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ORIGINAL ARTICLE

The economic, environmental and agricultural land use effects in the European Union of agricultural labour subsidies under the Common Agricultural Policy

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Abstract In this study, we assessed the economic, environmental and agricultural land use impacts in the EU of a 20% reduction in the Pillar I budget of the Common Agricultural Policy (CAP) of the European Union (EU) and spending the saved money via a subsidy on labour in primary agriculture. The impact of such a policy has been assessed with a computable general equilibrium (CGE) model and a partial equilibrium (PE) model. It is concluded that reallocation of Pillar I budgets to a coupled agricultural labour subsidy increased employment in agriculture, especially in agricultural sectors and regions that are relatively labour intensive. Average employment in agriculture in the EU increased with 1.6% in the CGE model and with 0.6% in the PE model. Agricultural production and environmental emissions from agriculture increased as well. At the same time, prices of agricultural outputs decreased. Value added including subsidies increased for agricultural labour, but total value added in agriculture decreased. The latter was especially explained by decreased land prices and land-related value added. Measured in terms of equivalent variation, total welfare in the EU decreased. Welfare costs equalled about 1400 € per full-time work equivalent in agriculture extra. These results show that policy makers should weigh carefully the pros and cons of the direct and indirect overall economic, environmental and land use impacts of a subsidy on agricultural labour at the expense of the Pillar I budget of the EU CAP.

Keywords Agriculture · Employment · European Union · Common Agricultural Policy · Economic models

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Introduction

In 2010 about 12 million farms in the European Union were counted with about 25 million people regularly active in farm work (European Commission 2013c). However, for many of these people, farm work only represents a minor share of their total working hours. So, measured in full-time equivalent jobs or annual working units (AWU) in agriculture, these 25 million persons only represent 9.8 million AWU. Slightly different figures are provided by the economic accounts of agriculture, namely 10.1 million AWU in 2012 in the agricultural sector in the EU. In the period from 2000 to 2012, 4.8 million full-time jobs in the EU agriculture disappeared, a decrease in a little more than 3% per year (European Commission 2013c). In the same period, the share of agriculture in total employment in the EU decreased from about 7.3% to about 4.6% (Worldbank 2016). Obviously, in rural areas this share in total employment differs from the EU average. In fact, in the EU farming and agriculture are considered an important sector to preserve and stimulate employment and economic growth in rural areas (Hill 2012). This can be seen from the fact that farming is not an isolated activity, but embedded in a long production chain, including extension services, input delivering industries and agricultural processing.

Agriculture can also stimulate rural employment via, for example, agri-tourism, day-care farms, education on the farm and environmental protection. The important position of farming in rural employment is also recognised by the European Commission, and the creation and maintenance of jobs in agriculture has been a traditional objective of the EU Common Agricultural Policy (CAP) (European Commission 2010). The increase in the number of jobs as a top priority has recently been restated by the European Commission (EC) (2015). Given the policy priority to create jobs and the importance of farming and agriculture in rural areas, it is peculiar that agricultural policies in the EU do not include instruments directly aimed at preserving agricultural employment (Mattas et al. 2008).

Since 1992, the EU CAP has been reformed several times, broadly speaking from subsidies linked to output to subsidies linked to land (area payments) to direct payments linked to farms (European Commission 2012).[1] Currently, the CAP of the EU consists of two pillars. Pillar I comprises the EU agricultural market and income policy. The 2003 reform of the CAP introduced a new system of direct or decoupled payments to farmers in Pillar I, known as the Single Payment Scheme (SPS). The SPS is based on payments entitlements linked to eligible land and replaces most but not all previously existing agricultural schemes linked to specific sectors (coupled payments). Altogether the Pillar I coupled and decoupled payments accounted for about 42 billion € in 2015. Pillar II of the CAP of the EU includes more targeted and diverse rural development measures. The different reforms of the CAP have been subject to many ex-post and ex-ante studies using different approaches and looking at different aspects. In general, it can be concluded that subsidies linked to farms (e.g. the SPS) have the smallest impact on production and investments in agriculture, while subsidies linked to output have the largest impact (Dupraz and Latruffe 2015; Petrick and Zier 2012; Dewbre et al. 2001; Sckokai and Moro 2009). Using a panel dataset of 69 East German regions, Petrick and Zier (2012) found that the full introduction of the SPS in 2005 reduced average employment by 7 and 35% in the short and long run, respectively. According to these authors, “this is a plausible result as decoupling allowed the release of labour no longer necessary to maintain the production levels previously required to obtain crop- and livestock-related subsidies”. Koundouri et al. (2009) observed heterogeneous attitudes with respect to production and labour input across 100 Finnish cereal FADN farmers and across years (1992–2003). Compared to no subsidies, an area payment of about 500 €/ha increased labour input on the average farm by about 1.4%, while an equivalent farm payment, decoupled from production level, increased labour input by about 0.7%. Mattas et al. (2008) applied case studies in five EU regions to analyse employment effects of the CAP. Different approaches were applied, including in-depth interviews. They found that extra budget for Pillar II measures can mitigate any negative employment impacts from reducing the budget of direct farm payments under Pillar I. The focus on a limited number of EU regions had the advantage that complexities of rural economic relations could be included. The disadvantage of the different approaches applied in Mattas et al. (2008) is that market feedback effects are not included in any of the approaches and the representativeness for the EU as whole is questionable. Nowicki et al. (2009) studied the economic, social and environmental impacts of shifting funding from Pillar I to Pillar II. They applied different approaches, namely farm-level modelling, regional sector modelling and economy-wide modelling as well as more qualitative case studies. The economy-wide model showed that a rather limited budget shift between the two pillars decreased agricultural employment by 0.12%. However, it is also stated that impacts on agricultural employment are complex and can be different per sector and region (Nowicki et al. 2009). Finally, an econometric study by Olper et al. (2012) based on static and dynamic panel data of 149 EU regions over the period 1990–2008 showed that CAP payments contributed significantly to job creation in agriculture. Averaged over the whole estimation period, a 1% increase in total CAP payments decreased out-farm migration by 0.117–0.187%, depending on the econometric approach. At the same time, the authors found that Pillar I subsidies exerted an effect approximately two times greater than that of Pillar II payments. This result seems to be in contrast to Mattas et al. (2008), but it should be kept in mind that Mattas et al. (2008) analysed a shorter but more recent period. Opposite effects, namely agricultural payments reducing labour in agriculture, are reported in the literature as well (Dupraz and Latruffe 2015; Goetz and Debertin 1996, 2001; Berlinschi et al. 2011). Differences in results are clearly explained by using different approaches, data and scenarios. However, it can be concluded that currently the impact of the EU CAP subsidies on agricultural employment is small. The explanation for small or even negative employment effects of agricultural subsidies is that subsidies are ineffective as income support policy as the subsidy increases production, decreases agricultural prices and capitalises in land and other inputs. To what extent this happens depends on the definition of the subsidy.

It can be argued that an EU policy specifically targeting agricultural employment such as a subsidy linked to employment in agriculture at least improves the effectiveness of CAP policies to employment objectives

[1] A historic overview of the EU CAP can be found at http://ec.europa.eu/agriculture/cap-history/index_en.htm.

in agriculture (Dupraz and Latruffe 2015). The objective of this paper is to verify this hypothesis. More specifically, the objective of this paper is to quantify and analyse the impact of a subsidy on employment in agriculture, financed by Pillar I. So the budget in Pillar I will be reduced in favour a subsidy on agricultural labour. Besides the impact of such a subsidy on employment in agriculture, the objective is to also analyse and quantify the welfare, environmental and land use impacts in the EU. Results will be compared to a reference scenario with unchanged CAP payments. The time horizon of the reference and the alternative policy scenario is 2020. For the quantification, two types of economic models are applied. The first model is the Modular Agricultural GeNeral Equilibrium Tool (MAGNET) model. MAGNET is a comparative static, global computable general equilibrium model that covers the whole economy including factor markets. MAGNET builds on the global general equilibrium Global Trade Analysis Project (GTAP) model. The second model is CAPRI. CAPRI is an EU-27 partial equilibrium model for the agricultural sector at NUTS2 level (aggregated regional farm approach). MAGNET and CAPRI are assumed complements. MAGNET is better suited to include economy-wide and structural effects, including substitution between fixed inputs (capital labour and land) and reallocation of labour between agricultural sectors and non-agricultural sectors. CAPRI gives a detailed description of the regional agricultural sector and the EU CAP payments, but the technology is assumed fixed in the short to medium term and labour markets are not explicitly modelled.

The remaining part of this paper is organised as follows. In the next section, we provide more detailed descriptions of CAPRI and MAGNET; in the third section, the reference and labour subsidy scenario are described. In the fourth section, results of CAPRI and MAGNET are presented focusing on economic, land use, environmental and agricultural employment effects. We complete this paper with conclusions and strengths and weaknesses of the different approaches.

CAPRI and MAGNET model descriptions

CAPRI is an EU27 partial equilibrium model for the agricultural sector at NUTS2 level (aggregated regional farm approach). It consists of a supply module and a global market model. The supply module of CAPRI comprises around 280 regional farm models (one farm model for each NUTS2 region in the EU27, Norway, Western Balkans and Turkey) covering about 50 crop and animal activities for each of the regions and including about 50 inputs and outputs.[2] Applications presented in this paper are based on CAPRI version "Trunk revision 4451" of April 2015.

The objective function of the regional farm model optimises regional agricultural income (gross margin) at given prices and subsidies, subject to constraints on land, policy variables and feed and plant nutrient requirements in each region. A land supply curve lets total area use shrink and expand depending on marginal returns to land. An interesting feature of the supply module of CAPRI is that agricultural activities are divided into an extensive (low input, low yield) and an intensive type (high input, high yield).

The gross margin is the total revenue including sale incomes from agricultural products and EU CAP payments to farmers (coupled and decoupled payments) minus the accounting variable costs of production activities. The accounting costs include costs of seeds, fertilizers, crop protection, feeding and other specific costs. A quadratic cost function per activity per region is introduced in the objective function to calibrate the regional farm model to the observed situation. This quadratic cost function intends to capture the effects of factors that are not explicitly included in the model such as price expectation, risk aversion, labour requirements and capital constraint (Heckelei 2002). Parameterisation is realised via the positive mathematical programming approach (Heckelei 2002). A subsidy to agricultural labour per activity per region would enter the objective function via a linear term, shifting the quadratic cost function per activity per region downwards. This means a decrease in marginal production costs per activity and an increase in supply, everything else assumed constant. The decrease in the marginal costs depends on the labour input per activity and the subsidy per unity of labour.

CAPRI features a detailed EU CAP payments module, including complex features of both Pillar I and Pillar II payment schemes. To mimic reality as closely as possible, the SPS is based on payment entitlements and these payment entitlements are linked to eligible land in CAPRI. If in the initial equilibrium the acreage of eligible land is below the number of payment entitlements, the subsidy will fully capitalise into the land rent (Britz and Witzke 2014). If, for example, the SPS per hectare decreases, the marginal return of land would decrease and the amount of land in agriculture reduces along the land supply curve in CAPRI. If the acreage of eligible agricultural land exceeds the payments entitlements, the marginal premium payment per hectare will be zero and the impact on the marginal return of land or land rent will be zero. In this case, a decrease in SPS will not affect land demand. In fact, the SPS is fully decoupled from production.

[2] A further disaggregation to ten farm types for each region (in total 2450 farm regional models, EU27) is also possible. This feature of CAPRI is, however, not used for the application in this paper.

The mathematical programming model CAPRI has been written using physical terms. This enables modelling of relations between agricultural production activities and environmental indicators such as NPK balances and output of gases linked to global warming potential (Britz and Witzke 2014).

To include market feedback, the supply module is linked to a market module. The CAPRI global market model is a comparative static multicommodity model. It covers 47 primary and secondary agricultural products. The supply module and the global market model of CAPRI are iteratively linked to model interaction between supply behaviour and price changes. Equilibrium ensures cleared markets for products and young animals (Britz and Witzke 2014).

The MAGNET model is an applied general equilibrium model of the world economy (Woltjer et al. 2014). It covers all sectors of the economy (agriculture, manufacturing and services) and all regions and major countries in the world. The core of the MAGNET model is based on the standard GTAP model (Hertel 1997). However, it extends this standard specification by several modules and features allowing to model agriculture, food security and bio-based economy and associated policies in a more detailed way. The features included in the model version used in this paper are land supply module, land allocation per sector module, CAP, biofuel and bioenergy policy and quota module. Production is modelled using flexible, multilevel nested constant elasticity of substitution (CES) production functions[3] allowing for substitution of different primary production factors (land, labour, capital and natural resources) and some intermediate production factors (energy and animal feed components). In particular, agricultural land can be substituted with a bundle of non-land primary production factors (labour and capital) and energy; percentage change, for example, in ratio of production factor land to non-land production factors depends on the percentage change in their prices; see footnote 3. In the review by Salhofer (2000), the land–labour substitution elasticities vary between −0.4 and 3.1 with an average of 1 and land–capital substitution elasticities vary between −2.1 and 2.2 with an average of 1.5. We have chosen low values of substitution elasticities, namely 0.05 for the crop sector and 0.1 for the livestock sectors, because in several studies and simulations we made in the past (e.g. Nowicki et al. 2007, 2009; Helming et al. 2010), we observed that low substitution elasticities produce more plausible simulation results. Salhofer (2000) also shows that land–animal input substitution elasticity is twice as high as the land–crop input substitution elasticity. We followed this result when calibrating MAGNET. The effect is a twice higher increase in labour demand and twice higher decrease in land and capital demand in livestock sectors than in crop sectors when agricultural real wage excluding the subsidy in relation to land and capital remuneration decreases. The above-mentioned substitution elasticities are applied to all MAGNET regions.

The land allocation module in MAGNET takes land as a heterogeneous production factor (e.g. having different biophysical characteristics) depending on the commodity produced by specific sector. This means that different land types cannot be perfectly substituted and that adjustment costs are involved when land moves from one sector to the other. This is modelled by using constant elasticity of transformation (CET) function. Basically, the land allocation module assumes that, for example, it is easier to change the allocation of land within the group of cereals, oilseed and protein crops (COP), while more adjustment costs are assumed to move land out of COP production into, for example, vegetables.

In MAGNET, the SPS is implemented as an equal payment rate to the land value in all eligible sectors, i.e. equal ad valorem subsidies for land for eligible sectors. Payment entitlements are not included as a separate production factor. The total agricultural land supply is a function of real land price. For the majority of EU countries, the price elasticity of land supply is 0.15. In MAGNET, capital and labour markets are segmented between agriculture and all other non-agriculture sectors. This means that they are assumed to be perfectly mobile within each of these two sectors, but imperfectly mobile between these sectors since adjustment costs (involving, for example, changing qualifications, learning new technical skills, moving from rural to urban areas, reallocation of resources and so on) are involved when labour and capital move between them. This assumption is motivated by the observed rural–urban wage differentials (Keeney and Hertel 2005). So, when changes in the real wage in agriculture exceed the changes in real wage in non-agriculture, labour supply in agriculture will increase and there will be outflow of labour from non-agriculture to agriculture. The increase in labour supply in agriculture is now a function of the above-mentioned relative prices changes and a speed of adjustment parameter. The latter is econometrically estimated and assumed equal for all MAGNET regions (Tabeau and Woltjer 2010).

In this paper, the MAGNET model uses version 6 of the GTAP data (Dimaranan 2006) with 2001 as the base year. The database was aggregated to 28 sectors and 45 regions. The sectoral aggregation includes 10 land-using (agricultural) sectors (7 crop and 3 animal sectors), a number of sectors using agricultural commodities (5 food-processing sectors, ethanol, biodiesel, DDGS, biodiesel by-products). The regional aggregation includes all EU-15 countries (with Belgium and Luxembourg as one region) and all EU-12 countries

[3] The CES production function is a neoclassical production function that assumes constant elasticity of substitution between production factors. This substitution elasticity measures the percentage change in the ratio of two production factors used in the production process in response to a percentage change in their prices.

individually, except for three regional aggregates: the Baltic countries which aggregated to a single region, with Malta/Cyprus and Bulgaria/Romania aggregated to a single region. Outside the EU, the analysis covers all important countries and regions from an agricultural production and demand point of view, e.g. USA, Canada, Brazil, India, Russia, China and Indonesia.

2020 reference scenario and agricultural labour subsidy scenario

In this study, the 2020 reference scenario assumed modest economic growth, a high growth of population and food demand, especially outside the EU27. In the EU, the milk quota was abolished, but the sugar quota was kept in place. The first-generation biofuel mandate equalled 10% in the EU27. A key feature of the 2020 reference scenario was that Pillar I coupled and decoupled payments, including the SPS, was put equal to the national ceilings mentioned in Commission Regulation (EU) No 1307/2013 (European Commission 2013a, b). This means that the 2020 reference scenario was consistent with the redistribution of the Pillar I budget among member states as agreed upon under the CAP reform 2014–2020. In line with the objective of this paper both in MAGNET and in CAPRI, the counterfactual scenario or labour subsidy scenario assumed that 20% of the Pillar I budget is reallocated to subsidy on labour in primary agriculture. All other exogenous variables were assumed equal to the reference scenario. In CAPRI, the labour subsidy was introduced as an average payment per unit of labour per eligible sector per region, based on the labour input in the reference scenario. In MAGNET, the labour subsidy was implemented as an equal payment or labour subsidy rate to the labour value, i.e. equal ad valorem subsidies for labour, for eligible sectors. Both in CAPRI and in MAGNET, labour input per agricultural sector was an endogenous variable in both the reference and the counterfactual scenario. The labour subsidy was independent of the type of labour (family labour, hired labour or contract work), regions or circumstances. Due to a lack of different types of agricultural labour in the models, substitution between family labour and paid or hired labour or contract work was not included in our analysis (Dupraz and Latruffe 2015).

Model results

Table 1 shows that average Pillar I payment of the CAP of the EU in the 2020 reference scenario was between about 175 €/ha and 275 €/ha, depending on the crop. This result of the reference scenario was taken from CAPRI. In the 2020 reference scenario, coupled Pillar I payments in

Table 1 Average revenue, including all EU CAP payments (Pillar I and Pillar II), Pillar I payment and labour input in 2020 reference scenario and average Pillar I payment and labour subsidy in 2020 agricultural labour subsidy scenario for selected activities in the EU27 *Source* CAPRI database and own calculations with CAPRI

	Reference			Labour subsidy scenario			Change in Pillar I payment plus labour subsidy (B–A) (€/ha or head)
	Total revenue, including EU CAP payments (€/ha or head)	o.w. Pillar I payment (A) (€/ha or head)	Labour input (hours/ha or head)	Pillar I payment (€/ha)	Labour subsidy (€/ha or head)	Total Pillar I payment plus labour subsidy (B) (€/ha or head)	
Soft wheat	1009	219	59	175	31	206	−13
Potatoes	7007	258	231	207	122	329	70
Sugar beet	2507	261	86	209	45	254	−7
Apples, pears and peaches	11,181	228	612	182	323	505	277
Fodder maize	1408	261	42	209	22	231	−30
Grass and grazing extensive	250	217	11	173	6	179	−38
Grass and grazing intensive	568	217	11	173	6	179	−38
Fallow land	8	160	34	128	18	146	−14
Livestock							
Dairy cows	3333	15	76	12	40	52	37
Other cows	658	66	28	53	15	67	2
Pig fattening	201		2	0	1	1	1
Poultry fattening	3247		213	0	112	112	112

CAPRI were mostly limited to suckler cows. In the 2020 reference scenario, Pillar I payments per activity were very different per region in the EU27. This can be explained by differences in agricultural structure and corresponding historical payment rights.

Family and paid labour input per activity per region (hours per ha per region or hours per head per region) are available from the CAPRI database. The labour input estimates are based on the standard econometrics from single farm records as found in FADN (Britz and Witzke 2014). Table 1 shows the average total labour input per activity (hours per ha or hours per head) in the EU27 in the period from 2007 to 2009. For reasons of simplicity, these were assumed constant in the 2020 reference scenario. Also for reasons of simplicity, the labour subsidy per hour was derived from the production structure and the available budget (20% of the Pillar I budget) in the reference scenario in the EU in 2020 and assumed constant during the simulation of the labour subsidy scenario. In the 2020 labour subsidy scenario for the EU27, the average labour subsidy per hour equalled about 0.53 €/h. Again differences per member state in the EU27 were large. The average labour subsidy per hour in the EU15 equalled about 0.82 €/h. The average labour subsidy per hour in the EU12 equalled about 0.24 €/h. The lower subsidy per hour in the EU12 can be explained by the relative higher labour input in agriculture in relation to the Pillar I budget. Table 1 shows that compared to the total revenue including subsidies (column 1), the sum of the decrease in Pillar I payment and the increase in the newly introduced agricultural labour subsidy was especially negative for fallow land and fodder crops (especially grassland) and cereals. The above-mentioned sum was positive for high-margin arable crops, vegetable and permanent crops and the livestock industry.

Table 2 shows selected results for CAPRI and MAGNET. The decrease in the Pillar I budget, including SPS, in favour of the labour subsidy decreased the marginal return to land at the farm level and consequently lowered land use along the land supply curve. Table 2 shows that agricultural land use decreased by 0.2 and 0.4% in MAGNET and CAPRI, respectively. At the same time, average land market prices in the EU decreased with about 10 and 3% in MAGNET and CAPRI, respectively. Differences between MAGNET and CAPRI are explained by data and structural model differences, among others differences in the land supply elasticities. Agricultural output increased, namely by 0.7 and 0.2% in MAGNET and CAPRI, respectively. This meant that the reduction in agricultural area was more than compensated by land use intensification. Table 2 shows that average yield in the agricultural sector increased by 0.9 and 0.5% in MAGNET and CAPRI, respectively. As output increased under the labour subsidy scenario, agri-food prices decreased, which is good for consumers and food demand. Table 2 shows that both CAPRI and MAGNET predicted a decrease in the prices for meat and dairy. MAGNET also predicted a decrease in the price of cereals and oilseeds, while these price changes were negligible in CAPRI.

Table 2 Impact of agricultural labour subsidy scenario on selected variables in the primary agricultural sector in the EU27: percentage difference compared to reference *Source* own calculations with MAGNET and CAPRI

	CAPRI	MAGNET
Output value (constant prices)	0.2	0.7
Yield per hectare UAA	0.6	0.9
Land use (UAA)	−0.4	−0.2
Employment	0.6	1.6
Agricultural output price		
Cereals	0.2	−0.9
Oilseeds	0.1	−1.8
Meat	−1	−0.7
Dairy	−0.4	−0.9
Land price	−3.2	−9.7
Wage excluding subsidy	–	−3.8
Wage including subsidy	–	1.9
Value-added land	–	−9.8
Value-added unskilled labour/skilled labour	–	3.6/3.3
Value-added capital	–	0.15
Value-added total	−1.2	−1.8

Labour costs at the farm level (wage, excluding subsidy) decreased by about 4% in MAGNET; see Table 2. As labour markets are lacking, there is no corresponding variable in CAPRI. At the same time, agricultural employment increased by about 1.6% and 0.6% in MAGNET and CAPRI, respectively. Again, differences between CAPRI and MAGNET model outcome can be explained by differences in data and model structure. In this case, the land–capital–labour substitution process was lacking in CAPRI and this at least partly explains why CAPRI predicted smaller employment changes in primary agriculture.

Due to decreased land prices and land-related value added, total value added in agriculture including subsidies decreased by about 1.8% in MAGNET and about 1.2% in CAPRI. However, total wages plus subsidies in agricultural sectors increased by about 2% in MAGNET; see Table 2. So, due to higher wages plus subsidies and higher employment in agriculture, the share of labour in total value added plus subsidies increased.

MAGNET also gives insights into the effect for the economy as a whole. Economy-wide value added in the EU27 decreased slightly due to decreased land-related value added. This offsets the overall increase in wages in the economy stimulated by labour subsidies in agriculture. Also capital remuneration increased as a result of higher demand for capital in non-agriculture resulting from reduced labour supply in non-agricultural sectors.

Agricultural employment impacts presented above correspond to findings in the literature, although impacts are at the lower end. For example, agricultural employment would increase by between 2.3% (=20% × 0.117%) and 3.7% (=20% × 0.187%) minus the employment impact of the 20% decrease in the Pillar I budget, using elasticities between CAP payments and agricultural employment as presented by Olper et al. (2012). Assuming symmetry, a 20% return to a coupled payment scheme would increase agricultural employment by 1.4 and 7%, respectively, using elasticities presented by Petrick and Zier (2012). Notwithstanding these impacts, autonomous factors as, for example, off-farm wage levels are much more important drivers of labour use in agriculture than the CAP (Petrick and Zier 2012).

It is interesting to calculate the total average costs (to society, in terms of welfare losses) of generating an additional full-time work equivalent in agriculture. This requires absolute employment impacts of the policy switch. Agricultural employment in the 2020 reference scenario would be about 7.8 million AWU if we assume a continuation of the trend, namely a yearly decrease of about 3.2% in the period 2012–2020; see introduction. Under the labour subsidy scenario, MAGNET predicted an increase of 1.6% and agricultural employment would be about 7.9 million AWU in 2020 (or a yearly decrease of about 3.0% in the period from 2012 to 2020). Given the welfare loss[4] as calculated by MAGNET, welfare costs are about 1400 € per full-time work equivalent in agriculture extra. It is worth noting that in MAGNET full employment is assumed. In a case of structural unemployment, subsidising agricultural employment can lead to total employment increase and stimulate further the economic growth. In that case, the welfare loss per full-time work equivalent in agriculture extra would be less.

The agricultural employment changes differed by EU27 country (see Fig. 1). The highest employment changes were observed for countries which have relatively high Pillar I subsidies and relatively high labour input per agricultural sector. Agricultural production and employment moved to individual agricultural sectors and countries that are relatively labour intensive. In MAGNET, the impact of the labour subsidy on total agricultural employment varied between about 0.4% for the Netherlands and 5.8% for Slovakia and 4.9% in the Baltic countries. Low agricultural employment changes were especially observed in EU15 countries. Only in three of them—Ireland, Spain and Portugal—did agricultural employment rise by more than 2%. On the other hand, only in two EU12 regions—Malta and Cyprus, and Rumania and Bulgaria—agricultural employment rose by less than 1.5%.

Table 3 shows selected CAPRI impacts on utilised agricultural area (UAA), land use and number of animals in the livestock industry in the EU27, EU15 and EU12. UAA decreased by about −0.4% in the EU27. In particular, the acreage of fallow land and grasslands decreased due to this reduction in UAA. Because the acreage of extensive grassland decreased more than the acreage of intensive grassland, the average intensity of grassland increased. Within the category of arable and vegetable and permanent crops, the more intensive and high-margin crops increased in the regional cropping share. The number of animals in the livestock industry increased. This is especially the case for poultry fattening. Table 3 shows that average impacts in the EU27 were more pronounced in the EU12 as compared to the EU15. This is explained by the relatively labour-intensive technologies of intensive and high-margin agricultural activities production in the EU12. Hence, the labour subsidy improved the competitiveness of these sectors and regions.

Figure 2 shows the impact of the labour subsidy scenario on UAA per NUTS2 region in CAPRI. The decrease in UAA was relatively large in Finland, regions in Eastern Europe, especially Poland and regions in Greece, Spain and Portugal. UAA increased in regions with zero marginal Pillar I payment per hectare (acreage used for agriculture exceeded the initial amount of payment rights). In these regions, the labour subsidy scenario had the effect of increasing the marginal return of land. As a result, the UAA increased along the land supply curve. Figure 2 shows that this was the case in Denmark and in some regions in France and Spain.

Figures S1 and S2 in the supplementary online material show the impact of the labour subsidy scenario on the acreages of cereals and potatoes (Figure S1) and total fodder crops and fallow land (Figure S2). Especially in Eastern Europe, arable crops increased at the expense of fallow land and fodder crops.

Under the labour subsidy scenario, global warming potential from agriculture measured in CO_2 equivalents per ha increased by 0.5, 0.4 and 0.8% in the EU27, EU15 and EU12, respectively. This was due to the intensification of the cropping plan, higher fertiliser input per crop and increased livestock production. This is especially the case in Eastern Europe; see Fig. 3. Figure 3 also shows that regional differences were large, ranging from more than 1% in the north and east of Europe to less than 0.3% in regions in France, the Netherlands, Spain, Denmark, Latvia and Estonia.

[4] In MAGNET, welfare loss is measured by the equivalent variation in US dollars. An exchange rate of 1.13 US $ per € is assumed to measure the welfare loss in €, equal to the exchange rate on September 9, 2016.

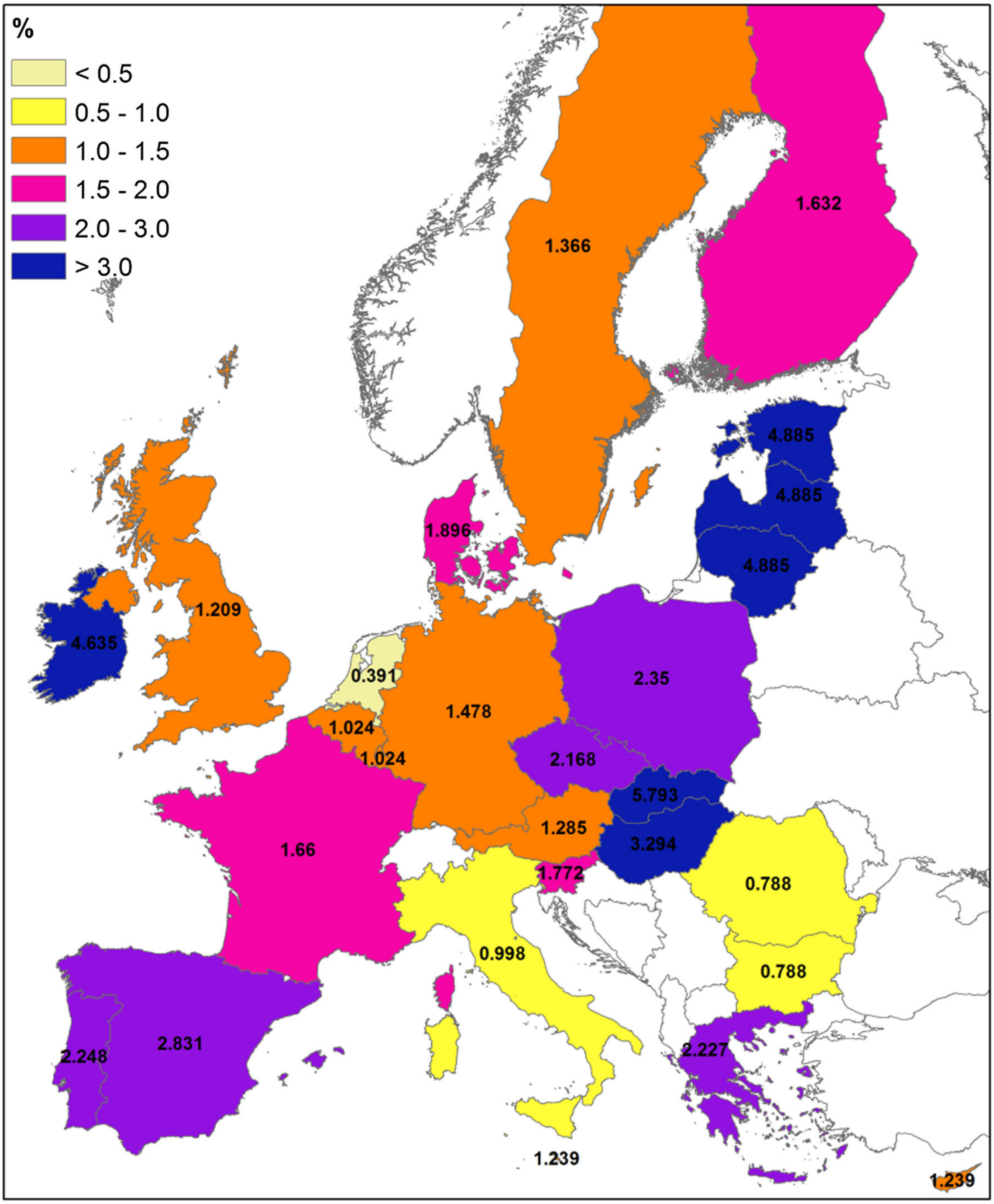

Fig. 1 Impact of agricultural labour subsidy scenario on agricultural employment per EU27 country in 2020; percentage change compared to 2020 reference scenario

Discussion and conclusion

The EU farming and agriculture are important sectors to preserve and stimulate employment and economic growth in rural areas (Hill 2012). On top of this, there is the EU investment plan to boost jobs and growth (European Commission 2015) and the traditional objective of the EU CAP to keep jobs in agriculture. Given these policy priorities and the importance of farming and agriculture in rural areas, it is peculiar that agricultural policies in the EU do not include instruments directly aimed at preserving agricultural employment. In fact, the introduction of the Single Payment Scheme (SPS) or system of decoupled payments to farmers in Pillar I of the CAP has decreased

Table 3 Impact of agricultural labour subsidy scenario on UAA, land use and number of animals in the EU27, EU15 and EU12. Percentage difference compared to reference scenario *Source* own calculations with CAPRI

	EU27	EU15	EU12
Land use			
UAA	−0.4	−0.3	−0.6
Soft wheat	0.2	0.1	0.3
Potatoes	0.7	0.0	2.1
Sugar beet	0.2	0.1	0.4
Apples, pears and peaches	0.1	0.1	0.2
Fodder maize	0.2	0.2	0.5
Grass and grazing extensive	−1.2	−1.0	−1.7
Grass and grazing intensive	−0.6	−0.5	−1.0
Fallow land	−6.4	−2.8	−12.3
Livestock			
Dairy cows	0.2	0.1	0.2
Other cows	0.6	0.5	2.9
Pig fattening	0.2	0.2	0.4
Poultry fattening	2.5	2.4	2.7

employment in agriculture (Petrick and Zier 2012). The objective of this paper was to investigate the effectiveness of a subsidy linked to employment in agriculture in relation to the current system of decoupled payments to farmers in Pillar I of the CAP. In our counterfactual scenario, also referred to as the agricultural labour subsidy scenario, 20% of the 2020 reference scenario Pillar I budget per member state will be used to finance a subsidy on agricultural labour. We also wanted to investigate impacts of such a scenario on welfare, environmental and land use in the EU. To achieve these goals, we applied both a CGE model (MAGNET) and a PE model (CAPRI). We found that in the agricultural labour subsidy scenario, employment in agriculture increased with 1.6% in the CGE model and 0.6% in the PE model as compared to the 2020 reference scenario. Agricultural employment increased in all member states, although at quite different rates. At the same time, EU agricultural production and environmental emissions from agriculture increased as well, especially in sectors and regions that are relatively agricultural labour intensive. Agricultural output prices decreased, and this dampened further production and employment increases in agriculture. Value added including subsidies increased for skilled and unskilled agricultural labour, but total value added in agriculture decreased slightly under the agricultural labour subsidy scenario. This was explained by the strong decrease in value added related to land. The agricultural labour subsidy scenario also decreased value added for the economy as a whole. Measured in terms of EV, welfare costs equalled about 1400 € per full-time work equivalent in agriculture extra. These results show that policy makers should weigh carefully the pros and cons of the direct and indirect overall economic, environmental and land use impacts of a subsidy on agricultural labour at the expense of the Pillar I budget of the EU CAP.

The strength of the approach described in this paper was the EU-wide application with regional differences in production and technologies, including interactions between

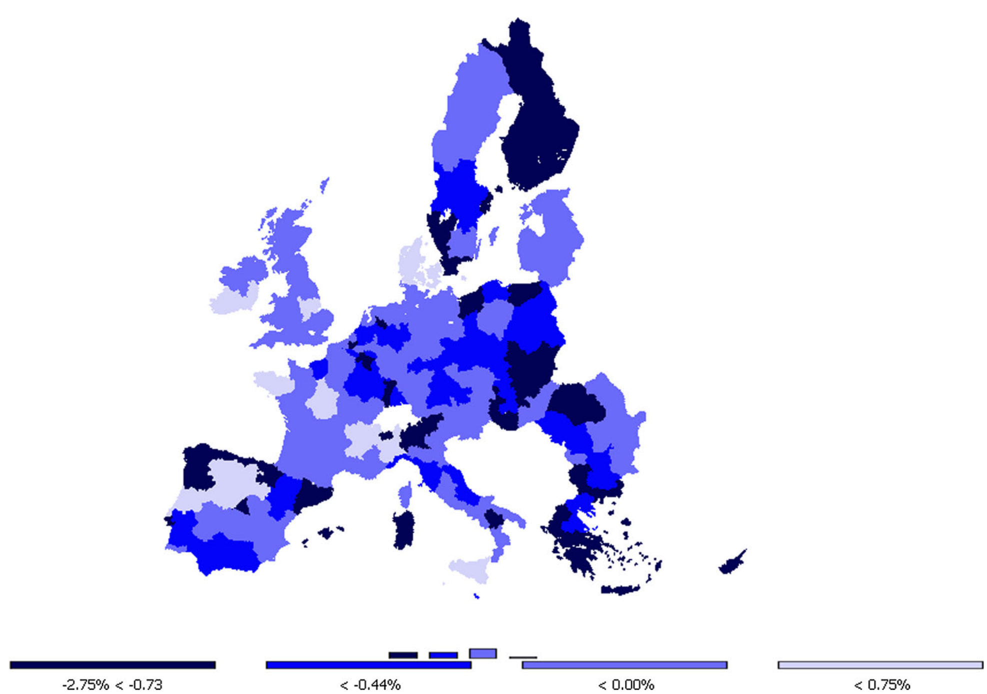

Fig. 2 Impact of agricultural labour subsidy scenario on utilised agricultural area (UAA) per NUTS2 region in 2020. Percentage change compared to 2020 reference scenario

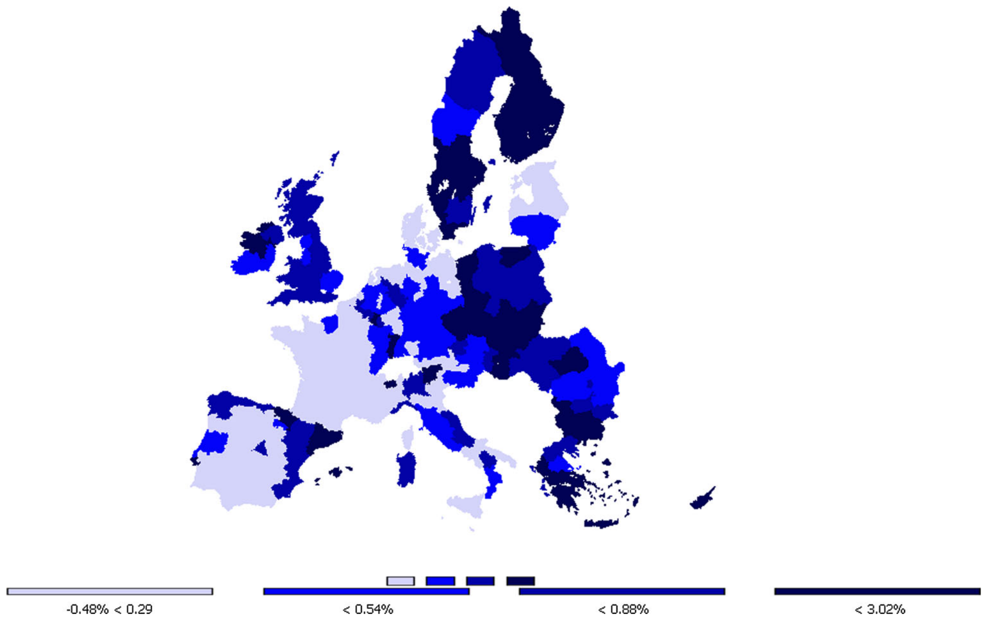

Fig. 3 Impact of agricultural labour subsidy scenario on global warming potential from agriculture per NUTS2 region in 2020. Percentage change compared to 2020 reference scenario

different agricultural activities via supply and demand and resulting equilibrium market prices. Price effects dampened the effects of the policy switch. MAGNET added to the analysis via the explicit modelling of labour markets, land–capital–labour substitution and the interactions with the rest of the economy. CAPRI gave insights into environmental impacts.

Some caveats of the data and the approach used in this paper should be mentioned as well. First of all, the recent reform of the CAP (2014–2020) brought various changes that were not included in our 2020 reference scenario. Most important is the further reform of the SPS, leading to a more targeted system of support. Targeted payments include a green payment, redistributive payments, a young farmers' scheme, an optional small farmers' scheme, voluntary coupled support and payments to farmers facing natural handicaps (the first pillar of the CAP). Under the reformed CAP, member states may grant voluntary coupled support to types of farming/specific sectors that are particularly important for economic, social and environmental reasons and that undergo certain difficulties. According to Nordin (2014), the green payments introduced under the reform of the CAP (2014–2020) may increase agricultural employment as these payments keep small farms from exiting the industry and counteract structural change. This should be included in the 2020 reference scenario, and the impacts of our agricultural labour subsidy scenario on agricultural employment would be less. This is especially the case for regions and sectors that will receive more coupled support under the reform of the CAP (2014–2020). It is, however, difficult to say by how much the agricultural employment effects are overestimated. In general, the impact of the labour subsidy scenario on agricultural employment was already very small.

Capitalisation of the SPS in land prices might also differ from what we assumed in the 2020 reference scenario, both in CAPRI and in MAGNET. In MAGNET and in most regions in CAPRI, the Pillar I payment was fully capitalised in land. However, evidence found in the literature is mixed; some studies indicate that CAP subsidies are only to a limited extent or marginally capitalised into land values (Ciaian et al. 2011; Ciaian and Kancs 2012). Other studies indicate that a considerable part of the farm subsidy is capitalised into land values (e.g. Feichtinger and Salhofer 2013). If in reality the SPS directly affects 2020 reference capital and labour allocation in agriculture, most probably the impact of our agricultural labour subsidy scenario on agricultural land use and agricultural employment would be less.

Finally, the models do not allow full welfare analysis in more rural regions, including value added and employment possibilities in sectors like agri-tourism, day-care farms, education on the farm and environmental protection. More detailed analyses are needed for this, also taking into account possible structural unemployment and limited employment possibilities in non-agricultural sectors in rural areas. Notwithstanding these caveats, the literature review and model results presented in this study clearly indicate that CAP policies could be more effective concerning agricultural employment.

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