Regional wage responsiveness to unemployment – rural–urban heterogeneity and policy implications

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Abstract

Previous studies of regional wage formation in Norway have indicated low regional wage responses to regional unemployment. However, previous analyses have not investigated whether wages are more rigid in rural areas than in urban areas, which in the case of Norway is important for the efficiency of regional differentiated payroll taxes. In the paper, the authors focus on the rural–urban nature of the wage curve in Norway. We re-estimate the wage curve on the basis of a large Norwegian microlevel dataset covering the entire Norwegian labour market during the years 2008–2013. Our findings are rural–urban heterogeneity in the wage curve, with higher unemployment elasticity of pay in the urban region than in the rural regions. The elasticity of the average rural wage curve is about 70% that of the of the urban wage curve. The authors conclude that to achieve the goals of regional policy in Norway, more rigid wages in rural areas seem to be an argument for continuing to have an active labour market policy for rural regions.

Keywords: microdata, regional wage curve, labour market, regional policy

JEL classification: J38, J42, J45, J48, J52, J61

1 Introduction

The main questions addressed in this paper are: *How responsive are Norwegian regional wages to regional unemployment?* and *How heterogeneous is regional wage responsiveness to unemployment across different types of regions?* Regional wage responsiveness to regional labour market conditions is an important

element in determining the regional equilibrium of unemployment. While a high degree of regional wage flexibility implies strong equilibrating mechanisms and where vigorous wage responsiveness to unemployment will lead to a low equilibrium rate of unemployment, whereas wage stickiness, on the other hand, implies unemployment persistence.

The question of wage responsiveness to unemployment is closely related to the wage curve literature initiated by Blanchflower and Oswald (1994), who estimated regional wage curves for a number of different countries. Although a large body of empirical literature on regional wage curves exists (described in more detail in Section 2), the empirical evidence for Norway is old and does not address variations in space. It is therefore interesting to investigate the robustness of the existing evidence using a new rich dataset for individual workers, and to provide results for a period with more variation in regional unemployment rates than in the past.

The regional heterogeneity of the Norwegian wage curve will potentially provide answers to several policy-relevant questions. Rural–urban variation in the wage curve is highly policy relevant, as it will have an impact on the effectiveness of a regional labour policy reform in Norway. We explore some dimensions of the wage curve that none of the previous analyses of Norway have addressed. We analyse regional variations in the wage curve for seven regional zones, following the regional differentiated payroll (RDP) tax reform in Norway. To support our findings of rural–urban slope variations,[1] we further investigate slope variations in the payroll tax zones between two subgroups of workers – manufacturing and non-manufacturing workers – in an attempt to provide explanations for an aggregated regional wage curve.

The remaining part of this paper is organized as follows. The next section introduces the following topics: background on wage formation in Norway, a brief overview of previous wage curve results from the literature, and why regional wage curve heterogeneity is important in light of the Norwegian labour market and a regional policy instrument. The regional policy instrument is further explained in Section 3. In Section 4, the micro-dataset features are presented. Section 5 presents the empirical model used in the paper. The results from the rural–urban wage curve variation between the RDP tax zones are presented in Section 6, and the rural–urban pattern is discussed further in Section 7, through an analysis of subgroups from the dataset. Section 8 presents the conclusions we have drawn from the results.

[1] The terms wage curve elasticity, unemployment elasticity of pay, and wage curve slope are used synonymously in this paper.

2 Background and literature review

Today, the Norwegian labour market is partially integrated into the European labour market. Since the EU expansions in 2004 and 2007,[2] the number of labour immigrants working in Norway has increased drastically, particularly since 2007. This type of labour supply shock has had a number of different implications for the labour market. For example, on the negative side, we may have social dumping challenges within some sectors.[3] Since Norway does not have a countrywide minimum wage, this is potentially a negative effect of the labour supply shock in 2007. Thus, to prevent social dumping, public authorities have agreed to minimum wages within eight sectors.

Gjelsvik et al. (2015) analyse whether the labour supply shock has altered the wage bargaining model in Norway. Their results indicate that wages have been affected, but they do not find any evidence for structural changes in the wage formation process. In general, the wage formation system in Norway is highly coordinated. Wages are negotiated by social partners and the main organizations are The Norwegian Confederation of Trade Unions (LO), which organizes blue-collar workers in manufacturing workers, and its counterpart, The Confederation of Norwegian Enterprise (NHO). Every year, the LO and NHO start the wage bargaining process at the central level. The result of central wage bargaining is an increment in existing tariffs.[4] The bargaining results provide a guideline for wage bargaining in the non-manufacturing sectors. In addition, there is also wage bargaining at the local firm level. Holden (1988) used this type of two-stage wage bargaining process to build a theoretical framework for the Norwegian bargaining situation. His model helps to explain the wage modesty[5] on the part of the central trade union (i.e. the LO). The reason for the wage modesty is that the central trade union concentrates more on employment levels in the first central bargaining round, in the knowledge that higher wages can be negotiated locally for sectors that can afford them. Centralized wage setting may imply that unfavourable shocks to regional labour markets will have effects that are more persistent because regional wages are not sufficiently adjusted.

Theoretically, a centralized wage formation system such as the one in Norway may imply high regional unemployment disparities because the centralized bargained wage floor is too high for less productive regions. To some extent, we could see higher unemployment rates for regions shown on the right-hand side in Figure 3 (in Section 4), which are regions located in northern Norway. However, Norway seems to be an exception, given its decades of low unemployment rates.

[2] $https://europa.eu/european-union/about-eu/countries\_en$

[3] Wage statistics show that Polish workers in the construction industry have wage levels below the common wage level in the industry, especially for employees on temporary contracts.

[4] The tariffs (wage levels) are part of the collective agreements between a union and either an employer or an employer's association.

[5] The term 'wage modesty' reflects how the trade union objective is not to maximize the wage growth.

One possible explanation behind the low unemployment rate in Norway is the huge role that active labour market policies play. These types of politics affect search effectiveness, matching, productivity, and wage formation (Raaum and Wulfsberg, 1995). Another mechanism behind the low regional unemployment rates is high migration responses to regional labour market conditions (Carlsen et al., 2013).

In their groundbreaking book titled The Wage Curve, Blanchflower and Oswald (1994) show a stable negative relationship between regional wages and the local unemployment rate, which they call the wage curve. Blanchflower and Oswald were able to provide a new perspective because they exploited microdata on individuals rather than the aggregated time series previously used to generate estimates, such as the Philips curve. The empirically determined wage curve from Blanchflower and Oswald (1994) was -0.1, which predicted that a 10% change in local unemployment would reduce local wages by 1%, other things being equal. The reason for such enormous interest in the wage curve was not the existence of the relationship between wages and unemployment, but rather that it showed that firms did not appear to be wage takers (as in the neoclassical theory), but instead adjusted wages downwards when local unemployment increased (Nijkamp and Poot, 2005). Furthermore, Card (1995) postulated that the wage curve seemed to be a new law of economics. According to Blanchflower and Oswald (1994) the wage curve for Norway was about -0.08 (with variations due to model specification and data collection period), which implies that despite the fact Norway is characterized by highly centralized wage formation, the wages are adjust to local labour market conditions.

Since 1994, wage curves have been estimated for many countries. The results reported in the literature are well summarized in the results of a meta-analysis performed by Nijkamp and Poot (2005). They compared the vast literature of wage curve elasticities (208 different analyses) and found that the reported values varied from -0.5 to $+0.1$. While the empirically founded wage curve elasticity reported by Blanchflower and Oswald (1994) was -0.1, the average value of the wage curve from the meta-analysis performed by Nijkamp and Poot (2005) was only -0.07. Much work (with varying objectives and data) has been done to estimate the wage curve on the basis of Norwegian data (Albæk et al., 1999, Dyrstad and Johansen, 2000, Johansen, 1995, 1997, 2002, Wulfsberg, 1997). Wulfsberg (1997) presents wage curve elasticity values in the interval range from -0.04 to -0.1, whereas Dyrstad and Johansen (2000) estimate the wage curve elasticity value as only -0.02. By comparison, the eight wage curve elasticities reported for Norway by Nijkamp and Poot (2005) have a mean of -0.05. Lastly, Albæk et al. (1999) conclude that if fixed effects are accounted for in the estimations, there is no wage curve in Norway or in any other Nordic countries. If data are available, the fixed-effects estimation is the preferred estimation method, according to Blanchflower and Oswald (1994). The main reason Albæk et al. (1999) give for the disappearing wage curve in Norway and other Nordic countries is centralized wage formation in these countries. We

expect that the altered dynamics of the EU labour market after 2004 and the availability of a new large micro-dataset enable us to make a significant contribution to wage curve estimations for Norway for two main reasons, as follows.

First, the wage drift (the change in wages relative to centrally agreed contractual wage increases due to bargaining at the local firm level) may be more important today than in the past.[6] This suggested has been made earlier by Dyrstad and Johansen (2000), who show that there was a higher regional wage response to regional unemployment in the 1980s than in the 1970s. Further, public statistics show that the wage drift for a typical industry worker in Norway was estimated as 89% of the total wage increase in 2009, which implies huge potential for local adjustment in wages.[7] Additionally, a continuously changing industry structure, for example in which an increasingly larger share of workers work in less unionised industries, will affect an aggregate wage curve estimate.

Second, the rural–urban heterogeneity of the Norwegian wage curve has not been estimated previously. Regional variations in the wage curve will have an impact on the effectiveness of a regional policy instrument in Norway, namely the regional differentiated payroll (RDP) tax (discussed in more detail in Section 3). The RDP tax is lower for companies located in regions suffering from low economic growth and outmigration. For example, companies in the most remote areas do not pay labour tax, whereas companies located in central areas pay up to 14.1% in labour tax. If regional wages do not respond closely to local unemployment, as indicated by several previous studies, RDP would be a well-suited policy measure to stimulate regional employment because peripheral wages might be too high to reflect local labour demand and productivity (Dyrstad and Johansen, 2000, Hervik and Rye, 2014).

There is an interesting new literature addressing the spatial heterogeneity of the wage curve (Baltagi and Rokicki, 2014, Deller, 2011, Longhi et al., 2006, Ramos et al., 2015). This literature includes reports of spatial spillover effects between regions as a result of unemployment in neighbouring regions affecting wages in the studied regions. Although, spatial interaction is not addressed in this paper, it could be incorporated in future studies. The results reported by Deller (2011) show that in the USA there were areas with significant negative wage curve elasticities, areas with no significant wage curve elasticities, and some areas with significant positive relationships, in line with the theory presented by Harris and Todaro (1970). Deller's results imply that the slope variations can be quite large within a country (Deller, 2011). Hence, we expected to find rural–urban variation in the wage curve elasticities between the zones covered under the Norwegian RDP reform.

[6] Data used for Norwegian wage curve analyses date back to at least the early 1990s.

[7] See Sosialdepartementet (2015) for statistical data on wage drift relative to the contractual wage increase.

3 The regional differentiated payroll (RDP) tax in Norway

One of the main purposes of Norway's regional policy in Norway is to counter depopulation and outmigration from rural to central areas. The regional differentiated payroll (RDP) tax aims to prevent depopulation and to stimulate settlement by subsidizing employment in specific municipalities. The tax has been in place since 1975, and is the most comprehensive regional state aid measure in Norway. Its importance in regional policy has increased over time, and in 2013 it was estimated that the tax resulted in approximately NOK 6.85 billion of accumulated aid to eligible undertakings.

The tax scheme is connected to the location of the employer and the aid is granted to offset private sector employers' employment costs. Subsidiaries of enterprises located in other regions or operating in other industries than the main enterprise, pay the tax rate applicable for the subsidiary's location and industry.

The aid is given in stepwise intervals for different municipalities according to a municipality–periphery index defined by the Ministry of Local Government and Modernisation. The Ministry uses the periphery index to distinguish rural areas from urban areas, and the index value is based on a composite index consisting of different statistics relating to the municipality (e.g. social, demographic, labour market characteristics).

Figure 1 shows how the municipalities are mapped in seven geographical zones according to the periphery index and which payroll tax rate they pay within the zone (Kommunal- og moderniseringsdepartementet, 2014). Companies located in white municipalities in Figure 1 are in zones that are not eligible for aid according to the scheme and pay the full tax rate of 14.1%. In the following, we refer to these zones collectively as zone 1, the urban zone. Zone 1a has a general tax rate of 14.1%, but a lower rate applies to some industries. Figure 1 shows that the shift to higher zones (from zone 2 to zone 5) occurs with increasing distance northwards and that the payroll tax level is reduced. One exception is zone 4a, which consists of three municipalities in Northern Norway: Bodø, Tromsø, and Harstad (municipalities shown in black in Figure 1). The three municipalities have a higher tax rate than surrounding municipalities in zone 4 because they have a higher periphery index value thus a higher tax rate. Although all seven zones are held separate in the empirical estimation, we hereafter refer to the six zones 1a–5 collectively as the rural zones when we analyse the empirical results.

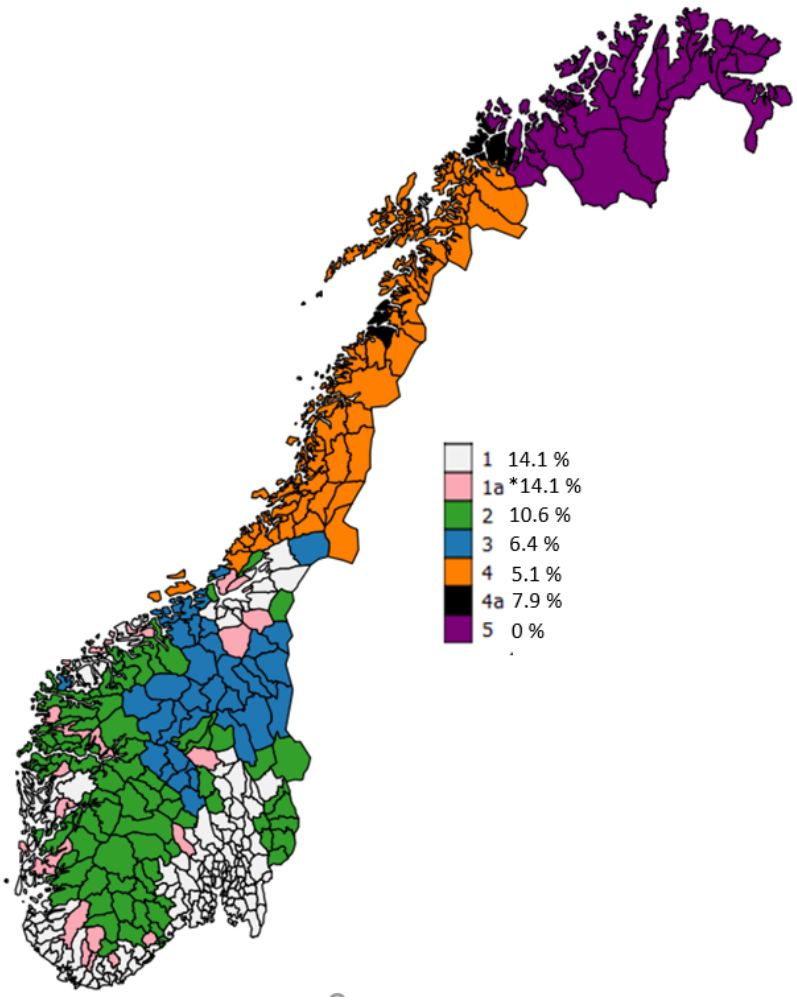

Figure 1: : The seven regional payroll tax zones in Norway (map prepared using GIS software QGIS Development Team (2009)). * Zone 1a has lower tax rate for some industries.

4 Data

The data used for this paper comprised a micro-dataset of the total workforce in Norway registered in 2013 in the age range 15–74 years. We measure wages as yearly income. We do not have any information on number of hours worked. This is a limitation of the dataset as our objective in this paper is to examine changes in wages due to changes in unemployment rates rather than in varying work hours.

To limit the effect of variation in hours worked in the empirical analysis, we used a reasonable minimum yearly wage level as the cut-off point. The minimum wage was based on annual wage data for different industries accessed from Statistics Norway.[8] We observed that the annual wage level in accommodation and food service activities had the lowest wage level during the period 2008–2013, with an average annual wage of NOK 321,000. The wage distribution for all observations is shown in Fig. 2, in which the dashed line '1' is the wage cut-off point. By excluding observations below this threshold the effect of hours worked is reduced, but not entirely eliminated. Considering the importance for the results, we performed a sensitivity analysis using other wage cut-off points at NOK 50,000, NOK 150,000, and NOK 250,000 (Section 7) to see how the wage cut-off point and thereby the share of part-time workers would affect the results.

For each person, we had up to six time observations for the period 2008–2013. In total, the dataset contained 23 million observations. After excluding observations for workers who were not active in the labour market, including only employees (not self-employed), private sector workers only, those with yearly wages above NOK 321,000, and workers with no missing data information, we were left with about 5.6 million observations. Notably, the number of total observations depended on the annual wage cut-off point. As pointed out in Section 2, wages in the public sector in Norway are defined through the central wage bargaining process. For this reason and because public sector workers not are included in the RDP tax system, individuals working in the public sector were excluded from our analysis.

Some individuals might have changed their labour market status during the period 2008–2013 or they might have migrated to or from Norway during that period, and therefore the dataset was unbalanced. For each person, we considered a number of variables that described individual characteristics: age, gender, education level, country of origin, and the type of household in which the person lived (single household and living with or without children). A complete list of variables is presented in Appendix A. The industry categories were aggregated from industry standard NACE5 (SN2007) to the industry standard A64, which is used by Statistics Norway and Eurostat. The groups with different educa-

[8] https://www.ssb.no/statbank/table/08702/tableViewLayout1/?rxid=41f5d25e-b29b-4ce6-962c-a5b8a79e4cfe.

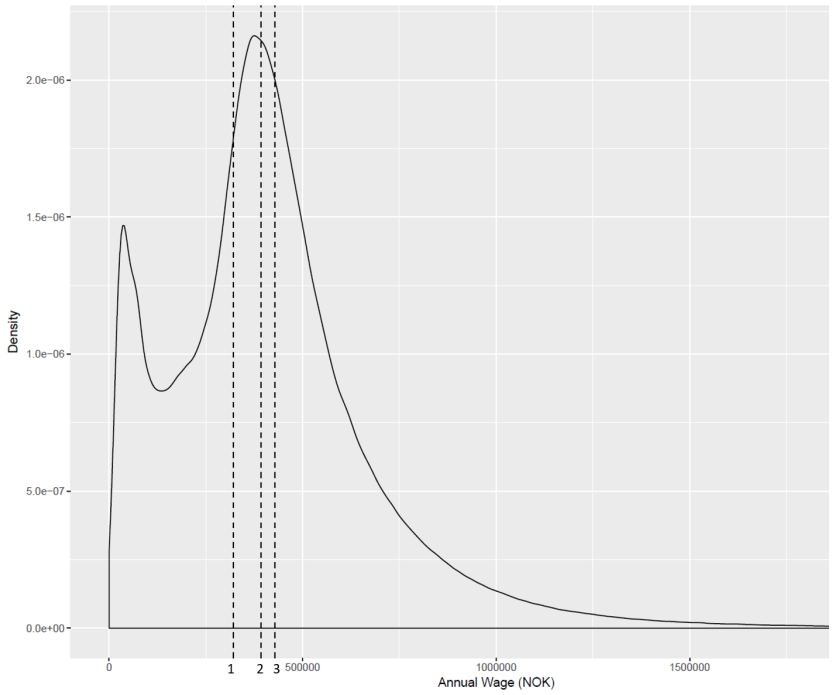

Figure 2: The wage distribution in the dataset. The dashed lines 1, 2, and 3 respectively represent the wage cut-off point (1) and the median (2) and mean (3) annual wage.

tion levels were converted and aggregated from a six-digit code (The Norwegian Standard Classification of Education (NUS) to the first digit, which gave us nine groups with different education levels. For the country of origin aggregate, we had five aggregated groups from the country-of-origin countries: Norway, Other Nordic countries, Baltic countries and Poland, Rest of Europe, and Rest of the world. Additionally, we considered variables covering individual work-related information: the industry in which each individual worked, number of persons working for the company, and whether the work relation was the main one or a secondary one. Finally, we considered information on individual wages. Wages were measured as yearly earnings based on register data on income in the third week in November each year.

We use official statistics to determine the unemployment rates for 160 different commuting regions which together cover all of Norway (Juvkam and Gundersen, 2013). The commuting regions were defined on the basis of statistics on commuting between multiplicities. The Norwegian Institute for Urban and Regional Research (NIBR) created the aggregation in 2013. Information on each individual location by residence in the microdata made it possible for us to link

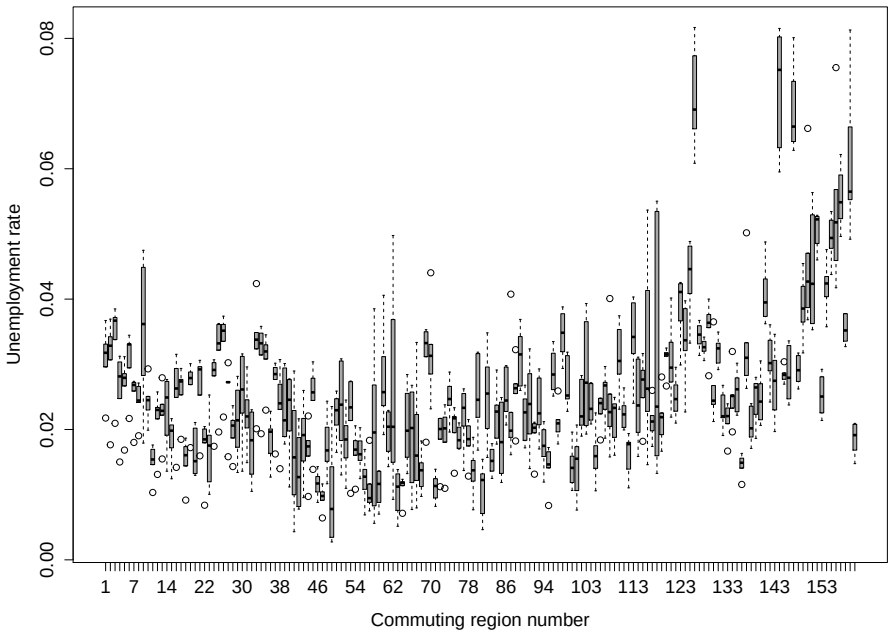

Figure 3: Unemployment rates for Norwegian commuting regions for the period 2008–2013 (Regions 1–160).

each individual to the correct commuting region. The unemployment rates for the period 2008–2013 for all 160 commuting regions are shown in a box plot in Figure 3. A general observation is that the unemployment rate in Norway was low during the period 2008–2013 about 2.5% on average. However, some regions faced unemployment rates above 8%. Another noteworthy observation is that at the national level the unemployment rate increased from 1.7% to 2.7% between 2008 and 2009, the first year of the global financial crisis. Figure 3 also indicates that there was considerable variation in unemployment rates between commuting regions and that there was some variation over time within each region. We attempted to capture the time variation in the unemployment rate within each region in the empirical model presented in Section 5, below. We controlled for the permanent differences in unemployment rates between regions by including regional dummies in the empirical model.

5 The empirical model

We have applied the empirical Mincer type regression model that has often been used in the wage curve literature (Blanchflower and Oswald, 1994, Card, 1995,

Mincer, 1974, Nijkamp and Poot, 2005):

$$ln\, W_{i,r,t} = \beta ln\,(U_{r,t}) + \gamma\,(X_{i,r,t})^{'} + \theta_r + \delta_t + e_{i,r,t} \quad (1)$$

where $W_{i,r,t}$ is a yearly wage rate for person i observed in local labour market r in period t. $U_{r,t}$ is the unemployment rate in the regional labour market in region r in different periods t. $X_{i,r,t}$ is a vector of characteristics of each individual i working in labour market r in period t. The general model allows for region and time-fixed effects, θ_r and δ_t, respectively. The region dummies and the unemployment rates are created at the same geographical level. Lastly, $e_{i,r,t}$ is an error term. Apart from the individual wage, the following variables were used for individuals in our regressions ($X_{i,r,t}$): gender, age, education level, country of origin, size of company, type of industry, living in a single or multi-person household, living with or without children, and main or secondary work relationship. Eq.(1) is estimated by including regional fixed-effects (FE) estimators. In order to capture potential endogeneity problems in Eq.(1) (c.f. Baltagi and Blien (1998)), we also used a formulation with the lagged value of the unemployment rates (FE–Lag), as well as a third specification whereby we use lagged value of the unemployment rates as an instrument for the contemporaneous unemployment rate (FE–2SLS).

For the estimation of wage curves for the seven payroll tax zones in Section 6 and Section 7, we extracted the relevant data subsets according to the descriptions in Section 3 and Section 4.

6 Empirical results

The wage curve estimations grouped by the seven payroll tax zones and the three estimators are listed in Table 1.[9] The first block in Table 1 ('Current employment, fixed effects') shows the values of the FE estimator. The majority of workers are located in payroll tax zone 1 (about 80% of all workers in Norway). The WC for these workers is -0.047. The unweighted average of the WC in rural zones 1a–5 is only 70% of the elasticity in urban zone 1. Except for in zone 4a, no elasticities in rural zones are higher than in zone 1. As mentioned in Section 3, this may be explained by zone 4a consisting of three municipalities in Northern Norway which are not rural with respect to some of the criteria used in the periphery index.

[9] To save space, we have only presented the results for in β in (1). However, the complete results are available upon request. Detailed estimates for all A64 industries and for all of the 160 commuting regions in Norway are presented in Appendix B. We used econometrics in R software (Team, 2008) for the estimations. The main supporting R packages used were: *plm* for the fixed-effects estimations (Croissant and Millo, 2008), and foreach for the parallel programming code (Analytics and Weston, 2015). We used a computer with 500 GB RAM of memory and 24 processing cores, which enabled us to use the foreach package (Analytics and Weston, 2015) for parallelizing the estimations.

Table 1: Unemployment elasticities of pay by regional variation and three different specifications of Eq. (1).

Payroll tax zone	**No. of re-gions**	β **(WC)**	**t-value**	R^2	df	**n**	**N**
		Current unemployment, fixed effects					
1	39	−0.047 (−0.047; −0.046)	−137.2	0.26	3 550	1 089	4 639
1a	31	−0.031 (−0.033; −0.029)	−28.9	0.30	185	64	249
2	34	−0.025 (−0.027; −0.024)	−26.7	0.27	148	51	199
3	15	−0.039 (−0.043; −0.035)	−19.5	0.29	59	21	80
4	38	−0.020 (−0.023; −0.018)	−16.3	0.30	203	71	274
4a	03	−0.056 (−0.062; −0.050)	−18.0	0.30	91	36	126
5	19	−0.030 (−0.037; −0.023)	−8.5	0.27	56	21	78
		Lagged unemployment, fixed effects					
1	39	−0.019 (−0.020; −0.018)	−58.1	0.25	2 507	1 089	4 639
1a	31	−0.017 (−0.019; −0.015)	−15.3	0.28	126	64	249
2	34	−0.016 (−0.018; −0.014)	−16.1	0.25	101	51	199
3	15	−0.019 (−0.023; −0.015)	−9.1	0.27	40	21	80
4	38	−0.006 (−0.008; −0.003)	−4.4	0.28	138	71	274
4a	03	−0.013 (−0.019; −0.007)	−4.5	0.29	63	36	126
5	19	−0.020 (−0.028; −0.012)	−5.0	0.24	38	21	78
		Current unemployment, fixed effects 2SLS*					
1	39	−0.112 (−0.115; −0.108)	−58.0	0.25	2 507	1089	4 639
1a	31	−0.068 (−0.076; −0.059)	−15.2	0.28	126	64	249
2	34	−0.072 (−0.081; −0.063)	−15.9	0.24	101	51	199
3	15	−0.088 (−0.107; −0.069)	−9.0	0.27	40	21	80
4	38	−0.026 (−0.038; −0.015)	−4.4	0.28	138	71	274
4a	03	−0.131 (−0.188; −0.074)	−4.5	0.28	63	36	126
5	19	2.194 (−0.558; 4.947)	1.6	0.01	38	21	78

Notes: *Current unemployment treated as endogenous and instrumented using lagged unemployment as an instrument.
The 95% confidence intervals are shown in parentheses. The t-statistics and confidence intervals are based on clustered standard errors clustered on individuals (Arai, 2011). Number of years included in the estimation are the same for all regions, T = 6. The numbers of n (unique workers), N (number of observations) and df are all reported in thousands.

In contrast to zone 4a, payroll tax zone 5 consists of the most remote regions in northern Norway, and the results for this zone deserve some discussion. While the FE wage curve estimate for workers in zone 5 a significant unemployment elasticity of −0.03, we found non-significant results in the 2SLS wage curve estimate. There are some patterns within zone 5 that may have contributed to this result; First, we see large variations in unemployment rates between the commuting regions within zone 5. In Figure 3 we see that unemployment rates among commuting zones 140–160 (the commuting regions falling inside

zone 5) vary a lot. E.g. the *within variance* of the unemployment rate is an order of magnitude smaller than the *between variance* in unemployment rates in zone 5 (See Table A.2). In contrast, for most of the other six payroll tax zones the *within* and *between variance* is more equal. The large *between variance* in unemployment rates may cause mixed results for different commuting zones within zone 5. To investigate if this is the case, we estimated Eq. (1) for each of the 160 commuting zones.[10] In particular, we found very mixed results for the commuting regions within zone 5. For several commuting regions we found positive FE elasticities, while some have values below -0.1, which are all quite far from the estimates for other zones. In Table A.2 we also see that the average unemployment rate for zone 5 is 4 percent, almost double as high as the unemployment rate for the other zones. Previously Johansen (1995, 1997) provide empirical evidence of a strongly non-linear aggregate wage curve for Norway. The empirical wage equation implies that the wage curve is very steep for low levels of unemployment, but becomes almost flat for an unemployment rate above 3 percent. This could also cause mixed results for zone 5. A second reason for the non-significant 2SLS wage curve for zone 5, may be that it is the smallest region and with low population density, yet a large share of Norway's indigenous population lives here. The indigenous population mainly works in the reindeer husbandry industry, which is an industry not interacting with changes in labour market characteristics. Also the starting up of the large Snøhvit gas field in zone 5 in 2008; i.e., in the first year of our dataset, may have affected the local job market and wages. In Section 7, we see that the mixed results for zone 5 mainly concern non-manufacturing workers and not manufacturing workers.

Questions about the FE estimator have been raised in the literature (e.g. Baltagi and Blien (1998)) because of the endogeneity in contemporaneous unemployment rates in Eq. (1). Hence, either treating unemployment as predetermined or using the predetermined unemployment rate as an instrument of contemporaneous unemployment is a reformulation of Eq. (1) to ensure exogeneity of unemployment rates. In Table 1, we include both the FE–Lag and FE–2SLS estimator results. When unemployment rates were treated as predetermined, we found a drop in the elasticities in all seven zones. However, the unweighted average wage curve elasticity in zones 1a–5 relative to the one in zone 1 stayed almost constant, at about 80% of the urban wage curve. The general drop in absolute values of the seven wage curves from a formulation with contemporaneous unemployment rates to the predetermined rates coincided with results reported in the literature (e.g., Baltagi et al. (2012)).

The FE–2SLS formulation in the third block in Table 1 shows the overall highest WC estimates. For zones 1 and 4a, the elasticities are even below the common -0.1. Interestingly, for this estimator, the ratio between rural–urban WC esti-

[10] See Appendix B, Figure A.1; the commuting regions within the circle or in Table A.4, regions 140–160.

mates is very similar to the results obtained using the FE and FE–Lag estimator (except for the not-significant elasticity for zone 5). The unweighted average wage curve elasticity of the FE–2SLS in zones 1a–4a relative to the one zone 1 was also about 70%. That irrespective of the formulation of Eq. (1) we find that the urban wage curve is more elastic than the rural wage curve, gives robustness to the result. To find out what might explain this difference, we further estimated the wage curve using different wage cut-off points and two sectoral distinctions with different relations to the coordinated wage bargaining in Norway. The results are discussed in Section 7.

7 Discussion and sensitivity analysis

A criticism of the higher wage curve elasticities we obtained compared with previous analyses for Norway is that they are based on yearly wages. Blanchflower and Oswald (1994) and Card (1995) discuss the possible effects of using hourly, weekly, or yearly earnings as a dependent variable in the estimation. Blanchflower and Oswald (1994) did not find significantly different results when using any of the three in their estimations. However, the empirical results in Card (1995) shows that the wage curve will be overestimated if yearly wages are used instead of hourly wages due to the correlation between unemployment rates and hours worked.

Due to limitations in our data, we could not control for hours worked in a comprehensive manner. However, variations in hours worked are likely to be less important for Norway than for the USA and the UK, since the Norwegian labour market is heavily regulated with regard to number of hours worked. Our method to control for part-time employment was to remove observations with a yearly wage lower than NOK 321,000. To verify robustness of our results we investigated the effects on the FE–2SLS estimates for three other cut-off values: NOK 50,000, NOK 150,000, and NOK 250,000. The sensitivity results are presented in Table 3. When we compared the FE–2SLS in Table 1 with the FE–2SLS in Table 3, we found that elasticities were dampened when we increased the wage cut-off point. In other words, the fewer low-income observations were in the data set, the lower the estimated elasticity. In particular, we found large reductions in the elasticity in the zone 1, the urban zone, and zone 4a, the rural zone with urban characteristics. For zone 1 the elasticities were reduced stepwise from -0.164 for observations earning over NOK 50,000 to -0.112 for the ones earning over 321,000. For zone 4a the wage curve elasticity reduction is not monotone, but drops from -0.176 to -0.131 at the same wage cut-off points as for zone 1. In total, these results show that the elasticities tend to stabilize towards the final wage cut-off point on NOK 321,000.

In line with Card (1995) our results have a positive correlation between hours worked and unemployment rates, which gives an upward bias in the wage curve elasticity. However, part of the higher elasticities when including more lower in-

come workers could have been due to the fact that part-time and/or low-income workers do in fact have a higher wage response to unemployment than workers above the wage cut-off point. Another implication of this analysis concerns the rigidity of wages in rural areas. It seems that more variation in the number of hours worked affected the wage curve more in the urban zone (and zone 4a) than in the rural zones.

Table 2: Unemployment elasticities of pay by regional variation and different wage cut-off points. Eq. (1) estimated with fixed effects, 2SLS*.

Payroll tax zone	β **(WC)**	**t-statistic**	R^2	df	**n**	**N**
Observations with yearly wage > NOK 50,000						
1	−0.164 (−0.169; −0.159)	−64.4	0.14	3455	1548	6512
1a	−0.082 (−0.095; −0.070)	−13.2	0.14	190	99	380
2	−0.092 (−0.105; −0.079)	−13.8	0.12	154	81	311
3	−0.094 (−0.120; −0.068)	−7.0	0.11	68	36	138
4	−0.039 (−0.057; −0.021)	−4.3	0.14	209	113	426
4a	−0.176 (−0.256; −0.096)	−4.3	0.13	89	54	186
5	−23.88 (−271; 223)	−0.2	0.00	59	34	124
Observations with yearly wage > NOK 150,000						
1	−0.133 (−0.136; −0.129)	−73.7	0.19	3171	1371	5865
1a	−0.077 (−0.086; −0.069)	−18.4	0.21	172	86	338
2	−0.071 (−0.080; −0.062)	−15.8	0.18	140	70	275
3	−0.095 (−0.111; −0.078)	−11.4	0.18	61	31	119
4	−0.032 (−0.044; −0.021)	−5.4	0.20	190	97	375
4a	−0.121 (−0.175; −0.068)	−4.4	0.20	81	47	164
5	16.25 (−89; 121)	0.3	0.00	53	29	108
Observations with yearly wage > NOK 250,000						
1	−0.119 (−0.122; −0.116)	−76.8	0.23	2867	1220	5262
1a	−0.072 (−0.079; −0.065)	−20.5	0.26	152	74	295
2	−0.072 (−0.079; −0.065)	−20.0	0.23	123	60	238
3	−0.089 (−0.102; −0.076)	−13.1	0.25	52	26	101
4	−0.034 (−0.043; −0.024)	−7.0	0.26	168	83	327
4a	−0.114 (−0.158; −0.070)	−5.0	0.26	73	41	146
5	3.274 (−1.141; 7.688)	1.5	0.00	46	25	94
Observations with yearly wage > NOK 321,000 (Results from Table 1)						
1	−0.112 (−0.115; −0.108)	−58.0	0.25	2 507	1089	4 639
1a	−0.068 (−0.076; −0.059)	−15.2	0.28	126	64	249
2	−0.072 (−0.081; −0.063)	−15.9	0.24	101	51	199
3	−0.088 (−0.107; −0.069)	−9.0	0.27	40	21	80
4	−0.026 (−0.038; −0.015)	−4.4	0.28	138	71	274
4a	−0.131 (−0.188; −0.074)	−4.5	0.28	63	36	126
5	2.194 (−0.558; 4.947)	1.6	0.01	38	21	78

Notes: The notes for Table 1 are valid for this table as well.

In the analysis in this paper we have excluded public sector workers. Public sector workers all fall under the central wage coordination, and their inclusion would have given a bias in the wage curve estimates.[11] We have only considered private sector workers that are included in the RDP tax system, as explained

[11] This group of workers is represented as workers in industries 54–57 in Table A.2. According to the FE estimate, there is no wage curve in the public sector in Norway.

in Section 3, and the results in Table 1 and 2 cover only private sector workers. Still, private sector workers are a heterogeneous group in relation to the wage bargaining, which we considered in a separate sensitivity analysis As in many countries, manufacturing workers in Norway are more unionized than workers in other sectors. Every year, the representatives of manufacturing workers start the national wage bargaining process. Due to this relatively high coordination level in the wage formation process in this part of the private sector, we expected to see lower wage curve elasticities for these workers than for the other private sector workers. Notably, previous analyses of the wage curve in Norway have only considered the manufacturing workers. In order to determine whether a distinction between manufacturing and non-manufacturing workers could provide additional insights into the empirical rural–urban variation, we present results for these two groups in Table 3.

Surprisingly, for most zones we found higher unemployment elasticities of pay for manufacturing workers than for non-manufacturing workers. Although key wage additions for manufacturing industry are the guiding principles for central wage settlement in the non-manufacturing industries such as wholesale, construction, accommodation and food service, we do not know much about the relative importance of local wage additions in these sectors compared to the manufacturing industry. Moreover, the non-manufacturing industry is a far more heterogeneous aggregate than the manufacturing industry, ranging from primary industry on the one hand to financial service industry at the other. With regard to the rural–urban variation, the non-manufacturing workers in the urban zone showed higher elasticities than non-manufacturing workers in rural zones. In contrast, the manufacturing workers had more mixed results along this axis (e.g. see the results for zone 3). As the non-manufacturing workers are the dominant worker group in the aggregate results, their results will largely characterize the rural–urban pattern we found in Section 6.

Table 3: Unemployment elasticities of pay by regional variation and manufacturing workers versus non-manufacturing workers. Eq. (1) estimated with fixed effects, 2SLS*.

Payroll tax zone	β **(WC)**	**t-statistic**	R^2	df	**n**	**N**
		Manufacturing workers				
1	−0.129 (−0.140; −0.118)	−35.1	0.27	212	138	467
1a	−0.082 (−0.103; −0.061)	−7.6	0.25	16	11	36
2	−0.066 (−0.083; −0.050)	−7.8	0.22	12	8	27
3	−0.267 (−0.412; −0.122)	−3.6	0.25	3	2	7
4	0.015 (−0.001; 0.032)	1.9	0.28	10	8	26
4a	−0.228 (−0.572; −0.117)	−1.3	0.27	2	2	5
5	−0.134 (−0.630; 0.365)	−0.5	0.27	1	1	8
		Non-manufacturing workers				
1	−0.094 (−0.099; −0.090)	−41.2	0.24	1848	892	3568
1a	−0.054 (−0.065; −0.043)	−9.5	0.28	75	44	157
2	−0.045 (−0.057; −0.032)	−7.1	0.25	60	36	127
3	−0.068 (−0.090; −0.047)	−6.4	0.26	27	17	59
4	−0.020 (−0.041; 0.000)	−1.9	0.28	98	56	203
4a	−0.128 (−0.188; −0.068)	−4.2	0.29	55	32	112
5	0.822 (−0.081; 1.724)	1.8	0.06	29	18	63

Notes: The notes for Table 1 are valid for this table as well. While the cut-off wage for non-manufacturing workers is the same as the one we used previously, 321,000 NOK, the wage cut-off point for the manufacturing workers is set to 453,000 NOK. The two wage cut-off points are based on the same source as referenced in Footnote 8.

To summarize our findings of the rural–urban wage curve in this section, the representation of low-income and/or part-time workers affected the results for the urban area and zone 4a more than the results for the (other) rural areas. When restricting the dataset to higher earning workers, we found a larger drop in the wage curve elasticities in the urban zone than in the rural zones. This may be due to higher wage curve elasticities for part-time workers. However, the drop may also be explained partly by variations in hours worked, for which we did not have information in the dataset. This left a less clear conclusion regarding the rural–urban variation in the wage curve discussed in Section 6, because the variation in hours worked is likely to be higher in the urban zone than in the rural zones. Furthermore, the clearest tendency towards higher elasticities in the urban zone was found for non-manufacturing workers, who to a lesser degree are part of the coordinating wage formation in Norway. This group is also the dominant worker group in each zone, and thus dominates the aggregated rural–urban wage curve results in Table 1.

8 Concluding remarks

The wage curve, which indicates how wages respond to changes in regional unemployment, has received much attention for several decades. A number of papers report a typical unemployment elasticity of pay of about -0.1 (e.g. Blanchflower and Oswald (1994)). Estimates for the Norwegian labour market have resulted in lower values (Albæk et al., 1999, Dyrstad and Johansen, 2000). Compared to other countries such as the USA and the UK, wages in Norway tend to be more rigid, due to a very centralized wage bargaining process in many sectors, which does not account for variety or changes in local unemployment rates.

We give insight into regional heterogeneity of the wage curve for Norway using a previously unexplored large micro-data set covering the period 2008–2013. Given the same specifications and estimation method, our results are consistent with the results in previous studies for Norway from the 90s. However, using the fixed effects instrumental variable method (which was not used in previous research) the estimated unemployment elasticity for Norway is much higher and more in line with the results in Blanchflower and Oswald (1994).

Concerning the rural–urban heterogeneity of the wage curve, we were interested in determining whether there were regional variations, because such differences would affect the efficiency of regional policy in Norway. All workers were grouped into seven payroll tax zones following the geographical grouping used in present regional policies. Generally, we found a significant wage curve for all zones in all specifications, with one exception: the most rural zone 5. For this zone we did not find a significant wage curve with the FE-2SLS estimation. We found higher average wage curve elasticities for zone 1, the urban region. Despite the fact that not all of the results from the regional heterogeneity analysis point in the same direction, we observed that rural regions according to the regional payroll tax reform in Norway tend to have lower unemployment elasticities than the urban zone. One exception was region 4a in northern Norway, for which some regional characteristics and results of the analysis were more similar to the urban region than to other rural regions. It might be worthwhile to investigate whether the larger cities in zone 4a could be charged a higher (but still moderated) tax rate in the RDP tax system. However, large differences in payroll tax rates to nearby regions in the north of Norway might provide incentives to undesired tax-motivated local business re-location.

The overall picture is that regionally differentiated payroll taxes are an efficient instrument to adjust the wage floor because rural wages in Norway are rigid, and may be too high given local labour demand and productivity. Hence the rigidity of rural wages makes regional differentiated payroll taxes to be a relevant instrument to achieve the goals of the regional policy in Norway, e.g., to preserve the existing population settlement pattern.

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A Micro data

Table A.1: Micro data variables

Variabellist	
Dependent variable	
Wage	log yearly income
Independent variable	
Unemployment	log regional unemployment rate
Year2008	a (1.0) dummy for year 2008
Year2009	a (1.0) dummy for year 2009
Year2010	a (1.0) dummy for year 2010
Year2011	a (1.0) dummy for year 2011
Year2012	a (1.0) dummy for year 2012
Year2013	a (1.0) dummy for year 2013
Work relation	a (1.0) dummy if main work relation
Employee	a (1.0) dummy if employee (not self-employed)
Age	age of the individual in representative year
Gender	a (1.0) dummy if male
Single household	a (1.0) dummy if living in a single household
Couples without children	a (1.0) dummy if living in a household with children
Size of establishment	the number of workers (full and part-time)
Industry dummies	
Crop and animal production, hunting and related service activities	a (1.0) industry dummy if worked in industry
Forestry and logging	a (1.0) industry dummy if worked in industry
Fishing and aquaculture	a (1.0) industry dummy if worked in industry
Mining and quarrying	a (1.0) industry dummy if worked in industry
Manufacture of food products, beverages and tobacco products	a (1.0) industry dummy if worked in industry
Manufacture of textiles, wearing apparel and leather products	a (1.0) industry dummy if worked in industry
Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	a (1.0) industry dummy if worked in industry
Manufacture of paper and paper products	a (1.0) industry dummy if worked in industry
Printing and reproduction of recorded media	a (1.0) industry dummy if worked in industry
Manufacture of coke and refined petroleum products	a (1.0) industry dummy if worked in industry
Manufacture of chemicals and chemical products	a (1.0) industry dummy if worked in industry
Manufacture of basic pharmaceutical products and pharmaceutical preparations	a (1.0) industry dummy if worked in industry
Manufacture of rubber and plastic products	a (1.0) industry dummy if worked in industry
Manufacture of other non-metallic mineral products	a (1.0) industry dummy if worked in industry
Manufacture of basic metals	a (1.0) industry dummy if worked in industry
Manufacture of fabricated metal products, except machinery and equipment	a (1.0) industry dummy if worked in industry
Manufacture of computer, electronic and optical products	a (1.0) industry dummy if worked in industry
Manufacture of electrical equipment	a (1.0) industry dummy if worked in industry
Manufacture of machinery and equipment n.e.c.	a (1.0) industry dummy if worked in industry
Manufacture of motor vehicles, trailers and semi-trailers	a (1.0) industry dummy if worked in industry
Manufacture of other transport equipment	a (1.0) industry dummy if worked in industry
Manufacture of furniture; other manufacturing	a (1.0) industry dummy if worked in industry
Repair and installation of machinery and equipment	a (1.0) industry dummy if worked in industry
Electricity, gas, steam and air conditioning supply	a (1.0) industry dummy if worked in industry
Water collection, treatment and supply	a (1.0) industry dummy if worked in industry
Sewerage; waste collection, treatment and disposal activities; materials recovery; remediation activities and other waste management services	a (1.0) industry dummy if worked in industry
Construction	a (1.0) industry dummy if worked in industry
Wholesale and retail trade and repair of motor vehicles and motorcycles	a (1.0) industry dummy if worked in industry
Wholesale trade, except of motor vehicles and motorcycles	a (1.0) industry dummy if worked in industry
Retail trade, except of motor vehicles and motorcycles	a (1.0) industry dummy if worked in industry
Land transport and transport via pipelines	a (1.0) industry dummy if worked in industry
Water transport	a (1.0) industry dummy if worked in industry
Air transport	a (1.0) industry dummy if worked in industry
Warehousing and support activities for transportation	a (1.0) industry dummy if worked in industry
Postal and courier activities	a (1.0) industry dummy if worked in industry
Accommodation and food service activities	a (1.0) industry dummy if worked in industry
Publishing activities	a (1.0) industry dummy if worked in industry
Motion picture, video and television programme production, sound recording and music publishing activities; programming and broadcasting activities	a (1.0) industry dummy if worked in industry
Telecommunications	a (1.0) industry dummy if worked in industry
Computer programming, consultancy and related activities; information service activities	a (1.0) industry dummy if worked in industry
Financial service activities, except insurance and pension funding	a (1.0) industry dummy if worked in industry
Insurance, reinsurance and pension funding, except compulsory social security	a (1.0) industry dummy if worked in industry
Activities auxiliary to financial services and insurance activities	a (1.0) industry dummy if worked in industry
Real estate activities (excluding imputed rents)	a (1.0) industry dummy if worked in industry
Imputed rents of owner-occupied dwellings	a (1.0) industry dummy if worked in industry
Legal and accounting activities; activities of head offices; management consultancy activities	a (1.0) industry dummy if worked in industry

Table A.1: Micro data variables

Variabellist	
Architectural and engineering activities; technical testing and analysis	a (1.0) industry dummy if worked in industry
Scientific research and development	a (1.0) industry dummy if worked in industry
Advertising and market research	a (1.0) industry dummy if worked in industry
Other professional, scientific and technical activities; veterinary activities	a (1.0) industry dummy if worked in industry
Rental and leasing activities	a (1.0) industry dummy if worked in industry
Employment activities	a (1.0) industry dummy if worked in industry
Travel agency, tour operator reservation service and related activities	a (1.0) industry dummy if worked in industry
Security and investigation activities; services to buildings and landscape activities; office administrative, office support and other business support activities	a (1.0) industry dummy if worked in industry
Public administration and defence; compulsory social security	a (1.0) industry dummy if worked in industry
Education	a (1.0) industry dummy if worked in industry
Human health activities	a (1.0) industry dummy if worked in industry
Social work activities	a (1.0) industry dummy if worked in industry
Creative, arts and entertainment activities; libraries, archives, museums and other cultural activities; gambling and betting activities	a (1.0) industry dummy if worked in industry
Sports activities and amusement and recreation activities	a (1.0) industry dummy if worked in industry
Activities of membership organisations	a (1.0) industry dummy if worked in industry
Repair of computers and personal and household goods	a (1.0) industry dummy if worked in industry
Other personal service activities	a (1.0) industry dummy if worked in industry
Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	a (1.0) industry dummy if worked in industry
Activities of extra-territorial organisations and bodies	a (1.0) industry dummy if worked in industry
Regional dummies	
Regional dummies for housing and labour marked region by residence (160 different regions)	a (1.0) region dummy if resident in region
Education dummies	
No education and pre-school education	a (1.0) education dummy if highest education level
Primary education	a (1.0) education dummy if highest education level
Lower secondary education	a (1.0) education dummy if highest education level
Upper secondary education, basic education	a (1.0) education dummy if highest education level
Upper secondary, final year	a (1.0) education dummy if highest education level
Post-secondary non-tertiary education	a (1.0) education dummy if highest education level
First stage of tertiary education, undergraduate level	a (1.0) education dummy if highest education level
First stage of tertiary education, graduate level	a (1.0) education dummy if highest education level
Second stage of tertiary education (postgraduate education)	a (1.0) education dummy if highest education level
Unspecified	a (1.0) education dummy if highest education level
Country of origin dummies	
Norway	a (1.0) country dummy if from Norway
Rest of Nordic countries	a (1.0) country dummy if from other Nordic countries
Baltic and Poland	a (1.0) country dummy if from Baltic countries or Poland
Rest of Europe	a (1.0) country dummy if from other European countries
Rest of the World	a (1.0) country dummy if from countries outside Europe

B Supplementary results

Table A.2: Means and variances in unemployment rates in the seven zones.

	Payroll zone						
	1	1a	2	3	4	4a	5
Mean (U)	0.025	0.025	0.020	0.021	0.027	0.022	0.040
Variance (Between)	0.00003	0.00002	0.00006	0.00004	0.00010	0.00000	0.00027
Variance (Within)	0.00002	0.00002	0.00004	0.00003	0.00003	0.00001	0.00004
Variance (Within)/Variance (Between)	0.80	1.02	0.59	0.67	0.32	11.67	0.13

Table A.3: Unemployment elasticities of pay in different industries

Industries (A64)	β **(WC)**	**t-statistic**	R^2	**n**	**N**
1 Crop and animal production. hunting and related service activities	-0.023	-4.77	0.17	19 463	44 152
2 Forestry and logging	-0.060	-6.03	0.20	2 827	8 972
3 Fishing and aquaculture	-0.016	-2.89	0.26	9 402	29 586
4 Mining and quarrying	-0.021	-12.86	0.29	75 344	292 043
5 Manufacture of food products. beverages and tobacco products	-0.025	-15.72	0.23	62 977	227 056
6 Manufacture of textiles. wearing apparel and leather products	-0.034	-6.40	0.19	5 888	19 981
7 Manufacture of wood and of products of wood and cork. except furniture; manufacture of articles of straw and plaiting materials	-0.060	-23.72	0.22	18 415	67 281
8 Manufacture of paper and paper products	-0.009	-1.67	0.13	6 392	23 235
9 Printing and reproduction of recorded media	-0.067	-16.05	0.12	9 208	33 898
10 Manufacture of coke and refined petroleum products	0.030	2.68	0.28	1 741	6 550
11 Manufacture of chemicals and chemical products	-0.028	-8.94	0.27	14 128	53 275
12 Manufacture of basic pharmaceutical products and pharmaceutical preparations	-0.016	-2.39	0.29	3 774	16 018
13 Manufacture of rubber and plastic products	-0.041	-8.58	0.19	7 371	25 382
14 Manufacture of other non-metallic mineral products	-0.058	-17.66	0.20	14 797	52 936
15 Manufacture of basic metals	-0.047	-21.72	0.21	14 600	55 982
16 Manufacture of fabricated metal products. except machinery and equipment	-0.079	-34.68	0.21	33 284	116 753
17 Manufacture of computer. electronic and optical products	-0.041	-10.51	0.22	12 488	46 621
18 Manufacture of electrical equipment	-0.063	-15.63	0.23	11 920	43 839
19 Manufacture of machinery and equipment n.e.c.	-0.055	-19.18	0.20	29 950	104 151
20 Manufacture of motor vehicles. trailers and semi-trailers	-0.067	-11.95	0.20	5 397	18 411
21 Manufacture of other transport equipment	-0.029	-13.53	0.22	38 379	125 145
22 Manufacture of furniture; other manufacturing	-0.029	-9.02	0.16	13 411	48 616
23 Repair and installation of machinery and equipment	-0.042	-15.60	0.19	29 210	91 907
24 Electricity. gas. steam and air conditioning supply	-0.014	-5.48	0.30	19 610	81 216
25 Water collection. treatment and supply	0.010	1.56	0.36	3 201	10 334
26 Sewerage; waste collection. treatment and disposal activities; materials recovery; remediation activities and other waste management services	-0.027	-8.33	0.25	16 554	55 672
27 Construction	-0.057	-54.33	0.22	234 732	861 297
28 Wholesale and retail trade and repair of motor vehicles and motorcycles	-0.041	-22.40	0.25	55 529	213 707
29 Wholesale trade. except of motor vehicles and motorcycles	-0.048	-41.00	0.20	155 593	554 653
30 Retail trade. except of motor vehicles and motorcycles	-0.020	-18.30	0.19	234 794	728 365
31 Land transport and transport via pipelines	-0.046	-26.20	0.12	75 272	260 997

Industries (A64)	β (WC)	t-statistic	R^2	n	N
32 Water transport	-0.010	-3.25	0.17	33 060	117 019
33 Air transport	-0.052	-10.36	0.14	8 980	35 555
34 Warehousing and support activities for transportation	-0.047	-20.85	0.18	44 768	156 687
35 Postal and courier activities	-0.032	-13.24	0.20	26 202	94 412
36 Accommodation and food service activities	-0.039	-19.06	0.18	95 338	259 864
37 Publishing activities	-0.055	-21.59	0.21	35 570	122 956
38 Motion picture. video and television programme production. sound recording and music publishing activities; programming and broadcasting activities	-0.021	-4.77	0.22	14 229	50 473
39 Telecommunications	-0.009	-3.11	0.33	19 664	71 621
40 Computer programming. consultancy and related activities; information service activities	-0.050	-22.00	0.22	58 510	204 611
41 Financial service activities. except insurance and pension funding	-0.139	-64.77	0.17	39 652	168 215
42 Insurance. reinsurance and pension funding. except compulsory social security	-0.044	-13.40	0.26	14 485	58 509
43 Activities auxiliary to financial services and insurance activities	-0.149	-18.54	0.07	13 822	45 465
44 Real estate activities	-0.037	-8.54	0.16	34 939	103 817
45 Legal and accounting activities; activities of head offices; management consultancy activities	-0.025	-8.50	0.17	56 665	189 429
46 Architectural and engineering activities; technical testing and analysis	-0.040	-18.14	0.20	71 895	248 824
47 Scientific research and development	-0.011	-3.66	0.31	21 127	76 819
48 Advertising and market research	-0.062	-10.76	0.15	13 096	36 577
49 Other professional. scientific and technical activities; veterinary activities	-0.033	-5.70	0.14	15 134	41 516
50 Rental and leasing activities	-0.070	-13.29	0.21	12 037	33 499
51 Employment activities	-0.075	-19.22	0.16	88 086	149 758
52 Travel agency. tour operator reservation service and related activities	-0.041	-7.65	0.21	8 387	26 715
53 Security and investigation activities; services to buildings and landscape activities; office administrative. office support and other business support activities	-0.018	-10.26	0.19	104 502	303 140
54 Public administration and defence; compulsory social security	0.002	2.41	0.29	202 288	792 085
55 Education	0.002	2.02	0.27	259 400	1 008 968
56 Human health activities	-0.009	-9.05	0.22	242 265	942 464
57 Social work activities	0.002	3.38	0.26	408 721	1 485 095
58 Creative. arts and entertainment activities; libraries. archives. museums and other cultural activities; gambling and betting activities	0.003	0.98	0.24	21 692	71 297
59 Sports activities and amusement and recreation activities	-0.022	-4.58	0.15	23 072	58 989
60 Activities of membership organisations	0.005	2.32	0.25	33 771	115 300
61 Repair of computers and personal and household goods	-0.023	-2.76	0.19	2 933	9 546
62 Other personal service activities	-0.027	-7.37	0.19	21 450	71 667
63 Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	0.014	0.55	0.18	667	1 646
64 Activities of extra-territorial organisations and bodies	0.023	0.73	0.32	223	746

Notes: T=1-6, and the dummies and explanatory variables specified in Table A.1 are included as controls. The t-statistic are based on clustered standard errors, clustered on commuting region (Arai, 2011).

Table A.4: Unemployment elasticities of pay (FE estimator) for all commuting regions. Columns 1–5 indicate for each region how many municipalities are located in each payroll zone. When discussing unemployment or WC elasticities for payroll tax zones in the paper, we have used the detailed information on where the municipalities in each commuting region are located.

Commuting region	1	1a	2	3	4	4a	5	β (WC)	t-statistic	R^2	n	N
1 Halden	2	0	0	0	0	0	0	-0.03	-6.7	0.22	10031	40 626
2 Moss	3	0	0	0	0	0	0	-0.05	-11.9	0.17	17041	62 019

Commuting region	1	1a	2	3	4	4a	5	β **(WC)**	**t-statistic**	R^2	**n**	**N**
3 Fredrikstad/Sarpsborg	5	0	0	0	0	0	0	-0.07	-12.2	0.18	46809	171 115
4 Askim/Eidsberg	5	0	0	0	0	0	0	-0.07	-14.4	0.20	13865	53 991
5 Oslo	30	0	0	0	0	0	0	-0.06	-74.7	0.17	466064	1 919 232
6 Kongsvinger	2	4	0	0	0	0	0	-0.05	-11.2	0.20	15407	60 508
7 Hamar	4	0	0	0	0	0	0	-0.07	-18.1	0.20	29147	118 306
8 Elverum	1	2	0	0	0	0	0	-0.06	-7.1	0.20	8566	32 796
9 Trysil/Engerdal	0	0	1	1	0	0	0	-0.04	-3.2	0.16	2489	9 708
10 Stor-Elvdal	0	0	0	1	0	0	0	-0.05	-1.5	0.23	698	2 558
11 Tynset	0	0	0	5	0	0	0	-0.04	-3.8	0.22	3943	14 994
12 Lillehammer	2	1	0	0	0	0	0	-0.05	-12.0	0.18	12559	48 257
13 Gjøvik	3	2	0	0	0	0	0	-0.03	-11.7	0.20	22713	93 301
14 Dovre	0	0	0	2	0	0	0	-0.10	-4.6	0.19	1563	5 741
15 Skjåk/Lom	0	0	0	2	0	0	0	-0.06	-3.4	0.22	1531	5 846
16 Midt-Gudbrandsdal	0	0	3	0	0	0	0	-0.03	-6.7	0.18	4548	17 475
17 Sel	0	0	0	2	0	0	0	-0.05	-5.4	0.20	3148	12 439
18 Fagernes	0	0	0	6	0	0	0	-0.02	-2.2	0.16	5822	22 376
19 Drammen	7	1	0	0	0	0	0	-0.06	-26.1	0.19	60521	246 161
20 Kongsberg	2	1	0	0	0	0	0	-0.02	-6.3	0.23	12036	50 027
21 Ringerike	4	0	0	0	0	0	0	-0.05	-8.4	0.17	15164	56 244
22 Hallingdal	0	0	6	0	0	0	0	-0.03	-7.5	0.17	7572	29 167
23 Nore og Uvdal	0	0	1	0	0	0	0	-0.03	-3.3	NA	833	3 101
24 Tønsberg	9	0	0	0	0	0	0	-0.05	-23.3	0.17	45135	179 942
25 Sandefjord/Larvik	3	0	0	0	0	0	0	-0.06	-23.5	0.17	32353	130 847
26 Grenland	5	2	0	0	0	0	0	-0.05	-16.8	0.17	43105	178 748
27 Notodden	3	1	0	0	0	0	0	-0.03	-4.3	0.21	7591	29 567
28 Tinn	0	0	1	0	0	0	0	-0.02	-1.5	NA	2036	8 028
29 Seljord/Kviteseid	0	0	2	0	0	0	0	-0.04	-4.4	0.18	1979	7 502
30 Nissedal	0	0	1	0	0	0	0	-0.04	-2.7	NA	477	1 720
31 Fyresdal	0	0	1	0	0	0	0	-0.04	-1.7	0.25	430	1 536
32 Vinje/Tokke	0	0	2	0	0	0	0	-0.04	-6.1	0.21	2044	7 833
33 Risør	1	1	0	0	0	0	0	-0.05	-6.9	0.19	3150	12 328
34 Arendal	4	2	0	0	0	0	0	-0.05	-13.7	0.19	26457	107 031
35 Evje/Bygland	0	0	2	0	0	0	0	-0.06	-3.1	0.21	1513	5 850
36 Valle/Bykle	0	0	2	0	0	0	0	-0.12	-4.0	0.22	872	3 166
37 Kristiansand	6	1	0	0	0	0	0	-0.05	-18.3	0.17	46952	191 776
38 Mandal	3	1	0	0	0	0	0	-0.04	-8.9	0.19	7873	31 795
39 Farsund/Lyngdal	2	1	0	0	0	0	0	-0.05	-8.2	0.20	6663	27 147
40 Flekkefjord	3	0	0	0	0	0	0	-0.03	-7.9	0.20	6142	25 038
41 Åseral	0	1	0	0	0	0	0	-0.02	-0.7	0.20	282	1 088
42 Sirdal	0	1	0	0	0	0	0	-0.03	-2.9	0.26	665	2 433
43 Eigersund	2	0	0	0	0	0	0	-0.03	-9.5	0.23	6847	28 657
44 Stavanger/Sandnes	12	1	1	0	0	0	0	-0.04	-40.2	0.24	129310	548 644
45 Haugesund	5	2	1	0	0	0	0	-0.04	-20.5	0.22	38423	161 724
46 Hjelmeland	0	0	1	0	0	0	0	-0.01	-0.6	0.32	1004	3 462
47 Suldal	0	0	1	0	0	0	0	-0.01	-0.9	0.23	1290	4 815
48 Sauda	0	1	0	0	0	0	0	-0.03	-3.2	0.24	1715	7 072
49 Utsira	0	0	1	0	0	0	0	0.01	0.3	0.34	79	271
50 Bergen	14	0	0	0	0	0	0	-0.07	-40.7	0.22	146202	595 106
51 Stord	2	2	0	0	0	0	0	-0.02	-6.7	0.22	13468	56 045
52 Jondal/Kvam	0	2	0	0	0	0	0	-0.05	-8.0	0.22	3376	13 262
53 Kvinnherad	0	1	0	0	0	0	0	-0.02	-4.2	0.20	4521	18 605
54 Odda	0	0	3	0	0	0	0	-0.02	-2.8	0.21	4125	16 937
55 Voss	1	0	2	0	0	0	0	-0.03	-3.7	0.22	5389	21 230
56 Austevoll	1	0	0	0	0	0	0	0.00	0.0	0.22	1845	7 040
57 Modalen	0	1	0	0	0	0	0	0.00	0.0	0.45	140	499
58 Fedje	0	0	1	0	0	0	0	0.02	1.5	0.34	198	739
59 Masfjorden/Gulen	0	0	2	0	0	0	0	-0.05	-4.8	0.26	1437	4 939
60 Flora	0	1	0	0	0	0	0	-0.03	-5.9	0.25	4448	18 414
61 Solund	0	0	1	0	0	0	0	-0.05	-1.5	0.28	281	1 012
62 Høyanger	0	0	2	0	0	0	0	0.00	-0.2	0.22	1885	7 239
63 Vik	0	0	1	0	0	0	0	-0.02	-2.6	0.24	879	3 390
64 Sogndal	0	1	2	0	0	0	0	-0.02	-2.3	0.22	4733	18 117
65 Aurland	0	0	1	0	0	0	0	-0.06	-1.4	0.30	643	2 312
66 Lærdal/Årdal	0	0	2	0	0	0	0	0.00	-0.1	0.16	3111	13 241
67 Hyllestad	0	0	1	0	0	0	0	-0.04	-4.9	0.24	498	1 988
68 Førde	0	1	5	0	0	0	0	-0.04	-8.5	0.23	8672	34 377
69 Bremanger	0	0	1	0	0	0	0	-0.01	-0.6	0.21	1288	5 006
70 Vågsøy	0	0	2	0	0	0	0	0.01	0.8	0.20	3253	12 980
71 Gloppen	0	0	1	0	0	0	0	-0.05	-4.7	0.27	1822	7 186
72 Stryn/Eid	0	0	3	0	0	0	0	-0.05	-7.1	0.21	5146	19 534
73 Molde	3	5	0	0	0	0	0	-0.04	-14.3	0.22	19921	79 888
74 Kristiansund	2	0	1	0	0	0	0	0.01	0.9	0.21	11821	43 470
75 Ålesund	6	2	0	0	0	0	0	-0.04	-16.0	0.20	32859	137 088
76 Vanylven	0	1	0	0	0	0	0	0.05	1.6	0.24	1172	4 594
77 Ulstein	2	2	0	0	0	0	0	-0.03	-3.4	0.20	9386	35 722
78 Ørsta/Volda	2	0	0	0	0	0	0	-0.05	-7.7	0.22	6350	25 354
79 Norddal/Stranda	0	0	2	0	0	0	0	-0.03	-5.1	0.24	2491	10 077
80 Rauma	0	0	1	0	0	0	0	-0.03	-4.6	0.22	2829	11 831
81 Sandøy	0	0	1	0	0	0	0	0.00	-0.1	0.25	503	2 067
82 Sunndal	0	0	1	0	0	0	0	-0.02	-4.0	0.16	2830	12 230
83 Surnadal	0	0	0	3	0	0	0	-0.04	-4.4	0.25	3220	13 091
84 Smøla	0	0	0	0	1	0	0	-0.01	-0.4	0.22	768	2 894
85 Aure	0	0	0	1	0	0	0	-0.01	-1.2	0.27	1286	4 913
86 Trondheim	6	4	0	0	0	0	0	-0.06	-31.6	0.24	98277	396 303
87 Hemne	0	0	0	1	0	0	0	-0.02	-2.6	0.31	1588	6 416
88 Hitra/Frøya	0	0	0	0	2	0	0	-0.03	-2.9	0.27	3221	12 229
89 Ørland	0	2	0	0	0	0	0	-0.02	-1.4	0.21	3021	11 400
90 Åfjord/Roan	0	0	0	0	2	0	0	-0.05	-3.6	0.24	1363	5 341

Commuting region	1	1a	2	3	4	4a	5	β **(WC)**	**t-statistic**	R^2	**n**	**N**
91 Osen	0	0	0	0	1	0	0	-0.07	-2.7	0.28	293	1 052
92 Oppdal/Rennebu	0	0	0	2	0	0	0	-0.06	-4.7	0.17	3154	12 170
93 Orkdal	1	2	0	1	0	0	0	-0.03	-6.3	0.24	6254	25 297
94 Røros	0	0	0	3	0	0	0	-0.03	-4.8	0.21	3296	13 180
95 Tydal	0	0	0	1	0	0	0	-0.03	-0.7	0.34	264	1 035
96 Steinkjer	3	0	2	1	0	0	0	-0.09	-10.9	0.21	10564	40 284
97 Namsos	0	0	0	0	6	0	0	-0.04	-4.4	0.21	7166	28 197
98 Meråker	0	0	1	0	0	0	0	-0.06	-2.2	0.24	775	3 009
99 Levanger/Verdal	2	1	0	0	0	0	0	-0.03	-4.7	0.23	11354	44 637
100 Lierne	0	0	0	0	1	0	0	0.01	0.5	0.33	477	1 722
101 Røyrvik	0	0	0	0	1	0	0	-0.05	-1.2	0.45	159	553
102 Namsskogan	0	0	0	0	1	0	0	0.05	1.6	0.30	311	1 127
103 Flatanger	0	0	0	0	1	0	0	-0.02	-0.8	0.29	350	1 249
104 Vikna/Nærøy	0	0	0	0	2	0	0	0.01	0.9	0.25	3304	12 869
105 Leka	0	0	0	0	1	0	0	-0.02	-0.6	0.29	166	549
106 Bodø	0	0	0	0	1	1	0	-0.10	-10.6	0.22	17604	68 733
107 Narvik	0	0	0	0	3	0	0	-0.04	-3.5	0.24	7202	27 880
108 Bindal	0	0	0	0	1	0	0	-0.03	-1.1	0.29	406	1 409
109 Brønnøy	0	0	0	0	4	0	0	-0.03	-3.0	0.23	3157	11 835
110 Alstahaug	0	0	0	0	4	0	0	-0.05	-3.6	0.23	4042	15 408
111 Vefsn	0	0	0	0	2	0	0	-0.08	-5.5	0.22	5059	20 815
112 Hattfjelldal	0	0	0	0	1	0	0	-0.05	-1.8	0.29	395	1 510
113 Nesna	0	0	0	0	1	0	0	-0.02	-0.9	NA	449	1 514
114 Rana	0	0	0	0	2	0	0	-0.03	-9.0	0.25	10412	43 089
115 Lurøy	0	0	0	0	1	0	0	0.05	1.8	0.23	630	2 260
116 Træna	0	0	0	0	1	0	0	-0.01	-0.8	NA	153	556
117 Rødøy	0	0	0	0	1	0	0	0.04	0.5	0.30	341	1 197
118 Meløy	0	0	0	0	1	0	0	0.00	0.1	0.17	2373	9 344
119 Beiarn	0	0	0	0	1	0	0	-0.10	-1.9	0.18	281	955
120 Fauske	0	0	0	0	3	0	0	-0.07	-3.7	0.24	5189	20 462
121 Steigen	0	0	0	0	1	0	0	-0.02	-1.1	0.24	764	2 754
122 Hamarøy	0	0	0	0	1	0	0	-0.01	-0.2	0.24	556	1 967
123 Tysfjord	0	0	0	0	1	0	0	-0.03	-0.9	0.22	652	2 315
124 Lødingen	0	0	0	0	1	0	0	-0.03	-1.0	0.24	671	2 388
125 Røst	0	0	0	0	1	0	0	0.10	1.0	NA	219	792
126 Værøy	0	0	0	0	1	0	0	-0.24	-2.6	0.17	221	780
127 Vestvågøy	0	0	0	0	2	0	0	-0.11	-2.8	0.21	3386	12 356
128 Vågan	0	0	0	0	1	0	0	-0.03	-0.7	0.24	3196	11 918
129 Sortland	0	0	0	0	4	0	0	-0.09	-6.0	0.22	7855	30 150
130 Andøy	0	0	0	0	1	0	0	0.04	1.3	0.22	1295	4 450
131 Moskenes	0	0	0	0	1	0	0	-0.10	-0.9	0.30	313	1 006
132 Tromsø	0	0	0	0	2	1	1	-0.06	-13.6	0.20	32783	121 321
133 Harstad	0	0	0	0	4	1	0	-0.05	-2.7	0.21	7949	13 630
134 Ibestad	0	0	0	0	1	0	0	-0.06	-1.0	NA	368	1 183
135 Salangen	0	0	0	0	2	0	0	-0.07	-1.8	0.19	782	2 610
136 Målselv	0	0	0	0	2	0	0	0.00	0.0	0.22	2562	8 396
137 Torsken/Berg	0	0	0	0	2	0	0	-0.06	-1.6	0.24	626	2 126
138 Lenvik	0	0	0	0	4	0	0	-0.05	-5.7	0.21	5401	20 209
139 Balsfjord/Storfjord	0	0	0	0	1	0	1	-0.04	-2.8	0.24	2215	7 937
140 Lyngen	0	0	0	0	0	0	1	0.00	0.2	0.23	932	3 323
141 Gaivuotna	0	0	0	0	0	0	1	-0.04	-1.0	0.25	640	2 152
142 Skjervøy/Nordreisa	0	0	0	0	0	0	2	-0.02	-1.0	0.20	2421	8 683
143 Kvænangen	0	0	0	0	0	0	1	-0.03	-0.6	0.17	328	1 091
144 Vardø	0	0	0	0	0	0	1	-0.17	-3.7	0.24	527	1 737
145 Vadsø	0	0	0	0	0	0	2	-0.13	-2.4	0.23	2062	7 244
146 Hammerfest	0	0	0	0	0	0	2	-0.06	-5.1	0.21	4307	15 517
147 Kautokeino	0	0	0	0	0	0	1	0.12	1.5	0.22	653	1 929
148 Alta	0	0	0	0	0	0	1	-0.08	-5.0	0.21	6956	26 316
149 Loppa	0	0	0	0	0	0	1	0.01	0.1	0.23	303	1 008
150 Hasvik	0	0	0	0	0	0	1	-0.02	-0.5	0.19	306	1 024
151 Måsøy	0	0	0	0	0	0	1	0.28	1.8	0.20	360	1 239
152 Nordkapp	0	0	0	0	0	0	1	-0.18	-2.2	0.20	1097	3 911
153 Porsanger	0	0	0	0	0	0	1	0.00	0.0	0.20	1323	4 701
154 Karasjok	0	0	0	0	0	0	1	-0.08	-1.7	0.22	765	2 537
155 Lebesby	0	0	0	0	0	0	1	-0.10	-0.9	0.22	374	1 152
156 Gamvik	0	0	0	0	0	0	1	-0.02	-0.7	0.29	322	1 104
157 Berlevåg	0	0	0	0	0	0	1	0.00	-0.1	0.25	336	1 182
158 Tana	0	0	0	0	0	0	1	-0.11	-1.9	0.27	879	3 014
159 Båtsfjord	0	0	0	0	0	0	1	0.02	0.9	0.22	815	2 956
160 Sør-Varanger	0	0	0	0	0	0	1	0.01	0.9	0.25	3352	12 340

Notes: T=1-6, and the dummies and explanatory variables specified in Table A.1 are included as controls. The t-statistic are based on clustered standard errors, clustered on commuting region (Arai, 2011).

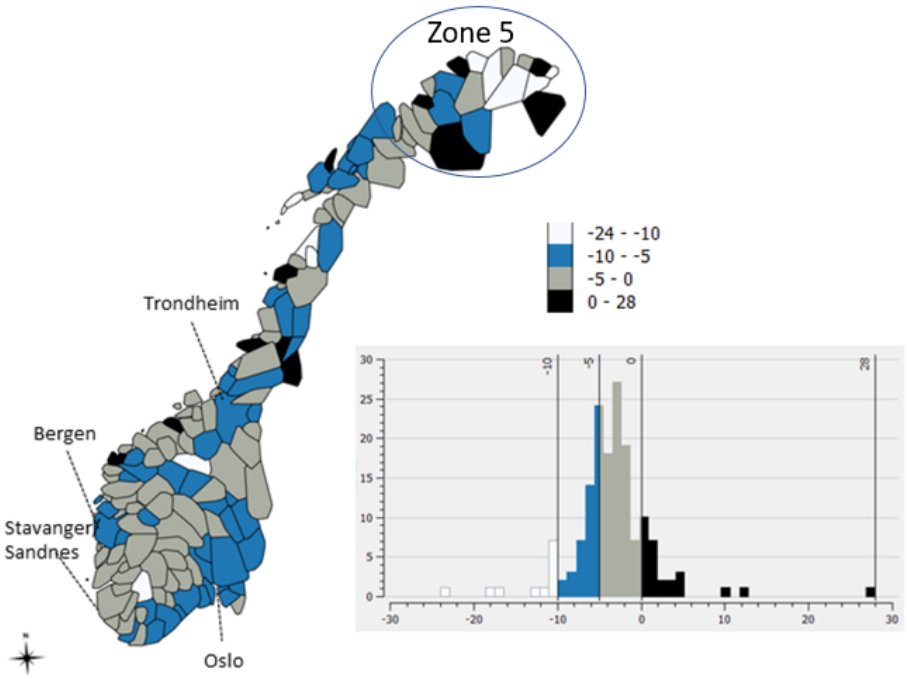

Figure A.1: Estimated WCs (FE estimator) for the 160 different commuting regions in Norway (GIS software used: QGIS Development Team (2009)). The colours represent WC elasticity intervals. The histogram depicts the number of observations in each of the four WC intervals.