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Modelling of net domestic migration and net commuting flows between Norwegian economic regions 2001-2014

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Preface

The Norwegian Regional General Equilibrium Model NOREG 2.2 has recently been augmented with a module for geographical movement of labour. This document reports some estimation results that have been exploited in conjunction with the establishment of the new module. We acknowledge financial support from the Norwegian Research Council, grant no. 283398.

Statistisk sentralbyrå, 27 June 2023

Linda Nøstbakken

Abstract

We document estimation results related to semi-log econometric models for scaled net domestic migration and commuting using panel data for 89 economic regions in Norway for the period 2001-2014. We study separately four educational groups. Net migration and commuting are scaled by relevant population variables. For both type of response variables, we include three incentive variables on the log scale corresponding to a relative real hourly wage variable, a relative difference in unemployment rates and a relative difference in employment rates. The equations are estimated with OLS using dummy variables for the different economic regions. The main attention is on the effects of a marginal change in the real wage variable. For individuals with low and vocational education we find that the relative real wage variable enters significantly, whereas mainly no significant effects are found for the two groups with high education.

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1. Introduction

Kornstad et al. (2023) modelled gross internal migration and commuting flows between 89 economic regions in Norway using data from 2001-2014. In the present analysis we take another approach and model net flows (scaled by the relevant population) between these regions. Considering the model requirements for developing an internal migration module for NOREG 2.2 (described below), it is better to use specifications and equations for net flows instead of gross flows. Whereas the left-hand side variables are changed when compared to Kornstad et al. (2023), the right-hand side variables and the transformations performed are retained. Focus is still on the effects of incentive variables, i.e., the relative difference in real hourly wage, unemployment rate and employment rate between an economic region and a weighted mean of the same variables of all other economic regions, using relevant population variables as a basis for time-varying weights. Since net internal migration for an economic region can assume both signs, taking log is not an option. Hence, what we now employ is a semi-logarithmic specification with net migration scaled by the relevant population measure as the response variable.

NOREG 2.2 is a Norwegian Regional General Equilibrium Modelling System (NOREG 2.2) developed to study effects of structural changes and policy reforms in the Norwegian economy over time. The model links economic theory, empirical research and economic modelling within economic geography and urban and regional studies and contributes to increasing the national competence base and the relevance of such models[1]. The aim of the current manuscript is to document results which constitute a basis of establishing a new module for NOREG 2.2 when it comes to internal migration and commuting. Whereas the model has been extended with endogenous internal migration, efforts to endogenize commuting have not yet been initiated.

An important aspect in Kornstad et al. (2023) was to handle heterogeneity in education. Separate modelling was carried out for four different educational groups. Also, in the current context when modelling net migration and commuting flows, we operate with four different educational groups, but they are somewhat modified compared to how they were defined in Kornstad et al. (2023). The group with low education is now broader than the one used in Kornstad et al. (2023) since it in addition to individuals with compulsory education, also covers individuals with basic secondary and study-oriented upper secondary education. Individuals with unknown education are also now included in this group. The group constituted of those with vocational education has been somewhat modified. Finally, we have divided the group with higher education into two groups, i.e., individuals with low and upper higher education. The new classification is deemed more satisfactory when it comes to different applications using NOREG 2.2.

Since NOREG 2.2 is a general equilibrium model characterized by full utilisation of resources, we focus especially on the effects of differences in real hourly wages on net migration and net commuting flows. For the groups with low and vocational education we obtain positive and significant effects of an increase in the relative wage on both net domestic migration and net commuting. In conjunction with net domestic migration, the results for those with lower and upper higher education are insignificant. For those with lower higher education the same is also true with respect to net commuting, whereas the result for those with upper higher education varies somewhat with the exact specification employed. The estimated effect is positive when the relative unemployment variable is omitted from the regression equation.

The rest of the document is organized in the following way: In Section 2, we specify our (semi-log) econometric models for net internal migration and net commuting. In Section 3, we provide estimates of parameters based on the models outlined in the previous section. Section 4 concludes. Two tables in an appendix show both the educational classification used in Kornstad et al. (2023) and in the current manuscript.

[1] For more information see https://www.vista-analyse.no/no/tjenester/modeller-og-databaser/noreg-2/

2. Modelling framework

2.1. Net internal migration

We employ a notation which is consistent with the one used in Kornstad et al. (2023).[2] Let $MIG_{it}^{IN,e}$ denote the number of individuals with education of type *e* aged 15-74 years migrating to economic region *i* from the other economic regions in Norway in period *t*. Likewise, let $MIG_{it}^{OUT,e}$ denote the number of individuals with education of type *e* aged 15-74 years migrating from economic region *i* to the other economic regions in Norway in period *t*. Furthermore, let POP_{it}^{e} be a stock variable denoting the number of individuals aged 15-74 years and with education of type *e* in the beginning of period *t*. We define the net (*NET*) internal migration rate (*r*) as

$$MIGr_{it}^{NET,e} = \frac{MIG_{it}^{IN,e} - MIG_{it}^{OUT,e}}{POP_{it}^{e}}, \tag{1}$$

where *e*={*LOW*, *VOC*, *LHE*, *UHE*}.[3]

Consider now the semi-log model:

$$\begin{aligned} MIGr_{it}^{NET,e} &= \mu_i^{M,NET,e} + \lambda_t^{M,NET,e} + \gamma^{M,NET,e}[\log(UR_{i,t-1}^{e}) - \log(UROTH_{i,t-1}^{e})] + \\ &\theta^{M,NET,e}[\log(RHWAGE_{i,t-1}^{e}) - \log(RHWAGEOTH_{i,t-1}^{e})] + \\ &\eta^{M,NET,e}[\log(EMPSHARE_{i,t-1}^{e}) - \log(EMPSHAREOTH_{i,t-1}^{e})] + \varepsilon_{it}^{M,NET,e}, \end{aligned} \tag{2}$$

where *e*={*LOW*, *VOC*, *LHE*, *UHE*}. In Eq. (2), $UR_{i,t-1}^{e}$, $RHWAGE_{i,t-1}^{e}$ and $EMPSHARE_{i,t-1}^{e}$ denote, respectively, the lagged unemployment rate, the lagged real hourly wage and the lagged employment share for the group with education *e*. The variables $UROTH_{i,t-1}^{e}$, $RHWAGEOTH_{i,t-1}^{e}$ and $EMPSHAREOTH_{i,t-1}^{e}$ are the companion 'outside' variables. They are weighted mean of the unemployment rate, real hourly wage and employment share variables in the 88 other economic regions. Furthermore, $\mu_i^{M,NET,e}$ and $\lambda_t^{M,NET,e}$ denote fixed effects for the economic regions and fixed annual effects, respectively. Lastly, $\varepsilon_{it}^{M,NET,e}$ is assumed to be a white noise error term. The superscript *M* denotes net migration, in contrast to net commuting (see next section). We estimate the equations separately using the least-squares dummy variables (LSDV) method.

2.2. Net commuting

We use a similar type of specification when modelling net commuting. Let $COM_{it}^{IN,e}$ and $COM_{it}^{OUT,e}$ denote, respectively, the number of individuals aged 15-74 years with education type *e* who commute to economic region *i* for work and the number of individuals aged 15-74 years with education type *e* who commute from economic region *i* to other economic regions in Norway for work in period *t*. We can then define the net (*NET*) commuting rate (*r*) for region *i* in period *t*.

[2] We refer to the appendix in Kornstad et al. (2023) for a definition of many of the variables used in this document.
[3] The four acronyms *LOW*, *VOC*, *LHE* and *UHE* stand for low, vocational, 'lower higher' and 'upper higher' education, respectively. See Table A2 for more details.

$$(3) \qquad COMr_{it}^{NET,e} = \frac{COM_{it}^{IN,e} - COM_{it}^{OUT,e}}{POP_{it}^{e}}.$$

Corresponding to Eq. (2) we now have

$$(4) \qquad \begin{aligned} COMr_{it}^{NET,e} &= \mu_i^{C,NET,e} + \lambda_t^{C,NET,e} + \gamma^{C,NET,e}[\log(UR_{i,t-1}^{e}) - \log(UROTH_{i,t-1}^{e})] + \\ &\theta^{C,NET,e}[\log(RHWAGE_{i,t-1}^{e}) - \log(RHWAGEOTH_{i,t-1}^{e})] + \\ &\eta^{C,NET,e}[\log(EMPSHARE_{i,t-1}^{e}) - \log(EMPSHAREOTH_{i,t-1}^{e})] + \varepsilon_{it}^{C,NET,e}, \end{aligned}$$

where the superscript *C* denotes net commuting, in contrast to net internal migration.

3. Empirical results

For each educational group we start out by estimating the most general specifications as outlined in the section above. Besides, we also report estimation results for specifications that are constrained relative to the specification used at the outset. These are numbered I, II etc. We first present the results for net internal migration and then the empirical results for net commuting.

3.1. Net internal migration, low education

The results for the most general model are in Table 3.1. The estimated effects of a partial change in relative unemployment and relative real hourly wage have the expected signs and are statistically significant at the 5 per cent level. Furthermore, the estimated effect of the relative employment share is insignificant.

Table 3.1 Net migration inflow of individuals with low education. LSDV estimates

Explanatory variable	Estimate	*t*-value
$\log(UR_{i,t-1}^{LOW}) - \log(UROTH_{i,t-1}^{LOW})$	-0.003	-2.438
$\log(RHWAGE_{i,t-1}^{LOW}) - \log(RHWAGEOTH_{i,t-1}^{LOW})$	0.011	2.015
$\log(EMPSHARE_{i,t-1}^{LOW}) - \log(EMPSHAREOTH_{i,t-1}^{LOW})$	0.006	0.621
Standard error of regression	0.004	
Number of observations	1,157	

Note: Left-hand side variable: $MIGr_{it}^{NET,LOW}$. Fixed effects for the economic regions and fixed annual effects are also accounted for. *t*-values are based on heteroscedastic-consistent estimates of standard errors.

Next, Table 3.2 contains the results when the relative employment share variable has been omitted from the regression. We note that the size and magnitude of the estimated parameters are as for the general model specification.

Table 3.2 Net migration inflow of individuals with low education. Constrained version I. LSDV estimates

Explanatory variable	Estimate	*t*-value
$\log(UR_{i,t-1}^{LOW}) - \log(UROTH_{i,t-1}^{LOW})$	-0.003	-3.853
$\log(RHWAGE_{i,t-1}^{LOW}) - \log(RHWAGEOTH_{i,t-1}^{LOW})$	0.011	2.131
Standard error of regression	0.004	
Number of observations	1,157	

Note: Left hand side variable: $MIGr_{it}^{NET,LOW}$. Fixed effects for the economic regions and fixed annual effects are also accounted for. *t*-values are based on heteroscedastic-consistent estimates of standard errors.

3.2. Net internal migration, vocational education

The results for the most general model are in Table 3.3. For this group, only the estimate of the relative wage variable is significant. It has the expected sign and the magnitude of the estimate is as for those with low education. Furthermore, the estimated effect of the relative unemployment rate is negative, as expected, and has a *t*-value that is about -1.5.

Table 3.3 Net migration inflow of individuals with vocational education. LSDV estimates

Explanatory variable	Estimate	*t*-value
$\log(UR_{i,t-1}^{VOC}) - \log(UROTH_{i,t-1}^{VOC})$	-0.0014	-1.480
$\log(RHWAGE_{i,t-1}^{VOC}) - \log(RHWAGEOTH_{i,t-1}^{VOC})$	0.014	2.079
$\log(EMPSHARE_{i,t-1}^{VOC}) - \log(EMPSHAREOTH_{i,t-1}^{VOC})$	-0.025	-1.380
Standard error of regression	0.005	
Number of observations	1,157	

Note: Left-hand side variable: $MIGr_{it}^{NET,VOC}$. Fixed regional effects and fixed annual effects are also accounted for. *t*-values are based on heteroscedastic-consistent estimates of standard errors.

In Table 3.4 we report the results when the relative employment share is dropped from the regression equation. The estimate for the relative real hourly wage share is almost unaltered compared to the one that was obtained in conjunction with the most general specification, and the estimate is still significant at the 5 per cent significance level. The estimate of the effect of the relative unemployment rate is lower and even less significant relative to what was reported in Table 3.3.

Table 3.4 Net migration inflow of individuals with vocational education. Constrained specification I. LSDV estimates

Explanatory variable	Estimate	*t*-value
$\log(UR_{i,t-1}^{VOC}) - \log(UROTH_{i,t-1}^{VOC})$	-0.0007	-0.893
$\log(RHWAGE_{i,t-1}^{VOC}) - \log(RHWAGEOTH_{i,t-1}^{VOC})$	0.013	1.982
Standard error of regression	0.005	
Number of observations	1,157	

Note: Left-hand side variable: $MIGr_{it}^{NET,VOC}$. Fixed effects for the economic regions and fixed annual effects are also accounted for. *t*-values are based on heteroscedastic-consistent estimates of standard errors.

3.3. Net internal migration, lower higher education

In Table 3.5 we report the results obtained when using the general model specification and the data for the group with lower higher education. In this case none of the estimates turn out as significant. The estimated effect of the relative real hourly wage is positive, but the *t*-value is only 1.4. The two other estimates are positive, but with very low *t*-values.

Table 3.5 Net migration inflow of individuals with lower higher education. LSDV estimates

Explanatory variable	Estimate	*t*-value
$\log(UR_{i,t-1}^{LHE}) - \log(UROTH_{i,t-1}^{LHE})$	0.0002	0.166
$\log(RHWAGE_{i,t-1}^{LHE}) - \log(RHWAGEOTH_{i,t-1}^{LHE})$	0.010	1.407
$\log(EMPSHARE_{i,t-1}^{LHE}) - \log(EMPSHAREOTH_{i,t-1}^{LHE})$	0.004	0.132
Standard error of regression	0.006	
Number of observations	1,157	

Note: Left-hand side variable: $MIGr_{it}^{NET,\,LHE}$. Fixed effects for economic regions and fixed annual effects are also accounted for. *t*-values are based on heteroscedastic-consistent estimates of standard errors.

In Table 3.6 we report estimates for the specification, where we have omitted the relative employment share variable. This leaves the estimate of the effect of the relative real hourly variable unaltered, and the estimated effect of the relative unemployment variables is still positive and very insignificant.

Table 3.6 Net migration inflow of individuals with lower higher education. Constrained specification I. LSDV estimates

Explanatory variable	Estimate	*t*-value
$\log(UR_{i,t-1}^{LHE}) - \log(UROTH_{i,t-1}^{LHE})$	0.0001	0.131
$\log(RHWAGE_{i,t-1}^{LHE}) - \log(RHWAGEOTH_{i,t-1}^{LHE})$	0.010	1.436
Standard error of regression	0.006	
Number of observations	1,157	

Note: Left-hand side variable: $MIGr_{it}^{NET,\,LHE}$. Fixed effects for economic regions and fixed annual effects are also accounted for. *t*-values are based on heteroscedastic-consistent estimates of standard errors.

In Table 3.7 we report the estimate of the effect of the relative real wage rate, when the relative unemployment rate and the relative employment share both are removed from the regression equation. Also, in this case the estimate of the relative hourly wage effect is retained, and the *t*-value is still below 1.5.

Table 3.7 Net migration inflow of individuals with lower higher education. Constrained specification II. LSDV estimates

Explanatory variable	Estimate	*t*-value
$\log(RHWAGE_{i,t-1}^{LHE}) - \log(RHWAGEOTH_{i,t-1}^{LHE})$	0.010	1.432
Standard error of regression	0.006	
Number of observations	1,157	

Note: Left-hand side variable: $MIGr_{it}^{NET,\,LHE}$. Fixed effects for economic regions and fixed annual effects are also accounted for. *t*-values are based on heteroscedastic-consistent estimates of standard errors.

3.4. Net internal migration, upper higher education

Table 3.8 shows the result of estimating the most general specification for those with upper higher education. Here all the estimates are negative and statistically insignificant.

Table 3.8 Net migration inflow of individuals with upper higher education. LSDV estimates

Explanatory variable	Estimate	*t*-value
$\log(UR_{i,t-1}^{UHE}) - \log(UROTH_{i,t-1}^{UHE})$	-0.001	-0.560
$\log(RHWAGE_{i,t-1}^{UHE}) - \log(RHWAGEOTH_{i,t-1}^{UHE})$	-0.001	-0.085
$\log(EMPSHARE_{i,t-1}^{UHE}) - \log(EMPSHAREOTH_{i,t-1}^{UHE})$	-0.044	-0.992
SER	0.018	
Number of observations[a]	1,109	

Note: Left-hand side variable: $MIGr_{it}^{NET,UHE}$. Fixed effects for economic regions and fixed annual effects are also accounted for. *t*-values are based on heteroscedastic-consistent estimates of standard errors.
[a]For some regions the unemployment rates are zero, and hence the number of observations is 1,109 instead of 1,157 in this case.

When dropping the relative employment share variable, we obtained the results revealed in Table 3.9. The estimates of the remaining parameters are still negative and highly insignificant.

Table 3.9 Net migration inflow of individuals with upper higher education. Constrained specification I. LSDV estimates

Explanatory variable	Estimate	*t*-value
$\log(UR_{i,t-1}^{UHE}) - \log(UROTH_{i,t-1}^{UHE})$	-0.0004	-0.240
$\log(RHWAGE_{i,t-1}^{UHE}) - \log(RHWAGEOTH_{i,t-1}^{UHE})$	-0.0017	-0.108
Standard error of regression	0.018	
Number of observations[a]	1,109	

Note: Left-hand side variable: $MIGr_{it}^{NET,UHE}$. Fixed effects for economic regions and fixed annual effects are also accounted for. *t*-values are based on heteroscedastic-consistent estimates of standard errors.
[a]For some regions the unemployment rates are zero, and hence the number of observations is 1,109 instead of 1,157 in this case.

When we drop both the relative unemployment rate and the relative employment share variable, we still obtain a negative estimate of the relative real hourly wage variable with a very low significance, as seen from Table 3.10.

Table 3.10 Net migration inflow of individuals with upper higher education. Constrained specification II. LSDV estimates

Explanatory variable	Estimate	*t*-value
$\log(RHWAGE_{i,t-1}^{UHE}) - \log(RHWAGEOTH_{i,t-1}^{UHE})$	-0.0005	-0.030
Standard error of regression	0.0019	
Number of observations[a]	1,157	

Note: Left-hand side variable: $MIGr_{it}^{NET,UHE}$. Fixed effects for economic regions and fixed annual effects are also accounted for. *t*-values are based on heteroscedastic-consistent estimates of standard errors.
[a]Some of the unemployment rates are zero, and hence the number of observations is 1,109 instead of 1,157 in this case.

3.5. Net commuting, low education

Table 3.11 reports the estimates related to net commuting using the most general specification for those with low education. The estimates related to the relative unemployment rate and the relative real hourly wage have the expected signs. Whereas the former estimate is almost significant at the 5 per cent significance level, the latter has a *t*-value at about 3. The relative employment share variable turns out to enter insignificantly.

Table 3.11 Net commuting inflow of individuals with low education. LSDV estimates

Explanatory variable	Estimate	*t*-value
$\log(UR_{i,t-1}^{LOW}) - \log(UROTH_{i,t-1}^{LOW})$	-0.0046	-1.805
$\log(RHWAGE_{i,t-1}^{LOW}) - \log(RHWAGEOTH_{i,t-1}^{LOW})$	0.0401	2.959
$\log(EMPSHARE_{i,t-1}^{LOW}) - \log(EMPSHAREOTH_{i,t-1}^{LOW})$	0.0067	0.268
Standard error of regression	0.009	
Number of observations	1,157	

Note: Left-hand side variable: $COMr_{it}^{NET,LOW}$. Fixed effects for the economic regions and fixed annual effects are also accounted for. *t*-values are based on heteroscedastic-consistent estimates of standard errors.

Table 3.12 shows the results when omitting the relative employment share variable from the regression equation. The estimates of the two remaining parameters resemble those obtained for the unrestricted specification.

Table 3.12 Net commuting inflow of individuals with low education. Constrained specification I. LSDV estimates

Explanatory variable	Estimate	*t*-value
$\log(UR_{i,t-1}^{LHE}) - \log(UROTH_{i,t-1}^{LHE})$	-0.0051	-2.071
$\log(RHWAGE_{i,t-1}^{LHE}) - \log(RHWAGEOTH_{i,t-1}^{LHE})$	0.041	3.019
$\log(EMPSHARE_{i,t-1}^{LHE}) - \log(EMPSHAREOTH_{i,t-1}^{LHE})$	0.009	
Standard error of regression	1,157	
Number of observations		

Note: Left-hand side variable: $COMr_{it}^{NET,LOW}$. Fixed effects for the economic regions and fixed annual effects are also accounted for. *t*-values are based on heteroscedastic-consistent estimates of standard errors.

3.6. Net commuting, vocational education

Table 3.13 reports the estimations results for those with vocational education according to the most general specification considered. The estimate of the relative unemployment rate variable is very close to 0, whereas the estimates of the two other variables are positive and significant at the 5 per cent significance level. The estimate of the effect of the relative hourly wage variable is a little bit larger than that obtained for those with low education.

Table 3.13 Net commuting inflow of individuals with vocational education. LSDV estimates

Explanatory variable	Estimate	*t*-value
$\log(UR_{i,t-1}^{VOC}) - \log(UROTH_{i,t-1}^{VOC})$	-0.0002	-0.062
$\log(RHWAGE_{i,t-1}^{VOC}) - \log(RHWAGEOTH_{i,t-1}^{VOC})$	0.053	2.494
$\log(EMPSHARE_{i,t-1}^{VOC}) - \log(EMPSHAREOTH_{i,t-1}^{VOC})$	0.166	2.416
Standard error of regression	0.017	
Number of observations	1,157	

Note: Left-hand side variable: $COMr_{it}^{NET,VOC}$. Fixed effects for the economic regions and fixed annual effects are also accounted for. *t*-values are based on heteroscedastic-consistent estimates of standard errors.

In Table 3.14 we report results from a specification in which we have omitted the relative employment share variable. The estimate of the effect of the relative unemployment variable is now larger in magnitude, but still not significant at the 5 per cent significance level. The estimate of the effect of the relative real hourly wage variable is not very different from what was obtained in the unconstrained model.

Table 3.14 Net commuting inflow of individuals with vocational education. Constrained model specification I. LSDV estimates

Explanatory variable	Estimate	*t*-value
$\log(UR_{i,t-1}^{VOC}) - \log(UROTH_{i,t-1}^{VOC})$	-0.0044	-1.499
$\log(RHWAGE_{i,t-1}^{VOC}) - \log(RHWAGEOTH_{i,t-1}^{VOC})$	0.058	2.681
Standard error of regression	0.017	
Number of observations	1,157	

Note: Left-hand side variable: $COMr_{it}^{NET,VOC}$. Fixed effects for the economic regions and fixed annual effects are also accounted for. *t*-values are based on heteroscedastic-consistent estimates of standard errors.

In Table 3.15 we consider results based on yet another constrained specification. In this case we have omitted the relative unemployment rate. We obtain positive effects of the two incentive variables retained in the model specification. Again, the estimate of the effect of the relative real hourly wage variable is not very different from what was obtained using the unconstrained model.

Table 3.15 Net commuting inflow of individuals with vocational education. Constrained specification II. LSDV estimates

Explanatory variable	Estimate	*t*-value
$\log(RHWAGE_{i,t-1}^{VOC}) - \log(RHWAGEOTH_{i,t-1}^{VOC})$	0.054	2.464
$\log(EMPSHARE_{i,t-1}^{VOC}) - \log(EMPSHAREOTH_{i,t-1}^{VOC})$	0.169	2.710
Standard error of regression	0.017	
Number of observations	1,157	

Note: Left-hand side variable: $COMr_{it}^{NET,VOC}$. Fixed effects for the economic regions and fixed annual effects are also accounted for. *t*-values are based on heteroscedastic-consistent estimates of standard errors.

Lastly, in conjunction with those with vocational education, we look at a model specification with relative real hourly wage as a single incentive variable. From Table 3.16 we note that the estimate of the effect of the wage variable again is positive, but now with a somewhat larger magnitude than in the unconstrained case.

Table 3.16 Net commuting inflow of individuals with vocational education. Constrained specification III. LSDV estimates

Explanatory variable	Estimate	*t*-value
$\log(RHWAGE_{i,t-1}^{VOC}) - \log(RHWAGEOTH_{i,t-1}^{VOC})$	0.069	3.103
Standard error of regression	0.017	
Number of observations	1,157	

Note: Left-hand side variable: $COMr_{it}^{NET,VOC}$. Fixed effects for the economic regions and fixed annual effects are also accounted for. *t*-values are based on heteroscedastic-consistent estimates of standard errors.

3.7. Net commuting, lower higher education

In Table 3.17 we report the estimates for those with lower higher education using the most general specification. Even though the estimates seem to have the correct signs, they are all insignificant.

Table 3.17 Net commuting inflow of individuals with lower higher education. LSDV estimates

Explanatory variable	Estimate	*t*-value
$\log(UR_{i,t-1}^{LHE}) - \log(UROTH_{i,t-1}^{LHE})$	-0.0015	-0.561
$\log(RHWAGE_{i,t-1}^{LHE}) - \log(RHWAGEOTH_{i,t-1}^{LHE})$	0.006	0.447
$\log(EMPSHARE_{i,t-1}^{LHE}) - \log(EMPSHAREOTH_{i,t-1}^{LHE})$	0.094	1.423
Standard error of regression	0.015	
Number of observations	1,157	

Note: Left-hand side variable: $COMr_{it}^{NET,LHE}$. Fixed effects for the economic regions and fixed annual effects are also accounted for. *t*-values are based on heteroscedastic-consistent estimates of standard errors.

Next, we omit the relative employment share variable and estimate a constrained specification. The estimates of the parameters not constrained to zero are still insignificant at the 5 per cent significance level, as we see from Table 3.18.

Table 3.18 Net commuting inflow of individuals with lower higher education. Constrained specification I. LSDV estimates

Explanatory variable	Estimate	*t*-value
$\log(UR_{i,t-1}^{LHE}) - \log(UROTH_{i,t-1}^{LHE})$	-0.0029	-1.218
$\log(RHWAGE_{i,t-1}^{LHE}) - \log(RHWAGEOTH_{i,t-1}^{LHE})$	0.010	0.726
SER	0.015	
Number of observations	1,157	

Note: Left-hand side variable: $COMr_{it}^{NET,LHE}$. Fixed effects for the economic regions and fixed annual effects are also accounted for. *t*-values are based on heteroscedastic-consistent estimates of standard errors.

In Table 3.19 we report estimates for yet another constrained specification, in which we have omitted the relative unemployment rate. Whereas the relative real hourly wage variable still enters rather insignificantly, the relative employments share now enters with a positive effect that is significant at the 10, but not at the 5 per cent significance level.

Table 3.19 Net commuting inflow of individuals with lower higher education. Constrained specification II. LSDV estimates

Explanatory variable	Estimate	*t*-value
$\log(RHWAGE_{i,t-1}^{LHE}) - \log(RHWAGEOTH_{i,t-1}^{LHE})$	0.006	0.426
$\log(EMPSHARE_{i,t-1}^{LHE}) - \log(EMPSHAREOTH_{i,t-1}^{LHE})$	0.108	1.788
Standard error of regression	0.015	
Number of observations	1,157	

Note: Left-hand side variable: $COMr_{it}^{NET,LHE}$. Fixed effects for the economic regions and fixed annual effects are also accounted for. *t*-values are based on heteroscedastic-consistent estimates of standard errors.

Also, for this education group we consider a model specification with the relative real hourly wage variable as the single incentive variable. The obtained estimate, reported in Table 3.20, has the expected sign, but the *t*-value is well below 1.

Table 3.20 Net commuting inflow of individuals with lower higher education. Constrained specification III. LSDV estimates

Explanatory variable	Estimate	*t*-value
$\log(RHWAGE_{i,t-1}^{LHE}) - \log(RHWAGEOTH_{i,t-1}^{LHE})$	0.011	0.777
Standard error of regression	0.015	
Number of observations	1,157	

Note: Left-hand side variable: $COMr_{it}^{NET,LHE}$. Fixed effects for the economic regions and fixed annual effects are also accounted for. *t*-values are based on heteroscedastic-consistent estimates of standard errors.

3.8. Net commuting, upper higher education

Table 3.21 contains parameter estimates in the most general specification for those with upper higher education. As for those with lower higher education, none of the incentive variables enter significantly.

Table 3.21 Net commuting inflow of individuals with upper higher education. LSDV estimates

Explanatory variable	Estimate	*t*-value
$\log(UR_{i,t-1}^{UHE}) - \log(UROTH_{i,t-1}^{UHE})$	-0.0023	-0.775
$\log(RHWAGE_{i,t-1}^{UHE}) - \log(RHWAGEOTH_{i,t-1}^{UHE})$	0.018	0.870
$\log(EMPSHARE_{i,t-1}^{UHE}) - \log(EMPSHAREOTH_{i,t-1}^{UHE})$	0.054	0.627
Standard error of regression	0.034	
Number of observations[a]	1,109	

Note: Left-hand side variable: $COMr_{it}^{NET,UHE}$. Fixed effects for the economic regions and fixed annual effects are also accounted for. *t*-values are based on heteroscedastic-consistent estimates of standard errors.
[a]For some regions the unemployment rates are zero, and hence the number of observations is 1,109 instead of 1,157 in this case.

In Table 3.22 we report estimates using a constrained specification in which the relative employment share variable has been left out. The estimates of the remaining incentive variables are still insignificant.

Table 3.22 Net commuting inflow of individuals with upper higher education. Constrained specification I. LSDV estimates

Explanatory variable	Estimate	*t*-value
$\log(UR_{i,t-1}^{UHE}) - \log(UROTH_{i,t-1}^{UHE})$	-0.0030	-1.095
$\log(RHWAGE_{i,t-1}^{UHE}) - \log(RHWAGEOTH_{i,t-1}^{UHE})$	0.018	0.894
Standard error of regression	0.034	
Number of observations[a]	1,109	

Note: Left-hand side variable: $COMr_{it}^{NET,UHE}$. Fixed effects for the economic regions and fixed annual effects are also accounted for. *t*-values are based on heteroscedastic-consistent estimates of standard errors.
[a]For some regions the unemployment rates are zero, and hence the number of observations is 1,109 instead of 1,157 in this case.

In Table 3.23 we consider yet another constrained specification, in which the relative employment share variable is retained but the relative unemployment rate is omitted. The relative real hourly wage now enters significantly at the 5 per cent significance level, whereas the relative employment share variable still enters insignificantly.

Table 3.23 Net commuting inflow of individuals with upper higher education. Constrained specification II. LSDV estimates

Explanatory variable	Estimate	*t*-value
$\log(RHWAGE_{i,t-1}^{UHE}) - \log(RHWAGEOTH_{i,t-1}^{UHE})$	0.050	2.164
$\log(EMPSHARE_{i,t-1}^{UHE}) - \log(EMPSHAREOTH_{i,t-1}^{UHE})$	0.027	0.328
Standard error of regression	0.036	
Number of observations	1,157	

Note: Left-hand side variable: $COMr_{it}^{NET,UHE}$. Fixed effects for the economic regions and fixed annual effects are also accounted for. *t*-values are based on heteroscedastic-consistent estimates of standard errors.

Lastly, we consider a specification in which only the relative real wage variable is retained among the incentive variables. Also, in this case it enters significantly with a positive sign, as seen from Table 3.24. The estimate is unaltered as compared to the results based on the constrained specification underlying the results in Table 3.23.

Table 3.24 Net commuting inflow of individuals with upper higher education. Constrained specification III. LSDV estimates

Explanatory variable	Estimate	*t*-value
$\log(RHWAGE_{i,t-1}^{UHE}) - \log(RHWAGEOTH_{i,t-1}^{UHE})$	0.050	2.167
Standard error of regression	0.036	
Number of observations	1,157	

Note: Left-hand side variable: $COMr_{it}^{NET,UHE}$. Fixed effects for the economic regions and fixed annual effects are also accounted for. *t*-values are based on heteroscedastic-consistent estimates of standard errors.

4. Conclusions

In this document, we have reported empirical results related to semi-log panel data models for net migration and net commuting rates for 89 Norwegian economic regions for the period 2001-2014. Our main concern was to say something about the effect of changes in some key incentive variables on net migration and net commuting rates for different educational groups. The empirical results related to net domestic migration are utilized in a new and updated version of the Norwegian regional equilibrium model, NOREG 2.2.

For both types of response variables, we employed the same set of right-hand side variables. Three of these are incentive variables. They are the relative differences in real hourly wages, the relative difference in unemployment rates and the relative difference in employment rates. Besides, we include dummy variables for the different economic regions. The econometric models were estimated by least-squares dummy variables method.

We found that the results, with respect to an increase in the relative real hourly wage, varied substantially across the educational groups. For those with low and vocational education we find a relatively small but positive and significant effect. Thus, the signs are as expected. For those with lower higher education, the estimation results are always insignificant, and thus do not depend on the exact specification. For the group with upper higher education we found no significant effect of the relative real hourly wage variable on net migration and neither on net commuting when the relative difference of unemployment rates was included in the model. However, with the relative unemployment rate omitted, a significant positive effect was obtained. Thus, in this case the estimation result is not very robust.

References

Barrabés, N. and G.K. Østli (2016): Norwegian Standard Classification of Education 2016. Revised 2000 Documentation (Updated 2016). Documents 2017/02. Statistics Norway.

Kornstad, T., Skjerpen, T. and L.S. Stambøl (2023): Empirical modeling of internal migration and commuting flows for economic regions in Norway. Annals of Regional Science. doi.org/10.1007/s00168-023-01208-3.

Appendix A: Educational classifications

Table A1. Educational classification used in conjunction with Kornstad et al. (2023)[a]

Own codes	Description	Classification numbers of education	English abbreviations used in the current paper
1	Compulsory education	0,1,2	*LOW*
2	Study-oriented upper secondary education	30, 315, 368, 40, 415, 468, 34, 44, 50, 54	*SUS*
3	Vocational education	3, 4, 5 (except for codes mentioned above)	*VOC*
4	First stage of education, undergraduate level	6	*HIGH*
4	Second stage of education (post-graduate education)	7, 8	*HIGH*
5	Unspecified/Unknown	9	

[a]For classification of educations see Barrabés and Østli (2016).

Table A2. Educational classification used in the current manuscript[a]

Own Codes	Description	Classification numbers of education	English abbreviations used in the current paper
1	Compulsory education	0,1,2	*LOW*
	Basic secondary education	3	
	Study-oriented upper secondary education	40, 411, 412, 413, 414, 415, 419, 42, 43, 441, 449, 451, 4521, 49	
	Unspecified/Unknown	9	
2	Vocational education	416, 442, 443, 444, 45, 4611, 4612, 4613, 4619, 462, 464, 465, 466, 467, 469, 47, 48	*VOC*
3	Lower higher education	5, 6	*LHE*
4	Upper higher education	7, 8	*UHE*

[a]For classification of educations see Barrabés and Østli (2016).