Estimating a model of collective bargaining
in the public sector

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Abstract

In this paper I develop a two-stage bargaining model determining wages and employment and apply it to the public sector. Solving the model leads to structural wage and employment equations that I estimate using data from the public sector in Iceland. Nested in the model are the major collective bargaining models (right-to-manage and efficient contracting). The model can be empirically tested to distinguish between the bargaining models.

Significant changes were made to collective bargaining contracts in the public sector in Iceland at the same time the bargaining process was decentralized. The model is estimated for the period before the changes were made and again after the changes had taken root. The result is that the bargaining power of unions has changed between the two periods and the bargaining structure has become more inefficient with the changes in the collective bargaining contracts.

Key words: Wage structure, collective bargaining, decentralization, public sector, trade union models.

JEL Codes: J31, J45, J52

1.   Introduction

Collective bargaining contracts between Iceland's public-sector unions and the central government underwent significant changes in 1997, providing a unique opportunity to study whether the structure of labor contracts and bargaining process decentralization influences the structure of bargaining.

I use Manning's collective bargaining model (Manning, 1987) to determine which bargaining model is in place in the public sector in Iceland. The advantage to using Manning's model is that the most important collective bargaining models are embedded in his model; monopoly union, right-to-manage and efficient contracting. It is thus possible to distinguish between these models based on the empirical findings. Also, it is possible to measure the bargaining power of unions and whether the bargaining power of unions differs between that over wages and employment.

2.   Developments in the public sector

2.1.   The development in the public sector in other countries

Public-sector pay systems in the OECD countries came under pressure in the early 1980s. Macroeconomic considerations created pressures to improve wage flexibility in both the public and private sectors at the same time pressures grew to curb public expenditures and government deficits (Maguire, 1993). In response to this, wage determination in the central government administrations of many countries which historically had been centralized, has in recent years become increasingly decentralized (Rexed et al, 2007).

Elliot and Bender (1997) examined public-sector reforms in the United Kingdom, Sweden, and Australia. These reforms were in the direction of decentralization of pay bargaining and the individualization of pay. Prior to the reforms all three countries had highly centralized and coordinated arrangements for determining the pay of central government employees.

The reforms in these three countries were, according to Elliot and Bender (1997), motivated by the search for increased flexibility and efficiency and by the desire to contain the public-sector pay bill. In these respects the public sector was following the lead of the private sector, as in all three countries, the private sector adopted a more decentralized approach to wage bargaining during the 1980s and 1990s.

Falch and Strom (2006) investigate the effects of moving a centralized pay system to a system with more local pay discretion, a change that took place in the local public sector in Norway in 1990. After 1990 central contracts stipulated a wage frame for each occupation and granted local governments considerable freedom to place individual employees within each wage frame. There is some evidence that wage differences increased somewhat as the wage setting was decentralized and that local wages have become more responsive to local budgets. The authors also suggest that because the changes in the wage distribution are small, the established pay equality norms across government workplaces continue to play a significant role in the determination of wages even after decentralization.

2.2.   Changes in the public sector in Iceland in the 1990s

The central government's policy in the early 1990s aimed to increase efficiency in the public sector. The government's human resource policy aimed to reduce the difference between the private and public sectors, enhancing a free flow between the two. In light of this policy, the government agreed to significant changes in the public-sector collective bargaining contracts in the negotiating round that began in 1997.

During the previous decades, public-sector wage contracts in Iceland were very rigid. All job titles were defined in the contracts and limited to a narrow range of pay levels. They included, however, large automatic wage increases tied to age and seniority. These agreements held that all related communication was to take place between the Ministry of Finance, on the one hand, and individual unions, on the other.

In the negotiating round that took place in 1997, the new pay schedule was implemented for a large number of unions and significant changes were made to the wage structure in each contract. The changes resulted in decentralization of the wage negotiation process as the negotiations were split in two.

First, there is a central contract between each union and the Ministry of Finance. This defines the wages in kronur and general wage increases during the term of the contract. In each contract, three to four wage ranges, or so-called frames, are defined in the central agreement and include a broad job definition for each wage range, with the ranges usually overlapping. This provided much greater flexibility in wage determination while reducing automatic wage increases significantly.

In the second stage of negotiation, decentralization was introduced. The members of a specific union in each workplace negotiate with the head of each institute on how the contract will be applied to that particular workplace, based on the broad definition given in the central agreement. Thus, an additional agreement, the institutional agreement, is made within each institute with each union operating in that institute. This institutional agreement is considered a part of the collective bargaining agreement.

3.   Models of trade union bargaining

Several models have been developed to describe the bargaining process between firms and unions. In the right-to-manage model, the firm and the union are assumed to bargain over any surplus in order to determine wages, while the employment level is determined by the firm. A special case of the right-to-manage model is the monopoly union model in which the union sets the wage level unilaterally subject to the firm's labor demand curve, thus acting as a monopoly. When the wage has been set by the union, the firm reads off the labor demand curve how many workers to hire at the given wage (Booth, 1995). Neither of these two models is Pareto efficient, as either party to the agreement can be made better off without making the other worse off by bargaining also over employment. This brings us to the efficient bargaining model; in this model both wages and employment are determined simultaneously in the bargaining process and, unlike the other two models, this model is efficient.

Traditionally the two competing models of bargaining, monopoly union and efficient bargaining, have been treated as separate models (see, for example, McDonald and Solow, 1981). In this chapter I make use of the collective bargaining model set forth by Manning (1987). In his paper, Manning introduces a sequential framework for bargaining in the private sector, bargaining separately over wages and employment. In his formulation it is possible to distinguish between the different collective bargaining models discussed above: right to manage and efficient bargaining.

In his sequential bargaining framework, Manning considers both the model where the two sides to the bargaining bargain first over employment and then over wages as well as when the bargaining is first over wages and then over employment. When the union and employer bargain first over employment, Manning shows that the level of employment will be such that the marginal product of labor equals the alternative wage and thus, the contract is socially efficient. If the union and

employer bargain over wages first and then over employment, the result of the bargaining can be classified as right-to-manage or efficient contracting, depending on the parameters of the model. If the result of the bargaining does not qualify for either of the other results, Manning labels the result inefficient contracting. A special case of efficient contracting is strong efficiency as described by Brown and Ashenfelter (1986) which implies that employment is only based on the alternative wage.

Although bargaining first over employment and then over wages gives a socially efficient outcome, the reverse can be considered more realistic in the case of the public sector in Iceland as the contract duration is usually around three years, while employment fluctuates throughout the duration of the contract. Union contracts all stipulate wages while only a handful have any stipulations on employment levels. Thus it is reasonable to assume that the bargaining power of the union could differ between the wage bargain and the employment bargain.

Trade union models usually focus on bargaining in the private sector where the employers' objectives are profit maximizing. Few attempts have been made to model bargaining in the public sector and there is no universally accepted model of how unions and government engage in bargaining (Hosken and Margolis, 1997). A few papers in the literature have extended the general model of collective bargaining to the public sector such as Currie (1991), Hosken and Margolis (1997) and Falch (2001).

Many models of bargaining rely on the presence of a threat point for both the employer and the union in the determination of the equilibrium contract. The threat points are usually the zero profit level for the firm and the value of time evaluated at the alternative wage for union workers (Abowd and Lemieux, 1993). However, in the public sector it is not clear that such a firm threat point exists for the employer. This implies the absence of the "zero profit condition" which is usually present in modelling collective bargaining in the private sector. Instead, outlays in the public sector depend on a budget allocated each year. Thus, there is little incentive to bargain tough with the unions and therefore wages might be higher than they would otherwise be as the budget can be sidestepped. Profit maximization is unlikely to be the objective of institutions or ministries in the public sector. Total available income limits the production in the public sector as opposed to product or service demand in the private sector. Public sector employees are also voters and through the political process might seek to increase the demand for their services. The effect of strikes in the public sector, however,

may be less than in the private sector as governments continue to receive tax revenues while in the private sector no revenue is received while production is halted (Freeman, 1986).

Only a few papers have been published estimating the structure of collective bargaining in the public sector. Eberts and Stone (1986) and Currie (1991) both look at teachers, Eberts and Stone in New York State and Currie in Canada. Falch and Ström (2006) look at the effects of decentralization of bargaining in local governments in Norway. Falch (2001) expands the Manning sequential bargaining model to include a third step which is the determination of the public sector budget.

Eberts and Stone (1986) use an efficient bargaining framework to test collective bargaining agreements made by teachers in New York State. The data is from New York Department of Education for the school years 1972-1973 and 1976-1977. They set up two competing models, a demand constraint model and a contract curve model. The results show a strong support for the contract curve model.

In her paper, Currie (1991) studied the contracts of school teachers in Ontario, Canada. She uses contract data from 1975-1983 and estimates different versions of her model, both a standard model and a reduced form model, with and without fixed effects. The results suggest that employment contracts are strongly efficient. However, she is not able to reject the monopoly union model.

Falch and Ström (2006) study decentralization of wage agreements in local governments in Norway. Decentralization of wage bargaining should, according to the competitive model, increase pay differences and enhance efficiency as decentralized decisions on pay issues moves the local wages toward their competitive levels. However, according to Falch and Ström observation and previous research suggest that public sector labor markets are not well described by the competitive model. Union influence and monopsony power are often considered important factors in the public sector. Thus, the outcome of decentralization in the public sector is an empirical question. Using individual earnings equations they find that with decentralization, a higher budget means higher wages. Thus, the effect of budget size on wages increases as wage setting is decentralized. They also find that wage differences increased somewhat as the wage setting was decentralized and local wages came more responsive to the local budget.

Falch and Ström conclude their paper by conjecturing that common arguments on the expected efficiency gains from increased local flexibility in wage setting in

public institutions may be exaggerated, as the actual wage setting process seems to be influenced by local unions, local interest groups, local monopsony power as well as pay equality norms which only change slowly through time.

Falch (2001) follows the Manning model of sequential bargaining while applying it to the public sector. He uses a model with two inputs, labor and non-labor and a Cobb-Douglas production function. Instead of two stage bargaining in the manner of Manning, he added the third stage and solved with backwards induction. The third stage in the bargaining is when the government budget is decided. Thus, he looks at different regimes. In the first regime the first stage of the bargaining is where the union and employer bargain over employment, in the second stage they bargain over the wage and in the third stage the budget is determined. The second regime discussed in the paper is where employment is determined first, then the budget and lastly the wage. Finally, Falch looks at the case where the budget is determined first, then employment and wages last.

The first regime is shown to lead to efficient bargaining as the outcome is on the contract curve. In the second regime, the wage is increasing in the budget size, which was shown empirically to be the case in Falch and Ström (2006). In general, the sign of the slope of the contract curve is independent of the timing of the budget decision. Furthermore, the wage is independent of the timing of the budget decision as long as nothing happens between the wage and employment bargains and if the budget is determined before the bargain, the employment level is lower than it otherwise would be.

Hosken and Margolis (1997) use Manning's model as they test collective bargaining agreements of teachers in public schools in New York State in 1983, 1986 and 1989. Using two stage sequential bargaining over employment and wages on public sector data they estimate union power over wages and employment. According to their findings the union power varies depending on the bargaining model applied, i.e. whether it is assumed to be monopoly union, right to manage, efficient contracting or inefficient contracting. In the least constrained case, Hosken and Margolis find that the union bargaining power of wages is 0.53 while the union bargaining power over employment is higher or 0.71.

According to their results, teachers in public schools in New York State do not engage in monopoly union or right to manage style bargaining. Most of them do not engage in efficient contracting either. Thus, the results suggest that the outcome of the bargaining is not Pareto efficient.

4. Modelling bargaining in the public sector

4.1. The bargaining model

In the manner of Manning (1987), collective bargaining is modeled here as a two-stage process. In the first step, the employer and the union bargain over wages and in the second over employment. The equilibrium is derived by solving the model using backwards induction. First the equilibrium employment level is found (the second stage) conditional on the outcome of the negotiated wage level (the first stage). Then the equilibrium wage bargain is derived given that both parties know how this wage will affect the subsequent employment bargain.

Using a formal representation, in the second stage of the bargain when w has already been determined, employment will be chosen to solve the following problem:

$$\max_L (1 - q) \log V(w, L) + q \log U(w, L) \qquad (1.)$$

Where q is the union power over the employment determination, $0 \leq q \leq 1$, V is the objective function of the employer and U is the objective function of the union, w is the wage level and L is the employment level. This problem will yield a solution $L(w, q)$, which is assumed to be unique.

In the first stage of the sequential bargain, when the wage level is determined, the wage, w, will be chosen to solve:

$$\max_w (1 - p) \log V[w, L(w, q)] + p \log U[w, L(w, q)] \qquad (2.)$$

Where p is the union power over the wage determination, $0 \leq p \leq 1$. The model assumes that union power can vary between the wage determination and employment determination, i.e. p does not have to equal q.

The different outcomes of the bargaining process can all be incorporated in this model. In the right to manage model, the union and employer bargain over wages and then the employer chooses the employment level. In terms of the model, this implies that $0 \leq p \leq 1$ and $q = 0$. The monopoly union model is a special case of the right to manage model where $p = 1$ and $q = 0$.

In the case of efficient bargaining, the union has equal power over the wage determination and the employment determination. In that case $p = q$ and the model becomes:

$$\max_{w,L} (1 - p) \log V[w, L(w, p)] + p \log U[w, L(w, p)] \qquad (3.)$$

The model cannot be estimated without assuming some functional form for the objective functions for the employer and the union. Thus the results are not independent of the assumptions made on the functional forms. In this paper, the employer is the central government of Iceland, while the union is one of the public sector unions.

In the absence of a universally accepted form for the employer's objective function in the public sector, I borrow the employer's objective function from the private sector and use a Cobb-Douglas production function and the objective of profit maximization, similar to Hosken and Margolis (1997) and Falch (2001). Thus, the employer's objective function is defined as

$$V(w, L) = \gamma L^\alpha - wL \qquad (4.)$$

where L is the employment level, γ is a constant and α is the returns to scale. A value of α between 0 and 1 implies decreasing returns to scale, while $\alpha = 1$ implies constant returns to scale and $\alpha > 1$ suggests increasing returns. As the model will be applied to the public sector, an option would have been to add the budget and thus the third stage to the bargaining in the manner of Falch (2001). However, in the case of the public sector in Iceland, collective bargaining takes precedence over the budget. Thus, if the total cost of the bargain exceeds the allocated budget, the difference will be added to the budget.

The union objective function is defined as:

$$U(w, L) = L(w - b) \qquad (5.)$$

Where b is the alternative wage or opportunity wage of a union member. Using backwards induction, equilibrium is found by first solving for employment and then for wages. The equilibrium level of employment (L) conditional on the negotiated wage (w) is found by solving the Nash cooperative bargaining game over employment, which is equivalent to solving:

$$\max_L (1 - q) \log(\gamma L^\alpha - wL) + q \log(L(w - b)) \qquad (6.)$$

This can be solved for L and given the solution we can close the model by solving the Nash cooperative bargaining game over wages. This is equivalent to solving:

$$\max_w (1 - p) \log\big(\gamma L(w, q)^\alpha - wL(w, q)\big) + p \log(L(w, q)(w - b)) \qquad (7.)$$

Where the solution to the second stage is substituted in for L, and p is not necessarily equal to q.

The level of employment that satisfies the first order conditions for an interior solution of equation (6) is:

$$L = \left(\frac{w}{\gamma(\alpha - q\alpha + q)} \right)^{\frac{1}{\alpha - 1}}$$

(8.)

Solving the Nash cooperative bargaining game over wages given the employment level gives:

$$w = b \left[\frac{\alpha - \alpha p + p}{\alpha} \right]$$

(9.)

Note that q, the bargaining power over employment is not a factor in the wage equation. Furthermore, the wage, w, is an increasing function of the alternative wage, b. The wage, w, is also increasing in p, when $\alpha < 1$.

Finally, substituting equation (9) into equation (8) yields:

$$L = \left[b \frac{1}{\gamma} \frac{\alpha - \alpha p + p}{\alpha(\alpha - \alpha q + q)} \right]^{\frac{1}{\alpha - 1}}$$

(10.)

4.2. Implications of the model

The different collective bargaining models discussed above are special cases of the model depending on the values of the parameters p and q.

The right-to-manage model implies that $0 \leq p \leq 1$ and $q = 0$, giving the solution:

$$L = \left(\frac{w}{\gamma\alpha} \right)^{\frac{1}{\alpha - 1}}$$

(11.)

$$w = b \left[\frac{\alpha - \alpha p + p}{\alpha} \right]$$

(12.)

The monopoly union model implies that $p = 1$ in the right-to-manage model.

If $p = q$ the contracts are efficient, that is the negotiated agreement is on the contract curve given by the state's and the union's preferences. In the efficient bargaining model, the solution is:

$$L = \left(\frac{w}{\gamma(\alpha - p\alpha + p\gamma)} \right)^{\frac{1}{\alpha - 1}}$$

(13.)

$$w = b \left[\frac{\alpha - \alpha p + p}{\alpha} \right] \tag{14.}$$

If $p \neq q$ we observe inefficient contracting, that is the wage/employment combination is off the contract curve and off the demand curve as well and the solution is identical to the original solution to the problem.

4.3.   Estimating the model

To estimate the model, equations (9) and (10) are transferred into log form and an error term is added:

$$logL = \left(\frac{1}{\alpha - 1} \right) [logb - \log \gamma - log(\alpha - q\alpha + q) \tag{15.}$$
$$+ \log(\alpha - \alpha p + p) - \log(\alpha)] + \varepsilon$$

$$logw = logb + log(\alpha - \alpha p + p) - \log(\alpha) + \zeta \tag{16.}$$

Before the model can be estimated some simplifying assumptions have to be made. The variables p, q, γ and α are not directly observable. Therefore, some assumptions have to be made in order to estimate these variables. The following approximating functions are defined to estimate the variables using observable characteristics. As p and q take values between 0 and 1, the functional form as shown in equations (17) and (18) is chosen so as to generate values between 0 and 1.

$$p = \frac{e^{z_1 \beta_1}}{1 + e^{z_1 \beta_1}} \tag{17.}$$

$$q = \frac{e^{z_2 \beta_2}}{1 + e^{z_2 \beta_2}} \tag{18.}$$

The functions allow the bargaining power for wages and employment to vary. As there is no a priori reason to believe that there are factors that affect the bargaining power over employment and not the bargaining power over wages or vice versa, the vector of variables used to explain p and q will be the same in the estimation. Thus,

$$z_1 = z_2 \tag{19.}$$

The employment characteristic γ is approximated using a vector of characteristics, x.

$$\gamma = x^{'}\delta \tag{20.}$$

The error term in the equations represent omitted variables, for instance missing information on the individuals, especially better information on education; measurement error in the included variables; unobserved heterogeneity on both the individuals and the institutes as well as any effects if functional form is not correct and assumptions given before the estimation do not hold.

5.   The data set

The data were supplied by the Ministry of Finance in Iceland. The data set consists of information on all wages paid by the central government to members of the public-sector unions.

The data used in this study are wages paid in October of each of the years 1994 to 1997 and again in October of 2001 to 2004. The years 1994 through 1997 are the 4 years leading up to the changes made to the collective bargaining agreements, and the period 2001–2004 represents 4 years after the changes were implemented for those unions that adopted the new scheme in the negotiating round of 1997–1998. The number of individuals in the sample each year ranges from 11,100 to 14,300.

The wage measures used are total earnings and base wages. Total earnings are the sum of all wages paid to the individual, base wages, and all other types of wages. The base wage is the wage paid for a normal working day without any extra payments, presented as a share of full-time work. To reduce the effect of different working hours in comparing base wages, all base wages are adjusted to reflect full-time work. On the other hand, there is no reliable measure of the amount of work behind total earnings, but in many cases it provides better information on wages as extra payments are often paid for a regular days work. Thus, there are advantages and disadvantages to both wage measures and thus, both are included. All wage figures are presented using the 2004 price level. Thus any wage changes shown reflect real wage changes.

The data on individuals is transformed into data on each bargaining unit when estimating the bargaining model. The bargaining unit is defined as each pair of union and ministry or institute that sign an institutional agreement. There can be many unions in a single institute and a single union can be present in many institutes. There are 3,780 bargaining pairs in the period 1994-1997 and 3,963 in

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the period 2001-2004. Table 1 shows the mean and standard deviation of the variables used in the regressions.

Table 1. Descriptive statistics

	1994-1997		2001-2004	
	Mean	St.dev.	Mean	St.dev.
log base wages	11.7828	0.2018	12.2985	0.2591
log total earnings	12.0470	0.4700	12.4411	0.4306
log alternative base wage	12.0322	0.3007	12.2416	0.5932
log alternative total earnings	10.6708	0.2766	12.4585	0.3628
average age	43.5183	8.7840	44.9403	8.0864
year 1	0.2394	0.4268	0.2549	0.4358
year 2	0.2537	0.4352	0.2602	0.4388
year 3	0.2513	0.4338	0.2526	0.4346
year 4	0.2556	0.4362	0.2324	0.4224
size of union	606.6677	585.4782	788.3169	955.3626
female share in union	57.1280	29.4580	60.1208	25.7892
part time share union	26.6909	19.8418	26.1546	19.1058
choice	0.7069	0.4553	0.7552	0.4300
federation bsrb	0.4503	0.4976	0.3954	0.4890
federation bhm	0.4257	0.4945	0.4855	0.4999
federation ki	0.0386	0.1927	0.0353	0.1846
outside federations	0.0854	0.2796	0.0838	0.2771
no strike	0.1336	0.3403	0.1408	0.3479
size of institute	51.9267	72.6559	65.5686	89.7195
average budget	5.3707	7.5520	13.4282	35.6798
N	3,780	-	3,963	-

The variables used are *log of base wages* and *log of total earnings* as described above. The *alternative wage*, both base wage and total earnings, is estimated using a data set from the private sector supplied by Statistics Iceland. The estimate was found by running a human capital regression on the private sector data and using the results to estimate what wages each public sector worker could expect if he were to move to the private sector given his characteristics. That is his measure of the alternative wage.

The *average age* shows the average age of the people forming the bargaining unit. I use *year dummies* to indicate each year. *Size of union* shows the number of individuals belonging to the union. *Female share in union* shows the share of women in the union. Unions with majority women might have different bargaining power than a union with majority men. *Part time share union* shows to what extent members of the union in question work part time. Depending on the type of specialization or education, some public sector employees would easily find a job outside the public sector, while others, nurses for instance, would find it hard. The dummy variable *choice* tries to catch this effect.

Most of those employed by the central government in Iceland belong to one of approximately 100 unions that bargain with the Ministry of Finance. Public-sector employees have separate organizations from those in the private sector. All central-government contracts are negotiated between each union and the State Negotiation Committee (SNR) on behalf of the Minister of Finance. The unions either belong to one of three federation, *BSRB*, *BHM* or *KI* while a few unions operate outside the federations. The data set does not include data on education. As the division into federation is in line with the education of the members, the dummies on federation serve as education dummies as well as federation dummies.

Most public sector workers are allowed to strike. Some however, including policemen, customs officers, prison guards, high level government workers and judges, are not allowed to strike. This is reflected in the *no strike* variable.

Finally there are variables for the institution. The *size of the institute* shows the number of individuals employed and the *average budget* shows the budget allocation for general operations for the institute in question divided by the number of full time equivalent employees.

6.   Estimating the bargaining model

To determine which of the bargaining models discussed in Section 3 is used in the public sector bargaining environment in Iceland, I estimate the bargaining model described in Section 4.

To estimate the structural model described in equations (15) and (16) in section 4, I use feasible generalized nonlinear least squares on a system of nonlinear equations (nlsur in Stata). The model is estimated using a different set of restrictions to match the different bargaining models as well as the simplifying assumptions described in the previous section.

Here, union power is defined as a function of the size of the union, share of women in the union, share of employees working part time in the union, the average age of union members in the workplace in question, a dummy variable indicating whether alternative employment options are readily available or not, dummy variables indicating the union federation, a dummy variable indicating whether the union has the right to strike or not, the size of the institute, the budget per employee in the institute and dummy variables indicating the years. The value of γ is estimated using the age of the union members in the workplace in question and dummy variables indicating the years.

In addition to estimating the unconstrained model, the model is estimated under the restriction of the right to manage model, i.e. where the union power over employment, q, is set equal to zero. The model is also estimated using the restriction of efficient bargaining, i.e. with the bargaining power over wages set equal to the bargaining power over employment or $p=q$.

The structural model is estimated for both wage measures, base wages for fulltime work and total earnings. The model is also estimated for each of the two time periods in question. Finally, an estimate of p and q is calculated by estimating $\hat{p}$ and $\hat{q}$ for each observation according to equations (17) and (18) and for each restriction on the model. The estimates of p and q reported are the mean of the $\hat{p}s$ and the $\hat{q}s$ across the bargaining units.

6.1. Unrestricted model

In the first specification of the structural model there are no restrictions on the estimation. Thus, the estimates of p and q are allowed to be different from each other. The results can be seen in table 2.

Table 2. Unrestricted model
Standard errors in parenthesis.

	Base wages		Total earnings	
	1994-1997	2001-2004	1994-1997	2001-2004
alfa	0.6993	0.0000	1.1135	0.9990
	(0.0082)	(0.0000)	(0.0152)	(0.0000)
alternative wage (empl. eq.)	0.3874	-0.9506	-0.0228	-0.0009
	(0.0236)	(0.0103)	(0.0087)	(0.0000)

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constant (γ)	-237.8626	-35.9576	1.1544	0.9843
	(77.0995)	-	(0.0979)	-
age (γ)	19.7988	2.1779	-0.0243	0.0003
	(6.0608)	(0.0463)	(0.0029)	(0.0000)
age-squared (γ)	-0.2136	-0.0236	0.0003	0.0000
	(0.0655)	(0.0008)	(0.0000)	(0.0000)
year 2 (γ)	2.1727	2.6077	0.0041	0.0000
	(3.7769)	-	(0.0040)	(0.0000)
year 3 (γ)	2.4417	1.6489	0.0023	0.0000
	(3.9059)	-	(0.0041)	(0.0000)
year 4 (γ)	4.8195	1.9148	0.0030	0.0001
	(4.2744)	-	(0.0041)	(0.0000)
size of union (q)	0.0086	0.0004	0.0059	0.0042
	(0.0013)	(0.0000)	(0.0011)	(0.0004)
female share in union (q)	-0.0553	-0.0063	-0.1048	0.0701
	(0.0164)	(0.0018)	(0.0264)	(0.0134)
age (q)	-0.2742	-0.0192	-0.4565	-0.8828
	(0.0650)	(0.0099)	(0.1023)	(0.0560)
age squared (q)	0.0024	0.0001	0.0049	0.0129
	(0.0008)	(0.0001)	(0.0012)	(0.0009)
part time share union (q)	0.0358	0.0032	0.1049	-0.3092
	(0.0214)	(0.0022)	(0.0330)	(0.0402)
choice (q)	-6.3952	-0.3835	3.8754	-1.7724
	(0.9885)	(0.0652)	(0.8830)	-
federation bhm (q)	1.3452	-0.7334	4.2529	-1.1098
	(0.8171)	(0.0734)	(1.0978)	-
federation ki (q)	2.6610	2.1420	9.1787	6.9170
	(1.0758)	-	(1.9524)	-
outside federations (q)	4.8787	-0.5306	2.4796	7.6346
	(1.1936)	(0.1214)	(1.2882)	-
no strike (q)	368.0194	0.4439	-0.9493	7.2722
	-	(0.0838)	(0.6656)	-
size of institute (q)	0.0704	0.0062	0.2521	0.1718
	(0.0096)	(0.0005)	(0.0442)	(0.0114)
year 2 (q)	0.0990	-0.2030	0.2606	-0.3207
	(0.5179)	(0.0645)	(0.5977)	-
year 3 (q)	0.3887	-0.1144	0.4851	-0.2457
	(0.5158)	(0.0652)	(0.5988)	-
year 4 (q)	0.0605	-0.1248	0.1101	-1.1271
	(0.5115)	(0.0679)	(0.5962)	-
average budget (q)	0.0287	-0.0036	-0.0505	-0.0613
	(0.0213)	(0.0006)	(0.0296)	(0.0265)
size of union (p)	0.0004	0.0000	-0.0217	-0.0086
	(0.0001)	(0.0000)	(0.0008)	(0.0009)
female share in union (p)	0.0453	-0.0008	0.2653	-0.0739
	(0.0046)	(0.0005)	(0.0208)	(0.0193)

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age (p)	-0.0469	0.0056	0.3575	-0.8274
	(0.0148)	(0.0045)	(0.0989)	(0.0539)
age squared (p)	0.0002	0.0000	-0.0038	0.0102
	(0.0002)	(0.0000)	(0.0014)	(0.0010)
part time share union (p)	0.0111	-0.0033	-0.1647	0.1977
	(0.0058)	(0.0006)	(0.0349)	(0.0288)
choice (p)	-1.6605	-0.2021	19.9100	4.8331
	(0.1639)	(0.0263)	(1.5873)	-
federation bhm (p)	-3.0462	0.9631	-3.2639	19.0179
	(0.2391)	(0.0777)	(1.6358)	-
federation ki (p)	-26.8823	0.5529	-0.6792	9.3542
	-	(0.0604)	(1.7987)	-
outside federations (p)	-0.0220	1.5900	8.8246	14.6256
	(0.2987)	(0.2008)	(2.0594)	-
no strike (p)	2.9887	-0.0138	-41.0900	-6.5153
	(0.2757)	(0.0247)	-	-
size of institute (p)	-0.0148	-0.0006	-0.1200	-0.0011
	(0.0015)	(0.0001)	(0.0061)	(0.0027)
year 2 (p)	0.2144	0.1089	0.3110	0.4299
	(0.1424)	(0.0197)	(0.8525)	-
year 3 (p)	0.0460	0.1836	-0.4238	0.4792
	(0.1415)	(0.0228)	(0.8303)	-
year 4 (p)	-0.2970	0.2166	-0.0807	0.5532
	(0.1403)	(0.0266)	(0.8112)	-
average budget (p)	-0.0034	0.0003	0.0437	0.1567
	(0.0066)	(0.0002)	(0.0466)	(0.0204)
alternative wage (wage eq.)	0.9689	0.0473	1.1359	0.9985
	(0.0004)	(0.0050)	(0.0011)	(0.0003)
R-squared				
Employment eq.	0.5809	0.6243	0.6145	0.6630
Wage eq.	0.9998	0.9998	0.9989	0.9996
Estimate of p	0.3287	0.6622	0.7098	0.5016
	(0.0215)	(0.0291)	(0.0267)	(0.0177)
Estimate of q	0.3774	0.2895	0.6612	0.2951
	(0.0356)	(0.0284)	(0.0382)	(0.0171)

The overall fit is similar between the four regressions. Looking at total earnings, the returns to scale (α) has a value of around one. The alternative wage has a small negative coefficient in the employment equation, while it has a coefficient close to one in the wage equation, except when looking at base wages in the second period.

Looking first at the bargaining power of unions over wages (p), the size of the union has a positive impact on base wages, while a negative impact on total earnings. Having a larger female share in the union has a positive impact in the first period, while a negative impact in the second period. Having an outside choice reduces the bargaining power over base wages, while it increases the bargaining power over total earnings. Not having the right to strike reduces the bargaining power over wages, except for base wages in the first period. The larger the institute, the lower the bargaining power over wages.

The bargaining power of unions over employment (q) increases with the size of the union. The bargaining power decreases with the share of females in the union and increases with the share of part time workers. The exception is total earnings in the second period. The explanation could be the correlation between female share and part time share. Having an outside option for employment reduces the bargaining power over employment, except for total earnings in the first period. Not having the right to strike increases the bargaining power over employment with the same exception. Also, the size of the institute increases the bargaining power over employment.

In this model p and q are allowed to vary and thus, there is a difference between the estimated values on p and q. There is also a difference between the estimated values for p and q between base wages and total earnings. Except for base wages in the first period, the bargaining power of unions over wages is larger than the bargaining power over employment. For base wages in the first period, the estimated values of p and q are quite similar, 0.33 and 0.38 respectively. For total earnings in the first period the estimated values of p and q are 0.71 and 0.66. Thus, in the first period, the bargaining power of unions seems to be higher when it comes to total earnings than base wages. The reverse is true in the second period, when the bargaining power over wages is smaller for total earnings than for base wages (0.50 compared to 0.66). The bargaining power over employment is similar for total earnings and base wages in the second period (0.30 compared to 0.29).

Based on these estimates, it is unlikely that $q=0$. It is, however, possible that $p=q$, especially in the first period. In those two cases, the estimates of p and q are easily within two standard deviations of each other. These possibilities will be explored further in the next two sections, when these restrictions will be imposed on the model.

6.2. Restricting the model to be right to manage ($q=0$)

In the right-to-manage model and the monopoly union model, the union power over employment, q, is equal to zero. It depends on the value of p, which model applies. If p is significantly lower than one, we have the right to manage model. However, if p is not significantly different from one, we have the monopoly union model. In this specification, the result of which can be seen in table 3, q is forced to be equal to zero, which is equivalent to imposing a labor demand model on the data.

Table 3. Restricted model where $q=0$
Standard errors in parenthesis.

| | Base wages | | Total earnings | |
	1994-1997	2001-2004	1994-1997	2001-2004
alfa	0.6944	8.4E-01	1.0136	1.0975
	(0.0071)	(0.0179)	(0.0139)	(0.0089)
alternative wage (empl. eq.)	0.5550	0.0810	-0.0072	0.0758
	(0.0046)	(0.0100)	(0.0073)	(0.0082)
constant (γ)	-2673.3640	-0.6912	0.9860	3.5593
	-	(0.7099)	(0.0192)	(0.4245)
age (γ)	200.0133	0.2314	-0.0042	-0.0699
	(3.7749)	(0.0659)	(0.0038)	(0.0121)
age-squared (γ)	-2.1705	-0.0025	0.0000	0.0008
	(0.0450)	(0.0007)	(0.0000)	(0.0001)
year 2 (γ)	36.0524	0.0477	0.0003	0.0064
	(29.2727)	(0.0375)	(0.0007)	(0.0097)
year 3 (γ)	67.5771	0.0618	-0.0005	0.0044
	(30.1601)	(0.0397)	(0.0008)	(0.0097)
year 4 (γ)	112.7157	0.1055	-0.0007	-0.0152
	(30.4947)	(0.0478)	(0.0009)	(0.0101)
size of union (q)	-	-	-	-
	-	-	-	-
female share in union (q)	-	-	-	-
	-	-	-	-
age (q)	-	-	-	-
	-	-	-	-
age squared (q)	-	-	-	-
	-	-	-	-
part time share union (q)	-	-	-	-
	-	-	-	-

choice (q)	-	-	-	-
	-	-	-	-
federation bhm (q)	-	-	-	-
	-	-	-	-
federation ki (q)	-	-	-	-
	-	-	-	-
outside federations (q)	-	-	-	-
	-	-	-	-
no strike (q)	-	-	-	-
	-	-	-	-
size of institute (q)	-	-	-	-
	-	-	-	-
year 2 (q)	-	-	-	-
	-	-	-	-
year 3 (q)	-	-	-	-
	-	-	-	-
year 4 (q)	-	-	-	-
	-	-	-	-
average budget (q)	-	-	-	-
	-	-	-	-
size of union (p)	-0.0001	-0.0112	-0.0214	-0.0923
	(0.0001)	(0.0038)	(0.0007)	(0.0038)
female share in union (p)	0.0447	-0.1055	0.1692	-0.7974
	(0.0044)	(0.0470)	(0.0236)	(0.0741)
age (p)	0.0033	0.6384	1.0850	-2.3103
	(0.0141)	(0.2302)	(0.0485)	(0.1577)
age squared (p)	-0.0004	-0.0075	-0.0119	0.0389
	(0.0002)	(0.0028)	(0.0008)	(0.0023)
part time share union (p)	0.0081	1.5479	0.1991	2.2719
	(0.0058)	(0.5308)	(0.0429)	(0.1071)
choice (p)	-1.4055	-9.1306	2.4800	26.9748
	(0.1452)	(3.6872)	(0.6762)	(1.6167)
federation bhm (p)	-3.3678	34.2306	-19.1435	68.8825
	(0.2623)	(11.8395)	(0.7917)	-
federation ki (p)	-10.5869	-18.5786	-27.1805	5.3691
	-	(6.4647)	-	-
outside federations (p)	-0.8771	167.3566	-18.9460	30.5541
	(0.2826)	-	(0.9187)	(2.4398)
no strike (p)	1.9923	-8.3576	-8.9622	-34.0236
	(0.2174)	(3.2409)	(0.6239)	(2.1639)
size of institute (p)	-0.0211	-0.2738	-0.1897	-0.2200
	(0.0019)	(0.0931)	(0.0092)	(0.0099)
year 2 (p)	0.2393	1.3538	0.1862	-0.5775
	(0.1420)	(1.1931)	(0.6993)	(1.7042)
year 3 (p)	0.1022	0.8644	0.2477	0.2231
	(0.1421)	(1.1469)	(0.7070)	(1.6310)

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year 4 (p)	-0.2352	1.9333	0.7077	0.8686
	(0.1413)	(1.3962)	(0.7166)	(1.6630)
average budget (p)	-0.0116	0.0023	0.0295	1.1227
	(0.0069)	(0.0378)	(0.0443)	(0.0564)
alternative wage (wage eq.)	0.9684	0.9910	1.1297	1.0026
	(0.0004)	(0.0016)	(0.0011)	(0.0005)
R-squared				
Employment eq.	0.4893	0.5002	0.5629	0.6004
Wage eq.	0.9998	0.9982	0.9989	0.9996
Estimate of p	0.3360	0.8217	0.6882	0.5356
	(0.0210)	(0.0196)	(0.0297)	(0.0126)
Estimate of q	-	-	-	-
	-	-	-	-

The overall fit of the model is similar for each of the regressions, while lower than in the unrestricted case with the exception of total earnings in the second period. The returns to scale (α) has a value of around one when looking at total earnings, which is similar to the unrestricted case. The alternative wage has only a small effect in the employment equation, while the coefficient in the wage equation is close to one, which is also in line with the results of the unrestricted model.

The effect of the female share in unions on the bargaining power of unions over wages, given that the bargaining power over employment is zero, is larger for total earnings than for base wages and it changes sign between the two periods. It is positive in the first period, while negative in the second. Similarly, the effect of a higher share of part time workers in a union on union bargaining power is larger in the second period than in the first and also larger for total earnings than for base wages. The effect of having an outside choice for employment is negative on base wages, while positive for total earnings and not being allowed to strike has a negative impact on the bargaining power of unions over wages, except for base wages in the first period. The effect of the size of the union on the bargaining power of wages turns out to be negative when restricting q to be zero. On the other hand, the larger the institute, the smaller is the union power over wages. The average budget does not affect union power over wages, except in the second period when determining total earnings.

With q being set equal to zero, p is estimated to be 0.34 for base wages in the first period while much higher in the second period, or 0.82. Looking at total earnings,

the difference is much smaller as the bargaining power of unions over wages (*p*) is estimated 0.69 in the first period while falling down to 0.54 in the second.

6.3.   Restricting the model to efficient bargaining (*p=q*)

In this specification, the bargaining power of unions over wages is set to be equal to the bargaining power of unions over employment. This imposes the efficient bargaining model on the data. The results of this specification can be seen in table 4.

Table 4. Restricted model where *p=q*
Standard errors in parenthesis.

	Base wages		Total earnings	
	1994-1997	2001-2004	1994-1997	2001-2004
alfa	0.0007	6.46E-06	0.0127	1.8650
	(0.0001)	(0.0000)	0.0037	(0.0744)
alternative wage (empl. eq.)	-0.0691	-0.5153	0.1145	0.4791
	(0.0102)	(0.0057)	0.0276	(0.0052)
constant (γ)	-4033.5100	-2182.9370	-1686.0210	918.2096
	-	-	-	-
age (γ)	267.7689	139.3654	112.9845	-37.4103
	(2.4371)	.	2.2870	(0.4598)
age-squared (γ)	-2.9571	-1.5254	-1.2491	0.4061
	(0.0392)	(0.0106)	0.0300	(0.0068)
year 2 (γ)	-52.8368	37.3454	-25.3648	0.8034
	-	-	34.2507	(3.3893)
year 3 (γ)	-54.9053	-22.6138	-20.1047	0.1889
	-	-	35.8497	(3.3940)
year 4 (γ)	43.9986	4.6733	17.7751	-2.4634
	-	-	32.2908	(3.3873)
size of union (q)	-0.0003	0.0000	-0.0003	-0.0024
	(0.0001)	(0.0000)	0.0001	(0.0006)
female share in union (q)	0.0185	-0.0002	0.0047	-0.0352
	(0.0019)	(0.0006)	0.0025	(0.0105)
age (q)	0.0677	0.0242	0.0612	0.3754
	(0.0080)	(0.0026)	0.0091	(0.0806)
age squared (q)	-0.0006	-0.0002	-0.0007	-0.0045
	(0.0001)	(0.0000)	0.0001	(0.0009)
part time share union (q)	-0.0138	-0.0061	-0.0241	0.3761
	(0.0035)	(0.0008)	0.0036	(0.0805)

choice (q)	-0.7779	-0.2555	-0.1384	-6.9432
	(0.1231)	(0.0324)	0.0813	(1.9380)
federation bhm (q)	0.9199	1.2667	-0.0926	0.4361
	(0.1279)	(0.0447)	0.0885	(0.5300)
federation ki (q)	-0.2275	0.9031	-0.5043	55.9294
	(0.1541)	(0.0860)	0.1490	-
outside federations (q)	3.8742	74.8451	0.3412	12.4401
	(1.6085)	-	0.2288	-
no strike (q)	124.2113	-0.0292	47.2439	5.6299
	-	(0.0332)	-	(2.1639)
size of institute (q)	-0.0009	-0.0004	-0.0010	-0.0017
	(0.0002)	(0.0001)	0.0003	(0.0011)
year 2 (q)	0.2627	0.1415	0.1358	-0.4124
	(0.0503)	(0.0237)	0.0769	(0.2722)
year 3 (q)	0.3230	0.2342	-0.0349	-0.2241
	(0.0528)	(0.0250)	0.0754	(0.2951)
year 4 (q)	0.4967	0.2869	-0.0533	1.0675
	(0.0595)	(0.0297)	0.0764	(0.4578)
average budget (q)	0.0207	0.0001	0.2702	-0.0121
	(0.0052)	(0.0002)	0.0318	(0.0036)
size of union (p)	-0.0003	0.0000	-0.0003	-0.0024
	(0.0001)	(0.0000)	(0.0001)	(0.0006)
female share in union (p)	0.0185	-0.0002	0.0047	-0.0352
	(0.0019)	(0.0006)	(0.0025)	(0.0105)
age (p)	0.0677	0.0242	0.0612	0.3754
	(0.0080)	(0.0026)	(0.0091)	(0.0806)
age squared (p)	-0.0006	-0.0002	-0.0007	-0.0045
	(0.0001)	(0.0000)	(0.0001)	(0.0009)
part time share union (p)	-0.0138	-0.0061	-0.0241	0.3761
	(0.0035)	(0.0008)	(0.0036)	(0.0805)
choice (p)	-0.7779	-0.2555	-0.1384	-6.9432
	(0.1231)	(0.0324)	(0.0813)	(1.9380)
federation bhm (p)	0.9199	1.2667	-0.0926	0.4361
	(0.1279)	(0.0447)	(0.0885)	(0.5300)
federation ki (p)	-0.2275	0.9031	-0.5043	55.9294
	(0.1541)	(0.0860)	(0.1490)	-
outside federations (p)	3.8742	74.8451	0.3412	12.4401
	(1.6085)	-	(0.2288)	-
no strike (p)	124.2113	-0.0292	47.2439	5.6299
	-	(0.0332)	-	(2.1639)
size of institute (p)	-0.0009	-0.0004	-0.0010	-0.0017
	(0.0002)	(0.0001)	(0.0003)	(0.0011)
year 2 (p)	0.2627	0.1415	0.1358	-0.4124
	(0.0503)	(0.0237)	(0.0769)	(0.2722)
year 3 (p)	0.3230	0.2342	-0.0349	-0.2241
	(0.0528)	(0.0250)	(0.0754)	(0.2951)

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year 4 (p)	0.4967	0.2869	-0.0533	1.0675
	(0.0595)	(0.0297)	(0.0764)	(0.4578)
average budget (p)	0.0207	0.0001	0.2702	-0.0121
	(0.0052)	(0.0002)	(0.0318)	(0.0036)
alternative wage (wage eq.)	0.3829	0.0511	0.7394	1.0463
	(0.0099)	(0.0049)	0.0274	(0.0032)
R-squared				
Employment eq.	0.4380	0.4906	0.4401	0.4914
Wage eq.	0.9999	0.9998	0.9991	0.9996
Estimate of p	0.9252	0.7700	0.8170	0.9647
	(0.0066)	(0.0081)	(0.0164)	(0.0106)
Estimate of q	0.9252	0.7700	0.8170	0.9647
	(0.0066)	(0.0081)	(0.0164)	(0.0106)

As when using the restriction $p=q$, the overall fit of the model is similar between the different regressions. The R-squared values are lower than in the unrestricted case and even lower than in the case of $q=0$.

As in the other two restrictions on the model, the alternative wage has little effect on base wages in the wage equation, while the coefficient is closer to one in the total earnings regressions. The size of the union has a very small negative effect on the bargaining power of unions. The share of females in the union changes sign between the two periods, going from positive to negative as in the case of $q=0$. Here, however, the coefficients are much smaller. Working part time has a negative effect on the bargaining power of unions, except for total earnings in the second period. Having an outside employment option has a negative effect on the bargaining power of unions. Not having the right to strike increases the bargaining power of unions under the restriction of $p=q$, except in the second period when it comes to base wages. Here the size of the institute has very little while negative effect on the bargaining power.

When the bargaining power over employment and wages is restricted to be identical, the bargaining power is lower for total earnings than base wages in the first period, while in the second period the bargaining power is lower for base wages than total earnings. The bargaining power is estimated between 0.77 and 0.96 under the restriction of $p=q$.

6.4.   Structural model estimates

Regardless of the different restrictions placed on the model, it does not seem to affect the explanatory power of the model to any great extent. The estimate of the returns to scale in public services (α) is close to one when looking at total earnings. When looking at base wages, the estimated value in the first period is between 0.6 and 0.7, while it is practically zero in the second period. These estimates hold for the different specifications of the model, except when p and q are restricted to be equal. In that case the estimated value of α is close to zero, except for total earnings in the second period where the value is 1.87.

Table 5. Estimated values for *p* and *q*

Standard errors in parenthesis.

1994-1997		no restrictions	q=0	p=q
Base wages	p	0.3287	0.3360	0.9252
		(0.0215)	(0.0210)	(0.0066)
	q	0.3774	-	0.9252
		(0.0356)	-	(0.0066)
Total earnings	p	0.7098	0.6882	0.8170
		(0.0267)	(0.0297)	(0.0164)
	q	0.6612	-	0.8170
		(0.0382)	-	(0.0164)

2001-2004		no restrictions	q=0	p=q
Base wages	p	0.6622	0.8217	0.7700
		(0.0291)	(0.0196)	(0.0081)
	q	0.2895	-	0.7700
		(0.0284)	-	(0.0081)
Total wages	p	0.5016	0.5356	0.9647
		(0.0177)	(0.0126)	(0.0106)
	q	0.2951	-	0.9647
		(0.0171)	-	(0.0106)

The estimated values for *p* and *q* can be seen in table 5. In the first period, under the old regime, the bargaining power of unions over wages and employment seem to be higher for total earnings than base wages, with the exception of the restriction *p=q*. This is reversed in the second period, when the bargaining power of wages and employment is higher for base wages than total earnings, with the same exception as in the first period.

Hosken and Margolis (1997) found that in the most unrestricted case when looking at teachers' wages, the bargaining power over wages (*p*) was 0.53 and the bargaining power over employment (*q*) was 0.71, which is contrary to my results, where I get similar values for *p* and *q* in the first period and a higher value for *p* than *q* in the second period.

The results for the estimated values of *p* and *q* suggest that in the first period, from 1994 to 1997 it is possible that the bargaining power of unions over wages, *p*, and the bargaining power of unions over employment, *q*, are equal. If I look at two standard deviations from the estimate for *p* and *q*, these ranges coincide. Thus there is a possibility of efficient bargaining in that period. On the other hand, if we look at two standard deviations from the estimate in the period from 2001 to 2004, I find that the ranges do not coincide and therefore it is unlikely that there is efficient bargaining in the second period.

The estimated values for *q* in all cases in the unrestricted case is more than ten standard deviations from zero and thus it is unlikely that *q* equals zero thus reducing the likelihood of the right to manage bargaining model. From the results it therefore looks like the collective bargaining model in the public sector in Iceland moved from being close to efficient to inefficient bargaining. Before concluding that, I will run some tests.

6.5.   Testing the results

Some statistical tests are in order to test the results of the regressions and help to determine which of the bargaining models applies to collective bargaining in the public sector in Iceland.

The first test is to jointly determine whether the individual coefficients in the estimation of *p* and *q* are equal, that is whether $\beta_1 = \beta_2$ in equations (17) and (18). A chi-square test is applied to the four regressions in the unrestricted model and the results are shown in table 6. In each case the null hypothesis of $\beta_1 = \beta_2$ can be rejected.

Table 6. Chi-square test on $\beta_1 = \beta_2$
P-values in parenthesis.

	1994-1997	2001-2004
Base wages	2362094.13	2900.15
	(0.0000)	(0.0000)
Total earnings	9717.21	1976.31
	(0.0000)	(0.0000)

This test places strong restrictions on *p* and *q* and *p* could equal *q* without $\beta_1 = \beta_2$. Still this test suggests that $p \neq q$, and the collective bargaining model therefore not efficient bargaining in any of the cases.

The estimates of *p* and *q* presented in table 5 are based on the average over all bargaining pairs. Now, I would like to see for which bargaining pairs I can reject the null hypothesis of the right to manage bargaining model, that is whether *q=0*, and for which bargaining pairs I can reject the null hypothesis of efficient contracting, or whether *p=q*.

Table 7. T-tests on estimated *q* for each bargaining unit for *q=0*

	t-value	$|t|<1.645$	$1.645 \leq |t| < 1.96$	$1.96 \leq |t|$
Base wages	1994-1997	50	7	42
	2001-2004	0	0	100
Total earnings	1994-1997	30	3	75
	2001-2004	52	8	40

First I calculate the fitted values for *q* and standard deviation in the unrestricted model. I then calculate t-values for each observation. The results are shown in table 7. Looking at base wages, I cannot rule out the possibility of *q=0* in the first period, while in the second period, the lowest t-value was over 3 and therefore I can conclude with 99% certainty that when bargaining over base wages in 2001-2004, the bargaining power of unions over employment is significantly different from zero. The tables are turned when it comes to total earnings, as 75% of the

bargaining units in the first period have an estimated value for *q* which is significantly different from zero, while in the second period only 40% of the bargaining units showed a t-value above 1.96.

Thus, it is only in the case of bargaining over base wages in the second period that I can reject the labor demand model. It seems to have some merit when bargaining over base wages in the first period and total earnings in the second period. Hosken and Margolis (1997) are able to reject the null hypothesis of *q=0* with 99% certainty in all cases.

Looking at the relationship between *p* and *q* in the unrestricted case, the correlation between the two estimates changes sign between the two periods. From 1994 to 1997 the correlation between *p* and *q* when bargaining over base wages is 0.1554 and 0.0404 for total earnings. In the second period the correlation is negative, -0.3776 for base wages and -0.1539 for total earnings.

To test for the restriction of *p=q* I use bootstrap techniques as the t-distribution is not necessarily appropriate to test whether *p-q=0*. The results can be seen in Table 8.

Table 8. Bootstrap analysis of *p-q*.

	Coef.est.	Bias	Std. err.	90% confidence interval		
1994-1997						
Base wages	-0.1504	0.0036	0.4789	-0.9381	0.6374	N
				-0.9696	0.6220	P
				-1.0000	0.3322	BC
Total earnings	-0.2977	0.1899	0.5655	-1.2279	0.6324	N
				-1.0000	0.9608	P
				-1.0000	0.0239	BC
2001-2004						
Base wages	-0.1619	0.4760	0.2841	-0.6293	0.3055	N
				-0.1753	0.6517	P
				-0.5146	-0.1542	BC
Total earnings	0.7538	-0.6823	0.7106	-0.4150	1.9225	N
				-1.0000	0.9999	P
				-0.0402	1.0000	BC

The estimates were made for *p-q* using 1000 replications clustering over the bargaining unit. Three confidence intervals are reported; N signifies normal confidence interval, P a percentile confidence interval, and BS a bias-corrected confidence interval. The estimate for *p-q* is similar for base wages in both periods, -0.15 in 1994–1997 and -0.16 in 2004–2007. The estimated standard error on both cases is quite large and thus it cannot be ruled out that *p=q*. The estimated coefficient for *p-q,* although similar for base wages between the two periods, changes for total earnings between the two periods. While an estimated -0.29 in the first period, it is 0.75 in the second period; thus it is much less likely that *p=q* in the second period than in the first when it comes to total earnings. This further supports the earlier findings that the collective bargaining seems to be less efficient in the second period than in the first period.

7. Conclusion

This paper develops a model of sequential bargaining over wages and employment in the public sector. Solving the model led to a set of structural equations for wages and employment. To be able to estimate the model, functional forms for the union objective function and the employer objective function had to be defined. In addition some simplifying assumptions were made.

Based on those structural equations the model was estimated using data from the central government of Iceland using both base wages for fulltime work as well as total earnings. The model was estimated using various restrictions implied by the different bargaining models. The unions seem to have a greater bargaining power over employment than over wages, while the bargaining power over wages seems to be much larger when it comes to base wages than total earnings.

Based on the mean of the estimates of *p* and *q*, the bargaining power of unions over wages and employment, respectively, under various restrictions, we can reject the monopoly union and right to manage bargaining models. When looking at individual bargaining units, these models can not be completely rejected. Although the mean estimates of *p* and *q* in the first period indicate that there could be efficient bargaining, the tests suggest that this is probably not the case.

Although the results are not clear cut in terms of the bargaining models applied, I can safely draw the conclusion that the decentralization of bargaining and the change in the collective bargaining agreements has changed the bargaining structure in the public sector in Iceland.

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