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Centralized Wage Setting and Active Labor Market Policies in Frictional Labor Markets: the Nordic Case

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Abstract

We adopt a standard search and matching model with endogenous job destruction to investigate two issues. First, we use a simplified version of Boeri and Burda (2009) to show that at sufficiently low levels of wage share, centralized wage bargaining performs better than decentralized bargaining in terms of average productivity, unemployment, and income inequality. Second, we incorporate active labor market policies in the model and establish that they are more effective in reducing unemployment when wage setting is centralized. Finally, numerical analysis suggests that the difference in effectiveness is sizeable.

Keywords: Centralized wage setting, active labor market policy, frictional unemployment, search and matching

JEL Classification: J31, J60, L16.

1 Introduction

The 'Nordic' model provides a way to look at the relation between inequality, productivity and employment compatible with the social democratic goal of combining egalitarian distribution of earnings, security of income, and efficiency (see Moene 2008). The original formulation of the model is due to two Swedish trade union economists, Gosta Rehn and Rudolf Meidner, and dates back to the 1940s. Later on, Rehn and Meidner perfected it and advocated its implementation by the Swedish government throughout the 1950s and 1960s.

Three main policies constituted the core of the model: restrictive fiscal policy, active labor market policies (ALMPs) and solidaristic wage policy. In the context of a small open economy during the post World War II boom, fighting inflation was a bigger concern than

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stimulating aggregate demand, which was kept high by the external channel: fiscal restraint served this purpose. The two other policies together aimed at fostering structural change while guaranteeing distributive equality and high employment. Centralized bargaining was at the centre of the system. By negotiating equal remuneration for identical jobs ('Equal pay for equal jobs') regardless of the productivity of plants or firms, centralized wage bargaining was thought of as a tool capable not only of providing the equalization of earnings but also of fostering productivity growth. A more compressed distribution of wages would put pressure on low productivity plants, obliging them either to rationalize production, thus increasing productivity directly, or to shut down, thus freeing resources potentially employable by more dynamic and productive firms or sectors. Put differently, wage compression would act as a subsidy to investment in more productive plants by increasing their relative value, and thereby enhancing the scope for job relocation in high-tech activities. ALMPs complement wage solidarity as they help the transition of workers from low to high productive firms, sectors or regions. ALMPs could be either universal (matching policies and employment subsidies); or selective (supply-side retraining, vocational education, relocation grants).

It is a matter of debate whether this model has been faithfully implemented (see Erixon 2010). Centralized wage-setting, in any case, became a distinctive feature of Swedish economic policy between 1956 and 1983. Two different phases can be distinguished. Phase I began in 1956, when national unions of blue-collar workers (LO) and employers (SAF) found the first comprehensive framework agreement for private blue-collar workers; it lasted till the late 60s. During this period solidarity wage policy was properly applied according to the principle 'equal pay for equal jobs', and centralized agreements favored wage equalization among analogous jobs in different industries and plants (Hibbs and Locking 2000, p. 760). In phase II, which began in the early 70s and ended in 1983 when the last comprehensive agreement was signed, the main goal of wage solidarity shifted from facilitating structural change to achieving wage equalization *per se*, irrespective of the type of job. As a result, wage inequality was reduced not only across plants and industries, but also within plants and across skill grades. From the late 70s, this extensive wage compression tended to reduce both returns to and investment in human capital, thus possibly favoring a productivity slowdown (Leamer and Lundborg 1997, Lindbeck 1997). Empirical evidence on the relation between wage dispersion and productivity (Hibbs and Locking 2000) supports the view that a reduction in 'across-plant' wage inequality positively affects labor productivity growth, while a reduction in 'within-plant' wage inequality–accompanied by an equalization across skill levels–would be harmful. Such difficulties led to a progressive abandonment of centralized national bargaining, which after 1983 mostly took place at industry and firm levels. Wage inequality regained ground, but currently it still stands at levels substantially lower than in Anglo-American economies (see Pontusson 2006).

Spending on ALMPs became a key component of Swedish economic policies in 1957, and it showed a positive trend as share of both GDP and government budget till the early 80s. In terms of international comparisons, the Swedish GDP share of ALMP expenditures was consistently among the top OECD countries throughout the 70s and the 80s (see Erixon 2010). Empirical evaluations of the effect ALMPs had on unemployment in Sweden are however not conclusive (see Calmfors 1993, Calmfors and Skedinger 1995).

Agell and Lommerud (1993), and Moene and Wallerstein (1997) provided possible formalizations for the Rehn-Meidner model by analyzing the positive relation between centralized wage bargaining and structural change. Agell and Lommerud (1993) develop an endogenous growth model to show that egalitarian pay compression, combined with active labor market policies, is analogous to an industrial policy of subsidizing the most promising industries. Moene and Wallerstein (1997) compare the performances of centralized and decentralized wage bargaining in terms of productivity and employment outcomes in a vintage growth model with exogenous technical change. They show that centralized bargaining is always superior to local bargaining in terms of steady state productivity while it is always inferior in terms of employment; the effects on investment and total output depend on the share of productivity accruing to workers, i.e. the degree of wage moderation. They do not consider, however, the role of active labor market policies.

Our paper adopts a standard search and matching model with endogenous job destruction to investigate two issues. First, we use a simplified version of Boeri and Burda (2009) to show that at low levels of wage share, centralized wage bargaining performs better than decentralized bargaining in terms of average productivity and unemployment. This result is similar to the findings of Moene and Wallerstein (1997) and appears to describe properly the experience of Nordic countries till the 80s. Next, we introduce ALMPs in Boeri and Burda (2009) to assess their comparative performance under decentralized and centralized wage bargaining regimes. We establish analytically that, under certain conditions, such policies are more effective in reducing unemployment under the centralized regime. Furthermore, numerical analyses allow us to demonstrate this result for more general configurations of the relevant parameters and to show that the difference in policy effectiveness is quantitatively relevant.

Notice that, by adopting a framework like the one proposed by Boeri and Burda (2009), we cannot properly talk about structural change, which would require a full-fledged multisectoral growth model. This is the cost we pay to be able to achieve an analytical comparison of active labor market policies under the alternative wage setting regimes.

The rest of the paper is organized as follows. Section 2 outlines a standard search and matching model with endogenous job destruction, and compares equilibrium outcomes between centralized and decentralized wage setting regimes. Section 3 introduces labor market policies in the model and carries out a comparison of their effectiveness under the two bargaining systems. Section 4 offers some concluding remarks.

2 Centralized and Decentralized Wage Bargaining with Frictional Labor Markets

The basic frictional labor market framework with endogenous job destruction is well known and builds on Chapter 2 of Pissarides (2000). We adopt a simplified version of an extension proposed by Boeri and Burda (2009), which allows a comparison of the effects of centralized and decentralized wage setting in terms of unemployment, labor market tightness and productivity.

2.1 Summary of the model

Workers are either employed earning the wage rate w or unemployed earning the unemployment benefit b. Firms search for workers at the periodic cost c when vacant, or produce output with productivity x when matched to a worker. The meeting process between firms and workers is governed by the constant returns to scale matching function $m(v, u)$ which gives the number of matches per unit of time as a function of the number of vacancies (v) and unemployed workers (u). A firm meets a worker with probability $\lambda_f = m(v, u)/v$. A worker meets a firm with probability $\lambda_w = m(v, u)/u$. Let $\vartheta \equiv v/u$ be the tightness of the labor market, then $\lambda_f = m(\vartheta, 1)/\vartheta$, and $\lambda_w = m(\vartheta, 1)$. We assume that the productivity of newly created matches is equal to 1. Productivity is subject to idiosyncratic shocks drawn from the distribution $G(x)$, with $x \in (0, 1]$. When hit by a shock, a job changes its productivity from its initial value x to some new value x'. Shocks arrive to matches at the exogenous Poisson rate σ.

We start by deriving the asset value of states when wage bargaining is decentralized (denoted by the subscript d), that is: when wages are negotiated at the individual match level[1]. Let the values for workers and active firms of productivity x be $W(x)$ and $J(x)$; and the values of unemployed workers and vacant firms be U and V. The following equations hold:

$$rW_d(x) = w_d(x) + \sigma \int_{R_d}^{1} [W_d(s) - W_d(x)]dG(s) + \sigma G(R_d)[U_d - W_d(x)] \tag{1}$$

$$rJ_d(x) = x - w_d(x) + \sigma \int_{R_d}^{1} [J_d(s) - J_d(x)]dG(s) + \sigma G(R_d)[V_d - J_d(x)] \tag{2}$$

$$rU_d = b + \lambda_w[W_d(1) - U_d] \tag{3}$$

$$rV_d = -c + \lambda_f[J_d(1) - V_d], \tag{4}$$

[1]It is worth recalling that a decentralized systems in a frictional environment is different from a competitive setting where workers' competition would tend to equalize wages.

where r is the interest rate, and R_d is the reservation productivity below which a match is no longer profitable and is destroyed. R_d is determined endogenously in the model as the solution to $J(R_d) = 0$. Expression (1) equates the flow value of being employed in a match of productivity x to the wage rate plus the expected capital gain associated with a shock, which will be either positive if the shock is higher than the current productivity or negative otherwise. If the new x is below the reservation productivity, the worker becomes unemployed and obtains the value of unemployment U_d. Analogously in equation (2) the flow value of an active firm is equal to the profit flow plus the expected capital gain or loss. Equation (3) defines the value of unemployment as the sum of unemployment benefits plus the expected gain from finding employment. In (4) the value of a vacancy is given by the expected gain from becoming active minus the cost of search. Notice that U_d and V_d are not productivity specific as all newly created matches have productivity $x = 1$.

Free entry implies that, in equilibrium, profits from new jobs are driven to zero, so that $V_d = 0$ and, from (4),

$$J_d(1) = \frac{c}{\lambda_f}. \tag{5}$$

Wages are derived as the solution to a Nash sharing rule. As a consequence, at all productivities x, the wage rate divides the total surplus of a match in fixed proportions:

$$W_d(x) - U_d = \beta[J_d(x) + W_d(x) - U_d], \tag{6}$$

where β is a measure of workers' bargaining power. Manipulating (1) and (2), and making use of (5), (6) and $V_d = 0$, yields the wage equation [2]

$$w_d(x) = (1-\beta)b + \beta(x + c\lambda_w/\lambda_f) = (1-\beta)b + \beta(x + c\vartheta_d). \tag{7}$$

The wage equation can be substituted into (2) to find

$$(r+\sigma)J_d(x) = (1-\beta)(x-b) - \beta c\vartheta_d + \sigma \int_{R_d}^{1} J_d(s)dG(s). \tag{8}$$

Evaluating (8) at $x = R_d$, and subtracting the resulting equation from (8), after using $J(R_d) = 0$ we get

$$(r+\sigma)J_d(x) = (1-\beta)(x - R_d), \tag{9}$$

which, calculated at $x = 1$, together with (5) yields the job creation condition as a function of R_d and ϑ_d

$$(1-\beta)\frac{1-R_d}{r+\sigma} = \frac{c}{\lambda_f} = \frac{c}{m(\vartheta_d, 1)}\vartheta_d. \tag{JC$_\mathrm{d}$}$$

[2]See Pissarides (2000, p. 42) for a derivation.

In $\mathrm{JC_d}$ the expected gain from a new job is equated to the expected hiring cost. It is downward sloping in the plane (R, ϑ) as a higher R_d reduces the expected lifetime of a job. Such a reduction in expected profitability has to be compensated by a higher probability of creating a match (λ_f), which is an inverse function of ϑ_d.

In order to derive the job destruction condition as a relation between R_d and ϑ_d, we substitute $J_d(x)$ from (9) into the integral expression of (8), then evaluate the resulting equation at $x = R_d$ and finally substitute it into the zero-profit condition for the reservation job, $J_d(R_d) = 0$:

$$R_d = b + \frac{\beta c}{(1-\beta)}\vartheta_d - \frac{\sigma}{r+\sigma}\int_{R_d}^{1}(s - R_d)dG(s). \tag{$\mathrm{JD_D}$}$$

$\mathrm{JD_d}$ slopes up as a higher tightness raises the workers' outside option and, in turn, their wages; then, a higher reservation productivity is required to make the marginal job break even. The system made up of $\mathrm{JC_d}$ and $\mathrm{JD_d}$ determines the equilibrium values R_d^* and ϑ_d^*.

Finally, steady state equilibrium requires the equalization of flows into and out of unemployment. Flow into unemployment is equal to the share of jobs hit by a productivity shock $x < R_d^*$, that is $\sigma G(R_d^*)(1-u)$. Flow out of unemployment is the number of unemployed workers finding a job, $m(\vartheta_d^*, 1)u$. Accordingly, equilibrium unemployment satisfies:

$$u_d^* = \frac{\sigma G(R_d^*)}{\sigma G(R_d^*) + m(\vartheta_d^*, 1)}. \tag{$\mathrm{u_d}$}$$

Let us now turn to the centralized bargaining case (denoted by the subscript c). Under this regime, wages are set independently of the productivity of an individual match. We assume $w_c(x) = \bar{x}$, with $\bar{x} \in (b, 1]$. The lower bound b ensures that the participation constraint for employment is satisfied. The valuation of states for workers and firms are

$$rW_c = \bar{x} + \sigma G(R_c)[U_c - W_c] \tag{10}$$

$$rJ_c(x) = x - \bar{x} + \sigma\int_{R_c}^{1}[J_c(s) - J_c(x)]dG(s) + \sigma G(R_c)[V_c - J_c(x)] \tag{11}$$

$$rU_c = b + \lambda_w[W_c - U_c] \tag{12}$$

$$rV_c = -c + \lambda_f[J_c(1) - V_c]. \tag{13}$$

Notice that only the job valuation by a firm is productivity specific. Proceeding analogously to the decentralized case, the job creation and job destruction condition can be obtained as[3]

[3] See Boeri and Burda (1999, p. 1462) for a derivation.

$$\frac{1-R_c}{r+\sigma}=\frac{c}{\lambda_f}=\frac{c}{m(\vartheta_c,1)}\vartheta_c \tag{JC$_\mathrm{c}$}$$

$$R_c=\bar{x}-\frac{\sigma}{r+\sigma}\int_{R_c}^{1}(s-R_c)dG(s). \tag{JD$_\mathrm{c}$}$$

Similarly to the decentralized case, $\mathrm{JC_c}$ is downward sloping in the $(R,\,\vartheta)$ plane and lies everywhere to the right of $\mathrm{JC_d}$. For any reservation productivity level (R), more vacancies are created in the centralized regime than in the decentralized one: the expected gain of a new job is higher as workers' remuneration is isolated from the firm's valuation of a newly created job $(J(1))$. In particular, workers do not split with the entrepreneurs the rents of the match. Contrary to the decentralized regime, the wage rate is fixed and does not respond to market conditions through the worker's outside option; therefore $\mathrm{JD_c}$ does not depend on ϑ and, it is flat in the $(R,\,\vartheta)$ plane.

Analogously to the decentralized case, the equilibrium unemployment condition is:

$$u_c^*=\frac{\sigma G(R_c^*)}{\sigma G(R_c^*)+m(\vartheta_c^*,1)}. \tag{u$_\mathrm{c}$}$$

Before proceeding to the comparison between the two wage setting systems, note that, both in the centralized and in the decentralized regime, the reservation productivity level R is positively related to the average productivity of the system since $E(x)=\int_R^1 x dG(x)$.

2.2 Discussion of the Nordic Model

The two sets of three equations (JC), (JD) and (u) allow a comparison of centralized and decentralized regimes, and can help us understand how Nordic countries managed to achieve relatively low unemployment rates, high productivity and low income inequality for a considerable period of time.

[Figure 1 about here.]

We have already established that $\mathrm{JC_c}$ lies to the right of $\mathrm{JC_d}$ in the $(R,\,\vartheta)$ plane. The relation between $\mathrm{JD_c}$ and $\mathrm{JD_d}$ is not as straightforward because the former is horizontal while the latter is upward sloping. We focus on one specific value at which $\mathrm{JD_c}$ is constant. Let us consider $\bar{x}$ as an exogenous variable, given at the institutional level, and let us start with the case $\bar{x}=b+[\beta/(1-\beta)]c\vartheta_d^*$, which, it can be shown, is the reservation wage in the decentralized case[4]. In such a situation, $\mathrm{JD_c}$ will be a flat line through the

[4]See eq. 2.9 in Pissarides (2000, p. 42) and remember that, by definition, the reservation wage is equal to the flow value of unemployment.

decentralized equilibrium (R_d^*, ϑ_d^*), so that $R_c^* = R_d^*$ and $\vartheta_c^* > \vartheta_d^*$ (see Figure 1). Moreover, since u is a decreasing function of ϑ in both systems, $u_c^* < u_d^*$. Given the decentralized (free market) equilibrium, we have built a centralized equilibrium that performs better in terms of employment, has lower (in fact zero) pay inequality and is as productive as the decentralized system. The result is not surprising. By keeping workers' remuneration in the centralized case at the minimum necessary to ensure their participation in the labor market in the decentralized case, our assumption implies a lower workers' income share in the centralized case, i.e. wage moderation. Firms internalize the share β of the surplus match, which goes to workers under the decentralized setting; accordingly, they invest more, thus raising the number of vacancies and reducing unemployment.

Figure 2 shows what happens if we raise $\bar{x}$ above its initial level. $\mathrm{JD_c}$ will be translated upward, and the centralized equilibrium will move continuously along the $\mathrm{JC_c}$, hence yielding a reduction in ϑ_c^* and an increase in R_c^*. Since unemployment is monotonic increasing in R, and monotonic decreasing in ϑ, raising $\bar{x}$ produces an increase in u_c^*. However, since u is continuous both in R and ϑ there will exist a range of values for $\bar{x}$, say $\bar{x} \in (b + \frac{\beta}{1-\beta} c\vartheta_d^*, x_0]$ with $x_0 < 1$ an unknown upper bound, where $\vartheta_c^* > \vartheta_d^*$, $R_c^* > R_d^*$ and $u_c^* < u_d^*$. This set of equilibria appears as a fairly accurate representation of the Scandinavian experience, where centralized wage bargaining combined with wage moderation, allowed the economic system to perform well in terms of productivity, employment and equality [5].

[Figure 2 about here.]

3 Policy Analysis

We now address the issue of how ALMPs perform in each system. We focus on policies which improve the prospects for successful pairings of unemployed workers and firms with vacancies[6]. We represent such policies by means of a shift variable in the matching function. Let z be expenses in labor market policies, the matching function becomes $m(v, u, z)$, with $m_z > 0$. In particular, in accordance with several empirical studies (see Pissarides 2000, p. 6), we assume a Cobb Douglas specification of the matching function

$$m(v, u, z) = g(z)v^{\alpha}u^{1-\alpha}, \tag{14}$$

where $g'(.) > 0$. Accordingly, we have $\lambda_f = g(z)\vartheta^{\alpha-1}$, and $\lambda_w = g(z)\vartheta^{\alpha}$.

The steady state equilibrium conditions for the decentralized case can be re-written as

[5] In section 3.2, we provide numerical examples supporting the argument that centralized wage setting allows to reach lower levels of unemployment when combined with wage moderation.

[6] Boone and van Ours (2004) formalize ALMPs in the context of frictional labor markets. However, they do not consider matching policies nor the interaction of ALMPS with decentralized and centralized wage setting regimes.

$$(1-\beta)\,\frac{1-R_d}{r+\sigma} = \frac{c\vartheta_d^{1-\alpha}}{g(z)} \tag{JC'$_\text{d}$}$$

$$R_d = b + \frac{\beta c}{(1-\beta)}\vartheta_d - \frac{\sigma}{r+\sigma}\int_{R_d}^{1}(s-R_d)dG(s) \tag{JD'$_\text{d}$}$$

$$u_d = \frac{\sigma G(R_d)}{\sigma G(R_d) + g(z)\vartheta_d^{\alpha}}, \tag{u'$_\text{d}$}$$

whereas the system of equations describing the centralized bargaining equilibrium becomes

$$\frac{1-R_c}{r+\sigma} = \frac{c\vartheta_c^{1-\alpha}}{g(z)} \tag{JC'$_\text{c}$}$$

$$R_c = \bar{x} - \frac{\sigma}{r+\sigma}\int_{R_c}^{1}(s-R_c)dG(s) \tag{JD'$_\text{c}$}$$

$$u_c = \frac{\sigma G(R_c)}{\sigma G(R_c) + g(z)\vartheta_c^{\alpha}}. \tag{u'$_\text{c}$}$$

Before proving our main result, we shall discuss how the introduction of a policy instrument changes the structure of the model. Let us first consider the interaction between JD and JC in the (R, ϑ) plane. In both the decentralized and the centralized case, our policy variable z enters JC but leaves JD unaltered. In particular, an increase in z raises the probability that a firm will find a match, thus boosting investment; but it does not affect the productivity level at which jobs are scrapped. The two systems, however, respond differently to an outward shift in the JC (due to the increase in z). In the centralized one, the flat JD implies that the equilibrium reservation productivity will stay constant, while the equilibrium tightness will increase; in the decentralized case, since the JD is upward sloping, both R^* and ϑ^* will rise. As for equilibrium unemployment, it may change in response to an increase in z through two channels. In the first place, the policy change directly alters unemployed workers' probability of finding a job, thus increasing the flow out of unemployment, and reducing the unemployment rate: this effect is present in both systems. Secondly, and only in the decentralized case, the policy change increases workers' reservation wage by raising their outside option. This effect increases unemployment by raising the equilibrium reservation productivity. On the contrary, the centralized system, by paying a fixed wage independently of the match productivity, turns off the increase in workers' reservation wage, and its adverse effect on unemployment.

We are now in the position to prove our main result on the complementarity between ALMP and centralized wage setting. We first prove this result analytically for value of w_c sufficiently close to the reservation wage in the decentralized case. We later verify our result for higher values of w_c by means of numerical analyses.

3.1 Analytical Result

The overall effect on unemployment of a policy change depends on the initial equilibrium position. Analytically, we cannot establish that matching policies are uniformly more effective in the centralized case; we restrict our proposition to the case when the centralized wage is equal to the outside option of the decentralized case, or when it is sufficiently close to it. We thus prove the existence of a set of values for w_c where ALMPs are more effective in reducing unemployment under the centralized system. Notice that values outside this set do not necessarily imply that the centralized system is less effective. Let $\hat{x} > b + \frac{\beta}{1-\beta} c\vartheta_d^*$ be an unknown productivity level, we state

Proposition 1 *when* $w_c(x) = \bar{x} \in [b + \frac{\beta}{1-\beta} c\vartheta_d^*, \hat{x}\ ]$*, an increase in* z *raises* ϑ_c^* *more than it raises* ϑ_d^**, i.e.* $d\vartheta_c^*/dz > d\vartheta_d^*/dz$*, and it reduces the ratio* u_c^*/u_d^**.*
Proof. *See Appendix.* ■

Our main result sheds light on a possible complementarity between the two building blocks of the Nordic model, that is centralized wage setting and active labor market policies. Matching policies display higher efficiency in reducing unemployment under the centralized case as wage setting is not affected by workers' higher probability of finding a job, which would raise their outside option and their reservation wage. It must be noted, however, that in the decentralized setting matching policies would have a virtuous effect on productivity by raising its reservation level.

Even if we cannot establish analytically that matching policies are uniformly more effective for unemployment in the centralized case, it is worth noticing that the effect of policy on ϑ is likely to be larger in the centralized case even for w_c much higher than the reservation wage. Comparing $d\vartheta_c^*/dz$ and an upper bound of $d\vartheta_d^*/dz$ for $R_d^{*'}(z) = 0$ (see eqs. 15-16 in the Appendix), we obtain the sufficient condition $d\vartheta_c^*/dz > d\vartheta_d^*/dz$ if $\vartheta_c^*/\vartheta_d^* > (1-\beta)^{1/\alpha} \left(\frac{1-R_d^*}{1-R_c^*}\right)^{1/\alpha}$. The term on the RHS of this inequality is lower than 1 for plausible value of β and of the reservation productivities[7]. With regard to the LHS, the $\mathrm{JC_c}$ lies to the right of the $\mathrm{JC_D}$ and hence ϑ_c^* tends to be larger than ϑ_d^* unless the centralized fix wage is extremely high. The sufficient condition appears satisfied in most realistic cases[8].

3.2 Numerical Result

In this section we show that the result we obtained in Proposition 1 holds for a larger set of values of w_c; in particular, we verify the result for cases where w_c is high relative to

[7]For instance, if $\beta = .5$, $RHS > 1$ when the ratio of the active technologies in use in the decentralized and centralized systems, is bigger than 2. This would require that the fixed wage in the centralized system puts so much pressure on plants that the set of active technologies in this system turns out being less than half the set of active technologies in the decentralized system, quite an unrealistic case.

[8]One may wonder whether the net welfare effect of adopting such policies would be positive. Our framework does not address this question as we have not incorporated the cost of financing the policy. This issue, however, does not affect the analysis of comparative benefits under the two wage setting regimes.

the reservation wage of the decentralized case (w_R). Additionally, we compare the relative magnitude of policy effects for different configurations of the labor market (LM) parameters, namely w_c in the centralized case and (β, b) in the decentralized case; notice that (β, b) are the two parameters affecting directly the reservation wage in the decentralized case.

In order to simplify our analysis we add the following two assumptions: the probability distribution of productivity shocks $G(x)$ is uniform in the support $(0, 1]$, i.e. $G(x) = x$; the matching function is linear in labor market policy expenses, given by $g(z) = A(1 + z)$ where A is a scale parameter with $A < 1$. The steady state equilibrium conditions for the decentralized case become

$$\vartheta_d^{1-\alpha} = (1-\beta)\frac{A(1+z)}{c}\frac{1-R_d}{r+\sigma} \tag{JC$''_\mathrm{d}$}$$

$$R_d = b + \frac{\beta c}{(1-\beta)}\vartheta_d - \frac{\sigma}{r+\sigma}\frac{(1-R_d)^2}{2} \tag{JD$''_\mathrm{d}$}$$

$$u_d = \frac{\sigma R_d}{\sigma R_d + A(1+z)\vartheta_d^\alpha}, \tag{u$''_\mathrm{d}$}$$

whereas the equilibrium conditions in the centralized system are now:

$$\vartheta_c^{1-\alpha} = \frac{A(1+z)}{c}\frac{1-R_c}{r+\sigma} \tag{JC$''_\mathrm{c}$}$$

$$R_c = w_c - \frac{\sigma}{r+\sigma}\frac{(1-R_c)^2}{2} \tag{JD$''_\mathrm{c}$}$$

$$u_c = \frac{\sigma R_c}{\sigma R_c + A(1+z)\vartheta_c^\alpha}. \tag{u$''_\mathrm{c}$}$$

Our additional assumptions allow us to find a closed form solution for the two systems of equations. However, assessing the sign of the derivative $d/dz(u_c^*/u_d^*)$ is still not possible unless numerical values are assigned to the models' parameters. Accordingly, our strategy is the following: we calibrate the exogenous parameters of the model to obtain the equilibrium unemployment levels in both systems as mere numerical functions of the policy variable z. At that point, evaluating $d/dz(u_c^*/u_d^*)$ at $z = 0$ tells us whether activating ALMP reduces the equilibrium unemployment ratio.

We perform this excercise for twelve different scenarios. We keep a set of core parameters constant, and we characterize the various cases by assuming different configurations of the LM parameters. For the LM parameters in the decentralized system, we consider four cases which can be ranked in ascending order of degree of decentralization: 1. $\beta = .2, b = .4$, 2. $\beta = .3, b = .3$, 3. $\beta = .4, b = .1$, 4. $\beta = .5, b = 0$. These cases can be thought of as either mimicking the mixed wage setting system gradually gaining ground in Sweden during the 80s or, more generally, as representing different degrees of decentralization across capitalistic regimes. For the centralized system, we have considered three values of w_c. First, we anchor w_c at the level of the reservation wage in order to replicate the results of Proposition 1[9]. Next, we set w_c equal to two values that are always above the reservation wages derived in the four cases, i.e. 0.75 and 0.8. These levels of w_c capture more realistic situations where national unions bargain a wage level higher than the outside option a worker would have had in the case of decentralized bargaining.

With regard to the parameters held constant across scenarios, we use the efficiency of the matching function A to generate realistic initial levels of unemployment in absence of the policy. We set $A = 0.15$. The other parameters are standard in the literature and chosen accordingly. In particular, the interest rate r is set equal to 2%, the exogenous separation rate σ and the cost of a new vacancy c equal 0.1, while the elasticity of the matching function to the labour market tightness is assumed to be 0.5 (see Blanchard and Diamond 1989, Yashiv 2000, Boeri and Burda 2009, and Pissarides and Vallanti 2007).

Table 1 presents the main results of the numerical exercises. First, columns $2-3$ show that when w_c is set at the level of the workers' reservation wage in the decentralized regime equilibrium unemployment, absent the policy ($z = 0$), is lower under the centralized bargaining regime. This result corroborates our analysis in Section 2: centralized bargaining combined with wage moderation yields low levels of unemployment. Second, column 3 confirms our main result since ALMPs appear more effective in the centralized regime regardless the level of w_c. In particular, the sign of $d/dz(u_c^*/u_d^*)$ is negative for all the levels of the centralized wage we have considered. In this regard, notice that we chose extremely high levels of w_c. By definition, w_c equals the product of the wage share times average labor productivity; since average productivity is strictly smaller than one, the wage share is bounded from below by the level of the centralized wage[10]. In fact, such high levels of w_c shows that the complementarity between ALMPs and centralized wage setting does not require wage moderation. Additional robustness checks for $z > 0$ confirm results obtained in column 3[11].

The last two columns of Table 1 enable us to compare the relative magnitude of the effects under different wage bargaining regimes. First, under the centralized regime, the negative growth rate of unemployment ranges from 2 to more than 4 times the one obtained under the various decentralized cases. Second, the effect of the policy in the centralized regime is lower the higher the level of w_c. Job relocation is, in fact, easier when the level of the reservation productivity is relatively lower, i.e. when the level of w_c is lower. In this case, a displaced worker is more likely to be matched with a technology with productivity higher than R_c. Finally, in line with our main result, complementarity between ALMPs and

[9]Notice that for every decentralized case there will be a corresponding reservation wage. Therefore, we consider four values for $w_c = w_R$.

[10]Under our additional assumption, $G(x) = x$, $E(x) = (1 + R)/2 < 1$.

[11]Results are available upon request.

relatively rigid labor market regimes appears to be valid not only in the comparison between centralized and decentralized systems, but also among systems with different degrees of decentralization. Indeed, ALMPs are significantly more effective in systems with mild levels of decentralization, such as cases 1 and 2, than in systems with relatively higher levels of decentralization, cases 3-4.

[Table 1 about here.]

4 Concluding remarks

This paper provides a new formalization of two important features of the Nordic labor market model prevailing in the 60s and 70s. Centralized wage setting, the first pillar of this model, partially isolates wages from variations in plant-specific productivity levels, thereby increasing the relative profitability of more productive with respect to less productive plants. However, this comes at the cost of reducing the expected lifetime of firms' investment and might generate structural unemployment. The second important feature of the Nordic model is represented by policies designed to offset the negative impact of centralized bargaining on employment; in particular, wage moderation and active labor market policies. We focus on the latter aspect and extend recent analyses of frictional labor markets with different wage setting rules (Boeri and Burda 2009) by considering active labor market policies. Our analysis suggests a complementarity between active labor market policies and centralized wage setting. We formally establish that these policies are more effective in reducing unemployment in a centralized rather than in a decentralized wage setting regime. Unlike in the centralized regime where wages are unaffected by market conditions, in the decentralized regime ALMPs increase the worker's external option by raising the value of search. A more valuable search induces an increase in the reservation productivity and partially hampers the positive effect of the policy on employment. On the other hand, this increase implies a positive effect of the policy on productivity that does not occur in the centralized system. Finally, numerical exercises enable us to show that the difference in policy effectiveness between the two regimes is sizeable.

In line with previous analyses by Moene and Wallerstein (1997), we show that, at low level of the fixed wage, centralized bargaining performs better than decentralized bargaining in terms of both employment and productivity. However, a more accurate analysis of the effect of wage moderation on employment would demand the wage rate be determined endogenously as the outcome of unions' maximizing behavior. In this fashion, wage moderation could emerge as the optimal decision of a central union that internalizes the general equilibrium effect of wage setting. The capacity to internalize the wage-unemployment trade-off of centralized systems has been advocated as an explanation of relatively good performance of centralized systems *vis à vis* decentralized ones (Calmfors and Driffill 1988, Howell et al. 2007).

Finally, effective job relocation depends in part on workers' willingness to invest in new skills, especially in phases of fast technological change as the ones followed the ICT revolution. By eliminating wage differences, centralized regimes might provide weak incentives to invest in skills complementary to new technologies, hence reducing the profitability of opening new, innovative plants. Compared to systems with flexible wage regimes, systems with rigid wage settings have to be more active in providing the right incentives to invest in skills through subsidies to higher education and retraining (Amendola and Vona 2012). Moreover, if general skills adapt to innovations better than specific ones (Krueger and Kumar 2004), the appropriate strategy to favor job relocation would require direct intervention in the educational system rather than on vocational and on-the-job training.

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A Appendix

Let us start by establishing the first claim of our proposition, that is $d\vartheta_c^*/dz > d\vartheta_d^*/dz$. Remember that our initial condition assures $R_c^* = R_d^*$, $\vartheta_c^* > \vartheta_d^*$ and that R_c does not depend on the position of JCc. Differentiate totally $\mathrm{JC}_c^{'}$ to find

$$\frac{d\vartheta_c^*}{dz} = \vartheta_c^{*'}(z) = g'(z)\frac{(1-R_c^*)}{c(r+\sigma)}\frac{\vartheta_c^{*\alpha}}{1-\alpha}. \tag{15}$$

Notice, on the contrary, that $R_d^* = R_d^*(z)$, with $R_d^{*'}(z) > 0$. Totally differentiating $\mathrm{JC}_D^{'}$ yields

$$\frac{d\vartheta_d^*}{dz} = \vartheta_d^{*'}(z) = \frac{(1-\beta)}{c(r+\sigma)}\frac{\vartheta_d^{*\alpha}}{1-\alpha}[g'(z)(1-R_d^*) - g(z)R_d^{*'}(z)]. \tag{16}$$

Comparison of (15) and (16) prove our claim since $\beta < 1$, $\vartheta_c^* > \vartheta_d^*$, $R_c^* = R_d^*$, and $R_d^{*'}(z) > 0$.

Let us now prove that $d(u_c^*/u_d^*)/dz < 0$, where:

$$\frac{u_c^*}{u_d^*}(z) = \frac{\sigma G(R_c^*)}{\sigma G(R_c^*) + g(z)\left(\vartheta_c^*(z)\right)^{\alpha}} \frac{\sigma G(R_d^*(z)) + g(z)\left(\vartheta_d^*(z)\right)^{\alpha}}{\sigma G(R_d^*(z))}.$$

Let us posit $\sigma G(R_c^*) \equiv k_1$, $\sigma G(R_d^*(z)) \equiv k_2(z)$, $g(z)\left(\vartheta_c^*(z)\right)^{\alpha} \equiv f_c(z)$, $g(z)\left(\vartheta_d^*(z)\right)^{\alpha} \equiv f_d(z)$. We can write $\frac{u_c^*}{u_d^*}(z) = \frac{k_1}{k_1 + f_c(z)} \frac{k_2(z) + f_d(z)}{k_2(z)} = k_1 \frac{1 + f_d(z)/k_2(z)}{k_1 + f_c(z)}$. For any arbitrary initial (i.e. pre- policy change) value $z = z_0$, our established results imply: $k_1 = k_2(z_0)$, $f_c(z_0) > f_d(z_0)$. Also notice that $k_2^{'}(z_0) > 0$, since $G^{'}(.) > 0$. Let us now prove $f_c^{'}(z_0) > f_d^{'}(z_0)$. $f_i^{'} = g'(z_0)\left(\vartheta_i^*(z_0)\right)^{\alpha} + g(z_0)\alpha\left(\vartheta_i^*(z_0)\right)^{\alpha-1}\vartheta_i^{*'}(z_0)$, with $i = c, d$. Since $\vartheta_c^*(z_0) > \vartheta_d^*(z_0)$, we only need to prove $\frac{\vartheta_c^{*'}(z_0)}{\left(\vartheta_c^*(z_0)\right)^{1-\alpha}} > \frac{\vartheta_d^{*'}(z_0)}{\vartheta_d^*(z_0)^{1-\alpha}}$. Making use of (15) and (16), the previous inequality is satisfied if $g'(z_0)\frac{(1-R_c^*)}{c(r+\sigma)}\frac{\vartheta_c^{*2\alpha-1}}{1-\alpha} > \frac{(1-\beta)}{c(r+\sigma)}\frac{\vartheta_d^{*2\alpha-1}}{1-\alpha}[g'(z_0)(1-R_d^*) - g(z_0)R_d^{*'}(z_0)]$. Substituting the equilibrium expression for ϑ_c^* and ϑ_d^* from $\mathrm{JC}_c^{'}$ and $\mathrm{JC}_D^{'}$, the inequality can be re-written as $\frac{1}{1-\alpha}\left(\frac{(1-R_c^*)}{c(r+\sigma)}\right)^{\frac{\alpha}{1-\alpha}} g'(z_0)\left(g(z_0)\right)^{\frac{2\alpha-1}{1-\alpha}} > \frac{1}{1-\alpha}\left(\frac{(1-\beta)(1-R_d^*)}{c(r+\sigma)}\right)^{\frac{\alpha}{1-\alpha}} \cdot$
$\cdot\left[g'(z_0)\left(g(z_0)\right)^{\frac{2\alpha-1}{1-\alpha}} - (1-R_d^*)R_d^{*'}(z_0)\left(g(z_0)\right)^{\frac{\alpha}{1-\alpha}}\right]$, which is always satisfied since $\beta < 1$, $R_c^* = R_d^*$, and $R_d^{*'}(z_0) > 0$.

Let us now calculate $\frac{d}{dz}\frac{u_c^*}{u_d^*}(z_0)$.

$$\frac{d}{dz}\frac{u_c^*}{u_d^*}(z_0) = k_1 \frac{\left(k_1 + f_c(z_0)\right)\frac{f_d^{'}(z_0)k_2(z_0) - f_d(z_0)k_2^{'}(z_0)}{\left(k_2(z_0)\right)^2}}{\left[k_1 + f_c(z_0)\right]^2} -$$
$$k_1 \frac{f_c^{'}(z_0)\left(1 + f_d(z_0)/k_2(z_0)\right)}{\left[k_1 + f_c(z_0)\right]^2} < 0 \Leftrightarrow$$
$$f_d^{'}(z_0) - \frac{k_2^{'}(z_0)}{k_2(z_0)}f_d(z_0) + \frac{f_c(z_0)f_d^{'}(z_0)}{k_2(z_0)} - \frac{f_c(z_0)f_d(z_0)k_2^{'}(z_0)}{\left(k_2(z_0)\right)^2} - f_c^{'}(z_0) - \frac{f_c^{'}(z_0)f_d(z_0)}{k_2(z_0)} < 0,$$

where we used $k_1 = k_2(z_0)$. Since we have established that $f_d^{'}(z_0) < f_c^{'}(z_0)$, a sufficient condition for $\frac{d}{dz}\frac{u_c^*}{u_d^*}(z_0) < 0$ is $f_c(z_0)f_d^{'}(z_0) < f_c^{'}(z_0)f_d(z_0)$. Let us verify it. $f_c(z_0)f_d^{'}(z_0) < f_c^{'}(z_0)f_d(z_0)$

$\Leftrightarrow \frac{f_d^{'}(z_0)}{f_d(z_0)} < \frac{f_c^{'}(z_0)}{f_c(z_0)}$. Notice that $\frac{f_i^{'}(z_0)}{f_i(z_0)} = \frac{g'(z_0)}{g(z_0)} + \alpha\frac{\vartheta_i^{*'}(z_0)}{\vartheta_i^*(z_0)}$, accordingly $\frac{f_d^{'}(z_0)}{f_d(z_0)} < \frac{f_c^{'}(z_0)}{f_c(z_0)} \Leftrightarrow \frac{\vartheta_d^{*'}(z_0)}{\vartheta_d^*(z_0)} < \frac{\vartheta_c^{*'}(z_0)}{\vartheta_c^*(z_0)}$.

$$\frac{\vartheta_d^{*'}(z_0)}{\vartheta_d^*(z_0)} = \frac{1-\beta}{c(r+\sigma)}\frac{1}{1-\alpha}\left(\vartheta_d^*(z_0)\right)^{\alpha-1}\cdot\left[g'(z_0)(1-R_d^*) - R_d^{*'}(z_0)g(z_0)\right] =$$

$$\frac{1}{1-\alpha}\left[\frac{g'(z_0)}{g(z_0)} - R_d^{*'}(z_0)g(z_0)\right];\ \frac{\vartheta_c^{*'}(z_0)}{\vartheta_c^*(z_0)} = \frac{(1-R_c^*)}{c(r+\sigma)}\frac{g'(z_0)}{1-\alpha}\left(\vartheta_c^*(z_0)\right)^{\alpha-1} = \frac{1}{1-\alpha}\frac{g'(z_0)}{g(z_0)};$$

Since since $\beta < 1$, and $R_d^{*'}(z_0) > 0$ we proved $f_c(z_0)f_d^{'}(z_0) < f_c^{'}(z_0)f_d(z_0)$ and, in turn, $\frac{d}{dz}\frac{u_c^*}{u_d^*}(z_0) < 0$.

In order to prove our result for $\bar{x} \in (b + \frac{\beta}{1-\beta}c\vartheta_d^*, \hat{x}]$ we can use a continuity argument analogous to the one developed in Section 2. Since both R_c^* and ϑ_c^* are continuous functions of $\bar{x}$, there exists a right neighborhood of $b + \frac{\beta}{1-\beta}c\vartheta_d^*$ where all the inequalities we used in our proof still hold. Notice that $x_0 \neq \hat{x}$, unless by a fluke.

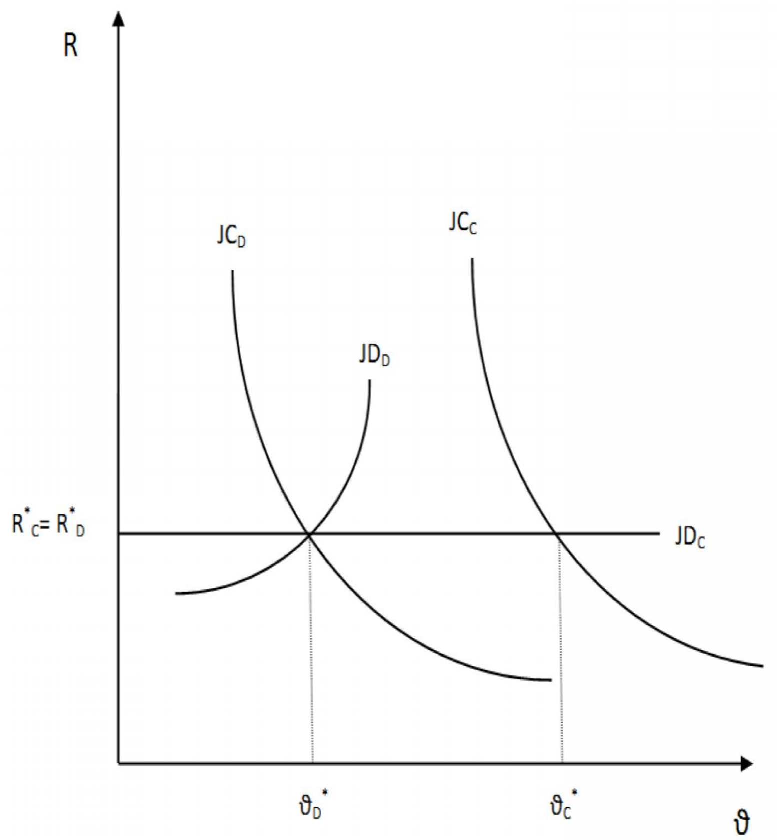

Figure 1: Equilibrium reservation productivity and market tightness under centralized and decentralized wage settings when $\bar{x} = b + [\beta/(1-\beta)]c\vartheta_d^*$.

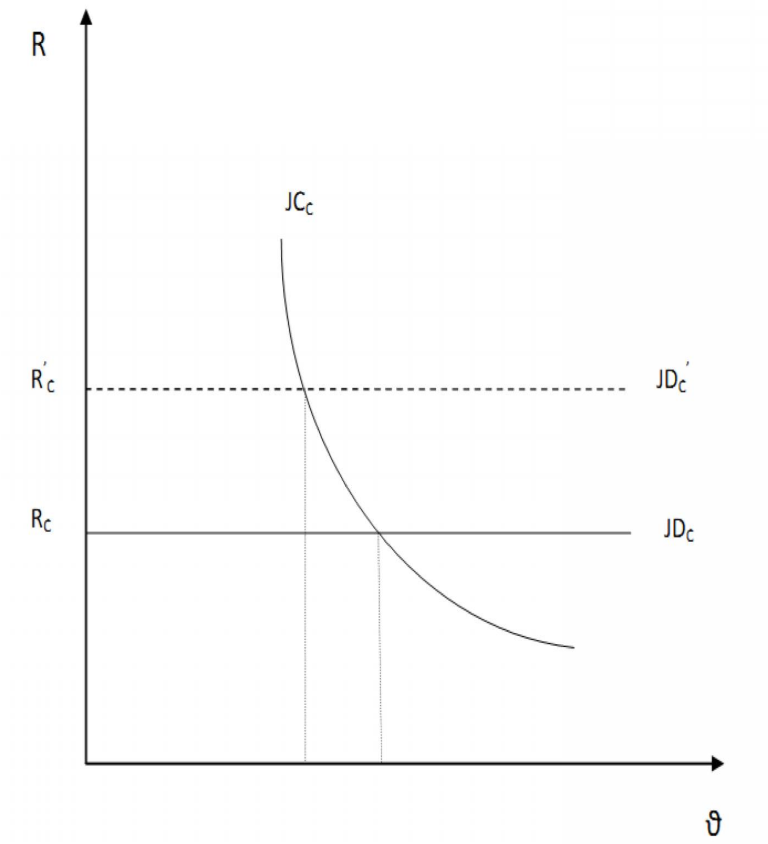

Figure 2: Effect on centralized equilibrium of an increase in the centralized wage.

Table 1: Effects of ALMP in different scenarios

	$u_c(0)$	$u_d(0)$	$sign[\frac{d(u_c/u_d)}{dz}\|_{z=0}]$	$\frac{du_c}{u_c}\|_{z=0}$	$\frac{du_d}{u_d}\|_{z=0}$
centralized wage $w_c = w_R$					
case 1: $\beta = .2, b = .4$	0.091	0.110	-	-1.81	-0.81
case 2: $\beta = .3, b = .3$	0.090	0.124	-	-1.78	-0.72
case 3: $\beta = .4, b = .1$	0.077	0.121	-	-1.85	-0.58
case 4: $\beta = .5, b = .0$	0.071	0.120	-	-2.34	-0.54
centralized wage $w_c = 0.75$	0.121			-1.76	
case 1: $\beta = .2, b = .4$	=	0.110	-	=	-0.81
case 2: $\beta = .3, b = .3$	=	0.124	-	=	-0.72
case 3: $\beta = .4, b = .1$	=	0.121	-	=	-0.58
case 4: $\beta = .5, b = .0$	=	0.120	-	=	-0.54
centralized wage $w_c = 0.80$	0.159			-1.68	
case 1: $\beta = .2, b = .4$	=	0.110	-	=	-0.81
case 1: $\beta = .3, b = .3$	=	0.124	-	=	-0.72
case 1: $\beta = .4, b = .1$	=	0.121	-	=	-0.58
case 1: $\beta = .5, b = .0$	=	0.120	-	=	-0.54

values of the other parameters: $\sigma = 0.1, \alpha = 0.5, c = 0.1, r = 0.02, A = 0.15$.