ISSN 1503-299X

WORKING PAPER SERIES

No. 6/2015

Resource curse avoidance: Governmental intervention and wage formation in the Norwegian petroleum sector

Jan Morten Dyrstad
Department of Economics
Norwegian University of Science and Technology

Department of Economics

Norwegian University of Science and Technology
N-7491 Trondheim, Norway
http://www.ntnu.edu/econ/working-papers

Resource curse avoidance:
Governmental intervention and wage formation in the Norwegian petroleum sector

By
Jan Morten Dyrstad*

Department of Economics
Norwegian University of Science and Technology
NO-7491 Trondheim, Norway
E-mail: jan.dyrstad@svt.ntnu.no

Revised version October 2015

Abstract

A likely channel for Dutch disease turning a presumably blessing resource windfall into a curse, is the wage formation process. By utilizing the shift from decentralized and uncoordinated wage bargaining in the Norwegian petroleum sector to co-ordinated bargaining, this paper analyzes the effectiveness of a governmental intervention aimed at preventing the extraordinary petroleum wage inflation to become detrimental to the economy. The empirical analysis shows that the intervention was successful as insider weights and insider hysteresis effects were effectively reduced, and that the system of coordinated wage bargaining was re-established. The principal conclusion is that institutions and institutional setting play a crucial role in avoiding adverse economic development.

JEL Classification: O43, J31, J38
Keywords: Resource curse, Wage formation, Insider-outsider forces

---

* I am particularly grateful to Bjarne Strøm and Gunnar Bårdsen for stimulating discussions and comments. I also wish to thank Karin Dyrstad, Frikk Nesje, Martin Seneca, Christa Brunnschweiler Valente, and Simone Valente for valuable comments and suggestions to a previous version of this paper.

1. Introduction

Open economies exploiting natural resources will experience Dutch disease forces.[1] Through the establishing period of her petroleum sector Norway experienced Dutch disease pressure both through the *indirect spending effect* (Bjerkholt *et al*., 1981, Hutchison, 1994, Røed Larsen, 2006) and through the *direct resource movement effect* (Dyrstad, 1987, Brunstad og Dyrstad, 1997). There is consensus of opinion that these natural resources have been a blessing by increasing welfare in the Norwegian society (Bjørnland, 1998, Eika and Magnussen, 2000, Røed Larsen, 2006) but Dutch disease forces could have turned the blessing into a curse. So, Why was the curse avoided?

The answer generally agreed upon is Norway's centralized and coordinated wage formation system. However, coordinated wage bargaining is an incomplete description of wage formation in the Norwegian petroleum sector, because in an important intervening period of its building-up wages in the sector were set locally without coordination.[2]

In the last part of the 1970s Norway experienced growth in petroleum wages which was regarded as a serious symptom of Dutch disease, and as a threat to the whole economy. The harmful wage inflation was by many explained by the right the drilling companies got in 1974 to negotiate and set wages at the local level, which stimulated establishment of plant unions outside *The Norwegian Federation of Trade Unions* (*Landsorganisasjonen i Norge*, hereafter *LO*).[3] So in late 1981 the Government made an extraordinary intervention towards the drilling companies with the aim of bringing growth in petroleum wages in line with the rest of the economy.

The topic of this paper is to investigate the effectiveness of this intervention: Did the intervention have an effect, and if so, through which channels? The answers to these questions give knowledge on how to break a process which possibly could end in Dutch disease and the resource curse.

The effectiveness and channels of the Government's intervention is analysed by estimating wage equations for skilled blue collar workers in the Norwegian petroleum sector within the framework of the insider-outsider model of wage determination: [4] Did the intervention affect the insider and/or outsider factors, and eventually to what degree? The empirical analyses are based on quarterly data covering the time span 1976(3)-1993(3).

---

[1] Corden and Neary (1982) and Corden (1984) are the central references to the Dutch disease literature. Eide (1973) is an early contribution (only available in Norwegian).

[2] The turbulence in this sector is possibly the explanation that it is often excluded from analyses of wage formation on Norwegian data, see, *e.g.*, Langørgen (1993).

[3] *LO* was – and still is – the main federation for unions organizing blue collar workers in Norway.

[4] See, *e.g.*, Lindbeck and Snower (2001).

The paper contributes to the literature in two main ways. First, it is a contribution to the resource curse literature as it analyses empirically the strong forces set in motion in the labour market when a highly profitable resource based industry is established and develops. This paper therefore follows up van der Ploeg's (2011) conclusion in his comprehensive review of the resource curse hypotheses that "More research needs to be directed towards the changing role of institutions […]" (p. 407), and that "It is worthwhile to investigate further the effects of resource dependence on wage formation in competitive and non-competitive labor markets" (p. 409).

Second, the paper contributes to the general wage formation literature. The Government's intervention gives a natural experiment situation, by moving from a bargaining scheme with plant unions and no coordination, to a scheme with coordination if the Government's call was effective. The contribution is twofold. First, using consistently collected data from a period of decentralized bargaining and from a period of possibly coordinated bargaining, new knowledge on centralized *versus* decentralized wage bargaining is gained. Second, the empirical analysis gives new knowledge on insider-outsider forces in wage formation.

Both these questions – the importance of centralization versus de-centralization, and insider-outsider forces in wage formation – were analyzed empirically in a number of papers in the 1990s without any common or general conclusion. [5] A brief review of this literature is given in Section 9.

As background for the paper, the next section presents development characteristics of wages in the petroleum sector and its institutional setting for wage formation. Section 3 gives the theoretical framework for the empirical analysis followed by sections presenting data and an overview of the econometric approach. The point in time in which the Government intervention became effective is analyzed statistically in Section 6. The estimated long run relationship for petroleum wages is presented in Section 7, and the results from the chosen Equilibrium Correcting Mechanism (EqCM) model are given in Section 8. The relevance and empirical consequences of using departure from a long run relationship in the turbulent pre-intervention period is also discussed in Section 8. I discuss the results and state the conclusions in Sections 9 and 10, respectively.

2. Background

The search for oil and gas on the Norwegian continental shelf started in 1966, and the first field expected to be profitable – *Ekofisk*, located 300 kilometres southeast of the town of *Stavanger* in *Rogaland* county – was discovered in 1969. Test production started two years later. The level of oil

[5] More recently Bentolila *et al.* (2012) use the insider-outsider model to analyse the need for reforming the Spanish labour market.

and gas extraction increased sharply from 1975 onwards. Accompanying higher extraction levels, the number of people employed in the petroleum sector also increased. In 1973 about 6,600 people in *total* worked in this and related sectors, of which 12.5 percent were foreigners. Eight years later this number was raised to 45,000, and to 78,200 in 1993.[6]

Figure 1 shows two different graphs of relative wages. The first (seen from left), from the third quarter of 1976 [1976(3)] till the same quarter seventeen years later [1993(3)] (solid line) is log of nominal hourly earnings for *skilled blue collar workers* in the Norwegian petroleum sector minus log of nominal hourly earnings for the same group of workers in Norway's manufacturing industries. These wage rates are obtained from *The Norwegian Employers' Confederation* (*Norsk Arbeidsgiverforening*, hereafter *NAF/NHO*)[7] and are used in the empirical analysis later. The second graph (dotted line) covers the period 1995(1)-2014(2), and shows log of hourly earnings calculated for *all* employees belonging to the national accounts sector *Oil and gas extraction* minus log of the corresponding figures from *Manufacturing industries*.[8] As both the employment groups and the sector definitions differ in these two data sets, the two series are not directly comparable. The national accounts series is included to get a picture of the development in relative wages after the period which is covered by the econometric analysis in this paper.

Figure 1 here

In the beginning of the period petroleum wages was about 35-40 percent higher than in manufacturing industries, which from the view of compensating differentials seems reasonable. However, the gap increased enormously till around 1983-84. In 1984 a change occurs as the gap starts to shrink, and from 1990 it stays almost constant. Looking at the second graph (dotted line), and keeping in mind that the two graphs are not directly comparable, relative wages might have been falling after 1993, too. On average, there is an increase in relative wages for the period 1995(1)-2014(2). For the whole period 1983(2)-2014(2) relative wages decrease possibly indicating a lasting change. The decrease 1983(2)-1993(3) is on average larger than the estimated average for the whole period 1983(2)-2014(2).[9]

---

[6] Directorate of Labor (1999) *Sysselsettingen i petroleumsrettet virksomhet august 1999* (Employment in petroleum directed activities August 1999. My translation.), Report No 6 (November), Oslo. For more details, see Section 4 and the separate Appendix to this paper.

[7] From 1 January 1989 *NAF* became *Norwegian Confederation of Enterprise* (*Næringslivets Hovedorganisasjon, NHO*). *NAF/NHO* is the main organization for private sector's employers in Norway.

[8] Source: *Quarterly National Accounts*, Statistics Norway. This series starts in 1995.

[9] The average decrease 1983(2)-2014(2) is obtained by combining the two data sets, where the five missing observations [1993(4)-1994(4)] are replaced by interpolation based on the observations in 1993(3) and 1995(1).

So, what was going on?

The increased wage gap in the 1970s seems inconsistent with coordinated trade union policies or centralized wage bargaining where "wage increases were limited to the increases in manufacturing sector".[10] A possible explanation of the reduced wage gap could be that wages in the manufacturing industries increased more than petroleum wages. Figure 2 shows graphs of log of nominal hourly earnings for blue collar workers in the petroleum sector (logWO), in manufacturing industries at the (aggregate) national level (logWN), and in manufacturing industries in *Rogaland* county (logWR).[11]

Figure 2 here

It is clear from Figure 2 that the decrease in the wage gap shown in Figure 1 is due to reduced wage growth in the petroleum sector, and not to increased wages in the manufacturing industries. On average, the quarterly growth in petroleum wages is 3.6 percent in the period 1976(3)-1983(1) and 1.4 percent in the period 1983(2)-1993(3), whereas the corresponding figures for manufacturing industries at the national level is 1.8 and 1.9 percent, respectively. The fitted lines for manufacturing industries in *Rogaland* county are not depicted in Figure 2 but the estimated quarterly growth rates are 2.2 percent [1976(3)-1983(1)] and 1.7 percent [1983(2)-1993(3)], *i.e.*, a slightly higher wage growth in the first period, and lower growth rates in the second, as compared to the national growth rates for manufacturing industries.

Another possible explanation could be that the observed increase and subsequent reduction in the wage gap is directly connected to the strong growth of the petroleum sector in the initial years. The number of people employed in firms registered in *Rogaland* county working in the petroleum sector illustrates this development, see Figure 3. Figure 3 shows that petroleum employment grew rapidly in the 1970s but through the 1980s more slowly. In the beginning of the 1990s the increase in employment was even stronger so it is unlikely that the explanation of the wage gap change is primarily related to changes in the petroleum sector's growth.

Figure 3 here

[10] Røed Larsen (2006), p. 621.

[11] *Rogaland* county was – and still is – *the* most important region for the Norwegian petroleum activities. Data on petroleum employment are discussed in detail in Section 4. See also Figure A4 and Figure A5 in the Appendix.

The explanation is more likely to lie in institutional changes for wage agreements. In the following I am primarily referring to changes relevant for blue collar workers, to which the empirical analyses refer.[12] The changes are reasonably separated into three phases.

The first phase, 1966-1973, is characterized by centralized and coordinated bargaining with local adjustments agreed upon in the tariff agreements. In this period one national union, affiliated to *LO*, organized petroleum workers. In 1973 *LO* decided that another union within the confederation should organize petroleum workers. This created dissatisfaction among the petroleum workers, and started a process of establishing alternative unions outside *LO*. The first plant union to appear was *Phillips Petroleum Company Norway Employee Committee*, founded in November in 1973.

The next phase, 1974-1981, is a period of fragmentation and uncoordinated bargaining. It starts with the *LO-NAF* tariff agreement in 1974[13] which implied nominal wage increases for petroleum workers in the range of 23-29 percent.[14] Workers outside the *LO-NAF* area got even higher wage increases through local agreements, and this hastened organizational fragmentation. The period is characterised by a large number of open conflicts between unions and employers, but also competition among the different unions. The employer side also was fragmented as the local agreements differed in many respects.

After years of large annual wage increases for both offshore and on-shore petroleum workers, claims from other sectors were growing accordingly. The aggregate rate of unemployment was still below 2 percent in 1981 but increasing. The rate of inflation was above 10 percent and exposed mainland industries lost international competitiveness. The problems of de-industrialisation and wage contagion from the petroleum sector were focused in public debates. In December 1981 the Government intervened.

The last phase, 1982 onwards, starts with the intervention. On 10 December 1981 the Prime Minister summoned the heads of the four operating companies at that time for a meeting to discuss the challenging situation with high wage inflation. Directly addressed towards the operating companies, the Prime Minister stated that

> "*the Government expects that the oil companies in their activities on the Norwegian shelf follow established Norwegian rules. The consequences of not doing this might be very serious,*

---

[12] This review builds on Smith-Solbakken (1997).

[13] The *LO-NAF/NHO* tariff agreement was – and still is – the main agreement for Norwegian blue collar workers, cf. Rødseth and Holden (1990).

[14] See also Figure 3, p. 245, in Rødseth and Holden (1990), where the *average* over the contract period is estimated to be slightly above 19 percent.

> *both regarding the problems that might arise for the Norwegian society, and the prospects of the companies for a future on the Norwegian continental shelf*."[15]

It was explicitly mentioned that the Government considered proposing laws and other measures to realizing the Government's goals. The plan of the Government was obviously that if the employer side could be pressured into the national wage bargaining scheme, the trade unions would have to follow.

Competition among the different unions continued after this meeting, and even some new unions were established. Strikes and lock-outs did in fact increase, and many negotiations in the petroleum sector were settled by wage boards and arbitration awards. [16]

The intervention was controversial and could be employed to good purpose by, *e.g.*, the political opposition. Hence, one may ask if the threat was credible.

The main argument that the threat was viewed as credible is the existence of a *deeply rooted underlying policy* which the Government forcefully could – or had to – implement to meet economic and political challenges. It is interesting to read the now more than forty year old White Paper on the role of the petroleum activities in the Norwegian society.[17] All of the central issues in today's research literature on the resource curse are discussed in this report, which the Parliament endorsed. The Report is a long-term political declaration that the revenues from the petroleum activities shall contribute to strengthening the Norwegian welfare state – the aim is "to develop a qualitatively better society" (*ibid*, p. 6*).[18] It is worth noting that the title of the first chapter is "Democracy and Control". A number of central policy areas are addressed: Saving versus spending of the huge future petroleum income, the role of fiscal policy, impacts on the labour market and industry policies with corresponding readjustment needs, environmental challenges, etc.

The Report was presented by a Minister of Finance from The Labour party, but the work on the Report started under a conservative government. This illustrates that the Government had professional expertise and administrative agencies that were able to address the important questions, analyze them and propose solutions, and it indicates political consensus.

[15] Smith-Solbakken, (1997), p. 324. My translation.
[16] Smith-Solbakken (1997), p. 277.
[17] St. meld. nr. 25 (1973-74).
[18] The act regulating the Norwegian petroleum activities makes the same statement in its introductory article 1-2. See: https://lovdata.no/dokument/NL/lov/1996-11-29-72#KAPITTEL_1

A second argument that the threat was taken seriously is that centralized wage bargaining in Norway historically is connected to The Labour party, which has very close relations to *LO*. Although the intervening Prime Minister represented The Conservative Party, it was highly unlikely that the opposition in Parliament should utilize the intervention for its own political purposes.

In the next section I present the theoretical framework of the insider-outsider model, and argue that the insider forces should be stronger in Phase II than Phase III, whereas the opposite applies to outsider forces, if the intervention succeeded.

3. Theoretical framework

The empirical analysis is based on the insider-outsider theory.[19] Briefly, in a given firm the insiders are employed as well-paid workers, as opposed to the outsiders who are less paid and want to work in the firm (the entrants). In this paper, the petroleum workers are the insiders, whereas all the other workers with relevant qualifications are the outsiders.

The Norwegian petroleum sector faced a mixed labour market in the 1970s and 1980s. On one hand there was a queue of qualified workers requesting work in the petroleum sector, because the sector paid high wages. Also the income tax was lower for work on some types of platforms, and working conditions, *e.g.*, two weeks on and two weeks off, were regarded as an advantage. On the other hand, for some types of workers the petroleum sector was rationed. For example, the sector experienced high shortage of welders, plumbers, and sheet-metal workers in these years.[20]

Employers in the petroleum sector wanted to hire the best-qualified workers because work in the North Sea is demanding, potentially dangerous, and accidents may have devastating consequences. Well-qualified and trained workers will reduce risks, and with high profitability the firms could also pay high wages. So both employers and employees had a common interest in higher wages than those settled for workers with similar qualifications, for example in the manufacturing sector. This makes the insider-outsider theory particularly relevant, as the central argument for insider power in wage bargaining is the insiders' possibility to gain rents by exploiting turnover costs.[21]

This background points to the efficiency wage hypotheses as well.[22] However, the aim of this paper is not to discriminate between alternative wage formation hypotheses, and theoretically and

[19] A review of the theory is, *e.g.*, given by Lindbeck and Snower (2001).
[20] See Dyrstad (1987) who also presents a theoretical and empirical modelling of this labour market.
[21] See, *e.g.*, Lindbeck and Snower (2001).
[22] The adverse selection model by Weiss (1980), the labour turnover model by Salop (1979) and the shirking model by Shapiro and Stiglitz (1984) could all explain why employers in the petroleum sector wanted to pay wages above the going level in comparable sectors.

empirically reciprocal reinforcement of efficiency wage mechanisms and insider forces due to union-firm bargaining has been ruled out.[23]

The discussion in the following builds on this empirically testable wage equation, outlined from the insider-outsider union-firm bargaining model in Nickell and Wadhwani (1990):[24]

$$(1)\ w_i = \mu_1[va_i + \mathrm{a}\Delta n_i] + \mu_2[wa + bu]$$

The parameters μ_1 and μ_2 are the inside and outside weights, respectively,[25] *i* is index for firm, w_i denotes wage rate, va_i is expected value added, Δn_i is expected change in employment (union membership), wa is the expected alternative wage rate, and u is the aggregate rate of unemployment. The insider weight is the effect on the wage rate of a change in the firm's expected value added, and the outside weight is the effect of a change in the alternative wage.

The first bracket in (1) contains the insider factors which all have a positive impact on the bargained wage, *i.e.*, the firms's ability to pay high wages depends on product prices and productivity (value added), and the trade union's strength depends on union membership or coverage. In a number of empirical papers change in employment, Δn_{it}, is included to capture membership or insider hysteresis effects.[26] The explanation of a positive relation between the bargained wage and Δn_{it} is that an expected increase in employment reduces the probability of being laid off, and *vice versa*. In Holmlund and Zetterberg (1991) lagged employment, n_{it-1}, captures hysteresis effects with a similar interpretation. I will later return to which insider hysteresis variable to use but for the present I am using the Nickell and Wadhwani framework.

The second bracket contains outside factors: Low (high) unemployment and high (low) alternative – or comparison – wage will increase (reduce) the bargained wage by reducing the firm's ability to "recruit, retain, and motivate" workers.

Provided a successful intervention, wage bargaining in the petroleum sector will be coordinated with other sectors thus reducing rent seeking and the importance of insider factors, whereas the importance of outside factors increases.[27]

[23] See Lindbeck and Snower (1987, 1991), and Walsh (2012).
[24] Nickell and Kong (1992), Forslund (1994), and Holmlund and Zetterberg (1991), among others, outline under slightly different conditions similar wage equations.
[25] Relation (1) captures the homogeneity property that follows from the theoretical model in *ibid.*, and the restriction $\mu_1 + \mu_2 = 1$ can be tested statistically.
[26] Δn_{it} follows directly from the assumptions in the theoretical model in Nickell and Wadhwani (1990).
[27] A number of papers argue that decentralized wage bargaining will increase inside power. Holmlund and Zetterberg (1991) build this formally into their wage bargaining model.

Letting D be a dummy variable which equals 1 after the Government's intervention, and zero before, the testing framework may be illustrated by

$$(2) \quad w_i = \mu_1[(1 + D \times m_{10})va_{\mathrm{i}} + (\mathrm{a} + D \times m_{11})\Delta n_i] + \mu_2[(1 + D \times m_{20})wa + (b + D \times m_{21})u]$$

In equation (2) m_{10}, m_{11}, m_{20} and m_{21} capture possible changes in the insider-outsider forces caused by the Government's intervention, so the null hypothesis H_0: $\mu_j \cdot m_{jk} = 0$ (j = 1,2, k =0,1) is testable against the respective alternatives H_1: $\mu_1 \cdot m_{1k} < 0$ and H_2: $\mu_2 \cdot m_{2k} > 0$.

4. Data

The empirical counterparts of the theoretical variables are the following:[28]

wo_t = log average nominal hourly earnings for blue collar workers in the Norwegian petroleum sector, 1976(3)-1993(3),

wa_t = the alternative wage, defined as log average nominal hourly earnings for skilled blue collar workers in manufacturing industries in Norway, 1976(3)-1993(3),

va_t = log value added per employee in the petroleum sector, 1978(1)-1993(3),

u_t = log aggregate (national) rate of unemployment, 1976(3)-1993(3),

no_t = log number of petroleum sector workers in *Rogaland* county, 1976(3)-1993(3), and

$\Delta no_t = no_t - no_{t-1}$.

All the data are quarterly. With the exception of data on value added (va_t), I have data from the third quarter of 1976 [(1976(3)] to the same quarter 17 years later [1993(3)], in total 69 observations.

The *wage rates* (wo_t and wa_t) are obtained from the quarterly wage statistics of *NAF/NHO*, which is the main organisation for firms employing blue collar workers in Norway. *NAF/NHO* was responsible for collecting quarterly wage data for blue collar workers from all its member firms until the middle of the 1990s. *LO* has in all these years accepted the *NAF/NHO* data as basis for the wage negotiations. Data collection was transferred to Statistics Norway during the second half of the 1990s. To be sure that there is a consistently estimated time series (no breaks), the estimation period ends in 1993(3). This is also a period of sufficient length for testing possible effects of the Government intervention.

The number of firms becoming members of *NAF/NHO* has increased over the years, and it is likely that more and more firms belonging to the petroleum sector became members during the 1980s. Relative to the population of *all* firms in Norway, the *NAF/NHO* data base may have an

[28] The Appendix gives more details.

overrepresentation of large firms. If large firms pay higher wages than small firms, an increase in the number of *NAF/NHO* firms could, *ceteris paribus*, contribute to higher wages.

It has not been possible to obtain relevant and reliable wage data for the petroleum sector before 1976(3).

However, it is the lack of quarterly data on *value added* for the petroleum sector (va_t) which at the outset determined the starting point of the empirical analysis, 1978(1). Data on value added are obtained from Quarterly National Accounts, Statistics Norway.[29] Annual data are available before 1978 but the issue in this paper is possible changes in wage formation in a period with a lot of turbulence and dynamics, so I get much more information by using quarterly data.

Important information regarding the adjustment process may disappear in annual data because of aggregation over quarters. This could also potentially harm the econometric modelling because a big change in one quarter will be dampened in the aggregate. If such a change has an effect on petroleum wages it will not be adequately captured by the aggregate variable but will appear as an innovation, thus creating correlation between the explanatory variable and the error term.

The aggregate *rate of unemployment* (u_t) is defined as persons registered as unemployed at the local labour offices (Employment and Seamen's Offices)[30] in percent of the labour force. The labour force is estimated by multiplying quarterly distributed population data from the age group 16-67 years with labour force participation rates obtained from the population and housing census 1970- 1990.[31]

Petroleum employment (no_t) should include those directly engaged in extraction of oil and gas in the North Sea: Underwater operations, search and production drilling, and on-shore bases for the platforms such as transportation, catering, technical support and public services.

I have decided to use *total employment in the petroleum sector in Rogaland* county, the central area for the Norwegian petroleum activities. This decision is discussed in detail in the Appendix but briefly, the reason is that this data set reduces the aggregation problems caused by interpolation using national data, and these data also give the best representation of the primary activities.

[29] See https://www.ssb.no/statistikkbanken/selectvarval/saveselections.asp
[30] *Labour Market Statistics*, Statistics Norway, several volumes.
[31] *Population and Housing Census 1970*, *1980* and *1990*, Statistics Norway. Participation rates in between 1970-1980 and 1980-1990 are obtained by linear interpolation. The rates for the period 1991(1)-1993(3) are obtained by linear extrapolation.

5. Econometric Modelling

The aim of the Government's intervention was to reduce turbulence and (re)establish normal rules for wage formation in the petroleum sector. Hence, the empirical model must adequately capture short run dynamics, as well as departures from possible long run equilibrium. The *Equilibrium-Correcting Mechanism* (EqCM) model is the obvious choice of model.

A *first* step in the modelling procedure regards the point in time the intervention eventually became effective. The Prime Minister's meeting with the heads of the petroleum companies took place in December 1981 but does not imply that the intervention became effective from the first quarter of 1982. After having confirmed also on statistical grounds when a new regime takes over, the *second* step is to estimate a long run equilibrium relationship for wages in the petroleum sector from a vector autoregressive (VAR) model with one co-integrating vector, applying a 'general-to-specific' approach. *Third*, consistent with the estimated long run relationship I derive an EqCM model capturing short run (impact) effects as well as speed of correcting disequilibrium (the feedback effect).

The econometric modelling in step 1 and 2 is based on this general (re-parameterized) autoregressive-distributed lag (ARDL) model for petroleum wages, wo_t, with up to four lags on the explanatory variables va_t, wa_t, u_t and no_t:

$$(3)\quad wo_t = \alpha_0 wo_{t-1} + \sum_{j,i=1}^{4} \alpha_{ji} \boldsymbol{X}^{\mathrm{T}}{}_{t-i} + \boldsymbol{\alpha}_0 \Delta \boldsymbol{Y}_t^{\mathrm{T}} + \boldsymbol{\alpha}_2 \Delta \boldsymbol{Y}_{t-1}^{\mathrm{T}} + \boldsymbol{\alpha}_3 \boldsymbol{\Delta}_2 \boldsymbol{Y}_{t-1}^{\mathrm{T}} + \boldsymbol{\alpha}_3 \boldsymbol{\Delta}_3 \boldsymbol{Y}_{t-1}^{\mathrm{T}}$$

$$+ \sum_{i=1}^{3} \alpha_i Q_i + \alpha_{79} D_{79} + \alpha_{8890} D_{8890} + \, const,$$

where *j* is an index for the explanatory variables va_t, no_t, wa_t, u_t. The variable vectors are defined as $\mathbf{X}_t = [va_t, no_t, wa_t, u_t]$ and $\mathbf{Y}_t = [wo_t, \mathbf{X}_t]$. Δ denotes differencing, so $\Delta Y_t = Y_t - Y_{t-1}$, $\Delta_2 Y_t = Y_t - Y_{t-2}$, and $\Delta_3 Y_t = Y_t - Y_{t-3}$. The parameter vector $\boldsymbol{\alpha}_k$ contains the corresponding parameters, *i.e.*, $\boldsymbol{\alpha}_k = [\alpha_{k,wo}, \alpha_{k,va}, \alpha_{k,no}, \alpha_{k,wa}, \alpha_{k,u}]$ with k = 0, 2, 3, 4. The dummy variables D_{79} and D_{8890} are included to capture possible effects of two wage and price freezes. The quarterly dummies Q_js capture systematic variation over the year due to for instance regular wage negotiations, holidays connected to Easter, summer or Christmas, or other factors. The error term ε_t is assumed to be iid$(0,\sigma_\varepsilon^2)$.

Value added (va_t) and petroleum employment (no_t) are treated as strictly exogenous variables. Value added is the product of petroleum prices determined at the world market, and average labour productivity. Petroleum extraction utilise the best available technology on the world market so productivity is also treated as exogenously given. The location and level of petroleum employment follows from the extraction plan set by the Norwegian Parliament, which depends on the location of the petroleum discoveries. Hence, no_t is strictly exogenous. Furthermore, I assume that wa_t, and u_t are weakly exogenous.

As I am using quarterly data, the variables in this general ARDL model are lagged four quarters in order to take adjustment time into account. However, the second and third lags are dropped to increase degrees of freedom and to reduce multicollinearity problems, imposing the restriction that $\boldsymbol{\alpha}_2 = \boldsymbol{\alpha}_3 = \mathbf{0}$ in (3).

Valid inference requires that the level variables forming departure from equilibrium, *i.e.*, the $EqCM_{t-1}$-term, cointegrate, and that the variables in the EqCM model are integrated of the same order. This is tested by augmented Dickey-Fuller tests (ADF tests),[32] and the results presented in Table A2 in the Appendix.[33]

The wage rates are clearly I(1) variables implying that their first differences are stationary I(0) variables. As Δwo_t is I(0), the explanatory variables in the EqCM model, including $EqCM_{t-1}$, must be I(0) as well. This is the case for all the variables except value added, va_t, which fluctuates a lot because of fluctuations in oil prices. With a trend (and seasonals) in the test equation the conclusion is that va_t has to be treated as an I(1) variable. From economic reasoning one may question that the rate of unemployment is I(0) but the test is clear.

These results have consequences for which hysteresis variable to include in a long run equilibrium equation as Δno_t is an I(0) variable, whereas the other variables are I(1). Hence, if a long run parameter related to petroleum employment is to be interpreted as an insider hysteresis effect within the framework of the Holmlund and Zetterberg (1991) model, no_{t-1} (plus additional lags) must be included, and not Δno_t corresponding to the model given by equation (1)[34]

6. The Break

It may take time before an intervention of the type described in Section 2 eventually takes effect. On the other hand, as the wage inflation in the petroleum sector had been a topic in public debates for some time before the intervention, processes might have been on the way in advance.

---

[32] Dickey and Fuller (1981).

[33] Data are quarterly, and results from the so-called HEGY-tests reject the hypotheses of seasonal unit roots. The HEGY-test is described in Hylleberg *et al*. (1992, p. 425-448).

[34] Estimating equation (3) with Δno_t yields an unsatisfactory model with serially correlated errors ($p = 0.058$), and the null hypotheses of normally distributed errors, homoscedasticity and correct specification (RESET tests) are all clearly rejected. The parameter estimates are also unreasonable.

Statistical information on a possible break is obtained by estimating the ARDL model (3) on data from the period 1979(1)-1993(3) as a Markow Switching Regime Model[35] with two regimes.[36] The result is illustrated in Figure 4, and shows an estimated regime shift between third and fourth quarter of 1982, not far from the regime shift implied by the formal intervention.

Figure 4 here

Further statistical information of a structural break is obtained by applying the automated model-selection techniques from the *Autometrics* software of *PC Give.*[37] Estimating the same ARDL model (3) on the same time period, the only difference being the inclusion of the shift variable D_{821}, taking the value 1 from the first quarter of 1982 and otherwise zero, gives *Impulse Indicator Saturation* (IIS) *every* quarter from 1979(1) till 1982(1), plus 1982(3) and 1982(4).[38] This general unrestricted model is data congruent as it passes all the mis-spcification tests, and will later be referred to as the GUM.[39] Statistically significant impulse dummies (IIS) *every* quarter till 1982(1) support the description of this period as chaotic, and that a change occur in the beginning of 1982. This result is consistent with the result from the Markow Switching Regime Model. The interesting next step is to find out and understand the economics behind this.

As there is clear evidence that the intervention takes effect in 1982, I include in the following the dummy variable D_{821}. The robustness of this will be tested by alternatives to D_{821}.

7. Long run equilibrium

The long-run equilibrium relationship is derived from the ARDL model (3) *augmented* with shift and interaction terms. This regime switching model is estimated as a vector autoregressive (VAR) model with one co-integrating vector, following a 'general-to-specific' approach. The interaction terms are constructed by multiplying the explanatory variables, except D_{79} and D_{8890}, by the dummy variable D_{821}.

The static long run relation obtained from the final model in the simplification process is given in Table 1, with statistics and diagnostics clearly indicating that the model is data congruent. The estimated standard error of 1.72 percent is 7.5 percent below that of the GUM. From Table 1 it

---

[35] See *e.g.* Hamilton (1994), ch. 22. The model is estimated by PC Give (Doornik and Hendry, 2013)
[36] Due to lags the sample size is reduced.
[37] See Doornik (2009), and Hendry and Doornik (2014).
[38] Alternatives with interaction terms *and* the shift variable D_{821}, *only* interaction terms, and *neither* interaction terms *nor* the shift variable, were estimated. All these alternatives failed because of serious serial correlation in the error terms.
[39] The GUM's estimated standard error of regression is 1.86 percent. The p-values for the mis-specification tests are 0.357 [AR(1-4)], 0.334 [ARCH(1-4)], 0.365 [Normality], 0.146 [Heteroskedasticity], and 0.953 [Chow-test for break after 1989(2)].

follows that the long run wage level in the Norwegian petroleum sector is only affected by the wage level in the manufacturing industries (the alternative wage) and the level of petroleum employment, *i.e.*, one outside variable and one insider variable.

Table 1 here

An interesting characteristic of this long run solution is that the intervention (D_{821}) only works through the alternative wage and the level of petroleum employment, as the interaction terms are highly significant. The interpretation is that *before* the intervention a one percent increase in the wage level in manufacturing industries increases the long run wage level for petroleum workers by 0.44 percent. *After* the intervention it increases to 0.77 percent, statistically larger than 0.44 and less than one ($\chi^2(1) = 60.86$). That the importance of manufacturing industry wages increases considerably coincides with the interpretation that this is a result of the intervention, pushing wage formation in the petroleum sector into a centralized and coordinated wage bargaining system.

Consistent with this, the intervention reduces the importance of the possible insider hysteresis variable petroleum employment. *Before* the intervention a one percent increase in the level of petroleum employment increases the wage level for petroleum workers by nearly 0.3 percent. After the intervention the effect is almost zero (0.29-0.25=0.04), also statistically. The intervention also changes seasonal pattern as the wage level appears to be higher in the first and second quarter compared the third and fourth quarters.

The long run parameter estimates of the GUM are qualitatively the same as those in Table 1. Except from the impulse dummies, which represent short run effects, and a correction of the intercept term, the long run wage level in the petroleum sector according the GUM results is driven by the alternative wage with an elasticity of 0.8 and a positive shift in the wage level every second quarter. The second quarter corresponds to the period of central wage bargaining in Norway.

The model has been tested by estimating with different definitions of the intervention dummy (D_{821}) in order to capture possible *expectations* of changes in the wage formation system, and adjustment *inertia*. Replacing D_{821} by D_{801}, *i.e.*, letting the intervention dummy take the value 1 from the first quarter of 1980 onwards (zero otherwise), gives a sequence of 17 models if the last one replaces D_{821} by D_{841}, defined accordingly. The estimated standard errors of these 17 models fall continuously from 0.1058 (D_{801}) to 0.0172 (the chosen model with D_{821}), and increases continuously from this minimum to 0.1009 (D_{841}). All of the alternative models fail at least one of the misspecification tests, and give unsatisfactory parameter estimates.

The result that petroleum sector value added does not have a statistically significant effect on petroleum wages in the long run is not surprising as value added fluctuates a lot, first and foremost because of large changes in world market oil prices.[40] The partly inconclusive result from the ADF test of va_t is therefore consistent with this, indicating that va_t is presumably not an I(1) variable. Moreover, if value added in this highly profitable sector had a long run impact on the petroleum wage level, the consequences for the economy could have been dramatic. Thus it is not surprising to get statistically insignificant effects of va_t in the long run.

A modelling consequence of excluding va_t in the reduction sequence is that the sample period increases, starting in 1977(4) instead of 1979(2).

Unemployment does not have a direct impact in the long run wage equation. An obvious interpretation is that the workplaces in the petroleum sector are regarded as so safe that tightness of the aggregate labour market does not affect the long run wage level in the sector. Alternatively, the tightness of the labour market influence petroleum wages through the alternative wage, a question I return to in Section 9.

Before turning to short run dynamics and the EqCM model, one may ask if it is reasonable to talk of a long run equilibrium relationship for Norwegian petroleum wages in the turbulent pre-intervention period.

Departures from the estimated long run relation in Table 1 is graphed as *EqCM_1977(4)* in Figure 5, and it satisfies the requirements for a long run equilibrium relation from 1982-83 onwards as the actual departures fluctuate around zero.[41]

Figure 5 here

In the pre-intervention period 1976(3)-1982(2) it is below zero, with a quarterly average of -0.0725, stating that the actual wage rate in the petroleum sector is *below* the equilibrium relationship. Estimating the long run relationship on the data set from 1982(1) [*EqCM_1982(1)* in Figure 5] and 1983(1) [*EqCM_1983(1)* in Figure 5] gives departures that are rather similar to *EqCM_1977(4)* for comparable periods.[42]

---

[40] See Figure A2 in the Appendix. Regarding oil price development in this period, see Eika and Magnussen (2000).

[41] The avareage from the first quarter of 1982 is -0.0099 and -0.0043 from the first quarter of 1983.

[42] The averages are -0.0219 and -0.0045, respectively, so EqCM_1982(1) deviates most from EqCM_1977(4).

On a priori grounds the main argument for using *EqCM_1977(4)* is that Norway for many decades has had a well-established model of coordinated wage bargaining.[43] Hence, there was an equilibrium relation in the background also in the turbulent period 1974-1982. Therefore, using *EqCM_1977(4)* in the EqCM model captures the transition from a disequilibrium period towards a possible equilibrium period implying that we get more information on the functioning of the economy using this term. In the next section I will return to the empirical implications of not letting the $EqCM_{t-1}$ be effective in the pre-intervention period.

8. Short run dynamics

The full sample estimates of the chosen EqCM model are given in Table 2. The model parsimoniously encompasses the preceding models in the simplification sequence, and the mis-specification tests clearly indicate that it is data congruent.

Table 2 here

The $EqCM_{t-1}$ enters with correct sign and is highly significant (t = -6.7), stating that departure from long run equilibrium in one quarter is corrected through the next two, *i.e.*, a very high speed of adjustment.

Moreover, the results show extensive short run dynamics *before* the intervention, consistent with a turbulent period.

There are strong positive and significant short run effects in the pre-intervention period of growth in the alternative wage (Δwa_{t-2}), in sector specific value added (Δva_{t-1}, Δva_{t-2}) and in petroleum employment (Δno_t), and the signs of the effects are according to expectations. The effects disappear after the intervention. The short run effect of the alternative wage appears after two quarters, indicating adjustment inertia.

Alternative definitions of the petroleum employment variable were tried when estimating both the long run equilibrium relation and the EqCM model, cf. Section 4. None of the tried alternatives changes qualitatively the basic results regarding parameter estimates but give models with considerably higher estimated standard errors.

The parameters of Δwo_{t-1} and Δwo_{t-2} have opposite signs but sum to 0.5, and may reveal comparison or efficiency wage mechanisms within the sector itself.

[43] The message from this model is that the equilibrium wage rate is the one that keeps labour's share of income in the traded-goods sector constant, which means that equilibrium wage growth is equal to growth in prices of traded goods and labour productivity in the traded goods sector. See Aukrust (1977).

As already noted, in the post-intervention period most of the short term dynamics disappear, and joint tests show that this disappearance is also statistically significant, cf. lower panel of Table 2.

One would expect a negative effect of aggregate unemployment on wages, so the positive sum (0.64) of the impacts of unemployment before the intervention looks strange. Based on the parameter estimates these short run effects are exactly equalized after the intervention as the effects sum to zero. However, a joint test of no effects of unemployment changes in the post-intervention period rejects the null, cf. lower panel of Table 2.

The model is also estimated on the sub-sample 1978(4)-1989(3) to check parameter stability and forecasting ability, using the last 16 observations [1989(4)-1993(3)] for this purpose. The parameter estimates are reported in Table 2, and show only marginal differences between the full sample and sub-sample models. Also the mis-specification tests are fine, including the forecast test of parameter constancy, cf. the last line in Table 2.

One argument against this sub-sample is that it is biased with only 13 observations before the intervention and 31 afterwards. Results from a symmetric sample and other forecasting periods are given in the Appendix and do not change the above conclusions.

Alternatives to $EqCM\_1977(4)_{t-1}$, for instance by setting $EqCM\_1977(4)_{t-1}$ equal to zero in alternative pre-intervention periods such as 1977(4)-1982(1) or 1977(4)-1983(1), gives qualitatively the same results as in Table 2. This is also the conclusion from using $EqCM\_1982(1)_{t-1}$ (estimation period 1982(1)-1993(3), see Figure 5), and setting it equal to zero in the alternative pre-intervention periods. With one exception, all the short run effects with alternative $EqCM_{t-1}$s are much stronger but qualitatively the same. The exception is that the effect of growth in the alternative wage becomes weaker and statistically insignificant.[44]

It is reasonable that in specifications with no equilibrium relation before the intervention the short run effects become much more important. The importance of these short run effects could be exaggerated, and the empirical results do not give arguments against the conclusion drawn in the end of the preceding section regarding which $EqCM_{t-1}$ term to use.

[44] The feedback effect is also very similar across specifications with variations in the interval -0.63 - -0.68. Estimated standard error of equation is higher in the alternative specifications, above 1.9 percent, and they pass the RESET mis-specification test with a considerably lower probability.

9. Discussion

In order to assess and interpret the results it is relevant and interesting to make comparison with the results in a series of empirical papers from the 1990s using the insider-outsider model as theoretical framework. Nine studies are particularly relevant, covering the Nordic countries, the UK, the Netherlands, West-Germany, and the USA. All the data used refer to manufacturing industries, and they have at least the time period 1974-82 in common. Level of data aggregation, and empirical definitions of wages and productivity, vary in these studies. Table 3 summarizes the findings regarding estimated insider weights and insider hysteresis effects.

Table 3 here

Insider weights

A general picture from these nine studies is that the *upper limits* of the estimated insider weights increase the more aggregate are data, *ceteris paribus*.[45] These results imply that the outside weight is more important than the insider weight, and that it is inversely related to level of aggregation.[46] This is reasonable if wage setting is coordinated at a higher level through centralized wage bargaining or significant market forces.

Unions influence the size of the insider weights according to expectations. The estimates in Nickell and Kong (1992) vary between zero and 0.52, with the highest in industries with strong unions. Also, Nickell and Wadhwani (1990) estimate higher inside weights in firms with high union coverage.

Regarding *degree of centralization in wage bargaining*, Johansen (1996) finds some evidence that the insider weight increases during the 1980s. His interpretation is that wage setting became more decentralized during these years because wage drift as part of total wage increases became more important in the last part of his sample period.[47] However, Wulfsberg (1998), and Dyrstad and Johansen (2000) find parameter stability in the 1970s and the 1980s.

My empirical results give no *long run* insider weight in the petroleum sector. This is not a surprise as the oil price fluctuates strongly and it is hard to think of a long run relationship.[48] On the other hand, I estimate sharply determined long run outside weights: 0.44 in the period with plant unions and uncoordinated local bargaining, and 0.77 after the intervention. Johansen (1996), from annual (1966-

[45] An exceptionis Holmlund and Zetterberg (1991).

[46] Some models are estimated under the restriction that the weights sum to one.

[47] Local wage bargaining takes place *after* the central settlement so the wage drift could be predicted and taken into account by the central parties (Rødseth and Holden, 1990).

[48] See Section 6. In connection to this it could be noted that Wulfsberg (1998) does not either get co-integration between wages and revenue per worker, which he uses instead of value added.

1987) national accounts data on wage costs from 117 different manufacturing sectors in Norway, gets almost exactly the same estimate, varying between 0.77 and 0.83, depending on model specification.

The estimated outside weights, changing from 0.44 to 0.77, is clear evidence of an effective intervention.

I estimate large *short run* insider weights (sum 0.60) in the pre-intervention period but completely disappearing afterwards. The interpretation must be that uncoordinated local wage setting gives room for rent sharing. The estimate of the *short run* outside weight, 1.69, is even larger and highly significant before the intervention. Afterwards it becomes zero and the long run relation for petroleum wages takes over. The inertia indicated by the short run estimate might be explained by incomplete information as the alternative wage is set in local bargaining in the manufacturing industries, and after the central agreement is settled.

The Nickell and Wadhwani (1990) model predicts that the insider and outside weights sum to one in the long run. As I do not estimate any long run effect of value added the implication is that the outside weight is one, a restriction which is clearly rejected in my model.

Insider hysteresis effects

Turning to possible insider hysteresis effects, the results obtained by others are in general negative. The paper by Nickell and Wadhwani (1990) is the only exception, as they get a clear positive effect in firms with decentralized wage bargaining. These firms also have less adjustment inertia.
For the period with plant unions and no coordination I estimate a strong long run positive relationship between petroleum wages and the petroleum employment *level*. It may be inconsistent to interpret this as an insider hysteresis effect because according to theory the estimate has the wrong sign.[49] The effect disappears when moving to coordinated or centralized wage bargaining, so something is changing due to the wage formation system.[50]

After the intervention the effect of employment growth, Δno_t, also disappears. The highly significant parameter estimate of 1.54 in the pre-intervention period is interpreted as a short run hysteresis effect. Nickell and Wadhwani (1990) correcting for degree of centralization estimate the insider

[49] See Section 3 regarding expected sign if no_{t-1} is used instead of Δno_t.

[50] In three industries Lee and Pesaran (1993), using changes in employment as hysteresis variable, get estimates statistically different from zero but they are all negative, and therefore not according to theory so they conclude “that the presence of this variable should be interpreted as part of adjustment rather than as evidence in favour of the insider-outsider explanation of hysteresis” (p. 42). The only industry with a positive estimate is Energy, 0.39 (t = 1.57).

hysteresis parameter to 0.475, clearly indicating that the more decentralized bargaining the more important is insider hysteresis.[51] I interpret their estimates as long run effects.

There is no long run relation between petroleum wages and aggregate unemployment, and the short run effects are not evident: In the pre-intervention period the immediate effect of an increase in unemployment is negative, and in the two subsequent quarters positive. The parameters are, respectively, -0.40, 0.82 and 0.22, and add up to 0.64. In the post-intervention period the effects sum exactly to zero.

The pattern of the unemployment parameters in the pre-intervention period could be explained by *low levels* but relatively *large fluctuations* in unemployment: The average in the pre-intervention period of $|\Delta u_t|$ is 0.19, and 0.13 in the post-intervention period, *i.e.*, nearly 50 percent more changes in the pre- than post-intervention period.[52] These in a Norwegian context sharp unemployment changes may explain that there is a negative contemporary effect which is adjusted when it is revealed that the unemployment rate is moving downward the next quarter.

However, *(outside) hysteresis* may also explain the positive effects on wages. If people becoming unemployed are less efficient job applicants or that it is the least effective and lowest paid workers that become unemployed, then a positive relation between unemployment and wages is established. Most of the above referred papers present results with positive effects of unemployment on wages, some of them statistically significant, and they are often explained by composition mechanisms.

Dyrstad and Johansen (2000) estimate negative *effects* of regional unemployment but positive (statistically insignificant) effects of *aggregate* (national) unemployment on regional manufacturing wages. The reduced form estimates give negative effects of aggregate unemployment. We interpret these findings that unemployment first and foremost works through the central wage settlements. This interpretation is consistent with the result that the direct effects of unemployment on wage growth in the petroleum sector disappear after the intervention.

Short run dynamics

The *differences in dynamics* between the pre- and post-intervention periods are very clear as almost all the extensive short run dynamics disappear after the intervention.[53]

[51] The dummy variable takes "the value one for those union firms for which national/industry wide bargaining was irrelevant" (*ibid*, p. 506). This applies to 15 out of 68 union firms, based on results from a questionnaire.
[52] If the averages are calculated from Δu_t, and not from the absolute value of Δu_t, I get 0.025 in the pre-intervention period and 0.029 in the post-intervention period, because there are more ups and downs in the pre-intervention period. Also, see Figure A3 in the Appendix.
[53] As noted above, also the results in Nickell and Wadhwani (1990) indicate reduced inertia in firms with decentralized wage bargaining.

The positive autocorrelation in sector specific wage growth mentioned in Section 8 indicates comparison or efficiency wage mechanisms. As these are short run effects, a feasible explanation of the negative impact after two quarters could be adjustments for over-shooting when adjusting for changes in the previous quarter elsewhere in the sector. The companies had the possibility to more or less continuously adjust wages.

Furthermore, the seasonal pattern changes a lot. In the pre-intervention period there is considerably higher wage growth in the first and third quarter but very much lower in the second quarter, both relative to the fourth quarter. The lower growth in the second quarter could be due to less work in these months because of Easter and other holidays in Norway in April and May. However, the interesting point is the comparison of seasonal variation related to the intervention, as the second quarter gives much higher wage growth in the post-intervention period compared to the pre-intervention period. Again, a reasonable explanation is that this is coordinated wage negotiations showing up because centralized wage bargaining takes place in April/May. This is also consistent with the result that the insider variable becomes less important and the outsider variable more important.

10. Conclusion

A glance at relative wages for blue collar workers in the petroleum sector and the same group of workers in the manufacturing industries displays that a break occurs in the first part of the 1980s. The empirical analysis based on the insider-outsider model explains this break very well to be the result of the Government's extraordinary intervention in late 1981. The estimated effects in comparison with those obtained by others show that the intervention was effective through the following channels: First, insider hysteresis disappeared completely after the intervention. Second, the outside weights became much larger in the post-intervention period both in the short and long run, consistent with reduced insider weights. Third, the changes in seasonal pattern together with reduced insider factors support the overall conclusion that wage bargaining in the petroleum sector became coordinated after the intervention.

In the pre-intervention period there is a statistically significant long run relation between wages in the petroleum sector and alternative wages but it becomes much stronger after the intervention and equals the results obtained by others. The interpretation is that most of the wage growth in the petroleum sector before the intervention is driven by short run effects. Hence, wage formation went back to the well-established system of coordinated wage bargaining as described in Aukrust (1977).

Further to this, the dynamics of the empirical modelling should be underlined. In a fast growing sector there are a lot of changes taking place during a year, so for instance systematic changes in seasonal pattern may contribute to reveal the channels of change and to understand the adjustment processes.

Returning to the question whether the intervention had a lasting effect or not, Figure 1 in Section 2 gives a mixed picture. Keeping in mind that the two series in this figure are not directly comparable, the reduction in the wage gap that started in the middle of the 1980s seems to be lasting at least till the turn of the century. But the national accounts data 1995-2014 give an average increase in the wage gap, and the increased seasonal variation from 2008 might indicate some challenges ahead.

Wage formation is crucial for resource curse avoidance if it is created by the spending effect and/or the resource movement effect. Hence, a country able to handling wage formation will also handle Dutch disease challenges but this requires strong and competent institutions. The intervention was implemented in such a way that the fundamental structure of wage formation in Norway was maintained and that coordinated wage bargaining was re-established. The principal conclusion from the analysis in this paper is that institutions play a crucial role in avoiding adverse economic development, in the case of Norway in the 1970s to the early 1980s by turning a likely resource curse to a blessing by reducing insider power in wage bargaining.

References

Aukrust, O. (1977) Inflation in the open economy: A Norwegian model, Articles no. 96, *Statistics Norway*, Oslo. [Also published in Krause, L. B. and Sâlant, W. S., eds. (1977.): *Worldwide Inflation*, Brookings Institution, Washington D.C., 1977].

Bentolila, S. Dolado, J. J. and Jimeno, J. F. (2012) Reforming an insider-outsider labor market: the Spanish experience, *IZA Journal of European Labor Studies*, **1**, 1-29.

Bjerkholt, O., Lorentsen, L. and Strøm, S. (1981) Using the oil and gas revenues: The Norwegian case, Articles no. 133, *Statistics Norway*, Oslo.

Bjørnland, H. C. (1998) The economic effects of north sea oil on the manufacturing sector, *Scottish Journal of Political Economy*, **45**, 553-585.

Brunstad, R. J. and Dyrstad, J. M. (1997) Booming sector and wage effects: an empirical analysis on Norwegian data, *Oxford Economic Papers,* **49**, 89-103.

Corden, W. M. and Neary, J. P. (1982) Booming Sector and De-Industrialization in a Small Open Economy, *The Economic Journal,* **92**, 825-48.

Corden, W. M. (1984) Booming sector and Dutch disease economics: Survey and consolidation, *Oxford Economic Papers*, **36**, 359-380.

Dickey, D. A. and Fuller, W. A. (1981): Likelihood ratio statistics for autoregressive time series with a unit root, *Econometrica*, **49**, 1057-1072.

Doornik, J. A. (2009): *Autometrics*, in Castle, J. L. and Shephard, N.: *The Methodology and Practice of Econometrics. A Festschrift in Honour of David F. Hendry*, Oxford University Press, Oxford.

Doornik, J. A. and Hendry, D. F. (2013) *Empirical Econometric Modelling - PcGIVE 14: Volume I*, Timberlake Consultants Ltd, London.

Dyrstad, J. M. (1987) Resource boom, wages and unemployment: Theory and evidence from the Norwegian petroleum experience, *Scandinavian Journal of Economics,* **89**, 125-143.

Dyrstad, J. M. and Johansen, K. J. (2000) Regional wage responses to unemployment and profitability: Empirical evidence from Norwegian manufacturing industries, *Oxford Bulletin of Economics and Statistics,* **62**, 101-117.

Eide, E. (1973) Virkninger av statens oljeinntekter på norsk økonomi (The impact from the state's oil revenues on the Norwegian economy. My translation.), *Sosialøkonomen*, **27** (10), 12-21.

Eika, T. and Magnussen, K. A. (2000) Did Norway gain from the 1979-1985 oil price shock, *Economic Modelling,* **17**, 107-137.

Forslund, A. (1994) Wage setting at the firm Level – insider versus outsider forces*, Oxford Economic Papers,* **46**, 245-61.

Hamilton, J. D. (1994): *Time Series Analysis*, Princeton University Press, Princeton.

Hendry, D. F. and Doornik, J. A. (2014): *Empirical Model Discovery and Theory Evaluation. Automated Selection Methods in Econometrics* (Arne Ryde Memorial Lectures), The MIT Press, London, England.

Holmlund, B. and Zetterberg, J. (1991) Insider effects in wage determination: Evidence from five countries, *European Economic Review,* **35**, 1009-34.

Hutchison, M. M. (1994) Manufacturing sector resiliency to energy booms: Empirical evidence from Norway, the Netherlands, and the United Kingdom, *Oxford Economic Papers,* **46**, 311-329.

Hylleberg, S., R. F. Engle, C. W. J. Granger and B. S. Yoo (1992) "Seasonal Integration and Cointegration", in Hylleberg, S. (ed): *Modelling seasonality*, Oxford University Press, Oxford.

Johansen, K. (1996) Insider forces, asymmetries and outsider ineffectiveness. Empirical evidence from Norwegian industries 1966-87, *Oxford Economic Papers,* **48**, 89-104.

Langørgen, A (1993) En økonometrisk analyse av lønnsdannelsen i Norge (An Econometric Analysis of the Wage Formation in Norway. My translation), Rapporter 93/5, Statistics Norway.

Lee, K.C. and Pesaran, M. H. (1993) The role of sectoral interaction in wage determination in the UK economy, *The Economic Journal,* **103**, 21-55.

Lever, M. H. C. and van Verkhooven, J. M. (1996) Insider power, firm size and wages: Evidence from Dutch manufacturing industries", *Labour Economics*, **3**, 93-107.

Lindbeck, A. and Snower, D. J. (1987) Efficiency wages versus insiders and outsiders, *European Economic Review*, 31, 407-426.

Lindbeck, A. and Snower, D. J. (1991) Interactions between the efficiency wage and insider-outsider theories*, Economics Letters*, **37**, 193-196.

Lindbeck, A. and Snower, D. J. (2001) Insiders versus outsiders, *Journal of Economic Perspectives*, **15**, 165-188.

Nickell, S. and Kong, P. (1992) An investigation into the power of insiders in wage determination, *European Economic Review,* **49**, 103-28.

Nickell, S. and Wadhwani, S. (1990) Insider forces and wage determination, *The Economic Journal*, **100**, 496-509.

Rødseth, A. and Holden, S. (1990) Wage Formation in Norway, in Calmfors, L (ed.) *Wage formation and macroeconomic policy in the nordic countries*, Oxford University Press, 237-280.

Røed Larsen, E. (2006) Escaping the resource curse and the Dutch disease? When and why Norway caught up with and forged ahead of its neighbors, *American Journal of Economics and Sociology*, **65**, 605-640.

Salop, S. C. (1979) A model of the natural rate of unemployment, *American Economic Review*, **69**, 117-25.

Shapiro, C. and Stiglitz, J. E. (1984) Equilibrium unemployment as a worker discipline device, *American Economic Review*, **74**, 433-44.

Smith-Solbakken, M. (1997) Oljearbeiderkulturen. Historien om cowboyer og rebeller (The Culture of Oil Workers. The History of Cowboys and Rebels. My translation.), Ph.D. Dissertation, Department of History, *Norwegian University of Science and Technology*, Trondheim.

St. meld. nr. 25 (1973-74) *Petroleumsvirksomhetens plass i det norske samfunn*. [Report No. 25 (1973-74) to the Storting: *The place of the petroleum activities in the Norwegian society*. My translation].

van der Ploeg, F. (2011) Natural Resources: Curse or Blessing?, *Journal of Economic Literature,* **49**(2), 366-420.

Walsh, F. (2012) Efficiency wages and bargaining, *Oxford Economic Papers*, 64, 635-654.

Weiss, A. (1980) Job queues and layoffs in labor markets with flexible wages, *Journal of Political Economy*, **88**, 526-38.

Wulfsberg, F. (1997) An application of wage bargaining models to Norwegian panel data, *Oxford Economic Papers,* **49**, 419-440.

Figures and Tables

Figure 1: Relative wages for employees in the Norwegian petroleum sector relative to employees in Norway's manufacturing industries, 1976(3)-1993(3) and 1995(1)-2014(2). Source: *Norwegian Confederation of Enterprise* and *Statistics Norway*.

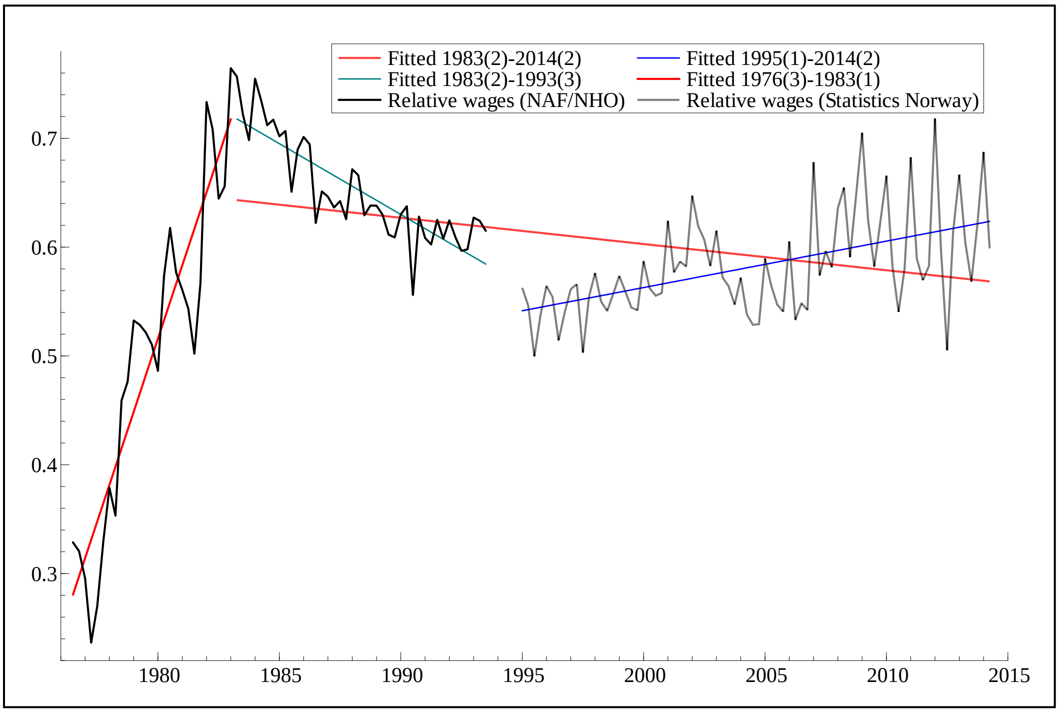


Figure 2: Log nominal hourly earnings for blue collar workers in the petroleum sector (*logWO*), in the manufacturing industries at the national level (*logWN*), and in *Rogaland* county (*logWR*). Source: *Norwegian Confederation of Enterprise* (*NAF/NHO*).

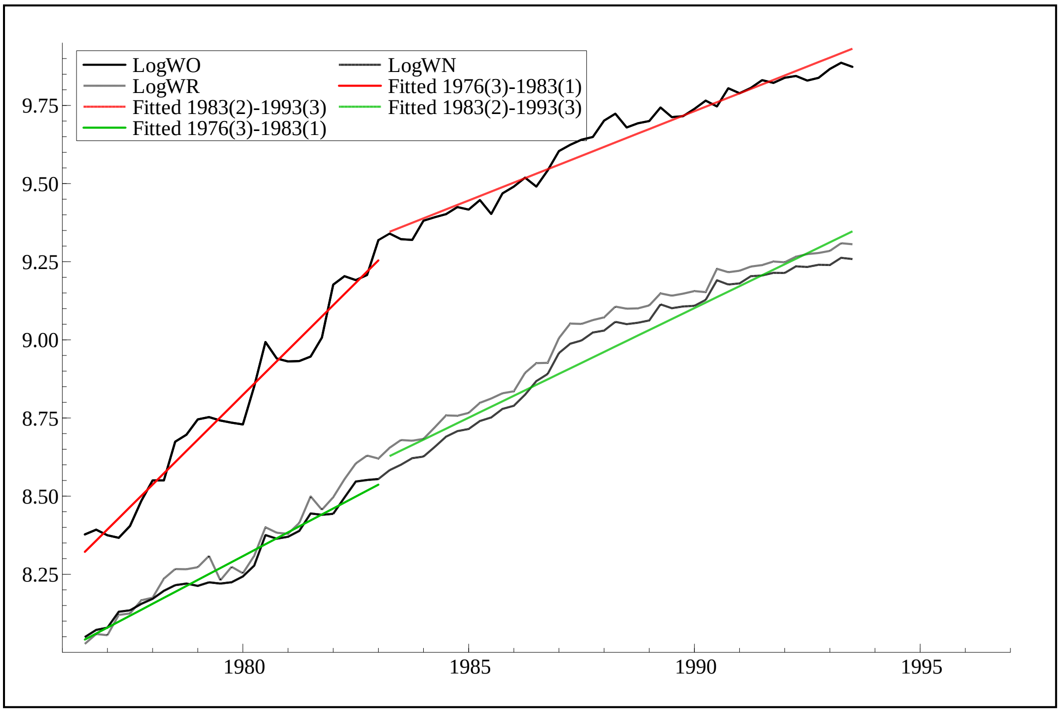


Figure 3: Number of people employed in firms registered in *Rogaland* county working in the Norwegian petroleum sector. Source: *Directorate of Labour*.

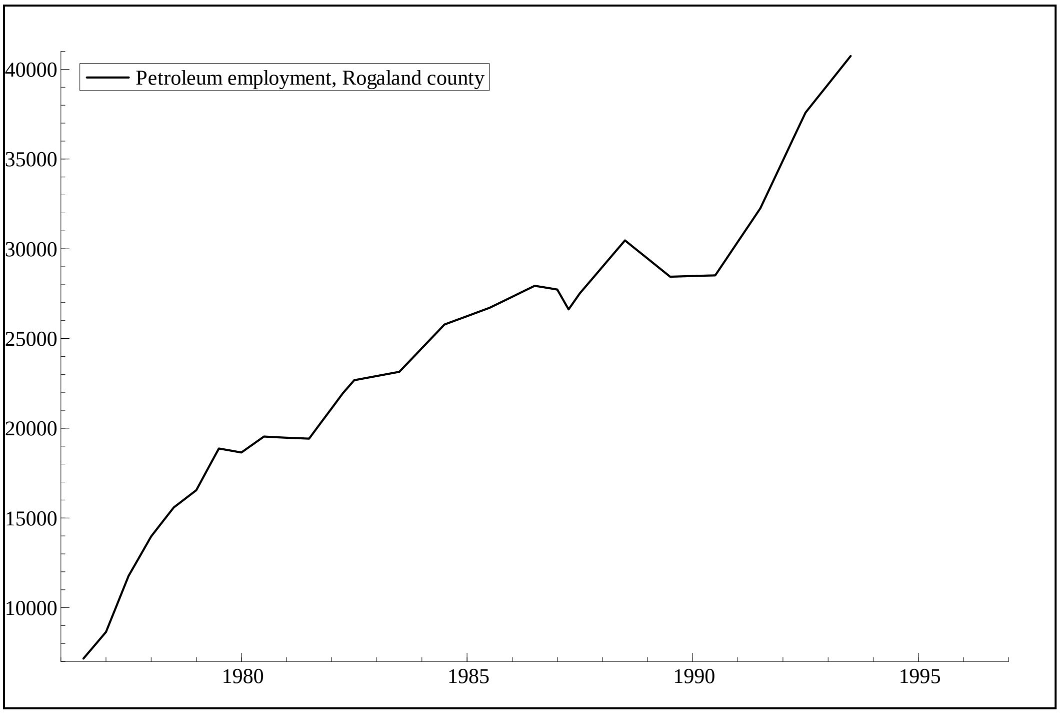


Figure 4: The Markow Switching Model with Two Regimes

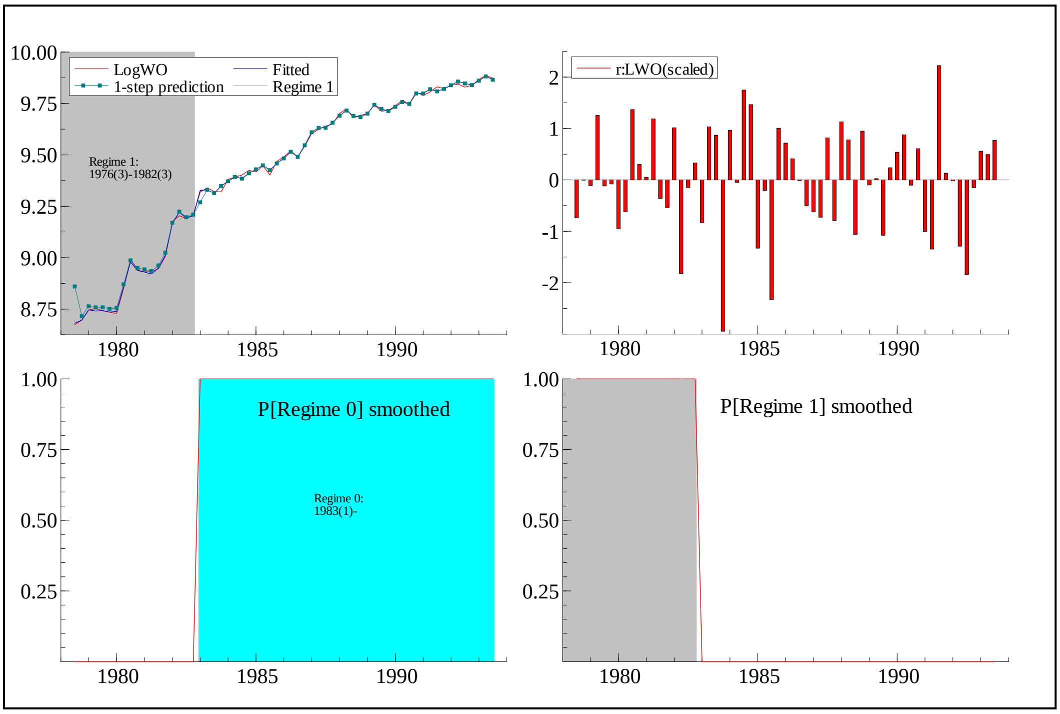


Figure 5: EqCM$_t$s estimated on different time periods

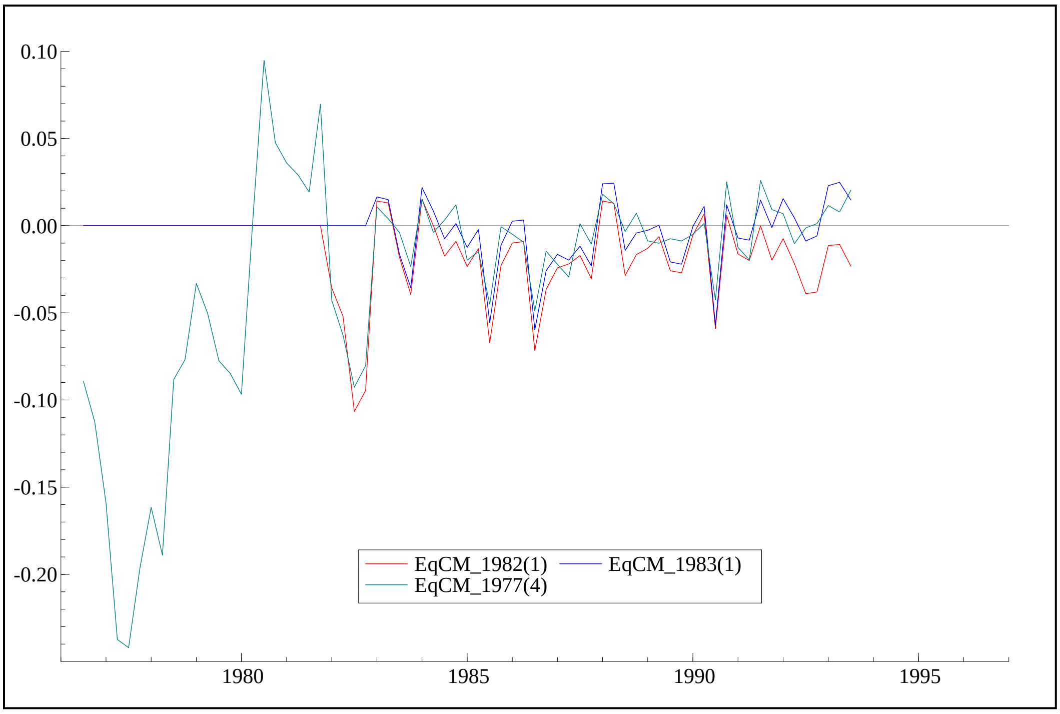


Table 1: Long run solution for petroleum wages, wo_t.*

Variables	Parameters (standard errors)
Constant	2.36 (0.261)***
Intervention dummy (***D_{821}***)	-
Log alternative wage rate (***wa_t***)	0.44 (0.065)***
Interaction term ***$wa_t \cdot D_{821}$***	0.33 (0.076)***
Log petroleum employment (***no_t***)	0.29 (0.053)***
Interaction term ***$no_t \cdot D_{821}$***	-0.25 (0.064)***
Interaction term ***$Q_1 \cdot D_{821}$***	0.018 (0.006)***
Interaction term ***$Q_2 \cdot D_{821}$***	0.023 (0.006)***
Statistics and diagnostics from the ARDL model	
S.E. of long run equation	0.0145
Wald test of long run equation	$X^2(6)$ = 29323***
Estimation period	1977(4) – 1993(3)
No. of observations/parameters	64/16
Mean and (SE) of dep. variable (**wo_t**)	9.38 (0.41)
S.E. of equation (ARDL)	0.0172
Adj. R^2	99.87 %
F-test	F(15,48) = 2424***
Portmanteau (7)	$X^2(6)$ = 3.16 [0.789]
Durbin-Watson	(2.04)
AR(1-5)	F(5,43) = 0.436 [0.821]
ARCH(1-5)	F(5,54) = 0.943 [0.461]
Normality	$X^2(2)$ = 1.380 [0.502]
Heteroscedasticity (squares)	F(28,35) = 1.058 [0.432]
RESET (squares)	F(1,47) = 0.186 [0.668]
RESET (squares, cubes)	F(2,46) = 0.126 [0.882]
Non-linearity (Core index)	F(26,22) = 1.37 [0.230]

$$EqCM\_1977(4)_t = wo_t - 2.36 - 0.44 wa_t - 0.33 D_{821} \times wa_t - 0.29 no_t + 0.25 D_{821} \times no_t - 0.018 D_{821} \times Q_1 - 0.023 D_{821} \times Q_2$$

Estimated standard errors (S.E.) in parentheses (·), probabilities in brackets [·].
* The models are estimated by using PcGive (Doornik and Hendry, 2013).

Table 2: Estimation of EqCM Models.* Dependent variable: Δwo_t.

Variables	**Parameter estimates (S.E.)** Full sample: 1978(4)-1993(3)	**Parameter estimates (S.E.)** Estimation period: 1978(4)-1989(3) Forecast period:1989(4)-1993(3)
Constant	-0.002 (0.003)	-0.003 (0.005)
$EqCM\_1977(4)_{t-1}$ [$= wo_{t-1} - 2.36 - 0.44\ wa_{t-1} - 0.29\ no_{t-1} - 0.33\ wa_{t-1} \times D_{821} + 0.25\ no_{t-1} \times D_{821} - 0.018\ Q1_t \times D_{821} - 0.023\ Q2_t \times D_{821}$]	-0.65 (0.097)***	-0.62 (0.125)***
$\Delta wo_{t-1} \times (1 - D_{821})$	1.19 (0.228)***	1.19 (0.271)***
$\Delta wo_{t-2} \times (1 - D_{821})$	-0.69 (0.139)***	-0.68 (0.164)***
$\Delta va_{t-1} \times (1 - D_{821})$	0.29 (0.111)**	0.30 (0.133)**
$\Delta va_{t-2} \times (1 - D_{821})$	0.31 (0.065)***	0.32 (0.077)***
$\Delta no_t \times (1 - D_{821})$	1.54 (0.385)***	1.57 (0.457)***
$\Delta wa_{t-2} \times (1 - D_{821})$	1.69 (0.415)***	1.64 (0.501)***
Δu_t	- 0.40 (0.116)***	-0.40 (0.137)***
$\Delta u_t \times D_{821}$	0.32 (0.12)***	0.32 (0.138)**
Δu_{t-1}	0.82 (0.195)***	0.82 (0.231)***
$\Delta u_{t-1} \times D_{821}$	-0.74 (0.196)***	-0.74 (0.232)***
$\Delta u_{t-2} \times (1 - D_{821})$	0.22 (0.064)***	0.22 (0.075)***
D_{79} [1978(4)-1979(4)]	-0.11 (0.022)***	-0.11(0.026)***
Q_1	-0.11 (0.039)***	-0.11 (0.046)**
$Q_1 \times D_{821}$	0.15 (0.039)***	0.16 (0.046)***
$Q_2 \times (1 - D_{821})$	-0.42 (0.093)***	-0.42 (0.111***
$Q_3 \times (1 - D_{821})$	0.15 (0.059)***	0.15 (0.069)**
Statistics and diagnostics		
No. of obs.	60	44
S.E. of equation	0.0176	0.0206
R^2 (adj)	0.821	0.803
F-test	F(17,42) = 16.89 [0.000]	F(17,26) = 11.33 [0.000]
Mean (SE) of Δwo_t	0.020 (0.042)	0.024 (0.046)
Portmanteau (5)	$X^2(5)$ = 6.629 [0.250]	$X^2(5)$ = 7.620 [0.179]
Durbin-Watson	(2.38)	(2.40)
AR(1-5)	F(5,37) = 0.887 [0.500]	F(5,21) = 0.920 [0.488]
ARCH(1-5)	F(5,50) = 1.201 [0.322]	F(5,34) = 1.154 [0.352]
Normality	$X^2(2)$ = 1.284 [0.526]	$X^2(2)$ = 0.846 [0.655]
Heteroscedasticity (squares)	F(22,37) = 1.390 [0.184]	F(22,21) = 0.821 [0.676]
RESET (squares)	F(1,41) = 0.424 [0.519]	F(1,25) = 0.306 [0.585]
RESET (squares, cubes)	F(2,40) = 0.234 [0.793]	F(2,24) = 0.1478 [0.863]
Non-linearity (Core index)	F(18,24) = 1.828 [0.083]	*Insufficient # of obs.*
Joint test: No effects after the intervention of • Δwo_{t-1}, Δwo_{t-2}, Δva_{t-1}, Δva_{t-2}, Δno_t, Δwa_{t-2}, Q_2, and Q_3 • Δwo_{t-1}, Δwo_{t-2}, Δva_{t-1}, Δva_{t-2}, Δno_t, Δwa_{t-2}, Q_2, Q_3, *and* Δu_t, Δu_{t-1}, Δu_{t-2} • Δwo_{t-1}, Δwo_{t-2}, Δva_{t-1}, Δva_{t-2}, Δno_t, Δwa_{t-2}, Q_2, Q_3, *and* Δu_{t-2}	 $X^2(8)$ = 9.311 [0.317] $X^2(11)$ = 57.092 [0.000] $X^2(9)$ = 9.964 [0.353]	 $X^2(8)$ = 6.928 [0.544] $X^2(11)$ = 34.084 [0.0004] X^2 (9) = 7.913 [0.543]
Parameter constancy forecast test (Chow)		F(16,26) = 0.28 [0.995]
Estimated standard errors (S.E.) in parentheses (·), probabilities in brackets [·]. * The models are estimated by using PcGive (Doornik and Hendry, 2013).		

Table 3: Summary of estimated insider weights and insider hysteresis effects

Level of aggregation	Country	Insider weights	Insider hysteresis effects
Firm level data [1)]	UK, Sweden, Norway	0.04 - 0.11	None, except Nickell and Wadhwani (1990)
Regional data [2)]	Norway	0.12 - 0.14	None.
Industry level data [3)]	Finland, Norway, Sweden, The Netherlands, UK, USA, West-Germany	0 – 0.52	None. Exception: Energy gets an estimate of 0.39 (t-value = 1.57) in Lee and Pesaran (1993)
[1)] Nickell and Wadhwani (1990), Forslund (1994), Wulfsberg (1998); [2)] Dyrstad og Johansen (2000); [3)] Holmlund og Zetterberg (1991), Nickell og Kong (1992), Lee og Pesaran (1993), Johansen (1996), Lever and van Verkhooven (1996).			

Appendix

1. Data

Definition of petroleum employment (no_t)

There are two sources from which I can get relevant data on petroleum employment.

The first is the *annual* (August) data from the Directorate of labour. These data divide petroleum employment into two main categories, primary activities and secondary activities. The *primary* activities are directly related to extraction of oil and gas in the North Sea, such as underwater operations, search and production drilling, and production. On-shore bases for the platforms; transportation, catering, technical support and public services also belong to the primary activities. Building and maintenance of platforms, and building and maintenance of supply vessels and equipments for the primary activities belong to the *secondary* activities.

Geographical location of petroleum employment in the data from the Directorate of labour is county, based on the actual firm's location and not the workers' residence. Nearly 25,000 people in *total* (both primary and secondary activities) were employed in the petroleum activities in August 1976, of which approximately 30 percent was working in *Rogaland* county. In August 1993 the total number was more than three times higher (78,228 persons), and 51.2 percent (40,052 persons) were located in *Rogaland*.

The second source is the Local Labour Office in *Rogaland*, which is the central area for the Norwegian petroleum activities. The office has most of the actual period collected data on *total* petroleum employment (both primary and secondary activities) *bi-annually* (January and August) in *Rogaland*, based on location of the actual firm. However, this database does not separate employment into primary and secondary activities.

Using national *primary* activities employment from the Directorate of labour has three important drawbacks. The first is that there is only one observation per year (August), so possibly important dynamic aspects of employment development in the petroleum sector will be lost. *Total* petroleum employment in *Rogaland* is available twice a year (January and August). Secondly, the definitions of the various activity groups in the Directorate's data base are not very clear-cut so there is room for considerable judgements. These judgments are mainly made by the firms reporting figures to the Directorate, and need not be consistent across firms. These arguments point in favour of using total petroleum employment in *Rogaland* county as the employment variable in the empirical analysis.

Third, primary activity employment from the Directorate in addition to primary activity employment in *Rogaland* (based on the August figures from the Directorate), is first and foremost located in Oslo. The number of people located in Oslo is quite constant since the beginning of the 1980s, around 4,000. These people have administrative functions and consequently they are not relevant in relation to my empirical setting. The number of people defined as to belonging to the primary activities in *Rogaland*'s neighbouring county (*Hordaland*) has increased from about 2,500 in 1980 to about 7,500 in 1993. Also in *Sør-Trøndelag* county has the number increased, from about 750 to 1,400.

This is the background for choosing to define no_t as total employment in the petroleum sector in *Rogaland* as this seems to capture the development in the primary activities in the best way.

The relationship between *total* petroleum employment in *Rogaland* county (no_t) and national employment in the *primary* activities ($no12_t$) is illustrated in Figure A4, and shows that the total number of people in the primary activities is approximately the same as total employment in Rogaland county. The two series have a parallel development, except from the middle of the 1980s and the beginning of the 1990s.

Figures A1-A6: Data graphs

Figure A1: Log average nominal hourly earnings for blue collar workers in the Norwegian petroleum sector (***wo_t***) and log average nominal hourly earnings for blue collar workers in Norwegian manufacturing industries (***wa_t***), 1976(3)-1993(3), measured in NOK *x*100 (øre). Source: Quarterly statistics of *NAF* and *NHO*.
Figure A2: Log nominal value added per employee in the petroleum sector (va_t), 1978(1)-1993(3), measured in NOK. Source: Statistics Norway.
Figure A3: Log aggregate rate of unemployment in Norway (u_t), 1976(3)-1993(3). Source: Statistics Norway.
Figure A4: Log number of petroleum sector workers in *Rogaland county* (no_t) and log national employment in the *primary* activities ($no12_t$), 1976(3)-1993(3). Source: Directorate of Labour.
Figure A5: Growth in petroleum employment in Rogaland county ($\Delta no_t = no_t - no_{t-1}$,), 1976(3)-1993(3). Source: Directorate of Labour.
Figure A6: Growth in value added ($\Delta va_t = va_t - va_{t-1}$,), 1978(1)-1993(3). Source: Statistics Norway.

Fig. A1

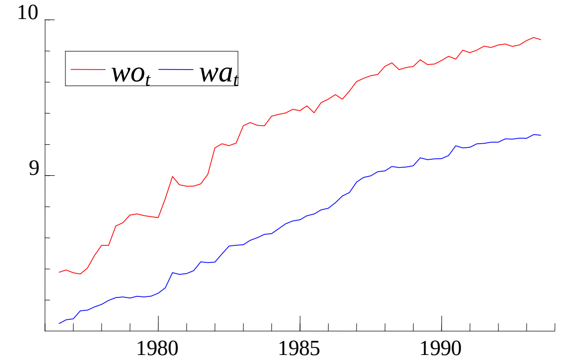


Fig. A2

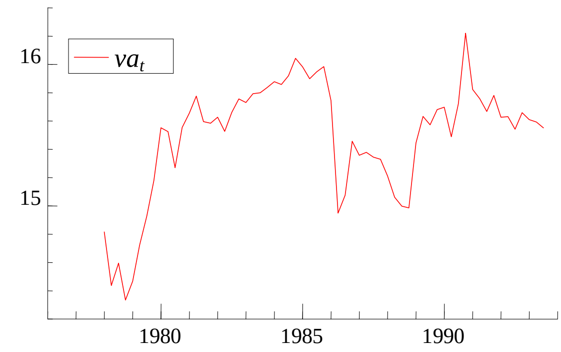


Fig. A3

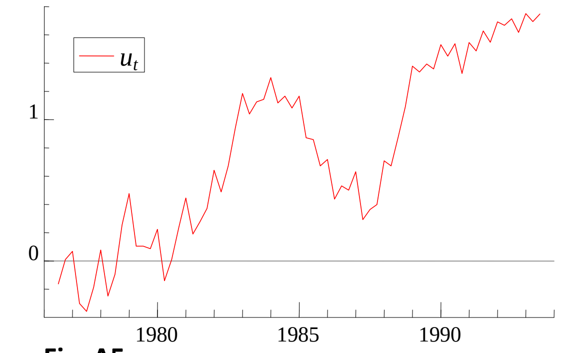


Fig. A4

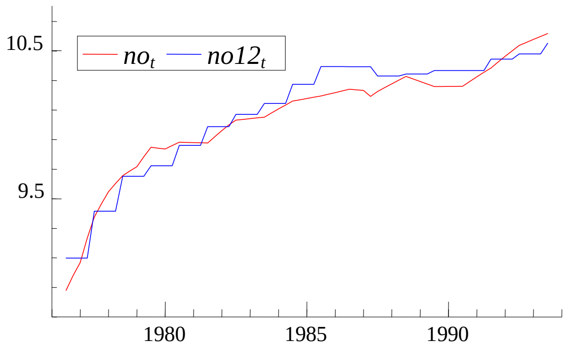


Fig. A5

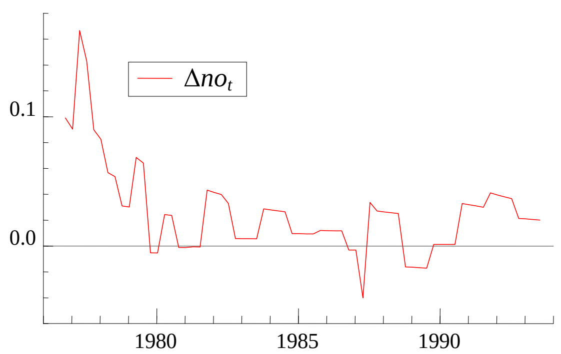


Fig. A6

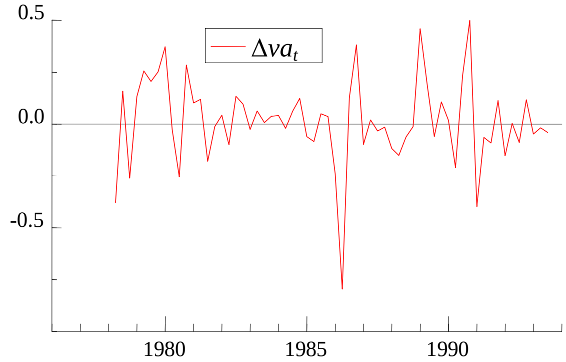


Table A1: Descriptive statistics

Variable:	wo_t	wa_t	va_t	u_t	no_t	Δno_t
Mean	9.3058	8.7142	15.489	0.77594	10.053	0.025561
Std. Dev.	0.47586	0.39538	0.41185	0.62233	0.37221	0.034802
Estimation period:	1976(3)-1993(3)	1976(3)-1993(3)	1978(1)-1993(3)	1976(3)-1993(3)	1976(3)-1993(3)	1976(4)-1993(3)

Table A2: Augmented Dickey-Fuller tests

Test statistics (t-values) on H_0: $(\Upsilon_0 - 1) = 0$ from the equations

a) Δy_t = const. + $(\Upsilon_0 - 1)y_{t-1} + \sum\Upsilon_i \Delta y_{t-i} + \xi_{at}$, **b)** Δy_t = const. + $(\Upsilon_0 - 1)y_{t-1} + \sum\Upsilon_i \Delta y_{t-i}$ + Trend + ξ_{bt}, and

c) Δy_t = const. + $(\Upsilon_0 - 1)y_{t-1} + \sum\Upsilon_i \Delta y_{t-i}$ + Trend + Seasonals + ξ_{ct}, where

$y_t = wo_t, wa_t, va_t, u_t, no_t, EqCM_t$ and $AltEqCM_t$, and i = 1, 2, 3, 4. Number of observations is 57.

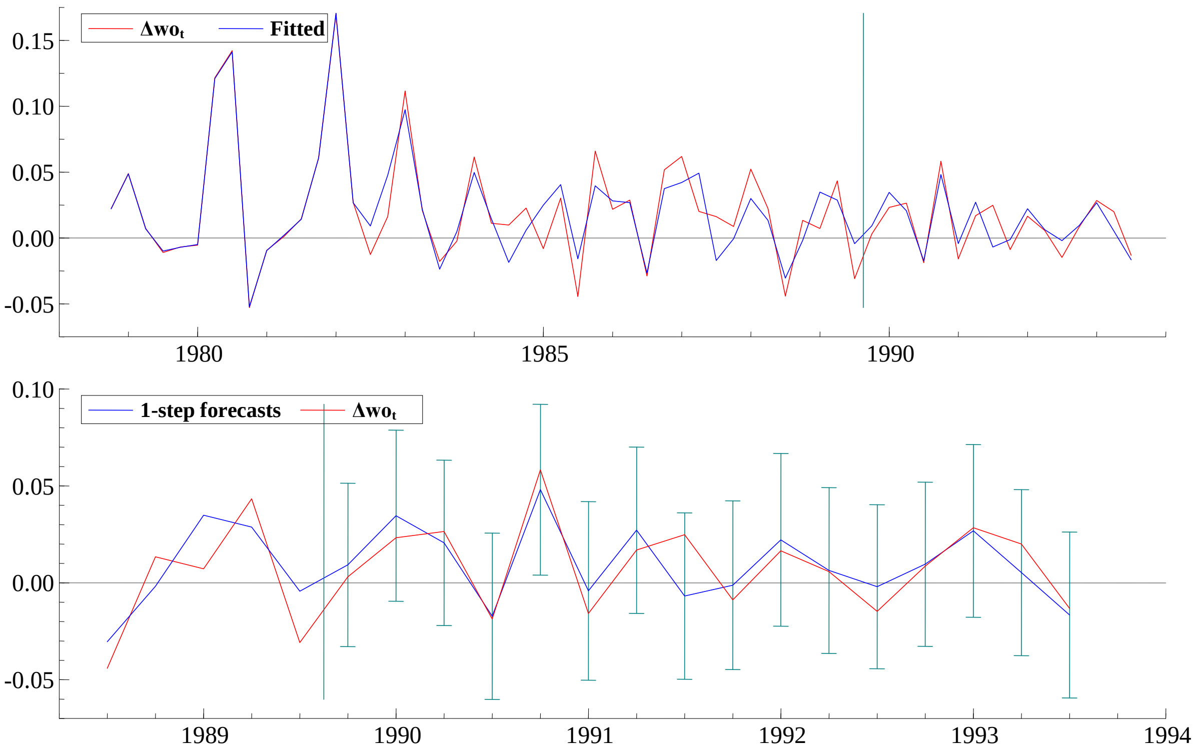
# lags	wo_t	Δwo_t	wa_t	Δwa_t	va_t	Δva_t
a) With a constant. Critical values: 5%=-2.91 (*) and 1%=-3.55 (**)						
4	-2.702	-3.983**	-1.879	-2.546	-3.464*	-3.704**
3	-2.747	-4.332**	-1.998	-3.062*	-3.459*	-3.789**
2	-2.362	-5.861**	-1.996	-4.643**	-3.409*	-4.654**
1	-1.952	-6.813**	-1.886	-5.923**	-3.672**	-6.637**
0	-1.996	-7.057**	-1.833	-7.672**	-3.524*	-7.000**
b) With a constant and trend. Critical values 5%=-3.49 (*) and 1%=-4.12(**)						
4	-0.677	-5.269**	-0.510	-3.022	-3.215	-3.953*
3	-0.740	-5.256**	0.044	-3.541*	-3.221	-3.999*
2	-1.119	-6.714**	-0.093	-5.153**	-3.182	-4.843**
1	-1.672	-7.343**	-0.502	-6.392**	-3.525*	-6.801**
0	-1.624	-7.310**	-0.692	-8.039**	-3.389	-7.050**
c) With a constant, trend and seasonals. Critical values 5%=-3.49 (*) and 1%=-4.12(**)						
4	-0.7429	-5.162**	-0.135	-3.040	-2.992	-3.967*
3	-0.8445	-5.294**	0.031	-3.704*	-3.090	-4.051*
2	-1.230	-6.308**	-0.167	-4.457**	-3.032	-4.441**
1	-1.634	-6.526**	0.062	-5.173**	-3.225	-5.951**
0	-1.594	-7.156**	-0.272	-7.872**	-3.117	-6.795**
# lags	u_t	Δu_t	no_t	Δno_t	**EqCM_1977(4)$_t$**	$AltEqCM_t$
a) With a constant. Critical values: 5%=-2.91 (*) and 1%=-3.55 (**)						
4	-2.153	-3.001*	0.1485	-3.904**	-3.255*	-2.656
3	-0.909	-1.711	0.1672	-3.795**	-3.745**	-2.863
2	-1.149	-5.391**	0.1688	-4.020**	-4.011**	-3.534*
1	-0.826	-4.754**	0.1374	-4.591**	-4.062**	-4.405**
0	-1.156	-9.823**	0.1594	-4.611**	-4.220**	-4.365**
b) With a constant and trend. Critical values 5%=-3.49 (*) and 1%=-4.12(**)						
4	-4.401**	-2.969	-1.786	-3.749*	-3.210	-2.168
3	-1.515	-1.695	-1.806	-3.679*	-3.859*	-2.612
2	-2.023	-5.327**	-1.756	-3.939*	-4.100*	-3.435
1	-1.571	-4.691**	-2.018	-4.527**	-4.114*	-4.365**
0	-1.967	-9.721**	-0.9964	-4.564**	-4.250**	-4.305**
c) With a constant, trend and seasonals. Critical values 5%=-3.49 (*) and 1%=-4.12(**)						
4	-3.478	-2.695	-1.697	-3.690*	-3.085	-2.323
3	-2.433	-2.001	-1.773	-3.694*	-3.762*	-2.897
2	-1.769	-2.823	-1.722	-3.848*	-3.970*	-3.498*
1	-2.025	-4.489**	-1.982	-4.422**	-3.988*	-3.999*
0	-1.200	-4.602**	-0.9530	-4.443**	-4.085*	-4.032*

2. Forecasting and parameter stability

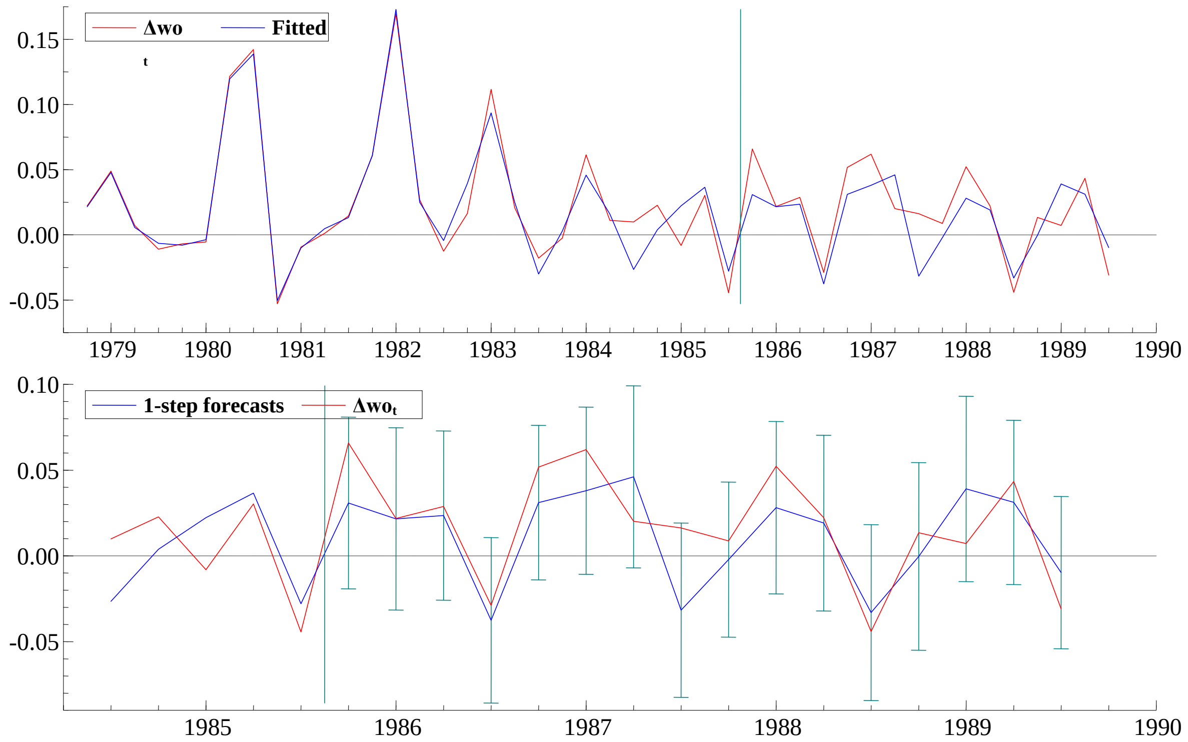
The sub-sample 1978(4)-1985(3) is symmetric with respect to the intervention. Using this sub-sample for parameter estimation, and the forecasting periods 1985(4)-1989(3) [16 observations] and 1985(4)-1993(3) [32 observations], respectively, I get results very similar to those in Table 2. The main difference regarding the estimates is that the feed-back parameter changes from -0.62 to -0.52 but is statistically significant (t = -3.05). Otherwise the parameter estimates in the two models are very similar. With respect to mis-specification tests there is one important difference, namely that the null of normally distributed errors is rejected when estimating on a symmetric sample ($\chi^2(2)$ = 9.68 [0.008]). Due to reduced sample size I am not able to carry out the heteroscedasticity and non-linearity tests. The other tests are carried out and do not statistically reveal any mis-specification. The parameter constancy forecast tests based on the symmetric sample [1978(4)-1985(3)] gives the statistics F(16,10) = 0.95 [0.55] for the forecast period 1985(4)-1989(3) and F(32,10) = 0.61 [0.86] for the longer forecast period 1985(4)-1993(3), clearly indicating constant parameters. The forecasting properties of these three models are illustrated in Figure A7 below.

Figure A7: Forecasting properties of the EqCM model

Panel A: Estimation period 1978(4)-1989(3), forecast period 1989(4)-1993(3)



Panel B: Estimation period 1978(4)-1985(3), forecast period 1985(4)-1989(3)



Panel C: Estimation period 1978(4)-1985(3), forecast period 1985(4)-1993(3)