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* Views expressed are those of the author and do not necessarily reflect official positions of De Nederlandsche Bank.

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Abstract

This paper analyses the efficiency of employment subsidies versus job retention schemes in a random search-and-matching model with human capital depreciation during unemployment and *endogenous* job destruction. Unlike under exogenous destruction, employment subsidies aimed at correcting inefficient hiring now distort the job-destruction margin, resulting in excess job destruction and turnover. Accordingly, employment subsidies no longer suffice to correct the inefficiency of the decentralised allocation: welfare can be further improved by optimally combining employment subsidies and job-retention schemes.

Keywords: Skill loss; Endogenous job-destruction; Job retention; Optimal policy
JEL codes: E24, J63, J64

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1 Introduction

While job retention (JR) schemes are now part of the standard labour-market policy toolbox in many advanced economies, the exact market failures they are meant to address have thus far remained elusive.[1] In this paper, we argue that the combination of endogenous job destruction and human capital depreciation (HCD) upon unemployment may render those schemes welfare improving – even in situations where an employment subsidy fixes potential inefficiencies arising from the job creation side.

Our analysis starts from the observation that, in standard random search-and-matching models of the labour market with generalised Nash bargaining, match separations are typically *socially* constrained-efficient, in addition to being bilaterally efficient. This is obviously the case when separations are exogenous and thus (by construction) independent of policy. More subtly, this is also the case when separations are endogenous because, in this situation, workers and firms only destroy matches that produce a negative overall surplus – see Mortensen and Pissarides (1994), Den Haan et al. (2000), Walsh (2005), Krause and Lubik (2007) and others. Of course, the hiring side of the market may be distorted (e.g., if the splitting of the match surplus does not satisfy the Hosios (1990) condition equating the share of the match surplus accruing to the firm with the elasticity of the matching function with respect to vacancies), but conditional on appropriate policies fixing the hiring distortion, no additional inefficiency can arise from the job destruction margin *per se*. This leaves no room for efficient JR schemes, provided the job creation margin is efficiently handled by policy (which can usually be done through suitable employment subsidies.)

To make room for welfare-improving JR, an additional friction must be introduced which, either on its own or through its interactions with other model features, may render endogenous job destruction socially inefficient. The friction we consider here is the possibility that workers lose general human capital during unemployment (which they may then regain through employment), following Pissarides (1992) and Ljungqvist and Sargent (1998, 2004, 2008). As shown by Laureys (2021), HCD creates a positive externality in hiring decisions, as firms contemplating posting vacancies do not internalise their beneficial effect on the skill composition of the unemployment pool and, ultimately, on the gains that future employers may expect from their matches with workers. Under *exogenous* job destruction, this externality rationalises the use of employment subsidies, even in situations where the Hosios (1990) condition holds and therefore, the bargaining process efficiently handles the

[1] In the context of the present paper, "job retention schemes" are synonyms for "short-time work programmes," (STW henceforth), defined by Cahuc (2024) as "government initiatives aimed at preserving employment with companies temporarily facing economic difficulties." We review the positive and normative literature on job retention below.

congestion externality. Our analysis departs from Laureys (2021)'s analysis in one single but essential dimension: we consider the case where job destruction is *endogenous* rather than exogenous. To be more specific, worker-firm matches are hit by idiosyncratic productivity shocks in every period and are separated if the idiosyncratic productivity level falls below a certain threshold. We show that, in this situation, employment subsidies no longer suffice to correct for the inefficiency of the decentralised allocation; ultimately, a combination of employment and JR subsidies allows reaching the highest level of welfare.

The intuition for this result is as follows. First, a job subsidy raises the match surplus (whether job destruction is exogenous or endogenous), which under HCD allows for the efficiency gains highlighted by Laureys (2021) and discussed above. Note that the increase in the overall match surplus results from two opposing forces, namely, the direct *positive* effect of the subsidy on the value of hiring firms and an indirect *negative* effect coming from a higher value of unemployment (since unemployment spells become shorter), which the latter mitigates (without overturning) the direct effect. Under endogenous job destruction, the increased value of unemployment brought about by the heightened rate of job creation also raises the job destruction threshold, throwing more workers into unemployment and ultimately generating excess labour turnover. Eventually, under endogenous job destruction, the employment subsidy *on its own* becomes partly self-defeating (unlike when the destruction rate is exogenous and thus unresponsive to the value of unemployment.) In this situation, a JR scheme that serves to contain job destruction may complement the employment subsidy and be welfare-improving.

While our model does not allow deriving exact closed-form expressions for the constrained-efficient levels of employment and JR subsidies, numerical analysis based on a calibrated version of the model delivers the following robust features. First, the decentralised allocation in the absence of both policies is inefficient; this configuration includes the special case where job separations are exogenous, consistent with Laureys (2021)'s finding. Second, either policy is welfare-improving in isolation when the endogenous separation margin is active. To be more specific, starting from a situation where none of the policies is in place, marginally activating either subsidy (holding the other at zero) raises welfare; this reflects the fact that the job-creation margin is distorted under Laissez-faire (as explained above), while either policy tool reduces the associated inefficiency – because both raise the value of matches and incentivise job creation. Moreover, when the taxes raised to finance those policies are sufficiently distortionary, then there exists an interior solution for each instrument considered in isolation.[2] Third, when the taxes are distortionary, the policy mix that

[2]When taxes are not distortionary, it may be optimal to set the employment subsidy or job retention subsidy that eliminates endogenous job destruction altogether.

attains the highest level of welfare involves an interior combination of employment and JR subsidies. This configuration rationalises the joint use of those policies in the labour-market policy menu.

Literature review We refer the reader to Cahuc (2024) for an extensive literature review and only point out the contributions that are most directly related to our paper. The first paper offering a normative analysis of JR is Burdett and Wright (1989), who analyse this issue from the point of view of a (static) optimal contract between firms and workers. They show that subsidised unemployment insurance (UI) benefits may produce inefficient separations, which STW schemes may alleviate by promoting work-sharing within the firm.[3] In recent work, Stiepelmann (2024) looks at the efficient combination of UI and STW in a fully-fledged search and matching model, showing that STW may help fix the fiscal externality created by UI. Both papers model job retention as an efficient way to mitigate the side effects of UI, while ours models it as the efficient response to the side effects of employment subsidies.[4] Giupponi and Landais (2023) informally point to – and provide supporting evidence of – two potential sources of inefficient separations possibly causing short-time work schemes to be welfare-improving: (i) liquidity constraints and (ii) inefficient bargaining. Our model has perfect credit markets and efficient bargaining and hence abstracts from both mechanisms. Relatedly, in their discussion of the relative merits of unemployment insurance versus short-time work, Giupponi et al. (2022) discuss two potential sources of inefficient separations, namely inefficient (bilateral) separations and search inefficiencies, while also pointing out that short-time work may slow down efficient reallocation. These sources of inefficient separations are absent in our model – since bargaining is efficient and search is efficient by construction. Inefficiencies arise from firms' job-creation and are handled by a combination of employment and JR subsidies.[5]

Second, our paper relates to a large strand of literature investigating the effects of job retention schemes from a *positive* rather than normative perspective. Many of these papers empirically study the impact of their use during the Great Recession; this includes Hijzen and Venn (2011), Cahuc and Carcillo (2011), Burda and Hunt (2011), Boeri and Bruecker (2011), Kopp and Siegenthaler (2021) and Cahuc et al. (2024). By and large, these studies find that STW schemes have effectively mitigated job losses during the period – though

[3]Within the efficient contracting approach, see also Wright and Hotchkiss (1988), Van Audenrode (1994), Braun and Brügemann (2017) and Teichgräber et al. (2022).

[4]In our economy, workers are risk-neutral, and the unemployed home-produce, leaving no role for optimal UI. Besides, our model does not have the intensive margin of labour supply that plays a critical role in the implicit contract approach.

[5]Tilly and Niedermayer (2017) rationalise using STW in a fully-fledged search and matching model with bilaterally inefficient separations.

the documented costs and effectiveness of the policy depend across studies.[6] Other positive papers on the use of JR take a more quantitative perspective by implementing JR into search and matching models with endogenous job destruction a la Mortensen and Pissarides (1994) – see Krause and Uhlig (2012), Balleer et al. (2016), Cooper et al. (2017), Gehrke et al. (2019), Albertini et al. (2022). Balleer et al. (2016) focus on rule-based versus discretionary STW schemes and use their model to rationalise their empirical finding that the former is more effective than the latter. Cooper et al. (2017) stress the trade-off between limiting the rise in unemployment during recessions and the lower allocative efficiency induced by the policy. Krause and Uhlig (2012) and Albertini et al. (2022) explicitly introduced human capital depreciation upon job loss into that framework. In particular, Albertini et al. (2022) construct a rich general-equilibrium directed-search model with incomplete markets and HCD to analyse the impact of STW policies in France during COVID-19. They stress the benefits of such policies in terms of saved jobs, but also their cost in terms of excessive reduction in hours worked. Neither paper, however, analyses the optimality of JR.

HCD upon job loss is a natural explanation for the overwhelming evidence that workers transiting through unemployment suffer long-term earnings losses.[7] This motivated the quantitative analysis of Ljungqvist and Sargent (1998), who coined this mechanism "turbulence" and applied it to the comparative study of European versus US labour markets – see also Ljungqvist and Sargent (2004, 2008), Den Haan et al. (2005) and Kitao et al. (2017). Ortego-Marti (2017a) and Lalé (2018) study the implications of HCD for the amplitude of labour-market fluctuations, Lalé (2018) examines its impact on older workers, and Ortego-Marti (2017b) uses a similar model to measure the contribution of HCD to TFP differences across OECD countries. As stressed above, within this strand of the literature, the paper closest to ours is Laureys (2021), which studies the implications of HCD for optimal employment subsidies. The insight that the general human capital gained (during employment) or lost (during unemployment) by workers has external effects and can thus generate inefficient labour-market flows can be traced back to Pissarides (1992) and Coles and Masters (2000).

[6] For a broader empirical assessment, see also Abraham and Houseman (1994), Van Audenrode (1994), Hoffmann and Lemieux (2016), Gehrke and Hochmuth (2021) and Costa Dias et al. (2020). In particular, Gehrke and Hochmuth (2021) show that STW schemes in Germany are much more effective in booms than in recessions.

[7] See, e.g., Jacobson et al. (1993), Couch and Placzek (2010), Davis and von Wachter (2011), Jarosch (2021).

2 The model

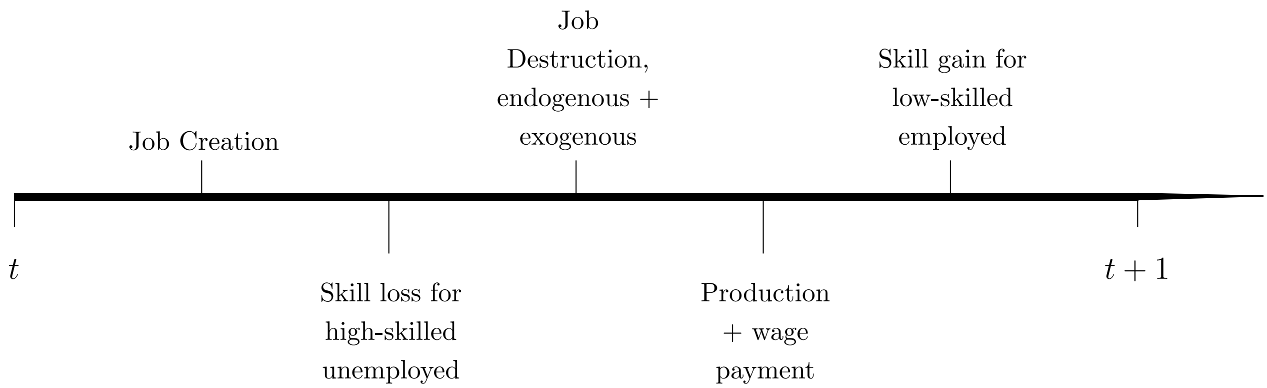
2.1 Set-up, timing, and policy instruments

Our model extends Laureys (2021) to allow for endogenous job destruction a la Mortensen and Pissarides (1994) and Den Haan et al. (2000), as well as employment and job retention subsidies. Time is discrete and ranges from $t = 0$ to ∞. There are two types of agents, "workers" and "firms", who form persistent but temporary employment relationships as in Mortensen and Pissarides (1994). Workers are in mass 1, transit between employment and unemployment, and are also subject to stochastic human capital depreciation (HCD) when unemployed and learning-by-doing (LBD) when employed. An employed worker in a match i gets a wage payment w_{it}^s, which is determined via generalized Nash bargaining, while unemployed workers all get the same home production income b. There are two skill levels, "high" ($s = H$) and "low" ($s = L$). The individual productivity of high-skill workers is normalised to 1, while low-skill workers suffer an individual-specific productivity discount of size $\delta^S \in [0, 1]$. A skilled worker loses skill (i.e., switches from high to low individual productivity) with probability $l \in [0, 1]$ in every period of unemployment, while an unskilled worker regains skills (i.e., switches back from low to high productivity) with probability $g \in [0, 1]$ in every period of employment.

In order to tractably incorporate skill transitions into the canonical search-and-matching model with endogenous job separation, we adopt the following timeline of events, summarised in Figure 1 for future reference. At the beginning of the period, vacancies are posted under free entry, and matches are formed. Next, high-skill workers who are unemployed at that time lose their skills with probability l. After this stage, every match (whether it was formed at the beginning of the period or at an earlier period) draws an idiosyncratic (match-specific) productivity level a_{it}. At that point, the total surplus from the match is known and can be bargained over, provided that (i) the match has not just been exogenously destroyed and (ii) the surplus is positive so that it does not lead to an endogenous separation. The surviving matches and their skill composition determine total labour supply and average labour productivity, from which output is generated and income components (wages for workers, quasi-rents for firms) can be paid. Finally, skill gains occur (with probability g) for employed workers who are still low-skill, and the period ends.

There are two policy instruments. Following Laureys (2021), all active matches may receive an employment subsidy $\Phi_t \geq 0$. This affects the surplus generated by all matches and thereby incentivises firms to post vacancies. Moreover, firms may claim a job-retention subsidy, which will affect the decision to separate conditional on a particular draw of the match-specific productivity. To be more specific, in case the match-specific productivity

Figure 1: Timeline



draw falls below the match destruction threshold in the absence of the job retention scheme, the firm-worker pair has the possibility to apply for a subsidy $d_t \geq 0$, whose effect is to raise the match surplus and to possibly overturn the initial separation decision. The subsidy d_t is common to all applying pairs, effectively paid only if the match is maintained, and cannot be claimed if the match would not have been destroyed otherwise.[8] Of course, the overall bite of the policy depends on d_t, and whether or not it can save a particular match depends on the realisation of the match-specific productivity – formally, the policy reduces the job separation threshold for firms (and only those firms) that are close to the destruction threshold in the absence of the policy. If a particular firm-worker pair ultimately decides not to separate, thanks to the job retention subsidy, it bargains over a match surplus that includes the subsidy. This implies that, depending on the size of d_t, the worker-firm pair can remain operative despite potentially low levels of idiosyncratic productivity. This is consistent with the observation that firms with workers on a job retention scheme usually operate at a lower capacity than firms not on the scheme. We adopt a flexible specification for the financing cost of the employment and job retention policy that allows for tax distortions. To be more specific, providing employment subsidies to x matches costs $c_\Phi(\Phi_t)x$, where $c'_\Phi(\Phi_t) > 0$ and $c''_\Phi(\Phi_t) \geq 0$. Similarly, providing job retention subsidies to x matches costs $c_d(d_t)x$, where $c'_d(d_t) > 0$ and $c''_d(d_t) \geq 0$. There is no tax distortion whenever $c_\Phi(\Phi_t) = \Phi_t$ and $c_d(d_t) = d_t$, so that $c'_\Phi(\Phi_t) = c'_d(d_t) = 1$ and $c''_\Phi(\Phi_t) = c''_d(d_t) = 0$. Taxes are distortionary whenever $c''_\Phi(\Phi_t) > 0$ or $c''_d(d_t) > 0$ or both. Those tax distortions will ensure that there always exist

[8] We assume for simplicity that the scheme cannot be manipulated, that is, the firm-worker pair cannot claim they would separate without the subsidy if that is not effectively the case.

an interior optimum for both instruments under endogenous job separations.[9]

2.2 Labour market flows

At the end of time $t-1$, or equivalently the very beginning of time t, total employment is n_{t-1} and the size of the unemployment pool is $u_{t-1} = 1 - n_{t-1}$, of which u_{t-1}^L are low-skilled and u_{t-1}^H are high-skilled. After job creation has taken place, total employment becomes $n_{t-1} + f_t u_{t-1}$, where f_t is the job-finding rate for unemployed workers. The latter is common to all workers and given by $f_t = m_t/u_{t-1}$, where m_t denotes the number of new matches formed at time t. m_t is given by the matching function:

$$m_t = \bar{m} v_t^{\gamma} u_{t-1}^{1-\gamma} \tag{1}$$

where $\gamma \in (0,1)$ and $\bar{m} > 0$ are parameters and v_t is the total number of vacancies posted by firms. Defining market tightness as $\theta_t = v_t/u_{t-1}$, we have $f_t = \bar{m}\theta_t^{\gamma}$, while the vacancy-filling rate is $\lambda_t = m_t/v_t = \bar{m}\theta_t^{\gamma-1}$.

Match destructions can be either exogenous or endogenous. To be more specific, every match is destroyed with an exogenous probability ρ_t^x. If a match is not exogenously destroyed (which occurs with probability $1-\rho_t^x$), it may still be endogenously destroyed if the idiosyncratic productivity draw is sufficiently low. We assume that match-specific productivities (a_{it}) are i.i.d. across time and matches and drawn from a continuous distribution over the support $[0,\infty)$ with c.d.f. $F(a)$. This implies that, for each worker's skill level $s \in \{L, H\}$, there is a marginal idiosyncratic productivity level $\tilde{a}_t^{sf}$ at which firms and workers are exactly indifferent between separating or keeping their match alive. These levels define the thresholds below which matches are destroyed, with the probability of endogenous destruction being given by $\rho^{ns} = F(\tilde{a}_t^{sf})$, $s \in \{L, H\}$. Ultimately, the overall probability that a match involving a worker of skill s will be destroyed is given by:

$$\rho_t^s = \rho^x + (1-\rho^x)\, F(\tilde{a}_t^{sf}), \quad s = L, H. \tag{2}$$

After workers' labour market transitions (between employment and unemployment) and the skill transitions (from high- to low-skilled) are complete, there are n_t^L unskilled employed workers and n_t^H skilled employed workers available for production, and total employment is $n_t = n_t^L + n_t^H$. Conversely, those transitions have left u_t^L unskilled workers and u_t^H skilled workers out of unemployment (so that $n_t^L + n_t^H + u_t^L + u_t^H = 1$). Given our assumptions

[9] As shown by Laureys (2021), there exists an interior optimal level of employment subsidy under exogenous separations and without tax distortions, a result that we recover as a special case of our analysis. However, the existence of an interior optimum is not guaranteed under endogenous separations unless the taxes used to finance labour-market policies are allowed to be distortionary.

about how events unfold within a period, those four variables (which define the endogenous aggregate state in our model) evolve according to the following flow equations:

$$u_t^L = (1-f_t)\left[u_{t-1}^L + l u_{t-1}^H\right] + \rho_t^L\left[f_t u_{t-1}^L + (1-g)n_{t-1}^L\right] \tag{3}$$

$$u_t^H = (1-f_t)(1-l)u_{t-1}^H + \rho_t^H\left[g n_{t-1}^L + n_{t-1}^H + f_t u_{t-1}^H\right] \tag{4}$$

$$n_t^L = (1-\rho_t^L)\left[(1-g)n_{t-1}^L + f_t u_{t-1}^L\right] \tag{5}$$

$$n_t^H = (1-\rho_t^H)\left[g n_{t-1}^L + n_{t-1}^H + f_t u_{t-1}^H\right] \tag{6}$$

2.3 Production and surplus sharing

An active match i with a high-skill worker produces $y_{it}^{Hn} = a_{it}$ units of goods, while an active match with a low-skill worker not on a retention scheme only produces $y_{it}^{Ln} = (1-\delta^S)a_{it}$, where a_{it} is the match-specific productivity. As mentioned above, matches that are under JR receive the subsidy d_t; this will lower the separation threshold and will cause some matches that would otherwise be destroyed to be saved. For this reason, the matches that operate on a JR scheme are of lower productivity on average that matches that operate without the scheme, as is consistent with the evidence.[10]

Given the properties of $F(a)$ and the properties of the job retention scheme described above, we conjecture and verify the existence of two match separation thresholds. For a sufficiently low realisation of the idiosyncratic productivity shock (and provided that the scheme is not too generous), the match will be destroyed, and therefore, firms will not apply for the retention subsidy. The corresponding separation threshold is skill-specific and denoted $\tilde{a}_t^{sf}$, $s \in \{L, H\}$. On the other hand, for sufficiently high realisations of the shock, the match will be maintained without resorting to the policy, and we denote the corresponding threshold $\tilde{a}_t^{sd}$, $s \in \{L, H\}$, where $\tilde{a}_t^{sd} > \tilde{a}_t^{sf}$. Finally, productivity draws that are below $\tilde{a}_t^{sd}$ but above $\tilde{a}_t^{sf}$ are those that are maintained thanks to the policy intervention.[11]

Denote by $J_{it}^s \equiv J_t^s(a_{it})$, $s \in \{L, H\}$, the value of the firm (also its share of the match surplus under free entry) at the time bargaining takes place, i.e., right after the job separation stage but before the production stage (see Figure 1.) Symmetrically, call W_{it}^s the intertemporal utility of a worker with skill level $s \in \{L, H\}$ and in a match with idiosyncratic productivity a_{it}, U_t^s the intertemporal utility the same worker obtains from walking away from the match, and $S_{it}^{Ws} = W_{it}^s - U_t^s$ the worker's surplus from sticking to the match. The total surplus from the match is then $S_{it}^s = S_{it}^{Ws} + J_{it}^s$, and any active match at this

[10] Empirically, this pattern also follows from the fact that, in many countries, workers on JR are compelled to work fewer hours. While we could easily add this feature into the model, selection into JR by low-productivity matches is enough to generate the observed correlation between match productivity and JR take-up.

[11] This way of incorporating job retention schemes is similar to that in Balleer et al. (2016).

stage satisfies $S^s_{it} \geq 0$ – else, it has been endogenously separated. Under generalised Nash bargaining with a surplus share $\alpha \in (0,1)$ accruing to the firm, we have $J^s_{it} = \alpha S^s_{it}$. This equality holds state by state (for every possible idiosyncratic productivity level) and hence, it also holds in expectations over all surviving matches:

$$\mathbb{E}_{a_{it}}[J^s_{it}|a_{it} \geq \tilde{a}^s_t] = \alpha \mathbb{E}_{a_{it}}[S^s_{it}|a_{it} \geq \tilde{a}^s_t], \quad s \in \{L, H\}. \tag{7}$$

2.4 Value functions

2.4.1 Unemployed workers

We are now in a position to write up the value functions for workers and firms, starting with unemployed workers. An unemployed worker gets the home-production income b at the time of production (see Figure 1 again). Such a worker may find a job in the next period but lose it before production actually takes place. Accordingly, the value to a low-skilled unemployed worker at the time of home production is defined as follows:

$$U^L_t = b + \beta \Bigg[\underbrace{f_{t+1}(1-\rho^L_{t+1})\mathbb{E}_{a_{it+1}}[W^L_{it+1}|a_{it+1} \geq \tilde{a}^{Lf}_{t+1}]}_{\text{find job and not destroyed}} + \underbrace{f_{t+1}\rho^L_{t+1}U^L_{t+1}}_{\text{find job and destroyed}} + \underbrace{(1-f_{t+1})U^L_{t+1}}_{\text{do not find job}} \Bigg] \tag{8}$$

The value U^L_t has four components, namely, the instant pay-off from home production b and the (probability-weighted) continuation values for the three possible scenarios that may unfold in period $t+1$: (i) the worker finds a job at the beginning of period $t+1$ with probability f_{t+1}, which is not destroyed with endogenous probability $1-\rho^L_{t+1}$ and receives expected pay-off of being a low-skilled employed worker; (ii) the workers finds a job at the beginning of period $t+1$, but either separates exogenously from the firm or match specific productivity is revealed to be too low, such that the match dissolves before production takes place and the worker will receive the value of being unemployed in period $t+1$; and (iii) the worker does not match with any firm and remains unemployed – and hence, low-skilled.

Similarly, we can define the value of a high-skilled unemployed worker as:

$$\begin{aligned} U^H_t = b + \beta \Bigg[& \underbrace{f_{t+1}(1-\rho^H_{t+1})\mathbb{E}_{a_{it+1}}[W^H_{it+1}|a_{it+1} \geq \tilde{a}^{Hf}_{t+1}]}_{\text{find job and not destroyed}} + \underbrace{f_{t+1}\rho^H_{t+1}U^H_{t+1}}_{\text{find job and destroyed}} + \\ & \underbrace{(1-f_{t+1})\Big[lU^L_{t+1} + (1-l)U^H_{t+1}\Big]}_{\text{do not find job today with potential skill-loss}} \Bigg] \end{aligned} \tag{9}$$

Equation (9) is analogous to Equation (8), but with expected pay-offs of being employed in period $t+1$ that are compatible with being a high-skilled worker. Moreover, the last term of equation (9) incorporates the possibility that high-skilled workers can lose their skills if they are not matched with a firm and, therefore, will be a low-skilled unemployed worker with probability l.

2.4.2 Employed workers

The intertemporal utility of employed workers is computed in a similar fashion, distinguishing between high-skill and low-skill employed workers and suitably incorporating probability-weighted continuation values. For low-skilled employed workers, we obtain:

$$W_{it}^{L} = w_{it}^{L} + \beta \Bigg[(1-g)\Big(\underbrace{(1-\rho_{t+1}^{L})\mathbb{E}_{a_{it+1}}[W_{it+1}^{L} | a_{it+1} \geq \tilde{a}_{t+1}^{Lf}]}_{\text{no skill gain, match not destroyed next period}} + \underbrace{\rho_{t+1}^{L} U_{t+1}^{L}}_{\text{no skill gain, match destroyed}} \Big) + g\Big(\underbrace{(1-\rho_{t+1}^{H})\mathbb{E}_{a_{it+1}}[W_{it+1}^{H} | a_{it+1} \geq \tilde{a}_{t+1}^{Hf}]}_{\text{skill gain, match not destroyed next period}} + \underbrace{\rho_{t+1}^{H} U_{t+1}^{H}}_{\text{skill gain, match destroyed}} \Big) \Bigg] \tag{10}$$

Equation (10) is a general expression for the present value of being a low-skilled employed worker when production takes place at time t. The worker receives a wage w_{it}^{L}, which depends on the realisation of idiosyncratic productivity and, hence, on whether the worker-firm match operates as usual or under a job retention scheme. After the production phase, the worker remains low-skilled with probability $1-g$ or becomes high-skilled with probability g. In either case, in the next period, the match can stay together and keep on producing or separate with endogenous probability ρ_{t+1}^{s} with $s \in \{L, H\}$.

Like for unemployed workers, the value of being employed and high-skilled (eq. (11)) is analogous to the value of being employed and low-skilled with the difference that high-skilled workers cannot improve their skill level any further; they thus remain high-skilled until they become unemployed and might lose their skill level with probability l each period:

$$W_{it}^{H} = w_{it}^{H} + \beta \left\{ (1-\rho_{t+1}^{H})\mathbb{E}_{a_{it+1}}[W_{it+1}^{H} | a_{it+1} \geq \tilde{a}_{t+1}^{Hf}] + \rho_{t+1}^{H} U_{t+1}^{H} \right\} \tag{11}$$

Now, the current wage, as well as the expected value of being employed in the next period, both depend on the aggregate state and the idiosyncratic productivity in each time period and, hence, on whether the worker-firm match is operating as usual or on a job-retention scheme in the respective period. The full expression for the expected value of being employed with a particular skill level is given by:

$$
\begin{aligned}
\mathbb{E}_{a_{it}}[W^s_{it}|a_{it} \geq \tilde{a}^s_t] = & \frac{1-F(\tilde{a}^{sd}_t)}{1-F(\tilde{a}^{sf}_t)}\mathbb{E}_{a_{it}}[W^{sn}_{it}|a_{it} \geq \tilde{a}^{sd}_t] + \\
& \frac{F(\tilde{a}^{sd}_t)-F(\tilde{a}^{sf}_t)}{1-F(\tilde{a}^{sf}_t)}\mathbb{E}_{a_{it}}[W^{sd}_{it}|\tilde{a}^{sf}_t \leq a_{it} \leq \tilde{a}^{sd}_t]
\end{aligned} \tag{12}
$$

where $s \in \{L, H\}$, the idiosyncratic productivity thresholds $\tilde{a}^{sf}$ and $\tilde{a}^{sd}$ are defined as above, W^{sn}_{it} is the value to an employed worker of skill level s of a match that operates as normal (indicated by n) and W^{sd}_{it} is the value to the same worker, where the match operates using a job retention scheme d. A match operates as usual with probability $\frac{1-F(\tilde{a}^{sd}_t)}{1-F(\tilde{a}^{sf}_t)}$, which is the probability that match specific productivity is above the JR threshold $\tilde{a}^{sd}_t$, conditional on the match not having separated endogenously, which happens with probability $1-F(\tilde{a}^{sf}_t)$. Furthermore, the match uses a job retention scheme with probability $F(\tilde{a}^{sd}_t)-F(\tilde{a}^{sf}_t)$, again conditional on the match not separating endogenously.

2.4.3 Firms

Denote by $\tilde{J}^s_t$ the value to the firm matched with a worker with skill $s \in \{L, H\}$ at the beginning of the period (when matches are formed), and J^s_{it} the corresponding value of the match at the time of production in case the match is not destroyed before. $\tilde{J}^L_t$ is given by:

$$
\begin{aligned}
\tilde{J}^L_t = \underbrace{(1-\rho^L_t)}_{\text{Not destroyed}} \Bigg[& \underbrace{\frac{1-F(\tilde{a}^{Ld}_t)}{1-F(\tilde{a}^{Lf}_t)}\mathbb{E}_{a_{it}}[(1-\delta^S)a_{it}-w^L_{it}|a_{it} \geq \tilde{a}^{Ld}_t]}_{\text{Probability of operating normally times expected pay-off}} + \underbrace{\Phi_t}_{\text{Employment subsidy}} \\
& + \underbrace{\frac{F(\tilde{a}^{Ld}_t)-F(\tilde{a}^{Lf}_t)}{1-F(\tilde{a}^{Lf}_t)}\mathbb{E}_{a_{it}}[(1-\delta^S)a_{it}-w^L_{it}+d_t|\tilde{a}^{Lf}_t \leq a_{it} < \tilde{a}^{Ld}_t]}_{\text{Probability of operating under JR times expected pay-off}} \\
& + \underbrace{\beta(1-g)\tilde{J}^L_{t+1}+\beta g\tilde{J}^H_{t+1}}_{\text{Continuing with low or high-skilled match}} \Bigg]
\end{aligned} \tag{13}
$$

Equation (13) implies that if the firm does *not* separate from the worker, which occurs with probability $1-\rho^L_t$, the firm receives an expected pay-off that can be summarised similarly to that of workers. If the firm operates as normal, its profits consist of production $(1-\delta^S)a_{it}$ minus the wage the firm pays to the worker, plus the employment subsidy Φ_t the firm receives. In case the firm operates under a job-retention scheme, profits come from production $(1-\delta^S)a_{it}$, the same expression as for firms operating normally but with lower realisations of a_{it}. The firm has to pay a wage to the worker and receives both the employment subsidy and the job retention subsidy d_t. Finally, the term $\beta(1-g)\tilde{J}^L_{t+1}+\beta g\tilde{J}^H_{t+1}$ is the continuation value in the next period, which captures the possibility that the low-skilled worker becomes high-skilled in the next period.

Similarly, the value of a firm matched with a high-skilled worker is given by:

$$\tilde{J}^H_t = (1-\rho^H_t)\Bigg[\underbrace{\frac{1-F(\tilde{a}^{Hd}_t)}{1-F(\tilde{a}^{Hf}_t)}\mathbb{E}_{a_{it}}\left[a_{it}-w^H_{it}|a_{it}\geq\tilde{a}^{Hd}_t\right]}_{\text{Probability of operating normally times expected pay-off}} + \underbrace{\Phi_t}_{\text{Employment subsidy}} \\ + \underbrace{\frac{F(\tilde{a}^{Hd}_t)-F(\tilde{a}^{Hf}_t)}{1-F(\tilde{a}^{Hf}_t)}\mathbb{E}_{a_{it}}\left[a_{it}-w^H_{it}+d_t|\tilde{a}^{Hf}_t\leq a_{it}<\tilde{a}^{Hd}_t\right]}_{\text{Probability of operating under JR times expected pay-off}} + \underbrace{\beta\tilde{J}^H_{t+1}}_{\text{Continuation value}}\Bigg] \tag{14}$$

These equations represent the value to the firm of being matched with either a low-skilled or high-skilled worker at the time of job creation, which we use to formulate the free-entry condition:

$$\kappa = \lambda_t\Big[q_t\tilde{J}^L_t + (1-q_t)\tilde{J}^H_t\Big] \tag{15}$$

where κ is the cost a firm needs to pay for posting a vacancy, q_t is the share of low-skilled workers in the unemployment pool and, hence, the probability a firm with an open vacancy meets a low-skilled worker and λ_t, $\tilde{J}^L_t$ and $\tilde{J}^H_t$ are as defined above.

2.5 Wages

Wages are determined each period after idiosyncratic productivity is revealed. generalised Nash-bargaining over the joint surplus. However, unlike in a standard model, the joint surplus is not only directly determined by the realisation of a_{it} but also indirectly since the level of a_{it} determines whether the worker-firm pair is operating on a JR scheme. That is if $a_{it}\geq\tilde{a}^{sd}_t$ the joint surplus over which the low-skilled and high-skilled worker and firm bargain is given by:

$$S^L_{it} = W^L_{it} - U^L_t + (1-\delta^S)a_{it} - w^L_{it} + \Phi_t \tag{16}$$

$$S^H_{it} = W^H_{it} - U^H_t + a_{it} - w^H_{it} + \Phi_t \tag{17}$$

respectively. On the other hand, if $\tilde{a}_t^{sf} \leq a_{it} < \tilde{a}_t^{sd}$, the joint surplus over which a firm and worker, with low or high skill, bargain is:

$$S_{it}^L = W_{it}^L - U_t^L + (1 - \delta^S)a_{it} - w_{it}^L + d_t + \Phi_t \tag{18}$$

$$S_{it}^H = W_{it}^H - U_t^H + a_{it} - w_{it}^H + d_t + \Phi_t \tag{19}$$

Therefore, the wage that solves each problem is not the same when the worker firm match receives the JR subsidy compared to when it does not.

2.6 Thresholds

We are now ready to formally define the separation threshold, $\tilde{a}_t^{sf}$, and the JR eligibility threshold, $\tilde{a}_t^{sd}$. The worker and firm endogenously separate when the joint surplus is no longer positive. Given the Nash-bargaining rule $S_{it}^s = \alpha J_{it}^s$, it is equivalent to say that the worker and firm endogenously separate if $J_{it}^s \leq 0$. Therefore, for skill level L and H respectively, the separation threshold is such that:

$$J_t^L(\tilde{a}_t^{Lf}) = (1 - \delta^S)\tilde{a}_t^{Lf} - w_{it}^L + d_t + \Phi_t + \beta\Big((1-g)\tilde{J}_{t+1}^L + g\tilde{J}_{t+1}^H\Big) = 0 \tag{20}$$

$$J_t^H(\tilde{a}_t^{Hf}) = \tilde{a}_t^{Hf} - w_{it}^H + d_t + \Phi_t + \beta\tilde{J}_{t+1}^H = 0 \tag{21}$$

Note that d_t appears in both equations because when the work and firm are about to separate, the corresponding idiosyncratic productivity threshold $\tilde{a}_t^{sf}$ must be below the JR eligibility threshold. This means all firm-worker pairs that break up would have been on a JR scheme if the realisation of idiosyncratic productivity had been slightly higher. The exact level of idiosyncratic productivity below which the worker-firm pair becomes eligible for a JR scheme is when the worker and firm would otherwise separate. That is, for skill level L and H respectively, the JR eligibility thresholds $\tilde{a}_t^{Ld}$ and $\tilde{a}_t^{Hd}$ satisfy:

$$J_t^L(\tilde{a}_t^{Ld}) = (1 - \delta^S)\tilde{a}_t^{Ld} - w_{it}^L + \Phi_t + \beta\Big((1-g)\tilde{J}_{t+1}^L + g\tilde{J}_{t+1}^H\Big) = 0 \tag{22}$$

$$J_t^H(\tilde{a}_t^{Hd}) = \tilde{a}_t^{Hd} - w_{it}^H + \Phi_t + \beta\tilde{J}_{t+1}^H = 0 \tag{23}$$

Observe now that d_t does not appear in Equations (22) and (23), because it solves for the level of idiosyncratic productivity at which the match would separate in the *absence* of a job retention scheme. This equation might look similar to what the equation for finding the separation threshold would be in a model where job retention policies are not incorporated, however, it is not exactly. The possibility of a JR scheme in future periods affects the expected value of the firm, which in itself changes the value of the JR eligibility threshold.

Firms take future possibilities of making use of a JR scheme into account when assessing the value of being matched to a worker. This means that in the presence of JR scheme, a wider range of match-specific productivity leads to a profitable match, which increases the probability that the match will continue in future periods. This increases the value to the firm. On the other hand, the resulting lower separation rates reduce the expected productivity of the firm, leading to a lower expected value. Which effect of the two dominates depends on the size of the job-retention subsidy d_t.

3 Optimal labour-market policies

3.1 Planning problem

We are now in a position to set up the optimal policy problem. The policymaker's objective is to choose the employment and job retention subsidies that maximises $\mathbb{W}_t = \sum_{t=0}^{\infty} \beta^t \mathbb{Y}_t$, where $\mathbb{Y}_t$ is total output net of vacancy costs and the financing cost of the policies, subject to Equations (3) to (23). The net flow payoff to the Ramsey planner $\mathbb{Y}_t$ is given by:

$$
\begin{aligned}
\mathbb{Y}_t = \Bigg[& \underbrace{b\Big(u_t^L + u_t^H\Big)}_{\text{home production}} - \underbrace{\kappa v_t}_{\text{vacancy costs}} + \underbrace{n_t^L \frac{1 - F(\tilde{a}_t^{Ld})}{1 - F(\tilde{a}_t^{Lf})} (1 - \delta^S) \mathbb{E}_{a_{it}}[a_{it} | a_{it} \geq \tilde{a}_t^{Ld}]}_{\text{output of matches with low-skilled workers not on JR}} \\
& + \underbrace{n_t^L \frac{F(\tilde{a}_t^{Ld}) - F(\tilde{a}_t^{Lf})}{1 - F(\tilde{a}_t^{Lf})} (1 - \delta^S) \mathbb{E}_{a_{it}}[a_{it} | \tilde{a}_t^{Lf} \leq a_{it} < \tilde{a}_t^{Ld}]}_{\text{output of matches with low-skilled workers on JR}} \\
& + \underbrace{n_t^H \frac{1 - F(\tilde{a}_t^{Hd})}{1 - F(\tilde{a}_t^{Hf})} \mathbb{E}_{a_{it}}[a_{it} | a_{it} \geq \tilde{a}_t^{Hd}]}_{\text{output of matches with high-skilled workers not on JR}} \\
& + \underbrace{n_t^H \frac{F(\tilde{a}_t^{Ld}) - F(\tilde{a}_t^{Lf})}{1 - F(\tilde{a}_t^{Lf})} \mathbb{E}_{a_{it}}[a_{it} | \tilde{a}_t^{Hf} \leq a_{it} < \tilde{a}_t^{Hd}]}_{\text{output of matches with high-skilled workers on JR}} \Bigg] \\
& - \underbrace{\left(n_t^L \frac{F(\tilde{a}_t^{Ld}) - F(\tilde{a}_t^{Lf})}{1 - F(\tilde{a}_t^{Lf})} + n_t^H \frac{F(\tilde{a}_t^{Ld}) - F(\tilde{a}_t^{Lf})}{1 - F(\tilde{a}_t^{Lf})} \right) c_d\big(d_t\big)}_{\text{cost of JR subsidies}} - \underbrace{\Big(n_t^L + n_t^H\Big) c_\Phi\big(\Phi_t\big)}_{\text{cost of employment subsidies}}
\end{aligned}
$$

The planning problem cannot be solved analytically, so we calibrate the model and solve it numerically. We focus on the steady state and find the optimal labour-market policy mix via a numerical grid search procedure, implemented as follows. First, we parameterise the model – see Section 3.2 below. Next, we compute the steady-state values of all endogenous variables for each pair of (time-invariant) employment and job retention subsidies (Φ, d)

on a grid. Finally, we compute the planner's flow payoffs $\mathbb{Y}_t$ and intertemporal utility $\mathbb{W}_t$ associated with each of these pairs.

3.2 Parameterisation

Our parameterisation of the model is summarised in Table 1 below. Following Laureys (2021), we calibrate the model to the monthly frequency, and most of our calibration follows hers. Note, in particular, that we set $\alpha = \gamma = 0.5$, so that congestion externalities are efficiently handled by bilateral bargaining (but not the other sources of inefficiencies). The main difference with Laureys (2021) is our assumption of endogenous job destruction, which is ultimately determined by the distribution of idiosyncratic productivity shocks a, i.e., the parameters (μ_a, σ_a) of the log-normal distribution. We assume that $\mu_a = -\frac{\sigma_a^2}{2}$, which normalises mean idiosyncratic productivity $\mathbb{E}(a)$ to 1. Next, we look for combinations of (b, σ_a) that deliver interior solutions for both destruction thresholds $(\tilde{a}^{Lf}, \tilde{a}^{Hf})$ in the absence of job retention scheme; accordingly, we set $\sigma_a = .336$ and $b = .85$, which jointly generate $\tilde{a}^{Lf} = .65$ and $\tilde{a}^{Hf} = .41$. Finally, we set the vacancy costs κ and matching parameter $\bar{m}$ to generate a plausible unemployment rate, given the other parameters; under the values of Table 1, the overall unemployment rate is 7.3%. Finally, we assume the following functional form for the convex cost of implementing the employment and job retention subsidy: $c_\Phi(y) = c_d(y) = \pi y^2$, and we set $\pi = 4.5$ (our qualitative results are robust to changes in π).

3.3 Results

The outcome of the grid search is depicted in Figure 2. We consider a grid $\Phi_t \in [0, 0.025]$ for employment subsidy Φ_t on the x-axis, a grid $d_t \in [0, 09]$ for the job-retention subsidy on the y-axis, and flow welfare $\mathbb{Y}_t$ is depicted on the z-axis (vertical axis). The red-dashed line indicates the level of $\mathbb{Y}_t$ when $\Phi_t = d_t = 0$ (or equivalently the level of $\mathbb{Y}_t$ in the Laissez-faire environment). The green-dashed line highlights the highest achieved level of $\mathbb{Y}_t$, which is attained by a positive combination of both policies. Moreover, each policy alone is welfare-improving when comparing steady states. To see this last point more clearly, consider Figure 3, which shows $\mathbb{Y}_t$ as defined above, for two special cases, where: (i) $d_t = 0$ and we compute the steady-state for different values of Φ_t (left panel); and (ii) $\Phi_t = 0$ and we compute the steady-state for different values of d_t (right panel). The value of the two subsidies is on the x-axes, while the resulting steady-state flow welfare is reflected on the y-axis. The highest flow welfare is achieved for positive values of both subsidies, which implies that each policy is welfare improving in itself (in steady-state).

While the two graphs in Figure 3 might look similar in the sense that the optimal levels of each policy is positive, achieving a seemingly similar level $\mathbb{Y}_t$, the mechanisms behind the functioning of these policies are different. The fact that the mechanisms are different also

Table 1: Calibrated parameters.

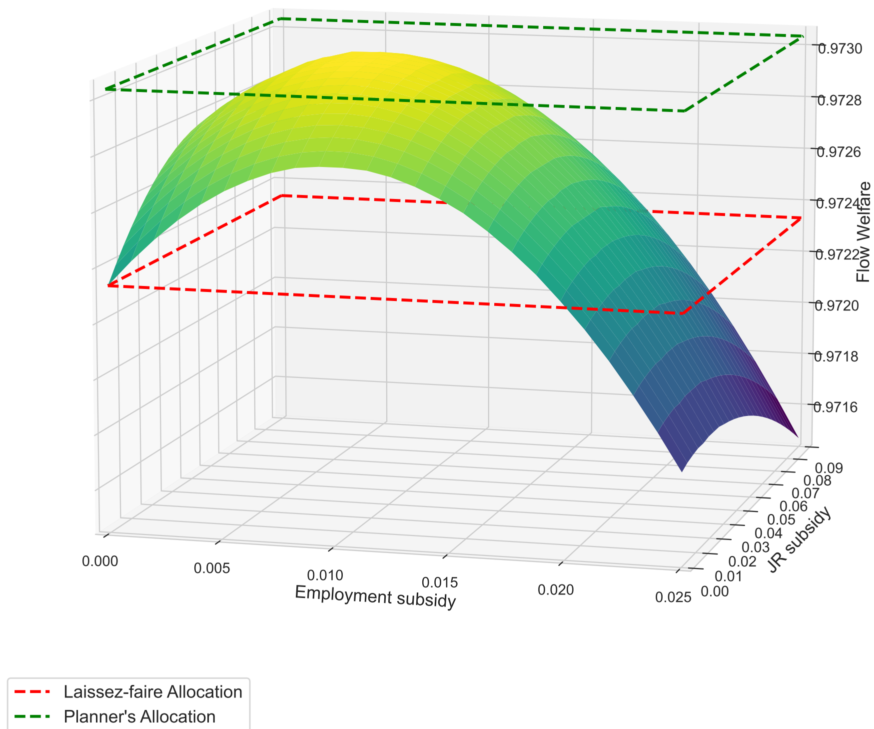
Parameter	**Symbol**	**Value**	**Source/Target**
Discount factor	β	0.996	Laureys (2021)
Surplus sharing	α	0.5	Laureys (2021)
Matching function elasticity parameter	γ	0.5	Laureys (2021)
Matching function efficiency parameter	$\bar{m}$	0.495	See text
Vacancy posting cost	κ	0.07	See text
Exogenous job destruction rate	ρ^x	0.046	Laureys (2021)
Home production	b	0.85	88% of mean wage
Probability skill growth	g	0.05	Laureys (2021)
Probability skill loss	l	0.167	Laureys (2021)
Productivity discount low-skilled	δ^S	0.181	Laureys (2021)
Idiosyncratic shocks (dispersion param.)	σ_a	0.336	See text
Idiosyncratic shcoks (level param.)	μ_a	$-\frac{\sigma_a^2}{2}$	Mean productivity $\mathbb{E}a = 1$

explains that it is when the policies are used simultaneously that the highest steady-state welfare $\mathbb{Y}_t$ is reached.

To understand the workings of each of the policies better, we consider steady-state values of the endogenous variables for four special cases in Table 2. The first column of Table 2 shows the steady-state values in the Laissez-faire allocation when both policies are inactive (i.e. $\Phi_t = d_t = 0$). In the second column, we report the steady-state values when $\mathbb{Y}_t$ is maximised when only the employment subsidy is available to the policymaker. That is, we report the steady state values for some value $\Phi_t = \Phi^*$ and $d_t = 0$, such that Φ^* is equal to the level of employment subsidy that realises the highest level of $\mathbb{Y}_t$ as depicted in the left panel of Figure 3. In the third column, we show the result of the opposite experiment, when the policymaker only has the job retention subsidy at its disposal and chooses a level $d_t = d^*$ such that it maximises $\mathbb{Y}_t$, while $\Phi_t = 0$ (see the green-dashed line in the right panel of Figure 3). Finally, the last column shows the steady-state results when the policymaker can make use of both policies and sets each policy such that the combination $\Phi_t = \Phi^{**}$ and $d_t = d^{**}$ maximises flow welfare at the level of the green-dashed line in Figure 2.

Notice first in Table 2 that the steady-state value of total unemployment, $u_t^L + u_t^H$, decreases with either subsidy compared to the Laissez-faire allocation. More specifically,

Figure 2: $\mathbb{Y}_t$ by Employment subsidy Φ_t and JR subsidy d_t



high-skilled unemployment is lower in the steady-state allocation with either or both subsidies. This means that both subsidies partially offset the distortion described by Laureys (2021), since the number of unemployed workers that are at risk of losing their skills when they are not hired by firms is lower. Moreover (the overall level of high-skilled workers (unemployed and employed) is higher in the economy with the policies, which should increase the average level of productivity in the economy.

Additionally, Table 2 shows that unemployed workers face a higher job-finding probability f_t when the policies are active. This means that, on average, workers stay in unemployment for shorter periods of time in the economy when $\Phi_t = \Phi^*$, $d_t = d^*$, or $\Phi_t = \Phi^{**}$ and $d_t = d^{**}$, than in the Laissez-faire economy.[12] This effect is stronger when the policymaker uses the

[12] Note that while vacancy creation is higher in the Laissez-faire economy, this is not necessarily in contradiction with the fact that hiring is more efficient when $\Phi_t = \Phi^*$, $d_t = d^*$, or $\Phi_t = \Phi^{**}$ and $d_t = d^{**}$. Since we are comparing steady-state values, the lower level of vacancies is an equilibrium effect, resulting from the fact that overall unemployment is lower. When unemployment is low, it is harder for firms to find workers,

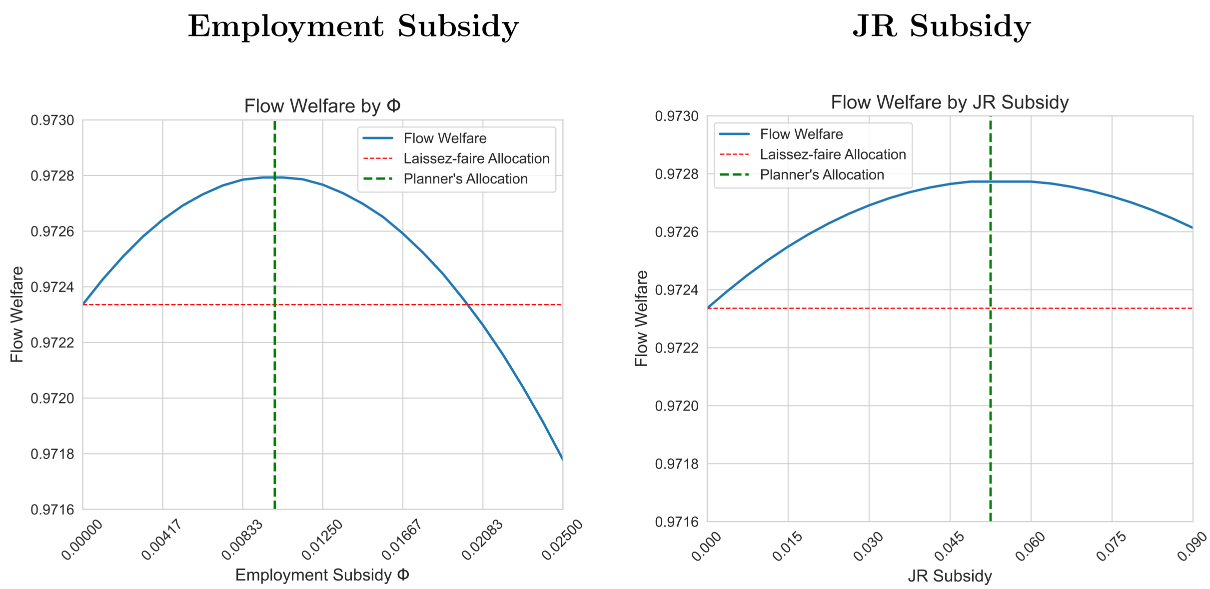


Figure 3: Flow welfare by each subsidy

employment subsidy than when it uses the JR subsidy. This suggests that the employment subsidy alone is better than the job retention subsidy at offsetting the externality described by Laureys (2021) – namely, that firms do not internalise their beneficial effect on the skill composition of the unemployment pool when making hiring decisions.

On the other hand, when looking at the job-destruction channel, even though both subsidies are successful, the JR policy is more effective at doing so, resulting in lower values for ρ_t^L and ρ_t^H. This difference between the subsidies becomes clearer when examining the value to the firm at the time of job creation. Compared to the Laissez-faire steady-state, when $d_t = d^*$, the expected value to the firm is lower. In principle, lower values of ρ^L and ρ^H should increase the value $\tilde{J}_t^L$ and $\tilde{J}_t^H$. However, a lower separation rate also leads to lower expected productivity. This negative effect on the value to the firm is partially offset by the subsidy, but the subsidy needs to be shared with the worker. Therefore, while still positive, the value of the firm decreases for certain values of d_t.

Putting this together, the job-retention subsidy effectively reduces the job-destruction rate. This is welfare improving because it leads to lower (high-skilled) unemployment, which implies that the externality described by Laureys (2021) has less bite. However, the subsequent reduced value of the firm inhibits the positive effect on job creation. On the other hand, while the employment subsidy increases the expected value to the firm and, therefore, is more effective at promoting job creation, the increased job-finding rate also leads to a

which makes posting a vacancy less profitable, leading to lower levels of hiring.

Table 2: Steady state results.

Var.	**Laissez-faire** $\Phi_t = 0,\ d_t = 0$	**Emp. subsidy only** $\Phi_t = \Phi^*,\ d_t = 0$	**JR subsidy only** $\Phi_t = 0,\ d_t = d^*$	**Both subsidies** $\Phi_t = \Phi^{**},\ d_t = d^{**}$
$\tilde{a}_t^{Ld}$	—	—	0.6509	0.6288
$\tilde{a}_t^{Lf}$	0.6486	0.6242	0.5914	0.5693
$\tilde{a}_t^{Hd}$	—	—	0.4212	0.4197
$\tilde{a}_t^{Hf}$	0.4100	0.4111	0.3724	0.3710
θ_t	2.4750	2.5864	2.5161	2.6068
f_t	0.7787	0.7961	0.7852	0.7992
λ_t	0.3146	0.3078	0.3121	0.3066
v_t	0.1832	0.1825	0.1647	0.1645
ρ_t^L	0.1712	0.1495	0.1237	0.1087
ρ_t^H	0.0522	0.0523	0.0487	0.0486
u_t^L	0.0145	0.0114	0.0097	0.0080
u_t^H	0.0595	0.0591	0.0557	0.0552
n_t^L	0.0440	0.0403	0.0400	0.0370
n_t^H	0.8820	0.8892	0.8946	0.8999
$\tilde{J}_t^L$	0.1422	0.1505	0.1420	0.1495
$\tilde{J}_t^H$	0.2816	0.2810	0.2763	0.2770
U_t^L	240.0642	242.3423	240.2630	242.2559
U_t^H	242.7143	245.0708	242.9073	244.9694
$\mathbb{Y}_t$	0.9723	0.9728	0.9728	0.9730

higher value of the worker's outside option. This, in turn, dampens the negative effect on job destruction and partially negates the positive effect coming from higher job creation. Finally, as is evident from Figure 2, the combination of both policies yields the highest welfare in steady state. The intuition is that the policies are together more effective at tackling both the job-creation margin and the job-destruction margin, making sure that welfare gains resulting from adjusting one margin are not offset by the other.

4 Conclusion

This paper analyses and compares the effectiveness of employment subsidies vis-à-vis job retention subsidies in a random search-and-matching model. The model incorporates human capital depreciation during unemployment spells and accounts for endogenous job destruction. Our findings suggest that in this environment, employment subsidies alone are no longer sufficient to address inefficient hiring of the decentralised allocation because of the policy's effect on the separation margin. In addition, we show that the introduction of job retention schemes are welfare-improving in this environment. Moreover, it is the combination of employment subsidies and job retention subsidies that achieves the highest level of welfare. This is because only the combination of both policies is able to tackle externalities in both the job-creation margin and the separation margin at the same time.

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