The Rise and Fall of Centralized Wage Bargaining

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Abstract

During the three decades spanning the early 50’s to the early 80’s, the wage-setting process in most Northern European countries was dominated by centralized bargaining, where peak level labor and employer associations set wages nationwide. In the early 80’s centralized wage bargaining began to collapse, and it was followed by a clear tendency towards less centralized instances of wage bargaining. In this paper we provide an explanation both for the initial establishment of a centralized wage-setting process, and for its subsequent collapse. According to our theory, centralized wage bargaining was set up as a response to the spillovers created by the unemployment benefit program. Its collapse was the result of the increase in the productivity gap across workers, brought about by equipment-specific technological progress and equipment-skill complementarity.

Keywords: Wage-Bargaining Arrangements; Unemployment Benefits; Equipment-Specific Technological Progress; Equipment-Skill Complementarity.

JEL Classification Numbers: J31; J41; J51.

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1 Introduction

From the end of the Second World War until the early 80’s, labor unions in Northern European countries combined into a unions’ federation which was mandated to meet with the employers' association and negotiate wages nationwide. This wage-setting arrangement reached its maximum strength in the heavily unionized Scandinavian economies —Denmark, Finland and Sweden— and has been referred to as the Scandinavian model or the centralized wage-bargaining model. Existing quantitative measures of centralization in wage-bargaining show that this arrangement began to collapse in the early 80’s, and that it went on declining at least until the mid 90’s. The chronology of events in Sweden supports the hypothesis that the collapse of centralized bargaining was triggered by the withdrawal of the skilled workers unions from the unions’ federation [see e.g. Freeman and Gibbons (1995)].

In view of these facts some questions come naturally to the fore: why did labor unions chose to form a federation and engage in centralized wage negotiations in the first place? What made labor unions change their strategies and undertake their own wage negotiations, abandoning an arrangement that had proved useful for 30 years? In this paper we construct a macroeconomic model that provides answers to these questions. Even though the model we propose is rather stylized, especially concerning issues non-central to our questions, it captures well the main tensions we think lie at the heart of the rise and fall of centralized wage bargaining. But before we describe the model and explain the results, it is appropriate to review some relevant empirical work on the relationship between wage bargaining arrangements and macroeconomic performance, which shows unambiguously the importance of wage bargaining in determining aggregate economic variables.

A first strand of this literature has focused on ascertaining the relationship between wage-bargaining arrangements and unemployment rates [see, e.g., Blanchard and Wolfers (2000) and Daveri and Tabellini (2000)]. These studies have found, using panel data for the OECD countries, that highly centralized wage bargaining leads to lower unemployment. These results have led many authors to believe that Scandinavian countries were able to maintain low levels of unemployment in the 70’s —while other European countries started to see their unemployment rates climb to two-digit figures— because of their highly centralized wage bargaining arrangements. A second strand of the literature has focused on the relationship between centralization and competitiveness [see, e.g., Alesina
and Perotti (1997) and Summers, Gruber and Vergara (1993)]. These studies have found that the effects of increases in labor taxes on labor costs are lower in countries with highly centralized labor markets than in countries with intermediate levels of centralization. These results have led to the conclusion that centralization has helped Scandinavian countries to improve their international competitiveness.

In this paper we present a model where the wage-bargaining arrangement is endogenous, and propose an explanation for the rise and fall of centralization. The main ingredients of our theory are: government-funded, union-administered unemployment benefits, progressive direct taxation, and technological progress. We show that both the setup of centralization and its collapse can be accounted for in terms of the interplay of fiscal and technological links among different types of workers. Fiscal links among workers are created by the unemployment benefits program, and technological links by the production process.

Our modeling of the above-mentioned ingredients, and their role in shaping the links among workers is the following. Under union-administered unemployment benefits (Ghent system of unemployment benefits), workers need to be affiliated with unions in order to collect benefits, thus leading to high unionization rates.\textsuperscript{1} Hence, we will assume full unionization. The unions’ role is to disburse benefits and negotiate wages in order to maximize the affiliated worker’s net income. Under government-funded benefits, when a union negotiates in a decentralized manner it imposes an externality on other unions, as it transfers part of the burden of financing benefits for its own unemployed to the rest of the economy. That is, a worker’s net income depends not only on the wages the union negotiates, but also on the wages negotiated by all other unions in the economy. This creates fiscal and benefit externalities among unions when negotiation is decentralized.

Workers are also linked by the production process, and technical change shapes the nature of that link. Our modeling of the production process and its evolution during the postwar period is based on Greenwood, Hercowitz and Krusell (1997). Technological progress is investment specific, as it is embodied in new capital equipment (i.e., in order to realize the benefits of technological progress firms must invest in new equipment). Following this approach to technological progress Krusell, Ohanian, Ríos-Rull and Violante (2000) and Lindquist (2005) estimate an aggregate production function for the U.S. and

\textsuperscript{1}Unionization rates in countries with a Ghent system, like Sweden, are above 90%, and, contrary to the US, the UK and other continental European countries have not shown a tendency to decline.
the Swedish economies, respectively. They find evidence for the existence of equipment-skill complementarity. The combination of equipment-specific technical progress and equipment-skill complementarity yields an increase in the spread of labor productivity across workers.

In a calibrated version of our model, we show that the interplay of the two linkages—fiscal and technological—can account both for the initial setup of centralized wage bargaining and for its subsequent collapse. The intuition for this result can be outlined as follows. Under the pre-80’s production technology, with expensive and scarce capital equipment, skilled and unskilled workers are productivity-wise fairly close. Therefore, the fiscal externalities created by the program of unemployment benefits when bargaining is decentralized open a route to multiple equilibria and then to coordination failures. Since coordination failures can impinge upon unions’ income, there are systems of expectations that support centralized bargaining as an equilibrium of the pre-80’s economy. Thus, according to our theory, the rise of centralization was a response to the need to internalize the fiscal spillovers of wage bargaining.

The collapse of centralization can be understood as the result of technological progress, which brought down the price of equipment and increased the productivity gap across skills. This increase in the technological heterogeneity among workers removes the possibility of coordination failures, and, consequently, the existence of rational expectations supporting centralized bargaining. Our explanation for the fall of centralization abstracts thus from issues of wage solidarity, and/or changes in the relative strength of different workers within the union federation. Although these are important factors for understanding labor market institutions, we show that they are not necessary to account for the evolution of centralized bargaining.

The paper is organized as follows. Section 2 contains a brief review of the related literature. In Section 3 we discuss some evidence of the rise and fall of centralization, and review some institutional features of the Scandinavian benefits program. In Section 4 we present the model and define the equilibrium. In Section 5 we parameterize and calibrate the model, and present our main results. Section 6 draws the main conclusions. Section 7 contains two Appendixes.

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2The role of heterogeneity in eliminating the possibility of coordination failures is well-known in the literature; see, e.g., Herrendorf, Valentinyi and Waldmann (2000).
2 Related Literature

Most explanations for the rise and fall of centralized bargaining presented in the literature, including this paper, share a common basic idea: decentralized wage bargaining imposes some type of externality, which, in fully unionized economies, can be internalized through centralized wage bargaining. When the gains from such an internalization are positive, centralization will emerge as the wage-setting arrangement, otherwise decentralization will prevail.

In a pioneering and influential paper, Calmfors and Driffill (1988) put forward the idea of price inflation externalities in the process of wage setting — i.e., claims for nominal wage increases by one union bring higher prices for the whole economy. These authors study the relationship between the centralization of wage bargaining and macroeconomic performance, and find the, by now well-known, hump-shaped relation between centralization and unemployment. Building upon the Calmfors and Driffill price inflation externality, a number of papers [e.g., Cukierman and Lippi (1999, 2001), Iversen (1998), Soskice and Iversen (1998) and Velasco and Guzzo (1999)] added to the model a role for monetary policy by introducing a central bank. The explanations for the rise and fall of centralization that seem to emerge from this literature depend on the goal assigned to central banks, either as inflation or unemployment fighters.

On the one hand, if the goal of the national central bank is to control national inflation, it will adopt non-accommodating, restrictive monetary policies as a response to unions’ claims for higher nominal wages. When such a central bank is sovereign in setting monetary policy, centralized wage bargaining is a means for labor unions to anticipate the central bank’s response to wage increases and, therefore, centralization may arise as the desirable wage-setting arrangement. With the advent of the European Monetary Union, national central banks lost part of their independence to set monetary policy in favor of the European Central Bank, whose target is European inflation. Consequently, national centralized bargaining becomes an invalid means to internalize the interest rate effects of union wage claims, thus explaining its collapse.

On the other hand, if the goal of the national central bank is unemployment, it will adopt accommodating, inflationary monetary policies as a response to higher nominal wages. The collapse of centralization in this case is explained as a consequence of globalization: increased international capital mobility hinders the use of inflationary monetary policies, and thus reduces the anticipatory gains of centralized bargaining. As an ex-
planation for the rise and fall of centralization, this inflation externality mechanism has been subject to criticism. Bleaney (1996) concludes that there is no evidence of a causal relationship between monetary policy and centralization.

Our paper is also related to Freeman and Gibbons (1995). These authors also see the threat of inflation as the main reason for centralization, but they point out two main reasons for its collapse: first, “a reduction in the importance of controlling inflation through centralized negotiations”, and, second, “the more heterogenous the groups covered by the central agreement, the more likely some groups will [...] consider a defect strategy.” In their framework the meaning of heterogeneity is, however, vague, and it is modeled as a shift parameter known to firms and unions, but unknown to the central federation. They interpret this parameter as a productivity or price shock. Even though our framework is different from theirs, both in the modeling of the labor market, and in the role played by labor unions and their union federation, some implications are, however, similar. Both analyses agree that the increase in heterogeneity was the main cause of the breakdown of centralization. In our paper, however, increased heterogeneity is given full content, within the context of a calibrated, macroeconomic model.

Our analysis shares important similarities with Acemoglu, Aghion and Violante (2001). These authors abstract from issues related to the centralization of wage bargaining, and focus on the decline in unionization rates in the US and the UK. They argue that skill-biased technical change causes deunionization because it increases the relative productivity of skilled workers, and, hence, weakens their incentives to remain in a union that compresses wages.

Finally, Alexopoulos and Cohen (2004) depart from the internalization argument outlined above and propose an explanation for the rise and fall of centralization based on a reallocation hypothesis. These authors argue that centralization was a means to help increase the supply of labor to the growing, export-oriented firms. They point to a decrease in inter-union solidarity as the main cause of the collapse in centralization.

3 Some Evidence on The Rise and Fall of Centralization

The rise and fall of centralized wage bargaining has been extensively reported in the literature [see Lundberg (1985) for an early contribution]. In more recent years, the construction of indexes of centralization has shed new light on issues such as the cross-
country disparity in centralization, and its collapse in countries where centralization was the long-standing wage-setting arrangement.

In order to show that the decline in centralization did actually imply a loss of ability to internalize macroeconomic constraints –i.e., that it was not compensated by other forms of coordination,– we also present indexes of coordination in wage bargaining, as centralization and coordination in wage bargaining are not equivalent concepts. Centralization describes the locus of the formal structure of wage bargaining. Typically, three broad levels are distinguished: national, industry and firm-level bargaining. Coordination refers instead to the degree of consensus between bargaining partners, or put in other words, to the degree of intentional harmonization in the wage-setting process. Coordination can thus be the result of communication and guidance between bargaining units without calling for the centralization of negotiations. The evidence presented in this section shows an unambiguous tendency towards less centralization and less coordination. This tendency was more accentuated in those countries with initially high levels of centralization and coordination.

The most widely used index of centralization in wage bargaining is the one constructed by Iversen (1999). His index ranges from 0 to 1, where 1 corresponds to full centralization. The index combines a measure of the level of bargaining (centralized, intermediate and decentralized) with a measure of union concentration. The index also takes into account the degree of enforceability of wage agreements, that is the ability of lower-level bargainers to elude the agreement. Enforceable agreements presuppose that bargaining agents can impose fines for non-compliance. Non-enforceable agreements means that there is a lack of credible threats of sanctions. The index covers 15 OECD countries from 1973 to 1993. Table 1 below presents the evolution of centralization for the three countries with the highest centralization scores in the early 70’s: Denmark, Finland and Sweden. During the twenty-year period 1973-1993, the centralization index in these countries declined by 50%. Other countries\(^3\) with moderate levels of centralization in the 70’s also experienced a significant falloff during the same period; an example is the UK, whose centralization scores are shown in Table 1. Finally, and in order to help assess the extent of centralization in these European countries in the early 70’s, we also present the index for the US.

\(^3\)Among these countries are Austria, Belgium and Germany.
Kenworthy (2001) presents an index of coordination in wage bargaining. Besides formal bargaining centralization, the index considers other ways of achieving coordination such as informal centralization and pattern-setting. The index distinguishes 5 categories, ordered by their increasing level of coordination: 1 corresponds to fragmented wage bargaining confined to individual firms or plants, and 5 corresponds to centralized bargaining by peak confederations with perfect enforceability. Table 2 presents this coordination index.

Finally, a combined index of centralization and coordination in wage bargaining is presented in Calmfors (2001) [the index is based on work by Visser (2000)]. This index includes measures of the level of negotiation, and of the share of union members organized by the federation. The index presents averages for the periods 1973-77, 1983-87 and 1993-97, for 15 OECD countries.
We find it convenient to review some events of the first postwar years, the mid-forties, which marked the rise of centralization. We restrict our attention here to the case of Sweden, since other countries where centralization was high, e.g. Denmark and Finland, present striking similarities with the Swedish case. We briefly describe the main building blocks of the Swedish unemployment program, and then argue that some of the features of this program played a key role in the rise of centralized wage negotiations.

Among all the policies adopted in the first years of the postwar period, those related to fiscal and social issues were at the forefront. Indeed, the construction of the welfare state was unarguably the flagship of the so-called Swedish model. These policies built on two main pillars: highly progressive direct taxation, and enlargement of social insurance programs. The latter included a generous system of union-administered, progressive unemployment benefits financed by the government, known as the Ghent system. In Sweden cash benefits for the unemployed are disbursed by forty societies that administer unemployment funds. Each society is ordinarily affiliated with one or more labor unions. To apply for income-related unemployment benefits from a society, a person must have been a member for at least one year immediately before becoming unemployed. Therefore, and not surprisingly, in countries with a Ghent system (Sweden, Denmark, Finland) unionization rates climbed and remained at rates in the order of 90%. Funds for the unemployment benefits program are provided by the government using a pay-as-you-go financing system. Labor unions’ contribution is purely symbolic amounting only to an average of six percent of the whole program. With pay-as-you-go financing, tax rates on factor incomes are set such that current tax revenues equal current benefits.4

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4 In the late 1990’s Scandinavian economies started a debate on reforming the financing of unemployment benefits. In Finland, buffer funding of unemployment benefits was discussed. Contributions to the unemployment program could exceed outlays in some periods and thus the buffer stock would be created. In Sweden, the Swedish Confederation of Professional Associations, SACO, (a federation of labor unions
Within the context of this institutional arrangement, Swedish unions’ and employers’ federations held the first centralized wage negotiations in the early fifties. Centralization went on almost uninterruptedly until the early 80’s. We argue in this paper that two features of the Ghent system, namely, the workers’ affiliation requirement and the public, pay-as-you-go funding of benefits, set necessary conditions for the centralization of wage bargaining. The first by leading to full unionization, and the second by creating fiscal externalities among labor unions under decentralized wage bargaining.

It may be worth noting that by the time Scandinavian economies were implementing a Ghent program of unemployment benefits, the UK and most non-Scandinavian European countries had already abandoned the Ghent system to adopt compulsory ones. In compulsory systems unemployment benefits are government-administered. Workers collect payments directly from the government without conditioning on affiliation with a labor union. As a result, unionization rates in non-Scandinavian economies hardly ever reached 50%.

4 The Model

In this section we present a simple model of frictional unemployment and define the equilibrium under different levels of centralization in wage bargaining. We consider an economy with two types of workers: skilled (s) and unskilled (u). Since our emphasis here is on the externalities generated by the financing of unemployment benefits, and on the production process, we abstract from other labor market externalities by assuming perfectly segmented labor markets. That is, skilled and unskilled workers do not congest each other when searching for a job. If we denote by \( s_{j,t} \) the number of workers of type \( j \) searching for a job at time \( t \), and by \( v_{j,t} \) the number of vacancies open for type-\( j \) workers at time \( t \), for \( j = s, u \), then, the total number of matches is given by

\[
M_{j,t} = M(v_{j,t}, s_{j,t}),
\]

where \( M(\cdot, \cdot) \) has the standard properties of a matching function, i.e., it is increasing in the number of vacancies, \( v_j \), and searchers, \( s_j \), jointly concave and linearly homogeneous.

\(^5\)Actually, unions’ and employers’ federations had already met in 1938, but only to reach agreements concerning procedures for settling disputes and work safety.
Unions

There is a continuum of workers of measure one. Let $x_j$ denote the measure of workers of type $j$, for $j = s, u$. Since unemployment benefits are union-administered, we can assume that all workers are affiliated with labor unions. Unions are risk neutral, and workers choose the union according to their type. There is a large number of identical unions for each type. A worker affiliated with a typical union can be in one of the following three states: employed ($e$), unemployed and entitled to unemployment benefits ($ub$), or unemployed and not entitled to benefits, in which case the worker enters the welfare program ($uw$). The number of hours worked by an employed worker is fixed and normalized to one. Thus, an employed union member’s net income at time $t$ is

$$y^e_{j,t} = \omega_{j,t} - \tau_t(\omega_{j,t} - d),$$

where $\omega_{j,t}$ is the wage rate, $\tau_t$ is the tax rate, and $d > 0$ is a personal deduction. The personal deduction is included in order to introduce progressivity in the tax scheme. An unemployed union member’s net income, if entitled to unemployment benefits, is

$$y^{ub}_{j,t} = \Phi_t(\omega_{j,t} + \varsigma) - \tau_t[\Phi_t(\omega_{j,t} + \varsigma) - d],$$

where $\Phi_t$ and $\varsigma \geq 0$ determine the generosity and progressivity of the unemployment benefit program. $\varsigma$ is a parameter that pins down the progressivity of benefits; for $\varsigma = 0$ the entitled unemployed receives a proportion $\Phi_t$ of the wage rate. If the unemployed worker is not entitled to unemployment benefits, he will receive a lump sum $B > 0$ from the welfare program. We will assume that this lump sum does not exceed the personal deduction, which leaves the net income of unemployed workers on welfare at $y^{uw} = B$.

The transition from unemployment to employment and vice versa is as follows. At the end of a period all jobs are destroyed. At the beginning of the next period all workers search for a job: those who are matched with a vacancy, and whose wage bargaining ended in an agreement, become employed. Remaining workers become unemployed.

Hence, the expected pre-matching net income of a typical union worker of type $j$ is given by,

$$y_{j,t} = m_{j,t}y^e_{j,t} + (1 - m_{j,t})[(1 - \psi)y^{ub}_{j,t} + \psi y^{uw}]$$

for $j = s, u$, (4.2)

where $m_{j,t}$ denotes the matching rate for workers of type $j$; $\psi$ is the rate that governs eligibility for unemployment benefits. That is, $\psi$ is the exit rate from the unemployment benefit program. Thus, conditional on remaining unemployed, an average unemployed worker receives unemployment benefits for $1/\psi$ periods. In order to simplify notation we will use $\phi_t$ to denote the product $\Phi_t(1 - \psi)$ whenever we find it convenient.

A typical union of type $j$ will choose to hold centralized wage negotiations when-
ever it yields a higher $y_{jt}$ than under decentralized bargaining. The analysis of wage determination under each of these two bargaining arrangements is presented below.

**Firms**

There is a large number of firms producing an aggregate good. The technology is constant returns to scale in skilled and unskilled labor, capital structures, $k_{st}$, and capital equipment, $k_{eq}$. The assumption of constant returns to scale renders constant capital-employment and vacancies-employment ratios across firms. Thus, we can write the maximization problem of a representative firm as,

$$
\pi_t = \max_{v_{s,t}, v_{u,t}, k_{st,t}, k_{eq,t}} \left\{ F(k_{st,t}, k_{eq,t}, n_{s,t}, n_{u,t}) - \sum_{j=s,u} (\omega_{j,t} n_{j,t} + a_j v_{j,t}) - \sum_{i=st,eq} r_{i,t} k_{i,t} \right\}. \quad (4.3)
$$

Employment levels are given by $n_{j,t} = \mu_{j,t} v_{j,t}$, for $j = s, u$, where $\mu_{j,t}$ denotes the matching rate for a vacancy of type $j$, which is taken as given by the firm when choosing the number of vacancies; $r_{st,t}$ and $r_{eq,t}$ denote the rental prices of structures and equipment, respectively; and $a_j$ denotes the cost of opening a vacancy in labor market $j$. So far, we only impose that $F$ satisfies the standard assumptions of concavity, differentiability and homogeneity of degree one. Further assumptions on the elasticities of substitution between equipment and each type of labor will be imposed below.

The timing of actions within a time period is: firms open vacancies, then wages are negotiated and capital is rented. Hence, as will become clearer in the next subsections, the problem of the individual firm depends critically on whether wage bargaining is decentralized or centralized. In the former scenario the firm is in charge of its own wage negotiations, and, therefore, it does not take wage rates as given when opening vacancies, but it anticipates the effects of hiring on the negotiated wages. Thus, in problem (4.3), the firm correctly anticipates wage functions $\omega_j(n_{s,t}, n_{u,t})$, for $j = s, u$. This is an application of so-called intra-firm bargaining first proposed by Stole and Zwiebel (1996), and then used by Cahuc and Wasmer (2001, 2004) within the framework of a search-matching model. On the other hand, when bargaining is centralized, the individual firm takes wages as given as they will be negotiated by the employers’ federation.

Capital stocks can be adjusted at no cost. Firms’ capital demands are obtained by equating rental prices to the respective marginal productivities,

$$
F_{k_{i,t}} = r_{i,t} \quad \text{for } i = st, eq, \quad (4.4)
$$

where $F_{k_{st,t}}$ and $F_{k_{eq,t}}$ denote the derivatives of the production function with respect to
and $k_{eq,t}$, respectively.

**Capitalists**

The owners of capital (structures and equipment) and the firms are called capitalists. We also assume that they are risk neutral, and their only decision is to split current income between consumption and investment. Their objective is to maximize discounted lifetime consumption of the aggregate good. Capitalists’ income is made up of capital income and firms’ profits. Factor incomes are subject to taxation at the rate $\tau_t$, net of the personal deduction $d$. Thus, capitalists’ time-$t$ consumption, $y^c_t$, is determined by the budget constraint,

$$y^c_t + \nst + \neq = (1 - \tau_t)[r_{st,t}k_{st,t} + r_{eq,t}k_{eq,t}] + \tau_t d + \pi_t,$$

(4.5)

where $\nst$ and $\neq$ denote gross investment in structures and equipment, respectively, and $\pi_t$ denotes firms’ profits. Structures depreciate at the rate $\delta_{st}$, and equipment at the rate $\delta_{eq}$. Our assumption of equipment-specific technical change implies that one unit of the aggregate good invested in equipment increases its stock by $q$ units. That is, the law of motion for capital equipment is,

$$k_{eq,t+1} = (1 - \delta_{eq})k_{eq,t} + \neq q.$$

(4.6)

On the contrary, one unit of the aggregate good invested in structures increases its stock by one unit. Thus, factor $q$ represents the level of technology for producing capital equipment, and an increase in $q$ is interpreted as equipment-specific technical progress. This particular modeling was first proposed by Greenwood, Hercowitz and Krusell (1997) in order to assess the role of sector-specific technical change in generating postwar U.S. growth. Since $1/q$ is the relative price of equipment, the rate of equipment-specific technological progress can be derived from the price series. It has been widely reported that $q$ increased during the postwar period in most industrialized countries. For example, in the U.S. economy the average annual rate of increase during the postwar period is well above 3%. Here, we will focus our attention on two dates and, therefore, will consider two different values for $q$.

Under the assumptions stated above it is straightforward to show that the optimal investment policy for the capitalists calls for,

$$\left(1 - \tau_t\right) r_{st,t} - \delta_{st} = \left(1 - \tau_t\right) q r_{eq,t} - \delta_{eq} = \frac{1}{\beta} - 1.$$  

(4.7)
The Unemployment Benefits and Welfare Program

Unemployment funding, including both unemployment benefits and welfare, is provided by the government, which is assumed to balance the program’s budget every period. Under these assumptions we can write the unemployment program’s budget constraint as,

\[
\tau_t = \frac{(1 - \psi) \sum_{j=s,u} (x_{j,t} - n_{j,t}) \Phi_t (\omega_{j,t} + \varsigma) + \psi \sum_{j=s,u} (x_{j,t} - n_{j,t}) B}{\sum_{j=s,u} (n_{j,t} (\omega_{j,t} - d) + (1 - \psi) (x_{j,t} - n_{j,t}) (\Phi_t (\omega_{j,t} + \varsigma) - d)) + \sum_{i=st,eq} r_{i,t} k_{i,t} - d}. \tag{4.8}
\]

The numerator of equation (4.8) represents total outlays of the program, namely, unemployment compensation to all entitled unemployed plus welfare payments to those not entitled to benefits. The denominator represents total taxable income. The public financing of unemployment benefits and welfare, along with the assumption of a balanced budget, implies that the tax rate is an endogenous variable which depends on the wage rates and employment levels prevailing in the whole economy.

Unemployment benefits are set by the government after wages have been bargained. Government’s preferences are represented by a generalized utilitarian social welfare function over utility (consumption) levels of all agents in the economy: capitalists, employed workers, unemployed workers on benefits and the unemployed on welfare. Thus, subject to (4.8), the government sets \( \Phi_t \) in order to maximize

\[
SW = \left( (y^c_t)^\gamma + \sum_{j=s,u} n_{j,t} (y_{j,t}^c)^\gamma + (1 - \psi) (x_{j,t} - n_{j,t}) (y_{j,t}^{ub})^\gamma + \psi (x_{j,t} - n_{j,t}) (y_{j,t}^{uw})^\gamma \right)^\frac{1}{\gamma} \tag{4.9}
\]

where \( \gamma \leq 1 \) determines the government’s attitude towards inequality, with \( \gamma = 1 \) corresponding to an inequality-insensitive government. Thus, we can think of the government as using unemployment benefits to redistribute income. When bargaining is centralized, bargaining units anticipate the effects of wages on both unemployment benefits, \( \Phi_t \), and taxes, \( \tau_t \). When bargaining is decentralized, individual unions and firms take both policy variables as given.

The next subsections present a formal definition of the equilibrium under decentralized and centralized bargaining. As is standard in the literature of frictional unemployment, we focus on the solution to Nash-bargaining problems.
4.1 The Decentralized Bargaining Equilibrium

In this subsection we characterize the decentralized bargaining equilibrium. As was explained above, when opening vacancies firms anticipate the effects of hiring on wages. Thus, first-order conditions for vacancies are,

\[
F_{n_{j,t}} - \omega_{j,t} + \frac{\partial \omega_{s}}{\partial n_{j,t}} (n_{s,t}, n_{u,t}) n_{s,t} - \frac{\partial \omega_{u}}{\partial n_{j,t}} (n_{s,t}, n_{u,t}) n_{u,t} \]

\[ \mu_{j,t} = a_{j} \quad \text{for} \quad j = s, u, \quad (4.10) \]

where \( F_{n_{j,t}} \) denotes the derivative of the production function with respect to \( n_{j,t} \); and \( \frac{\partial \omega_{i}}{\partial n_{j,t}} \) denotes the partial derivative of the wage for workers \( i \) with respect to the firm’s employment level of workers \( j \). These first-order conditions establish that the marginal cost of a vacancy equals its marginal return. It becomes clear from equation (4.10) that when assessing the return of a new vacancy of type \( j \) the firm weighs the effects of hiring on the total wage bill, as captured by the last two terms inside the square brackets.

The bargaining over wages that takes place after matching proceeds as follows. A union is assumed to engage in wage bargaining on behalf of each worker with the firm he/she was matched with. Since there is a large number of unions for each worker type and a large number of firms, each union bargains separately for each worker, without coordinating wage claims with other unions with matched workers in the same firm, and taking policy variables —taxes and benefits— as given.

We follow the literature on search and matching and assume that wages are the solution to a Nash-bargaining problem. Income values of employment to unions and firms are as follows. The net income value of employment to a union worker of type \( j \), at wage \( \omega_{j,t} \), is,

\[
W_{j,t} - U_{j,t} = \left[ \omega_{j,t} - \tau_{t}(\omega_{j,t} - d) \right] - \left[ (1 - \psi) \left( \Phi_{t}(\omega_{j,t} + \varsigma) - \tau_{t}(\Phi_{t}(\omega_{j,t} + \varsigma) - d) \right) + \psi B \right],
\]

which is the difference between net income from employment —the expression inside the first brackets— and net income from the unions’ outside option, unemployment —the expression inside the second brackets.

For a firm with employment levels \((n_{s,t}, n_{u,t})\), the net value of a marginal job of type \( j \) is,

\[
J_{j,t} = F_{n_{j,t}} - \omega_{j}(n_{s,t}, n_{u,t}) - \frac{\partial \omega_{s}}{\partial n_{j,t}} (n_{s,t}, n_{u,t}) n_{s,t} - \frac{\partial \omega_{u}}{\partial n_{j,t}} (n_{s,t}, n_{u,t}) n_{u,t}.
\]

\[ J_{j,t} = a_{j} \quad \text{for} \quad j = s, u, \quad (4.11) \]
Wage functions are hence given by,

$$\omega_j(n_{s,t}, n_{u,t}) = \arg \max \omega_{j,t} \left( W_{j,t} - U_{j,t} \right)^p J_{j,t}^{1-p}, \quad \text{for } j = s, u,$$

(4.13)

where $p$ denotes the bargaining power of the union. The first-order condition to this maximization problem is $(1-p)(W_{j,t} - U_{j,t})J'_{j,t} + pJ_{j,t}(W'_{j,t} - U'_{j,t}) = 0$, for $j = s, u$, where $J'_{j,t}$, $W'_{j,t}$, and $U'_{j,t}$ denote the corresponding derivatives with respect to $\omega_{j,t}$. Using the above values of employment for unions and firms, and the first-order condition to maximization problem (4.13), we can derive the wage functions for skilled and unskilled workers as,

$$\omega_j(n_{s,t}, n_{u,t}) = p \left[ F_{n_{j,t}} - \frac{\partial \omega_s}{\partial n_{j,t}}(n_{s,t}, n_{u,t})n_{s,t} - \frac{\partial \omega_u}{\partial n_{j,t}}(n_{s,t}, n_{u,t})n_{u,t} \right] + (1-p) \left( 1 - \tau_t \right) \phi_s + \psi(B - \tau_t d) \left( 1 - \tau_t \right) \left( 1 - \phi_t \right).$$

(4.14)

**Definition.** A decentralized bargaining equilibrium (DBE) is a set of infinite sequences for rental prices of capitals, $\{r_{st,t}, r_{eq,t}\}$, employment levels, $\{n_{s,t}, n_{u,t}\}$, capital stocks $\{k_{st,t}, k_{eq,t}\}$, vacancies $\{v_{s,t}, v_{u,t}\}$, matching rates for vacancies $\{\mu_{s,t}, \mu_{u,t}\}$, matching rates for workers $\{m_{s,t}, m_{u,t}\}$, the tax rate $\{\tau_t\}$, unemployment benefits, $\{\Phi_t\}$, and a pair of wage functions $\omega_s(n_{s,t}, n_{u,t})$ and $\omega_u(n_{s,t}, n_{u,t})$, such that,

(i) Taking rental prices, wage functions and matching rates as given, $\{k_{st,t}, k_{eq,t}\}$, and $\{v_{s,t}, v_{u,t}\}$ solve the firms’ maximization problem, and $n_{j,t} = \mu_{j,t} v_{j,t}$, for $j = s, u$.

(ii) Taking tax rates and rental prices as given, $\{k_{st,t}, k_{eq,t}\}$ maximize capitalists’ lifetime utility.

(iii) Taking tax rates and unemployment benefits as given, wage functions are the Nash solution to uncoordinated bargaining problems.

(iv) Matching rates are given by the matching function, i.e., $\mu_{j,t} = M_{j,t}/v_{j,t}$, and $m_{j,t} = M_{j,t}/x_{j,t}$, for $j = s, u$.

(v) $\{\Phi_t\}$ solves the government’s maximization problem, and the budget constraint of the unemployment benefit program holds.

(vi) The following participation constraints are satisfied. Employed workers’ net incomes are greater or equal than those of the unemployed: $y_{j,t}^e \geq y_{j,t}^a$, for $j = s, u$. We also
impose that net incomes of the unemployed on benefits are above those of the unemployed on welfare: \( y_{ub,j,t} \geq y_{uw,j,t} \).

The possibility of multiple equilibria stems from the externalities generated by the unemployment benefits program. From the two wage equations (4.14), it is clear that the wage rate for a union j’s worker depends on benefits and the tax rate. Since both policy variables are determined in equilibrium by all wages bargained in the economy, there is room for multiple expectational equilibria. Thus, there may be multiple values for \( \tau_t \) and \( \Phi_t \) such that when they are expected to prevail in equilibrium by all unions and firms, they also solve the government’s maximization problem at the wages satisfying (4.14).\(^6\) It is also evident from (4.14) that the multiplicity of decentralized equilibria depends crucially on two main factors. First, the strength of the fiscal externalities—i.e., the extent to which fiscal and benefit variables affect negotiated wages. The last terms in the wage equations show that the progressivity of unemployment benefits, the progressivity of the tax scheme, and eligibility to benefits are key determinants of the fiscal externalities. Second, the productivity gap across workers, as captured by \( F_{n_s,t} \) and \( F_{n_u,t} \) in the first terms of the wage equations.

The computation of decentralized bargaining equilibria involves the numerical solution of the two partial differential equations in (4.14). In Section 7 (Appendix I) we provide a detailed explanation of the numerical algorithm developed for such computation. We will restrict our attention to equilibria with strictly positive levels of employment, both for the skilled and the unskilled.

### 4.2 The Centralized Bargaining Equilibrium

Under centralized wage bargaining, all workers, both skilled and unskilled as employed and unemployed, are represented in wage negotiations. Salaries to all matched workers are set simultaneously, taking into account the effects on both taxes and unemployment benefits.\(^7\)

---

\(^6\)The existence of multiple equilibria under balanced-budget rules is typically referred to as a type of Laffer curve. Indeed, multiple equilibria would be as likely to emerge under the alternative scenario where the tax rate is fixed, and the personal deduction or the progressivity of unemployment benefits is made an endogenous variable so that it balances the social program’s budget.

\(^7\)This particular modeling of centralization is in concordance with the Swedish experience. In the Swedish economy, LO was the central workers’ confederation in charge of negotiating for workers for more
Individual firms do not engage directly in wage negotiations, and then intra-firm bargaining does not apply. Firms take wage rates as given when opening vacancies, which renders the following first-order conditions,

\[ F_{n_{j,t}} - \omega_{j,t} \mu_{j,t} = a_j \]  

for \( j = s, u, \) \hspace{1cm} (4.15)

Since our analysis abstracts from wage solidarity — both within and across unions — and since workers are heterogeneous — both in terms of skills and of the matching outcome — we envision two different ways of modeling the unions’ federation. The first one is to assume that the encompassing unions’ federation is utilitarian, seeks to maximize the sum of all workers’ net incomes and engages in a two-agent bargaining with the employers’ federation. Alternatively, we can model the unions’ federation as being made up of coalitions of homogeneous workers, which engage in a multi-agent bargaining with the employers’ federation. The results do not depend on which model is adopted. In this section we present the results using the latter, and Appendix II outlines the analysis of centralized bargaining under the former.

Thus, the income value of having \( n_{s,t} \) and \( n_{u,t} \) workers employed at wages \( \omega_{s,t} \) and \( \omega_{u,t} \) for the different coalitions of homogeneous workers and for the employers’ federation are as follows. Within the coalition of unions for type-\( j \) workers there are two homogeneous coalitions of sizes \( M_j \) and \( x_j - M_j \) (which in equilibrium are \( n_j \) and \( x_j - n_j \), respectively). Income values for each worker within each of the coalitions are now presented. The value to a matched worker in a union for type-\( j \) workers is,

\[ W_{j,t} = \omega_{j,t} - \tau_t(\omega_{j,t} - d). \]  

The value to an unmatched union worker of type \( j \) is,

\[ V_{j,t} = \Phi_t(\omega_{j,t} + \varsigma) - \tau_t(\Phi_t(\omega_{j,t} + \varsigma) - d). \]  

The income value to the employers’ federation of employing \( n_{s,t} \) and \( n_{u,t} \) workers at wages \( \omega_{s,t} \) and \( \omega_{u,t} \), respectively, is

\[ J_t = F(k_{st,t}, k_{eq,t}, n_{s,t}, n_{u,t}) - \sum_{j=s,u} \omega_{j,t} n_{j,t} - \sum_{i=st,eq} r_{i,t} k_{i,t}. \]  

than three decades. In LO’s web site one can read “LO is primarily an organization for coordination, research and creating public opinion. Wage bargaining and labor market insurance schemes are some of the areas for which LO is responsible for coordination. Affiliates of LO have independent status and are responsible for the administration of the unemployment insurance funds.”
The outside option to centralized bargaining, both for workers and the employers’ federation, is to return to the decentralized economy where individual unions and firms engage in wage negotiations as described in the previous section. The value of this option to a worker in a type- \( j \) union is his expected income under decentralization, which we denote by \( E_{j,t} \), for \( j = s, u \). The value to the employers’ federation is given by expected firms’ profits, which we denote by \( \bar{J}_t \). When there are multiple decentralized bargaining equilibria, expectations are taken using subjective probabilities over those equilibria. For simplicity it is assumed that both federations have the same subjective probabilities.

Wage rates in the centralized bargaining equilibrium are the solution to a Nash-bargaining problem between the coalitions within type-\( s \) unions, coalitions within type-\( u \) unions and the employers’ federation. The maximization problem is given by,

\[
\max_{\omega_{s,t}, \omega_{u,t}} \prod_{j=s,u} [(W_{j,t} - E_{j,t})^{n_{j,t}}(V_{j,t} - E_{j,t})^{(x_{j,t} - n_{j,t})}]^p (J_t - \bar{J}_t)^{1-p},
\]

subject to the unemployment program budget constraint, equation (4.8), the first-order condition to \( \Phi_t \), and \( W_{j,t} \geq E_{j,t}, V_{j,t} \geq E_{j,t}, J_t \geq \bar{J}_t \).

Thus, by taking into account the two equations that determine policy variables, centralized bargaining internalizes the externalities stemming from the unemployment benefits program.

**Definition.** A centralized bargaining equilibrium (CBE) is a set of infinite sequences for rental prices of capitals, \( \{r_{st,t}, r_{eq,t}\} \), wages \( \{\omega_{s,t}, \omega_{u,t}\} \), employment levels, \( \{n_{s,t}, n_{u,t}\} \), capital stocks \( \{k_{st,t}, k_{eq,t}\} \), vacancies \( \{v_{s,t}, v_{u,t}\} \), matching rates for vacancies \( \{\mu_{s,t}, \mu_{u,t}\} \), matching rates for workers \( \{m_{s,t}, m_{u,t}\} \), the tax rate \( \{\tau_t\} \) unemployment benefits \( \{\Phi_t\} \), and subjective probabilities over the decentralized bargaining equilibria such that,

(i) Taking rental prices, wage and matching rates as given, \( \{k_{st,t}, k_{eq,t}\}, \text{ and } \{v_{s,t}, v_{u,t}\} \) solve the firms’ maximization problem and \( n_{j,t} = \mu_{j,t}v_{j,t} \) for \( j = s, u \).

(ii) Taking tax rates and rental prices as given, \( \{k_{st,t}, k_{eq,t}\} \) maximize capitalists’ lifetime utility.

(iii) Wages are the Nash solution to a bargaining problem between the unions’ and

---

\(^8\)Our modeling of negotiation between homogeneous coalitions follows Kalai (1977) by assuming that each coalition member has right to talk. For an alternative modeling of negotiation between coalitions see, for instance, Chae and Heidhues (2001).
employers’ federations with the stated subjective probabilities over the outcome of decentralized bargaining.

(iv) Matching rates are given by the matching function, i.e., \( \mu_{j,t} = M_{j,t}/v_{j,t} \), and \( m_{j,t} = M_{j,t}/x_{j,t} \) for \( j = s, u \).

(v) \( \{\Phi_t\} \) solves the government’s maximization problem, and the budget constraint of the unemployment benefit program holds.

(vi) Participation constraints are satisfied.

The decision of labor unions regarding whether to engage in centralized wage bargaining or, on the contrary, to conduct uncoordinated decentralized bargaining can be thought of in terms of a standard, infinitely repeated game, where labor unions observe the current state of the economy before they choose their actions. If we narrow the analysis by assuming Nash reversion or grim trigger strategies, and focus on pure strategy subgame perfect equilibria, then the problem can be analyzed using standard results in the literature of repeated games.

For our problem at hand, however, the analysis becomes even simpler. Since centrally bargained wages are enforceable, no labor union can increase the instantaneous income of the affiliated worker by deviating from cooperation within a given period. This enforceability implies that the labor unions’ decision problem becomes a period-by-period problem with no intertemporal links. This, added to the fact that there are no side payments within nor across unions, simplifies the analysis of the model significantly. Indeed, as will be shown below, under certain conditions on technology, there are systems of subjective probabilities over the outcome of decentralized bargaining for which centralization arises endogenously as the equilibrium bargaining arrangement.

5 The Rise and Fall of Centralized Wage Bargaining

Under the production technology extant before the 80’s, a program of unemployment benefits like the one outlined in the previous section sets the conditions for the rise of centralized wage bargaining. More specifically, we show in this section that when we calibrate our model to match some key values of the Swedish economy in 1970, the externalities from the program of unemployment benefits yield two expectational equilibria under decentralized wage bargaining. In one of these equilibria unemployment rates are
high, and capital accumulation and workers' incomes are low. It is hence the existence of this bad equilibrium, along with a positive subjective probability of its occurrence, that renders centralization the wage bargaining arrangement of the 1970 economy. In short, centralization arises as a response to the existence of multiple expectational equilibria. However, for the level of equipment-specific technology reached in the early 90’s the social welfare program no longer creates the threat of a bad expectational equilibrium, and, consequently, centralized bargaining is no longer sustainable.

Before continuing with the analysis of our model, and with the parameterization of the production function, we parameterize the matching process, $M(v_j, s_j)$. We assume a matching technology as the one presented by Den Haan, Ramey and Watson (2000), i.e.,

$$M_{j,t} = \frac{v_{j,t}x_{j,t}}{(v_{j,t}^\rho + x_{j,t}^\rho)^{1/\rho}} \quad \text{for} \quad j = s, u.$$

This function satisfies the standard assumptions typically imposed on a matching technology, i.e., it has constant returns to scale, and is increasing in the number of vacancies and searchers. As explained by Den Haan, Ramey and Watson (2000) the main advantage of this matching function, with respect to the standard Cobb-Douglas matching function, is that matching probabilities lie between zero and one for all values of $v_j$ and $x_j$.

Regarding the parameterization of the production technology and its evolution in the postwar period we will assume equipment-specific technological progress, and equipment-skill complementarity. According to Greenwood, Herkowitz and Krusell (1997), the growth in production per capita experienced by the U.S. economy in the postwar period is, to a great extent, the result of equipment-specific technological progress. Krusell, Ohanian, Ríos-Rull and Violante (2000) take this idea as a starting point and estimate an aggregate production function for the U.S. economy. Their main result is that the elasticity of substitution between equipment and skilled labor is lower than that between equipment and unskilled labor: there is equipment-skill complementarity. The same result is found by Lindquist (2005) for the Swedish economy. In our model, this scenario can be represented by increases in $q$, and by assuming equipment-skill complementarity in our production function $F$.

*The Krusell, Ohanian, Ríos-Rull and Violante Production Function*

Krusell, Ohanian, Ríos-Rull and Violante (2000) modify the standard two-factor aggregate production function and develop a four-factor aggregate production function with capital equipment, capital structures, skilled and unskilled labor. Their function allows
for different elasticities of substitution among factors of production. In particular, they choose a Cobb-Douglas function over structures and a CES function of equipment, skilled and unskilled labor. The production function they estimate is,

\[ F(k_{st,t}, k_{eq,t}, n_{st}h_s, n_{at}h_u) = k_{st,t}^\alpha \left[ \lambda k_{eq,t}^\sigma + (1 - \lambda)(n_{st}h_s)^\sigma \right]^{\alpha/\sigma} + (1 - \theta)(n_{at}h_u)^\alpha \left(1 - \phi\right) \]

(5.1)

The efficiency or quality of labor is denoted by \( h_j \), for \( j = s, u \). Lindquist (2005) estimates this production function for the 1967-1996 Swedish economy. Parameters \( \alpha \) and \( \sigma \) are of especial importance in our analysis since they determine key elasticities of substitution. The elasticity of substitution between equipment and unskilled labor is given by \( \frac{1}{1-\alpha} \), and the elasticity of substitution between equipment and skilled labor is \( \frac{1}{1-\sigma} \). The estimates for these two parameters presented by both Krusell, Ohanian, Ríos-Rull and Violante (2000) and Lindquist (2005) indicate that the elasticity of substitution between equipment and unskilled labor is higher than that between equipment and skilled labor. That is, there is equipment-skill complementarity. In our notation this implies \( \alpha > \sigma \).

Parameter values

In order to explore the relationship between the level of technology in the equipment-goods sector and the wage-setting arrangement, we need to assign values to all parameters in the model. Our selection of parameter values follows the standard procedure, and will be guided by a priori information, and by a number of observations for the Swedish economy. In addition to matching the values of some key economic variables, we also have to match the wage-setting arrangement, which ultimately amounts to matching unions’ strategies. The observations that will be matched correspond to 1970, a year in which centralized bargaining was at its peak.

Parameters set with a priori information are the following. The measure of skilled workers, \( x_s \), is set at 0.05, which is the fraction of university graduates in the labor force (see the labor force surveys, Statistics Sweden). The value of \( \psi \) is set at 0.2, which corresponds to an average eligibility for unemployment compensation of five years. The parameters in the production function are taken from the estimates for the Swedish economy by Lindquist (2005). As for the elasticities, this author reports a value for \( \alpha \) equal to 0.4, and a value for \( \sigma \) equal to -0.4. The rate of depreciation for equipment is set at 12.5%, which is the value used by Statistics Sweden for constructing the stock of capital equipment for the Swedish economy [this is the same rate found by Greenwood, Herkowitz and Krusell (1997) for the U.S. economy]. The rate of depreciation for structures is set at
5%, which is the value reported by Lindquist (2005). The value of $\rho$, the parameter in the matching function, is set at 1.26 as reported by Den Haan, Ramey and Watson (2000). Parameter $h_u$ is set arbitrarily. We choose to normalize $h_u = 1$, so that skilled workers’ efficiency, $h_s$, is written in units of $h_u$. The level of technology in the equipment-goods sector $q$ is set at 0.75.

The remaining nine parameters ($B$ is set equal to $d$): $a_s$, $a_u$, $\beta$, $h_s$, $p$, $d$, $\varsigma$, $\gamma$, and the subjective probability over decentralized equilibria, say $\eta$, are selected so that the following observations are matched by the centralized bargaining equilibrium. (i) An unemployment rate for the skilled of 0.6%. (ii) An unemployment rate for the unskilled of 2.4%. (iii) A capital’s share of income of 30%. (iv) A capital output ratio of 2.8. (v) A skill premium, defined as the university-gymnasium log wage differential, of 0.6 [this is the value for 1970 reported by Edin and Holmlund (1995), who use data from the Level of Living Survey (LNU), and the Household Market and Non-market Activities Survey (HUS)]. (vi) A benefit replacement rate (computed as net-of-tax benefit entitlements as a percentage of net-of-tax earnings) for skilled workers of 60%, which is the number reported by SACO (the Swedish Confederation of Professional Associations). (vii) A benefit replacement rate for unskilled workers 10% higher than that for the skilled. (viii) Unemployment compensation outlays amount to 0.8% of GDP, as reported by the Swedish Unemployment Insurance Board (IAF). (ix) All unions endogenously choose to hold centralized wage negotiations.

For expositional clarity we present our calibrated parameters in Table 4 below. We will refer to these parameters as the benchmark economy.

<table>
<thead>
<tr>
<th>Workers</th>
<th>Capitalists</th>
<th>Technology</th>
<th>Matching</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>$x_u = 0.95$</td>
<td>$\sigma = -0.4$</td>
<td>$\alpha = 0.4$</td>
<td>$\rho = 1.26$</td>
<td>$\gamma = 0.4$</td>
</tr>
<tr>
<td>$x_s = 0.05$</td>
<td>$\beta = 0.96$</td>
<td>$\alpha = 0.4$</td>
<td>$a_s = 0.025$</td>
<td>$\psi = 0.2$</td>
</tr>
<tr>
<td>$h_u = 1$</td>
<td>$\delta_{st} = 0.05$</td>
<td>$\theta = 0.37$</td>
<td>$a_u = 0.01$</td>
<td>$d = 0.1$</td>
</tr>
<tr>
<td>$h_s = 3.75$</td>
<td>$\delta_{eq} = 0.125$</td>
<td>$\lambda = 0.5$</td>
<td></td>
<td>$\varsigma = 0.05$</td>
</tr>
<tr>
<td>$p = 0.6$</td>
<td></td>
<td>$\varphi = 0.19$</td>
<td></td>
<td>$B = 0.1$</td>
</tr>
</tbody>
</table>

The Rise of Centralization

For these parameter values, for a level of technology in the equipment sector equal to 0.75, and a value of $\eta$ of 0.9 (i.e., the subjective probability on the bad equilibrium under
decentralization), the centralized bargaining equilibrium of our model economy matches
the observations for the 1970 Swedish economy listed above. To address the question of
why unions opted for centralized bargaining in 1970, we present in Table 5 below unem-
ployment rates and expected pre-matching workers’ net incomes both under centralized
and decentralized bargaining. Several comments on our results are in order. First, the
two equilibria arising in the decentralized bargaining economy can be ranked in terms of
pre-matching workers’ net incomes: the equilibrium with low unemployment rates, DBE1,
is associated with higher expected incomes. Second, the centralized bargaining equilib-
rium, CBE, yields lower unemployment rates than decentralization, both for the skilled
and the unskilled. In terms of expected workers’ incomes, centralized bargaining domi-
nates decentralization for the unskilled. For skilled workers centralization yields income
levels inferior to DBE1, but above income levels unions expect in DBE2. However, for the
subjective probability on the occurrence of DBE2 in our calibrated economy, expected
income for skilled workers in the centralized economy is higher than expected income
under decentralization.

Therefore, centralized bargaining arises as the wage-setting arrangement in the 1970
economy. According to our theory labor unions for skilled workers embarked in cen-
tralized bargaining along with the unskilled during the 50’s, 60’s and 70’s because of
the threat posed by the possibility of coordination failures under decentralization, which
might otherwise have lessened workers income substantially.

<table>
<thead>
<tr>
<th></th>
<th>Decentralized Bargaining</th>
<th>Centralized Bargaining</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DBE1</td>
<td>DBE2</td>
</tr>
<tr>
<td>ur_s</td>
<td>1.4%</td>
<td>5.9%</td>
</tr>
<tr>
<td>ur_u</td>
<td>4.5%</td>
<td>15.2%</td>
</tr>
<tr>
<td>ur_total</td>
<td>4.4%</td>
<td>14.7%</td>
</tr>
<tr>
<td>ys</td>
<td>0.5692</td>
<td>0.4238</td>
</tr>
<tr>
<td>yu</td>
<td>0.2852</td>
<td>0.2316</td>
</tr>
</tbody>
</table>

Note: Equilibrium values correspond to the economy with \( q = 0.75 \) and the parameter values
presented in Table 4. Note that \( y_s \) and \( y_u \) denote expected pre-matching net incomes of skilled
and unskilled union workers, respectively.

Before exploring the consequences of increasing \( q \) to the levels of the early 1990’s, some
remarks are worth making. The multiplicity of equilibria under decentralized bargaining results from the fiscal externalities created by the unemployment benefit program in combination with the low productivity gap across workers (i.e., a low $q$). The basic principle underlying the results in this subsection is that a generous and progressive welfare state may be a source of macroeconomic instability, which induces economic agents—labor unions in this case—to respond by creating new institutions that mitigate the implied volatility on their income levels. The robustness of the multiplicity result with respect to the unemployment program’s parameter values is explored below. Finally, our assumption of complete unionization of the labor force implies that in the CBE the union federation internalizes the fiscal spillovers fully, as there are no unrepresented workers.

The Fall of Centralization

As stated above, the hypothesis advanced in this paper regarding the collapse of centralized wage bargaining is the breakdown of the unions’ alliance. That is, individual labor unions found that it was no longer in their interest to continue holding centralized wage negotiations. We show in this Section that the change in the wage-bargaining arrangement can be accounted for as the result of the two following trends observed in the Swedish economy between 1970 and 1990: 1) An increase in the level of technology in the equipment sector. According to estimates using relative prices of equipment, the average rate of equipment-specific technological progress in the 1970-1990 period is around 3%. This implies an increase in $q$ from 0.75 to 1.25. 2) An increase in the relative supply of skilled labor. The proportion of the Swedish workforce with a university degree increased from 5% in 1970 to 15% in 1990 [see Edin and Holmlund (1995)].

We carry out this exercise in two steps. First, we modify our benchmark economy to update $q$ and $x_s$ to their 1990 values, and show that our model accounts for the collapse of centralized wage negotiations. Second, we ask the following question: could either of the previous trends, when considered in isolation, bring about the collapse of centralization? This is a thought experiment, since the two trends are strongly related, and most likely neither of them could have been possible without the other.

The results of the first part of this exercise are presented in Table 6 below. The de-

---

9It should be noted that an account of the increase in the relative supply of skilled labor between 1970 and 1990 should also include the relative change in hours worked. In our model, however, hours worked are fixed and normalized to one. We will perform a sensitivity analysis with respect to both the level and the increase in $x_s$. 

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centralized equilibrium with high unemployment rates that was operating as a threat to
decentralization in 1970 no longer exists in the 1990 economy. Equipment-specific tech-
nical progress renders equilibrium uniqueness under decentralized bargaining by increasing
the productivity gap across workers, $F_{n_s}/F_{n_u}$. For given government aversion to inequality
and given progressivity of benefits and taxes, the relative increase in the productivity of
skilled labor leads to the violation of participation constraints in the equilibrium with high
unemployment rates. Therefore, workers’ outside option values to centralized bargaining
are given by net incomes at the unique equilibrium that would emerge under decentral-
ization. In other words, subjective probabilities on the outcome of holding decentralized
negotiations are degenerate at equilibrium DBE1 in Table 6. For these outside values the
bargaining set under centralization is empty. That is, there is no pair of equilibrium wage
rates that can yield all coalitions of workers net incomes above their outside values. In
short, according to our theory, equipment-specific technological progress and the increase
in the relative supply of skilled labor caused the end of centralization via the removal of
the threat of coordination failures in the decentralized economy.

TABLE 6—UNEMPLOYMENT RATES AND WORKERS EXPECTED INCOMES UNDER DECENTRALIZED AND
CENTRALIZED BARGAINING

<table>
<thead>
<tr>
<th></th>
<th>Decentralized Bargaining</th>
<th>Centralized Bargaining</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DBE1</td>
<td>DBE2</td>
</tr>
<tr>
<td>$ur_s$</td>
<td>3%</td>
<td>–</td>
</tr>
<tr>
<td>$ur_u$</td>
<td>2.4%</td>
<td>–</td>
</tr>
<tr>
<td>$ur_{total}$</td>
<td>2.49%</td>
<td>–</td>
</tr>
<tr>
<td>$y_s$</td>
<td>0.5239</td>
<td>–</td>
</tr>
<tr>
<td>$y_u$</td>
<td>0.3283</td>
<td>–</td>
</tr>
</tbody>
</table>

Note: Equilibrium values correspond to the economy with $q = 1.25$, $x_s = 0.15$, $x_u = 0.85$ and
parameter values presented in Table 4.

In addition to accounting for the collapse of centralization, our model’s predictions are
also in concordance with the patterns in unemployment and the skill premium observed
in the Swedish economy between 1970 and the early 1990’s. Regarding unemployment,
the Swedish unemployment rate remained almost unchanged in the 80’s, notwithstanding
the sharp decline in centralization. The economy-wide unemployment rate in 1990 was
2.3 percent.10 Our model’s prediction that moving from full centralization to decentral-

10 The Swedish unemployment rate experienced, however, an abrupt increase in the second half of the
ization does not affect the unemployment rate in a significant manner is thus consistent with Swedish unemployment rates. Regarding the skill premium, the Swedish college-gymnasium wage differential declined during the 70’s and the first half of the 80’s, and then increased during the second half of the 80’s and the 90’s.\textsuperscript{11} By 1990 the Swedish skill premium was still 25% lower than in 1970. Our model yields a skill premium in 1990 that is 20% lower than the value matched in 1970. In our model, this decline is the net result of three effects: (i) the relative increase in skilled labor, a \textit{relative quantity effect}; (ii) the relative increase in equipment capital, a \textit{capital-skill complementarity effect}; and (iii) the decline in centralization, a \textit{wage-bargaining effect}.

In the second part of our exercise we increase \( q \) and \( x_s \) one at a time, and investigate their respective effects on the wage-setting arrangement. Our results indicate that the increase in equipment-specific technology can account for the collapse of centralization, while the increase in the relative supply of skilled labor cannot. The intuition for this result is simple, and it can be easily derived from our arguments above. In sum, equipment-specific technological progress increases the productivity gap across skill groups and consequently prevents coordination failures from occurring under decentralized wage bargaining.

Before closing this subsection, we want to emphasize that these results are not specific to the particular representation of the production process presented above. The same results hold under the alternative representation proposed by Heckman, Lochner and Taber (1998). Instead of the complementarity relationship between capital and skilled labor, these authors propose a representation with skill-biased, disembodied technical change. Their aggregate production function is

\[
F(k, L) = \left[ a_2 k^{\rho_2} + (1 - a_2) L^{\rho_2} \right]^{1/\rho_2}
\]

where \( k \) denotes physical capital and \( L \) is a labor aggregate given by,

\[
L = \left[ a_1 (n_u h_u)^{\rho_1} + (1 - a_1) (n_s h_s)^{\rho_1} \right]^{1/\rho_1}.
\]

The elasticity of substitution between capital and the labor aggregate is given by \( \frac{1}{1-\rho_2} \).

\textsuperscript{90’s, to rates in the order of 8–9 per cent.}

\textsuperscript{11}This pattern is qualitatively similar to the one observed in the US economy, which constitutes the subject of study in Krusell, Ohanian, Rios-Rull and Violante (2000). These authors explain the U-shaped time profile of the US skill premium as the net result of two opposite effects: a \textit{relative quantity effect}, and a \textit{capital-skill complementarity effect}. The first effect —the relative increase in the skilled labor input— contributes to reduce the skill premium. The second effect —the relative increase in capital equipment— contributes to increase the skill premium under equipment-skill complementarity.
The elasticity of substitution between skilled and unskilled labor is $\frac{1}{1-\rho_1}$. Skill-biased, disembodied technical change is represented by changes in $a_1$. We solved our model with this representation of the production process, and found exactly the same predictions in terms of equilibrium bargaining arrangements.

5.1 Sensitivity Analysis

In this section we conduct a sensitivity analysis with respect to selected parameters. We explore the effects of changes in the values of those parameters that play a prominent role either in shaping the fiscal externalities under decentralized wage bargaining —and thus in setting up the conditions for centralized bargaining— or in restoring equilibrium uniqueness after the increase in technology. We start out with our benchmark economy and then change the value of those key parameters. By so doing, we address two different but related questions. First, how robust are our results to changes in parameter values? Second, can we find patterns explaining the variation in the wage-setting arrangement across countries? The results from this exercise may be summarized as: (i) our results are fairly robust to parameter values; (ii) variation in parameter values that determine the generosity and progressivity of unemployment benefits, $\gamma$, $\psi$ and $\varsigma$, and the progressivity of taxation, $d$, have an unambiguous effect on multiplicity. The lower the generosity and progressivity of benefits, and the progressivity of taxation, the less likely the possibility of multiple equilibria.

First we study the sensitivity of the multiplicity result with respect to parameters defining the social program: $\gamma$, $\psi$, $\varsigma$, $B$, and $d$. We set values for these parameters so that the externalities generated by the social program are just enough to yield multiple equilibria in the decentralized economy. That is, further changes in those parameters in the direction of weakening redistribution, progressivity and eligibility would result in a unique equilibrium under decentralization. These values are: $\gamma = 0.8$, $\varsigma = 0.01$, $B = 0.08$, $d = 0.089$ and $\psi = 0.45$. These values define a program with progressivity in benefits less than three percent points, and an average eligibility of about two years. We have also explored how some of these parameters trade off in maintaining the multiplicity of equilibria. For instance, a decrease in the progressivity of benefits, $\varsigma$, from its benchmark value to 0.02 must be accompanied either by an increase in government’s aversion for inequality (i.e., a decrease in $\gamma$) to 0.05, or by an increase in $B$ to 0.12. From this sensitivity exercise we conclude that the conditions for centralized wage bargaining are
directly related to the generosity and progressivity of the social program. We use these results below to assess the cross-country differential in centralization scores.

The effects of changes in the production function’s parameter values are as follows. The multiplicity of equilibria under decentralized bargaining is robust to changes in these parameter values. However, the extent to which equipment-specific technical change can restore equilibrium uniqueness—and thus cause the fall of centralization—depends critically on the differential in the elasticities of substitution between equipment and the two types of labor. That is, on the value of $\alpha$ relative to $\sigma$. Starting from our benchmark economy, we compute the highest value of $\alpha$ for which centralized bargaining would have survived the increase in technology. This value is 0.1 (i.e. for values of $\alpha$ below this number, equipment-specific technical progress would not have caused the collapse of centralization). Since Lindquist (2005) has shown that his estimate, $\alpha = 0.4$, is robust to different model specifications, a value of the order of 0.1 can be considered far beyond the range of estimated values for the Swedish economy.

Finally, one of the parameters we set using *a priori* information is the fraction of skilled workers in the labor force. We chose to define a skilled worker as a university graduate. Then—and to be consistent with this definition—we matched the skill premium using the university premium, and matched the unemployment rate of skilled workers as that among university graduates. This definition of skilled workers is not critical for our results. Our sensitivity analysis with respect to $x_s$ and the magnitude of its increase between 1970 and 1990 shows that our results are robust to the definition of skilled labor.

5.2 Cross-Country Differentials in Centralization Scores

In light of our model and the results above, we now turn our attention to wage bargaining in non-Scandinavian countries. Rather than aiming at a full accounting and explanation of bargaining institutions in those countries, we simply seek additional evidence supporting the mechanism for the rise and fall of centralization outlined in this paper. Thus, the type of question we address here is: can we, within the context of our model, provide some rationale for the low and medium levels of centralization in wage bargaining observed in non-Scandinavian economies?

According to Iversen’s (1999) index, Italy had one of the most decentralized wage-bargaining arrangements among Western European economies. For the period 1973-79,
Iversen’s index averaged 0.1978; for the period 1980-1986, it was 0.1410, and 0.1587 for the period 1987-1993. Italy’s low centralization compares to that of the US, and is in sharp contrast to most of its neighboring countries, where centralization scores in the seventies were in the order of 0.3-0.35. According to the theory developed in this paper, Italy’s decentralization may be understood as a consequence of its lack of a proper program of unemployment benefits. Labor market policy in Italy has been stubbornly directed toward employment protection, leading to high firing restrictions and high severance payments.

We argue that by turning away from a policy of unemployment benefits, Italy did not nurture the fiscal externalities that lie at the heart of centralized wage bargaining. A similar argument can be used to account for the highly decentralized wage-setting process in the US economy. With low benefit replacement rates, short benefit duration, and stringent eligibility conditions, the US unemployment benefit program seems to have fallen short of generating large enough externalities, which set the conditions for centralized bargaining.

In contrast to the Italian and US cases, we cannot resort to the absence of fiscal externalities to rationalize the medium levels of centralization observed in many European countries in the early 1970’s (e.g., Austria, Belgium, Germany, Netherlands and the UK). Although the generosity and progressivity of benefit programs in these countries did not reach the marks of the Swedish’s, all these countries had fairly developed programs to assist the unemployed. Indeed, with the exception of the Netherlands where benefits were as generous as in Sweden, replacement rates in most of the other countries were only around 15 – 20 per cent lower than in Scandinavian economies [see e.g., Martin (1996)]. Yet a more substantial difference between Scandinavian and non-Scandinavian benefit programs is the way they are handled. As we pointed out above, in non-Scandinavian countries benefit programs are compulsory, and do not call for worker affiliation with labor unions. Hence, unionization rates in these countries have remained in the range of 30% to 50%. We argue that incomplete unionization may help explain why in these economies centralization did not attain Scandinavian standards. The implications of incomplete unionization for the extent of centralization in wage bargaining are the following.

\[\text{12} \text{From the mid 40's to the mid 80's, unemployment benefits in Italy were essentially provided by the so-called \textit{cassa di integrazione}. Benefits had a maximum duration of 13 weeks, and were non-universal, as they were granted only to workers employed in firms satisfying certain special conditions. The program was mainly designed to assist workers in firms engaged in the restructuring of their activities, or in firms affected by temporary productivity shocks non-attributable to the workers or the firms themselves. Workers receiving benefits were only temporarily fired, and remained on hold until the firm resumed activities.}\]
First, if non-unionized workers conduct their own wage negotiations, centralization scores are necessarily lower, even if unions choose to coordinate wage bargaining. Further, the union federation will be unable to fully internalize the fiscal externalities stemming from the wage-setting process. Second, in the case in which wages bargained by the union federation are extended to non-unionized workers, centralization will not reach maximum scores either. On the one hand, federation-bargained wages are less enforceable, as the federation in this case typically bargains a floor wage, and then allows full wage drift. On the other hand, union concentration is also significantly lower. Since Iversen’s index includes measures of enforceability and union concentration, the medium levels of centralization in the above-mentioned countries may be explained by their relatively lower unionization rates. In sum, a generous and progressive program of unemployment benefits is a necessary, but not sufficient, condition for maximum centralization scores.

6 Conclusions

In this paper we have analyzed a model of wage bargaining that explains the evolution of the wage-setting process in Scandinavian economies. Our model is built upon the standard matching model, extended to include heterogeneity among workers, and both fiscal and technological links among these heterogeneous workers. Fiscal links in our model are created by a generous and progressive unemployment benefit program, which is funded by the government and administered directly by labor unions. Equipment-skill technical progress, along with equipment-skill complementarity, shape the evolution of the productivity gap across workers. Our analysis shows that when capital equipment is expensive and scarce, and, therefore, skilled and unskilled workers are relatively alike, the externalities stemming from the program of unemployment benefits can create coordination failures. Since coordination failures yield substantial losses in unions’ income, centralized wage bargaining may arise as an equilibrium, thus explaining why Scandinavian countries held centralized wage negotiations until the early 80’s. With the advent of technological progress, which increased the relative productivity of skilled workers, the possibility of coordination failures vanished. Thus, labor unions regained their role as individual wage negotiators. Our modeling of technological progress follows recent contributions, which have uncovered the nature of technological progress during the postwar period. A calibrated version of our model that takes into account the increase in technology successfully explains the rise and fall of centralization in wage bargaining.
There are several important implications from our results. A first implication is related to how the collapse of centralization should be assessed. Our theory shows that the collapse of centralization must be seen as the unions’ response to technological progress, i.e., as a way of accommodating the bargaining arrangement to the new production technology. Accordingly, the fall of centralization must not be attributed to a shift in monetary policy or to a mismanagement of centralized bargaining agreements. This stands in sharp contrast to previous theories which place monetary policy at the center stage of the collapse of centralization and which seem to suggest a whole re-assessment of monetary policy in Europe.

A second implication concerns the design of the unemployment benefit program, and its ability to bring into existence other labor market institutions. Highly generous and progressive benefit programs with government funding are bound to create fiscal externalities among labor unions. If, in addition, labor unions administer benefit funds—which causes full unionization—those externalities may end up triggering highly centralized wage-setting arrangements. This is an important consequence of the unemployment benefit program that has passed unnoticed in the literature. Our results thus introduce some new arguments which should not be dismissed in the debate on unemployment policy reform.

There are several directions in which our model can be extended. In our model, either all unions belong to the federation, or there is no federation, i.e., we have narrowed down the analysis to full centralization or full decentralization. It seems natural, however, to think of situations in which only a fraction of unions belong to the federation. Even though allowing for partial centralization will not change our conclusions, it will certainly give rise to new questions, and will shed further light on wage-bargaining institutions in non-Scandinavian economies. A second extension that can also open new avenues to the study of related problems is the consideration of inter-union solidarity arguments. As we pointed out above, our explanation for the rise and fall of centralization has intentionally abstracted from such issues. Our aim was to show that the former does not hinge on the latter. Finally, our results suggest a number of testable propositions regarding wage-setting arrangements and social welfare programs. Empirical work along the lines set by our model will not only help confront our theory with the data, but will also bring new insights for future research.
7 Technical Appendix

Appendix I

In this appendix we sketch the algorithm used to compute the decentralized bargaining equilibrium defined in Section 4.1, and, more specifically, to the numerical computation of wage functions $\omega_j(n_s, n_u)$ for $j = s, u$.

The wage functions are the solutions to the two partial differential equations given by (4.14) for $j = s, u$, along with equations in (4.4), (4.5), (4.6), (4.7), (4.8) and the first-order condition to unemployment benefits. To compute the two unknown functions we adopt a version of a projection method with Chebyshev polynomials and Chebyshev collocation. The two unknown functions are approximated using Chebyshev polynomials, which are a basis for the space of continuous functions. Then we compute the coefficients of the Chebyshev polynomials so that these approximations exactly satisfy the two wage equations at some conveniently selected collocation points. Finally, and in order to verify the quality of the approximation, we check the errors at all points other than these collocation points.

Hence, the wage function for workers of type $j$ is approximated by,

$$\tilde{\omega}(n_s, n_u, b^j) = \sum_{\kappa = 1}^{z_1} \sum_{\iota = 1}^{z_2} b^j_{\kappa \iota} T_{\kappa \iota}(n_s, n_u) \quad \text{for} \quad j = s, u,$$

(7.1)

where the two-dimensional Chebyshev polynomials, $T_{\kappa \iota}(n_s, n_u)$, are the tensor products of the one-dimensional polynomials, that is, $T_{\kappa \iota}(n_s, n_u) = T_{\kappa - 1}[2(n_s - n_s^{\min})/(n_s^{\max} - n_s^{\min}) - 1]T_{\iota - 1}[2(n_u - n_u^{\min})/(n_u^{\max} - n_u^{\min}) - 1]$. The one-dimensional Chebyshev polynomials are evaluated by recursion: $T_0(x) = 1, \quad T_1(x) = x, \ldots, \quad T_{\kappa + 1}(x) = 2xT_\kappa(x) - T_{\kappa - 1}(x)$. The matrix $b^j = (b^j_{\kappa \iota}), \quad \kappa = 1, \ldots, z_1; \quad \iota = 1, \ldots, z_2$, is the matrix of unknown coefficients in the wage function for type-$j$ workers. The values $n_s^{\min}, n_s^{\max}, n_u^{\min}$ and $n_u^{\max}$ are used to transform the original variables, since the Chebyshev polynomials are defined in the interval $[-1, 1]$. Solutions are therefore restricted to the set $[n_s^{\min}, n_s^{\max}] \times [n_u^{\min}, n_u^{\max}]$.

The total number of coefficients to be determined is $2 \times (z_1 \times z_2)$. These coefficients are fixed by imposing that $\tilde{\omega}(n_s, n_u, b^s)$ and $\tilde{\omega}(n_s, n_u, b^u)$ satisfy the two partial differential equations in (4.14), and equations (4.4), (4.5), (4.6), (4.7), (4.8) and the first-order condition to unemployment benefits, at $z_1 \times z_2$ collocation points in the set $[n_s^{\min}, n_s^{\max}] \times [n_u^{\min}, n_u^{\max}]$. Thus, the problem reduces to solving a system of non-linear equations. Once wage functions have been so computed, solutions to $k_s, k_{eq}, \tau$, and $\Phi$ are
obtained from (4.4), (4.7), (4.8) and the first-order condition to benefits. Employment
levels \( n_s \) and \( n_u \) are the solutions to (4.10). Vacancies and matching rates are obtained
from \( n_j = \mu_j v_j \) for \( j = s, u \) and from the two matching functions.

**Appendix II**

This Appendix presents the centralized bargaining equilibrium with a utilitarian unions’
federation. The unions’ federation is assumed to have a purely utilitarian welfare function
over all workers’ incomes, both the employed and the unemployed. The federation cares
only about the total sum of net incomes without taking into account its distribution across
different workers, thus embedding our assumption of no wage solidarity among unions.
For such a federation the income value of having \( n_{s,t} \) and \( n_{u,t} \) workers employed at wages
\( \omega_{s,t} \) and \( \omega_{u,t} \) is then,

\[
W_t = \omega_{s,t} n_{s,t} + \omega_{u,t} n_{u,t} + \tau_t [r_{st,t} k_{st,t} + r_{eq,t} k_{eq,t} - d]
\]  (7.2)

where we have already made use of the budget constraint of the unemployment benefits
program. The outside option to centralized bargaining is decentralization, whose value
to the unions’ federation, \( \bar{W}_t \), is the expected sum of the corresponding workers’ net
incomes. Expectations are taken using subjective probabilities over the equilibria arising
under decentralization.

Wages in the centralized bargaining equilibrium with a utilitarian unions’ federation
are the solutions to the following maximization problem,

\[
\{\omega_{s,t}, \omega_{u,t}\} = \arg\max (W_t - \bar{W}_t)^p (J_t - \bar{J}_t)^{1-p},
\]  (7.3)

subject to the unemployment program budget constraint, the first-order condition to
benefits, and \( W_t \geq \bar{W}_t, J_t \geq \bar{J}_t \). The net value of employment for the firms’ federation
is the same as in Section 4. We computed this centralized bargaining equilibrium for
parameter values in Table 4 and the results remain qualitatively unchanged with respect
to those presented in Section 5, where the utilitarian unions’ federation is replaced by
coalitions of homogeneous workers.
References


