European Planning Studies
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/ceps20

Ex-Ante Analysis of the Regional Impacts of the Common Agricultural Policy: A Rural-Urban Recursive Dynamic CGE Model Approach

Maria Espinosa[a], Demetrios Psaltopoulos[b], Fabien Santini[a], Euan Phimister[c], Deborah Roberts[c], Sebastien Mary[ac], Tomas Ratinger[d], Dimitris Skuras[b], Eudokia Balamou[b], Manuel A. Cardenete[ae] & Sergio Gomez y Paloma[a]

[a] IPTS, Joint Research Centre, Seville, Spain
[b] Department of Economics, University of Patras, Patras, Greece
[c] Business School, University of Aberdeen, Old Aberdeen, UK
[d] Department of Agricultural Markets, Institute for Agricultural Economics and Information (UZEI), Praha, Czech Republic
[e] Department of Economics, University Loyola de Andalucia, Seville, Spain

Published online: 24 Apr 2013.

European Planning Studies, 2014
Vol. 22, No. 7, 1342–1367, http://dx.doi.org/10.1080/09654313.2013.786683

Routledge
Taylor & Francis Group

Ex-Ante Analysis of the Regional Impacts of the Common Agricultural Policy: A Rural–Urban Recursive Dynamic CGE Model Approach

MARIA ESPINOSA*, DEMETRIOS PSALTOPOULOS**, FABIEN SANTINI*, EUAN PHIMISTER†, DEBORAH ROBERTS†, SEBASTIEN MARY*,†, TOMAS RATINGER‡, DIMITRIS SKURAS**, EUDOKIA BALAMOU**, MANUEL A. CARDENETE*,§ & SERGIO GOMEZ Y PALOMA*

*IPTS, Joint Research Centre, Seville, Spain, **Department of Economics, University of Patras, Patras, Greece, †Business School, University of Aberdeen, Old Aberdeen, UK, ‡Department of Agricultural Markets, Institute for Agricultural Economics and Information (UZEI), Praha, Czech Republic, §Department of Economics, University Loyola de Andalucia, Seville, Spain

(Received August 2012; accepted March 2013)

Abstract *A recursive dynamic regional Computable General Equilibrium model is developed to assess the economic impacts of two Common Agricultural Policy (CAP) scenarios in six NUTS-3 (Nomenclature of Territorial Units for Statistics) (NUTS-1: major socio-economic regions, NUTS-2: basic regions for the application of regional policies, NUTS-3: small regions for specific diagnoses) regions of the European Union (EU). The main goal of the analysis is to assess the scenario effects (change in production, prices, income, employment) in the rural and urban parts of these regions as well as on the different sectors. The two scenarios analysed are related to a 30% reduction in Pillar 1 (market measures and direct support to farmers) support and the introduction of an EU-wide flat rate level of Pillar 1 support complemented by a 45% increase in Pillar 2 (Rural Development Policy) funds. Results show that the overall gross domestic product effects are not significant, due to the relatively low importance of both the agricultural sector and CAP spending in the regional economies. However, impacts on the agricultural sector are quite important and differ according to the nature of the policy shock. Also, the structural characteristics of each case study influence the rural–urban and sectoral spillovers, including impacts on region-specific agricultural activity.*

Correspondence Address: M. Espinosa, IPTS, Joint Research Centre, C/Inca de Garcilaso 3, Seville 41003, Spain. Email: maria.espinosa@ec.europa.eu

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

1. Introduction

According to the "EU 2020" strategy (European Commission, 2010a), agriculture should contribute to a smart (knowledge and innovation-based), sustainable and inclusive growth. More specifically, the debate on the future of the Common Agricultural Policy (CAP) after 2013, involving European and national institutions and stakeholders, focuses on the evolution of direct payments as well as other remaining intervention instruments for market regulation (Pillar 1 of the CAP), and different types of public support associated with European Union (EU) Rural Development Policy (RDP) (Pillar 2 of the CAP).

There have been numerous previous studies of the impact of changes in agricultural and rural development measures using various alternative quantitative models. These include simulation models (e.g. the agent-based model Agripolis), partial equilibrium models (e.g. CAPRI, ESIM) and models based on Input–Output/Social Accounting Matrix (SAM) databases.

Computable General Equilibrium (CGE) models are able to assess the policy impact on all the sectors in the regional economy and, in addition, overcome the weaknesses of linear techniques used in Input–Output/SAM models (Midmore (1993) and, for SAM models, Waters *et al.* (1999) and Roberts (1995)). Indeed, CGE models are based on fundamental microeconomic principles including non-linear feedback mechanisms which can be used to model both price and volume changes as all markets equilibrate simultaneously. Due to advances in computing technologies and economic theory, the construction and use of CGE models tailored to agricultural policy analysis has been widely applied to the investigation of trade policy issues (Tongeren *et al.*, 2001). In addition, several studies based on CGE models have also investigated the impacts of changes in farm support at the EU or national level (e.g. Bascou *et al.*, 2006; Gohin and Latruffe, 2006; Keyzer *et al.*, 2002). However, few have explored the general equilibrium effects of changes in agricultural support at the regional level, despite the fact that past studies have shown that the economic effects of the CAP differ at the sectoral and spatial levels. In particular, the sectoral effects from CAP reform will depend on the level of support given to different agricultural commodities, the linkages between agricultural and non-agricultural sectors and the pattern of factor income and consumer demand for the different sectors (Roberts, 1995). The spatial effects of the CAP differ because the distribution of support is heterogenous across territories (Shucksmith *et al.*, 2005) and because the structure of the regional economy and strength of links across rural and urban boundaries (Psaltopoulos *et al.*, 2006) also differ between regions.

Therefore, regional models, like the one applied in this research, can investigate such impacts in areas with different socio-economic, structural and environmental conditions and enhance knowledge on the heterogeneity of CAP economic impacts. This will allow policy-makers to design more targeted CAP policies at the regional level according to the specific characteristics, needs and potentialities of the regions.

One aspect when considering the impact of CAP reform is the distribution of effects across urban–rural space. The CAP aims (among other things) to improve economic prosperity and quality of life in rural areas and, accordingly, is not targeting urban areas. However, research efforts have proved the existence of considerable leakages of rural policy benefits (and disbenefits) to urban areas (Baldock *et al.*, 2001; Psaltopoulos *et al.*, 2006; Roberts *et al.*, 2009). Consequently, the modelling approach adopted in this paper differentiates the urban and rural areas of the regions in order to separately account for urban and rural policy effects.

In summary, the aim of this paper is to apply a bi-regional (urban–rural) CGE modelling approach to the *ex-ante* assessment of two potential CAP reform scenarios. The first scenario is the most drastic based on a 30% reduction on Pillar 1 (Pillar 2 expenditure it is maintained), while in the second scenario there is a redistribution of Pillar 1 expenditure among EU regions and a 45% increase in Pillar 2 expenditure. These two scenarios reflect CAP trends over the last decades: increasing trend in the share of Pillar 2 in total CAP spending and progressive homogenization of direct payments towards a flat rate. The analysis is undertaken in six NUTS-3 regions in order to investigate potential cause–effects patterns associated with region-specific characteristics, current CAP implementation and the policy impact findings. The next section describes the six case studies regions and the construction process of the SAMs, followed in Section 3 by the description of the model and its construction. Section 4 defines the scenarios and the simulations, while the article finishes with the results and conclusions.

2. Description of the Six Case Study Regions and Construction Process of the SAM

2.1 *The Six Case Study Regions*

For the purpose of analyses, six NUTS-3 case study regions were selected through the application of a three-stage procedure based on the TERA-SIAP typology[1] (Weingarten *et al*., 2009), the OECD (Organization for Economic Cooperation and Development)-refined typology[2] (European Commission, 2009) and a cluster analysis based on selected regional variables (e.g. population, agricultural productivity, etc.).[3]

Table 1 presents descriptive statistics of the six case study regions selected.

As shown in Table 1, the six regions are heterogeneous regarding their characterization by the defined typologies, their economic size (in terms of gross domestic product (GDP) and population) and in the CAP spending and distribution. In particular, OECD urban regions (GUI and RHE[4]) are comparatively wealthier regions (incomes are over 20,000 euros/*per capita* and are quite similar in magnitude in both the urban and rural components) with low spending on the CAP relative to total GDP (less than 0.5%). Rural regions (ARK and POT) correspond to poorer regions (incomes are less than 15,000 euros/*per capita*, and much higher in urban areas), while the importance of the CAP in total GDP is over 2%. On the other hand, intermediate regions (JIH and AA) vary in terms of both the income level and the relative importance of CAP spend.

2.2 *Construction Process of the SAM*

The first phase of a CGE model construction is to have a SAM for each NUTS-3 case study. The SAM tables were constructed through a four-stage process (Figure 1). Stage 1 involved the regionalization of existing national (or in the case of GUI NUTS-2) I–O (Input–Output) Tables for year 2005, through the use of location quotient and RAS procedures (Bacharach, 1970). This was followed by the rural–urban disaggregation of sectors, households and factors of production, performed through the utilization of secondary data (for example, employment data were used to split sectors, population data to split households). A key issue required at this point is the definition of rural and urban boundaries in the region. In some cases (e.g. ARK), this was straightforward as the urban area consists solely of the city of Tripoli. In others (e.g. GUI), the definition of rural and urban was based on population density at the municipality level.

Table 1. Descriptive statistics of the case study regions

Region (Country)	Arkadia (Greece)	Potenza (Italy)	Jihomoravsky kraj (Czech Republic)	Aberdeen and Aberdeenshire (UK)	Guipúzcoa (Spain)	Rheintal-Bodenseegebiet (Austria)
Acronym	ARK	POT	JIH	AA	GUI	RHE
OECD type	Rural peripheral	Rural accessible	Intermediate closed space	Intermediate closed space	Urban space open	Urban closed space
TERA-SIAP	Agri dependent/low farm pluriactivity	Agri average/low farm pluriactivity	Agri average/high farm pluriactivity	Agri low/low farm pluriactivity	Agri low/low farm pluriactivity	Agri low/high farm pluriactivity
Area (km^2)	4420	6544	7172	6504	1942	725
Population (thousands)	89.3	391.1	1130.3	504.4	682.1	273.2
% GDP rural	61%	78%	50%	34%	32%	6%
% GDP Urban	39%	22%	50%	66%	68%	94%
Per capita GDP (in thousand euros)[a]						
Total	13.8	12.4	8.5	29.8	26.2	26.8
Urban	20.8	15.6	9.0	37.1	26.7	26.9
Rural	11.3	11.7	8.1	21.5	25.3	26.1
Contribution of agriculture to total GDP (%)	6.6%	5.2%	3.3%	1.0%	0.7%	0.9%
Contribution of agriculture to rural areas (%)						
Employment	37.5	11.5	2.9	0.8	1.0	0.1
Value added	12.5	6.6	2.6	2.8	0.8	0.2
% CAP/total GDP	2.1%	3.5%	1.8%	0.7%	0.1%	0.4%
% CAP/agric. GDP	29.0%	65.5%	39.1%	56.7%	12.2%	38.2%

[a]The baseline, as it will be further described (in Section 5) represents the path of the implementation of the health check and the RDP 2007–2013 extended to year 2020.
Source: authors' calculations based on the SAMs base year.

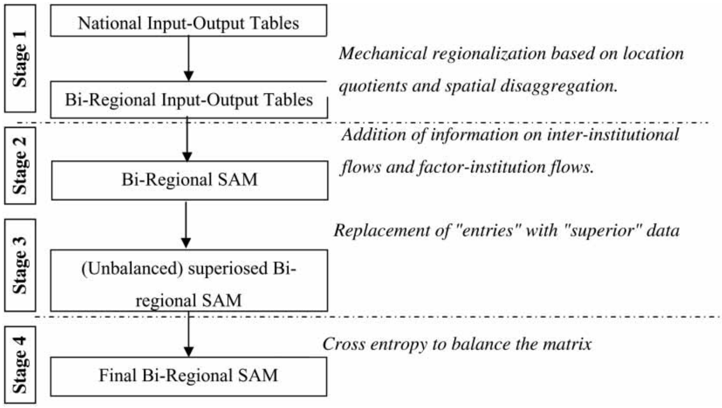

Figure 1. Construction process of the SAM.

Stage 2 involved the disaggregation of agricultural activity through the use of FADN (Farm Accountancy Data Network Information) on the farm typology (European Commission, 2008). Then, the regional I–O table is converted into a SAM structure by filling in the inter-institutional transactions of the SAM table. The latter was carried out via the utilization of regional household income and expenditure data, as well as information from key informants (regional agencies and local policy makers). In Stage 3, initial SAM entries were "superiorized"; in other words, replaced with values considered more accurate, collected from elite interviews with local policy-makers and stakeholders. Finally, Stage 4 involved the application of the cross entropy optimization procedure (Robinson *et al*., 2001) in order to estimate balanced SAMs.

While the structure of the six SAMs is identical across all study regions, there are some differences in terms of the degree of disaggregation of accounts, as a result of both data availability and different regional characteristics (Table 2). For example, more food processing activities are included in the ARK SAM because a greater disaggregation of such activities is present in the Greek national I–O table than the Scottish or Czech tables. The choices of factor and household accounts are very similar across study areas, with one extra labour skills category in the ARK SAM compared with the other regions, while due to data availability constraints, the JIH SAM is the only one to distinguish rural households by commuting status. In five of the six SAMs (the exception RHE), separate farm household accounts are distinguished.

SAM construction was followed by model calibration, which required the specification of elasticities, exogenous region-specific trends and closure rules. The choices of model elasticities (see Appendix 1) and trend parameters varied between the study areas, reflecting differences in economic structure.[5]

In contrast, the choice of model closure rules was almost identical in all six models. For the current account, it was assumed that real exchange rate was set as endogenous and the current account deficit as fixed. For the Savings–Investment balance, investment was taken as fixed and savings were assumed to adjust. Under this closure rule, the government consumption is fixed in real terms while the savings rates of selected institutions are scaled so as to generate enough savings to finance investment. The selection of these two macro-closure rules was influenced by the methodology adopted for modeling RDP investment shocks (see Section 4, last paragraph). In the government account balance, as is the

Table 2. Model description in the six case study regions

	ARK	POT	JIH	AA	GUI	RHE
Production activities	39	32	30	48	30	20
Rural	27	19	17	24	15	10
Farm types	8 (0 urban)	7 (1 urban)	4 (1 urban)	12 (6 urban)	4 (2 urban)	2 (combined with forestry and fishing)
Forestry	Yes	Yes	Yes	Yes	Yes	See above
Fishing	No	No	No	Yes	Yes	See above
Food processing	7 (5 rural)	2 (1 rural)	4 (2 rural)	4 (2 rural)	Combined with other manufacturing	2 (1 rural)
Commodities	22	23	16	20	13	10
Food, fishing and forestry	9	12	6	6	4	1
Labour factors	3	2	2	2	2	2
Households	5 (3 rural)	5 (3 rural)	4 (3 rural. including one commuter status)	5 (3 rural)	4 (2 rural)	3 (1 rural)
Agricultural household	Yes (large and small)	Yes (large and small)	Yes	Yes (large and small)	Yes	No
Tourist account	Yes	Yes	Yes	Yes	Yes	Yes

Source: authors' calculations.

case in most regional CGE models, it was assumed that government savings adjust endogenously and tax rates are fixed. Therefore, the level of direct and indirect taxes, as well as government consumption are held constant. As a result, the balance on the government budget adjusts to ensure that public expenditures equal receipts.

Regarding factor markets closure rules, for capital it was assumed that it is sector-specific for the agricultural sector while for the non-farm sectors, it was assumed mobile between sectors and between the rural and urban part of the regions. The labour market closure rule varied among case studies, with two regions (AA and GUI) assuming an upward-sloping labour supply function for both skilled and unskilled workers while the other four models assumed neoclassical adjustment in the unskilled labour market.

3. Description and Construction of the Recursive Dynamic CGE Rural–Urban Regional Model

The simplest static CGE modelling approach considers the regional or national economy as being in the long-run equilibrium at a given point in time. Simulations in this type of model

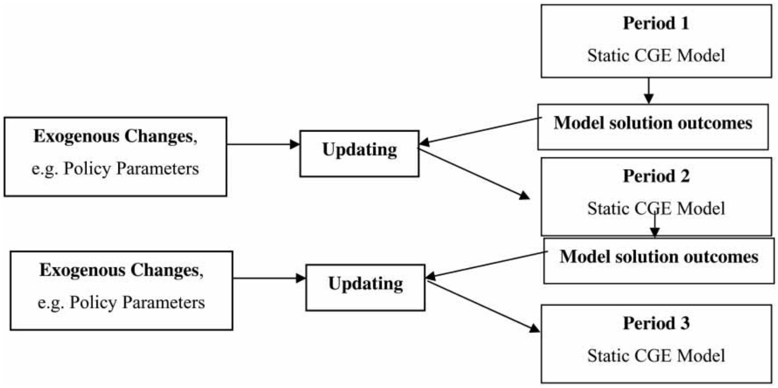

Figure 2. Recursive dynamic CGE model.
Source: author's elaboration. Full details of the model and the equations can be found in Thurlow (2008).

therefore consider how exogenous shocks change the long-run equilibrium structure of the economy. One weakness of the comparative-static models approach is that it is difficult to model policies which are implemented in a phased manner over time and take several years to reach their full effect as the path from the original to new equilibrium cannot be tracked. The static model can be extended by allowing period-to-period updating of key model parameters, either endogenously or exogenously, and then solving the model recursively in each period: in this way, it is possible to generate a dynamic time path for model simulations. This means that the model loses some of its consistency with microeconomic theory, in the sense that actors are maximizing the profits in one period rather than considering an overall dynamic optimization problem. However, it allows adjustment processes to be incorporated and thus time paths to new equilibrium to be assessed.

The models that have been developed and are used here are recursive dynamic CGE models adapted from the IFPRI (International Food Policy Research Institute). Since a recursive model is solved one year at a time, it is possible to separate the *within-period* component (static CGE model; Lofgren *et al*., 2002) and the *between-period* component (dynamic component; Thurlow, 2008).

As shown in Figure 2, in the between-period component, a number of parameters of the within-period model are updated endogenously using outcomes of the model solution in the previous period (capital stocks) and exogenously (population projections, labour supply, capital depreciation, total factor productivity, government consumption and transfers). As a result, the model is able to generate a path for each regional economy under different scenarios.

An abridged version of the model is included in Appendix 3.

4. Scenario Description and Simulation

The CAP has existed for 50 years as one of the most important pan European policies. The CAP budget has historically represented a large proportion of the overall EU budget and expenditure but is decreasing as other EU-level policies have developed.

Nowadays, CAP represents 40% of the total EU budget (i.e. less than 0.5% of GDP in the EU).

The CAP is divided into two Pillars. Pillar 1 relates to market support and direct payments to farmers, while Pillar 2 relates to RDP. The importance of the RDP has been increasing over time and now it represents around one-fourth of the total CAP spending. In addition, the mechanisms in place have been evolving over time as the emphasis of the early CAP aimed to encourage better agricultural productivity (therefore generating incentives to the farmers to produce more), while in the CAP of today the link to production has been severed. Specifically, the 2003 reform introduced the Single Farm Payment (SFP) which is a direct payment to farmers decoupled from production (payment per hectare of land cultivated whatever the production). However, some sectors are still receiving coupled support (where the amount of grants received is in some way correlated to the physical production level).

The CAP is facing a new reform to be implemented in 2014. The instruments proposed for the post-2013 CAP (European Commission, 2010b) should assure a minimum level of stability for agricultural incomes within the EU budget restrictions, taking into account the expansion of the EU to 27 Member States. In this context, three broad policy scenarios have been presented (European Commission, 2010b) which differ in the management of direct payments, market measures and rural development and with potentially very different repercussion for the spending distribution between Pillar 1 and Pillar 2.

In one of the three options, the phasing out of direct payments is identified. In addition, it is quoted that the direct payment mechanisms should assure more equity in the distribution of direct payments between Member States, pointing to the consideration of a flat rate support mechanism, without providing the spatial resolution of this option (EU, national or regional flat rate). Regarding the new EU budgetary framework 2014–2020 (European Commission, 2011) the European CAP spending will be frozen in nominal terms at 2013 levels which corresponds to a rather significant reduction in comparison with the 2007–2013 period in "real" terms assuming a 2% inflation rate.[6] Considering the above background, the following scenarios have been tested in the six case study areas. The main policy impact tested in the first scenario is a drastic reduction in Pillar 1 spending, while in the second scenario the introduction of the flat rate is tested. In both cases, the maintenance/increase of Pillar 2 spending was assumed as a realistic trend.

Scenario 1: Reduction of Pillar 1 support: This scenario takes into account the current CAP orientation and assumes a decrease in farm support. Hence, Pillar 1 support is reduced by 30%, while Pillar 2 it is maintained as in the Baseline (but because Pillar 1 is reduced modulation funds are also reduced in proportion within Pillar 2).

Scenario 2: Rebalancing scenario: An EU-wide flat SFP (229 €/ha) rate is introduced in Pillar 1 with non-SFP Pillar 1 funds decrease by 15% in nominal terms. Pillar 2 funds increase by 45% in nominal terms. The 2007–2013 distribution of axes and measure-specific financing holds for each study area.

These two scenarios are compared with a baseline scenario, which reflects the path corresponding to the implementation of the Fischer reform policy (introduction of the SFPs) for years 2006–2009 and the CAP Health Check (reform aiming to make the SFP more effective) for years 2010–2020 (including national specificities regarding the degree of decoupling. article 68, national top-ups,[7] etc.). Pillar 2 measures are defined as in the 2007–2013 RDP identified in each case study (European Council, 2009a, 2009b, 2009c). In the baseline scenario, there is an initial adjustment in the SAM construction, in order to reflect changes from the "old" CAP (as reflected in the base year 2005) to the "Fischler and Health Check Reform" (based on SFP). Pillar 1 subsidies, which in 2005 constituted payments linked to production in these areas, are (where applicable) set to zero and the equivalent value is transferred from government to agricultural households (in the form of the SFP).

One important aspect of the project is the collection of the policy data (Pillars 1 and 2) in the baseline. Data accessibility for the case studies differ; however, in all the case studies, Pillar 1 expenditure was determined by the national paying agencies. For Pillar 2 expenditure (and allocation among the different axis and measures of the Rural Development program), a combination of actual and total planned expenditure related to the Regional Rural Development Programmes for the period 2007–2013 was used in order to obtain the baseline estimations for the period 2007–2020.

As shown in Table 3, Pillar 1 spending is more important than Pillar 2 in all the regions (ranging between 53% of total CAP spending in ARK and 72% in AA), except in the case of RHE where Pillar 2 accounts of 80% of overall CAP spending. In addition, in terms of CAP Pillar 1 support, it is important to distinguish between coupled and decoupled payments (SFP) as these different support instruments are associated with different beneficiaries. Coupled support benefits agricultural activities while decoupled support is associated with income transfer to households. This can, in principle, induce different patterns of effects. In the case of ARK and AA, there are very few subsidies attached to production and therefore more than 90% of the subsidies are decoupled. In the case of POT and GUI only 44% and 55% of the payments, respectively, are decoupled to production. In JIH and RHE, decoupled payments are not considered and direct payments are assumed to be coupled to farm businesses and decoupled to commodity production. In the case of JIH, this is due to the fact that expert knowledge suggests that Single Area Payment Scheme is directed to current accounts of the agriculture business rather than to savings and dividends. In the case of RHE, it is due to the fact that Pillar 1 payments and the agricultural sector is very marginal in the region and the lack of reliable data to disaggregate the specific agricultural household.

Table 3. CAP distribution

	ARK	POT	JIH	AA	GUI	RHE
Average annual CAP support in baseline[a]						
Total (ME)	26.6	169.7	172.0	86.8	18.8	31.7
Distribution of CAP spending						
Pillar 1 (%)	53.0%	68.2%	66.3%	71.5%	70.2%	19.9%
Coupled	3.4%	38.3%	66.3%	3.0%	31.4%	19.9%
Decoupled	49.6%	29.9%	0.0%	68.5%	38.8%	0.0%
Pillar 2 (%)	47.0%	31.8%	33.7%	28.5%	29.8%	80.4%

[a]The baseline, as it will be further described (in Section 5) represents the path of the implementation of the health check and the RDP 2007–2013 extended to year 2020.

Source: authors' calculations.

Table 4. Change in the CAP support in Scenarios 1 and 2 (scenario expenditure/baseline expenditure)

	ARK		POT		JIH		AA		GUI		RHE	
	Sc.1 (%)	Sc.2 (%)	Sc.1 (%)	Sc.2 (%)	Sc.1 (%)	Sc.2 (%)	Sc.1 (%)	Sc.2 (%)	Sc.1 (%)	Sc.2 (%)	Sc.1 (%)	Sc.2 (%)
Pillar 1	70	31	70	102	69	71	70	109	70	110	70	85
Coupled	70	85	70	85	69	71	69	85	70	85	70	85
Decoupled	70	27	70	123	0	0	70	110	70	130	0	0
Pillar 2	98	134	98	139	93	131	95	119	96	143	98	143
Total	83	79	79	114	78	88	77	112	70	110	94	134

Source: authors' calculations.

The time span of the model is the year 2020. The target year 2020 accommodates the financial perspectives for the EU and in addition is in line with the policy perspectives target year ("Europe 2020 strategy") and some other impact assessment research undertaken at the European level such as "Scenar 2020" (Nowicki *et al*., 2009).

Table 4 indicates the change in CAP support for both scenarios compared with the baseline in each case study. According to the definition of Scenario 1, overall Pillar 1 spending is reduced by around 30%, while Pillar 2 spending is similar to the base level (some slight variations due to modulation). Regarding Scenario 2, results show that the implementation of the EU flat rate (229 Euros/ha, as calculated by Velazquez (2008) and Thurston (2008)) increases the amount of decoupled payments compared with the current SFP average rate in all the regions (with the exception of ARK), while total Pillar 1 spending is reduced in all the regions. Overall spending (Pillars 1 and 2) decreases in ARK and JIH, while it increases in POT, GUI, AA and RHE.

In the case of Pillar 1, different mechanisms were applied for the modelling of coupled and decoupled payments. Decoupled payments were modelled as a change in income; therefore, a transfer from the government account to the farm households account which are the beneficiaries of the SFP. While agricultural (coupled) subsidies are portrayed as a negative indirect activity tax (due to the SAM structure). Thus, a reduction in coupled payments is modelled as an increase in the indirect activity tax rate of the agricultural sector, which implies a direct decrease of value added for the agricultural sector and consequently a decrease in the agricultural production. The adjustments in the agricultural sector will affect the resource allocation in the economy. Labour will be redeployed in more profitable sectors and the prices of capital (and land) tied to agriculture will decrease. Household income will also change depending on the pattern of factor ownership and will induce further second-order production and price effects, which may be positive or negative depending on inter-industry dependencies and household consumption patterns. The net aggregate regional effect and the net effect in each of the rural and urban sub-areas will be determined by the relative strength of the competing forces.

The methodology used to model Pillar 2 payments is through investment. Therefore, the key mechanism in place in the model has been to focus on the assumed induced changes in the short run (through extra investment commodity demand) and in the long run (through extra capital stock) within key industries that assumedly benefit from such measures. A somewhat similar approach has been used in previous CGE-related work (see Törmä, 2008). In contrast to conventional static demand shocks, the methodology followed in

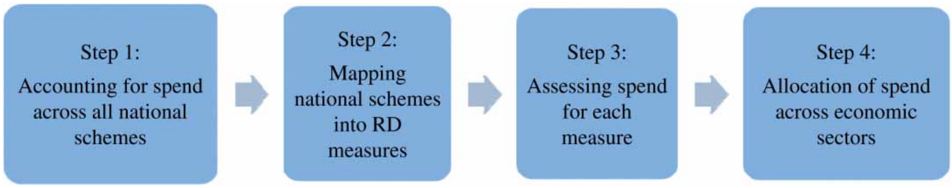

Figure 3. Mapping RDP spending to SAM sectors.
Source: author's elaboration.

this study can accommodate the RDP investment projects (and their economic effect) are generally specific to a time path and, in parallel, generate a dynamic capital stock adjustment amongst different activities (see Psaltopoulos *et al*., 2012). In order to operationalize this approach, RDP spending in each region has to be mapped into investment in specific SAM sectors as shown in Figure 3.

5. Results and Impact Analysis

Results are presented as average annual differences between the scenario-specific and baseline values over the period 2006–2020. Results obtained are specific to indicators such as GDP, employment level, income, producer prices and domestic production (see Appendix 2).

As expected, the impacts are much stronger on the agricultural sector due to the fact that both scenarios are specific to shocks associated with farm activity and households. The impacts in total (i.e. rural and urban) GDP are small or insignificant (less than 0.1%) in all case studies, except in JIH case study for Scenario 1. The income effects are above 0.1% in only two regions (POT and RHE) and only under Scenario 2 (specifically in the rural areas of these regions). The small size of the overall effects highlights the low importance of the agricultural sector and/or the small size of CAP expenditure relative to the size of all regional economies at stake.

One important advantage of the rural–urban CGE model applied here lies in its ability to separately estimate urban and rural policy effects. The magnitude and the direction of effects in the rural and urban areas are region-specific. In terms of total economic activity (GDP), both rural and urban areas are in general more affected by both scenarios than the aggregate economy; however, the impacts remain small. Spillover effects to urban regions are above 0.1% only in Scenario 2 (Rebalancing) for POT and in Scenario 1 (reduction of Pillar 1 payments) for JIH, while for the rest of case studies the impact on urban GDP is below 0.1%.

According to the Commission Communication on "The CAP towards 2020" (European Commission, 2010b), the support of farm income is considered as an important element of both the post-2013 CAP and Europe 2020 strategy growth ("... supporting farmers' income to maintain a sustainable agriculture throughout Europe"). With this in mind, Figures 4 and 5 show the impact of the two scenarios on agricultural GDP and farm household income.

The effects of Scenario 1 are, as expected, negative or insignificant in all study areas. In theory, the decrease in Pillar 1 payments impacts the level of SFP and therefore affects farm household income. In addition, the reduction of subsidies that are still coupled to

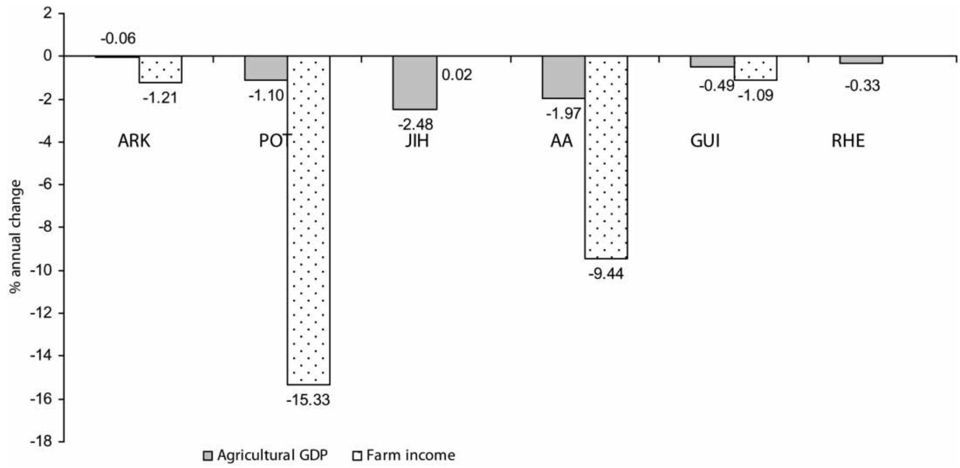

Figure 4. Average annual percentage change in agricultural GDP and farm household income in Scenario 1 (30% reduction in Pillar 1).
**The change in farm income is not represented in Rheintal as there is no agricultural household.
Source: authors' calculations.

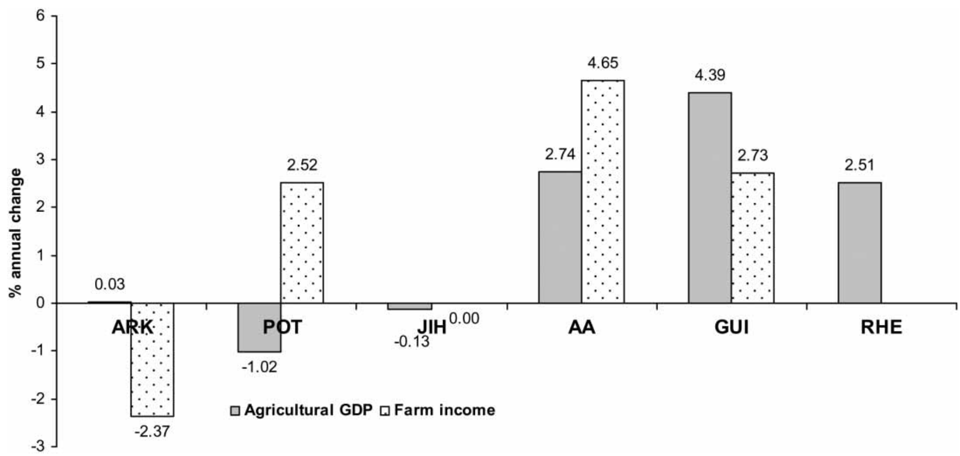

Figure 5. Average annual percentage change in agricultural GDP and farm household income in Scenario 2 (Rebalancing scenario).
**The change in farm income is not represented in Rheintal as there is no agricultural household.
Source: authors' calculations.

production (the degree of coupling is case-dependent as shown in Table 1) should have a negative impact on farm output and, consequently, on income and employment.

Results show that the most important effects are reflected in farm household incomes in POT and AA. These two regions are very dependent on Pillar 1 subsidies as such subsidies represent more than 40% of the agricultural output (Table 1), and therefore they are the most affected by a reduction in Pillar 1 subsidies. In the case of POT where there is a relative balance between coupled and decoupled support (56% of Pillar 1 payments are coupled), the decrease in agricultural income is mainly driven by the decrease in agricultural production (−0.63%) in heavily subsidized sectors (cereals, vegetables) which drives a reduction on rural employment (−5.61% for skilled labour and −5.91% for unskilled labour). Agricultural GDP decreases by 1.10% compared to the baseline conditions. On the other hand, in the case of AA, the impact on agricultural GDP is higher (−1.97%). In this case study region, only 4.1% of Pillar 1 payments are coupled to production; therefore, the overall impact on domestic primary production is lower (0.1%). There is a decrease in the domestic production of cereals and livestock (−2.53% and −2.25% respectively) and an increase in the other use of land that becomes more profitable (forestry increases by 0.95%). There is an increase in agricultural prices of 0.34% and a decrease in both skilled and unskilled rural labour in primary sectors (−2.52%).

The most important decrease in domestic production (−2.47%) and agricultural GDP (−2.48%) is observed in JIH. This is mainly due to two reasons: first Pillar 1 payments in this region are 100% coupled to production and secondly 25.9% of the agricultural output depend on Pillar 1 subsidies. On the other hand, the effect on agricultural income is negligible (0.02%) as, in this case study, the decrease in domestic production produces an increase in primary prices of 0.73%. However, this region has the highest "spillover" effect to urban sectors in this scenario reflected in an increase in urban secondary (0.37%) and urban tertiary (0.22%) GDP. This is consistent with the reduction of funds to agriculture increasing the allocative efficiency of factors to other sectors (secondary and tertiary) in the rural and urban parts of the region.

In the urban regions of GUI and RHE, Pillar 1 payments represent only 8.6% and 7.6% of the total agricultural GDP, respectively. Both areas present a similar pattern with a slight reduction of agricultural output value (−0.49% and −0.36%) compared to the intermediate regions of JIH and AA (average of −2.25%), a moderate decrease in the volume of agricultural production (−0.23% and −0.35% for GUI and RHE, respectively) and a significant decrease in rural primary employment, specially for unskilled labour (−5.26% in GUI and −2.68% in RHE). However, the main difference among both regions is related to the characteristics of Pillar 1 subsidies. In GUI, 53.8% of Pillar 1 subsidies are decoupled to production, which is reflected in a decrease of −1.09% in the agricultural income.

In the agriculturally dependent region of ARK, the impacts of the reduction in Pillar 1 payments are not as significant as expected, mainly due to the rather low dependence on Pillar 1 agricultural subsidies on this region (15.4% of the total agricultural GDP). The impact on agricultural GDP is negligible; however, there is a reduction in agricultural income by 1.21%, mainly driven by the fact that that most Pillar 1 payments in this region are decoupled to production (92.9%). There is a slight reduction in agricultural domestic production (−0.41%) and a significant decrease in agricultural prices (−6.8%) leading to a decrease in employment in the primary sector (−2.11% for skilled and −1.45% for unskilled).

In the case of Scenario 2 (Rebalancing), the impact results seem dependent on the case study-specific current levels of Pillar 1 support. Therefore, the variable direction of impacts is not surprising, given the fact that the switch to an EU-wide flat rate Single Payment Scenario would increase Pillar 1 funds in some study areas (POT, AA and GUI) and decrease it in others (ARK. JIH and RHE) as reflected in Table 3.

In general, in regions where overall (Pillars 1 and 2) CAP payments (Table 3) are increased (POT, AA, GUI and RHE), there is an increase in agricultural GDP and/or farm income, while the opposite can be observed for ARK and JIH. The most important changes in terms of increase in agricultural output are observed for AA, GUI and RHE (2.7%, 4.4% and 2.5%, respectively) which correspond to the regions with the higher increase in agricultural production (2.6%, 2.2% and 2.5%, respectively). In these regions, there is as well a positive effect on the agricultural sector derived from the farm diversification and investment driven by the 45% increase in Pillar 2 spending. This effect is particularly important in the case of RHE, where Pillar 2 spending accounts for 30.6% of the total agricultural GDP. Therefore, the increase of 43% in total Pillar 2 spending offsets the decrease of 15% in Pillar 1 payments in this area. On the other hand, in AA and GUI, there is simultaneously an increase in Pillar 1 and Pillar 2 payments. In addition, in these two regions, there is an increase in agricultural income (4.7% and 2.7% for AA and GUI, respectively), driven from the factors previously mentioned and by an increase in employment in the primary sector (3.8% and 1.0% for AA and GUI, respectively).

In POT, agriculture receives less coupled support but more decoupled support compared to the baseline, and overall Pillar 1 spending increases by 2%. As a result, there is a decline in the output of heavily subsidized farm sub-sectors (cereals) and agricultural GDP (−1.02%), but overall farm output increases (0.22%). However, the most important effect is observed in the increase in farm household income (2.52%) due to an increase in primary prices (0.17%) and an increase in agricultural productive capital stock due to from increased Pillar 2 spending. POT is the region experiencing a highest spillover effect to urban sectors. The results are driven from the increase in urban agriculture (increase by 13.4%), even if the contribution of the agricultural sector to urban GDP is only 1.5%.

ARK is the only region experiencing a considerable decline in agricultural income (−2.37%) due to the significant decrease in decoupled payments compared to the baseline. However, the impacts on agricultural GDP are minor as only 7% of the subsidies in this region are coupled to production and therefore there is only a slight decrease in domestic primary production (−0.21%).

In the case of JIH, the Rebalancing scenario effects are almost negligible, as the significant decrease in Pillar 1 payments is compensated by the very significant increase in Pillar 2 spending. Therefore, the overall changes in this region on domestic primary production and prices are the lowest ones among the six case study regions.

6. Conclusions

In this paper, a recursive dynamic CGE model has been used to assess the impacts of two scenarios dealing with a change in the amount and distribution of the CAP payments in six selected EU NUTS-3 regions. The models are based on case-specific Social Accounting Matrices especially constructed for the present analysis. In order to evaluate the leakages of rural policy benefits to urban areas, activities, households and factors of production are distinguished as located either in the urban or rural part of the region. Alternative scenarios are compared on the time period 2006–2020 with a baseline scenario that it is consistent with the outcomes of the 2008 CAP Health Check.

The six NUTS-3 case studies selected are heterogeneous in terms of population, income *per capita*, importance of agriculture and degree of diversification, as well as in the nature and importance of CAP expenditure. Due to the relatively low importance of the agricultural sector, scenario-specific estimated effects on total regional GDP are very small. However, when focusing the analysis on the agricultural sector, the effects on agricultural GDP are significant. The "Reduction in Pillar 1 payments" scenario results in a decline in Agricultural GDP in all case studies with a range from -0.06% in ARK to -2.48% in JIH. In the "Rebalancing scenario", the effects on agricultural output are also significantly stronger than for the total economy; however, the change is positive or negative depending on whether the switch to an EU-wide flat rate decreases or increases total CAP and/or Pillar 1 expenditure in each study area. These results suggest that for the scenarios specified in the article, a partial sectoral equilibrium model would have produced similar results.[8]

Another important indicator to consider is the change in farm household income. Farm incomes typically originate from two main sources: the production of agricultural commodities (therefore, dependent on the agricultural production volumes, prices and the coupled support payments) and from decoupled payments (detached from the level of agricultural production). As these two sources interact and the share of coupled/decoupled payments is region-specific, the overall impacts are region-dependent. Therefore, the overall effect of a change in CAP support seems to considerably depend on the share of decoupled payments compared to total Pillar 1 payments and on the dependence of agricultural GDP on subsidies in each region. As an example, the total effect of Scenario 1 on farm household income is most important in the rural region of Potenza and in the intermediate region of Aberdeen City and Aberdeenshire. This is because in both these regions, agricultural activity is more strongly supported by Pillar 1 subsidies than in others. However, while in Potenza the decrease is mainly driven by the decrease in agricultural production as there is a balance between coupled and decoupled support (44% of Pillar 1 payments are decoupled), in the case of Aberdeen and Aberdeenshire, the decrease is mainly driven by the fall in decoupled payments (96% of payments are decoupled from production).

The spillover effect of CAP changes to urban sub-regions in the six areas seems to be influenced by the regional economic structures. Indicatively, in the case of Potenza, urban effects of the "Rebalancing" scenario are quite significant mainly because of the high increase in the urban primary sector. The same effects are observed in Jihomoravsky; however, in this case, the leakage is derived from the increase in the urban secondary and urban tertiary economic activities.

From the description of the characteristics of the six case studies and the impact analysis results, it can be derived that the importance of CAP support (and the distribution between coupled and decoupled Pillar 1 and Pillar 2 subsidies) to rural areas varies widely across the EU in ways that are not reflected by the economic importance of agriculture. In this context, findings of this study confirm that even if the economy-wide overall effects of the scenarios are small, the effects on the agricultural sector are quite "discernible". Especially in the scenario involving a 30% reduction in Pillar 1 support, results show that a decrease in Pillar 1 subsidies would have important negative impacts on both farm household income and agricultural GDP.

Finally, as in the case of every modelling approach, the CGE method applied here suffers from a number of constraints. In a more general context, these include the judgemental nature of model parametrization (especially applicable in the small area case studies) and the black-box criticism of CGE models. In a more case-specific manner, in the six regional models specified here, the external account captures the region's economic relationships with an "aggregate" rest of the world (rest of the national economy and the third countries) therefore ignoring inter-regional relations, balances and the associated effects on the labour market between the region and other parts of the country. In order to overcome this constraint, a multiregional model would be required, but this was beyond available resources. The second limitation is related to the definition of urban/rural sub-regions which are dependent on different indicators in each case study (population densities, institutional boundaries, etc.). Future research might attempt harmonization of the definition of rural and urban space. Indicatively, the European Commission has classified Local Administrative Units-2 as urban, rural or intermediate based on the criterion of geographical contiguity in combination with a minimum population threshold. The third limitation is derived from the small coverage of the EU in the present modelling approach. Even, if the selection of case studies followed a specific methodology in order to have a heterogeneous sample of EU NUTS-3 regional economies, the six case studies only represent 0.5% of the total 1303 NUTS-3 EU regions. Therefore, the extension of the modelling approach to more case studies would enhance the significance of findings in an EU context.

Notes

1. TERA-SIAP typology classifies regions according to the actual and the potential diversification.
2. The OECD typology classifies regions according to the degree of *rurality* and *peripherality*.
3. Full details of the selection procedure are available in chapter 2 (Psaltopoulos *et al*., 2012).
4. The acronyms of the case study regions presented in Table 1 will be used along the text.
5. Full details of the six SAMs and choice of trends values are available from the authors on request or can be consulted in Psaltopoulos *et al.* (2012).
6. The CAP budget commitment for 2014 and 2020 respectively is 55.9 and for 50.2 (in billion euros in constant prices). The Commission proposal specifies the amounts of 281.8€ bn (compared to 301.1€ bn for 2007–2013) and of 89.9€ bn (compared to 96.2€ bn for the period 2007–2013) for Pillars 1 and 2, respectively.
7. In the Czech case study, direct payments (including national top-ups) are gradually increased and reach their 100% level in 2013.
8. This research is embedded in the project "RURAL EC-MOD" where other scenarios (more devoted to the assessment of Pillar 2 measures) were specified and therefore a partial equilibrium model was not suitable.

References

Bacharach, M. (1970) *Biproportional Matrices and Input–Output Change* (Cambridge: Cambridge University Press).

Baldock, D., Dwyer, J., Lowe, P., Petersen, J. E. & Ward, N. (2001) *The Nature of Rural Development: Towards a Sustainable Integrated Rural Policy in Europe* (London: Institute for European Environmental Policy).

Bascou, P., Londero, P. & Munch, W. (2006) Policy reform and adjustment in the European Union: Changes in the CAP and enlargement, in: D. Blandford & B. Hill (Eds) *Policy Reform and Adjustment in the Agricultural Sectors of Developed Countries*, pp. 55–68 (Wallingford: CABI).

European Commission (2008) *Commission Regulation (EC) No 868/2008* (Brussels: Official Journal of the European Union L 237/18).

European Commission (2009) *Definition of Rural Areas—OECD Methodology*. DG AGRI L2. RD Network TWG1 Expert Preparatory Meeting, Brussels.

European Commission (2010a) *Europe 2020. A European Strategy for Smart. Sustainable and Inclusive Growth* (Brussels: European Commission).

European Commission (2010b) *Communication from the Commission to the European Parliament. The Council. The European Economic and Social Committee and the Committee of the Regions. The CAP towards 2020: Meeting the Food. Natural Resources and Territorial Challenges of the Future*, COM (2010) 672 Final, Brussels.

European Commission (2011) *Communication from the Commission to the European Parliament. The Council. The European Economic and Social Committee and the Committee of the Regions. A Budget for Europe 2020*, COM (2011) 500 Final, Brussels.

European Council (2009a) *Council Regulation (EC) No 72/2009* (Brussels: Official Journal of the European Union L 30).

European Council (2009b) *Council Regulation (EC) No 73/2009* (Brussels: Official Journal of the European Union L 30).

European Council (2009c) *Council Regulation (EC) No 74/2009* (Brussels: Official Journal of the European Union L 30).

Gohin, A. & Latruffe, L. (2006) The Luxembourg Common Agricultural Policy reform and the European food industries: What's at stake? *Canadian Journal of Agricultural Economics*, 54(1), pp. 175–94.

Keyzer, M. A., Merbis, M. D. & Van Riet, M. (2002) *The CAP Reform Proposal of the Mid-Term Review: Decoupling with Strings Attached* (Amsterdam: Centre for Word Food Studies).

Lofgren, H. Harris, R. L. & Robinson, S. (2002) *A Standard Computable General Equilibrium Model (CGE) in GAMS*, Microcomputers in Policy Research 5 (Washington: IFPRI).

Midmore, P. (1993) Input–output forecasting of regional agricultural policy impacts, *Journal of Agricultural Economics*, 44(2), pp. 284–300.

Nowicki, P., Goba, V., Knierim, A., Meijl, H. V., Banse, M., Delbaere, B., Helming, J., Hunke, P., Jansson, K., Jansson, T., Jones-Walters, L., Mikos, V., Sattler, C., Schlaefke, N., Terluin, I. & Verhoog, D. (2009) *Scenar 2020-II—Update of Analysis of Prospects in the Scenar 2020*, Directorate General of Agriculture and Rural Development, European Commission, Brussels.

Psaltopoulos, D., Balamou, E. & Thomson, K. J. (2006) Rural–urban impacts of CAP measures in Greece: An inter-regional SAM approach, *Journal of Agricultural Economics*, 57(3), pp. 441–458.

Psaltopoulos, D., Phimister, E., Ratinger, T., Roberts, D., Skuras, D., Balamou, E., Bednarikova, Z., Espinosa, M., Gomez y Paloma, S., Mary, S., Nohel, F. & Santini, F. (2012) *Ex-Ante Spatial Policy Impact Analysis of the Rural Development Policy in European Rural Areas (RURAL ECMOD)*, JRC Technical report EUR 25238 EN. Available at http://ftp.jrc.es/EURdoc/JRC68412.pdf (accessed 15 July 2012).

Roberts, D. (1995) UK agriculture in the wider economy: The importance of Net SAM linkage effects, *European Review of Agricultural Economics*, 22(4), pp. 495–511.

Roberts, D., Pouliakas, K., Psaltopoulos, D. & Balamou, E. (2009) The rural–urban effects of a reduction in farm support: A bi-regional CGE analysis. Paper Presented at the 83rd Annual Conference of the Agricultural Economics Society, 30 March–1 April, Dublin.

Robinson, S., Cattaneo, A. & El-Said, M. (2001) Updating and estimating a social accounting matrix using cross entropy methods, *Economic Systems Research*, 13(1), pp. 47–64.

Shucksmith, M., Thomson, K. J. & Roberts, D. (2005) *CAP and the Regions: Territorial Impact of Common Agricultural Policy* (Wallingford: CAB International).

Thurlow, J. (2008) *A Recursive Dynamic CGE Model and Microsimulation Poverty Module for South Africa* (Washington: IFPRI). Available at http://www.tips.org.za/files/2008/Thurlow_J_SA_CGE_and_microsimulation_model_Jan08.pdf (accessed 3 July 2012).

Thurston, J. (2008) *Moving Towards a Flat Rate Farm Payment?* Available at http://capreform.eu/moving-towards-a-flat-rate-farm-payment/ (accessed 5 July 2012).

Tongeren, V. F., Meijl, V. H. & Surry, Y. (2001) Global models applied to agricultural and trade policies: A review and assessment, *Agricultural Economics*, 26(2), pp. 149–172.

Törmä, H. (2008) Do small town development projects matter, and can CGE help? *Spatial Economic Analysis*, 3(2), pp. 247–268.

Velazquez, B. (2008) The Single Payment Scheme in the impact assessment of the CAP health check. Paper presented at the 109th EAAE seminar "The CAP after the Fischler Reform: National Implementations. Impact Assessment and the Agenda for Future Reforms". November 20–21, Viterbo.

Waters, E. C., Weber, B. A. & Holland, D. W. (1999) The role of agriculture in Oregon's economic base: Findings from a Social Accounting Matrix, *Journal of Agricultural and Resource Economics*, 24(1), pp. 266–280.

Weingarten, P., Neumeier, S., Copus, A., Psaltopoulos, D., Skuras, D. & Balamou, E. (2009) *Building a Typology of European Rural Areas for the Spatial Impact Assessment of Policies: Final Report* (Seville: JRS-IPTS).

Appendix 1

Table A1. Model elasticities

	Arkadia	Potenza	Jihomoravsky kraj	Aberdeen & Aberdeenshire	Guipúzcoa	Rhiental-Bodensee-gebiet
Production block						
Top level (substitution between value-added and intermediate inputs)	0.6 for all sectors	0.6 for all sectors	0.7 for all sectors	0.2 for all sectors	0.4 for all sectors	0.7 for all sectors
Bottom level (substitution between factors of production)	Activity-specific (range: 0.3–1.5)	0.8 for all sectors	0.9 for all sectors	Activity-specific (range: 0.1–0.4)	Activity-specific (range: 0.2–0.8)	0.9 for all sectors
Output aggregation (commodity output aggregation)	6	6	1.3 (construction & trade = 0.5)	6	6	1.3
Trade block						
Armington (substitution between imports and domestic output in domestic demand)	Commodity-specific (range: 0.5–2.0)	Commodity-specific (range: 0.5–2.0)	2.0 for all sectors	Commodity-specific (range: 0.5–2.0)	Commodity-specific (range: 0.5–2.0)	Commodity-specific (range: 0.5–2.0)
CET (transformation for domestic marketed output between exports and domestic demand)	Commodity-specific (range: 1.0–4.0)	Commodity-specific (range: 0.5–1.6)	1.6 for all sectors	Commodity-specific (range: 0.5–1.6)	Commodity-specific (range: 0.5–1.6)	Commodity-specific (range: 0.5–1.6)
Household consumption						
Frisch (elasticity of the marginal utility of income)	−1	−1	−1	−1	−1	−1
Market (linear expenditure system elasticities for market demand)	Commodity-specific (range: 0.4–1.3)	Commodity and household type-specific (range: 0.5–1)	1 for all commodities except for transport (0.001)	Commodity-specific (range: 0.33–1.0)	Commodity-specific (range: 0.33–1.0)	Commodity and household type-specific (range: 0.33–1.24)

Appendix 2

Table A2. Average impacts over years 2006–2020 in Scenario 1 (%) in the six case studies

	ARK	POT	JIH	AA	GUI	RHE
GDP						
Total	0.00	−0.00	0.16	−0.01	0.00	0.02
Rural	0.01	−0.03	0.09	−0.09	0.00	−0.01
Urban	0.00	0.09	0.23	0.03	0.00	0.02
Agricultural	−0.06	−1.1	−2.48	−1.97	−0.49	
Forestry		0.16				
Agricultural/forestry						−0.33
Other primary				0.27	0.07	
Rural secondary	0.12	0.75	0.31	−0.05	0.01	0.03
Rural tertiary	−0.07	−0.27	0.16	−0.04	−0.01	0.00
Urban secondary	0.72	0.41	0.37	0.01	0.01	0.03
Urban tertiary	−0.19	−0.19	0.22	0.00	−0.01	0.02
Employment						
Urban skilled						
Primary		9.86		−0.06	0.06	
Secondary	1.04	0.53	0.38	0.01	0.02	0.02
Tertiary	−0.06	−0.11	0.12	−0.02	−0.01	0.00
Rural skilled						
Primary	−2.11	−5.61	−3.61	−2.52	−0.31	−2.68
Secondary	0.44	0.85	0.34	0.30	0.02	0.02
Tertiary	−0.07	−0.26	0.07	−0.07	−0.01	−0.01
Urban unskilled						
Primary		9.58		−0.06	0.07	
Secondary	0.95	0.53	0.40	0.02	0.01	0.02
Tertiary	−0.50	−0.51	0.14	0.00	−0.01	0.00
Rural unskilled						
Primary	−1.45	−5.91	−3.58	−2.52	−0.31	−2.68
Secondary	0.28	0.86	0.36	0.32	0.02	0.02
Tertiary	−0.36	−0.32	0.11	−0.09	−0.01	−0.02
Household income						
Urban	−0.02	−0.05	0.05	−0.01	0.00	0.00
Rural	0.00	−0.06	0.03	−0.01	0.00	0.00
Farm	−1.21	−15.33	0.02	−9.44	−1.09	
Producer prices						
Primary	−6.38	−0.23	0.73	0.02	0.11	0.03
Secondary	−0.04	0.09	−0.02	0.01	0.00	0.00
Tertiary	0.00	−0.04	−0.09	−0.01	0.00	0.00
Domestic production						
Total	0.04	0.03	0.22	0.00	0.00	0.02
Primary	−0.41	−0.63	−2.47	0.10	−0.23	−0.35
Secondary	0.37	0.65	0.35	−0.05	0.01	0.03
Tertiary	−0.16	−0.27	0.21	−0.01	−0.01	0.02
Cereals		−1.53		−2.53	−0.54	
Crops	0.11					
Vegetables and flowers		−1.44				
Grapes		−0.50				

(*Continued*)

Table A2. Continued

	ARK	POT	JIH	AA	GUI	RHE
Fruit	−0.06					
Grapes, fruits and vegetables			−3.01			
Other agricultural products		−0.66	−2.98	−0.48		−0.35
Beef and veal		0.05				
Sheep and goat		−0.11				
Livestock	−0.36			−2.25	−0.29	
Fish				0.01	0.03	
Forestry	−7.14			0.91	0.23	
Fruit processing	−0.25					
Olive oil	0.30	−1.02				
Dairy/milk	−0.11	−0.04				
Wine	0.22	−0.83				
Wine, processed fruits and vegetables			−0.31			
Other food	−0.17	−0.84	−0.30	−0.62		0.02
Tourism	−0.47	−0.71	−0.07	−0.18	−0.01	−0.01
Energy			−0.07			0.00
Civil services			−0.25			−0.01

Blank: Not applicable as the specific case study SAM does not distinguish the account.
Source: authors' calculations.

Table A3. Average impacts over years 2006–2020 in Scenario 2 (%) in the six case studies

	ARK	POT	JIH	AA	GUI	RHE
GDP						
Total	0.00	0.00	0.08	0.01	0.03	−0.03
Rural	0.00	−0.04	0.09	0.16	0.06	0.26
Urban	0.01	0.15	0.07	−0.07	0.02	−0.05
Agricultural	0.03	−1.02	−0.13	2.74	4.39	
Forestry		0.09				
Agricultural/forestry						2.51
Other primary				−0.24	0.10	
Rural secondary	0.11	−0.05	0.14	0.12	−0.01	−0.09
Rural tertiary	−0.10	0.07	0.07	0.10	0.01	0.29
Urban secondary	1.03	−0.08	0.09	−0.01	−0.01	−0.10
Urban tertiary	−0.25	−0.01	0.06	−0.05	0.00	−0.05
Employment						
Urban skilled						
Primary		10.25		0.13	0.04	
Secondary	1.48	−0.06	0.13	0.04	−0.02	−0.11
Tertiary	−0.08	0.00	0.07	−0.04	0.00	−0.02
Rural skilled						
Primary	−0.82	−5.07	−1.70	3.84	1.01	15.98
Secondary	0.51	−0.06	0.13	−0.25	−0.02	−0.10
Tertiary	−0.08	0.06	0.07	0.17	0.01	0.17

(*Continued*)

Table A3. Continued

	ARK	POT	JIH	AA	GUI	RHE
Urban unskilled						
Primary		10.17		0.16	0.07	
Secondary	1.38	−0.14	0.14	0.02	−0.01	−0.09
Tertiary	−0.72	−0.07	0.09	−0.08	−0.01	0.00
Rural unskilled						
Primary	−0.26	−5.11	−1.68	3.83	1.01	15.99
Secondary	0.37	0.13	0.14	−0.27	−0.02	−0.08
Tertiary	−0.53	0.25	0.11	0.18	0.00	0.19
Household income						
Urban	−0.01	−0.08	0.02	0.00	−0.01	0.09
Rural	0.00	−0.11	0.01	0.00	0.00	0.12
Farm	−2.37	2.52	0.00	4.65	2.73	
Producer prices						
Primary	−6.03	0.17	0.09	−0.02	−1.05	−0.17
Secondary	−0.02	0.10	0.00	0.01	0.01	−0.01
Tertiary	−0.06	−0.01	0.00	0.02	0.02	−0.02
Domestic production						
Total	0.04	0.00	0.09	0.02	0.02	−0.05
Primary	−0.21	0.22	−0.11	0.00	2.24	2.48
Secondary	0.52	−0.07	0.11	0.10	−0.01	−0.10
Tertiary	−0.29	0.04	0.07	−0.01	0.00	−0.03
Cereals		−0.98		3.66	5.25	
Crops	0.35					
Vegetables and flowers		−0.86				
Grapes		−0.11				
Fruit	0.11					
Grapes, fruits and vegetables			−0.02			
Other agricultural products		−0.37	−0.19	0.68		2.48
Beef and veal		0.41				
Sheep and goat		0.31				
Livestock	−0.02			3.18	1.75	
Fish				−0.06	−0.09	
Forestry	−6.86			−0.86	0.78	
Fruit processing	−0.59		−0.01	0.83		
Olive oil	0.43	−0.11				
Dairy/milk	−0.21	0.31				
Wine	0.24	0.10				
Wine, processed fruits and vegetables						
Other food	−0.34	0.19	−0.02			−0.06
Tourism	−0.87	0.05	0.82	0.30	0.02	0.47
Energy			0.57			0.06
Civil services			−0.23			0.52

Blank: Not applicable as the case study SAM does not differentiate the specific account.
Source: authors' calculations

Appendix 3

Table A4. Abridged mathematical version of the CGE model

Within-period CGE model (Lofgren *et al.*, 2002)		
Prices		
Absorption	$PQ_c(1 - tq_c)QQ_c = PDD_cQD_c + PM_cQM_c$	(A1)
Marketed output value	$PX_cQX_c = PDS_cQD_c + PE_cQE_c$	(A2)
Import price	$PM_C = pwm_c(1 + tm_c)EXR$	(A3)
Export price	$PE_c = pwe_c(1 - te_c)EXR$	(A4)
Activity revenue/costs	$PA_a(1 - ta_a)QA_a = PVA_aQVA_a + PINTA_aQINTA_a$	(A5)
Production and trade		
CES technology: activity production function	$QA_a = \alpha_a^a(\delta_a^aQVA_a^{-\rho_a^a} + (1 - \delta_a^a)QINTA_a^{-\rho_a^a})^{-1/\rho_a^a}$	(A6)
Leontief technology: demand for aggregate value-added	$QV_a = iva_aQA_a$	(A7)
Leontief technology: demand for aggregate intermediate input	$QINTA_a = \mathrm{int}a_aQA_a$	(A8)
Value–added and factor demands	$QVA_a = a_a^{va}(\sum_{f\in F}\delta_{fa}^{va}QF_{fa}^{-\rho_a^{va}})^{-1/\rho_a^{va}}$	(A9)
Output transformation (CET function)	$QX_c = \alpha_c^t(\delta_c^tQE_c^{\rho_c^t} + (1 - \delta_c^t)QD_c^{\rho_c^t})^{1/\rho_c^t}$	(A10)
Composite supply (Armington function)	$QQ_c = \alpha_c^q(\delta_c^qQM_c^{-\rho_c^q} + (1 - \delta_c^q)QD_c^{-\rho_c^q})^{-1/\rho_c^q}$	(A11)
Output aggregation function	$QX_c = \alpha_c^{ac}(\sum_{\alpha\in A}\delta_{ac}^{ac}QXAC_{ac}^{-\rho_c^{ac}})1/\rho_c^{ac} - 1$	(A12)
Institution block		
Factor income	$YF_f = \sum_{a\in A} WF_{\mathrm{f}}\overline{\mathrm{WFDIST}}_{fa}QF_{fa}$	(A13)
Institutional factor incomes	$YIF_{if} = shif_{if}[(1 - tf_f)YF_f - trnsfr_{ROWf}EXR]$	(A14)
Income of domestic non-government institutions	$YI_i = \sum_{f\in F} YIF_f + \sum_{i\in INSDNG} TRII_{ii'} + trnsf_{igov} + trnsfi_{ROW}EXR$	(A15)
Household consumption expenditure	$EH_h = (1 - \sum_{i\in INSDNG} shii_{ih})(1 - MPS_h)(1 - TINS_h)YI_h$	(A16)
Household consumption demand for marketed commodities (similar for home commodities)	$PQ_cQH_{ch} = PQ_c\gamma_{ch}^m + \beta_{ch}^m(EH_h - \sum_{c\in C} PQ_c\gamma_{ch}^m - \sum_{a\in A}\sum_{c\in C} PXAC_{ac}\gamma_{ach}^h)$	(A17)

Government revenue	$YG = \sum_{i\in INSDNG} TINS_i YI_i + \sum_{f\in F} tf_f YF_f + \sum_{a\in A} tva_a PVA_a QVA_a + \sum_{a\in A} ta_a PA_a QA_a +$ $+ \sum_{c\in CM} tm_c pwm_c QM_c EXR + \sum_{c\in CE} te_c pwe_c QE_c EXR +$ $+ \sum_{c\in C} tq_c PQ_c QQ_c + \sum_{f\in F} YIF_{govf} + trnsf_{govROW} EXR$	(A18)
Government expenditure	$EG = \sum_{c\in C} PQ_c QG_c + \sum_{i\in INSDNG} transf_{igov}$	(A19)
System constraint block		
Factor Market:	$\sum_{a\in A} QF_{fa} = \overline{QFS} f$	(A20)
*Upward Sloping Labour Supply (*Thurlow, 2008*)*	$\frac{QFS_f}{QFS_f^0} = \left(\frac{RWF_f}{RWF_f^0}\right)^{etas_f}$	(A21)
Average real wage	$RWF_f = \left(\frac{YF_f}{QFS_f}\right) \Big/ \left(\frac{CPI_f}{CPI_f^0}\right)$	(A22)
Composite commodity markets	$QQ_c = \sum_{a\in A} QINT_{ca} + \sum_{h\in H} QH_{ch} + QG_c + QINV_c + qdst_c$	(A23)
Current account balance	$\sum_{c\in CM} pwm_c QM_c + \sum_{f\in F} trnsfr_{ROWf} = \sum_{c\in CE} pwe_c QE_c + \sum_{i\in INSD} trnsfr_{iROW} + \overline{FSAV}$	(A24)
Government balance	$YG = EG + GSAV$	(A25)
Saving–investment balance	$\sum_{i\in INSDNG} MPS_i (1 - TINS_i) YI_i + GSAV + EXR\overline{FSAV} = \sum_{c\in C} PQ_c QINV_c + \sum_{c\in C} PQ_c qdst_c$	(A26)
Total absorption	$TABS = \sum_{h\in H} \sum_{c\in C} PQ_c QH_{ch} + \sum_{a\in A} \sum_{c\in C} \sum_{h\in H} PXAC_{ac} QHA_{ach} +$ $+ \sum_{c\in C} PQ_c QG_c + \sum_{c\in C} PQ_c QINV_c + \sum_{c\in C} PQ_c qdst_c$	(A27)
Between-period capital updating (Thurlow, 2008)		
Average capital rental rate	$AWF_{ft}^a = \sum_{a\in A} \left[\left(\frac{QF_{fat}}{\sum\limits_{a\in A} QF_{fat}} \right) WF_{ft}.WDIST_{fat} \right]$	(A28)
Share of new capital	$\eta_{ft}^a = \left(\frac{QF_{fat}}{\sum_{a\in A} QF_{fat}}\right)\left(\beta^a \left[\frac{WF_{ft}.WDIST_{fat}}{AWF_{ft}^a} - 1\right] + 1\right)$	(A29)
New investment	$\Delta K_{fat}^a = \eta_{ft}^a \left[\frac{\sum PQ_{ct}.QINV_{ct}}{PK_{ft}}\right]$	(A30)
New capital by sector	$QF_{fat+1} = QF_{fat}\,[1 + \Delta K_{fat}^a / QF_{fat} - \nu_f]$	(A31)

Definitions of model parameters/variables

Sets

$a \in A$	activities (disaggregated according to rural–urban status)
$c \in C$	commodities
$c \in CM$	imported commodities
$c \in CE$	exported commodities
$f \in F$	factors (disaggregated according to rural–urban status)
$i \in$ ISNDNG	domestic non-government institutions
$h \in H$	households (disaggregated according to rural–urban status)

Parameters

α_a^a	efficiency parameter in the CES activity function
α_a^{va}	efficiency parameter in the CES value added function
α_c^t	CET function shift parameter
α_c^q	Armington function shift parameter
α_c^{ac}	shift parameter for domestic commodity aggregation function
β_{ch}^m	marginal share of consumption spending on marketed commodity *c* for household *h*
δ_a^a	CES activity function share parameter
δ_{fa}^{va}	CES value-added share parameter for factor *f* in activity *a*
δ_c^t	CET function share parameter
δ_c^q	Armington function share parameter
δ_c^{ac}	share parameter for domestic commodity aggregation function
γ_{ch}^m	subsistence consumption of marketed commodity *c* for household *h*
γ_{ach}^h	subsistence consumption of home commodity *c* from activity a for household *h*
ρ_a^a	CES production function exponent
ρ_a^{va}	CES value-added function exponent
ρ_c^t	CET function exponent
ρ_c^{ac}	domestic commodity aggregation function exponent
iva_a	quantity of value-added per activity unit
$\text{int}\, a_a$	quantity of aggregate intermediate input per activity unit
tq_c	rate of sales tax
tf_f	direct tax rate for factor *f*
tva_a	rate of value-added tax for activity *a*
tm_c	import tariff rate
te_c	export tax rate
$shif_{if}$	share for domestic institution *i* in income of factor *f*
$trnsfr_{if}$	transfer from factor *f* to institution *i*
pwm_c	import price (foreign currency)

pwe_c	export price (foreign currency)
$qdst_c$	quantity of stock change
etasf	labour supply elasticity factor *f*
ν_f	capital stock depreciation rate
β^a	capital sector mobility factor

Exogenous variables

$\overline{\mathrm{QFS}}_f$	quantity of factor supplied
$\overline{\mathrm{WFDIST}}_{fa}$	wage distortion factor for factor *f* in activity *a*
$\overline{\mathrm{FSAV}}$	foreign saving (foreign currency unit)
MPS_i	marginal propensity to save for domestic non-government institution
$\overline{\mathrm{CPI}}$	consumer price index (normalized)

Endogenous variables

PQ_c	composite commodity price
PDD_c	*demand price for commodity produced and sold* domestically
PE_c	export price (domestic currency)
PM_c	import price (domestic currency)
PX_c	aggregate producer price for commodity
$PXAC_{ac}$	producer price of commodity *c* for activity *a*
PDS_c	supply price for commodity produced and sold domestically
PVA_a	value-added price (factor income per unit of activity)
QA_a	quantity (level) of activity
QQ_c	quantity of goods supplied to domestic market (composite supply)
QD_c	quantity sold domestically of domestic output
QE_c	quantity of exports of commodity
QM_c	quantity of imports of commodity
$QXAC_{ac}$	quantity of marketed output of commodity *c* from activity *a*
QX_c	aggregate marketed quantity of domestic output of commodity
QVA_a	quantity of (aggregate) value-added
$QINTA_a$	quantity of aggregate intermediate input
$QINT_{ca}$	quantity of commodity *c* as intermediate input to activity *a*
QF_{fa}	quantity demanded of factor *f* from activity *a*
QH_{ch}	quantity consumed of commodity *c* by household *h*
QHA_{ach}	quantity of household home consumption of commodity *c* from activity *a* for household *h*
$QINV_c$	quantity of investment demand for commodity
QG_c	government consumption demand for commodity
YF_f	income of factor *f*
WF_f	average price of factor *f*

YIF_{if}	income to domestic institution i from factor f
YI_i	income of domestic nongovernment institution
EH_h	consumption spending for household
EXR	exchange rate (local currency unit per foreign currency unit)
$TINS_i$	direct tax rate for institution i
YG	government revenue
EG	government expenditures
$GSAV$	government savings
$TABS$	total nominal absorption
RWF_f	average real wage by factor
η^a_{ft}	share of new capital time t factor f
ΔK^a_{fat}	new investment by factor, activity and period
AWF^a_{ft}	average capital rental rate by factor and period