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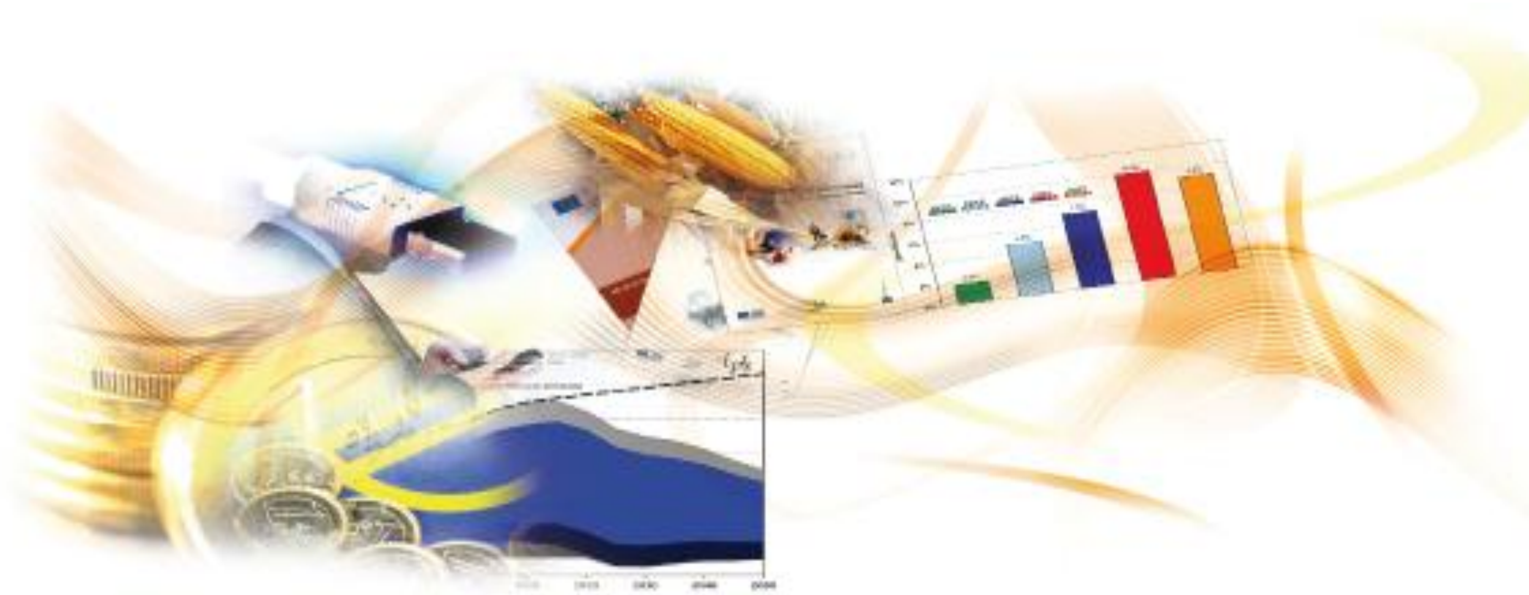

Modelling regional labour market dynamics: Participation, employment and migration decisions in a spatial CGE model for the EU

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Abstract

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Modelling regional labour market dynamics: Participation, employment and migration decisions in a spatial CGE model for the EU[☆]

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Abstract

This paper outlines how regional labour market adjustments to macro-economic and policy shocks are modelled in RHOMOLO through participation, employment and migration decisions of workers. RHOMOLO, being a multi-sectoral, inter-regional general equilibrium model, is complex both in terms of its dimensionality and the modelling of spatial interactions through trade flows and factor mobility. The modelling of the labour market is therefore constrained by the tractability and computational solvability of the model. The labour market module consists of individual labour participation decisions, including the extensive margin (to participate or not) and the intensive margin (hours of work). Unemployment is determined through a wage curve and inter-regional labour migration decisions are modelled in a discrete-choice framework, with backward-looking expectations.

Keywords: Participation, unemployment, labour migration, wage curve, CGE, new economic geography.
JEL code: C68, D58, F22, J20, J61, J64, O15.

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[☆] The views expressed are purely those of the author and may not in any circumstances be regarded as stating an official position of the European Commission.

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1. Introduction

Labour markets serve as an important adjustment channel to macro-economic shocks, such as regional integration and economic crises. Changes in regional employment can be accommodated in a model through changes in labour force participation, changes in unemployment, or labour migration. The present paper describes the modelling approach of regional labour markets taken in the newly developed dynamic spatial general equilibrium model RHOMOLO[1]. It is crucial to account for all three adjustment channels of regional labour markets in the modelling framework, as there exist important interactions between them. Failing to model them simultaneously may result in suboptimal policy recommendations (Boeters and Savard, 2012). Therefore, in RHOMOLO, the labour market equilibrium is determined by firms' labour demand, the participation decision of representative households, a wage curve relating wages to unemployment and inter-regional labour migration.

Inclusion of households' participation decisions is desirable, as the empirical evidence has shown that in the EU changes in regional employment opportunities are predominantly absorbed through changes in participation decisions by individuals, rather than migration or changes in unemployment (Decressin and Fatás, 1995). In addition, it is important to distinguish between the intensive and extensive margin of participation. If the change in participation occurs at the intensive margin, workers simply adjust their number of hours worked and unemployment remains unaffected. For given levels of employment however, participation decisions at the extensive margin do alter unemployment. In RHOMOLO the participation decision is modelled both at the intensive and the extensive margin and closely follows the approach by Boeters and van Leeuwen (2010), describing the labour market in WORLDSCAN, a CGE model developed and used by the Dutch Central Planning bureau (CPB).

The empirical evidence suggests that unemployment is not driven by excess labour supply. In contrast, regions and countries with high employment rates have low unemployment rates, and there is limited job creation in regions and countries with high unemployment rates, rather than large differences in labour supply. This implies that labour market imperfections must be accounted for, in order to explain the prevalance of unemployment. The modelling of unemployment in RHOMOLO follows Blanchflower (1994) and adopts the wage curve approach – an empirical regularity describing the negative relation between wages and unemployment. This approach allows us to pragmatically introduce unemployment, while

[1]For a detailed description of the RHOMOLO model, see Brandsma *et al.* (2014), published in this issue of *Investigaciones Regionales*.

avoiding strong assumptions on the underlying labour market imperfections causing it.

Although the importance of international migration as an adjustment channel is only of limited importance in the EU, inter-regional labour migration flows do mitigate demand shocks to a significant extent(Blanchard and Katz, 1992; Decressin and Fatás, 1995; European Commission, 2012), especially over longer time periods. Consequently, interregional migration is also modelled in RHOMOLO. The migration decision of households in RHOMOLO is based on a comparison of expected regional income differences. All parameters governing the elasticity of the migration decision are estimated empirically.

The remainder of the paper is structured as follows. Section 2 introduces the participation decisions of workers, section 3 describes the wage curve and estimates country-specific wage curve elasticities, and section 4 details the modelling of inter-regional labour migration in RHOMOLO and the estimation procedure applied to uncover the elasticities determining inter-regional labour migration flows.

2. Labour market participation

The approach taken in modelling participation in RHOMOLO is based on Boeters and van Leeuwen (2010). We introduce participation decisions both at the intensive and extensive margins.

2.1. Modelling participation: intensive margin

The representative individual divides her total available time T between leisure, F, and hours worked, H. As working increases the available income for consumption, the individual faces a trade-off between consumption and leisure in utility when optimising the following CES utility function:

$$V_e = \left[\theta_c \left(\frac{C}{\bar{C}}\right)^{\frac{\gamma-1}{\gamma}} + (1-\theta_c)\left(\frac{F}{\bar{F}}\right)^{\frac{\gamma-1}{\gamma}}\right]^{\frac{\gamma}{\gamma-1}}. \tag{1}$$

Bars above variables denote the observed benchmark values. We use the 'calibrated share form' notation of Böhringer *et al.* (2003) to facilitate the practical implementation and calibration of the model additions in GAMS. The only parameter that requires calibration then is θ_c, which is the value share of consumption, at its benchmark point. Write p_c for the price of the consumption good C. The price of leisure F corresponds to its opportunity cost, the wage w. Write p_v for the expenditure required to obtain a unit of utility. Given the CES form of utility, the price of utility is a CES price index of w and p_c:

$$p_v = \left[\theta_c \left(p_c\right)^{\frac{1-\gamma}{\gamma}} + (1-\theta_c)\left(\frac{w(1-t_m)}{\bar{w}(1-\bar{t_m})}\right)^{\frac{1-\gamma}{\gamma}}\right]^{\frac{1}{1-\gamma}}, \tag{2}$$

where t_m is the marginal tax rate on labour.

Consider the extended income Y_D which equals total income plus the initially consumed amount of leisure when valued at the benchmark wage, such that $Y_D = w\left(H(1-t_a) + (T-H)(1-t_m)\right)$. The level of obtainable utility in the benchmark equals $V_e = Y_d/p_v$. The optimal demand of consumption and leisure relative to their baseline value are given equations (3) and (4).

$$\frac{C}{\bar{C}} = V_e\left(\frac{p_v}{p_c}\right)^{\gamma} \tag{3}$$

$$\frac{F}{\bar{F}} = V_e\left(p_v\frac{\bar{w}(1-\bar{t_m})}{w(1-t_m)}\right)^{\gamma} \tag{4}$$

A shift in the budget constraint increases the obtainable level of utility V_e and shifts the demand functions. The number of hours of work supplied then can be readily calculated from the demand of leisure as $H = T - F$.

In order to set the elasticity of substitution between leisure and consumption γ, we make us of the fact that under appropriate assumptions [2] $\gamma = 1 - \frac{\eta_{Lw}}{\eta_{LY}}$, with η_{Lw} the wage elasticity of the hours of work supplied, and η_{LY} the income elasticity of the hours of work supplied. The values for these elasticities are set at $\eta_{LY} = -0.1$ and $\eta_{wY} = 0.1$, which results in $\gamma = 2$. Furthermore, under the appropriate assumption, an income elasticity of labour, $\eta_{LY} = -0.1$ implies $T/H = 1.1$ (see (Boeters and van Leeuwen, 2010)). Future work will consider setting the parameter values according to recent empirical work on these elasticities, such as Bargain *et al.* (2014).

2.2. Modelling participation: extensive margin

Next, we introduce labour supply decisions along the extensive margin. Our aim is to determine the number N of labour market participants.

Following Boeters and van Leeuwen (2010) we model the combined labour supply decision (intensive and extensive) as a two-step procedure, which is solved backwards by the individuals.

[2]See (Boeters and van Leeuwen, 2010) for an elaborate discussion on the assumption underlying this result. A detailed exposition of the complete build up of all elements of the model is beyond the scope of this paper. We restrict ourselves to the intuiting of the mechanisms driving the most important results.

Individuals first determining their optimal number of hours worked, assuming a positive participation decision. The expected utility of supplying labour V_l then is compared to a fixed (and individual specific) cost of working, V_0 to determine whether to participate or not. This fixed cost of working, V_0, is assumed to be uniformly distributed across individuals.

In the presence of involuntary unemployment (see section 3), the assignment of labour market participants between the employed and unemployment is assumed to be random (the individuals are assumed to be identical apart from their idiosyncratic cost of participation V_0). The unemployment rate, u, is assumed to be exogenous from the perspective of the individual, V_u is the utility of an unemployed individual (see below), and V_e is the utility of an employed individual shown above in equation 1. The expected utility of supplying labour for every individual therefore is given by:

$$\bar{V}_l = (1-u)\bar{V}_e + uV_u, \tag{5}$$

where the utility of an unemployed individual is given by:

$$V_u = \left[\theta_c \left(\frac{C_u}{\bar{C}}\right)^{\frac{\gamma-1}{\gamma}} + (1-\theta_c)\left(\frac{T-\delta\bar{L}}{\bar{F}}\right)^{\frac{\gamma-1}{\gamma}}\right]^{\frac{\gamma}{\gamma-1}}, \tag{6}$$

with $C_u \equiv rwL(1-t_a)$ the consumption level of the unemployed with a replacement income determined by the replacement rate r. It is assumed that the unemployed can enjoy only a share δ of the total available time T in the form of leisure (due to, for example, time spent searching for jobs). The utility level of the unemployed contains no decision variables and hence is fully determined by model parameters.

Writing h for the value of the density function of V_0's, the number of labour market participants then can be calculated as

$$N = \bar{N} + h(U_l - \bar{U}_l). \tag{7}$$

Assuming the U_l remains within the upper and lower limit of this distribution, the change in the number of participants N in function of wage increases will be higher for a high value of h, the case where individuals have rather similar values of V_0. The value of h therefore determines the elasticity of labour supply at the extensive margin.

More formally, the elasticity of labour supply at the extensive margin which is implied by a specific value for h equals

$$\begin{aligned}\eta_{Nw} \equiv \frac{\partial \log N}{\partial \log w} = \frac{\partial \log N}{\partial \log V_l}\frac{\partial \log V_l}{\partial \log w} = h\frac{V_l}{N}\frac{\partial \log V_l}{\partial \log w} \\ = h\frac{(1-u)V_e}{N}\frac{wL(1-t_m)}{Y_D}.\end{aligned}$$

Note that the value of the elasticity does not only depend on h but also on N and other variables, and therefore is endogenous. We follow Boeters and van Leeuwen (2010) and fix h at the value which correponds to $\eta_{Nw} = 0.2$ at the benchmark level of $N = \bar{N}$. In the simulations, η_{Nw} will vary depending on the value of N.

Alternatively, the participation module could be calibrated using country-specific econometric elasticity estimatesy. Some recent empirical estimates are available from Bargain *et al.* (2014).

3. Unemployment

3.1. Conceptual framework of a wage curve

Following Blanchflower (1994), unemployment in RHOMOLO is modelled by means of a wage curve. The fundamental empirical regularity of the wage curve – a negative relationship between the local unemployment to local real wages – can be derived from a number of micro-founded theoretical models (Card, 1995): the implicit contract model, where the local presence of valued amenities compensate for lower wages and higher unemployment; the efficiency wage model, where employers need to be paid a premium to prevent them from shirking on the job and the negative relation arises because the no-shirking premium is lower in times of high unemployment (because the penalty of getting caught shirking increases); and finally, the union bargaining model, where increasing unemployment leads to a worsening of the workers' outside option, reducing their wage demands during negotiations with employers.

Figure 1 illustrates the equilibrium on the labour market in the presence of a wage curve. Take for example a unionised regional labour market, where unions bargain a higher wage during negotiations with employers, albeit at the cost of decreased job creation. The negotiations drive a wedge between the competitive wage level (A) and the bargained wage (B), leading to equilibrium unemployment, a desirable future for a spatial equilibrium model.

Now consider the effect of a regional labour demand shock: in a perfectly competitive labour market with an inelastic labour supply, such a shock would solely affect the wage

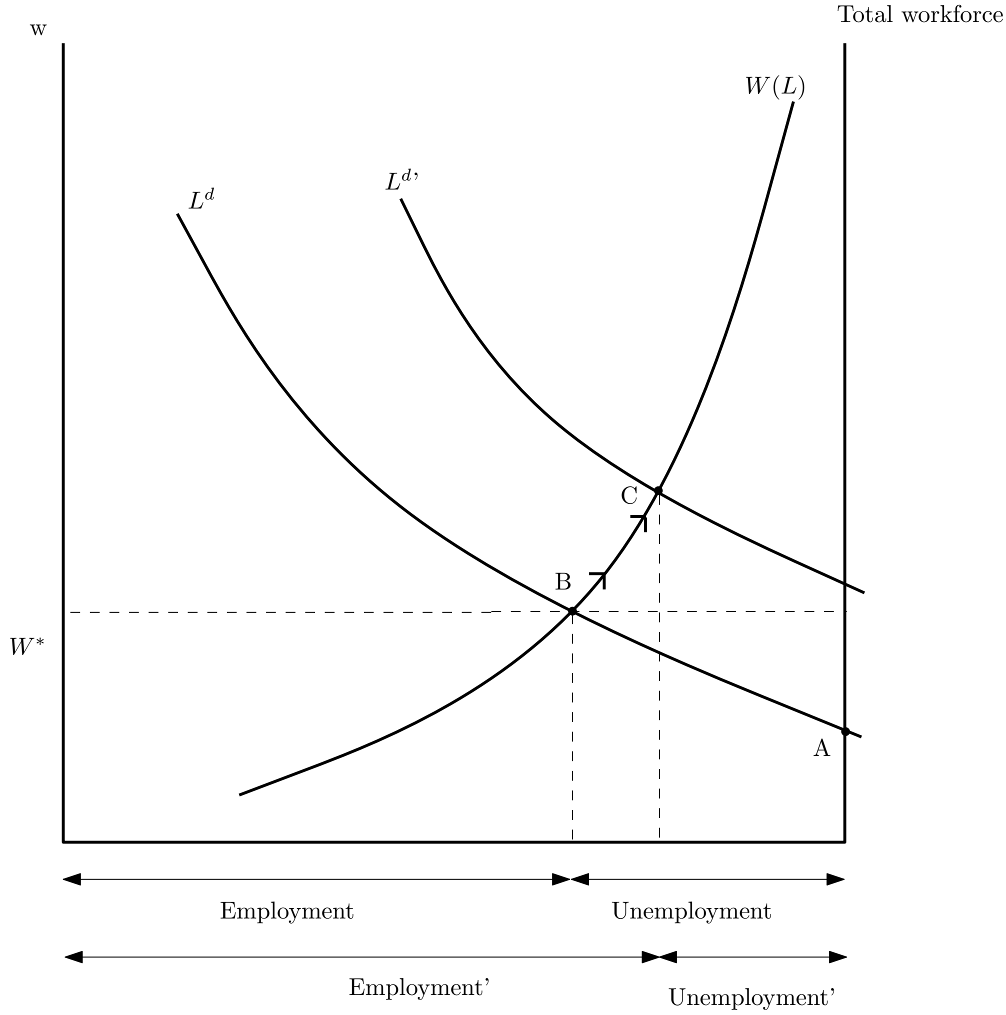

Figure 1: The local labour market equilibrium in the presence of a wage curve and an illustration of the effect of a labour demand shock on wages and (un)employment.

level and leave employment unaltered at the full-employment level. A wage curve ensures that a labour demand shock is translated into an increase in both employment (decrease in unemployment) as well as the wage level (A→B). Because in the RHOMOLO economy people can migrate between regions, this is not the end of the story. How migration mitigates the initial local wage increase in the change in the unemployment rate is illustrated in section 4.

A key parameter determining the effect of shocks on regional unemployment is the wage curve elasticity. In the current version of RHOMOLO, the slope of all regional wages curves is assumed to be equal to -0.1, a commonly recurring value in the empirical literature (Card, 1995; Blanchflower and Oswald, 1995; Janssens and Konings, 1998; Fagan *et al.*, 2005). Since reported estimates in the empirical literature vary considerably, future research will aim to provide country specific estimates of the wage curve elasticity. Our approach will be based on Baas *et al.* (2007) and Jimeno and Bentolila (1998). The pragmatic approach of using a reduced-form wage curve allows us to avoid explicitly modelling the exact mechanisms generating unemployment and thus circumvent making strong assumptions about parameters driving those models, which are often unobservable. Introducing national variation in the slope of the wage curves, allows the model to capture fundamental differences between countries' labour market institutions. With a more structural approach, this would be difficult to achieve as calibrating such modelling frameworks would place heavy demands on the data requirements.

4. Labour migration

4.1. A discrete choice model of labour migration

The equilibrating effect of migration flows in RHOMOLO is illustrated in figure 2. Keeping everything else constant, the initial labour demand shock, illustrated in figure 1, triggers in-migration which causes both wages and unemployment rates to return back to their pre-shock level (B→C). It is important to keep in mind that in a general equilibrium model, as in reality, everything else is not fixed. Firms will be exiting or entering the region which results in additional labour demand shifts and other regions will be affected through trade-links or knowledge spillovers, preventing complete equalisation of regional labour market outcomes.

The modelling of migration in RHOMOLO follows the approach of Sorensen *et al.* (2007) and Grogger and Hanson (2011) and is described in detail in Brandsma *et al.* (2013). It starts from the individual migration decision, where worker k from origin region o, maximises indirect utility, V_{kor}, across all possible destinations r. Destination d will be chosen if

$$V_{kod} > V_{kor} \quad \forall\, r.$$
$$V_{kod} = Z_{od}\beta + \xi_{od} + e_{kod}.$$

The indirect utility V_{kod} of worker k migrating from origin region o to destination region d is determined by characteristics Z_{od} of regions o and d. These characteristics are pair specific and contain for example bilateral distance. Term $Z_{od}\beta$ represents the utility that workers k associates with these characteristics, so that β is a vector of marginal utilities. Error term ξ_{od} represents unobserved location characteristics. $Z_{od}\beta$ and ξ_{od} assign the same utility level to all workers in o considering migration to d. The idiosyncratic error term e_{kod} varies across

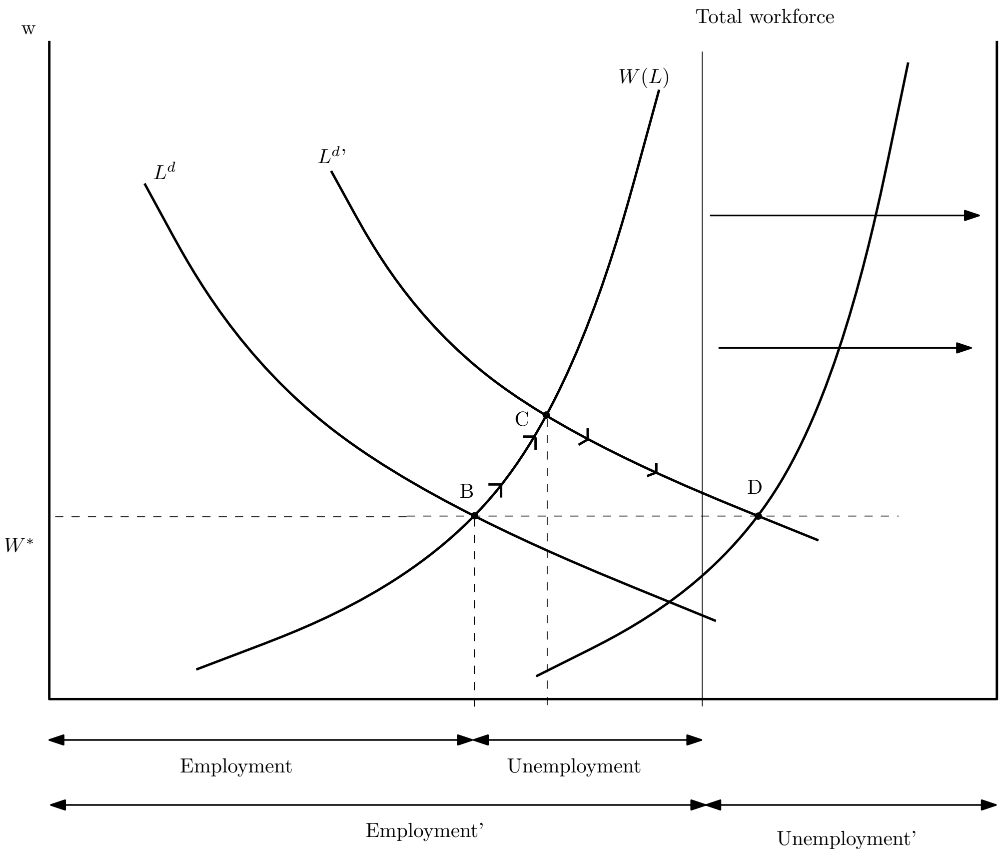

Figure 2: An illustration of a single shift in labour demand (A→B), and subsequent in-migration (B→C) on regional wages, employment and unemployment in a *partial equilibrium* setup. The shift only has a temporary effect on the local wage level and unemployment rate, but a permanent effect on the size of the local labour force.

both workers and regions and accounts for the fact that not all workers from the same region choose the same destination. The probability that location d is chosen by individual k from region o then equals:

$$\Pr\left(V_{kod} > V_{kor}\right) \quad \forall\, d \neq r$$
$$\Pr\left(e_{kod} - e_{kor} > Z_{or}\beta - Z_{od}\beta + \xi_{or} - \xi_{od}\right) \quad \forall\, d \neq r.$$

Now assume that the idiosyncratic error term e_{kod} follows an i.i.d. extreme value distribution. McFadden (1973) shows this yields the following probability for a worker k from o to migrate to d:

$$\Pr\left(M_{kod} = 1\right) = \frac{\exp\left(Z_{od}\beta + \xi_{od}\right)}{\sum_{d=1}^{R} \exp\left(Z_{od}\beta + \xi_{od}\right)}. \qquad (8)$$

Berry (1994) in turn shows that probability (8) of migrating from o to d coincides with the share of workers from o migrating to d. Following Sorensen *et al.* (2007), we therefore write the share of migrants from o to d as:

$$s_{od} = \Pr\left(M_{kod} = 1\right) = \frac{\exp\left(Z_{od}\beta + \xi_{od}\right)}{\sum_{d=1}^{R} \exp\left(Z_{od}\beta + \xi_{od}\right)} \tag{9}$$

and the share of stayers in region o as:

$$s_{oo} = \Pr\left(M_{koo} = 1\right) = \frac{\exp\left(Z_{oo}\beta + \xi_{oo}\right)}{\sum_{d=1}^{R} \exp\left(Z_{od}\beta + \xi_{od}\right)}. \tag{10}$$

Dividing equation (9) by (10) and applying a logarithmic transformation yields a simple econometrically estimable migration equation:

$$\ln\left(\frac{s_{od}}{s_{oo}}\right) = \ln\left(\frac{\exp\left(Z_{od}\beta + \xi_{od}\right)}{\exp\left(Z_{oo}\beta + \xi_{oo}\right)}\right) = Z_{od}\beta - Z_{oo}\beta + \xi_{od} - \xi_{oo} \tag{11}$$

Next, we allow the e_{kod} to be correlated within countries, while maintaining the i.i.d. assumption between countries. Using the same index c for countries (nests) and c_d for the country of destination, the estimable migration equation can then be written as:

$$\ln\left(\frac{s_{od}}{s_{oo}}\right) = \left(Z_{od} - Z_{oo}\right)\beta + \sigma \ln(s_{od|c_d}) + \left(\xi_{od} - \xi_{oo}\right) \tag{12}$$

4.2. Econometric specification and empirical implementation

The estimation of equation (12) requires an instrumental variable approach due to the endogeneity of the conditional probability (share). Following the common approach in the literature on discrete choice in the context of product demand estimation (Berry *et al.*, 1995), we chose the number of regions in country as an instrument for the probability of choosing a specific region as the destination of choice, conditional on the destination country choice. The share of people choosing a particular region in a country will on average be inversely related to the number of regions in the country. The number of regions in a country is exogenous to the migration decision in itself, as the size of countries and the number of NUTS-2 regions contained in them are clearly unrelated to contemporary migration patterns.

In order to construct a matrix with bilateral regional migration flows, two datasets were merged: Eurostat's data on within-country interregional migration flows and OECD's data on international migration. Data on migration between NUTS2 regions *within* countries is available from Eurostat for most of the EU member states. The first step in constructing an approximate dataset of gross bilateral migration flows between NUTS2 regions consists of calculating migration probabilities between every pair of regions within each country, for each country separately. Secondly, international migration flows without any regional dimension were obtained from the OECD. These international migration flows were subsequently 'regionalised', assuming that international migrants distribute themselves between the regions of the country of destination according to the same pattern as within-country migrants do. Similarly, the international migrants are assumed to originate from specific regions of origin in the source country in the same proportions as the within-country migrants originate from different regions in the source country. Obviously, this approach is an approximation, and will introduce errors, if the true distribution of international migrants differs significantly from the observed distribution of within-country migrants.

Explanatory variables. In line with the underlying conceptual framework, we measure the indirect utility for living in region d for an individual from region o, $V_{kod} = Z_{od}\beta + \xi_{od} + e_{kod}$ by the expected real income in destination region d, net of migration costs for migrating between o and d. We approximate the real expected income in region r by $income_r = W(r) \cdot (1 - u(r))/P(r)$, with the average local wage $W(r)$, the unemployment rate $u(r)$, and the local consumer price index $P(r)$. The migration costs are approximated by a log-linear function of the great circle distance between the geographic centre of the origin and destination NUTS-2 region. A dummy variable $\mathrm{I}(intl_{od})$ for international migration equals 1 in case region o and d are located in different countries. The empirical specification of the estimation equation then becomes

$$\begin{aligned} \ln\left(\frac{s_{od}}{s_{oo}}\right) &= \beta_1 \ln(income_o) + \beta_2 \ln(income_d) + \beta_3 \ln(distance_{od}) \\ &\quad + \beta_4 \mathrm{I}(intl_{od}) + \beta_5 \ln(s_{od|c_d}) + (\xi_{od} - \xi_{oo})\,. \end{aligned} \tag{13}$$

The data on wages, the unemployment rate and consumer price index (CPI) were taken from the Eurostat regional databases. The year 2004 was chosen to perform the analysis, as this year has the best data coverage.[3] Although, according to the underlying conceptual framework, coefficients β_1 and β_2 should be of opposite sign and of equal size, we follow Kancs (2011) and do not impose this restriction in our empirical application. We report the empirical results for specifications including a log-linear distance term to estimate the elasticity of migration with respect to distance. In the simulations using RHOMOLO, however, in order to obtain results which are as realistic as possible a fifth-order polynomial in log-distance

[3]Choosing a different year does not materially affect the results.

will be used to capture non-linearities in the response of migration to distance. We omit these results here.

4.3. Empirical results

Using the imputed interregional migration flows, equations (11) and (12) were subsequently estimated.

Column (I) of Table 1 shows the results of estimating equation (11) using the OLS estimator. Column (II) reports the instrumental variables estimation described above for equation (12). The estimated effect of income in the destination region decreases and the elasticity of distance increases when taking into account the endogeneity of the conditional probability, but overall the results of OLS and IV are rather similar. The size of the effect of the international migration dummy $\mathrm{I}(intl_{od})$ is remarkable, emphasising the importance of international borders (often corresponding to important cultural and language barriers) on labour mobility. One important point is that the coefficient on the conditional share implies an estimate of σ, the measure of within-country correlation in taste has the opposite sign and is outside of the theoretically consistence range between 0 and 1. In this light, and because the difference between the OLS and IV estimates are quite close, we opted to use the OLS estimates in the simulation analysis.

	(I)	(II)	(III)
lnexpto	0.840***	0.855***	0.758***
	(0.0236)	(0.0234)	(0.0275)
lnexpfrom	-0.465***	-0.461***	-0.488***
	(0.0197)	(0.0196)	(0.0243)
logdist	-1.724***	-1.696***	-1.877***
	(0.0202)	(0.0202)	(0.0330)
lncondshareto		0.228***	-1.221***
		(0.0172)	(0.0423)
_cons	-4.163***	-3.902***	-5.563***
	(0.292)	(0.291)	(0.426)
N	14485	14485	14485

Table 1: Estimation results

Being rooted in the discrete choice theory, the estimated migration model allows us to infer the structural parameters governing the individual behaviour from observable aggregate migration flows. An important advantage of this approach is that when assessing the effects of policy simulations –to which we turn in the next section– the predicted migration flows will obey key macro-accounting rules. In particular, the predicted increase in migration inflow resulting from an increasing attractiveness of regions must imply an equal increase in outgoing migration from other regions, such that the total EU population is unaffected by migration internal to the EU. Such properties do not hold when modelling migration flows in an ad-hoc way, or as a Poisson process (for a discussion, see Schmidheiny and Brülhart, 2011).

5. Conclusions

This paper describes how regional labour market adjustments to macro-economic and policy shocks through participation, employment and migration decisions of workers are modelled in RHOMOLO, a spatial CGE model. Being a multi-sectoral, inter-regional general equilibrium model, RHOMOLO is complex both in terms of its dimensionality and the modelling of spatial interactions through trade flows and factor mobility. The modelling of the labour market is therefore constrained by the tractability and computational solvability of the model. The labour market module consists of individual labour participation decisions, both at the extensive (to participate or not) and the intensive margin (hours of work). Unemployment is determined through a wage curve. Inter-regional labour migration is modelled in a discrete-choice framework with backward-looking expectations, for which migration elasticities have been estimated econometrically.

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