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Assessing the Social and Macroeconomic Impacts of the High-Skill Labour Market Integration: The European Qualifications Framework☆

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Abstract

In the age of the knowledge economy and globalisation, the skill mobility is perceived as one of the key factors for fully unlocking the human capital potential. The European Qualifications Framework (EQF) aims at increasing the workers' and learners' mobility among the EU Member States by making national qualifications readable across the EU. The present study analyses the impact of the EQF on education, skills, migration and the economic growth by performing a conceptual analysis and numerical simulations of the high-skill market integration through the EQF with a newly developed macroeconomic model of the European Commission. Whereas education is the main driver of the upward skill mobility, migration drives the spatial skill mobility. Our results suggest that the EQF would facilitate the high-skill labour market integration, which in turn would generate significant welfare gains for the EU. Both the social and macroeconomic effects of the EQF are positive at the aggregate level. However, their distribution across different Member States, regions, economic sectors and skill levels is differentiated. Hence, accompanying policy measures may be required to ensure an inclusive growth arising from the high-skill market integration.

Keywords: Education, skills, employment, labour, migration, wage, human capital, macroeconomic modelling.
JEL code: C68, D58, F22, J20, J61, J64, O15.

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1. Introduction

In the age of the knowledge economy and globalisation, the skill mobility is perceived as one of the key factors for unlocking the human capital potential in the EU. The European Qualifications Framework (EQF) is a policy instrument, established within the context of the European cooperation in the field of Education and Training, aimed at promoting workers' and learners' mobility.[1] The present paper aims to assess the potential social and macroeconomic impacts of the EQF on education, migration, skills, the human capital and the economic growth.

The economic theory (see for example Agenor, 1996) suggests that labour markets can adjust in response to changes in the macroeconomic environment through a number of channels: adjustments in employment/unemployment, investment in education, adjustments in the labour force participation/nonparticipation, labour migration, adjustments in the worker remuneration, and others. In the context of the EQF and the high-skill market integration, two channels of the labour market adjustment are particularly important – the *upward skill mobility* and the *spatial skill mobility*. Whereas education is the main driver of the upward skill mobility, migration drives the spatial skill mobility. Both the education channel of adjustment and the migration channel of adjustment are singled out and their response to the EQF studied in detail in this study.[2]

The findings of empirical studies suggest that, in addition to the skill level, also the regional dimension is important, when looking at the social and macroeconomic effects of labour market policy interventions. As noted by Blanchard and Katz (1992); Decressin and Fatás (1995), regional labour markets are fundamentally different from national labour markets. For example, in the EU there is significantly more inter-regional migration in response to changes in the macroeconomic environment, such as economic integration or financial crisis, than international migration in response to country-level shocks (European Commission, 2015). Another reason to consider labour markets at the regional level is the pattern and degree of specialisation in the production of goods and services, which is higher at the regional level when compared to the national level, such that analysing the national labour market response to changes in the macroeconomic

[1]The EQF was established by the Recommendation of the European Parliament and of the Council of 23 April 2008 (2008/C 111/01). http://ec.europa.eu/education/policy/strategic-framework/skills-qualifications_en.htm

[2]In the context of this study, we abstract from other types of skill mobility, such as the sectoral skill mobility, the occupational skill mobility, etc.

environment would provide less nuanced understanding of the functioning of labour markets.

In order to assess the social and macroeconomic impacts triggered by the EQF in a disaggregated way by the skill level and the region of location, the present study singles out and analyses in detail two key mechanisms through which policy shocks are absorbed in regional labour markets – the *upward skill mobility* and the *spatial skill mobility* – in two different ways: by performing numerical simulations with a macroeconomic model, and by undertaking a conceptual analysis in a diagrammatic framework. The two approaches are complementary and are presented in a non-formal way to intuitively analyse the potential impacts of the EQF policy scenario related to the high-skill market integration, which is simulated as a migration cost reduction. Due to the full EU-wide recognition of qualifications for high-skill workers triggered by the EQF, they become fully mobile across EU regions, and have a perfect information about skill demand and supply in every EU region. The social and macroeconomic impacts of the high-skill market integration are assessed against the segmented labour market baseline.

The newly developed macroeconomic model of the European Commission (RHOMOLO), which we employ in the present study, is designed for the EU policy impact assessment and provides sector-, region- and skill-specific support to EU policy makers on structural reforms, growth, infrastructure and human capital policies.[3] In the past, RHOMOLO has been used for the impact assessment of the EU Cohesion Policy and for European Investment Bank's investments. The current version of RHOMOLO covers all NUTS2 regions of the EU, and each regional economy is disaggregated into six economic sectors. Spatial interactions between regions are captured through the trade of goods and services (which is subject to trade costs), factor mobility and knowledge spillovers, making RHOMOLO particularly well suited for simulating human capital, R&D and innovation policies. In the context of the present study, RHOMOLO simulation results allow not only for providing a scientific model-based support to EU policy makers, but also for deriving skill-specific policy recommendations related to the accumulation, employment and remuneration of the human capital on the one hand, and macroeconomic impacts on regional economies, such as growth, income, consumption, investment, savings, etc., on the other hand.

In the context of the EQF, an important advantage of the RHOMOLO model – vis-a-vis other macroeconomic models – is that it is able to capture at the skill, regional and

[3]See Brandsma *et al.* (2015) for a formal description of the key mechanisms in the RHOMOLO model.

sectoral level all induced direct and indirect, short- and long-run general equilibrium effects of labour market policy interventions, such as the EQF and the associated deeper high-skill market integration between EU Member States, according to which both the labour supply and the labour demand would adjust in RHOMOLO. As regards the labour supply, in RHOMOLO reduced migration costs and the triggered emigration of high-skill workers from low-wage regions would exert an upward pressure on high-skill wages, which in turn would create incentives for low- and medium-skill workers to invest into education and acquire higher skills, respectively, in the low-wage sending regions. Hence both, migration-induced wage-adjustments in sending and receiving regions, and wage-driven adjustments in the skill accumulation and composition of workforce in each region are captured in RHOMOLO. As regards the labour demand, in RHOMOLO there would be two types of induced effects. On the input side, changes in the relative low-, medium- and high-skill wages would trigger adjustments in the factor demand for production of goods, because the low-, medium- and high-skill labour and capital are mutually substitutable. On the output side, companies would adjust their specialisation patterns according to changes in the relative skill-abundance in the region where company is located. In addition, firms may find it profitable to relocate to another region, which also would change the labour demand on regional labour markets. Hence, both skill demand and skill supply channels are captured endogenously and simultaneously in RHOMOLO.

The results from our analysis suggest that the European Qualifications Framework would facilitate the high-skill market integration, which in turn would generate significant welfare gains for the EU. Both the social and macroeconomic effects of the EQF are positive at the aggregate level. However, their distribution across different Member States, regions, economic sectors and skill levels is differentiated. Those Member States and regions, where the high-skill wage is particularly high compared to the EU average, may experience a high-skill wage decrease. The opposite would take place in those regions, where the high-skill wage is particularly low compared to the EU average. Hence, accompanying policy measures may be required to ensure an inclusive growth arising from the high-skill market integration.

Our findings have important policy implications. From the policy perspective, it is important that the particular mechanisms, through which labour market adjustments occur, are identified at the skill and regional level, as they may have regionally differentiated policy implications (Boeters and Savard, 2012). For example, in the regional development policy, there is an ongoing debate surrounding the appropriateness of people-based policies versus place-based strategies (Barca *et al.*, 2012). One of the key issues in this debate is that policy measures to improve the skill of people in a particular region via place-based strategies may be confounded, if the immigration response is large. In other words, EU policies could end up benefiting new entrants to the region rather than the initial target population. Hence, analysing the inter-regional labour markets dynamics with skill, regional and sectoral detail is required for deriving policy relevant recommendations, as many of the effects would average out at the aggregate level.

2. European Qualifications Framework

In the context of the ongoing globalisation, the mobility of workers is perceived as one of the key factors for unlocking the human capital potential. Despite the increasing global mobility, the cross-country mobility of qualified professionals is low in the EU. As indicated in a recent EU survey (Eurobarometer 2010), 28 percent of EU citizens are considering working abroad. However, less than 2% do actually work abroad. These numbers suggest a major unexploited potential for the worker mobility. Among others, the mobility of workers is hampered and complicated at the system level by a lack of communication and co-operation between EU Member States and the education sector relating to the recognition of their qualifications and providing the transparency of the education system. At the institutional level, the lack of communication between different education providers and employers creates in-transparencies for all stakeholders (education providers, employers, workers and learners) (European Parliament, 2012; Lester, 2015).

One of the objectives of the EU single market is that EU citizens are able to travel, study and work in each EU Member State without facing severe administrative barriers. This requires that their qualifications, certificates and knowledge should be recognised in other Member States. The way in which different qualifications are related to each other should also facilitate the use of different learning pathways within a country, also after leaving the initial education. The recognition of professional qualifications can be considered as key to make fundamental internal market freedoms work effectively for EU citizens. Increasing the transparency in qualifications and educational systems, making qualifications more readable and understandable across different countries, would stimulate the worker mobility to meet current and future EU challenges.

The need for promoting the workers' and learners' mobility has been included as a general theme in EU policies since more than a decade. The 2000 Lisbon Council's declaration called for giving higher priority to facilitating the labour mobility by providing a common European format for the curricula vitae. Further, the Lisbon Council concluded that an increased transparency of qualifications should be one of the main components necessary to adapt education and training systems in the EU to the demands of the knowledge society and economy.[4] Similarly, the Monti (2010) report on the future of the single market indicated that the labour mobility is hampered by a number of barriers, including the complexity of the international recognition of professional qualifications (European Parliament, 2012; Lester, 2015).

Following the conclusions from the Lisbon European Council in 2000, there has been an increasing number of policy actions at the EU level towards the development of the EQF to strengthen the links between frameworks at the national and sectoral level. In 2004 the Joint Interim Report on the implementation of the 'Education and Training 2010' work programme of the European Council and the European Commission concluded that priority should be given to the development of the EQF as an essential contribution towards achieving the Lisbon strategy's objectives (European Parliament, 2012).

In 2005 the European Council asked for the adoption of the EQF, significantly strengthening the political basis for taking this initiative forward. In 2006 the European Commission published a consultation document that emphasised that the success of the EQF depends on its credibility and relevance for education institutes, employers, policy makers and individual learners.[5] After the consultation process in 2006, the Recommendation of the European Parliament and the European Council was accepted in 2008.[6]

The EQF aims to relate different countries' national qualifications systems to a common European reference framework (European Parliament, 2012). The Recommendation, which entails voluntary involvement of countries without entailing any legal obligations – thus respecting the principle of subsidiarity, suggests that:

- By 2010 Member States relate their national qualifications systems to the European Qualifications Framework, either by referencing, in a transparent manner, their qualification levels to the EQF levels, or, where appropriate, by developing national qualifications frameworks;

[4] http://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/ec/00100-r1.en0.htm
[5] SEC(2005) 957.
[6] 2008/C 111/01.

- Starting from 2012, all new qualification certificates, diplomas and Europass documents contain a reference to the appropriate EQF level;
- Member States use an approach based on learning outcomes when defining and describing qualifications, and promote the validation of the non-formal and informal learning;
- Member States promote and apply the principles of the quality assurance in education and training;
- Member States designate national co-ordination points, in order to support the relationship between national qualifications systems and the EQF.

In a nutshell, the EQF is a translation grid for qualifications around the EU containing eight reference levels, covering basic to most advanced qualifications:

1. **Level**
   Knowledge: Basic general knowledge
   Skills: Basic skills required to carry out simple tasks
   Competence: Work or study under direct supervision in a structured context
2. **Level**
   Knowledge: Basic factual knowledge of a field of work or study
   Skills: Basic cognitive and practical skills required to use relevant information in order to carry out tasks and to solve routine problems using simple rules and tools
   Competence: Work or study under supervision with some autonomy
3. **Level**
   Knowledge: Knowledge of facts, principles, processes and general concepts, in a field of work or study
   Skills: A range of cognitive and practical skills required to accomplish tasks and solve problems by selecting and applying basic methods, tools, materials and information
   Competence: Take responsibility for completion of tasks in work or study; adapt own behaviour to circumstances in solving problems
4. **Level**
   Knowledge: Factual and theoretical knowledge in broad contexts within a field of work or study
   Skills: A range of cognitive and practical skills required to generate solutions to

specific problems in a field of work or study exercise self-management within the guidelines of work or study contexts that are usually predictable, but are subject to change
Competence: Supervise the routine work of others, taking some responsibility for the evaluation and improvement of work or study activities

5. **Level**
   Knowledge: Comprehensive, specialised, factual and theoretical knowledge within a field of work or study and an awareness of the boundaries of that knowledge
   Skills: A comprehensive range of cognitive and practical skills required to develop creative solutions to abstract problems
   Competence: Exercise management and supervision in contexts of work or study activities where there is unpredictable change; review and develop performance of self and others
6. **Level**
   Knowledge: Advanced knowledge of a field of work or study, involving a critical understanding of theories and principles
   Skills: Advanced skills, demonstrating mastery and innovation, required to solve complex and unpredictable problems in a specialised field of work or study
   Competence: Manage complex technical or professional activities or projects, taking responsibility for decision-making in unpredictable work or study contexts; take responsibility for managing professional development of individuals and groups
7. **Level**
   Knowledge: Highly specialised knowledge, some of which is at the forefront of knowledge in a field of work or study, as the basis for original thinking; Critical awareness of knowledge issues in a field and at the interface between different fields
   Skills: Specialised problem-solving skills required in research and/or innovation in order to develop new knowledge and procedures and to integrate knowledge from different fields
   Competence: Manage and transform work or study contexts that are complex, unpredictable and require new strategic approaches take responsibility for contributing to professional knowledge and practice and/or for reviewing the strategic performance of teams
8. **Level**

Knowledge: Knowledge at the most advanced frontier of a field of work or study and at the interface between fields
Skills: The most advanced and specialised skills and techniques, including synthesis and evaluation, required to solve critical problems in research and/or innovation and to extend and redefine existing knowledge or professional practice
Competence: Demonstrate substantial authority, innovation, autonomy, scholarly and professional integrity and sustained commitment to the development of new ideas or processes at the forefront of work or study contexts including research.

Within the EQF, Each Member State classifies its national qualifications into eight EQF levels by means of its National Qualifications Framework or the levels of its national qualifications system. Member States are not required by the EQF Recommendation to develop National Qualifications Frameworks and can, in principle, relate their qualifications levels to the EQF without formally establishing a national framework. The EQF is envisaged as a meta-framework increasing transparency and supporting the mutual trust. It will thereby enable qualification frameworks and systems at the national and sectoral level to be related to each other – thus facilitating the transfer and recognition of qualifications of individual citizens across the EU boarders. Workers and employers will be able to use the EQF to better understand and compare the qualifications levels of different countries and different education and training systems, leading to an increased labour mobility between countries and education systems.

3. Conceptual analysis of the high-skill market integration

In this section we offer a conceptual analysis of the EQF and the high-skill market integration. First, we introduce the conceptual framework. We employ a diagrammatic analysis, as it greatly facilitates the understanding of numerical simulation results, which will be presented in the following sections, and helps highlighting the most important channels of adjustment without requiring a formal mathematical analysis. We decompose and explain graphically two key channels – the *upward skill mobility* and the *spatial skill mobility* – through which regional labour markets adjust to the high-skill market integration. We also show how the interaction between the two channels affects labour market outcomes. Second, we analyse the impact of the high-skill market integration on education, skills, wages and human capital. We present the social and macroeconomic effects of the high-skill market integration in turn.

3.1. Setup: upward and spatial skill mobility

For the sake of graphical tractability of the diagrammatic analysis, we make several simplifying assumptions. First, we assume that there are only two regions (one Less Developed Region (LDR) and one More Developed Region (MDR)), and only two types of skills (low-skill and high-skill). Second, we consider only two channels of labour market adjustment (education and migration), whereas we abstract from two other important channels (e.g. participation and employment), which however are present in RHOMOLO (see Brandsma *et al.* (2014); Persyn *et al.* (2014)). Third, we assume that the demand for the low-skill labour is infinitely elastic. If the elasticity of the low-skill labour demand would be lower, then an additional low-skill wage effect would arise, which would affect the ratio of high-skill/low-skill workers in LDR.[7] Finally, in the presented diagrammatic analysis we abstract from labour market demand effects, although in reality (and in RHOMOLO), an increase in population in a region would increase local consumption for goods, which in the presence of non-zero transportation costs would favour local producers, resulting in higher production and higher demand. These simplifications are required to keep the graphical analysis tractable, while showing the main mechanics of skill adjustments.

Suppose that the less developed region, LDR, is endowed with L^{LDR} units of labour, which is shown on the horizontal axis in the left panel of Figure 1. The high-skill labour, L_H^{LDR}, is measured from left to right, whereas the low-skill labour, L_L^{LDR}, from right to left, with $L^{LDR} = \lambda_H L_H^{LDR} + \lambda_L L_L^{LDR}$. Curves D_H^{LDR} and D_L^{LDR} represent the firm demand for the high-skill and low-skill labour, respectively, and S_H^{LDR} is the worker supply of the high-skill labour in LDR. λ_H and λ_L are efficiency parameters measuring the relative labour productivity of high-skill and low-skill workers, respectively.

We abstract from participation and employment decisions and focus on two decisions of workers: education and migration. First, we consider the education decision, where workers choose between offering the low-skill labour versus investing into education and acquiring high skills in LDR. Given that education is costly, workers invest into education only when education would increase their net wage.[8] Net of schooling costs, workers must earn at least the low-skill wage, which is equal to w_L^{LDR*} in Figure 1. The vertical difference between the high-skill labour supply, S_H^{LDR}, and the low-skill wage

[7] Moreover, it can be easily verified that, as long as the condition $L_H^{LDR}/L_L^{LDR} \leq L_H^m/L_L^m$ holds, the results with low-skill labour migration would be qualitatively equal to those presented here.

[8] We implicitly assume that all workers, for whom it pays off to become skilled, invest in education.

rate, w_L^{LDR*}, represents the cost of acquiring education (Figure 1, left panel). The last low-skill worker, who enters education at L_H^{LDR*}, is just able to compensate his education costs, though his skill premium is equal to zero. In equilibrium, the education cost of the marginal worker who enters education is equal to EC^*. Abstracting from participation and employment channels of adjustment, the rest of workers, $L^{LDR} - L_H^{LDR*}$, remain with low skills. The equilibrium wage of low-skill workers without migration, w_L^{LDR*}, is at the point where the demand for the low-skill labour, D_L^{LDR}, intersects the vertical line at L_H^{LDR*}. The equilibrium stock of the high-skill labour is L_H^{LDR*} and the high-skill wage rate is w_H^{LDR*}.

The labour market equilibrium for the receiving region, MDR, is analogous. In the absence of migration, the equilibrium high-skill wage, low-skill wage and the stock of high-skill workers are w_H^{MDR*}, w_L^{MDR*}, and L_H^{MDR*}, respectively (Figure 1, right panel).

Next, consider the high-skill worker decision where to offer their skills, locally or abroad. The trade-off, which high-skill workers face here, is given by the expected wage increase after migration versus migration costs, MC.[9] Differences in development and hence wage levels between less developed and more developed regions trigger migration from LDR to MDR. Workers migrate if the expected wage income arising from relocation is higher than migration costs.[10] In the presence of positive migration costs, $MC > 0$, the net wage which high-skill migrant workers earn in MDR is lower than the high-skill wage of incumbent workers, because the net wage of migrants is the high-skill wage in the destination region, w_H^{MDR}, minus migration costs, MC.

According to the migration network theory and the estimated migration elasticities in Section 4.3, migration costs are not constant, they are decreasing in the number of migrants from LDR residing in MDR. In Figure 1 (middle panel) these network effects are captured by a decreasing distance between curves S_{MC}^m and S^m. Curve S^m is the migrant work supply on the migrant labour market, which is derived by subtracting the high-skill labour supply, S_H^{LDR}, from the high-skill labour demand, D_H^{LDR}, in LDR. Curve S_{MC}^m is the migrant labour supply adjusted for migration costs, MC.

In equilibrium, L_H^m high-skill workers emigrate from LDR incurring migration cost,

[9] These costs include not only the direct transportation costs to the destination country, but also employment uncertainty (which is higher abroad than at home), social costs of leaving family and/or friends behind, cultural adjustment costs, language barriers etc. (Kancs, 2011).

[10] We recognise that in reality the migration decision of workers is driven not only by wage differences but also by non-economic considerations. However, in the present study we abstract from all other determinants of migration and consider cross-country wages differences as the only force driving labour migration.

MC^{*}, and receive the net wage, $w_{H}^{m}\left(=w_{Ho}^{MDR*}-MC^{*}\right)$ in MDR. The equilibrium wage rate of the high-skill labour, w_{Ho}^{MDR*}, is determined by the intersection of the migration supply, S_{MC}^{m}, and the migration demand, D^{m} (Figure 1, middle panel). Migration demand, D^{m}, is derived by subtracting the high-skill labour demand, D_{H}^{MDR}, from the high-skill labour supply, S_{H}^{MDR} in MDR (right panel in Figure 1). In the presence of migration, the high-skill wage in MDR is reduced from w_{H}^{MDR*} (high-skill equilibrium wage without migration) to w_{Ho}^{MDR*} (high-skill equilibrium wage with migration). Migration causes a reduction in the stock of the high-skill labour in LDR and an increase in MDR. The equilibrium stock of the high-skill labour in the presence of migration is L_{H}^{LDRn} in LDR, which is less than without migration, $L_{H}^{LDRn} < L_{H}^{LDR*}$. In MDR the equilibrium stock of the high-skill labour is L_{H}^{MDRm}, with $L_{H}^{MDRm} > L_{H}^{MDR*}$.

3.2. *Impact of the high-skill market integration*

The high-skill market integration affects the spatial labour market equilibrium by reducing migration costs and improving access to high-skill jobs in the more developed region, MDR, which in the short-run leads to a positive high-skill wage gap between MDR and LDR. Positive net of migration cost wage differences trigger migration of high-skill workers from LDR to MDR. In the long-run, in addition to these direct labour market effects, the high-skill labour migration triggers further induced general equilibrium effects, the most important of which are explained in the following sections. In Figure 1 we show the labour market integration by reducing migration costs, MC, to zero. This implies a shift of the migrant work supply from S_{MC}^{m} to S^{m}.

3.2.1. *Social and labour market effects*

Through reduced migration costs and improved access to high-skill jobs in MDR in the short-run the high-skill market integration increases the net of migration cost wage gap between MDR and LDR, and hence disturbs the spatial labour market equilibrium. Increased wage differences trigger the skill migration – driven by higher expected earnings in MDR – high-skill workers migrate from LDR to MDR. In the long-run, in addition to this direct short-run effect on the high-skill labour force distribution between LDR and MDR, migration itself affects factors which drive migration, e.g. inter-regional wage differences and migration costs. Both the high-skill worker outflow (direct effect) in LDR and induced second-round migration effects – triggered by changes in relative wages in LDR and MDR and changes in migration costs – are examined in this section.

The most direct and visible effect induced by the high-skill market integration is the transfer of the human capital embodied in migrant skills from LDR to MDR.[11] Given that high-skill migrants embody private productive skills, the exclusiveness of the human capital implies that a migration-driven increase in the stock of human capital in MDR is proportional to a decrease in the stock of human capital in LDR. In Figure 1, the high-skill labour migration increases from L_H^m to L_{HB}^m (middle panel). Under the integrated high-skill labour market equilibrium, LDR has less high-skill workers, L_{HB}^{LDRn}, with $L_{HB}^{LDRn} < L_H^{LDRn}$ (Figure 1, left panel). Thus, because of the brain drain, the high-skill market integration has a strictly negative impact on the human capital in LDR. In MDR the high-skill labour stock expands from L_H^{MDRm} to L_{HB}^{MDRm}, with $L_{HB}^{MDRm} > L_H^{MDRm}$ (Figure 1, right panel).

In the medium- to long-run, the high-skill worker migration affects wages in LDR. By reducing the high-skill labour supply in LDR, the high-skill worker emigration will exert an upward pressure on high-skill wages in LDR (assuming that the labour demand does not change). This will narrow the migration-driving wage gap between LDR and MDR, implying less migration in the long-run. Thus, because of the increasing skill premium in LDR, the long-run losses of the human capital induced by the high-skill market integration may be lower compared to the short-run.

Notice that the inter-regional labour migration affects the wage rate not only in sending regions but also in the receiving regions. Through the increased labour supply of high-skill workers in MDR, emigration will exert a downward pressure on high-skill wages. Lower high-skill/low-skill wage ratio in MDR will narrow the migration-driving wage gap between LDR and MDR, which in turn will attract fewer migrants from LDR. Thus, the long-run losses of human capital induced by the high-skill market integration are lower compared to short-run also because of a decreasing skill premium in MDR.

Both wage effects and the inter-regional distribution of the labour force are shown in Figure 1, where in the long-run the high-skill labour migration equalises the high-skill wage rate between LDR and MDR. The high-skill labour migration reduces the high-skill wage in MDR from w_{Ho}^{MDR*} to w_{HB}^m. In contrast, in LDR the high-skill wage increases from w_H^m to w_{HB}^m (Figure 1). Again, these findings are in line with RHOMOLO simulation results, which will be presented in Section 4.3. In the long-run, the equilibrium wage rate for the high-skill labour, w_{HB}^m, is equalised across regions and migration equals to L_{HB}^m.

[11]Given that the human capital embodied in skilled workers is draining out of country, in the migration literature this effect is often referred to as a 'brain drain'.

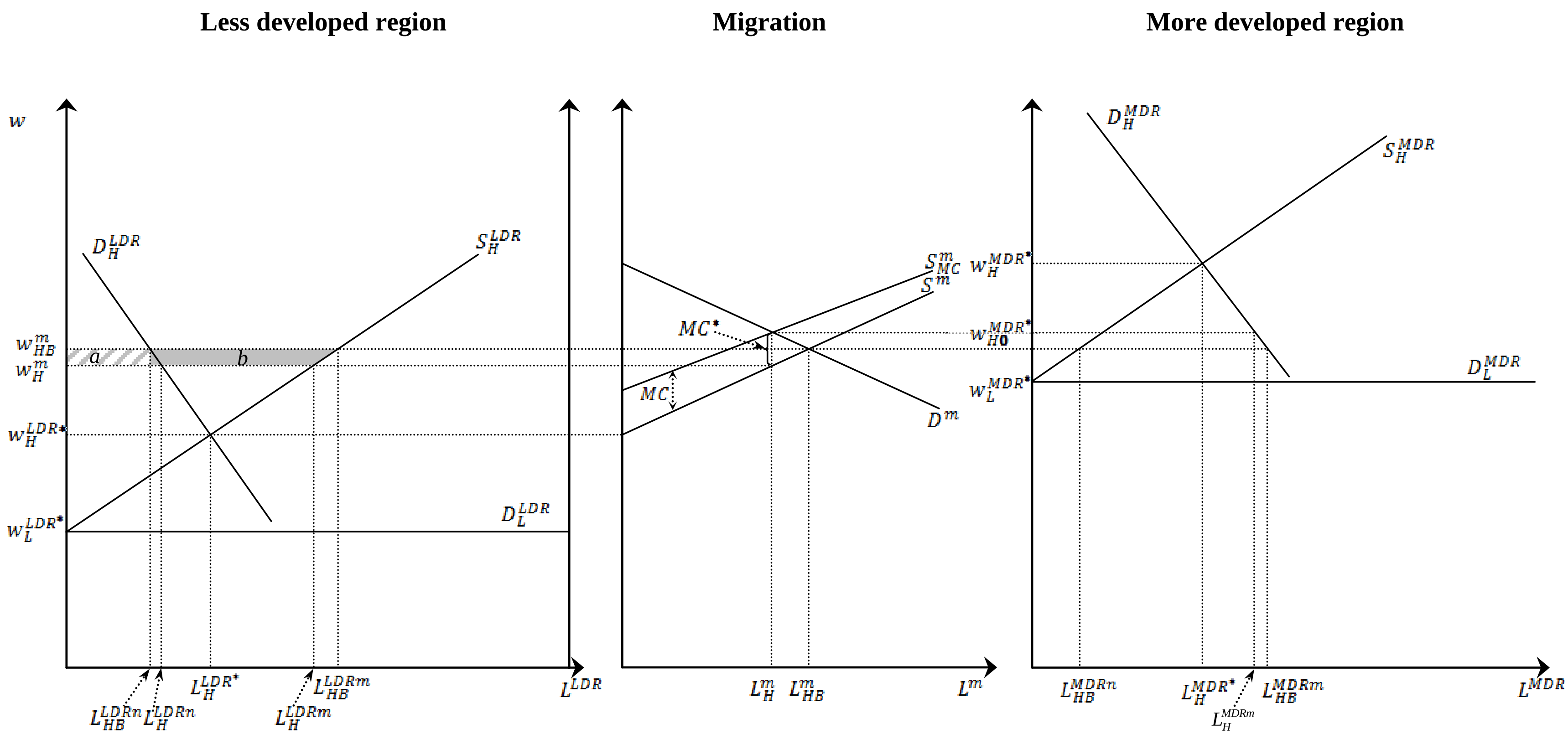

Figure 1: The impact of the high-skill migration on education

Hence, because of LDR and MDR wage effects, the long-run losses of human capital induced by the high-skill market integration are lower compared to the short-run.

The high-skill market integration affects also the long-run education equilibrium, which determines the share of the educated workforce in each region. Through the high-skill worker emigration, the high-skill market integration induces changes in relative wages in LDR, which in turn affects education incentives. Given that in the high-skill market integration scenario only high-skill workers can migrate or, alternatively, more high-skill workers migrate than low-skill workers, $L_H^{LDR}/L_L^{LDR} \leqslant L_H^m/L_L^m$, the ratio of high-skill/low-skill workers will decrease in LDR. A declining supply of the high-skill labour will exert an upward pressure on the high-skill wage rate in LDR. An increased high-skill/low-skill wage gap will provide incentives for additional low-skill workers to enter the education system to acquire skills. Thus, through wage adjustments in LDR, the high-skill market integration will increase the long-run education equilibrium in LDR.

The education effect of high-skill/low-skill wage ratio is shown in Figure 1. In the segmented high-skill labour market baseline, the equilibrium wage of the high-skill labour in LDR is w_H^m and the equilibrium wage of the low-skill labour is w_L^{LDR*} (Figure 1, left panel). The high-skill market integration reduces migration costs, MC. In Figure 1 we assume that migration costs, MC, are reduced to zero. As a result, the excess supply of the high-skill labour increases from S_{MC}^m to S^m and the equilibrium high-skill wage in LDR increases to w_{HB}^m, implying that the wedge between the high-skill and low-skill wage in LDR increases (Figure 1, middle panel).[12] Because of higher skill premium, more workers acquire education under the high-skill market integration. The amount of LDR workers that acquire education increases from L_H^{LDRm} to L_{HB}^{LDRm}.

3.2.2. Macroeconomic effects

In this Section, as an example, we show and explain one specific macroeconomic effect triggered by the skill mobility – the impact on the government budget revenue through household taxes. Through the high-skill worker emigration, the high-skill market integration reduces the number of taxpayers and hence the tax revenue in LDR. Given that, on average, high-skill workers are higher net contributors to the government budget than low-skill workers, the government revenue decreases both due to fewer tax contributors

[12]The exact magnitude of this wage ratio effect depends on the elasticity of the low-skill labour demand. In Figure 1 the elasticity of the low-skill labour demand is assumed to be infinitely elastic implying no unskilled wage effect.

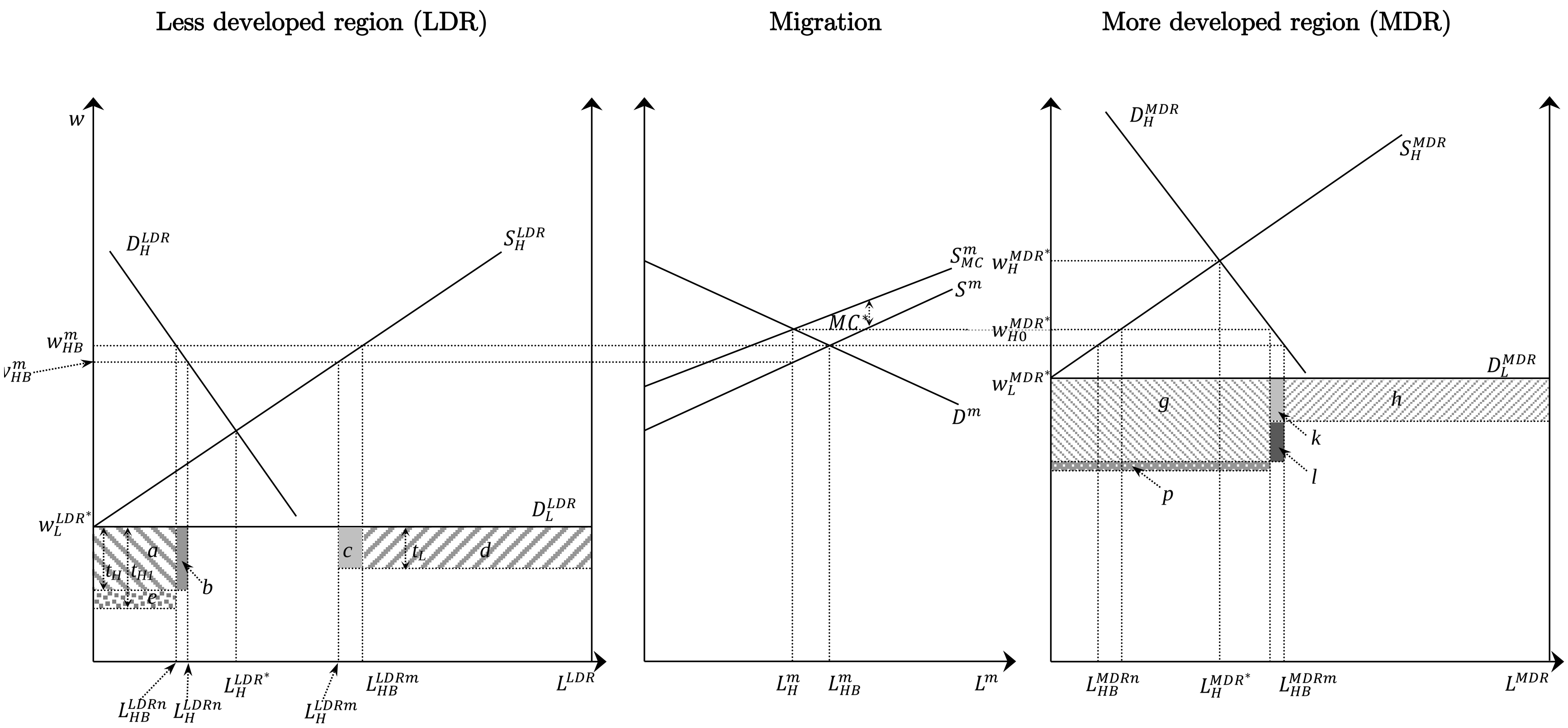

Figure 2: The budgetary effect of the high-skill migration

and less taxpayers of high taxes.[13] On the other hand, higher high-skill/low-skill wage ratio (due to an upward pressure on high-skill wages) increases the government tax revenue per high-skill worker. Thus, because of a smaller government budget (larger per capita budget), the impact of the high-skill market integration may be either decreasing or increasing on the accumulation of the human capital.

The fiscal impact of the high-skill market integration is shown in Figure 2. The income taxes paid by high-skill and low-skill workers under segmented high-skill labour markets are t_H and t_L, respectively, where $t_H > t_L$. If taxes are paid as a fixed rate of gross wages, then the absolute value of taxes paid by the high-skill labour increases under the market integration, t_{H1}, because of higher wage, $t_H < t_{H1}$. The total tax revenue under segmented high-skill labour markets is equal to area *abcd*, and to area *ade* under the integrated high-skill labour market. The high-skill market integration reduces the number of individuals who pay taxes in LDR by $L_H^{LDRn} - L_{HB}^{LDRn}$ for the high-skill labour and by $L_{HB}^{LDRm} - L_H^{LDRm}$ for the low-skill labour, which reduces tax revenues by area *bc*. Because the high-skill wage increases under the free migration, the tax revenue increases by area *e*. If area *bc* is larger than area *e*, then the tax revenue declines, otherwise, it increases due to the high-skill market integration. Thus, the total impact of the high-skill market integration on the government budget depends on the relative size of these areas.

Analogous budgetary effects occur in MDR. The total tax revenue under segmented high-skill labour markets is equal to area *gkhp*, and to area *gkhl* under integrated high-skill labour markets. The high-skill market integration decreases the low-skill labour in MDR, which reduces tax revenues by area *k*. The low-skill labour is replaced by the high-skill labour, which increases tax revenues in MDR by area *kl*. Further, the high-skill wage decreases, which reduces the tax revenue by area *p*. If area *l* is larger than area *p*, then the tax revenue in MDR increases, otherwise it decreases due to the high-skill market integration (Figure 2).

Note that the budgetary effects shown in Figure 2 take into account only changes in income tax revenues induced by the high-skill market integration. They do not account for other macroeconomic effects or budgetary costs & revenues, such as changes in welfare transfers, unemployment payments, or education costs. The reason for neglecting them is to simplify the exposition of the diagrammatic analysis, while focusing on the direct budgetary effects of the high-skill market integration. As explained above, RHOMOLO

[13] Because on average the wage rate for high-skill work is higher than for low-skill and the unemployment rate among high-skill workers is lower, per capita, high-skill workers contribute more to tax revenue than low-skill workers.

considers all the induced budgetary costs and benefits in a holistic general equilibrium framework, which however cannot be shown in a diagrammatic framework.

4. Numerical simulations of the labour market integration

First, we briefly present the underlying simulation model - a newly developed macroeconomic model of the European Commission. Second, the spatial skill mobility in the EU is estimated econometrically. Finally, the estimated migration parameters are implemented in the RHOMOLO model and the European Qualifications Framework is simulated.

4.1. Overview of the RHOMOLO model

In the tradition of general equilibrium macroeconomic models, RHOMOLO relies on an equilibrium framework à la Arrow-Debreu where supply and demand depend on the system of prices.[14] Policies are introduced as shocks to the existing equilibrium of prices, which drive the system towards a new equilibrium by clearing all the markets after policy shocks. Therefore, general equilibrium models have the advantage of providing a rigorous view of interactions between all the markets in an economy.

Given the regional detail of RHOMOLO, a particular attention is devoted to the explicit modelling of spatial linkages, interactions and spillovers between regional units of analysis. For this reason, models such as RHOMOLO are referred to as Spatial Computable General Equilibrium (SCGE) models. A richer market structure has been adopted to describe the pricing behaviour, as RHOMOLO deviates from the standard large-group monopolistic competition à la Chamberlin (1890). Given the presence of large firms in small regional markets, the assumption of atomistic firms of negligible size has been relaxed in favour of a more general small-group monopolistic competition framework (Baldwin *et al.*, 2003).

Each region is inhabited by households, whose preferences are captured by a representative consumer, who consumes with a love for variety (Dixit and Stiglitz, 1977). Households derive income from labour (in the form of wages), capital (profits and rents) and transfers (from national and regional governments). The income of households is split between savings, consumption and taxes. Households own factors of production (labour and capital), which they supply to firms and receive remuneration in return.

[14]See Brandsma *et al.* (2015) for a formal description of the key mechanisms in the RHOMOLO model and Brandsma *et al.* (2014) for labour market policy applications.

Firms in each region produce goods that are consumed by households, government or firms (in the same sector or in others) as an input in their production process. Transport costs for trade between and within regions are assumed to be of the iceberg type and are sector- and region-pair-specific. This implies a 5 x 267 x 267 asymmetric trade cost matrix derived from the European Commission's transport model TRANSTOOLS.[15]

Economic sectors in each region differ with respect to the scope for the product differentiation between varieties. The public sector operates under the constant-returns-to-scale sectors produce undifferentiated commodities and price at marginal costs. Firms in the differentiated good sector produce one particular variety of a good, under increasing returns to scale. These firms can price-discriminate their export markets and, given the small-group monopolistic competition structure, can set different levels of mark-ups in the different destination markets. The number of firms in each sector-region is empirically estimated through the national Herfindahl indices, assuming that all the firms within one region share the same technology. Given their higher weight in the price index, firms with higher market shares are able to extract higher mark-ups from consumers than their competitors, and, since market shares vary by the destination market, also mark-ups vary by the destination market.

4.1.1. Labour market

The labour market in RHOMOLO captures all key interactions between the labour demand and the labour supply. On the labour supply side, each region is populated by workers, who are differently skilled. The RHOMOLO model distinguishes between three skill levels of workers: low-skill, medium-skill and high-skill, which correspond to three levels of education: primary and lower-secondary education (ISCED 0-2), upper-secondary and post-secondary education (ISCED 3-4), and tertiary education (ISCED 5-6).[16] As it will be explained in Section 4.1.3, using the Labour Force Survey (LFS) qualification data allows us to calculate the educational attainment rates for each EU region and the education level in the base year, which are required for the calibration of the RHOMOLO model. On the labour demand side, the relative price of labour together with the demand for final goods and services determine the labour demand. Companies (and public sector) rent labour services from households, for what they receive wage income. In line with the empirical evidence, in RHOMOLO wages differ between skill

[15] http://energy.jrc.ec.europa.eu/transtools/

[16] International Standard Classification of Education (ISCED), see Annex 1 for details.

levels: high-skill workers earn higher wage than medium-skill workers, which in turn is higher than the wage of low-skill workers.

There are two ways how workers from a particular region can increase the remuneration per unit of their labour supply in RHOMOLO. First, workers can upgrade their skills through investment into education (*upward skill mobility*), which however is costly for workers. Moreover, while in education, workers do not receive any wage income. Upgrading skills from low to medium or from medium to high would increase the worker wage, if employed. Second, workers can migrate to another EU region with a higher wage rate and offer their skills there (*spatial skill mobility*). In RHOMOLO, the labour migration between EU regions is costly for workers. Migration costs capture not only the physical relocation costs, but also social, cultural, linguistic costs, information imperfections, people's preferences for a particular region, climate, etc. Moving to a high-wage region would increase worker's wage for the same skill level, if employed. These two channels of labour adjustment – *upward skill mobility* and *spatial skill mobility* – are the main focus of the present study.

In addition, in RHOMOLO labour supply decisions are also modelled through labour market participation choices of people and employment decisions of companies (see Brandsma *et al.* (2014); Persyn *et al.* (2014)). In the same time, also the worker remuneration may change, which in turn may affect the labour supply decisions of workers and the labour demand decisions of firms. As noted by Boeters and Savard (2012), it is crucial to account for all key adjustment channels of regional labour markets in the policy impact assessment, as there exist important interactions between them. Failing to model them simultaneously may result in suboptimal policy recommendations.

In addition to those labour market mechanisms, which are modelled explicitly in RHOMOLO, many more peculiarities of regional labour markets are captured implicitly. For example, differences in skill and hence productivity levels among people with the same level of education are captured by calibrating RHOMOLO to the base year regional labour market data. Productivity differences between workers living in different regions together with migration costs between regions account for sizeable inter-regional wage differences for people with the same education level.

4.1.2. Spatial dimension

The structure of the RHOMOLO model engenders different endogenous agglomeration and dispersion patterns of firms by making the number of firms in each region endogenous (see Di Comite and Kancs (2014); Di Comite *et al.* (2016)). Three effects drive the mechanics of the endogenous agglomeration and dispersion of economic agents: the market access effect, the price index effect and the market crowding effect. The market access effect captures the fact that firms in central regions are closer to a large number of consumers (in the sense of lower transportation costs) than firms in peripheral regions. The price index effect captures the impact of having the possibility of sourcing cheaper intermediate inputs because of the proximity of suppliers and the resulting price moderation because of competition. Finally, the market crowding effect captures the idea that, because of higher competition on input and output markets, firms can extract smaller mark-ups from their customers in central regions. Whereas the first two forces drive the system of regional economies towards agglomeration by increasing the number of firms in core regions and decreasing in the periphery, the third force causes dispersion by reducing the margins of profitability in the regions.

RHOMOLO contains three endogenous location mechanisms that bring the agglomeration and dispersion of firms and workers about: the mobility of capital, the mobility of labour, and vertical linkages. Following the mobile capital framework of Martin and Rogers (1995), we assume that capital is mobile between regions in the form of new investments, and that the mobile capital repatriates all of its earnings to the households in its region of origin. Following the mobile labour framework of Krugman (1991), we assume that workers are spatially mobile; workers not only produce in the region where they settle (as the mobile capital does), but they also spend their income there (which is not the case with capital owners); workers' migration is governed by differences in the expected income, and differences in the cost of living between regions (the mobility of capital is driven solely by the equalisation of the nominal rates of return).[17] Following the vertical linkage framework of Venables (1996), we assume that, in addition to the primary factors, firms use intermediate inputs in the production process; similarly to final goods consumers, firms value the variety of intermediate inputs. Furthermore, the trade of intermediate inputs is costly.

In addition to these effects, which are common to theoretical New Economic Geography models with symmetric varieties, the specific characteristics of RHOMOLO implicitly add important stability mechanisms in location patterns by calibrating consumer preferences over the different varieties in the base year. Through calibration, the regional patterns of the intermediate and final consumption observed in base year data

[17] As noted above, in RHOMOLO also the regional unemployment rates enter the migration problem of workers.

are translated into variety-specific preference parameters, which ensure a given level of demand for varieties produced in each region, including peripheral ones. Therefore, in simulations it is unlikely to obtain extreme spatial configurations in the terms of agglomeration or dispersion because firms in the regions with very low number of firms would enjoy very high operating profits due to the high level of demand provided by their relative scarce variety and thus would attract more firms to the region.

4.1.3. Data and empirical implementation

The RHOMOLO model covers 267 NUTS2 regions in the EU27, which are disaggregated into six NACE Rev. 1.1 sectors plus an R&D sector (see Table 1 and Figure 3, respectively).[18] The regional and sectoral disaggregation implies considerable data needs. In particular, for the empirical implementation of the RHOMOLO model, data for all exogenous and endogenous variables at regional (and sectoral) level for the base year (2010), as well as numerical values for all behavioural parameters are required.

Table 1: Sectoral disaggregation of the RHOMOLO model

NACE code	Sector description
AB	Agriculture, hunting and forestry
CDEF	Mining and quarrying, manufacturing, electricity and gas and construction
GHI	Wholesale and retail trade, repair of motor vehicles, motorcycles, personal and household goods, hotels and restaurants, transport and communications
JK	Financial intermediation, real estate and business services, excluding R&D
R&D	Research and development activities (R&D)
LMNOP	Non-market services

Source: Authors' aggregation based on the EUROSTAT (2003) NACE Rev. 1.1 classification. R&D sector is separated out from the standard NACE group JK.

The base year (2010) data are compiled in form of regional Social Accounting Matrices (SAMs) (see Thissen *et al.*, 2014, for details). For the construction of national SAMs, data are taken from the World Input Output Database (WIOD) project and the Global Trade Analysis Project (GTAP). The WIOD database consists of International Input-Output

[18]The simulations presented in this paper were performed with the RHOMOLO model, which was calibrated to 2010 base year data. In the next updates of the base year RHOMOLO will be updated to 2013 and extended to include more regions. See https://ec.europa.eu/jrc/rhomolo for the latest version of the RHOMOLO model and base year data.

tables, International and National Supply and Use tables, National Input-Output tables, and Socio-Economic and Environmental Accounts covering all EU27 countries and the rest of the world for the period from 1995 to 2009. In the context of the RHOMOLO model, an attractive feature of the WIOD data is that an attempt is made to identify and correct for the re-exports before calculating the total value of exports by country.

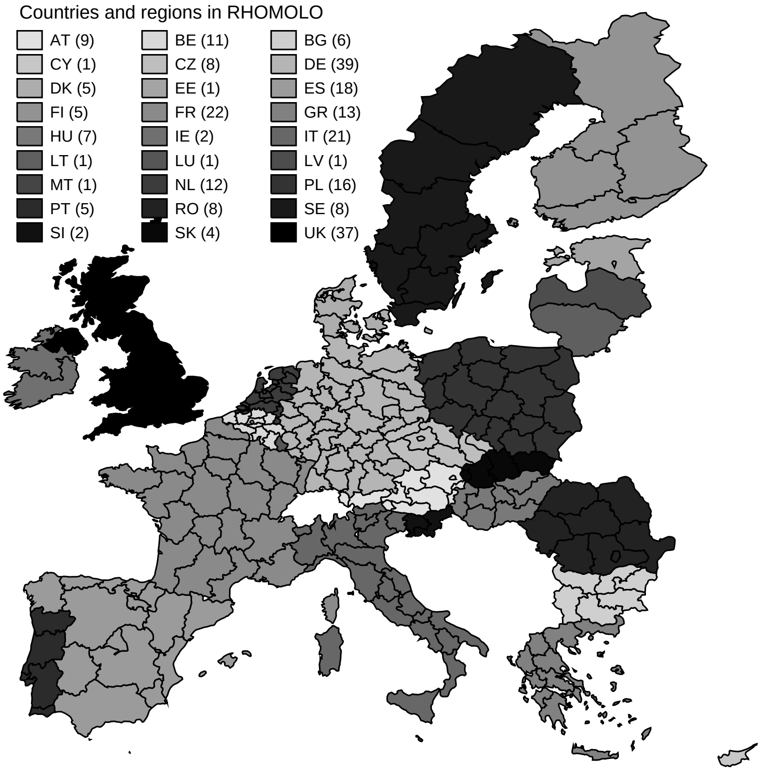

Figure 3: Spatial disaggregation of the RHOMOLO model. Notes: The number of NUTS2 regions in each country are in parentheses (in total these numbers sum up to 267).

Inter-regional labour migration patterns are captured in RHOMOLO by data on net changes in the regional labour force (see Brandsma *et al.*, 2014, for details). Using these data, the relocation of workers between any pair of regions is modelled as a function of expected income and migration costs. For the estimation of migration elasticities data are required on labour migration, consumer price index (CPI), regional GDP and unemployment. The EUROSTAT's Regional Migration Statistics provides data on migration within Member States. In order to complete the regional migration matrix, national totals are brought in line with the OECD data on migration flows between countries. The Household Income and Active Population data, which are extracted from EUROSTAT, together with data on unemployment and wages, which are computed from the Labour Force Survey (LFS), provide the necessary input to the estimation, calibration and modelling of regional labour markets and interactions between them in RHOMOLO.

Inter-regional trade flows are estimated using detailed inter-regional transport and freight data from Thissen *et al.* (2013, 2014). These data are aligned with the available regional accounts: the distribution of production and consumption over EU regions and national SAMs to ensure consistency with the rest of RHOMOLO data. Asymmetric region-pair-specific trade costs are extracted from the TRANSTOOLS model, which add up to country level trade and transportation margins calculated from WIOD.

Knowledge capital enters RHOMOLO through the R&D sector, whose data are also retrieved from the World Input Output Database. In RHOMOLO the stock of capital builds up over time by accounting for the annual national R&D services supplied to the market (which is a flow variable).

The regional stock of human capital is proxied in RHOMOLO by 3 different levels of education: primary and lower-secondary education (ISCED 0-2), upper-secondary and post-secondary education (ISCED 3-4), and tertiary education (ISCED 5-6). Wages are differentiated on the basis of the corresponding categories of education levels to account for the decision of households to spend their time on education. Data for this are available in the LFS and EU KLEMS databases.

Data on the regional stock of physical capital are constructed using the Perpetual Inventory Method (PIM). This approach starts with an estimate of the initial stock by country and industry, regionalised by the share in gross value added (GVA) in 1995 and calculates the final capital stock by region and by industry in 2010 by adding the yearly capital investments and making assumptions on depreciation. The following data can be estimated: gross fixed capital formation by sector at the NUTS2 level in current prices for the years 1995-2010; price deflators for conversion into constant prices; initial stocks for calculating the net capital stocks for each year applying the PIM from the EU KLEMS database. These data are available at the national level, which are regionalised by the GVA share. Depreciation rates are calculated by weighing the average service life of each of the six types of assets for each country.

The structural parameters of RHOMOLO are estimated econometrically or, where econometric estimations are not possible due to data limitations, borrowed from the literature (Okagawa and Ban, 2008). The parameters related to inter-regional labour migration are estimated in a panel data setting for each country separately. Similarly, the parameters related to the elasticities of substitution both on the consumer and on the producer side are estimated econometrically.

Finally, as usual in spatial computable general equilibrium models, all shift and share parameters are calibrated to reproduce the base year (2010) data in the SAMs. In order to determine the sensitivity of simulation results with respect to the implemented parameters in RHOMOLO, we perform extensive sensitivity analysis and robustness checks. Among others, the sensitivity analysis allows us to establish confidence intervals (in addition to the simulated point estimates) for RHOMOLO's simulation results.

4.2. Simulation setup

Generally, there are many different ways how labour market policy interventions can be modelled. For example, spatial mobility-related labour market policy interventions can be modelled as a reduction of geographical relocation/migration costs, which facilitates the *spatial skill mobility*. The European Qualifications Framework, as one of such policy initiatives, aims to improve the recognition of skills and qualifications across different countries and systems in the EU. In RHOMOLO, an EU-wide recognition of skills and qualifications increases the mobility of workers across EU regions and improves the match between the skill demand and the skill supply in every EU region.

Assessing the impacts of labour market policy interventions in RHOMOLO consists of two main steps. The first step consists of econometric estimations of behavioural parameters. In the EQF scenario the link between EU policies deepening the labour market integration and the regional human capital stock needs to be estimated econometrically using historical data. The econometric analysis has to provide answers to questions such as: how many people would be willing to migrate from low-income to high-income regions given certain net income differences between regions? How many additional people would migrate when migration costs would decrease? Estimating the link between EU labour market policy interventions and the human capital growth in each region is one of the main empirical challenges which have to be addressed when assessing labour market policy interventions and deriving skill-specific and policy-relevant recommendations.

In the second step, the estimated skill-specific policy impact on the regional human capital growth is used as a policy scenario input into the RHOMOLO model to simulate the labour market policy impact on regional macroeconomic outcomes, such as growth, income, consumption, employment, savings, investments, trade, inequality, etc. An important advantage of the RHOMOLO model is that it is able to capture all the induced direct and indirect general equilibrium effects of labour market policy interventions, such as changes in the relative wage for the low-, medium- and high-skill labour, according to which both the labour supply and the labour demand would adjust in RHOMOLO.

In addition, also the government budgetary effects of policy interventions are fully captured in RHOMOLO. On the government expenditure side, many policy interventions need to be financed through taxes, which is captured explicitly in RHOMOLO. On the government income side, potential policy benefits include higher contributions to income taxes, welfare (e.g. pension) system, as well as resolving labour market shortages in specific sectors and regions, leading to higher value added tax revenue. Also they are accounted for in RHOMOLO.

4.3. Econometric estimations of the skill mobility

As noted above, first the elasticity of the spatial worker mobility needs to be estimated econometrically. The main challenge of econometric estimations is to derive an estimable migration equation which is able to relate the aggregate inter-regional migration flows to labour mobility parameters of RHOMOLO. We follow Brandsma *et al.* (2014), who have derived such an estimable migration equation starting from the individual migration decision of Sorensen *et al.* (2007); Grogger and Hanson (2011). The dependent variable in the estimable equation of Brandsma *et al.* (2014) is the inter-regional labour migration, whereas explanatory variables are related to the expected work income.

Dependent variable: inter-regional labour migration. As explained in Brandsma *et al.* (2014), the estimation of migration equation requires a complete matrix of gross bilateral migration flows between all NUTS2 regions in the EU. However, such data are not available for all EU countries and regions. In order to address this issue of data paucity, Brandsma *et al.* (2014) have merged two available data sets: EUROSTAT's data on within-country interregional migration flows and OECD's data on international migration flows. This allows to construct an imputed matrix of bilateral migration flows, which can be used in empirical estimations. Data on migration between NUTS2 regions *within* countries are available from EUROSTAT for most of the EU Member States.[19] As explained in Brandsma *et al.* (2014), the first step in constructing an approximate data set 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. Second, international migration flows without any regional dimension

[19]The countries for which internal regional migration data are available are Austria, Belgium, Bulgaria, the Czech Republic, Spain, Finland, Hungary, Italy, the Netherlands, Poland, Romania, Sweden, Slovenia and Slovakia.

were extracted from the OECD data base. These international migration flows were subsequently 'regionalised', assuming that international migrants distribute themselves between the regions of the country of destination following the same pattern as within-country migrants do. Analogously, 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.[20]

Explanatory variables. In line with the underlying conceptual framework of RHOMOLO and Brandsma *et al.* (2014), the indirect utility for living in region d for an individual from origin region o, is measured by the expected real income in destination region d, net of migration costs for migrating between o and d. The real expected income in region r is approximated by $income_r = W(r) \cdot (1 - u(r))/P(r)$, with $W(r)$ the average regional wage, $u(r)$ the unemployment rate, and $P(r)$ the regional consumer price index. 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. Following Brandsma *et al.* (2014), in the estimable equation we include a log-linear distance term that captures the elasticity of migration with respect to distance. In order to obtain results, which are as realistic as possible, a fifth-order polynomial in distance is used. A dummy variable, $I(intl_{od})$, 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

$$\begin{aligned} \ln\left(\frac{s_{od}}{s_{oo}}\right) &= \beta_1 \ln(income_o) + \beta_2 \ln(income_d) + \beta_3 \ln(distance_{od}) \\ &\quad + \beta_4 I(intl_{od}) + \beta_5 \ln(s_{od|c_d}) + (\xi_{od} - \xi_{oo}) . \end{aligned} \tag{1}$$

where s_{od} is the share of migrants from o to d, $s_{oo}$is the share of stayers in region o, and $s_{od|c_d}$ is the conditional probability (share) of migration. Although, according to the underlying conceptual framework, coefficients β_1 and β_2 should be of the opposite sign and of an equal size, we follow Kancs (2011) and do not impose this restriction in econometric estimations.

[20]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. One can imagine, for example, that Austrian migrants would have a stronger tendency to migrate towards northern Italy when compared to the average Italian inter-regional migrant, given the geographic proximity of Austria to northern Italy. Whereas we believe that this effect exists and will affect the estimated migration flows, its impact on the estimated parameters of the migration equation, which are our key interest, will likely be limited.

As detailed in Brandsma *et al.* (2014), the estimation of equation (1) requires an instrumental variable approach, because of the endogeneity of the conditional probability (share). Following the common approach in the literature on the discrete choice in the context of the product demand estimation, 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 each country are clearly unrelated to contemporary migration patterns.

Table 2: Estimation results

Dependent variable: $\log(s_{od}/s_{oo})$		
	OLS	IV
$\ln(income_o)$	-0.520^{***}	-0.509^{***}
	(0.0185)	(0.0221)
$\ln(income_d)$	0.824^{***}	0.787^{***}
	(0.0242)	(0.0273)
$\ln(distance_{od})$	-0.453^{***}	-0.656^{***}
	(0.0219)	(0.0326)
$I(intl_{od})$	-4.478^{***}	-4.119^{***}
	(0.041)	(0.062)
$\ln(condshare_d)$		-1.227^{***}
		(0.0461)
_cons	-4.168^{***}	-5.566^{***}
	(0.284)	(0.433)
N	14485	14485

Source: Authors' estimations. Notes: estimates of equation (1). Standard errors are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Estimations are based on the data and code of Damiaan Persyn.

Table 2 reports estimation results. Column OLS of Table 2 shows the results of estimating equation (1) using the ordinary least squares (OLS) estimator. Column IV reports the instrumental variables (IV) estimation described above. 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, though overall the results of OLS and IV estimators are rather similar. The size of the effect of the international migration dummy, I($intl_{od}$), is remarkable, emphasising the importance of international borders (often corresponding to important cultural and language barriers) on the 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 opt to use the OLS estimates in the simulation analysis.

Being rooted in the discrete choice theory, the estimated migration model allows us to infer the structural parameters of RHOMOLO governing skill mobility from observable aggregate labour migration flows. As detailed in Brandsma *et al.* (2014), an important advantage of this approach is that when assessing the effects of policy simulations – to which we turn in the next section – predicted migration flows will obey all the key macro-accounting rules. In particular, the simulated increase in the migration inflow resulting from an increasing attractiveness of regions must imply an equal increase in the outgoing migration from other regions, such that the total EU population is unaffected by the 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 Brandsma *et al.*, 2014).

4.4. Simulations using the RHOMOLO model

In this section we perform simulations of the EQF scenario with the RHOMOLO model and skill mobility parameters estimated in the previous section. Note that, even though in this example we simulate a labour market policy intervention through an improved *spatial skill mobility*, both adjustments in the *upward skill mobility* and adjustments in the *spatial skill mobility* take place simultaneously in RHOMOLO. That is, high-skill workers respond to an increase (decrease) in the remuneration of skills in regional labour markets both through the investment into education (*upward skill mobility*), and through immigration (emigration) from (to) other regions, where the high-skill wage rate is lower (higher) (*spatial skill mobility*). In order to better identify these skill mobility effects, in the following simulations two other important labour market adjustment channels – participation/nonparticipation and employment/unemployment – are shut down.

4.4.1. Social and labour market effects

In order to assess the social impacts of the high-skill market integration in the EQF scenario, first a segmented labour market baseline scenario, against which we will assess the impact of the high-skill market integration, needs to be simulated. In the base year data, we observe significant high-skill wage differences across EU regions, because the *spatial skill mobility* channel is partially inactive (due to high migration costs, non-recognition of skills acquired in other Member States, etc.), only the *upward skill mobility* channel is fully active. However, the education channel alone is not strong enough to evade completely or to reduce significantly inter-regional wage differences. Depending on the sectoral structure, in each region there is lower or higher demand for low- and medium-skill workers. If all workers in a region would attain higher education and become highly skilled then, because of lower supply, wages for low- and medium-skill workers would go up, reducing in such a way the skill premium. The skill premium must be large enough to cover education costs, as no worker would invest into education, if the skill premium would not cover her education costs.

The labour market integration scenario reinforces the second channel of adjustment – the *spatial skill mobility*. Figure 4 reports the impact of the high-skill market integration on real (adjusted for price changes) high-skill wages in EU regions as percentage differences between the baseline and counterfactual equilibrium. The simulation results reported in Figure 4 suggest that in most regions the real wage of workers would increase (green colour), only in few regions the real wage would decrease (red and orange colours). High-skill wages would increase particularly strong in those regions, where they are below the EU-average, and where the largest emigration of high-skill workers would take place. The high-skill wage would increase more than +2% in a number of less developed regions of Eastern Europe, Greece, and Portugal. In contrast, the high-skill wage would decrease by more than -1% in several more developed regions in Benelux, Denmark, France and Ireland regions.

In RHOMOLO, high-skill workers from regions, where the demand and hence the relative wage for the high-skill labour is low, would migrate to regions with higher wages for the high-skill work. Arriving in high-wage regions and supplying their skills there would increase the supply of the high-skill labour, which in turn would exert a downward pressure on high-skill wages. The opposite would happen in low-wage regions, where the wage rate for the high-skill labour would increase because of a decrease in the skill supply. In such a way the spatial skill mobility reduces high-skill wage differences across EU regions. Note, however, that wages are not fully equalised across EU regions, e.g. due to differences in the labour productivity.

Wage adjustments trigger further general equilibrium effects in regional labour mar-

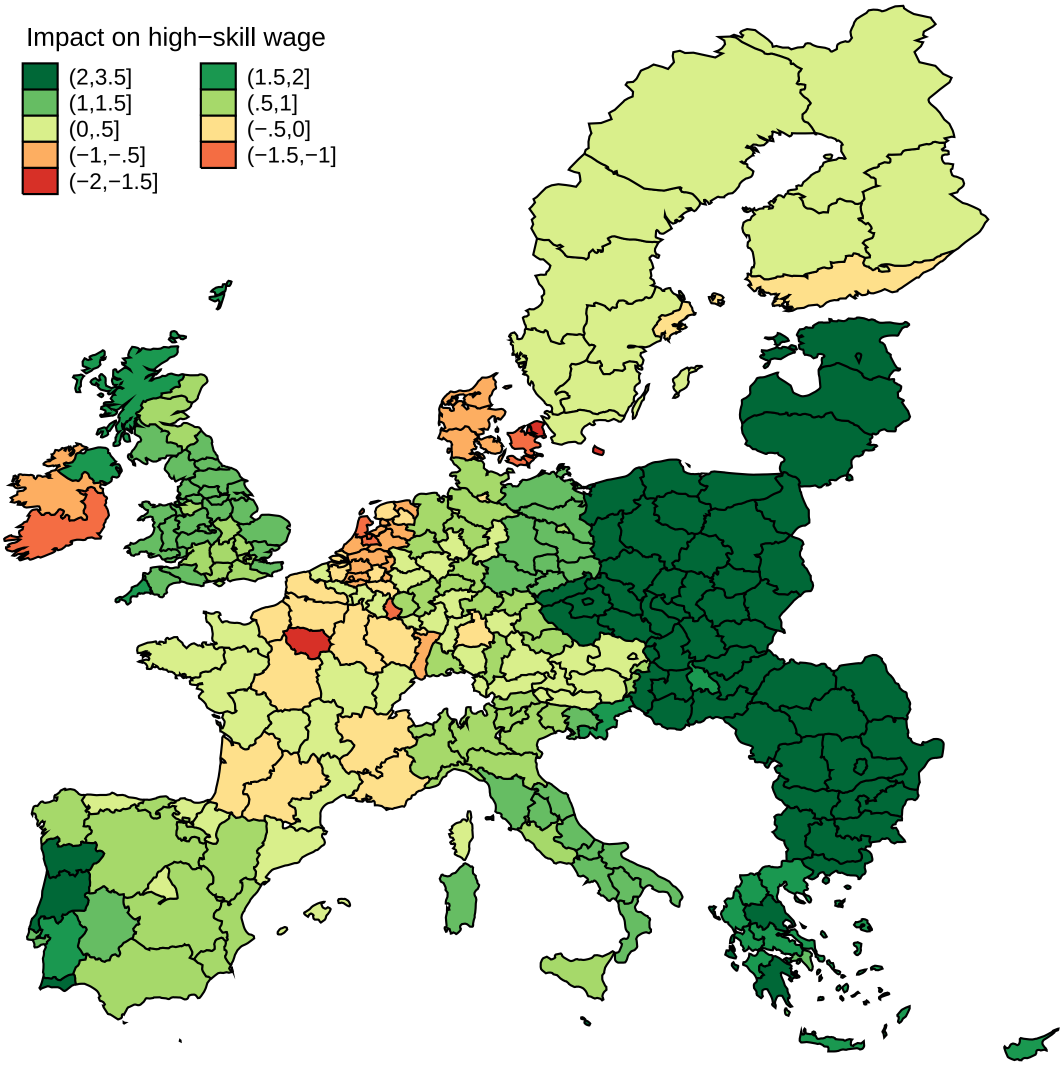

Figure 4: **Simulation results:** The impact of high-skill labour market integration on real high-skill wage in EU regions. Source: Authors' simulations with the RHOMOLO model.

kets. As regards the labour supply, the emigration of high-skill workers from low-wage regions exerts an upward pressure on high-skill wages, which in turn creates incentives for low- and medium-skill workers to invest into education and become medium and highly skilled, respectively. As regards the labour demand, there are two types of induced effects. On the input side, changes in the relative low-, medium- and high-skill wages trigger adjustments in the factor demand for production of goods, because the low-, medium- and high-skill labour and capital are mutually substitutable. On the output side, companies adjust their specialisation patterns according to changes in the relative skill-abundance in the region where the company is located. Firms located in high-skill abundant regions specialise in the production of skill-intensive goods, whereas firms located in low-skill abundant regions specialise in the production of skill-extensive goods. In addition, also companies may find it profitable to relocate between regions, if fierce competition on input and/or output markets drives profits to zero, whereas in other regions they are positive. These and other adjustments within and between regional economies take place until a new global equilibrium is established, in which no worker and no company can be better off by changing their education, location, employment, consumption, investment, production, trade, migration, etc. patterns. Hence, the new (counterfactual) equilibrium describes the optimal response of utility maximising households and profit maximising firms to the labour market integration shock in terms of macroeconomic outcomes, such as growth, income, employment, consumption, production, savings, investment behaviour, etc. In order to identify the pure policy impact, in Figure 4 each of counterfactual equilibrium variables is compared to the corresponding baseline variable. The difference between the two can be attributed to the net policy impact of the high-skill market integration.

4.4.2. Macroeconomic effects

As for the macroeconomic impacts, Table 3 reports selected aggregated results of the high-skill market integration for the whole EU. An important result from the simulated EQF scenario appears that at the aggregate level the total EU economy would gain in terms of GDP growth (+0.94%). As reported in Table 1, the impact would be differentiated between different skill levels at the aggregated EU level: high-skill workers would gain the most in terms of wage increase. A further interesting result is that also low- and medium-skill workers would gain from the high-skill market integration. Among others, a more efficient use of labour in the production process is an important driver for these gains.

One of the key mechanisms, which generates aggregate gains for the EU economy, is a more efficient resource allocation, particularly of the high-skill labour. Although, they themselves are only indirectly linked to the *spatial skill mobility*, aggregate productivity gains are important general equilibrium effects arising from the EQF. On the input side, because of the high-skill market integration, high-skill workers are employed relatively more in those regions and sectors where the marginal product and hence the wage rate of the high-skill labour is the highest. A more efficient allocation of the high-skill labour yields productivity gains at the aggregate level. On the output side, regional economies can better exploit their comparative advantages by deeper specialising in the production

Table 3: Simulated policy impact on selected macroeconomic variables for the EU

Macroeconomic variable	Percentage change from the baseline
GDP	+0.94%
Wage: low-skill	+0.27%
Wage: medium-skill	+0.31%
Wage: high-skill	+0.88%
Output	+1.15%
Productivity (TFP)	+0.60%
Investment	+0.79%
Exports	+2.63%
Imports	+1.42%

Source: Authors' simulations with the RHOMOLO model.

of skill intensive (skill extensive) goods, yielding additional productivity gains. These results are in line with other migration studies (for example, see Anderson, 2015a,b; Ciaian *et al.*, 2016; Kancs and Lecca, 2016; Nelson, 2014; Taylor, 2015).

Note that in the simulated EQF scenario we assumed that high-skill workers become fully mobile across EU regions and receive full information about the skill demand and supply in every EU region. As a result, the labour migration considerably reduces spatial wage disparities across EU regions. In reality, however, workers do not have a perfect information, national labour markets are rather segmented in the EU, there are important quality differences between different education systems across the EU Member States, etc. Hence, in reality, the impact of a deeper high-skill market integration on inter-regional wage differences may not be as pronounced as simulated in the EQF scenario.

For the sake of expository simplicity, only few effects and results of the RHOMOLO model have been presented and discussed in this section. In RHOMOLO, however, there are many more channels of adjustment present and many more effects take place simultaneously. The simple simulation example presented above aims solely at providing intuition for a better understanding of the key mechanics of the RHOMOLO model and its potential for policy impact assessment. Analogously, in Table 1 only few selected output variables of RHOMOLO are reported and even they have been aggregated together for the whole EU. The RHOMOLO model, however, produces more than 50 different macroeconomic indicators, for each regional economy, each industrial sector, each skill level and each year.

5. Conclusions

In the age of the knowledge economy and globalisation, the skill mobility is perceived as one of the key factors for unlocking the human capital potential in the EU. The European Qualifications Framework is a policy instrument, established within the context of the European cooperation in the field of Education and Training, aimed at promoting workers' and learners' mobility. The present paper aims to assess the potential social and macroeconomic impacts of the EQF on education, migration, skills, the human capital and the economic growth.

In order to assess the social and macroeconomic impacts triggered by the EQF in a disaggregated way by the skill level and the region of location, the present study singles out and analyses in detail two key mechanisms through which policy shocks are absorbed in regional labour markets – the *upward skill mobility* and the *spatial skill mobility* – in two different ways: by performing numerical simulations with a macroeconomic model, and by undertaking a conceptual analysis in a diagrammatic framework. The two approaches are complementary and are presented in a non-formal way to intuitively analyse the potential impacts of the EQF policy scenario related to the high-skill market integration, which is simulated as a migration cost reduction. Due to the full EU-wide recognition of qualifications for high-skill workers triggered by the EQF, they become fully mobile across EU regions, and have a perfect information about skill demand and supply in every EU region. The social and macroeconomic impacts of the high-skill market integration are assessed against the segmented labour market baseline.

The results from our analysis suggest that the European Qualifications Framework would facilitate the high-skill market integration, which in turn would generate significant welfare gains for the EU. Both the social and macroeconomic effects of the EQF are positive at the aggregate level. However, their distribution across different Member States, regions, economic sectors and skill levels is differentiated. Those Member States and regions, where the high-skill wage is particularly high compared to the EU average, may experience a high-skill wage decrease. The opposite would take place in those regions, where the high-skill wage is particularly low compared to the EU average. Hence, accompanying policy measures may be required to ensure an inclusive growth arising from the high-skill market integration.

Our findings have important policy implications. From the policy perspective, it is important that the particular mechanisms, through which labour market adjustments occur, are identified at the skill and regional level, as they may have regionally differentiated policy implications. For example, in the regional development policy, there is an ongoing debate surrounding the appropriateness of people-based policies versus place-based strategies. One of the key issues in this debate is that policy measures to improve the skill of people in a particular region via place-based strategies may be confounded, if the immigration response is large. In other words, EU policies could end up benefiting new entrants to the region rather than the initial target population. Hence, analysing the inter-regional labour markets dynamics with skill, regional and sectoral detail is required for deriving policy relevant recommendations, as many of the effects would average out at the aggregate level.

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Annex 1: Skill and education correspondence in RHOMOLO

Low-skill: Primary and lower secondary education (ISCED 0-2)

Medium-skill: Upper-secondary and post-secondary education (ISCED 3-4)

High-skill: Tertiary education (ISCED 5-6)

ISCED 0: pre-primary education

ISCED 1: primary education or first stage of basic education

ISCED 2: lower secondary education or second stage of basic education

ISCED 3: upper secondary education

ISCED 4: post-secondary non tertiary education

ISCED 5: first stage of tertiary education (not leading directly to an advanced research qualification)

ISCED 6: second stage of tertiary education (leading to an advanced research qualification)