age), because at $T-1$ the value of this outside opportunity is null. Then, for $\lambda_e > 0$, the shape of $R_{0,t}$ with age depends on bargaining powers. The match surplus now takes into account the possibility of job-to-job mobility, and depends on the firm-worker pair's ability to extract a share of the surplus gap between the incumbent firm and the poaching firm. The lower the bargaining power of the poaching firm (β), the higher the current match surplus.

Consider, for instance, $\lambda_u = \lambda_e$. If we are interested in the case $R_{0,T-2} < R_{0,T-1}$ (and, more generally, $R_{0,t} < R_{0,t+1}$), then the bargaining power of the incumbent firm (α) must be higher than that of the poaching firm (β). If $\alpha = \beta$, $\lambda_u < \lambda_e$ is a sufficient condition.

Overall, this analysis emphasizes that the identification of the respective bargaining powers of incumbent and poaching firms crucially depends on the job contact rates of nonemployed and employed workers. Obviously, studies that assume $\alpha = \beta$ are unable to address the key role played by the respective bargaining powers on the age dynamics of job creation and job destruction. Accordingly, our empirical investigation strategy focuses on job-to-job and nonemployment-to-employment transitions to identify the key parameters. Based on this set of identified parameters, we run counterfactual simulations to assess the potential of the transfer fee system.

Theoretically, the impact of the transfer fee system can already be analyzed by examining the impact of Ψ on the equilibrium, as Ψ is higher with transfer fees than without. However, we still focus first on the impact of Ψ on job creation and destruction without training.

Corollary 2 :

Assuming no training and $\frac{\alpha+\gamma}{\gamma}\Psi > \frac{\lambda_u}{\lambda_e}$, then $\frac{dR_{0,t}}{d\Psi} \leq 0$, and the transfer fee system increases (decreases) job creation (destruction).

Proof. Considering the proof of Corollary 1, we first note that $\frac{dR_{0,T-1}}{d\Psi} = 0$ and $\frac{dR_{0,t}}{d\Psi} < 0$. Then, assuming $\frac{\alpha+\gamma}{\gamma}\Psi > \frac{\lambda_u}{\lambda_e}$, from Corollary 1 we also know that $R_{0,t+1} - R_{0,t} > 0$ and the productivity threshold characterizing job creation satisfies:

$$R_{0,t} = b - \tilde{v}_{t+1}\left\{\Psi\lambda_e - \lambda_u\frac{\gamma}{\alpha+\gamma}\right\}\int_{R_{0,t+1}}(x - R_{0,t+1})dG(x),$$

where $\tilde{v}_t \equiv \sum_{j=0}^{T-(t+1)}\{1 - \Psi\lambda_e[1 - G(R_{0,t+1})]\}^j$. From this, it is straightforward that $\frac{dR_{0,t}}{d\Psi} \leq 0$. *QED.*

This emphasizes the potential role of the transfer fee system in reducing nonemployment at each age. This is due to the positive impact of this system on the match surplus, which is unambiguously raised by the transfer fees. Transfer fees lead to an unambiguous increase in job creation.

We now turn to training issues and the role of the transfer fee system. Interestingly, we find that this is no longer clear-cut.

Corollary 3 :

The age-differentiated effect of the transfer fee system on access to training is ambiguous. While $\frac{dF_{T-1}}{d\Psi} = 0$; and $\frac{dF_{T-2}}{d\Psi} < 0$, it can be the case F_{T-i} increases with Ψ for younger individuals.

Proof. See Appendix A.

Corollary 3 highlights that the impact of the transfer fee system on access to training is not trivial; at some ages, the payment of transfer fees can increase the training productivity threshold (decreases access to training). As the Appendix shows, $\frac{\partial[U_{2,T-3}-U_{0,T-3}]}{\partial\Psi} < 0$ can indeed increase F_{T-4} when Ψ increases. In other words, it could be that transfer fees lead to a higher selection to enter the training process because the relative gain for the nonemployed of being trained is lowered (as all surpluses increase).

3 General Model and Estimation

Our goal now is to investigate quantitatively the expected effects on job creation/destruction, employment, and training of implementing a transfer fee system in France. To that end, we add further extensions to the model to make it consistent with the most salient features of the French labor market and, in particular, the observed labor market transitions.

3.1 Additional assumptions

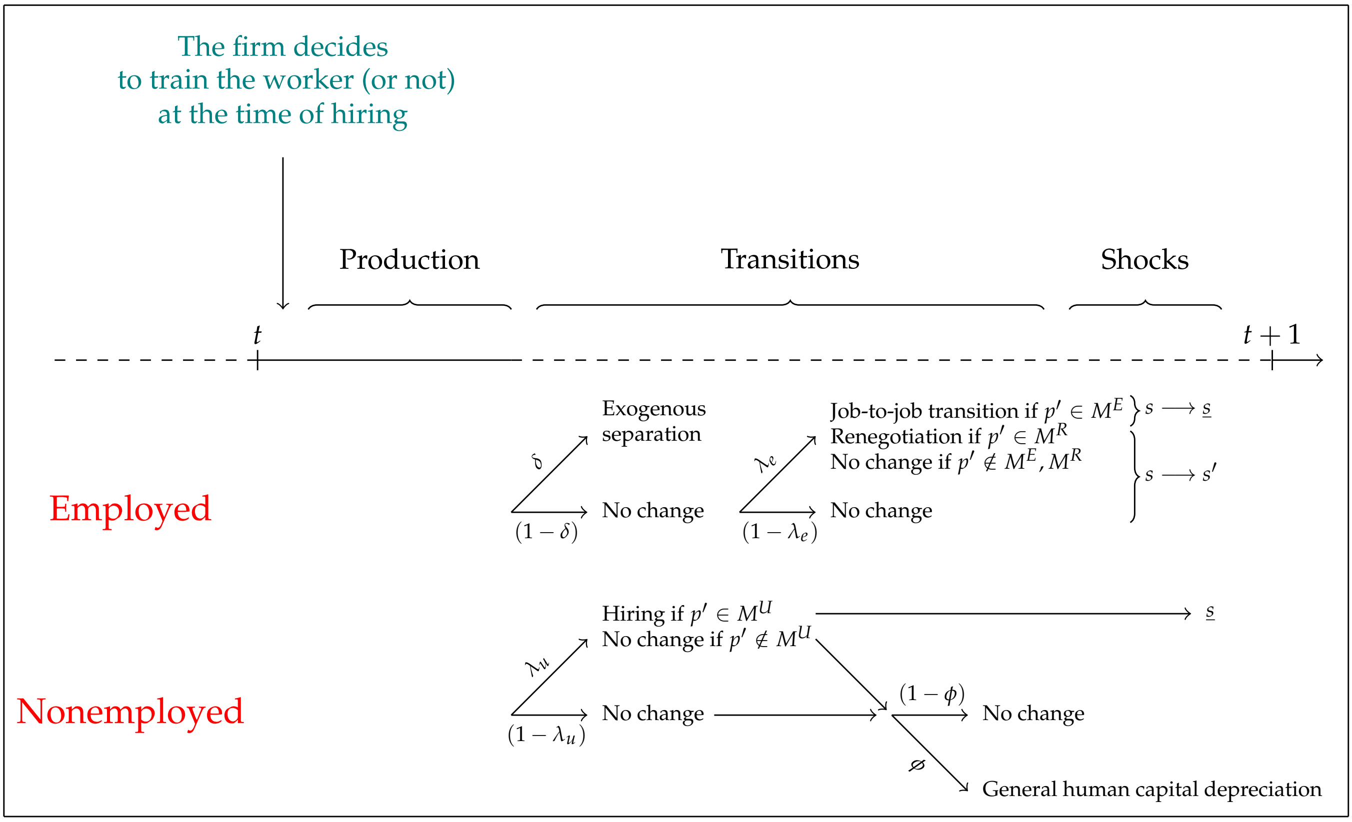
In addition to our main assumptions, we now consider that workers are not only characterized by their level of general human capital but also by their level of specific human capital, which they can accumulate through learning-by-doing. Let s be the level of specific human capital, which can be low ($\underline{s}$) or high ($\bar{s}$). By definition, new matches begin with $s = \underline{s}$. At the end of the period, the worker can switch from $s' = \underline{s}$ to $s' = \bar{s}$ with probability ρ. Specific human capital increases the productivity of workers from p to $(1+s)p$ if they have no general human capital, and from $(1+\Delta)p$ to $(1+\Delta)(1+s)p$ if they have general human capital. Note that workers lose their specific human capital if they change employer or lose their jobs[5]. See Appendix B for more details.

Following Ljungqvist and Sargent (1998), we also consider that general human capital may depreciate during nonemployment with probability ϕ. Accordingly, the term untrained workers ($j = 0$) now refers to either workers who have never been trained or workers who have lost their general human capital during a nonemployment period. Lastly, we assume that employed workers may transition from employment to nonemployment not only because of endogenous separations but also because of exogenous separations that occurs with probability δ.

Figure 1 shows the timing of the events in this general model. Appendix B provides a full description of value functions and joint surpluses, while Appendix C describes the labor market flows.

[5]The model presented here assumes a binary representation of human capital: the individual may either have no human capital (general or specific), or have a certain level of human capital (general or specific) which can no longer increases afterwards. In an alternative version, we simulate a model in which there are several levels of human capital. This increases the model's resolution time exponentially without changing the results, either qualitatively or quantitatively.

Figure 1: Timing of events



3.2 Data

We take advantage of the FLFS over the period of 2017-2019 to compute labor market outcomes over the life cycle (transition rates, employment rate, and rate of access to training). The observation period begins in 2017, as some variables (particularly those related to training) were created or added in 2017, and ends in 2019 before the COVID-19 pandemic. We focus on individuals aged 25 to 60. Decisions related to education or retirement are beyond the scope of this study. Table 1 reports the quarterly labor market flows, employment rates, and access to training for individuals aged 25 to 60.

Table 1: Labor market variables

Variable	Trained workers	Untrained workers	All workers
Transition rate from employment to nonemployment	1.74	3.38	2.80
Transition rate from nonemployment to employment	20.02	7.57	9.24
Job-to-job transition rate	1.98	1.91	1.93
Employment rate	91.05	71.95	77.36
Rate of access to training	-	-	28.36

Sample: Individuals aged 25 to 60. Note: Transition rates are determined on a quarterly basis.

Table 1 calls for some comments. First, the transition rate from employment to nonemployment of untrained workers is twice as high as that of trained workers, whereas the transition rate from nonemployment to employment is 2.5 lower. This results in an average employment rate of 91.05 vs. 71.85, suggesting the key labor market impact of training. It is worth emphasizing that the job-to-job transition rates are quite similar, although we observed a slightly higher rate for trained workers.

3.3 Calibrated parameters

Our model does not aim to analyze labor market entry and exit, but rather the dynamics of training investments over the life cycle. We abstract from education and retirement decisions by considering that workers enter the labor market at age $t_0 = 25$ and retire at determined age of $T = 60$. The discount factor is set to $\zeta = 0.99$ (the model is simulated quarterly). We suppose that firms' productivity is distributed over the support $[\underline{p} = 0.15, \overline{p} = 1.50]$ and that the value of domestic production is $b = 0.40$. Note that $\underline{p} < b$ implies that firms at the bottom of the distribution are viable only if they employ workers with a high level of human capital and high expected employment duration. Note also that $\overline{p} = 10\underline{p}$, which implies that the firm with the best technology is ten times more productive than the firm with the worst technology. Table 2 summarizes the values of the calibrated parameters.

Table 2: Calibrated parameters

Description	Parameter	Value
Age of labor market entry	t_0	25
Age of labor market exit	T	60
Discount factor	ζ	0.99
Lower support of the Pareto distribution of firms' productivity	$\underline{p}$	0.15
Upper support of the Pareto distribution of firms' productivity	$\overline{p}$	1.50
Home production	b	0.40

3.4 Estimated parameters

We estimate the remaining parameters using the method of simulated moments proposed by McFadden (1989). Let Θ be the set of structural parameters.

$$\Theta = \{k, \lambda_u, \lambda_e, \alpha, \gamma, z, \Delta, \phi, \overline{s}, \rho\}$$

Our goal is to reproduce the following life cycle series: (i) the transition rate from nonemployment to employment (by training status), (ii) the job-to-job transition rate (by training status), and (iii) access to training. In the spirit of Albertini et al. (2020), we simulate the model from age 25 to age 60 and target series (i)-(iii) over the range of 30-59.

Thus, we have $5 \times 30 = 150$ moments for 10 parameters[6]. We note here that our model also allows for exogenous and endogenous separations. We derive exogenous separations directly from the data by fitting the observed employment-to-non-employment transition rates by age and training status[7].

[6]Note that β is not estimated but derived from the constraint $\beta = 1 - \alpha - \gamma$.

[7]We simulated alternative versions of the model (single δ based on the average separation rate; single δ based on the lowest separation rate observed during the life cycle; age-dependent δ_t based on the average separation rate by age; status-dependent δ_j based on the average separation rate by training status). We also followed the strategy proposed by Hairault et al. (2019) of imposing that the share of exogenous separations in total separations remains constant throughout the life cycle, based on the work of Fujita and Ramey (2012). In all cases, the

Let $\hat{\boldsymbol{Y}}_n^D$ be a vector of moments from data with n observations. Let $\hat{\boldsymbol{Y}}_{s,n}^M$ be a vector of the corresponding moments from the s simulations of n observations. Let $\boldsymbol{W}_n$ be the weighting matrix. The estimation procedure consists of finding the vector of parameters that minimizes the distance between the model and data moments. Formally, the SMM estimator $\hat{\Theta}_{s,n}$ solves

$$\hat{\Theta}_{s,n} \quad = \quad \arg\min_{\Theta} \left[\hat{\boldsymbol{Y}}_n^D - \hat{\boldsymbol{Y}}_{s,n}^M(\Theta)\right]' \boldsymbol{W}_n \left[\hat{\boldsymbol{Y}}_n^D - \hat{\boldsymbol{Y}}_{s,n}^M(\Theta)\right]$$

Table 3 reports the estimated parameter values.

Table 3: Estimated parameters

Description	Parameter	Value
Parameter of the Pareto distribution of firms' productivity	k	0.296
Job offer arrival rate during nonemployment	λ_u	0.218
Job offer arrival rate during employment	λ_e	0.259
Bargaining power of the current firm	α	0.227
Bargaining power of the worker	γ	0.294
Bargaining power of the poaching firm*	β	0.479
Training cost	z	20.005
Productivity gain related to general human capital (training)	Δ	0.1964
Probability of general human capital depreciation during nonemployment	ϕ	0.471
Productivity gain related to specific human capital (learning by doing)	$\bar{s}$	0.700
Probability of specific human capital appreciation during employment	ρ	0.147

Notes: 1. All estimates are statistically significant at 1% level, using a bootstrapping procedure with 1,000 replications. 2. The first-step estimation uses the identity matrix as a weighting matrix, whereas the second-step estimation computes the optimal weighting matrix as the inverse of the variance-covariance matrix of the empirical moments using a bootstrapping procedure with 1,000 replications. 3. (*) The estimate of β is derived from the constraint of the bargaining parameters $\beta = 1 - \alpha - \gamma$.

values of the estimated parameters remain fairly close, and the model results remain almost the same.

We first discuss our structural estimation in light of our former theoretical results, particularly Corollary 1, which stresses the joint role of relative bargaining power and relative job contact rates for nonemployed and employed workers. According to our estimation, we obtain $\lambda_u < \lambda_e$, and $\beta > \gamma > \alpha$. Therefore, Corollary 1 suggests, because the point is that since job contact rate of the nonemployed is relatively lower, the model can mimic age-decreasing (increasing) job creation (destruction) despite $\beta > \alpha$. This is crucial because, as Amand et al. (2023) emphasize, the value of the bargaining power of the poaching firm determines the size of the potential underinvestment in training; hence, it is much higher when β is high. Accordingly, our identification strategy for the model parameters, based on the age dynamics of labor market transitions, suggests that there should be room for public intervention.

The other comments on the estimated parameters are straightforward. It is worth noting that the general human capital depreciation occurs in about 2 quarters, while specific human capital appreciation takes on average 7 quarters. Endogenous general human capital investment increases the match by 20%, whereas exogenous specific human capital appreciation increases it by 70%.

3.5 Model vs. Data

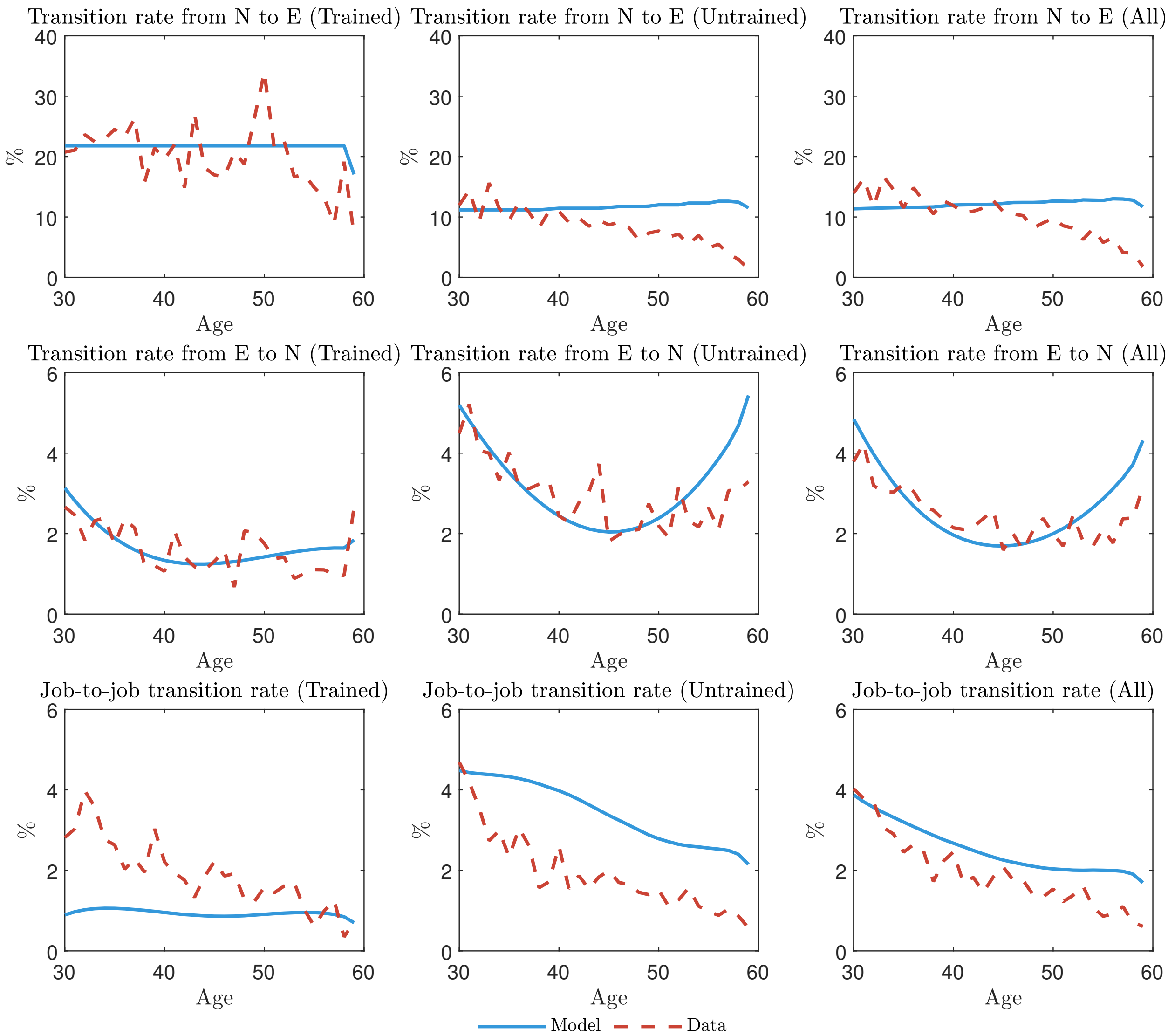
To what extent is our model able to reproduce the main characteristics of the labor market? Figure 2 reports labor market flows by age observed in the data and those induced by the model. As we can see, our model reproduces the overall transition rates quite well. In particular, our model captures the decline in nonemployment-to-employment transitions at the end of the life cycle and the decreasing profile of job-to-job transitions over the life cycle.[8] The model can also capture the differences in transition rates according to the training status (trained or untrained). In particular, the model captures the fact that the transition rate from nonemployment to employment is almost twice as high for trained workers as it is for untrained workers. Another interesting feature relates to the model's ability to mimic job-to-job transition rates, as this is crucial regarding training investments and our main issue dealing with the

[8] As exogenous separation rates are estimated to fit employment-to-nonemployment transition rates, we do not discuss model performance regarding that type of transitions.

potential role of introducing transfer fees. Regardless of the type of worker, the job-to-job transition rate is divided by three between the age of 30 and the age of 60. For trained workers, it is worth emphasizing that for younger workers, the value of the job-to-job transition rate generated by the model is too low in comparison with what is found in the data. This result suggests that there should exist additional exogenous sources of job-to-job mobility, at least for younger people, which our model does not consider.

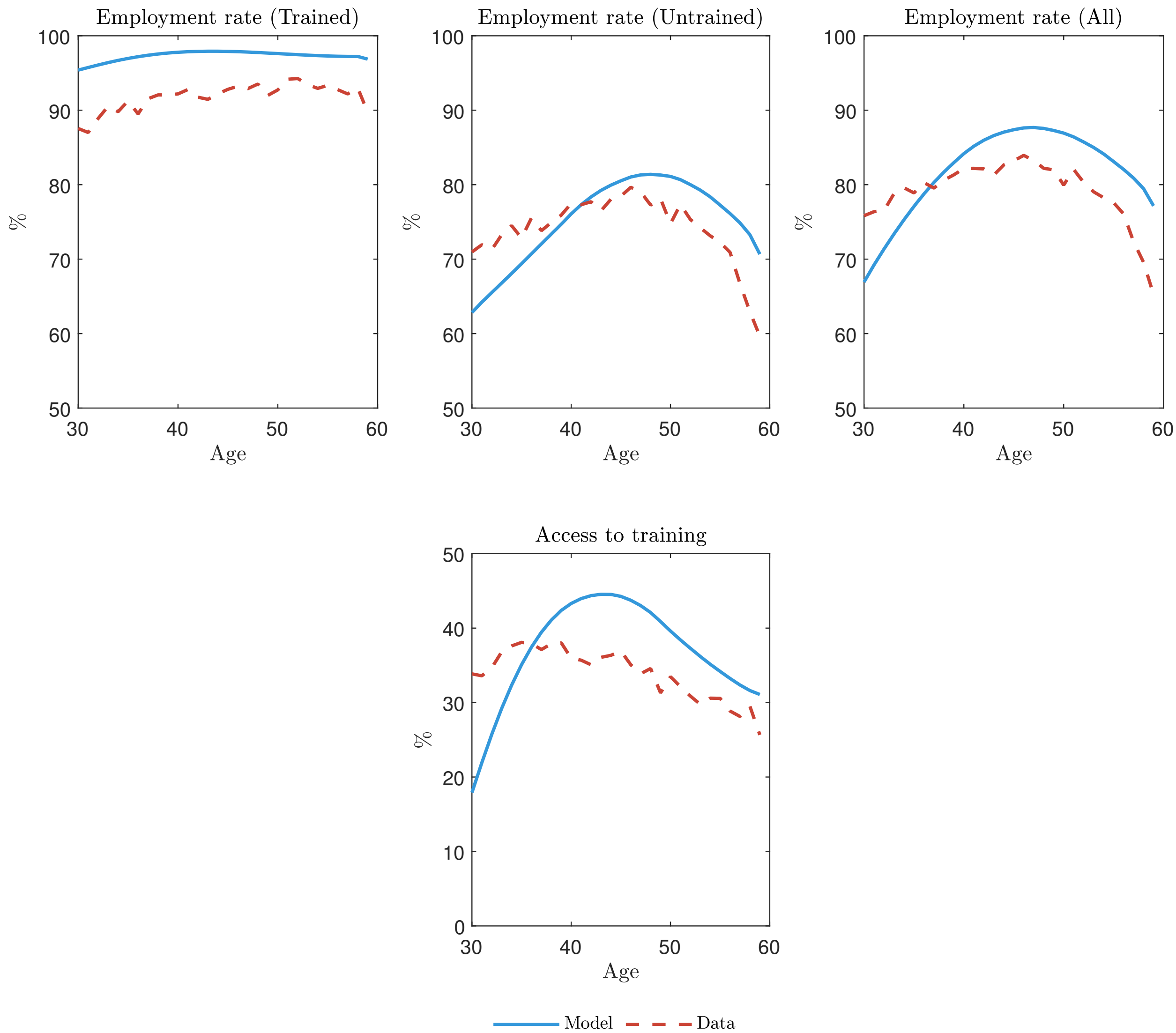
Figure 3 shows the life-cycle profiles of employment (not targeted by the estimation procedure) and access to training we find in the data and as our model implies. The model does a good job in replicating the hump-shaped age-dynamics of the employment rate at the aggregate level and by type of workers. Our simulations are consistent with the fact that, for all ages, the employment rate is relatively higher for trained workers (more than 10 points greater), although our predictions of this positive impact are slightly overestimated. Specifically, the model replicates the strong decrease in the employment rate of untrained workers at the end of their working life and the smooth decrease in access to training.

Figure 2: MODEL VERSUS THE DATA (LABOR MARKET FLOWS)



Source: FLFS 2017-2019. Note: Transition rates are determined on a quarterly basis. "E" represents "Employment" and "N" represents "Nonemployment".

Figure 3: MODEL VERSUS THE DATA (EMPLOYMENT AND ACCESS TO TRAINING)



Source: FLFS 2017-2019. Note: Transition rates are determined on a quarterly basis.

4 Assessing the Impact of Transfer Fees on Labor Market Equilibrium

We now examine the quantitative impact of implementing a transfer fee system. As a preliminary step to gain intuition regarding our forthcoming quantitative results, it is worth stressing on the main mechanisms at work.

First, we clearly find a direct impact of the transfer fee system, which raises the intertemporal value of job matches regardless of the training status of the worker. This policy notably raises the value of training investments: whether the worker moves to a poaching firm, the incumbent firm receives compensation (which is bargained). The net surpluses related to job matches increases, and consequently, intermediate p-firms that would not train workers without such a compensation system would now choose to train workers. It is also clear that such an increase in the intertemporal value of employment is as much lower as the firm's type p is high. Ultimately, for a worker hired by the highest p-firm, no job-to-job transition can occur, and there is no increase in the value of employment related to the transfer fee system.

Second, due to this direct effect, the implementation of this transfer fee system unambiguously raises employment opportunities (whatever the expected p-type firm contacted) and hence job-finding rates, thereby decreasing nonemployment. Otherwise, this leads to an indirect positive effect on the intertemporal value of nonemployment, which is actually not p-dependent, because workers who became nonemployed are searching for all jobs, irrespective of their past job matches. Then, the point is that this in turn generates a negative impact on the net surplus related to job matches.

Therefore, the transfer fee system generates two opposite effects. Typically, at the top of the p distribution, the latter effect dominates, and vice versa at the bottom of the p distribution. Therefore, while the nonemployment impact of the compensation system is clear cut, as Corollary 3 already suggests, it is no longer the case for access to training. It could be the case that the productivity threshold F_t over which a worker of age t is trained would be raised whether the impact on the intertemporal value of nonemployment is high enough. Only a quantitative investigation would allow us to draw conclusions from this perspective.

Another issue to discuss before the quantitative assessment relates to the duration of the transfer fee entitlement. In the soccer market, players are tied to their clubs (who can therefore benefit from transfer compensation in the event of poaching) for a maximum period of 5 years (FIFA, 2021). To deal with this time restriction, we consider two versions (two counterfactual experiments) to account for the fact that entitlement to transfer fees can be limited in time.

For instance, this can relate to the worker's seniority, as the latter determines the elapsed time from the training investment. In our model, we approximate seniority using the worker's status with respect to specific human capital. The latter can be either low ($\underline{s}$) or high ($\bar{s}$), and every job starts low and then becomes high with some probability. Accordingly, our first counterfactual experiment assumes that a poaching firm must pay transfer fees only if the firm-worker pair has low specific human capital. Our estimation procedure suggests that $\rho = 0.147$, meaning that the entitlement to transfer fees lasts for almost two years, on average.

The second deals with the implementation of a transfer fee system without any duration dependence. In the remainder of this paper, we assess the quantitative impact of these two transfer fee systems. Figures 4-5 illustrates the corresponding simulations.

4.1 The impact of a transfer fee system with time restriction

We begin by examining the impact of implementing a time-limited entitlement to compensation in the event of poaching, comparable to that used in soccer. Compared to the benchmark (with no transfer system), the economy with a time-limited entitlement to compensation is characterized by a higher job-finding rate (see Figure 4). This policy increases the value of the surplus, particularly at the bottom of the distribution, thereby increasing job opportunities for the nonemployed. Some matches that would have been unprofitable in the absence of a transfer system became profitable with its introduction. Even if the firm is not sufficiently productive to train a worker, the joint surplus increases because workers now represent assets that can be transferred to another firm (in return for compensation), which can train them.

Time-limited entitlement to compensation also increases access to training (see Figure 5). The employment rate increases by 3.5 percentage points, not only because the overall job-finding rate increases but also because the proportion of trained workers, characterized by a higher (lower) job-finding (destruction) rate, increases (composition effect).

With this transfer fee system, only low-specific human capital firm-worker pairs (matches with expected seniority of less than two years) are entitled to some compensation, so this entails a mild effect on employment opportunities, and hence the value of nonemployment. Then, the direct effect on the net surplus quantitatively dominates the indirect effect for job-match productivities that are not too high. Accordingly, job-finding rates for untrained workers (low-productivity jobs) significantly increase. The minimum job match productivity to be trained also falls; hence, more workers are trained (slightly more than 3 percentage points). This, in turn, reinforces the initial positive impact of the policy on employment, because trained workers are characterized by a higher (lower) job-finding (destruction) rate.

Therefore, such a policy is well-suited for boosting both employment and access to training.

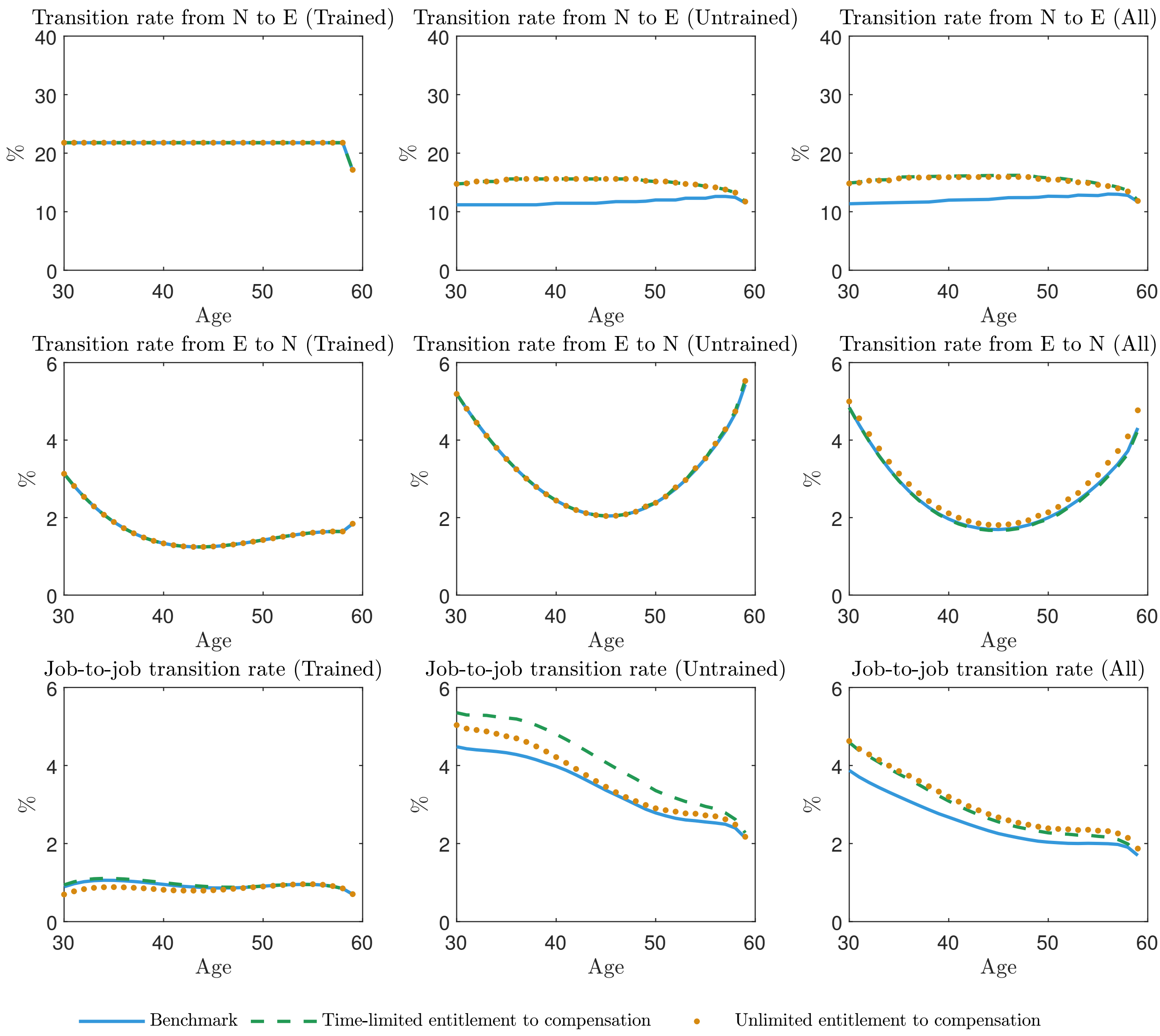
4.2 The impact of a transfer fee system without time restrictions

Alternatively, we now consider that there is no time restriction on the possibility of receiving compensation when the worker moves to another firm. Overall, this has some contrasting effects: the aggregate employment rate now rises by only 2.5 percentage points, while overall access to training is reduced by 8.5 percentage points.

This is due to the very strong initial impact on the job-match surplus, as there is no time restriction for the payment of transfer fees to the incumbent firms, which generates an increase in the value of nonemployment so important that the minimum productivity threshold for training increases. A public policy with this alternative design raises the net surplus only for the lowest productivities. For intermediate productivities, such as the one that initially provides the threshold for training, this is not the case because the probability that the workers move to a higher productivity level (and the incumbent firm receives the transfer fee) decreases with p. Consequently, in this experiment, we have fewer trained workers.

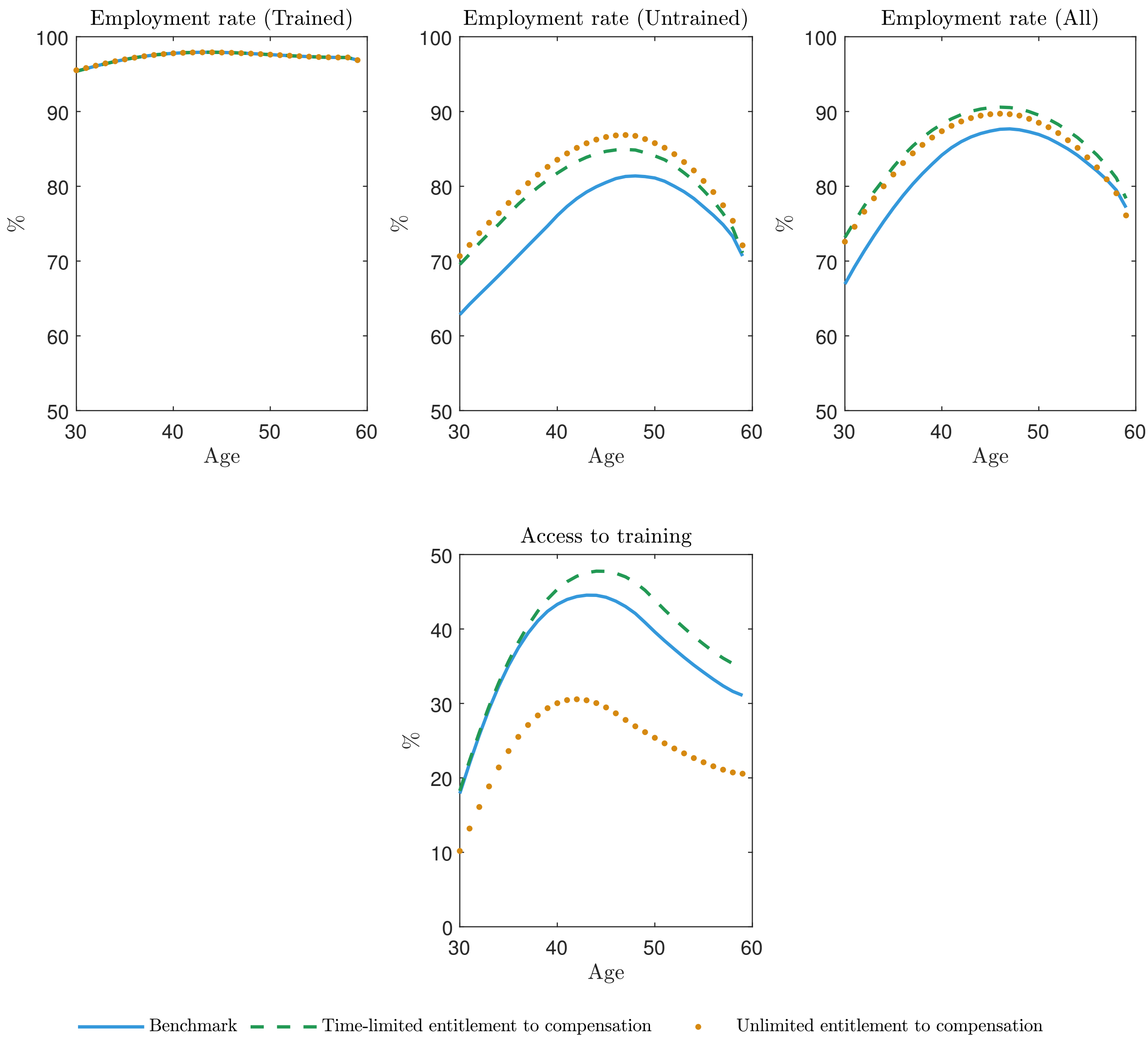
In turn, because there are more untrained workers whose job finding rates are relatively low, this tempers the initial positive impact of the policy on aggregate employment. Thus, the policy has a greater impact on employment when we implement a transfer system with a time restriction on compensation payments.

Figure 4: COUNTERFACTUAL EXPERIMENTS (LABOR MARKET FLOWS)



Note: "E" stands for "Employment" and "N" for "Nonemployment".

Figure 5: COUNTERFACTUAL EXPERIMENTS (EMPLOYMENT AND ACCESS TO TRAINING)



5 Conclusion

Although literature on human capital is abundant, few works propose solutions to stimulate investment in training. The proposed solutions are generally based on the same type of instrument (subsidies or tax cuts) and are relatively expensive. This study explores the impact of an original policy consisting of a transfer system equivalent to that used in soccer applied to the standard labor market. In this system, workers are tied to their employers for a limited period; in the case of poaching, the new employer must pay a transfer fee to the current employer. New wages and transfer fees are negotiated *ex post*; once the training occurs, its impact on productivity is revealed and the worker receives an external offer.

We develop a life-cycle search model with an on-the-job search in which investment in training is endogenous. We estimate the parameters of the model using the method of simulated moments and data from the FLFS. We show that our model reproduces the dynamics of labor market flows, employment, and access to training over the life cycle well. We then simulate the impact of implementing a transfer system comparable to that used in soccer. We show that a time-limited entitlement to compensation fees can significantly increase access to training and employment at no cost. We then explore an alternative policy that introduces unlimited entitlement to compensation. We find that this policy results in lower gains in terms of access to training and employment. The time-limited policy targets untrained workers (as training takes place at the start of the employment relationship) and avoids targeting workers who are employed in unproductive firms and those who were trained long ago, thus avoiding increasing excessively the value of nonemployment and reducing the positive effects on employment and training.

Overall, our results argue in favor of a transfer system comparable to that used in soccer. In this system, firms benefit from a 2-year entitlement to transfer indemnity in the event of poaching. In practical terms, this system could draw inspiration from the *"rupture conventionnelle"* (mutually agreed termination of contract) introduced in 2008 in France. The *rupture conventionnelle* makes it possible to terminate a permanent employment contract without resorting to dismissal or resignation. In this system, the employee and employer agree to terminate the contract and negotiate compensation. Therefore, we can adapt this procedure to the specific case of job-to-job mobility. In the case of poaching, the current employer, worker, and new employer come together to negotiate the worker's new salary and transfer fees to the initial employer. Unlike non-compete clauses, it is not necessary to define the conditions of the clause application *ex ante* because the negotiation takes place *ex post*. We can safely surmise that such a system would be easier to establish or, at least, result in fewer cases going to court. We believe that this transfer system has several advantages that justify its introduction.

Although our study analyzes many aspects of human capital accumulation and explores the impact of an innovative policy, some questions remain unanswered. First, although we show that it is more effective to limit the duration of transfer indemnity entitlement over time, we did not determine the contract duration that best stimulates training and employment. Second, our paper did not address the question of the optimal policy. It would be interesting to assess the extent to which the implementation of a transfer system allows us to approach the optimum. We leave these questions for future research.

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Appendix

A Proof of Corollary 3

To prove Corollary 3, we determine explicit solutions for equilibrium surplus, hence training thresholds, starting from $T-1$. As we shall demonstrate, the overall effect of the transfer fee system can be captured only in $T-4$ (and before). The transfer fee system notably impacts the expected nonemployment value of training, which is indeed zero on $T-1$, and still does not depend on the transfer fee system on $T-2$.

In $T-1$, it is straightforward that $R_{0,T-1} = b, F_{T-1} = z/\Delta$ and $R_{2,T-1} = b/(1+\Delta)$. Then, in $T-2$, we can explicit surplus values, which satisfy for $p \geq b$:

$$
\begin{aligned}
S_{0,T-2}(p) &= p - b + S_{0,T-1}(p) \\
&\quad + \Psi\lambda_e \int_p^{\frac{z}{\Delta}} \Big(S_{0,T-1}(p') - S_{0,T-1}(p)\Big) dG(p') \\
&\quad + \Psi\lambda_e \int_{\frac{z}{\Delta}} \Big(S_{1,T-1}(p') - S_{0,T-1}(p)\Big) dG(p') \\
&\quad - \frac{\gamma}{\alpha+\gamma}\lambda_u \bigg(\int_b^{\frac{z}{\Delta}} S_{0,T-1}(p') dG(p') + \int_{\frac{z}{\Delta}} S_{1,T-1}(p') dG(p') \bigg) \\
&= 2(p-b) + \Psi\lambda_e \bigg[\int_p (p'-p) dG(p') + \Delta \int_{\frac{z}{\Delta}} \Big(p' - \frac{z}{\Delta}\Big) dG(p') \bigg] \\
&\quad - \frac{\gamma}{\alpha+\gamma}\lambda_u \bigg[\int_b (p'-b) dG(p') + \Delta \int_{\frac{z}{\Delta}} \Big(p' - \frac{z}{\Delta})\Big) dG(p') \bigg]
\end{aligned}
$$

$$
\begin{aligned}
S_{1,T-2}(p) &= (1+\Delta)p - b - z + S_{2,T-1}(p) \\
&\quad + \Psi\lambda_e \int_p \Big(S_{2,T-1}(p') - S_{2,T-1}(p)\Big) dG(p') \\
&\quad - \frac{\gamma}{\alpha+\gamma}\lambda_u \bigg(\int_b^{\frac{z}{\Delta}} S_{0,T-1}(p')dG(p') + \int_{\frac{z}{\Delta}} S_{1,T-1}(p')dG(p') \bigg) \\
&= 2[(1+\Delta)p - b] - z + \Psi\lambda_e(1+\Delta) \int_p (p'-p)dG(p') \\
&\quad - \frac{\gamma}{\alpha+\gamma}\lambda_u \bigg[\int_b (p'-b)dG(p') + \Delta \int_{\frac{z}{\Delta}} \Big(p' - \frac{z}{\Delta}\Big) dG(p') \bigg]
\end{aligned}
$$

$$
\begin{aligned}
S_{2,T-2}(p) &= (1+\Delta)p - b + S_{2,T-1}(p) \\
&\quad + \Psi\lambda_e \int_p \Big(S_{2,T-1}(p') - S_{2,T-1}(p)\Big) dG(p') \\
&\quad - \frac{\gamma}{\alpha+\gamma}\lambda_u \int_{\frac{b}{1+\Delta}} S_{2,T-1}(p')dG(p') \\
&= 2[(1+\Delta)p - b] + (1+\Delta)\Psi\lambda_e \int_p (p'-p)dG(p') \\
&\quad - (1+\Delta)\frac{\gamma}{\alpha+\gamma}\lambda_u \int_{\frac{b}{1+\Delta}} \Big(p' - \frac{b}{1+\Delta}\Big) dG(p')
\end{aligned}
$$

Accordingly, we get:

$$
\begin{aligned}
S_{1,T-2}(p) - S_{0,T-2}(p) &= 2\Delta p - z + \Psi\lambda_e\Delta \bigg[\int_p (p'-p)dG(p') - \int_{\frac{z}{\Delta}} \Big(p' - \frac{z}{\Delta}\Big) dG(p') \bigg] \\
S_{2,T-2}(p) - S_{0,T-2}(p) &= 2\Delta p + \Psi\lambda_e\Delta \bigg[\int_p (p'-p)dG(p') - \int_{\frac{z}{\Delta}} \Big(p' - \frac{z}{\Delta}\Big) dG(p') \bigg] \\
&\quad - \frac{\gamma}{\alpha+\gamma}\lambda_u \bigg[(1+\Delta) \int_{\frac{b}{1+\Delta}} \Big(p' - \frac{b}{1+\Delta}\Big) dG(p') - \int_b (p'-b)dG(p') \\
&\quad - \Delta \int_{\frac{z}{\Delta}} \Big(p' - \frac{z}{\Delta}\Big) dG(p') \bigg]
\end{aligned}
$$

This implies notably:

$$\frac{\partial[S_{1,T-2}(p) - S_{0,T-2}(p)]}{\partial p} > 0$$
$$\frac{\partial[S_{2,T-2}(p) - S_{0,T-2}(p)]}{\partial p} > 0$$

At this stage, it is worth emphasizing that the impact of the transfer fee system on surplus gaps with respect to the untrained situation is actually productivity dependent. We indeed have:

$$\text{if} p > \frac{z}{\Delta}, \frac{\partial[S_{1,T-2}(p) - S_{0,T-2}(p)]}{\partial \Psi} < 0 \text{and} \frac{\partial[S_{2,T-2}(p) - S_{0,T-2}(p)]}{\partial p} < 0 \quad (1)$$
$$\text{if} p < \frac{z}{\Delta}, \frac{\partial[S_{1,T-2}(p) - S_{0,T-2}(p)]}{\partial \Psi} > 0 \text{and} \frac{\partial[S_{2,T-2}(p) - S_{0,T-2}(p)]}{\partial p} > 0 \quad (2)$$

Then, from $S_{0,T-2}(F_{T-2}) = S_{1,T-2}(F_{T-2})$, it comes that

$$2F_{T-2} = \frac{z}{\Delta} - \Psi\lambda_e \left[\int_{F_{T-2}} (p' - F_{T-2}) dG(p') - \int_{\frac{z}{\Delta}} \left(p' - \frac{z}{\Delta} \right) dG(p') \right]$$

which impliques $\frac{dF_{T-2}}{d\Psi} < 0$. In words, the transfer fee system does increase access to training at $T-2$. But then, the point is that it is not necessarily the case for younger ages.

First, consider $T-3$ and notice in particular that the gap between the value of nonemployment for trained workers and untrained workers now enters surplus for type-1:

$$
\begin{aligned}
S_{1,T-3}(p) &= (1+\Delta)p - b - z + S_{2,T-2}(p) \\
&+\Psi\lambda_e \int_p \Big(S_{2,T-2}(p') - S_{2,T-2}(p)\Big) dG(p') \\
&-\frac{\gamma}{\alpha+\gamma}\lambda_u \bigg(\int_b^{F_{T-2}} S_{0,T-2}(p')dG(p') + \int_{F_{T-2}} S_{1,T-2}(p')dG(p')\bigg) \\
&+\Big(U_{2,T-2} - U_{0,T-2}\Big)
\end{aligned}
$$

with

$$
\begin{aligned}
U_{2,T-2} - U_{0,T-2} &= \Big(U_{2,T-1} - U_{0,T-1}\Big) + \frac{\gamma}{\alpha+\gamma}\lambda_u \bigg(\int_b^{F_{T-1}} (S_{2,T-1}(p') - S_{0,T-1}(p'))dG(p') \\
&+ \int_{F_{T-1}} (S_{2,T-1}(p') - S_{1,T-1}(p'))dG(p')\bigg) \\
&= \frac{\gamma}{\alpha+\gamma}\lambda_u \bigg(\Delta \int_b p' dG(p') - z \int_{F_{T-1}} dG(p')\bigg)
\end{aligned}
$$

But yet, this gap between nonemployment values does not depend on Ψ, that is the existence (or not) of a transfer fee system. This is no longer the case in $T-4$ since the surplus for type-1 workers is given by:

$$
\begin{aligned}
S_{1,T-4}(p) &= (1+\Delta)p - b - z + S_{2,T-3}(p) \\
&+\Psi\lambda_e \int_p \Big(S_{2,T-3}(p') - S_{2,T-3}(p)\Big) dG(p') \\
&-\frac{\gamma}{\alpha+\gamma}\lambda_u \bigg(\int_b^{F_{T-3}} S_{0,T-3}(p')dG(p') + \int_{F_{T-3}} S_{1,T-3}(p')dG(p')\bigg) \\
&+\Big(U_{2,T-3} - U_{0,T-3}\Big)
\end{aligned}
$$

with

$$
\begin{aligned}
U_{2,T-3} - U_{0,T-3} &= \Big(U_{2,T-2} - U_{0,T-2}\Big) + \frac{\gamma}{\alpha+\gamma}\lambda_u \bigg(\int_b^{F_{T-2}} (S_{2,T-2}(p') - S_{0,T-2}(p'))dG(p') \\
&+ \int_{F_{T-2}} (S_{2,T-2}(p') - S_{1,T-2}(p'))dG(p')\bigg)
\end{aligned}
$$

The key point is that $\frac{\partial[U_{2,T-2} - U_{0,T-2}]}{\partial\Psi} = 0$ and from equation (1) we do know that for some $p > \frac{z}{\Delta}$ we have $\frac{\partial[S_{2,T-2}(p') - S_{0,T-2}(p')]}{\partial \Psi} < 0$, $\frac{\partial[S_{1,T-2}(p4) - S_{0,T-2}(p')]}{\partial \Psi} < 0$. Therefore, depending notably on the cdf G, ie. $G(\frac{z}{\Delta})$ low enough, it can be the case:

$$\frac{\partial[U_{2,T-3} - U_{0,T-3}]}{\partial \Psi} < 0$$

Accordingly, since the training threshold at $T-4$ is given by:

$$\begin{aligned}
\Delta F_{T-4} &= z - [S_{2,T-3}(F_{T-4}) - S_{0,T-3}(F_{T-4})][1 - \Psi \lambda_e (1 - G(F_{T-4}))] \\
&\quad - \Psi \lambda_e \int_{F_{T-4}} \Big(S_{2,T-3}(p') - S_{0,T-3}(p')\Big) dG(p') \\
&\quad - \Psi \lambda_e \int_{F_{T-4}} \Big(S_{1,T-3}(p') - S_{0,T-3}(p')\Big) dG(p') \\
&\quad - (U_{2,T-3} - U_{0,T-3})
\end{aligned}$$

The impact of Ψ on F_{T-4} is no longer clear cut, and in particular whether the transfer fee system leads to a large decrease of $U_{2,T-3} - U_{0,T-3}$, then it would lead to an increase of F_{T-4}, hence a lower share of workers accessing training. *QED*.

B Value fonctions and joint surpluses

Firms are characterized by their technology $p \in [\underline{p}, \overline{p}]$, distributed according to a distribution function $G(p)$.

Workers are characterized by their type $j \in \{0, 1, 2\}$ and their age $t \in [1, T]$. They are also characterized by their level of specific human capital, denoted by s, with $\underline{s}$ and $\bar{s}$ the lowest and highest level of specific human capital, respectively. At the end of the period, the specific human capital of an employed worker may increase with probability ρ, provided that it has not already reached the highest level. Specific human capital is thus governed by the following Markov process:

$$\mu(s, s') = \begin{cases} 1-\rho & \text{if} \quad s < \bar{s} \quad \text{and} \quad s' = s \\ \rho & \text{if} \quad s < \bar{s} \quad \text{and} \quad s' = s+1 \\ 1 & \text{if} \quad s = \bar{s} \end{cases}$$

Note that, in our simulations, we only consider two levels of specific human capital, which can be low ($\underline{s}$) or high ($\bar{s}$).

We consider that the wage is fixed and can only be renegotiated if either party has a credible threat. The wage thus depends on the worker's negotiation benchmark, noted NB, which corresponds to the maximum between the value of nonemployment and the value of the highest outside offer received while employed. We denote by $w_{j,t}(p, s, NB)$ the wage of a worker of type j and age t, with specific human capital s and negotiation benchmark NB, matched with a p-firm.

Let's define the following value functions:

- $E_{j,t}(p, s, NB)$ is the value of employment for a worker of type j and age t, matched with a p-firm, with specific human capital s and negotiation benchmark NB
- $U_{j,t}$ is the value of nonemployment for a worker of type j and age t
- $J_{j,t}(p, s, NB)$ is the value of a filled job for a p-firm, matched with a worker of type j and age t, with specific human capital s and negotiation benchmark NB

Let $S_{j,t}(p, s) = E_{j,t}(p, s, NB) - U_{j,t} + J_{j,t}(p, s, NB)$ be the joint surplus of a match between a p-firm and a worker of type j and age t. Note that $S_{j,t}(p, s)$ depends on p and s, which determines the productivity of the worker and therefore the value of the joint surplus, but not on NB, which has no impact on the value of the joint surplus but only on the way in which the worker and firm share it. Note also that an initial match is formed only if the surplus is non-negative and that an existing match is endogenously destroyed if the value becomes negative.

In the rest of the paper, we will use the following notation:

$$S^{+}_{j,t}(p, s) = \max\{S_{j,t}(p, s), 0\}$$

Workers search on and off the job. Employed workers receive an outside offer from a p'-firm (which can lead to job-to-job mobility or wage renegotiation) with an arrival rate λ_e, while nonemployed workers receive a job offer from a p'-firm with an arrival rate λ_u. Existing matches can be exogenously destroyed with probability $\delta_{j,t}$, which depends on the worker's type and age. The discount factor is denoted by $\zeta \in (0, 1)$. Finally, for the equilibrium with transfer fees, we let $T_{j,t}(p', s, p)$ be the transfer fees paid by the poaching firm to the incumbent firm.

B.1 Joint surplus - Type 0 - Equilibrium without transfer fees

$$E_{0,t}(p,s,NB) = w_{0,t}(p,s,NB) + \zeta\Bigg[(1-\delta_{0,t})\Bigg[\lambda_e\Bigg(\int_{p'\in M^{R_0}_{t+1}(p,s,NB)}\sum_{s'}\mu(s,s')E_{0,t+1}(p,s',p')\,dG(p')$$

$$+\int_{p'\in M^{E_0}_{t+1}(p,s,NB)} E_{0,t+1}(p',\underline{s},p)\,dG(p') + \int_{p'\in M^{E_1}_{t+1}(p,s,NB)} E_{1,t+1}(p',\underline{s},p)\,dG(p')\Bigg)$$

$$+\Bigg(1-\lambda_e\int_{p'\in M^{R_0}_{t+1}(p,s,NB)\cup M^{E_0}_{t+1}(p,s,NB)\cup M^{E_1}_{t+1}(p,s,NB)} dG(p')\Bigg)\sum_{s'}\mu(s,s')E_{0,t+1}(p,s',NB)\Bigg] + \delta_{0,t}U_{0,t+1}\Bigg]$$

$$U_{0,t} = b + \zeta\Bigg[\lambda_u\Bigg(\int_{p'\in M^{U_0}_{t+1}} E_{0,t+1}(p',\underline{s},u)\,dG(p') + \int_{p'\in M^{U_1}_{t+1}} E_{1,t+1}(p',\underline{s},u)\,dG(p')\Bigg)$$

$$+\Bigg(1-\lambda_u\int_{p'\in M^{U_0}_{t+1}\cup M^{U_1}_{t+1}} dG(p')\Bigg)U_{0,t+1}\Bigg]$$

$$J_{0,t}(p,s,NB) = (1+s)p - w_{0,t}(p,s,NB) + \zeta(1-\delta_{0,t})\Bigg[\lambda_e\int_{p'\in M^{R_0}_{t+1}(p,s,NB)}\sum_{s'}\mu(s,s')J_{0,t+1}(p,s',p')\,dG(p')$$

$$+\Bigg(1-\lambda_e\int_{p'\in M^{R_0}_{t+1}(p,s,NB)\cup M^{E_0}_{t+1}(p,s,NB)\cup M^{E_1}_{t+1}(p,s,NB)} dG(p')\Bigg)\sum_{s'}\mu(s,s')J_{0,t+1}(p,s',NB)\Bigg]$$

$$S_{0,t}(p,s) \quad = \quad E_{0,t}(p,s,NB) - U_{0,t} + J_{0,t}(p,s,NB)$$

where:

- $p' \in M^{R_0}_{t+1}(p,s,NB)$ if $\sum_{s'}\mu(s,s')S_{0,t+1}(p,s') > S_{j,t+1}(p',\underline{s}) > S_{j,t+1}(NB,\underline{s})\ \forall\, j \in \{0,1\}$
- $p' \in M^{E_0}_{t+1}(p,s,NB)$ if $S_{0,t+1}(p',\underline{s}) > \sum_{s'}\mu(s,s')S_{0,t+1}(p,s')$ and $S_{0,t+1}(p',\underline{s}) > S_{1,t+1}(p',\underline{s})$
- $p' \in M^{E_1}_{t+1}(p,s,NB)$ if $S_{1,t+1}(p',\underline{s}) > \sum_{s'}\mu(s,s')S_{0,t+1}(p,s')$ and $S_{1,t+1}(p',\underline{s}) \geq S_{0,t+1}(p',\underline{s})$
- $p' \in M^{U_0}_{t+1}$ if $S_{0,t+1}(p',\underline{s}) > 0$ and $S_{0,t+1}(p',\underline{s}) > S_{1,t+1}(p',\underline{s})$
- $p' \in M^{U_1}_{t+1}$ if $S_{1,t+1}(p',\underline{s}) > 0$ and $S_{1,t+1}(p',\underline{s}) \geq S_{0,t+1}(p',\underline{s})$

The surplus can therefore be rewritten as follows:

$$
\begin{aligned}
&S_{0,t}(p,s) = (1+s)p - b \\
&+\zeta\Bigg[(1-\delta_{0,t})\Big[\sum_{s'}\mu(s,s')E_{0,t+1}(p,s',NB) - U_{0,t+1} + \sum_{s'}\mu(s,s')J_{0,t+1}(p,s',NB) \\
&+\lambda_e\Big(\int_{p'\in M^{R_0}_{t+1}(p,s,NB)}\Big(\sum_{s'}\mu(s,s')E_{0,t+1}(p,s',p') + \sum_{s'}\mu(s,s')J_{0,t+1}(p,s',p')\Big)\,dG(p') \\
&-\int_{p'\in M^{R_0}_{t+1}(p,s,NB)} dG(p')\Big(\sum_{s'}\mu(s,s')E_{0,t+1}(p,s',NB) + \sum_{s'}\mu(s,s')J_{0,t+1}(p,s',NB)\Big) \\
&+\int_{p'\in M^{E_0}_{t+1}(p,s,NB)} E_{0,t+1}(p',\underline{s},p)\,dG(p') \\
&-\int_{p'\in M^{E_0}_{t+1}(p,s,NB)} dG(p')\Big(\sum_{s'}\mu(s,s')E_{0,t+1}(p,s',NB) + \sum_{s'}\mu(s,s')J_{0,t+1}(p,s',NB)\Big) \\
&+\int_{p'\in M^{E_1}_{t+1}(p,s,NB)} E_{1,t+1}(p',\underline{s},p)\,dG(p') \\
&-\int_{p'\in M^{E_1}_{t+1}(p,s,NB)} dG(p')\Big(\sum_{s'}\mu(s,s')E_{0,t+1}(p,s',NB) + \sum_{s'}\mu(s,s')J_{0,t+1}(p,s',NB)\Big)\Big)\Big] \\
&-\lambda_u\Big(\int_{p'\in M^{U_0}_{t+1}}\Big(E_{0,t+1}(p',\underline{s},u) - U_{0,t+1}\Big)\,dG(p') + \int_{p'\in M^{U_1}_{t+1}}\Big(E_{1,t+1}(p',\underline{s},u) - U_{0,t+1}\Big)\,dG(p')\Big)\Bigg]
\end{aligned}
$$

with:

$$\sum_{s'}\mu(s,s')E_{0,t+1}(p,s',NB) - U_{0,t+1} + \sum_{s'}\mu(s,s')J_{0,t+1}(p,s',NB) = \sum_{s'}\mu(s,s')S_{0,t+1}(p,s')$$

$$\sum_{s'}\mu(s,s')E_{0,t+1}(p,s',p') - U_{0,t+1} + \sum_{s'}\mu(s,s')J_{0,t+1}(p,s',p') = \sum_{s'}\mu(s,s')S_{0,t+1}(p,s')$$

$$E_{0,t+1}(p',\underline{s},p) - U_{0,t+1} = \sum_{s'}\mu(s,s')S_{0,t+1}(p,s') + \frac{\gamma}{\beta+\gamma}(S_{0,t+1}(p',\underline{s}) - \sum_{s'}\mu(s,s')S_{0,t+1}(p,s')) \text{ if } p' \in M^{E_0}_{t+1}(p,s,NB)$$

$$E_{1,t+1}(p',\underline{s},p) - U_{0,t+1} = \sum_{s'}\mu(s,s')S_{0,t+1}(p,s') + \frac{\gamma}{\beta+\gamma}(S_{1,t+1}(p',\underline{s}) - \sum_{s'}\mu(s,s')S_{0,t+1}(p,s')) \text{ if } p' \in M^{E_1}_{t+1}(p,s,NB)$$

$$E_{0,t+1}(p',\underline{s},u) - U_{0,t+1} = \frac{\gamma}{\alpha+\gamma}S_{0,t+1}(p',\underline{s})$$

$$E_{1,t+1}(p',\underline{s},u) - U_{0,t+1} = \frac{\gamma}{\alpha+\gamma}S_{1,t+1}(p',\underline{s})$$

With a little calculation, we get the following expression:

$$
\begin{aligned}
S_{0,t}(p,s) \;=\;& (1+s)p-b \\
&+\zeta\Bigg[(1-\delta_{0,t})\Bigg[\sum_{s'}\mu(s,s')S^{+}_{0,t+1}(p,s') \\
&+\frac{\gamma}{\beta+\gamma}\lambda_e\Bigg(\int_{p'\in M^{E_0}_{t+1}(p,s,NB)}\Big(S^{+}_{0,t+1}(p',\underline{s})-\sum_{s'}\mu(s,s')S^{+}_{0,t+1}(p,s')\Big)\,dG(p') \\
&+\int_{p'\in M^{E_1}_{t+1}(p,s,NB)}\Big(S^{+}_{1,t+1}(p',\underline{s})-\sum_{s'}\mu(s,s')S^{+}_{0,t+1}(p,s')\Big)\,dG(p')\Bigg)\Bigg] \\
&-\frac{\gamma}{\alpha+\gamma}\lambda_u\Bigg(\int_{p'\in M^{U_0}_{t+1}}S_{0,t+1}(p',\underline{s})\,dG(p')+\int_{p'\in M^{U_1}_{t+1}}S_{1,t+1}(p',\underline{s})\,dG(p')\Bigg)\Bigg]
\end{aligned}
$$

where:

- $p' \in M^{E_0}_{t+1}(p,s,NB)$ if $S_{0,t+1}(p',\underline{s}) > \sum_{s'}\mu(s,s')S_{0,t+1}(p,s')$ and $S_{0,t+1}(p',\underline{s}) > S_{1,t+1}(p',\underline{s})$
- $p' \in M^{E_1}_{t+1}(p,s,NB)$ if $S_{1,t+1}(p',\underline{s}) > \sum_{s'}\mu(s,s')S_{0,t+1}(p,s')$ and $S_{1,t+1}(p',\underline{s}) \geq S_{0,t+1}(p',\underline{s})$
- $p' \in M^{U_0}_{t+1}$ if $S_{0,t+1}(p',\underline{s}) > 0$ and $S_{0,t+1}(p',\underline{s}) > S_{1,t+1}(p',\underline{s})$
- $p' \in M^{U_1}_{t+1}$ if $S_{1,t+1}(p',\underline{s}) > 0$ and $S_{1,t+1}(p',\underline{s}) \geq S_{0,t+1}(p',\underline{s})$

B.2 Joint surplus - Type 0 - Equilibrium with transfer fees

$$E_{0,t}(p,s,u) = w_{0,t}(p,s,u) + \zeta\Bigg[(1-\delta_{0,t})\Bigg[\lambda_e\Bigg($$
$$+ \int_{p'\in M^{E_0}_{t+1}(p,s,NB)} E_{0,t+1}(p',\underline{s},p)\,dG(p') + \int_{p'\in M^{E_1}_{t+1}(p,s,NB)} E_{1,t+1}(p',\underline{s},p)\,dG(p')\Bigg)$$
$$+\Bigg(1-\lambda_e\int_{p'\in M^{E_0}_{t+1}(p,s,NB)\cup M^{E_1}_{t+1}(p,s,NB)} dG(p')\Bigg)\sum_{s'}\mu(s,s')E_{0,t+1}(p,s',u)\Bigg] + \delta_{0,t}U_{0,t+1}\Bigg]$$

$$U_{0,t} = b + \zeta\Bigg[\lambda_u\Bigg(\int_{p'\in M^{U_0}_{t+1}} E_{0,t+1}(p',\underline{s},u)\,dG(p') + \int_{p'\in M^{U_1}_{t+1}} E_{1,t+1}(p',\underline{s},u)\,dG(p')\Bigg)$$
$$+\Bigg(1-\lambda_u\int_{p'\in M^{U_0}_{t+1}\cup M^{U_1}_{t+1}} dG(p')\Bigg)U_{0,t+1}\Bigg]$$

$$J_{0,t}(p,s,u) = (1+s)p - w_{0,t}(p,s,u) + \zeta(1-\delta_{0,t})\Bigg[\lambda_e\Bigg($$
$$\int_{p'\in M^{E_0}_{t+1}(p,s,NB)} T_{0,t+1}(p',s,p)\,dG(p') + \int_{p'\in M^{E_1}_{t+1}(p,s,NB)} T_{1,t+1}(p',s,p)\,dG(p')\Bigg)$$
$$+\Bigg(1-\lambda_e\int_{p'\in M^{E_0}_{t+1}(p,s,NB)\cup M^{E_1}_{t+1}(p,s,NB)} dG(p')\Bigg)\sum_{s'}\mu(s,s')J_{0,t+1}(p,s',u)\Bigg]$$

$$S_{0,t}(p,s) = E_{0,t}(p,s,u) - U_{0,t} + J_{0,t}(p,s,u)$$

where:

- $p' \in M^{E_0}_{t+1}(p,s,NB)$ if $S_{0,t+1}(p',\underline{s}) > \sum_{s'}\mu(s,s')S_{0,t+1}(p,s')$ and $S_{0,t+1}(p',\underline{s}) > S_{1,t+1}(p',\underline{s})$
- $p' \in M^{E_1}_{t+1}(p,s,NB)$ if $S_{1,t+1}(p',\underline{s}) > \sum_{s'}\mu(s,s')S_{0,t+1}(p,s')$ and $S_{1,t+1}(p',\underline{s}) \geq S_{0,t+1}(p',\underline{s})$
- $p' \in M^{U_0}_{t+1}$ if $S_{0,t+1}(p',\underline{s}) > 0$ and $S_{0,t+1}(p',\underline{s}) > S_{1,t+1}(p',\underline{s})$
- $p' \in M^{U_1}_{t+1}$ if $S_{1,t+1}(p',\underline{s}) > 0$ and $S_{1,t+1}(p',\underline{s}) \geq S_{0,t+1}(p',\underline{s})$

The surplus can therefore be rewritten as follows:

$$
\begin{aligned}
&S_{0,t}(p,s) = (1+s)p - b \\
&+\zeta\Bigg[(1-\delta_{0,t})\Bigg[\sum_{s'}\mu(s,s')E_{0,t+1}(p,s',u) - U_{0,t+1} + \sum_{s'}\mu(s,s')J_{0,t+1}(p,s',u) \\
&+\lambda_e\Bigg(\int_{p'\in M^{E_0}_{t+1}(p,s,NB)} E_{0,t+1}(p',\underline{s},p)\,dG(p') \\
&-\int_{p'\in M^{E_0}_{t+1}(p,s,NB)} dG(p')\Big(\sum_{s'}\mu(s,s')E_{0,t+1}(p,s',u) + \sum_{s'}\mu(s,s')J_{0,t+1}(p,s',u)\Big) \\
&+\int_{p'\in M^{E_1}_{t+1}(p,s,NB)} E_{1,t+1}(p',\underline{s},p)\,dG(p') \\
&-\int_{p'\in M^{E_1}_{t+1}(p,s,NB)} dG(p')\Big(\sum_{s'}\mu(s,s')E_{0,t+1}(p,s',u) + \sum_{s'}\mu(s,s')J_{0,t+1}(p,s',u)\Big) \\
&+\int_{p'\in M^{E_0}_{t+1}(p,s,NB)} T_{0,t+1}(p',s,p)\,dG(p') + \int_{p'\in M^{E_1}_{t+1}(p,s,NB)} T_{1,t+1}(p',s,p)\,dG(p')\Bigg)\Bigg] \\
&-\lambda_u\Bigg(\int_{p'\in M^{U_0}_{t+1}}\Big(E_{0,t+1}(p',\underline{s},u) - U_{0,t+1}\Big)\,dG(p') + \int_{p'\in M^{U_1}_{t+1}}\Big(E_{1,t+1}(p',\underline{s},u) - U_{0,t+1}\Big)\,dG(p')\Bigg)\Bigg]
\end{aligned}
$$

with:

$$\sum_{s'}\mu(s,s')E_{0,t+1}(p,s',u) - U_{0,t+1} + \sum_{s'}\mu(s,s')J_{0,t+1}(p,s',u) = \sum_{s'}\mu(s,s')S_{0,t+1}(p,s')$$

$$E_{0,t+1}(p',\underline{s},p) - U_{0,t+1} = \frac{\gamma}{\alpha+\gamma}\sum_{s'}\mu(s,s')S_{0,t+1}(p,s') + \frac{\gamma}{\alpha+\beta+\gamma}\big(S_{0,t+1}(p',\underline{s}) - \sum_{s'}\mu(s,s')S_{0,t+1}(p,s')\big) \text{ if } p' \in M^{E_0}_{t+1}(p,s,NB)$$

$$E_{1,t+1}(p',\underline{s},p) - U_{0,t+1} = \frac{\gamma}{\alpha+\gamma}\sum_{s'}\mu(s,s')S_{0,t+1}(p,s') + \frac{\gamma}{\alpha+\beta+\gamma}\big(S_{1,t+1}(p',\underline{s}) - \sum_{s'}\mu(s,s')S_{0,t+1}(p,s')\big) \text{ if } p' \in M^{E_1}_{t+1}(p,s,NB)$$

$$E_{0,t+1}(p',\underline{s},u) - U_{0,t+1} = \frac{\gamma}{\alpha+\gamma}S_{0,t+1}(p',\underline{s})$$

$$E_{1,t+1}(p',\underline{s},u) - U_{0,t+1} = \frac{\gamma}{\alpha+\gamma}S_{1,t+1}(p',\underline{s})$$

$$T_{0,t+1}(p',s,p) = \frac{\alpha}{\alpha+\gamma}\sum_{s'}\mu(s,s')S_{0,t+1}(p,s') + \frac{\alpha}{\alpha+\beta+\gamma}\Big[S_{0,t+1}(p',\underline{s}) - \sum_{s'}\mu(s,s')S_{0,t+1}(p,s')\Big]$$

$$T_{1,t+1}(p',s,p) = \frac{\alpha}{\alpha+\gamma}\sum_{s'}\mu(s,s')S_{0,t+1}(p,s') + \frac{\alpha}{\alpha+\beta+\gamma}\Big[S_{1,t+1}(p',\underline{s}) - \sum_{s'}\mu(s,s')S_{0,t+1}(p,s')\Big]$$

With a little calculation, we get the following expression:

$$
\begin{aligned}
S_{0,t}(p,s) \quad = \quad & (1+s)p - b \\
& + \zeta \Bigg[(1-\delta_{0,t}) \Bigg[\sum_{s'} \mu(s,s') S^{+}_{0,t+1}(p,s') \\
& + (\alpha+\gamma)\lambda_e \Bigg(\int_{p' \in M^{E_0}_{t+1}(p,s,NB)} \Big(S^{+}_{0,t+1}(p',\underline{s}) - \sum_{s'} \mu(s,s') S^{+}_{0,t+1}(p,s') \Big) \, dG(p') \\
& + \int_{p' \in M^{E_1}_{t+1}(p,s,NB)} \Big(S^{+}_{1,t+1}(p',\underline{s}) - \sum_{s'} \mu(s,s') S^{+}_{0,t+1}(p,s') \Big) \, dG(p') \Bigg) \Bigg] \\
& - \frac{\gamma}{\alpha+\gamma} \lambda_u \Bigg(\int_{p' \in M^{U_0}_{t+1}} S_{0,t+1}(p',\underline{s}) \, dG(p') + \int_{p' \in M^{U_1}_{t+1}} S_{1,t+1}(p',\underline{s}) \, dG(p') \Bigg) \Bigg]
\end{aligned}
$$

where:

- $p' \in M^{E_0}_{t+1}(p,s,NB)$ if $S_{0,t+1}(p',\underline{s}) > \sum_{s'} \mu(s,s') S_{0,t+1}(p,s')$ and $S_{0,t+1}(p',\underline{s}) > S_{1,t+1}(p',\underline{s})$
- $p' \in M^{E_1}_{t+1}(p,s,NB)$ if $S_{1,t+1}(p',\underline{s}) > \sum_{s'} \mu(s,s') S_{0,t+1}(p,s')$ and $S_{1,t+1}(p',\underline{s}) \geq S_{0,t+1}(p',\underline{s})$
- $p' \in M^{U_0}_{t+1}$ if $S_{0,t+1}(p',\underline{s}) > 0$ and $S_{0,t+1}(p',\underline{s}) > S_{1,t+1}(p',\underline{s})$
- $p' \in M^{U_1}_{t+1}$ if $S_{1,t+1}(p',\underline{s}) > 0$ and $S_{1,t+1}(p',\underline{s}) \geq S_{0,t+1}(p',\underline{s})$

B.3 Joint surplus - Type 1 - Equilibrium without transfer fees

$$E_{1,t}(p,s,NB) = w_{1,t}(p,s,NB) + \zeta\Bigg[(1-\delta_{2,t})\Bigg[\lambda_e\Bigg(\int_{p'\in M^{R_2}_{t+1}(p,s,NB)}\sum_{s'}\mu(s,s')E_{2,t+1}(p,s',p')\,dG(p')$$
$$+\int_{p'\in M^{E_2}_{t+1}(p,s,NB)} E_{2,t+1}(p',\underline{s},p)\,dG(p')\Bigg)$$
$$+\Bigg(1-\lambda_e\int_{p'\in M^{R_2}_{t+1}(p,s,NB)\cup M^{E_2}_{t+1}(p,s,NB)} dG(p')\Bigg)\sum_{s'}\mu(s,s')E_{2,t+1}(p,s',NB)\Bigg] + \delta_{2,t}U_{2,t+1}\Bigg]$$

$$U_{0,t} = b + \zeta\Bigg[\lambda_u\Bigg(\int_{p'\in M^{U_0}_{t+1}} E_{0,t+1}(p',\underline{s},u)\,dG(p') + \int_{p'\in M^{U_1}_{t+1}} E_{1,t+1}(p',\underline{s},u)\,dG(p')\Bigg)$$
$$+\Bigg(1-\lambda_u\int_{p'\in M^{U_0}_{t+1}\cup M^{U_1}_{t+1}} dG(p')\Bigg)U_{0,t+1}\Bigg]$$

$$J_{1,t}(p,s,NB) = (1+\Delta)(1+s)p - w_{1,t}(p,s,NB) - z + \zeta(1-\delta_{2,t})\Bigg[\lambda_e\int_{p'\in M^{R_2}_{t+1}(p,s,NB)}\sum_{s'}\mu(s,s')J_{2,t+1}(p,s',p')$$
$$+\Bigg(1-\lambda_e\int_{p'\in M^{R_2}_{t+1}(p,s,NB)\cup M^{E_2}_{t+1}(p,s,NB)} dG(p')\Bigg)\sum_{s'}\mu(s,s')J_{2,t+1}(p,s',NB)\Bigg]$$

$$S_{1,t}(p,s) \;=\; E_{1,t}(p,s,NB) - U_{0,t} + J_{1,t}(p,s,NB)$$

where:

- $p' \in M^{R_2}_{t+1}(p,s,NB)$ if $\sum_{s'}\mu(s,s')S_{2,t+1}(p,s') > S_{2,t+1}(p',\underline{s}) > S_{2,t+1}(NB)$
- $p' \in M^{E_2}_{t+1}(p,s,NB)$ if $S_{2,t+1}(p',\underline{s}) > \sum_{s'}\mu(s,s')S_{2,t+1}(p,s')$
- $p' \in M^{U_0}_{t+1}$ if $S_{0,t+1}(p',\underline{s}) > 0$ and $S_{0,t+1}(p',\underline{s}) > S_{1,t+1}(p',\underline{s})$
- $p' \in M^{U_1}_{t+1}$ if $S_{1,t+1}(p',\underline{s}) > 0$ and $S_{1,t+1}(p',\underline{s}) \geq S_{0,t+1}(p',\underline{s})$

The surplus can therefore be rewritten as follows:

$$
\begin{aligned}
&S_{1,t}(p,s) = (1+\Delta)(1+s)p - b - z \\
&+\zeta\Bigg[(1-\delta_{2,t})\Bigg[\sum_{s'}\mu(s,s')E_{2,t+1}(p,s',NB) - U_{2,t+1} + \sum_{s'}\mu(s,s')J_{2,t+1}(p,s',NB) \\
&+\lambda_e\Bigg(\int_{p'\in M^{R_2}_{t+1}(p,s,NB)}\Big(\sum_{s'}\mu(s,s')E_{2,t+1}(p,s',p') + \sum_{s'}\mu(s,s')J_{2,t+1}(p,s',p')\Big)\,dG(p') \\
&-\int_{p'\in M^{R_2}_{t+1}(p,s,NB)} dG(p')\Big(\sum_{s'}\mu(s,s')E_{2,t+1}(p,s',NB) + \sum_{s'}\mu(s,s')J_{2,t+1}(p,s',NB)\Big) \\
&+\int_{p'\in M^{E_2}_{t+1}(p,s,NB)} E_{2,t+1}(p',\underline{s},p)\,dG(p') \\
&-\int_{p'\in M^{E_2}_{t+1}(p,s,NB)} dG(p')\Big(\sum_{s'}\mu(s,s')E_{2,t+1}(p,s',NB) + \sum_{s'}\mu(s,s')J_{2,t+1}(p,s',NB)\Big)\Bigg)\Bigg] \\
&-\lambda_u\Bigg(\int_{p'\in M^{U_0}_{t+1}}\Big(E_{0,t+1}(p',\underline{s},u) - U_{0,t+1}\Big)\,dG(p') + \int_{p'\in M^{U_1}_{t+1}}\Big(E_{1,t+1}(p',\underline{s},u) - U_{0,t+1}\Big)\,dG(p')\Bigg) \\
&+\Big(U_{2,t+1} - U_{0,t+1}\Big)\Bigg]
\end{aligned}
$$

with:

$$\sum_{s'}\mu(s,s')E_{2,t+1}(p,s',NB) - U_{2,t+1} + \sum_{s'}\mu(s,s')J_{2,t+1}(p,s',NB) = \sum_{s'}\mu(s,s')S_{2,t+1}(p,s')$$

$$\sum_{s'}\mu(s,s')E_{2,t+1}(p,s',p') - U_{2,t+1} + \sum_{s'}\mu(s,s')J_{2,t+1}(p,s',p') = \sum_{s'}\mu(s,s')S_{2,t+1}(p,s')$$

$$E_{2,t+1}(p',\underline{s},p) - U_{2,t+1} = \sum_{s'}\mu(s,s')S_{2,t+1}(p,s') + \frac{\gamma}{\beta+\gamma}\big(S_{2,t+1}(p',\underline{s}) - \sum_{s'}\mu(s,s')S_{2,t+1}(p,s')\big)$$

$$E_{0,t+1}(p',\underline{s},u) - U_{0,t+1} = \frac{\gamma}{\alpha+\gamma}S_{0,t+1}(p',\underline{s})$$

$$E_{1,t+1}(p',\underline{s},u) - U_{0,t+1} = \frac{\gamma}{\alpha+\gamma}S_{1,t+1}(p',\underline{s})$$

With a little calculation, we get the following expression:

$$\begin{aligned} S_{1,t}(p,s) &= (1+\Delta)(1+s)p - b - z \\ &+\zeta\Bigg[(1-\delta_{2,t})\Bigg[\sum_{s'}\mu(s,s')S^{+}_{2,t+1}(p,s') \\ &+\frac{\gamma}{\beta+\gamma}\lambda_e\Bigg(\int_{p'\in M^{E_2}_{t+1}(p,s,NB)}\Big(S^{+}_{2,t+1}(p',\underline{s}) - \sum_{s'}\mu(s,s')S^{+}_{2,t+1}(p,s')\Big)\,dG(p')\Bigg)\Bigg] \\ &-\frac{\gamma}{\alpha+\gamma}\lambda_u\Bigg(\int_{p'\in M^{U_0}_{t+1}} S_{0,t+1}(p',\underline{s})\,dG(p') + \int_{p'\in M^{U_1}_{t+1}} S_{1,t+1}(p',\underline{s})\,dG(p')\Bigg) \\ &+\Big(U_{2,t+1} - U_{0,t+1}\Big)\Bigg] \end{aligned}$$

with:

$$\begin{aligned} U_{2,t} - U_{0,t} &= \zeta\Bigg[\frac{\gamma}{\alpha+\gamma}\Bigg[\lambda_u\int_{p'\in M^{U_2}_{t+1}} S_{2,t+1}(p',\underline{s})\,dG(p') \\ &-\int_{p'\in M^{U_0}_{t+1}} S_{0,t+1}(p',\underline{s})\,dG(p') - \int_{p'\in M^{U_1}_{t+1}} S_{1,t+1}(p',\underline{s})\,dG(p')\Bigg] \\ &+\Bigg[1-\phi\Bigg(1-\lambda_u\int_{p'\in M^{U_2}_{t+1}} dG(p')\Bigg)\Bigg]\Big[U_{2,t+1} - U_{0,t+1}\Big]\Bigg] \end{aligned}$$

where:

- $U_{2,T-1} - U_{0,T-1} = 0$

and where:

- $p' \in M^{E_2}_{t+1}(p,s,NB)$ if $S_{2,t+1}(p',\underline{s}) > \sum_{s'}\mu(s,s')S_{2,t+1}(p,s')$
- $p' \in M^{U_0}_{t+1}$ if $S_{0,t+1}(p',\underline{s}) > 0$ and $S_{0,t+1}(p',\underline{s}) > S_{1,t+1}(p',\underline{s})$
- $p' \in M^{U_1}_{t+1}$ if $S_{1,t+1}(p',\underline{s}) > 0$ and $S_{1,t+1}(p',\underline{s}) \geq S_{0,t+1}(p',\underline{s})$
- $p' \in M^{U_2}_{t+1}$ if $S_{2,t+1}(p',\underline{s}) > 0$

B.4 Joint surplus - Type 1 - Equilibrium with transfer fees

$$E_{1,t}(p,s,u) = w_{1,t}(p,s,u) + \zeta\Bigg[(1-\delta_{2,t})\Big[\lambda_e\Big($$
$$+ \int_{p' \in M^{E_2}_{t+1}(p,s,NB)} E_{2,t+1}(p',\underline{s},p)\, dG(p')\Big)$$
$$+ \Big(1 - \lambda_e \int_{p' \in M^{E_2}_{t+1}(p,s,NB)} dG(p')\Big) \sum_{s'} \mu(s,s') E_{2,t+1}(p,s',u)\Big] + \delta_{2,t} U_{2,t+1}\Bigg]$$

$$U_{0,t} = b + \zeta\Bigg[\lambda_u\Big(\int_{p' \in M^{U_0}_{t+1}} E_{0,t+1}(p',\underline{s},u)\, dG(p') + \int_{p' \in M^{U_1}_{t+1}} E_{1,t+1}(p',\underline{s},u)\, dG(p')\Big)$$
$$+ \Big(1 - \lambda_u \int_{p' \in M^{U_0}_{t+1} \cup M^{U_1}_{t+1}} dG(p')\Big) U_{0,t+1}\Bigg]$$

$$J_{1,t}(p,s,u) = (1+\Delta)(1+s)p - w_{1,t}(p,s,u) - z + \zeta(1-\delta_{2,t})\Big[\lambda_e\Big($$
$$+ \int_{p' \in M^{E_2}_{t+1}(p,s,NB)} T_{2,t+1}(p',s,p)\, dG(p')\Big)$$
$$+ \Big(1 - \lambda_e \int_{p' \in M^{E_2}_{t+1}(p,s,NB)} dG(p')\Big) \sum_{s'} \mu(s,s') J_{2,t+1}(p,s',u)\Big]$$

$$S_{1,t}(p,s) = E_{1,t}(p,s,u) - U_{0,t} + J_{1,t}(p,s,u)$$

where:

- $p' \in M^{E_2}_{t+1}(p,s,NB)$ if $S_{2,t+1}(p',\underline{s}) > \sum_{s'} \mu(s,s') S_{2,t+1}(p,s')$
- $p' \in M^{U_0}_{t+1}$ if $S_{0,t+1}(p',\underline{s}) > 0$ and $S_{0,t+1}(p',\underline{s}) > S_{1,t+1}(p',\underline{s})$
- $p' \in M^{U_1}_{t+1}$ if $S_{1,t+1}(p',\underline{s}) > 0$ and $S_{1,t+1}(p',\underline{s}) \geq S_{0,t+1}(p',\underline{s})$

The surplus can therefore be rewritten as follows:

$$
\begin{aligned}
&S_{1,t}(p,s) = (1+\Delta)(1+s)p - b - z \\
&+\zeta\Bigg[(1-\delta_{2,t})\Bigg[\sum_{s'}\mu(s,s')E_{2,t+1}(p,s',u) - U_{2,t+1} + \sum_{s'}\mu(s,s')J_{2,t+1}(p,s',u) \\
&+\lambda_e\Bigg(\int_{p'\in M^{E_2}_{t+1}(p,s,NB)} E_{2,t+1}(p',\underline{s},p)\,dG(p') \\
&-\int_{p'\in M^{E_2}_{t+1}(p,s,NB)} dG(p')\Big(\sum_{s'}\mu(s,s')E_{2,t+1}(p,s',u) + \sum_{s'}\mu(s,s')J_{2,t+1}(p,s',u)\Big) \\
&+\int_{p'\in M^{E_2}_{t+1}(p,s,NB)} T_{2,t+1}(p',s,p)\,dG(p')\Bigg)\Bigg] \\
&-\lambda_u\Bigg(\int_{p'\in M^{U_0}_{t+1}}\Big(E_{0,t+1}(p',\underline{s},u) - U_{0,t+1}\Big)\,dG(p') + \int_{p'\in M^{U_1}_{t+1}}\Big(E_{1,t+1}(p',\underline{s},u) - U_{0,t+1}\Big)\,dG(p')\Bigg) \\
&+\Big(U_{2,t+1} - U_{0,t+1}\Big)\Bigg]
\end{aligned}
$$

with:

$$\sum_{s'}\mu(s,s')E_{2,t+1}(p,s',u) - U_{2,t+1} + \sum_{s'}\mu(s,s')J_{2,t+1}(p,s',u) = \sum_{s'}\mu(s,s')S_{2,t+1}(p,s')$$

$$E_{2,t+1}(p',\underline{s},p) - U_{2,t+1} = \frac{\gamma}{\alpha+\gamma}\sum_{s'}\mu(s,s')S_{2,t+1}(p,s') + \frac{\gamma}{\alpha+\beta+\gamma}(S_{2,t+1}(p',\underline{s}) - \sum_{s'}\mu(s,s')S_{2,t+1}(p,s'))$$

$$E_{0,t+1}(p',\underline{s},u) - U_{0,t+1} = \frac{\gamma}{\alpha+\gamma}S_{0,t+1}(p',\underline{s})$$

$$E_{1,t+1}(p',\underline{s},u) - U_{0,t+1} = \frac{\gamma}{\alpha+\gamma}S_{1,t+1}(p',\underline{s})$$

$$T_{2,t+1}(p',s,p) = \frac{\alpha}{\alpha+\gamma}\sum_{s'}\mu(s,s')S_{2,t+1}(p,s') + \frac{\alpha}{\alpha+\beta+\gamma}\left[S_{2,t+1}(p',\underline{s}) - \sum_{s'}\mu(s,s')S_{2,t+1}(p,s')\right]$$

With a little calculation, we get the following expression:

$$\begin{aligned} S_{1,t}(p,s) &= (1+\Delta)(1+s)p - b - z \\ &+\zeta\Bigg[(1-\delta_{2,t})\Bigg[\sum_{s'}\mu(s,s')S^{+}_{2,t+1}(p,s') \\ &+(\alpha+\gamma)\lambda_e\Bigg(\int_{p'\in M^{E_2}_{t+1}(p,s,NB)}\Big(S^{+}_{2,t+1}(p',\underline{s}) - \sum_{s'}\mu(s,s')S^{+}_{2,t+1}(p,s')\Big)\,dG(p')\Bigg)\Bigg] \\ &-\frac{\gamma}{\alpha+\gamma}\lambda_u\Bigg(\int_{p'\in M^{U_0}_{t+1}} S_{0,t+1}(p',\underline{s})\,dG(p') + \int_{p'\in M^{U_1}_{t+1}} S_{1,t+1}(p',\underline{s})\,dG(p')\Bigg) \\ &+\Big(U_{2,t+1} - U_{0,t+1}\Big)\Bigg] \end{aligned}$$

with:

$$\begin{aligned} U_{2,t} - U_{0,t} &= \zeta\Bigg[\frac{\gamma}{\alpha+\gamma}\Bigg[\lambda_u\int_{p'\in M^{U_2}_{t+1}} S_{2,t+1}(p',\underline{s})\,dG(p') \\ &-\int_{p'\in M^{U_0}_{t+1}} S_{0,t+1}(p',\underline{s})\,dG(p') - \int_{p'\in M^{U_1}_{t+1}} S_{1,t+1}(p',\underline{s})\,dG(p')\Bigg] \\ &+\Bigg[1-\phi\Bigg(1-\lambda_u\int_{p'\in M^{U_2}_{t+1}} dG(p')\Bigg)\Bigg]\Big[U_{2,t+1}-U_{0,t+1}\Big]\Bigg] \end{aligned}$$

where:

- $U_{2,T-1} - U_{0,T-1} = 0$

and where:

- $p' \in M^{E_2}_{t+1}(p,s,NB)$ if $S_{2,t+1}(p',\underline{s}) > \sum_{s'}\mu(s,s')S_{2,t+1}(p,s')$
- $p' \in M^{U_0}_{t+1}$ if $S_{0,t+1}(p',\underline{s}) > 0$ and $S_{0,t+1}(p',\underline{s}) > S_{1,t+1}(p',\underline{s})$
- $p' \in M^{U_1}_{t+1}$ if $S_{1,t+1}(p',\underline{s}) > 0$ and $S_{1,t+1}(p',\underline{s}) \geq S_{0,t+1}(p',\underline{s})$
- $p' \in M^{U_2}_{t+1}$ if $S_{2,t+1}(p',\underline{s}) > 0$

B.5 Joint surplus - Type 2 - Equilibrium without transfer fees

$$E_{2,t}(p,s,NB) = w_{2,t}(p,s,NB) + \zeta\Bigg[(1-\delta_{2,t})\Bigg[\lambda_e\Bigg(\int_{p'\in M^{R_2}_{t+1}(p,s,NB)}\sum_{s'}\mu(s,s')E_{2,t+1}(p,s',p')\,dG(p')$$

$$+\int_{p'\in M^{E_2}_{t+1}(p,s,NB)} E_{2,t+1}(p',\underline{s},p)\,dG(p')\Bigg)$$

$$+\Bigg(1-\lambda_e\int_{p'\in M^{R_2}_{t+1}(p,s,NB)\cup M^{E_2}_{t+1}(p,s,NB)} dG(p')\Bigg)\sum_{s'}\mu(s,s')E_{2,t+1}(p,s',NB)\Bigg] + \delta_{2,t}U_{2,t+1}\Bigg]$$

$$U_{2,t} = b + \zeta\Bigg[\lambda_u\Bigg(\int_{p'\in M^{U_2}_{t+1}} E_{2,t+1}(p',\underline{s},u)\,dG(p')\Bigg)$$

$$+\Bigg(1-\lambda_u\int_{p'\in M^{U_2}_{t+1}} dG(p')\Bigg)\Bigg((1-\phi)U_{2,t+1}+\phi U_{0,t+1}\Bigg)\Bigg]$$

$$J_{2,t}(p,s,NB) = (1+\Delta)(1+s)p - w_{2,t}(p,s,NB) + \zeta(1-\delta_{2,t})\Bigg[\lambda_e\int_{p'\in M^{R_2}_{t+1}(p,s,NB)}\sum_{s'}\mu(s,s')J_{2,t+1}(p,s',p')\,dG($$

$$+\Bigg(1-\lambda_e\int_{p'\in M^{R_2}_{t+1}(p,s,NB)\cup M^{E_2}_{t+1}(p,s,NB)} dG(p')\Bigg)\sum_{s'}\mu(s,s')J_{2,t+1}(p,s',NB)\Bigg]$$

$$S_{2,t}(p,s) \quad = \quad E_{2,t}(p,s,NB) - U_{2,t} + J_{2,t}(p,s,NB)$$

where:

- $p' \in M^{R_2}_{t+1}(p,s,NB)$ if $\sum_{s'}\mu(s,s')S_{2,t+1}(p,s') > S_{2,t+1}(p',\underline{s}) > S_{2,t+1}(NB,\underline{s})$
- $p' \in M^{E_2}_{t+1}(p,s,NB)$ if $S_{2,t+1}(p',\underline{s}) > \sum_{s'}\mu(s,s')S_{2,t+1}(p,s')$
- $p' \in M^{U_2}_{t+1}$ if $S_{2,t+1}(p',\underline{s}) > 0$

The surplus can therefore be rewritten as follows:

$$
\begin{aligned}
&S_{2,t}(p,s) = (1+\Delta)(1+s)p - b \\
&+\zeta\Bigg[(1-\delta_{2,t})\Bigg[\sum_{s'}\mu(s,s')E_{2,t+1}(p,s',NB) - U_{2,t+1} + \sum_{s'}\mu(s,s')J_{2,t+1}(p,s',NB) \\
&+\lambda_e\bigg(\int_{p'\in M^{R_2}_{t+1}(p,s,NB)}\Big(\sum_{s'}\mu(s,s')E_{2,t+1}(p,s',p') + \sum_{s'}\mu(s,s')J_{2,t+1}(p,s',p')\Big)\,dG(p') \\
&-\int_{p'\in M^{R_2}_{t+1}(p,s,NB)} dG(p')\Big(\sum_{s'}\mu(s,s')E_{2,t+1}(p,s',NB) + \sum_{s'}\mu(s,s')J_{2,t+1}(p,s',NB)\Big) \\
&+\int_{p'\in M^{E_2}_{t+1}(p,s,NB)} E_{2,t+1}(p',\underline{s},p)\,dG(p') \\
&-\int_{p'\in M^{E_2}_{t+1}(p,s,NB)} dG(p')\Big(\sum_{s'}\mu(s,s')E_{2,t+1}(p,s',NB) + \sum_{s'}\mu(s,s')J_{2,t+1}(p,s',NB)\Big)\bigg)\Bigg] \\
&-\lambda_u\bigg(\int_{p'\in M^{U_2}_{t+1}}\Big(E_{2,t+1}(p',\underline{s},u) - U_{2,t+1}\Big)\,dG(p')\bigg) \\
&+\phi\bigg(1-\lambda_u\int_{p'\in M^{U_2}_{t+1}} dG(p')\bigg)\Big(U_{2,t+1} - U_{0,t+1}\Big)\Bigg]
\end{aligned}
$$

with:

$$\sum_{s'}\mu(s,s')E_{2,t+1}(p,s',NB) - U_{2,t+1} + \sum_{s'}\mu(s,s')J_{2,t+1}(p,s',NB) = \sum_{s'}\mu(s,s')S_{2,t+1}(p,s')$$

$$\sum_{s'}\mu(s,s')E_{2,t+1}(p,s',p') - U_{2,t+1} + \sum_{s'}\mu(s,s')J_{2,t+1}(p,s',p') = \sum_{s'}\mu(s,s')S_{2,t+1}(p,s')$$

$$E_{2,t+1}(p',\underline{s},p) - U_{2,t+1} = \sum_{s'}\mu(s,s')S_{2,t+1}(p,s') + \frac{\gamma}{\beta+\gamma}\big(S_{2,t+1}(p',\underline{s}) - \sum_{s'}\mu(s,s')S_{2,t+1}(p,s')\big)$$

$$E_{2,t+1}(p',\underline{s},u) - U_{2,t+1} = \frac{\gamma}{\alpha+\gamma}S_{2,t+1}(p',\underline{s})$$

With a little calculation, we get the following expression:

$$\begin{aligned}
S_{2,t}(p,s) &= (1+\Delta)(1+s)p - b \\
&+\zeta\Bigg[(1-\delta_{2,t})\Bigg[\sum_{s'}\mu(s,s')S^{+}_{2,t+1}(p,s') \\
&+\frac{\gamma}{\beta+\gamma}\lambda_e\Bigg(\int_{p'\in M^{E_2}_{t+1}(p,s,NB)}\Big(S^{+}_{2,t+1}(p',\underline{s}) - \sum_{s'}\mu(s,s')S^{+}_{2,t+1}(p,s')\Big)\,dG(p')\Bigg)\Bigg] \\
&-\frac{\gamma}{\alpha+\gamma}\lambda_u\Bigg(\int_{p'\in M^{U_2}_{t+1}} S_{2,t+1}(p',\underline{s})\,dG(p')\Bigg) \\
&+\phi\Bigg(1-\lambda_u\int_{p'\in M^{U_2}_{t+1}} dG(p')\Bigg)\Bigg(U_{2,t+1}-U_{0,t+1}\Bigg)\Bigg]
\end{aligned}$$

with:

$$\begin{aligned}
U_{2,t}-U_{0,t} &= \zeta\Bigg[\frac{\gamma}{\alpha+\gamma}\Bigg[\lambda_u\int_{p'\in M^{U_2}_{t+1}} S_{2,t+1}(p',\underline{s})\,dG(p') \\
&-\int_{p'\in M^{U_0}_{t+1}} S_{0,t+1}(p',\underline{s})\,dG(p') - \int_{p'\in M^{U_1}_{t+1}} S_{1,t+1}(p',\underline{s})\,dG(p')\Bigg] \\
&+\Bigg[1-\phi\Bigg(1-\lambda_u\int_{p'\in M^{U_2}_{t+1}} dG(p')\Bigg)\Bigg]\Bigg[U_{2,t+1}-U_{0,t+1}\Bigg]\Bigg]
\end{aligned}$$

where:

- $U_{2,T-1} - U_{0,T-1} = 0$

and where:

- $p' \in M^{E_2}_{t+1}(p,s,NB)$ if $S_{2,t+1}(p',\underline{s}) > \sum_{s'}\mu(s,s')S_{2,t+1}(p,s')$
- $p' \in M^{U_2}_{t+1}$ if $S_{2,t+1}(p',\underline{s}) > 0$

B.6 Joint surplus - Type 2 - Equilibrium with transfer fees

$$E_{2,t}(p,s,u) = w_{2,t}(p,s,u) + \zeta\Bigg[(1-\delta_{2,t})\Bigg[\lambda_e\Bigg(
+ \int_{p' \in M^{E_2}_{t+1}(p,s,NB)} E_{2,t+1}(p',\underline{s},p)\, dG(p')\Bigg)
+\Bigg(1 - \lambda_e \int_{p' \in M^{E_2}_{t+1}(p,s,NB)} dG(p')\Bigg)\sum_{s'}\mu(s,s')E_{2,t+1}(p,s',u)\Bigg] + \delta_{2,t}U_{2,t+1}\Bigg]$$

$$U_{2,t} = b + \zeta\Bigg[\lambda_u\Bigg(\int_{p' \in M^{U_2}_{t+1}} E_{2,t+1}(p',\underline{s},u)\, dG(p')\Bigg)
+\Bigg(1 - \lambda_u \int_{p' \in M^{U_2}_{t+1}} dG(p')\Bigg)\Bigg((1-\phi)U_{2,t+1} + \phi U_{0,t+1}\Bigg)\Bigg]$$

$$J_{2,t}(p,s,u) = (1+\Delta)(1+s)p - w_{2,t}(p,s,u) + \zeta(1-\delta_{2,t})\Bigg[\lambda_e\Bigg(
+ \int_{p' \in M^{E_2}_{t+1}(p,s,NB)} T_{2,t+1}(p',s,p)\, dG(p')\Bigg)
+\Bigg(1 - \lambda_e \int_{p' \in M^{E_2}_{t+1}(p,s,NB)} dG(p')\Bigg)\sum_{s'}\mu(s,s')J_{2,t+1}(p,s',u)\Bigg]$$

$$S_{2,t}(p,s) \quad = \quad E_{2,t}(p,s,u) - U_{2,t} + J_{2,t}(p,s,u)$$

where:

- $p' \in M^{E_2}_{t+1}(p,s,NB)$ if $S_{2,t+1}(p',\underline{s}) > \sum_{s'}\mu(s,s')S_{2,t+1}(p,s')$
- $p' \in M^{U_2}_{t+1}$ if $S_{2,t+1}(p',\underline{s}) > 0$

The surplus can therefore be rewritten as follows:

$$
\begin{aligned}
&S_{2,t}(p,s) = (1+\Delta)(1+s)p - b \\
&+\zeta\Bigg[(1-\delta_{2,t})\Big[\sum_{s'}\mu(s,s')E_{2,t+1}(p,s',u) - U_{2,t+1} + \sum_{s'}\mu(s,s')J_{2,t+1}(p,s',u) \\
&+\lambda_e\Big(\int_{p'\in M^{E_2}_{t+1}(p,s,NB)} E_{2,t+1}(p',\underline{s},p)\,dG(p') \\
&-\int_{p'\in M^{E_2}_{t+1}(p,s,NB)} dG(p')\Big(\sum_{s'}\mu(s,s')E_{2,t+1}(p,s',u) + \sum_{s'}\mu(s,s')J_{2,t+1}(p,s',u)\Big) \\
&+\int_{p'\in M^{E_2}_{t+1}(p,s,NB)} T_{2,t+1}(p',s,p)\,dG(p')\Big)\Big] \\
&-\lambda_u\Big(\int_{p'\in M^{U_2}_{t+1}}\Big(E_{2,t+1}(p',\underline{s},u) - U_{2,t+1}\Big)\,dG(p')\Big) \\
&+\phi\Big(1-\lambda_u\int_{p'\in M^{U_2}_{t+1}} dG(p')\Big)\Big(U_{2,t+1} - U_{0,t+1}\Big)\Bigg]
\end{aligned}
$$

with:

$$
\sum_{s'}\mu(s,s')E_{2,t+1}(p,s',u) - U_{2,t+1} + \sum_{s'}\mu(s,s')J_{2,t+1}(p,s',u) = \sum_{s'}\mu(s,s')S_{2,t+1}(p,s')
$$

$$
E_{2,t+1}(p',\underline{s},p) - U_{2,t+1} = \frac{\gamma}{\alpha+\gamma}\sum_{s'}\mu(s,s')S_{2,t+1}(p,s') + \frac{\gamma}{\alpha+\beta+\gamma}(S_{2,t+1}(p',\underline{s}) - \sum_{s'}\mu(s,s')S_{2,t+1}(p,s'))
$$

$$
E_{2,t+1}(p',\underline{s},u) - U_{2,t+1} = \frac{\gamma}{\alpha+\gamma}S_{2,t+1}(p',\underline{s})
$$

$$
T_{2,t+1}(p',s,p) = \frac{\alpha}{\alpha+\gamma}\sum_{s'}\mu(s,s')S_{2,t+1}(p,s') + \frac{\alpha}{\alpha+\beta+\gamma}\left[S_{2,t+1}(p',\underline{s}) - \sum_{s'}\mu(s,s')S_{2,t+1}(p,s')\right]
$$

With a little calculation, we get the following expression:

$$
\begin{aligned}
S_{2,t}(p,s) &= (1+\Delta)(1+s)p - b \\
&+\zeta\Bigg[(1-\delta_{2,t})\Big[\sum_{s'}\mu(s,s')S^{+}_{2,t+1}(p,s') \\
&+(\alpha+\gamma)\lambda_e\Big(\int_{p'\in M^{E_2}_{t+1}(p,s,NB)}\Big(S^{+}_{2,t+1}(p',\underline{s})-\sum_{s'}\mu(s,s')S^{+}_{2,t+1}(p,s')\Big)\,dG(p')\Big)\Big] \\
&-\frac{\gamma}{\alpha+\gamma}\lambda_u\Big(\int_{p'\in M^{U_2}_{t+1}} S_{2,t+1}(p',\underline{s})\,dG(p')\Big) \\
&+\phi\Big(1-\lambda_u\int_{p'\in M^{U_2}_{t+1}} dG(p')\Big)\Big(U_{2,t+1}-U_{0,t+1}\Big)\Bigg]
\end{aligned}
$$

with:

$$
\begin{aligned}
U_{2,t}-U_{0,t} &= \zeta\Bigg[\frac{\gamma}{\alpha+\gamma}\Big[\lambda_u\int_{p'\in M^{U_2}_{t+1}} S_{2,t+1}(p',\underline{s})\,dG(p') \\
&-\int_{p'\in M^{U_0}_{t+1}} S_{0,t+1}(p',\underline{s})\,dG(p')-\int_{p'\in M^{U_1}_{t+1}} S_{1,t+1}(p',\underline{s})\,dG(p')\Big] \\
&+\Big[1-\phi\Big(1-\lambda_u\int_{p'\in M^{U_2}_{t+1}} dG(p')\Big)\Big]\Big[U_{2,t+1}-U_{0,t+1}\Big]\Bigg]
\end{aligned}
$$

where:

- $U_{2,T-1}-U_{0,T-1}=0$

and where:

- $p'\in M^{E_2}_{t+1}(p,s,NB)$ if $S_{2,t+1}(p',\underline{s}) > \sum_{s'}\mu(s,s')S_{2,t+1}(p,s')$
- $p'\in M^{U_2}_{t+1}$ if $S_{2,t+1}(p',\underline{s}) > 0$

C Labor market flows

Specific human capital has an impact on workers' mobility and firms' training decisions. To determine labour market flows, we thus need to define the following thresholds:

- $\ddot{p}_j(t,s)$, which solves $S_{j,t}(\ddot{p}_j(t,s),s) = 0 \; \forall t,s$ and $j \in \{0,1,2\}$.
  This is the productivity threshold above which the match is viable. If a worker of type j, age t, and specific human capital s is employed in a firm of type $p < \ddot{p}_j(t,s)$, the job is destroyed endogenously and the worker enters the pool of nonemployed.

- $\hat{p}_j(t,p,s)$, which solves $S_{j,t}(\hat{p}_j(t,p,s),\underline{s}) = S_{j,t}(p,s) \; \forall t,p,s$ and $j \in \{0,1,2\}$.
  This is the productivity threshold above which it is in the worker's interest to move from job to job. If a worker of type j, age t, and specific human capital s is employed in a firm of type p and receives an external offer from a firm of type $p' > \hat{p}_j(t,p,s)$, the worker accepts the offer and moves from job to job. Note that $\hat{p}_j(t,p,\underline{s}) = p$.

- $\check{p}_j(t,p,s)$, which solves $S_{j,t}(p,\underline{s}) = S_{j,t}(\check{p}_j(t,p,s),s) \; \forall t,p,s$ and $j \in \{0,1,2\}$.
  This is the symmetrical threshold to the previous one. If a worker of type j, age t, and specific human capital s is employed in a firm of type $p < \hat{p}_j(t,p,s)$ and receives an external offer from a firm of type p, the worker accepts the offer and moves from job to job.

- $\tilde{p}(t)$, which solves $S_{1,t}(\tilde{p}(t),\underline{s}) = S_{0,t}(\tilde{p}(t),\underline{s}) \; \forall t$. This is the productivity threshold above which it is profitable to train the worker. If an untrained worker of age t is hired by a firm of type $p \geq \tilde{p}(t)$, the worker is trained.

Let's define the following stocks:

- $u_{j,t}$ is the stock of nonemployed workers of type j and age t

- $e_{j,t}(p,s)$ is the stock of employed workers of type j, age t, and specific human capital s, matched with p-firms

The stocks of nonemployed workers are defined by the following laws of motion, $\forall t \in [2, T-1]$:

$$
\begin{aligned}
u_{0,t} =& u_{0,t-1}\Big(1-\lambda_u[1-G(\ddot{p}_0(t,\underline{s}))]\Big) + u_{2,t-1}\Big(1-\lambda_u[1-G(\ddot{p}_2(t,\underline{s}))]\Big)\phi + \delta_{0,t-1}\Big(\sum_s \int e_{0,t-1}(p,s)dp\Big) \\
&+ \Big(1-\delta_{0,t-1}\Big)\Big(\sum_s \sum_{s'} \mu(s,s') \int^{\ddot{p}_0(t,s')} \Big(1-\lambda_e[1-G(\hat{p}_0(t,p,\underline{s}))]\Big) e_{0,t-1}(p,s')dp\Big)
\end{aligned}
$$

$$
\begin{aligned}
u_{2,t} =& u_{2,t-1}\Big(1-\lambda_u[1-G(\ddot{p}_2(t,\underline{s}))]\Big)\Big(1-\phi\Big) + \delta_{2,t-1}\Big(\sum_s \int [e_{1,t-1}(p,s)+e_{2,t-1}(p,s)]dp\Big) \\
&+ \Big(1-\delta_{2,t-1}\Big)\Big(\sum_s \sum_{s'} \mu(s,s') \int^{\ddot{p}_2(t,s')} \Big(1-\lambda_e[1-G(\hat{p}_0(t,p,\underline{s}))]\Big)[e_{1,t-1}(p,s')+e_{2,t-1}(p,s')]dp\Big)
\end{aligned}
$$

The stocks of employed workers are defined by the following laws of motion, $\forall t \in [2, T-1]$:

$$
\begin{aligned}
e_{0,t}(p,\underline{s}) =& \mathbb{1}\{\tilde{p}(t) > p \geq \ddot{p}_0(t,\underline{s})\} \times \Big\{ e_{0,t-1}(p,\underline{s})\Big(1-\delta_{0,t-1}\Big)\Big(1-\lambda_e[1-G(\hat{p}_0(t,p,\underline{s}))]\Big)\Big(1-\rho\Big) \\
&+ u_{0,t-1}\lambda_u g(p) + \Big(1-\delta_{0,t-1}\Big)\lambda_e g(p)\Big(\sum_s \int^{\check{p}_0(t,p,s)} e_{0,t-1}(p,s)dp\Big)\Big\}
\end{aligned}
$$

$$
\begin{aligned}
e_{0,t}(p,s) =& \mathbb{1}\{\tilde{p}(t) > p \geq \ddot{p}_0(t,s)\} \times \Big\{ e_{0,t-1}(p,s)\Big(1-\delta_{0,t-1}\Big)\Big(1-\lambda_e[1-G(\hat{p}_0(t,p,s))]\Big)\Big(1-\rho\Big) \\
&+ e_{0,t-1}(p,s-1)\Big(1-\delta_{0,t-1}\Big)\Big(1-\lambda_e[1-G(\hat{p}_0(t,p,s-1))]\Big)\rho\Big\}
\end{aligned}
$$

$$
\begin{aligned}
e_{0,t}(p,\bar{s}) =& \mathbb{1}\{\tilde{p}(t) > p \geq \ddot{p}_0(t,\bar{s})\} \times \Big\{ e_{0,t-1}(p,\bar{s})\Big(1-\delta_{0,t-1}\Big)\Big(1-\lambda_e[1-G(\hat{p}_0(t,p,\bar{s}))]\Big) \\
&+ e_{0,t-1}(p,\bar{s}-1)\Big(1-\delta_{0,t-1}\Big)\Big(1-\lambda_e[1-G(\hat{p}_0(t,p,\bar{s}-1))]\Big)\rho\Big\}
\end{aligned}
$$

$$
\begin{aligned}
e_{1,t}(p,\underline{s}) =& \mathbb{1}\{p \geq \tilde{p}(t) \geq \ddot{p}_0(t,\underline{s})\} \times \Big\{ u_{0,t-1}\lambda_u g(p) \\
&+ \Big(1-\delta_{0,t-1}\Big)\lambda_e g(p)\Big(\sum_s \int^{\check{p}_0(t,p,s)} e_{0,t-1}(p,s)dp\Big)\Big\}
\end{aligned}
$$

$$
\begin{aligned}
e_{2,t}(p,\underline{s}) =& \mathbb{1}\{p \geq \ddot{p}_2(t,\underline{s})\} \times \Big\{ \Big(e_{1,t-1}(p,\underline{s}) + e_{2,t-1}(p,\underline{s})\Big)\Big(1-\delta_{2,t-1}\Big)\Big(1-\lambda_e[1-G(\hat{p}_2(t,p,\underline{s}))]\Big)\Big(1-\rho\Big) \\
&+ u_{2,t-1}\lambda_u g(p) + \Big(1-\delta_{2,t-1}\Big)\lambda_e g(p)\Big(\sum_s \int^{\check{p}_2(t,p,s)} [e_{1,t-1}(p,s) + e_{2,t-1}(p,s)]dp\Big)\Big\}
\end{aligned}
$$

$$
\begin{aligned}
e_{2,t}(p,s) =& \mathbb{1}\{p \geq \ddot{p}_2(t,s)\} \times \Big\{ \Big(e_{1,t-1}(p,s) + e_{2,t-1}(p,s)\Big)\Big(1-\delta_{2,t-1}\Big)\Big(1-\lambda_e[1-G(\hat{p}_2(t,p,s))]\Big)\Big(1-\rho\Big) \\
&+ \Big(e_{1,t-1}(p,s-1) + e_{2,t-1}(p,s-1)\Big)\Big(1-\delta_{2,t-1}\Big)\Big(1-\lambda_e[1-G(\hat{p}_2(t,p,s-1))]\Big)\rho\Big\}
\end{aligned}
$$

$$
\begin{aligned}
e_{2,t}(p,\bar{s}) =& \mathbb{1}\{p \geq \ddot{p}_2(t,\bar{s})\} \times \Big\{ \Big(e_{1,t-1}(p,\bar{s}) + e_{2,t-1}(p,\bar{s})\Big)\Big(1-\delta_{2,t-1}\Big)\Big(1-\lambda_e[1-G(\hat{p}_2(t,p,s))]\Big) \\
&+ \Big(e_{1,t-1}(p,s-1) + e_{2,t-1}(p,s-1)\Big)\Big(1-\delta_{2,t-1}\Big)\Big(1-\lambda_e[1-G(\hat{p}_2(t,p,s-1))]\Big)\rho\Big\}
\end{aligned}
$$

with the following initial conditions:

$$
\begin{aligned}
&u_{0,1} = 1 \\
&u_{2,1} = 0 \\
&e_{0,1}(p,s) = e_{1,1}(p,s) = e_{2,1}(p,s) = 0 \; \forall p, s
\end{aligned}
$$

and the condition:

$$
e_{1,t}(p,s) = 0 \; \forall p, \forall s > \underline{s}
$$

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