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Assessing potential coupling factors of European decoupled payments with the Modular Agricultural GeNeral Equilibrium Tool (MAGNET)

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Scientific literature reveals different coupling channels such as capitalisation in land value, farmers' risk behaviour, credit accessibility, uncertainty about future policies and labour allocation through which European decoupled payments influence farm choices and thus output. For each of these channels the relevant literature introducing theoretical and empirical assessments is evaluated with the aim of deriving plausible behavioural parameters that improve the representation of decoupled payments in economic simulation models.

To capture completely decoupled production behaviour, many CGE models typically represent decoupled payments as a uniform subsidy rate to the land using (agricultural) sectors. Nevertheless based on a thorough review of the literature, it appears that a more suitable modelling approach which caters for heterogeneous member state land markets, may be to split the allocation of decoupled payments. On the one hand, a proportion is committed to land as a function of the capitalisation rate into the rental value, whilst a second tranche is distributed uniformly across all factors, reflecting a balance of different coupling channels. A sensitivity analysis concludes that if one assumes differing degrees of coupling, it does have some implication for output and price results when conducting policy analysis.

Table of contents

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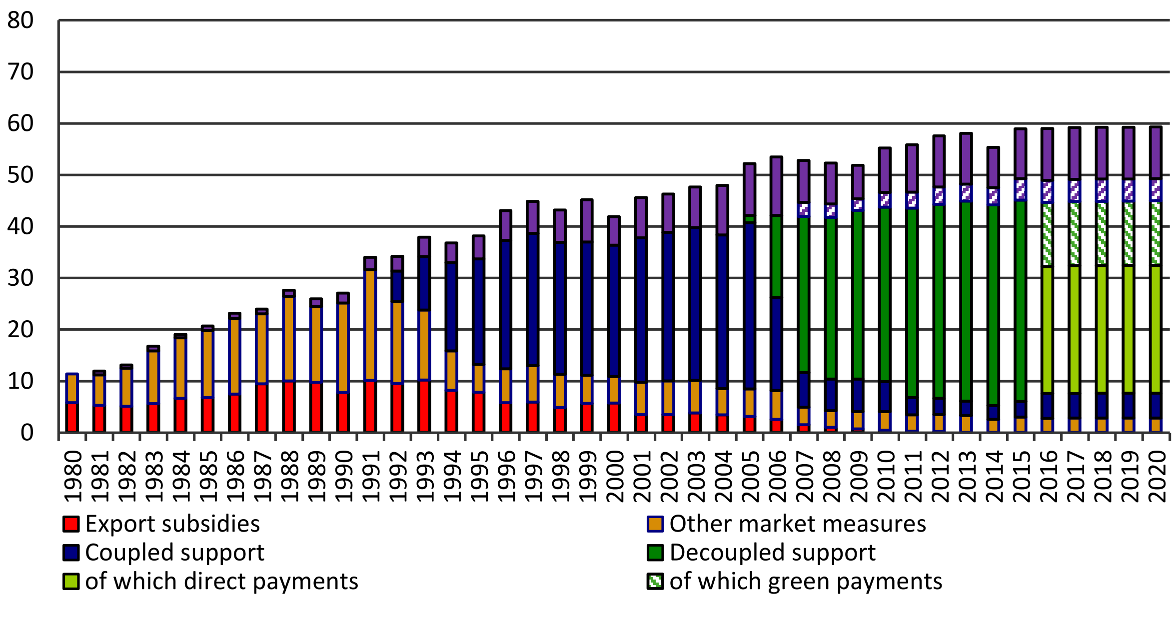
1. Introduction

Decoupled payments are the prevalent instrument of the Common Agricultural Policy (CAP), both in terms of the number of recipients and its share of CAP expenditure. Initiated within the 2003 CAP reform, in 2015 decoupled payments accounted for two-thirds of CAP budget outlay and will represent approximately 63% of the CAP budget by 2020 or 42% if one excludes green payments (Figure 1). Decoupled payments are not linked to production and thus should not create incentives to produce. There are two main definitions of decoupled payments. On the one hand, the Uruguay Round Agreement on Agriculture (URAA) defines decoupling in terms of policy design such as the fulfilment of specific criteria in its Annex 2. On the other hand, the Organisation for Economic Co-operation and Development (OECD) defines decoupling in terms of policy effects (Cahill, 1997). Decoupled payments were first introduced in the United States of America (USA) with the 1996 Federal Agricultural Improvement and Reform (FAIR). Without presenting market distorting effects, they are considered as green box support according to the World Trade Organization (WTO) criteria and thus are exempted from any domestic support reduction commitments.

The introduction of decoupled payments in the European Union (EU) with the 2003 Mid-Term Review (MTR) or 2003 CAP reform appeared as a natural evolution of the direct payments launched with the 1992 CAP reform. Decoupled payments gradually substituted an almost exclusive price support system with compensatory coupled subsidies based on income losses induced by price support decreases. Further CAP reforms have gradually decoupled these payments from production and prices, and conditioned to the respect of European and national statutory requirements (cross compliance).

Figure 1. Breakdown of CAP support (billion euros, 1980-2020)



Source: European Commission, DG AGRI.

Following the 2003 CAP reform, the EU started to implement the Single Payment Scheme (SPS) to replace coupled area and output based payments. The EU member states selected between different models to implement the SPS – historical model, regional model, hybrid model. Consequently, the value of each entitlement within a region varied – and still varies – according to the implemented model, with a fixed total amount of support by region. The average hectare farmed in the reference period 2000 to 2002 determined the number of entitlements a farmer obtained, entitlements which could be traded within each member state or specified region. However, farmers needed to activate their entitlements every year with an equal area of farmed land to receive the decoupled payments. Because SPS eligibility was tied upon cross-compliance, there were still a linkage between the SPS and land. Member states that joined the EU in 2004 and 2007 got the possibility to apply a flat-rate decoupled area payment – Single Area Payment Scheme (SAPS) – based on eligible farm land.

The 2013 CAP reform substituted the SPS with the Basic Payment Scheme (BPS) that can be topped up with further direct payments targeting specific type of practices or territories. The BPS is a compulsory scheme, however those member state applying the SAPS have been allowed to continue applying the scheme until 2020. The BPS presents the same fundamental characteristics as SPS, i.e., based on payment entitlements, activated on eligible land and decoupled from production. Importantly the 2013 reform conceptualised the "greening" of the CAP with decoupled payments for agricultural practices beneficial for the climate and the environment. Furthermore it increased the harmonization of the level of decoupled payments across member states and the convergence of the value of payment entitlements within member states.

It remains inconclusive whether European decoupled payments[1] are fully decoupled from production or whether they still create incentives to produce via other coupling channels such as land markets, risk, credit constraints, future expectations and labour markets (Bhaskar and Beghin, 2009) and therefore are somewhat coupled to production. There is an increasing theoretical and empirical literature addressing the effect of decoupled farm support on farmers' risk behaviour (e.g., Goodwin and Mishra, 2006; Goodwin, 2009; Hennessy, 1998; Kallas et al., 2012; Koundouri et al., 2009; Sckokai and Antón, 2005; Sckokai and Moro, 2009, 2006; Serra et al., 2005, 2011, 2006), on the access to credits for credit constrained farmers (e.g., Ciaian and Swinnen, 2009; Latruffe et al., 2010; O'Toole and Hennessy, 2015), on the influence of farmers' off-farm labour decisions (e.g., Dewbre and Mishra, 2007; El-Osta et al., 2008; Hennessy and Rehman, 2008; Key and Roberts, 2009; Nordin, 2014; Petrick and Zier, 2012, 2011; Serra et al., 2005), on the linkage of current decisions to future payments and on the effect on land rental prices (e.g., Ciaian and Kancs, 2012; Ciaian et al., 2014; Guyomard et al., 2004; Latruffe and Le Mouël, 2009; Latruffe et al., 2008; Michalek et al., 2014; Mishra et al., 2008; O'Neill and Hanrahan, 2012; Patton et al., 2008). However, according to Moro and Sckokai (2013) despite many theoretical and empirical analyses of the different coupling channels, there is still research effort needed, particularly for the EU.

CGE and partial equilibrium (PE) models are often used to analyse the possible outcome of reforms of agricultural policies such as the CAP. Recently published articles assessing the impact of CAP reforms from 2003 onwards have dealt with the modelling of European decoupled payments. Employing the MAGNET CGE model, Boulanger and Philippidis (2015a) simulate different scenarios to analyse the effect of CAP budget cuts. They model decoupled payments as homogenous payments to land assuming they are production neutral. This approach was firstly applied by Frandsen et al. (2003) and also in several other studies (Nowicki et al., 2009; Urban et al., 2016, 2014) based on Global Trade Analysis Project (GTAP) model or MAGNET. In the standard GTAP model, the decoupled payments are modelled as partially decoupled payments that are distributed at a homogenous rate according to the factor usage. Using a recursive dynamic regional CGE model, Espinosa et al. (2014) analyse the effect of pillar 1 reductions, the harmonization the decoupled payments and an

[1] In this report, European decoupled payments stands for support under both SPS (now BPS) and SAPS.

increase in pillar 2 support modelling decoupled payments as changes in income of the farm households. Applying a single country CGE model to assess the effects of the SPS on the agricultural sector in Scotland, Gelan and Schwarz (2006) model the SPS as income transfer to households and thus as decoupled from production. Boysen et al. (2015) employ a CGE model designed to analyse the economic effects and household impacts of agricultural policy reforms on the agricultural and food sector in Ireland. Compared to the other studies, they do not rely on ad-hoc assumptions. To overcome this problem, they use available data on agricultural output trends after the implementation of the SPS in Ireland to calibrate the degree of decoupling.

Balkhausen et al. (2008) conduct a literature review to represent the effect of the introduction of the SPS on land allocation and production. They conclude that the most important factor that drives the results is the models' assumption with regard to the degree of decoupling of the SPS. In addition, Gohin (2006) provides an analysis testing the sensitivity of MTR 2003 studies' results due to the assumptions about the degree of decoupling when modelling Agenda 2000 direct payments. The sensitivity analysis reveals that when eligibility criteria and land market imperfections are considered, the effects on production are much larger. Urban et al. (2016, 2014) use the GTAP modelling framework to explore the effects of different degrees of decoupling first on production and welfare in the EU member states and second on international trade pattern. Their analyses reveal substantially different effects due to the underlying assumptions with regard to the degree of decoupling. They state that the degree of decoupled support is a decisive factor in models' results.

Decoupled payments in economic simulation models are currently based on "ad-hoc" assumptions due to lacking theoretical based estimation results covering the effect of the beforehand mentioned coupling channels. Thus, based on the analyses (Balkhausen et al., 2008; Gohin, 2006; Boulanger and Philippidis, 2015a; Urban et al., 2016, 2014) we can conclude that it is important to further investigate the question of how to model decoupled payments in CGE and PE models. This implies a better comprehension of the functioning of capital, land, and labour markets and a reconsideration of parameters such as supply elasticities and the degree of capitalisation in land rent to determine the actual impact of income support.

The objective of this report is to gather a collection of empirical analysis results that help to better understand and quantify the representation of decoupled payments in economic simulation models. First, we conduct an extensive literature review including articles analysing the effect and channels of EU decoupled payments on agricultural production, investment, and land and labour allocation. In a second step, we intend to evaluate the outcome of these empirical assessments and to derive the most reliable degrees of capitalisation in the land rent, and further effects on output and investment. These estimated parameters should contribute in determining a more consistent representation in a CGE model that is tested later on.

The remainder of this study is organised as follows. Section 2 presents the results of the literature review of articles focusing on the effect of decoupled payments in the EU. Section 3 provides a sensitivity analysis of coupling factor, based on the literature review output. Section 4 concludes.

2. Literature review

This section provides a literature overview describing the effects of the five major coupling channels on agricultural output, investment, labour allocation and land prices in the EU.

Table 1 gathers available studies for each of the coupling channels. Coupling channel no. 1 refers to coupling via land markets, no. 2 refers to coupling via risk, no. 3 refers to coupling via imperfect credit markets, no. 4 refers to coupling via future expectations and no. 5 refers to coupling via labour allocation.[2] In addition, Table 1 includes information on country coverage, payment types and based period.

Table 1. Reviewed literature on coupling channel in the EU

Article	Coupling Channel:					Country or region	Payment type	Period/ data
	1	2	3	4	5			
(Patton et al., 2008)	X					Northern Ireland	DP	1994-2002
(Michalek et al., 2014)	X					EU15	SPS	
(Ciaian et al., 2014)	X					EU27	SPS	
(O'Neill and Hanrahan, 2012)	X			X		IE	SPS	2000-2009
(Latruffe et al. 2008)	X					CZ	pre CAP	1995-2001
(Ciaian and Kancs, 2012)	X					New EU12	SAPS	2004-2005
(Kilian and Salhofer, 2008)	X						SPS	
(Kilian et al., 2012)	X					DE, Bavaria	SPS	
(Breustedt and Habermann, 2011)	X					DE, Lower Sax.	AP	1999-2001
(Ciaian and Swinnen, 2006)	X					New EU12	DP/ AP	
(Nilsson and Johansson, 2013)	X					SE	SPS	2007-2008
(Karlsson and Nilsson, 2014)	X					SE	SPS	2007-2008
(Feichtinger and Salhofer, 2015)	X					DE, Bavaria	SPS	2001+2007
(Sckokai and Antón, 2005)		X				FR DE IT ES GB	AP	1990-2002
(Koundouri et al., 2009)		X				FI	SPS	192-2003
(Sckokai and Moro, 2009)		X		X		IT	SPS	1994-2002
(Sckokai and Moro, 2006)		X				IT	SPS	1993-1999
(Kallas et al., 2012)		X				ES	PD	2000-2004
(O'Toole and Hennessy, 2015)		X	X			IE	SPS	2005-2010
(Ciaian and Swinnen, 2009)			X			FR	AP	2003-2004
(Latruffe et al., 2010)			X	X		LT	SAPS	2000-2002
(Lobley and Butler, 2010)				X		GB, South West	SPS	2006
(Lagerkvist, 2005)				X		SE	SPS	2002
(Breen et al., 2005)				X		IE	SPS	2002
(Tranter et al., 2007)				X		DE PT GB	SPS	2001-2002
(Viaggi et al., 2011)				X		FR DE GR HU IT PO ES NL	SPS	2006
(Nordin, 2014)					X	SE	SPS	2001-2009
(Hennessy and Rehman 2008)					X	IE	SPS	2002
(Petrick and Zier, 2012)					X	DE, East	CAP	1994-2006
(Dupraz and Latruffe 2015)					X	FR	CAP	1990-2007
(Petrick and Zier, 2011)					X	DE, East	CAP	1999-2006

Note: DP = direct payments, pre CAP = policy instrumented applied before accessing the EU, AP = area payments, PD = partially decoupled payments.

[2] This literature review includes assessments with regard to EU decoupled payments that follows a similar set-up as Bhaskhar and Beghin (2009). The latter includes mainly articles dealing with decoupled payments in the USA due to the earlier introduction of decoupled support in the USA (1996) compared to the EU (2005). Following a similar set-up enables the comparison of results between the two literature reviews.

Literature analysing the effects of decoupled payments on farm choices through other coupling channels in the EU is relatively scarce. Empirical analyses of the different coupling channels are mostly conducted for specific member states or regions, very seldom for the EU15, the new member states or the EU28 and by far not for all countries are empirical results available. Most of the empirical studies are based on Farm Accountancy Data Network (FADN) data, and most data precede the implementation of the decoupled payments. In addition, empirical analyses are conducted for different "production types" such as arable crops, livestock or grassland.

This implies that outcome of different reviewed studies tends to be region-specific, and should be considered with care. In order to fit with the purpose of this study, the remainder of this section is built upon the three standard factors of production in economic models, i.e., land, capital and labour.

2.1 Land

Decoupled payments are based on entitlements which are activated on eligible land. In order to receive full payments, farmers have to comply with a set of basic rules that influence land management (cross compliance).[3] Ciaian and Swinnen, (2006), Ciaian et al. (2014), Courleux et al. (2008), Kilian and Salhofer (2008), Kilian et al. (2012), and Michalek et al. (2014) develop and apply a conceptual model to illustrate the general impact of the SPS on the land market and identify key drivers of decoupled payment capitalisation in the land value.

It seems that the ratio of the eligible land to the total number of entitlements determines the degree of capitalisation in land rent. There is no capitalisation in the rental price of land if the total of entitlements is lower than the total of eligible land (deficit entitlements). In this case the farmer benefits from the payment under the SPS, but it does not cause an increase in land rent. By contrast, a surplus of entitlements leads to a capitalisation of the support into the land rent. Such a capitalisation increases as the relative scarcity of eligible land to entitlements increases. Additionally, the eligibility of new entrants affects the degree of capitalisation. According to Ciaian and Swinnen (2006) new entrants that are eligible for SPS entitlements increase the benefits landowners obtain from the SPS. Furthermore, the entitlement trading also impacts the capitalisation, i.e., a more constrained entitlement trading regime implies a higher degree of capitalisation.

The degree of capitalisation also depends significantly on the selected implementation model. Theoretical studies have pointed out that the greater the SPS variation between farms, the lower the capitalisation rate (Ciaian et al., 2014). Accordingly, the capitalisation of SPS payment is higher applying the hybrid model than applying the historical model, because the differences in entitlement values is higher when the historical model is chosen. The regional model leads to the highest capitalisation.

Farmers need to comply with basic requirements on environment, public and animal health, as well as, animal welfare (cross compliance) to receive decoupled payments that add supplementary costs to land use. According to Michalek et al. (2014) the additional cost reduces the marginal return from land farming activities, and thus reduces the willingness to pay for land rent. Consequently, the capitalisation rate in the land rent is expected to be higher in the absence of cross compliance. Thus, cross compliance decreases the degree of capitalisation.

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[3] Cross compliance covers two elements, i.e., Statutory Management Requirements (SMRs) and Good agricultural and environmental conditions (GAECs). Note that direct payment "greening" requirements supplement cross-compliance (out of the scope of this this report).

The "greening" of the CAP associated with the 2013 reform links decoupled payments even further to climate and environmental conditions. Requirements supplement cross compliance, and are at least as demanding as SMRs and GAECs. According to Ciaian et al. (2014) green decoupled payments likely decrease land rents because additional requirements increase production costs, reduce the productivity of land due to restrictions with regard to crop choice and the use of land. It results a decline in profits from land use, and leads to a decrease in land demand. However, Ciaian et al. (2014) state that farm heterogeneity with regard to production structure, specialisation, location and technology may lead to significantly diverse effects of the CAP "greening" across member states, regions and farms.

Region-specific factors such as imperfect credit markets and social capital also impact SPS capitalisation in the land value. Furthermore, formal (and informal) land market institutions impact land rents differently across regions. Therefore Michalek at al. (2014) highlight that the adjustment of land rents to the SPS appears more sluggish and that the influence of regional factors on land rents may be higher than the influence of aggregates or external drivers. The regulation of land prices and the termination of rental contracts affect the level of capitalisation. In the short-run, the SPS is not fully capitalised in land rents because of long-term rental contracts, regulated land prices and informal relationships. Credit constraints faced by farmers can be reduced in presence of decoupled payments, resulting in increases in input use, productivity of land, and increases in capitalisation in land rent (Ciaian and Swinnen, 2009). Regulations of land prices lower the capitalisation of the SPS in land rental prices. In addition, the longer the duration of rental contracts, the more gradual is capitalisation in the land value.

Compared to the SPS, no entitlements were required to receive the area payments implemented under the MacSharry and Agenda 2000 reforms. All farmers cultivating eligible land benefited from the subsidy and received the same amount per hectare within a predetermined area. Assuming surplus SPS entitlements, the capitalisation rate of the equivalent payments would have been equal or higher compared to the SPS (Courleux et al., 2008; Kilian et al., 2012; Michalek et al., 2014). Capitalisation increased after 2005. According to Kilian et al. (2012) only the arable crop direct payments were linked to land before the introduction of the SPS while livestock subsidies were provided per animal. With the introduction of decoupling a large share of both payment types were transferred into the SPS.

Beyond the conceptualisation of SPS general impacts introduced in previous paragraphs, studies which empirically analyse the level of capitalisation in land rent are limited. Breustedt and Habermann (2011) and Patton et al. (2008) quantify the effect of the CAP in Lower Saxony in Germany and Northern Ireland, respectively, applying data preceding the implementation of the SPS. Kilian and Salhofer (2012) and O'Neill and Hanrahan (2012) utilize more recent farm data to investigate the effect of the SPS on land rent in Bavaria and Ireland, respectively. The most promising analyses are first Ciaian and Kancs (2012) who investigate the effect of the SAPS on land rental rates in the new EU member states based on farm level data for the period 2004 to 2005, and second Michalek et al. (2014) who estimate the capitalisation of the SPS into land rents utilizing generalized propensity score matching based on farm level panel data for the EU15. Table 2 provides a summary of the most promising results. By contrast, Latruffe et al. (2008) investigate the effect of agricultural support on land prices in the Czech Republic. Nilsson and Johansson (2013) and Karlsson and Nilsson (2014) analyse the extent to which the SPS is capitalised in farm prices, and Feichtinger and Salhofer (2015) estimate the effect of the CAP on land prices in Bavaria. Compared to the other studies concentrating on land rental prices, these analyses focus on the effect of the SPS on farmland sales prices.

Table 2. Capitalisation of decoupled payments into land value (%)

Member state	Transfer from[a]	Average capitalisation into land rent[b]	Effect of 2013 CAP reform[c]
EU15		6-7	
Austria (AT)		8	-, +
Belgium (BE)		5	-, 0
Denmark (DK)		5	--, --
Finland (FI)		9	-, -
France (FR)		8	-, 0
Germany (DE)		5	--, --
Greece (GR)		4	-, -
Ireland (IE)		6	0, 0
Italy (IT)		7	-, 0
Luxembourg (LU)		7	-, 0
Netherlands (NL)		5	-, 0
Portugal (PT)		18	-, ++
Spain (ES)		14	-, +
Sweden (SE)		9	-, -
United Kingdom (UK)		8	-, +
New member states			
CEEC 8		10	
Bulgaria (BG)	CEEC 8, CZ	*10 – 17*	---, ---
Croatia (HR)			
Cyprus (CY)			----, ---
Czech Republic (CZ)		17	---, ---
Estonia (EE)		12	--, --
Hungary (HU)		13	---, ---
Latvia (LV)		8	--, --
Lithuania (LT)		12	--, --
Malta (MT)			-, 0
Poland (PO)		5	---, ---
Romania (RO)	EE, LV, LT, SK	*8 – 18*	--, --
Slovakia (SK)		18	--, --
Slovenia (SI)	CEEC 8, PL, LT, LV	*5 – 12*	-, 0

Note: [a] This column indicates if results from other countries would be transferrable, e.g., for Bulgaria no information is available, but the average capitalisation of 8 Central and East European Countries (CEEC 8) or the Czech Republic can be used as approximation. [b] Figures for the EU15 aggregate and EU15 member states are based on Michalek et al. (2014) and for new member states on Ciaian and Kancs (2012). [c] Based on Ciaian, Kancs and Swinnen (2014), increase (decrease) in the capitalisation rate = "+" ("-"), the higher the expected effect on the capitalisation rate, the larger the number of "+" and "-" respectively. A "0" indicates no effect. The first sign presents the impact with entitlements based on the pre-reform level, and the second sign with entitlements based on land use in the post-reform period.

Figures from Michalek et al. (2014) and Ciaian and Kancs (2012) show that in the EU15 and the new member states, respectively, decoupled payments are partially capitalised into the land value. The marginal capitalisation rate of the EU15 at member state level differs between -43 to 94%, while the average capitalisation rate differs between 3 to 94% and exhibits a negative correlation with the level of support. Compared to the SPS, Breustedt and Habermann (2011) quantify the marginal impact of area payments in Lower Saxony equal to 38 cents for each additional euro of the subsidy. Kilian et al. (2012) state a 28 to 78 cents increase in land rent due to a 1 euro increase in direct payments in Bavaria. In addition, they derive from their results that the degree of capitalisation is higher with decoupled payments than 1992-2004 coupled direct payments. Indeed they identify additional 16 to 20 cents capitalised in the land rental price for contracts signed after 2005. Feichtinger and Salhofer (2015) show that a decrease of coupled payments by 50 euros/ha preceding the implementation of the SPS would lead to a decrease in land sales prices between 227 euros/ha and 445 euros/ha, whereas a 50 euros/ha decrease in the SPS in 2007 would reduce agricultural sales price between 723 euros/ha and 1397 euros/ha in Bavaria.

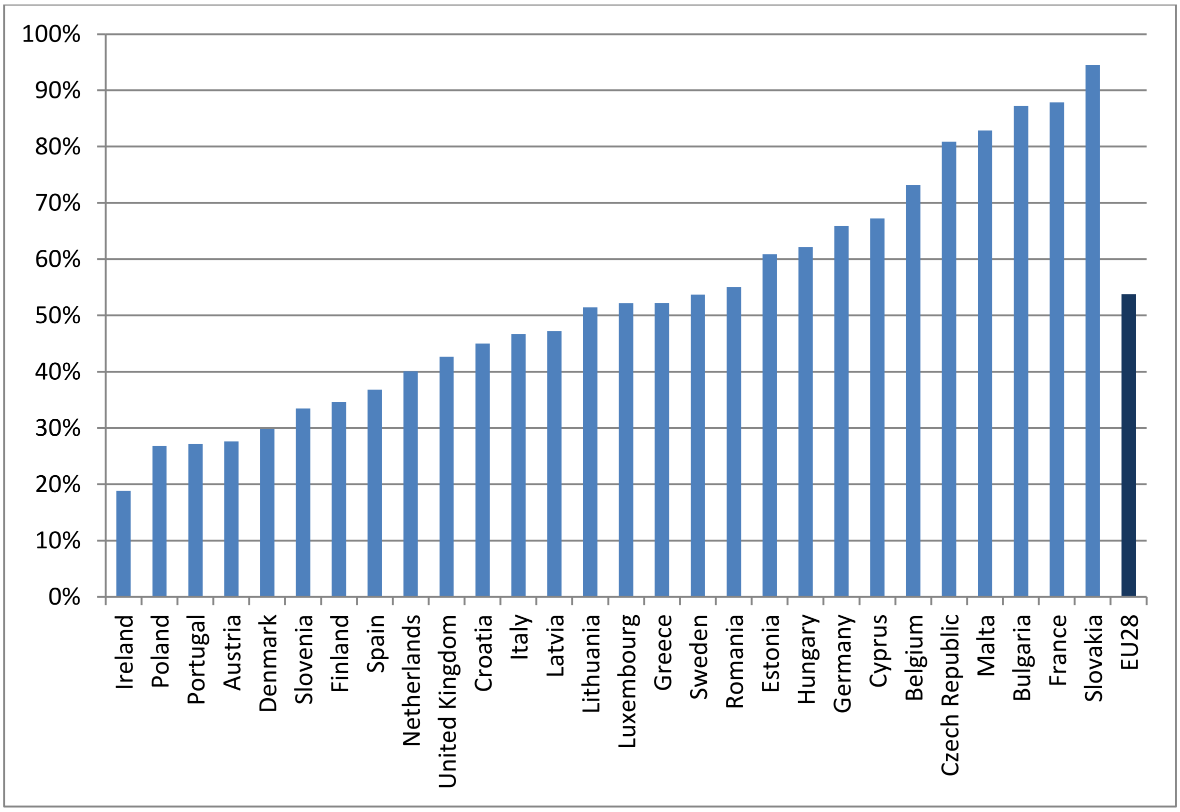
Thus they state an increase of the capitalisation elasticity from 0.07 to 0.09% in 2001 to 0.2 to 0.28% in 2007. According to Nilsson and Johansson (2013) a 1% increase of the SPS would lead to a 54% increase in land sale prices.

According to Michalek et al. (2014) cross compliance reduces EU15 land rental price by 7 to 12%. Up to 50% of area or 86% of the farms exhibit an average capitalisation rate equal or less than 10%. By contrast, the aggregated average capitalisation rate for the EU15 is equal to 6 to 7%. According to Ciaian and Kancs (2012) the average capitalisation rate in the new member states is equal to 10% and the marginal capitalisation rate is equal to 19%. Furthermore, estimation results reveal that non-farming landowners obtain on EU15 average 4% of the SPS, whereas the leakage to landowners differ across member states with the highest shares in Portugal (18%) and Finland (9%) and the lowest shares in Germany, Belgium, Denmark and the Netherlands (5%) and Greece (4%) (Michalek et al., 2014). The range of the leakage in the new member states is comparable to the EU15 member states with the highest shares in the Czech Republic and Slovakia (18%) and the lowest shares in Latvia (8%) and Poland (5%).

For the EU15 average, the capitalisation is higher for large farms, which is confirmed at the member state level for Finland, France, Luxembourg and the United Kingdom. However, this does not hold for all member states. The opposite effect is exhibited in Austria, Greece, Spain and Portugal, whereas the difference is only minor in all other member states. Ciaian and Kancs (2012) show higher effects for corporate farms than for family farms. Ciaian and Swinnen (2006) emphasize that the structural condition of the household and the importance of corporate farms particularly drives the effect on rural households. The capitalisation of subsidies in land rent and thus leakages to landowners is much higher in countries such as Slovakia and the Czech Republic where the agricultural sector is dominated by large scale farms renting most of the cultivated land compared to countries such as Poland, Lithuania, Latvia and Slovenia where farming concentrates on small family farms that own most of their land. Figure 2 classifies EU member states according their share of national rented Utilised Agricultural Area (UAA).

In general, Michalek et al. (2014) conclude that the share of rented land relative to owned land drives the results. All studies mention several limitations especially with regard to rental contracts and covered data period. Several analyses are based to a large extent on rental contracts pre-2005 (Kilian et al., 2012) whereas other are based on a two to four year period, i.e. not fully capturing long-term rent adjustments (Ciaian and Kancs, 2012; Michalek et al., 2014). Most of the analyses are based on data covering the first years after decoupled payments implementation when farmers.

Figure 2. Share of rented UAA by member state (%, 2013)



Source: FADN.

In comparison to all other land market studies, O'Neill and Hanrahan (2012) do not analyse SPS capitalisation into the land value but the effect on farmers' land market decisions in Ireland. They show uneven impacts depending on whether a farmer cultivates crops or produces cattle, sheep or milk. However, in general, decoupling does not significantly influence land market decisions of Irish farmers.

The only study referring to effects of the CAP reform after 2013 is conducted by Ciaian, Kancs and Swinnen (2014). Based on a conceptual model of the land market they analyse the effects of SPS budget changes, harmonization across farms, differentiation of SPS across farms, green payments, and the reference period for entitlements and the eligibility for entitlements. They derive the following theoretical impacts of the reform. The capitalisation rate will be affected by the 2013 reform, with a capitalisation effect that is clearly determined by the initial SPS implementation model and can go in either direction. The reference period of the entitlement allocation is a key determinant. Across EU28 member states, the harmonization and reference period have zero or positive impact on land rent, whereas budget changes, differentiations between farms and the CAP "greening" have zero or negative impact on land rent. Assuming the same entitlement allocation as in the pre-reform period, the overall impact of the CAP reform on land prices is zero or negative, and likely rather limited. Assuming an entitlement allocation according to the post-reform period, the SPS capitalisation will increase in several member states, particularly in those with deficit entitlements in the pre-reform period. The differentiated and offsetting results of reform components make it difficult to straightforwardly determine the net effect (Ciaian and Swinnen, 2006).

2.2 Capital

Agricultural sector's capital endowment can be influenced especially by risk behaviour, imperfect credit markets and farmers' expectations about future payments (Urban et al., 2016). This sub-section focuses on each of these coupling channels.

2.2.1 Risk

Farmers have to cope with considerably fluctuating yields and prices. However conventional approaches analysing the impact of agricultural subsidies on farm's output assume perfect competition, constant returns to scale, certainty and risk neutrality of producers. In such a framework, farmers maximize their profit without considering risks such as price risks and output risks that lead to profit variability. According to Moro and Sckokai (2013) a standard result of such an approach is that subsidies to agricultural producers only affect output if payments are coupled to production decisions. Most of reviewed articles based their analyses on data preceding the 2003 CAP reform. Therefore results have to be evaluated carefully (Table 3).

Linking producer's risk behaviour and decoupled support suffers from scarce researches in the EU. All types of agricultural policy instruments have a supporting and stabilizing effect on income. They potentially affect production choices and benefit risk-averse producers. In this context, Hennessy (1998) identifies three risk-related effects. First, he sheds some light on a wealth effect that corresponds to income-supporting attributes, affecting farmer's total wealth and thus reducing risk aversion. Under the assumption of decreasing absolute risk aversion, decoupled payments would stimulate production and create incentives to produce. Second, he identifies an insurance effect that corresponds to the income-stabilizing attribute, reducing income variability or variability of returns. Income stabilization reduces the degree of risk and thus effects farmers' output decisions. Third, he recognises a coupling effect that corresponds to the explicit linkage of subsidies to production decisions.

With a focus on the MacSharry reform, Sckokai and Anton (2005) estimate the effect of different policy instruments on acreage and yield and the degree of decoupling of the MacSharry area payments in France, Germany, Italy, Spain and the UK. They account for risk-related effects and individual responses to relative prices and area payment. They simulate and compare farmers' response to a 1% increase in intervention prices and equivalent increase in area payment. To obtain the degree of decoupling they divide the payment response by the price response that is equal to zero for a fully decoupled payment. Results confirm that for 12 out of 21 commodity-country pairs the effect on acreage is larger for area payments than for price support, for 11 out 21 commodity-country pairs the impact of area payments in yield is negative and for 12 out of 15 commodity-country pairs[4] the degree of decoupling is smaller than 1, i.e., partially decoupled. The computed degree of decoupling largely differs between commodities and countries (e.g., 0.107 for soft wheat in and 0.987 for barley in the UK). Furthermore the authors note that the three hypotheses together are only confirmed in 6 out of 21 commodity-country pairs. They conclude an estimation of the SPS degree of decoupling is not possible. This would require new econometric estimations that consider the structural impact of the SPS on farmer's behaviour.

[4] Cases with negative ratios are excluded.

Table 3. Effect on output and land in presence of risk (%)

Member state	Effect on total cereal or wheat output in %[a]			Effect on land in %[b]		Degree of decoupling[c]	
	Inter-vention prices	area payment	SPS/SAPS	Intervention prices	area payment	(*) area pay-ment	(**) SPS/ SAPS
EU15							
AT							
BE							
DK							
FI							
FR	0.4	0.83		-0.04	0.13	0.21	
DE	0.19	0.04		0.16	0.00	0.2	
GR							
IE							
IT	C: 2.6 W: 0.02	C: 0.5 W: 0.03	0.07	0.01	0.03	C: 0.17 W: 1.3	0.03
LU							
NL							
PT							
ES	0.07	0.007		0.02	0.01	0.11	
SE							
UK	-0.2	0.21		-0.2	0.08	-1.03	

Note: [a] Response to a 10% increase in intervention prices/ response to an equivalent increase in MacSharry area payments/ response to an equivalent increase in SPS, results for total cereal output in Italy (Sckokai and Moro, 2009), all other results for wheat (Sckokai and Antón, 2005). [b] Response to a 10% increase in intervention prices/ response to an equivalent increase in MacSharry area payments using wheat as example (Sckokai and Antón, 2005). [c] Average production ratio = support equivalent increase in (*) area payments and (**) decoupled payment per cent increase in intervention prices for total cereals in Italy (Sckokai and Moro, 2009) and all others for wheat only (Sckokai and Antón, 2005).

Sckokai and Moro (2006) empirically measure the change in acreage due to the introduction of decoupled payments accounting for the policy impact on expected returns and risk for the Italian arable crop sector. They simulate a 15% reduction of intervention prices and the elimination of cereal area payments. To compensate farmers they introduce a single farm payment based on land allocation in 1999, cereal area payments and oilseed payments levels of the Agenda 2000 reform. Accordingly they provide additional income to each farmer equal to the discounted 2005 to 2015 sum of farmer's SPS to increase the initial wealth. They simulate the combination of Agenda 2000 and 2003 CAP reform under the assumption that the parameters estimated for 1993 to 1999 are valid under the changed policy environment. The reduction of guaranteed prices together with the elimination of cereal area payments decreases average profit, whereas the introduction of decoupled support increases average initial income. Furthermore, decoupled support seems to compensate the increased price and output risks caused by the reduction of intervention prices and thus reduce income variability. The results show that the insurance effect clearly influence the total acreage effect (0.9 to 7.7%) whereas the positive wealth effect is rather small (0.1 to 1.2%).

Sckokai and Moro (2009) apply a dynamic dual model of farm decision making considering farmers' risk attitudes to analyse the effect of the CAP arable crop instruments in Italy on farm investment and output. The application of the estimated model to simulate a 10% increase in cereal intervention prices, an equivalent rise in MacSharry area payments and an equivalent rise in the SPS reveals that the effects are the largest in the first two scenarios. Changes induced by the SPS are the lowest because decoupled payments do not affect price uncertainty. They shed some light on significant effects on farm investment from rise in intervention prices which are mainly caused by reduced price fluctuations. By contrast, both coupled and decoupled direct payments do not affect price uncertainty, thus lead to much smaller effects. However, they assume a 10% increase in intervention prices turns out to be equal to a slightly more than 1% increase in expected prices. With SPS payments, output changes vary between -0.08% for durum wheat and 0.25% for other cereals. Compared to Sckokai and Anton (2005) the computed degrees of decoupling of the MacSharry area payments also largely differ between products, between 0.13 for maize to 0.75 to other cereals. By contrast, the range for the estimated SPS degree of decoupling is much lower, between 0.01 for maize to 0.15 for other cereals. Results depend on the assumption that the estimated parameters using data preceding the SPS introduction are also appropriate under the new policy environment.

Koundouri et al. (2009) apply a model of grain production to determine the impact of agricultural subsidies on farmers' risk behaviour, agricultural production and the allocation of land in Finland. Compared to the other reviewed analyses, they estimate a set of equations including risk preference, production technology and land allocation simultaneously. They do not rely on a-priori assumptions on risk behaviour. However, in this study the focus is on production risk that is identified as the most important risk for cereal crops in Finland. Consequently the authors mention that their results might not be relevant if price risk is included in the analysis. The approach is used to simulate and compare the effect of area payments and SPS. Results confirm that decoupled payments increase wealth. Both area payments and SPS decrease risk aversion that in return changes farmers' optimal input mix toward more hazardous mix and thus lead to a slightly negative effect on aggregated production.[5] Effects of area payments are twice as high as those of the SPS.

Kallas et al. (2012) use a model based on Sckokai and Moro (2009) to assess the impacts of partially decoupled payments[6] on on-farm investment and production choices in the Spanish cereal, oilseeds and protein crops sector. The estimation results reveal that partially decoupled payments affect production decisions mainly through risk and dynamic effects. A rise in partially decoupled payments lowers farmer's risk aversion, increases variable input use and hence increases production in the short-run. Furthermore the land allocation is influenced by additional income. Investment also rises with an increase in partially decoupled payments, which affects production in the long-run. Consequently, results state that the farmer's degree of risk aversion decreases and investment/expansion increases with an increase in wealth.

Estimated parameters for the Italian arable crop sector in Sckokai and Moro (2006) reveal that the price elasticities are similar to those estimated under risk neutrality. Both output supplies and input demands are price inelastic. By contrast, the elasticities considering the CAP payments and the land allocation function show the opposite behaviour under risk neutrality as estimated in Moro and Sckokai (1999), indicating that CAP instruments cannot be regarded as fully decoupled from production decisions. They suggest that the land allocation function indirectly affects production, because there is a positive responsiveness of cereal output supplies to own payment that, however, is always lower than the responsiveness to prices. The land allocation elasticities depicting the acreage responsiveness to own prices are always positive, but

[5] Changing input mix can increase for instance the use of plant protection. Interestingly an increase in pesticide use is stated by Serra et al. (2005) using FADN data for the period 1994 to 1999 for French farms. They applied Lichtenberg-Zilberman damage control technology model to assess the effect of the EU agricultural policy reforms on the use of pesticides.

[6] With the MacSharry reform and later the Agenda 2000 the EU shifted their agricultural support from market price to income support. These direct payments are granted based on animal heads or area together with specific production requirements, so that these payments are no longer linked to prices. They can be regarded as coupled or partially decoupled from production depending on the production requirements that determine the eligibility for these payments.

smaller than supply elasticities. The estimation leads to relatively larger responses of output and land allocation compared to wealth.

Due to time period of selected FADN data (1993-1999) the estimated parameters reflect the specific policy environment of the MacSharry reform. The same applies for other studies, i.e., 1990-2002 period for France, Germany, Italy, Spain and the UK in Sckokai and Anton (2005) or 1994-2002 period for Italy in Sckokai and Moro (2009). Furthermore parameter estimation results in Kallas et al. (2012) are based on Spanish FADN data for the 2000-2004 period and the Finish risk parameters estimated by Koundouri et al. (2009) is done over the 1992-2003 period. In addition, Koundouri et al. (2009) state that the EU accession of Finland affects risk. In the pre-accession period the predicted mean values of risk aversion are positive implying that farmers are risk averse. Interestingly they fall considerably with the accession. In the post-CAP period (1998-2003), results reveal a negative predicted risk aversion that is deepened over time. The authors conclude that the CAP induces substantial rise in farm income that increase the willingness of Finnish farmers to adopt risky strategies.

2.2.3 Imperfect credit markets

Put forward in subsection 2.1, substituting missing finance with decoupled payments might lead to an increase in the degree of capitalisation. The general idea behind this argument is that the SPS improves famers' income, which might increase farmers' saving and consequently investment. This is particularly important for credit constrained farmers, since the additional income improves their credit worthiness and thus their access to credit.

Capital is a factor that determines current farm production, and capital availability determines farmers' investment decisions. Consequently, capital availability affects not only current but also future production. Under the assumption of perfect capital markets, coupled payments clearly affect investment, whereas decoupled payments have no influence. However, capital markets tend to be imperfect, i.e. facing gaps between borrowing and lending rates, binding debt constraints and high bankruptcy risk. Therefore decoupled payments may affect investment decisions (Moro and Sckokai, 2013; Vercammen, 2007).

As noted by Moro and Sckokai (2013) only a few studies have analysed the effects of decoupled payments on access to credits, and three deal with the CAP.

Ciaian and Swinnen (2009) analyse how credit market imperfections affect the reaction of agents to policy changes. They first apply a conceptual framework of the land market with credit constrained farmers. Afterwards they use a model with homogenous farms to simulate the introduction of area payments and perform a sensitivity analysis (e.g., varying the share of rented land). The empirical analysis use FADN data for France over the 2003-2004 period. By contrast, Latruffe et al. (2010) analyse the impact of the SPS on farm expansion strategies in Lithuania specifically addressing financial constrained farmers. They combine the estimation of an investment model based on FADN data over the 2000-2002 period, and a survey about farmers' intention to grow or to invest in land in the next five years considering two options, the pre-accession policy and SPS plus national top-ups. The third study investigates whether the SPS decrease farm investment constraints by altering the risk-profile of farm earning. It is also linked to the coupling channel via risk using FADN data for Ireland over the 2005-2010 period (O'Toole and Hennessy, 2015). The approach is based upon a fundamental Q model of investment that first identifies financial constrained farms, and second introduces some linkage with investment equations at the farm level. To estimate the effect of the SPS on credit constraints the study associate risk protection, measured as the ratio of decoupled SPS to net farm income, with cash flow.

Table 4. Effect on surplus and investment via increased credit accessibility (%)

Member state	Transfer from[a]	Farms surplus change as share of subsidy expenditure[b]	Increase in investment[c]
EU15			
AT			
BE	FR	12-66	
DK			
FI			
FR		12-66	
DE			
GR			
IE	FR	75-141	
IT	FR	75-141	
LU			
NL			
PT			
ES			
SE			
UK			
New member states			
BG	LT		87.9-122.3
HR			
CY			
CZ	FR, LT	12-66	87.9-122.3
EE	LT		87.9-122.3
HU	LT		87.9-122.3
LV	FR, LT	75-141	87.9-122.3
LT			87.9-122.3
MT			
PO	FR, LT	75-141	87.9-122.3
RO	LT	12-66	87.9-122.3
SK	FR, LT		87.9-122.3
SI	LT		87.9-122.3

Note: [a] This column indicates if results from other countries would be transferrable. [b] The actual share depends on e.g., non-land input supply elasticity, land supply elasticity, output demand elasticity (Ciaian and Swinnen, 2009). [c] (Latruffe et al., 2010) analysed two scenarios: (i) intention to grow under pre-accession policy and (ii) intention to grow under SPS including top ups. The increase in investment is the change between both scenarios.

All studies reveal that decoupled support is coupled to production via credit market imperfections so that an increase of the share of SPS relative to farm income decreases credit constraints and increases investment as displayed in Table 4. Ciaian and Swinnen (2009) show that the introduction of area payments leads to an increase in the land rent that can exceed the additional income from the subsidy. The effect on farm profits is negative, because the loss from the increase in land rent offsets the direct gain from the subsidy and the indirect gain from increased productivity. Under the assumption of infinite non-land input supply elasticity, the empirical results for French land supply elasticity and output demand elasticity show that the change in farm household surplus increases as the share of landownership increases. Comparing the effect of subsidies on credit constrained farmers, Latruffe et al. (2010) confirm that farmers are less credit constrained in the pre-accession period when they receive more subsides than the sample average. However, farmers who were credit constrained during the pre-accession period intend to grow much more after the introduction of the SPS. O'Toole and Hennessy (2015) show that as risk-free income increases, credit constraints faced by farmers are reduced. Thus, the SPS has a negative effect on credit constraints which increases with farm size and decreases with age. Furthermore, with regard to the 2013 CAP reform, the harmonization of the SPS entitlement across member states leads to a reduction in investment on cash crop farms in Ireland.

2.2.3 Future expectations

Besides alleviating the accessibility of credits and influencing risk attitudes to change decision and investment behaviour, decoupled payments affect farmers' choices through their expectations about future policies. According to Bhaskar and Beghin (2009), farmers' current production or investment decisions are coupled to expected future payments based on historical behaviour. Currently the CAP budget is decided until 2020. CAP spending post-2020 is uncertain as farmers' decisions based on their expectations about future CAP development.

Most existing studies are based on surveys collecting information on farmers' intention. Results are presented in Table 5. To identify the extent to which the implementation of the SPS influences farmers' decisions, Lobley and Butler (2010) collect information on farmers' strategic plans in the 5 years following the implementation in South West England (2006). The survey reveals that 34% of farmers believe that they are not influenced by the CAP. The reform impacts positively dairy and arable farms whereas livestock farms decrease. Within the 5 years after the reform, 62.6% of farmers will continue as before and 27.7% will retire. According to survey, the CAP reform seems to reinforce many trends such as diversification and polarization between smallest and largest farms.

Breen et al. (2005) adopt a two-pronged approach comparing survey outcomes of Irish farmers post-decoupling production plans with projections of the FAPRI-Ireland model that consider SPS as unlinked to production. With regard to farmers' intention, the majority of farmers will continue as before. However, 33% (10%) of farmers will decrease (increase) livestock numbers, so that Irish beef production will decline. Only 11% of the dairy farmers plan to exit within the next five years. These results are not confirmed by the FAPRI-Ireland modelling exercise according to which beef supply declines in the longer term and 32% of dairy farmers exit over the next 10 years. Furthermore 10% of the cattle farmers and 3.5 to 6.5% of arable farmers become entitlement farmers.

By contrast, Lagerkvist (2005) conducts a survey to collect information of Swedish farmers with regard to two types of uncertainty – the timing of the reform and the level of post-reform payments – to analyse the impact of the CAP area payments on farmland investment incentives. The analysis shows that the return on investment to farmland is influenced by uncertainty. The pre-reform return on investment to land under uncertainty on both timing and payment amount is smaller than only under timing uncertainty.

Tranter et al. (2007) compare how farmers in Germany, UK and Portugal respond to the introduction of the SPS considering different implementation models. Very similar responses appear when facing surveys' outcome. Livestock farms show smaller changes than predicted by modelling exercises, whereas cereal farms state larger changes than forecasted.

Table 5. Effect on investment decision via future expectations (%)

Member state	Changes in on-farm investment - stated effects: no change/ increase/ decrease (% of farmers who intend to invest)[a]											
	MA[b]	ML	PA	PL	D	EL	IL	C	GC	PC	PP	H
EU15 av.	63/ 25/ 6											
AT												
BE												
DK												
FI												
FR			100/ 0/ 0									
DE	100/ 0/ 0	50/ 33/ 17	50/ 0/ 50	75/ 25/ 0	68.1/ 19.3/ 5.2	69.8/ 6.8/ 14	70.7/ 6.9/ 9.9	64.4/ 10.2/ 10	65.4/ 9.9/ 3.2	67.9/ 10.4/ 3.8	59.9/ 10.9/ 3.6	62.2/ 12.2/ 4.1
GR			100/ 0/ 0									
IE					16/ 50/ 11	50/ 10/ 33	50/ 10/ 33		70/ 10/ 20			
IT	100/ 0/ 0	80/ 0/ 20	67/ 0/ 17	75/ 25/ 0								
LU												
NL				67/ 17/ 17								
PT					68.1/ 19.3/ 5.2	69.8/ 6.8/ 14	70.7/ 6.9/ 9.9	64.4/ 10.2/ 10	65.4/ 9.9/ 3.2	67.9/ 10.4/ 3.8	59.9/ 10.9/ 3.6	62.2/ 12.2/ 4.1
ES			25/ 75/ 0									
SE												
GB					68.1/ 19.3/ 5.2	69.8/ 6.8/ 14	70.7/ 6.9/ 9.9	64.4/ 10.2/ 10	65.4/ 9.9/ 3.2	67.9/ 10.4/ 3.8	59.9/ 10.9/ 3.6	62.2/ 12.2/ 4.1
BG												
HR												
CY												
CZ												
EE												
HU			50/ 50/ 0	100/ 0/ 0								
LV												
LT												
MT												
PO		0/ 80/ 0	20/ 40/ 0	0/ 83/ 0								
RO												
SK												
SI												

Note: [a] For more information please refer to Viaggi et al. (2011), Tranter et al. (2007), Breen et al. (2005) for Ireland. [b] Mountain arable (MA), Mountain livestock (ML), Plain arable (PA), Plain livestock (PL), Dairying (D), Extensive sheep/ cattle (EL), Intensive sheep/ cattle (IL), Cereals (C), General cropping (GC), Permanent crops (PC), Pigs/ poultry (PP), Horticulture (H).

Viaggi et al. (2011) go one step further and analyse the role of farm-household surveys and farm-household models with regard to the analysis of the effects of decoupling in France, Germany, Greece, Hungary, Italy, Poland, Spain and the Netherlands. The introduction of the SPS leads to a reduction in investment except in

Poland. Nevertheless results between the 2006-2013 and 2014-2020 periods differ. Lastly stated behaviour is in 63% of the cases the same as the modelled behaviour.

2.3 Labour

The last production factor to be analysed is labour. Decoupled payments are linked to production via their impact on labour allocation thus on-farm and off-farm labour supply decisions. Moro and Sckokai (2013) explain the effects using a general farm household production model that maximizes utility first by differentiating between on-farm labour and leisure allocation and second by differentiating additionally between on-farm and off-farm labour. Assuming a perfect labour market, the former distinction reveals that decoupled payments substitute labour allocation thus reducing production, whereas the later has no impact on production decisions since changes are offset by off-farm labour adjustments. Accordingly, decoupled payments decrease the likelihood of off-farm work or time allocated to off-farm work (Serra et al., 2005; El-Osta et al., 2008).

Dewbre and Mishra (2007) use a farm household model to analyse the effect of decoupled payments on time allocation in the USA (on-farm work, off-farm work and leisure time) and on farm household income. They state that farm household time distribution to on-farm work, off-farm work or leisure time is probably altered through farm program payments. According to their estimation, decoupled payments increase leisure time. Therefore, farmers with some off-farm work time would be expected to decrease off-farm labour opting for more leisure time, whereas those not participating in off-farm work increase leisure at the expense of on-farm work which leads to a decrease in production.

Serra et al. (2005) argue that the likelihood of off-farm job decreases with the rise in farm household wealth. This can be explained by the coupling via risk channel (see above) because an increase in income increases farmers' willingness to take risks and hence reduces farmers' incentives to search for additional or more reliable income from off-farm work. They also shed some light on the complexity decoupling causes on labour allocation, since the implementation of new policy instruments affects uncertainty with regard to future development that also influence risk aversion and thus on- and off-farm labour decisions.

Key and Roberts (2009) use also a household model to analyse farmers' labour allocation. They assume farmers maximize utility from leisure, consumption and non-pecuniary benefit to farming. By contrast, under the assumption that farmers have high marginal utility from income, in case of low payment levels, farmers satisfy their consumption wishes working off-farm at higher wages. Therefore an increase in decoupled payments reduces marginal utility from income. It increases on-farm labour, especially to generate non-pecuniary benefits, and expand output while off-farm labour decreases.

The evaluation of available empirical assessments reveals that the majority of studies are conducted for the US. Only four studies address the effects on labour markets in the EU. Two of the studies focus on effects of the CAP on agricultural employments in East Germany (Petrick and Zier, 2012, 2011) whereas the other two studies investigate the impact of the SPS on labour allocation. Nordin (2014) assesses the impact of the SPS on the Swedish labour market with a focus on grassland support payment, whereas Hennessy and Rehman (2008) study the effect of decoupling on farmers' labour allocation decisions in Ireland. They show that farmers would opt for reducing animal numbers and for retaining/ cultivating the same area of land. Decoupling diminishes the return to farm labour by withdrawing the direct payments. The consequence is a decline mainly in farm income. However, in many cases the SPS represents a high share of Irish farmers' profit so that the majority of Irish farmers still gain from decoupling. Compared to the results presented for the US, the probability of participating in off-farm labour increases for 84% of the observations. Hours spent for off-farm work increases from 1,481 hours to 1,760 hours. Consequently the introduction of the SPS reduces available farm labour so that the labour substituting effect exceeds the wealth effect. By contrast, the introduction of decoupled payments in Sweden largely affects agricultural employment, in particular, observing that employment increases as the share of grassland increases. Nordin (2014) shows that every 11,000 euros of subsidy create 0.4 jobs. The grassland support keeps small farms in activity and counteracts structural change. It remains unclear whether the eligibility of grassland would have been affected if arable support remained. Furthermore he emphasizes that further CAP "greening" may increase agricultural employment.

Petrick and Zier (2012, 2011) apply different labour models and estimation techniques to investigate the effect of the CAP on the labour market. They observe only few desirable effects of the CAP on maintaining and creating jobs in the agricultural sector, whereas the introduction of the SPS leads to significant reductions (Petrick and Zier, 2011). They conclude that the SPS leads to labour shedding, and reduced average employment in Eastern Germany by 7% in the short-run, by 35% in the long-run. In the short-run, labour adjustment is inelastic, but tends to be more elastic in the long-run. Off-farm wage level is identified as an important driver of labour use in agriculture, and decoupling has a negative effect on general wage level.

Finally, Dupraz and Latruffe (2015) analyse the effects of the CAP on various labour types – contract labour, hired labour and family labour - employed by French crop farms. According to their results family and hired labour are complements, whereas hired and contract labour are substitutes. The implementation of the SPS decreases labour demands for family labour, and overall both coupled and decoupled reduce labour use on farm.

2.4 Discussion

European decoupled payments influences farm choices and thus output. The literature reveals different coupling channels such as capitalisation in land rents/ land sales prices, farmers' risk behaviour, credit accessibility, uncertainty about future policies and labour allocation. For each of these channels the relevant literature introducing theoretical and empirical assessments has been evaluated, and pertinent parameters have been identified. Nevertheless such an exercise reveals several limitations and obstacles.

First, despite an increasing number of studies investigating the impact of EU decoupled payments in recent years, most of the research is based on data preceding the introduction of the SPS. Empirical results addressing the post-2013 period are hardly to find. Studies applying post-2005 data mostly base their analysis on the first years next to the SPS implementation when adjustments are still limited (e.g., farmers are still not familiar with this type of payment). In addition, several studies cover only relatively short data periods, so that they do not fully capture long-term rent adjustment. Furthermore, the duration of land rental contract differs largely between the EU member states. Consequently, effects for the post-2013 period are difficult to derive. This raises special concern, especially when considering that the BPS should ensure a better distribution of decoupled payments across member states through external and internal convergence.

Second, experiment design largely differs across studies with regard to selected countries or regions, sectors, farm types or payment types. Many of the studies emphasis even a specific feature of decoupled payments such as selected implementation model, eligibility criteria or reference period (Moro and Sckokai, 2013). In addition, the simulated scenarios are barely comparable, e.g., Sckokai and Moro (2009) compare the effect of a 10% increase in intervention prices with an equivalent increase in decoupled payments, whereas Koundouri et al. (2009) compares the effect of cereal area payments with decoupled payments that correspond to half of area payments.

Third, though most of the analyses apply FADN data, others based on individual farm data and survey results raise the question of how to generalize these results to aggregated sector level (e.g., studies assessing coupling through future expectations). Furthermore it appears challenging to characterise qualitative surveys' outcome into simulation model framework.

Fourth, despite robustness of undertaken research, some approaches remain vulnerable, e.g., risk analyses rely on normative values and lack of changing farmers' risk preferences (Moro and Sckokai, 2013). Fifth, the inter-linkages between the effects of different coupling channels are only seldom addressed. Furthermore SPS analyse use to be treated independently of other payments of the CAP, such as rural development support or green decoupled payment. Sixth, research conducted to determine the effects of a specific coupling channel is concentrated on the work already done by few researchers, e.g., Ciaian, Kancs, Michalek, Swinnen and Kilian, Salhofer for the coupling via land, and Sckokai, Moro for the coupling via risk.

Overall capitalisation rates of decoupled payments into land rent seem to be the most suitable parameters for generating adjustments in CGE or PE models (Table 2). Michalek et al. (2014) use the most actual data and provide estimations of the effect for every EU15 member states that reveal an average SPS capitalisation rate that varies between 4 and 18%. Ciaian and Kancs (2012) conduct a study estimating the degree of capitalisation in selected new EU member states. They find capitalisation rates between 5 and 18%, and claim that leakage to land owners increases as rented land increases. In view with Ciaian and Swinnen (2006) one option to challenge this missing capitalisation would be to consider ratios of rented to owned farmland, selected implementation models, level of support and ratio of entitlements to eligible hectares. Furthermore Ciaian et al. (2014) provide the estimated trend of the effect of the post-2013 period. These estimated capitalisation rates can be used to determine the share of the SPS that needs to be fully capitalised into land rents at a homogenous rate across sectors.

Beyond the capitalization into the land value, the remaining 96 to 82% of the decoupled payment seem to be coupled to production via other coupling channels. It implies part of the payments under the SPS need to be distributed to other factors of production such as capital and labour. Coupling channels via risk, credit constraints, future expectations and labour are less clear compared to the capitalisation in land rent.

The SPS increases the credit accessibility of credit constrained farmers. For Ciaian and Swinnen (2009) this leads to an increased rate of capitalisation into the land value. They state that landowners gain even more than the subsidy amount (e.g., in France between 114 and 229% of the subsidy amount). Therefore an additional share of the SPS would need to be allocated to the land factor, differentiating again rented and owned lands. Furthermore, Latruffe et al. (2010) observe an increase in investment next to the implementation of decoupled payments. Consequently, part of decoupled payments has to be allocated to the capital factor to account for increased credit accessibility, and thus a rise in farm investment.

Sckokai and Anton (2005) and Sckokai and Moro (2009) reveal only small effects of increases in subsidies considering risk behaviour. Koundouri et al. (2009) state larger percentage changes in output due to decoupled support for Finland. However they qualify their analysis results as not transferrable to other EU member states, because grain yields in Finland are relatively low and grain production support is more pronounced compared to other member states. Furthermore, they emphasize an effect on input use, which might indicate that a coupling via input use requires some consideration. Several analyses results also present some acreage effects due to decoupled payments, which indicate that an additional share of the SPS needs to be allocated to the land factor, however not fully capitalised into the land rent.

The SPS increases farmers' income. It affects farmers' decisions with regard to investment, production choices and the optimal input mix. In a CGE model, these effects can be reflected through allocating the SPS to all factors of production, i.e. capital, labour and land. For including risk behaviour in CGE models Gohin and Zheng (2016) suggest a stochastic modelling approach. Introducing exogenous productivity shocks and farmer risk attitudes, they find that the impact of the CAP is larger under risk aversion compared to risk neutrality, mainly because larger price elasticities of supply for risk adverse farmers.

Studies on effects of future expectations present limited value for parameter approximation in CGE models. However it appears that this coupling channel also influences farm investment decisions, input use and production choices. Therefore expectations on potential policy changes can be reflected in a CGE model through alterations of production factor use.

Finally, the effect on labour allocation needs to be considered. The studies reveal conflicting developments. Hennessy and Rehman (2008) observe a reduction in the return to farm labour and an increase in off-farm work in Ireland, Petrick and Zier (2012) indicate a negative effect on agricultural wage level and labour shedding in Eastern Germany and Dupraz and Latruffe (2015) claim a further decrease in agricultural labour demand in France, while Nordin (2014) shows an increase in employment in Sweden. The review clearly indicates the local specific nature of these effects and jeopardizes any general finding due to the absence of EU empirical results. The effect of decoupled payments on the labour market is less pronounced than those of coupled payments. This explains why studies such as Petrick and Zier (2012) reveal negative effects on labour due to the progressive implementation of the SPS. As a result, part of decoupled payments should be allocated to the labour factor.

To conclude the literature review, the most suitable representation of the SPS in economic models is a breakdown of the payment into two components. This first component is based on the share of decoupled payment which is capitalised into the land value, and can be regarded as fully decoupled from production decisions. This component needs to be distributed in CGE models to the factor land at a homogeneous rate across agricultural sectors. By contrast, the second component captures the effects of the SPS through all remaining coupling channels. According to the existing literature, it appears that the effects of the SPS can be represented via the allocation of the support to all production factors, i.e., land, capital and labour. Since the actual impact is still unknown, best practice seems to be the distribution of this second component at a homogenous rate across agricultural sectors according to the factor usage, which reflects partial decoupling in CGE models.

3. Coupling factor modelling with MAGNET

Using outcomes of the literature review, the aim of this section is to examine the effect of different coupling factors on production and trade. This sensitivity analysis is of particular relevance in policy analysis when examining the impacts of changes in CAP instruments. For the purposes of the current experiment, the same sectoral and regional aggregation is employed as in Philippidis et al. (2016). This is a useful point of departure for different coupling factors because it includes a detailed breakdown of agricultural bio-based activities, all of the features of the improved CAP Budget module (Boulanger and Philippidis, 2015a), and a representative selection of EU and non-EU players on world agricultural markets.

3.1 Modelling framework

MAGNET, fully documented in Woltjer and Kuiper (2014), is a recursive dynamic variant of the well-known multi-regional neoclassical GTAP model (Hertel, 1997) and database (Narayanan et al., 2015). The GTAP data fuses a series of input-output tables for 140 countries/regions and 57 tradables (including agriculture, food, manufacturing, services, natural resources and energy), with gross bilateral trade, transport and trade policy data (i.e., ad valorem applied tariffs). In each region, both the data and the model accounting conventions ensure that the standard Keynesian macro balances are observed (i.e., zero balance of payments). The behavioural equations employ standard assumptions of neoclassical constrained optimisation, constant returns to scale technologies and perfect competition, whilst a series of market clearing equations are imposed to ensure that supply equals demand.

MAGNET builds on this foundation by including state-of-the-art modelling drawing from the latest developments in the literature, as well as significant data developments to include new or emerging industries which are not included within the standard classification of the national input-output accounts. Given its modular structure, MAGNET affords the user the flexibility to choose from a list of non-standard modules which are most pertinent to the study at hand.

The focus here is on agricultural market developments. Thus, a full representation of agricultural and food sectors is chosen, whilst the study also takes advantage of further data sector splits to include biomass usage in energy and feed. The model explicitly treats the specificities of agricultural factor and input markets to cater for endogenous changes in regional land supply, feed and fertiliser input substitution possibilities, heterogeneous land transfer between different agricultural activities and the possibility of characterising sluggish transfer of labour and capital between agricultural and non-agricultural sectors to capture wage/rent differentials.[7]

Furthermore, the model captures changes in the pattern of agri-food demand elasticities over time resulting from structural economic change (Woltjer and Kuiper, 2014). A Leontief joint production technology is assumed in forestry and agricultural sectors to model residue by-products, whilst the same modelling technique is used to treat oilcake and distiller's dried grains with soluble (*DDGS*) feeds by-products from first generation bio-diesel and bio-ethanol sectors.

Finally, an additional module (Boulanger and Philippidis, 2015a) characterizes a CAP baseline consisting of detailed shocks which capture the splits between coupled and decoupled pillar 1 payments (both national and EU sourced), and different categories of pillar 2 payments (including co-finance rates).

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[7] In the current study, changes to this behavioural assumption are key when modelling the degree of coupling of CAP payments.

In the real world, agricultural output is employed not only for food and feed, but also as a source of bio-mass for alternative uses such as chemical production or as an energy source. Thus, to capture these alternative channels of value added, and thereby improve model estimates of agricultural activity supply responsiveness under CAP changes, a more inclusive bio-based aggregation is considered in this study. Thus, 49 tradable goods are disaggregated from the modified GTAP database, of which 39 are bio-based (see Table 6). To maintain the model within manageable proportions, the regional disaggregation is limited to 23 regions. The selection criteria incorporates larger EU members (i.e., France, Germany, Italy, Spain, UK) whilst the specific choice of Ireland and Poland reflects the relative importance of primary agriculture in these countries. In addition, EU member state disaggregation reflected more pragmatic modelling considerations, to allow for the correct budgetary allocation to those countries which receive special dispensation under the CAP budget rebate.[8] The remaining EU27 countries are aggregated together. Lastly, as the 28th EU member state from July 1st, 2013, Croatia is treated separately to allow for its explicit inclusion within the single market (via exogenous tariff rate adjustments) and the "own resources" of the CAP budget mechanism. In the non-EU regions, *large players* (both net exporters and importers) on world agri-food markets are identified, whilst to examine the possible impacts on impoverished partners, both the Middle East and North Africa (MENA), and Sub-Saharan African (SSA) regions are represented. All residual trade and output flows are captured within a Rest of the Word (ROW) region.

[8] The Netherlands and Sweden are grouped together since their modelling treatment within the own resources mechanism of the CAP budget is identical (see Boulanger and Philippidis, 2015a).

Table 6. GTAP data aggregation

Sectoral disaggregation (49 commodities): **Primary agriculture (9 commodities):** wheat (wht); corn, barley, rye, oats, other cereals (grain); oilseeds (oils); raw sugar (sug); vegetables, fruits and nuts (hort); other crops (crops); cattle and sheep (cattle); pigs and poultry (pigpoul); raw milk (milk) **Food and beverages (6 commodities):** meat (meat); dairy (dairy); sugar processing (sugar); crude vegetable oil (cvol); vegetable oils and fats (vol); other food and beverages (ofdbv) **Other "traditional" bio-based activities (7 Commodities):** fishing (fish); forestry (frs); textiles (tex); wearing apparel (weapp); leather products (leath); wood products (wood); paper products and publishing (ppp) **Bio-mass supply (5 commodities):** plantations (plan); residue processing (res); pellets (pel); agricultural residues (r_agric); forestry residues (r_frs) **Bio-based energy (5 commodities):** 1st generation biodiesel (biod); 1st generation bioethanol (biog); bioelectricity (bioe); 2nd generation thermal technology biofuel (ft_fuel); 2nd generation biochemical technology biofuel (eth) **Bio-based chemicals (4 commodities):** lignocelluose sugar (lsug); polylactic acid (pla); polyethylene (pe); mixed bio/fossil chemicals (f_chem) **Bio-based and non bio-based animal feeds (3 commodities):** bioethanol by-product distillers dried grains and solubles (ddgs); biodiesel by-product oilcake (oilcake); animal feed (feed) **Fertiliser (1 commodity):** fertiliser (fert) **Fossil fuels and energy (6 commodities):** crude oil (c_oil); petroleum (petro); gas (gas); gas distribution (gas_dist); coal (coa); electricity (ely) **Other sectors (3 commodities):** chemicals, rubber and plastics (crp); transport (trans); other sectors (othSec) **Regional disaggregation (23 regions):** **EU members (12 regions):** United Kingdom (UK); Netherlands & Sweden (NL-SE); Denmark (DK); Germany (DE); Austria (AT); France (FR); Ireland (IE); Italy (IT); Poland (PL); Spain (ES); Rest of the EU27 (RoEU27); Croatia (HR) **Non EU regions (11 regions):** United States of America (USA); Canada (CAN); Mercosur (MERC); Russian Federation (RUS); China (CHN); India (IND); Japan (JAP); Australia & New Zealand (AUS-NZ); Middle East & North Africa (MENA); Sub-Saharan Africa (SSA); Rest of the World (ROW)

In terms of the model closure, all primary factor endowments (except land) and policy variables (ad valorem taxes and tariffs) are assumed exogenous. In neoclassical CGE models, technical change is traditionally treated as exogenous, although output- and input-augmenting technical changes in relation to pillar 2 expenditures are treated endogenously (Woltjer and Kuiper, 2014). To ensure macro closure, withdrawals (savings (S), imports (M) and CAP contributions (CC)) must equal injections (investment (I), exports (X) and CAP receipts (CR)).[9] Under conditions of fixed savings rates and steady state investment behaviour, as well as marginal changes in net CAP budget contributions (i.e., CC – CR) by member state, the trade balance adjusts to ensure a fully closed macroeconomic circular flow.

3.2 Baseline

As a basis upon which different agricultural coupling options can be implemented over a medium terms time horizon, it is necessary to implement a baseline which captures market developments under a business as usual set of assumptions conditioned by macroeconomic, technological and biophysical developments. Thus, in the first instance, projections are calculated for two periods. The choice of time intervals for both periods (i.e., 2007-2013, 2013-2020) is motivated by the need to reconcile Croatian accession to the EU and the multiannual financial framework (MFF). A full description of all of the shocks over the two periods is given in Table 7.

As a global benchmark, the Agricultural Model Intercomparison and Improvement Project (AgMIP) (von Lampe et al., 2014) considers a range of scenarios or narratives projecting up to 2050 with the objective of identifying how variation in the underlying

[9] In the non-EU regions, both CR and CC are zero

macroeconomic, technological and biophysical drivers under different future pathways lead to differing market developments in the long-run (2050) and very long (2100).

Since the current research focus is on the influence of government policy rather than projections, the experiments in the current study borrow AgMIP estimates of developments in real GDP growth and population characteristic of shared socio-economic pathway 2 (SSP2). These assumptions reflect a status quo vision of the world and are assumed common to each of the policy narratives in the current study.

Table 7. Assumptions shaping the CAP baseline (2007-2013-2020)

(2007-2013 period)

Projections

- Skilled and unskilled labour, capital, natural resources, population, and macro growth (SSP2)

Agricultural Policy (including 2008 health check reforms)

- Phasing in of decoupled payments for 2004 and 2007 accession members
- Targeted removal of specific pillar 1 coupled support payments: Arable crops, olives and hops to be fully decoupled from 2010; Seeds, beef and veal payments (except the suckler cow premium) decoupled by 2012, Protein crops, rice and nuts will be decoupled by 1 January 2012, Abolish the energy crop premium in 2010
- Re-coupling of support under the article 68 provision: Member states may use up to 10 per cent of their financial ceiling to grant measures to address disadvantages for farmers in certain regions specialising in dairy, beef, goat and sheep meat, and rice farming
- Pillar 2 payments to the EU27 under the financial framework
- Cumulative shocks for milk quotas rise of 1 per cent annually from 2009 to 2013
- Projected reduction in CAP expenditure share of the EU budget
- Change in Swedish and Dutch lump sum rebates corresponding to CAP expenditure share of EU budget

Fossil Fuel Prices

- Impose historical changes in world prices for coal, gas and crude oil

(2013-2020 period)

Projections

- Skilled and unskilled labour, capital, natural resources, population, and real GDP (SSP2)

Agricultural Policy

- Pillar 1 and pillar 2 nominal expenditures are cut 13% and 18%, respectively (European Council, 2013). This corresponds to a 15.2% cut in nominal CAP budgetary funding.
- Phasing in of decoupled payments for 2007 accession members and Croatia
- Greening of 30% of pillar 1 payments, represented as pillar 2 agri-environmental payments
- Pillar 2 payments extended to Croatia
- Abolition of raw milk (2015) and raw sugar (2017) quotas
- Croatia incorporated within the CAP budget and UK rebate mechanism
- Projected reduction in CAP expenditure share of the EU budget consistent with 15.2% cut in nominal CAP budget reduction
- Change in Swedish, Dutch and Danish lump sum rebates corresponding to CAP expenditure share in EU budget. UK rebate is maintained (European Council, 2013)

Fossil Fuel Prices

- Impose projections of expected changes in world prices for coal, gas and crude oil

Annual rates of population and real growth consistent with SSP2 are compounded over the two periods and implemented into MAGNET (Table 8); labour projections are assumed to follow regional population trends; capital endowment shocks are equal to regional macro growth forecasts (i.e., one assumes a fixed medium to long-run capital-output ratio) and natural resources are assumed to grow at one quarter the rate of the change in the capital stock. In the case of the labour market, one is effectively assuming that the participation rate of the workforce remains unchanged, which at the same time is theoretically consistent with a medium to longer term assumption of a fixed natural rate of unemployment.

Table 8. Real GDP and population shocks (%)

	2007-2013 POP	2007-2013 GDP	2013-2020 POP	2013-2020 GDP
UK	4.00	0.46	4.54	17.83
NL-SE	3.20	5.53	3.88	15.32
DK	2.87	-1.77	3.20	13.06
DE	-0.38	4.75	-0.35	10.14
AT	2.32	6.47	2.28	14.00
FR	3.64	1.99	4.16	12.47
IE	8.38	-5.37	8.30	18.77
IT	2.83	-3.99	0.85	8.14
ES	5.80	-0.18	3.34	8.94
PL	0.43	21.92	0.14	23.77
RoEU27	0.46	0.84	0.16	15.90
HR	-0.92	-3.88	-1.05	13.20
USA	5.14	5.51	5.64	22.25
CAN	6.48	7.95	7.54	19.29
MERC	5.86	24.54	5.90	29.31
RUS	-0.33	13.66	-0.60	29.56
CHN	2.54	71.05	1.79	72.72
IND	8.59	51.82	8.89	57.37
JPN	-0.13	0.63	-1.22	7.51
AUS-NZ	10.08	15.89	10.50	25.45
MENA	11.72	26.22	11.42	37.54
SSA	15.72	31.25	17.23	46.85
ROW	6.98	20.95	7.33	33.00

Note: Shocks consistent with SSP2. Source: Von Lampe et al. (2014)

For both time periods contemplated within this study, historical and projections shocks to coal, crude oil and gas prices are also implemented. In 2007, the coal price was 65.7 US dollars per metric tonne, the oil price was 71.1 US dollars per barrel and the average gas price was 7.7 US dollars per million British Thermal Units (BTU). The assumptions on fossil fuel prices across both periods are detailed in Table 9.

Table 9. World fossil price shocks (%)

	2007-2013	2013-2020
Coal	28.64	-11.66
Crude oil	46.34	-30.92
Gas	31.20	-7.4

Source: World Bank, Commodity Price Data Forecasts: http://www.worldbank.org/en/research/commodity-markets

Finally, in addition to the projections, productivity and world energy price shocks, a CAP baseline are added. Thus, the 2007-2013 period incorporates detailed sector and region specific pillar 1 and 2 'actual' expenditures (i.e., not ceiling limits) up to 2011, taken from the CATS database. Over the 2007-2013 period, EU28 expenditures on decoupled payments increase, largely due to the gradual implementation of the CAP to the new member states (2004 and 2007 accessions), whilst in the case of France, Italy and Spain, rises in decoupled payments over this period are also due to the (partial or full) decoupling of payments on (inter alia) fruit and vegetables; arable crops; olive hops; seeds; and beef and veal (except suckler payments).

Pillar 2 payments are aggregated to the five categories employed within MAGNET ('agri-environmental schemes'; 'least favoured areas'; 'physical capital'; 'human capital' and 'wider rural development'). Given the 'co-financed' nature of pillar 2 support between EU and individual member state budgets, policy shocks to national government pillar 2 spending are also implemented in the first period based on the CATS data.

In the 2013-2020 period, it is assumed that the structure of pillar 1 payments (decoupled/coupled), pillar 2 co-finance rates and the distribution of pillar 2 expenditures in member states remain the same at the end of the first period. Payment totals for Croatia in the second period are taken from the European Commission (2009), whilst exogenous spending limit reductions for the CAP budget over the 2014-2020 MFF are taken from the European Commission (2011).

Finally, in light of recent CAP reforms, the "greening" of 30% of pillar 1 decoupled payments is modelled by characterising them in an identical fashion to pillar 2 agri-environmental payments, i.e., following Nowicki et al. (2009), it is assumed that labour and capital productivity in agricultural sectors decreases by 5% for every one euro of expenditure on green decoupled payments.

3.3 Experiments

As a departure from previous studies employing the CAP baseline shocks (Boulanger and Philippidis, 2015a; Boulanger and Philippidis, 2015b; Philippidis et al., 2015), this study implements three simulation experiments over the 2007-2020 time horizon with different treatments of the allocation of pillar 1 decoupled payments across the factors of production.

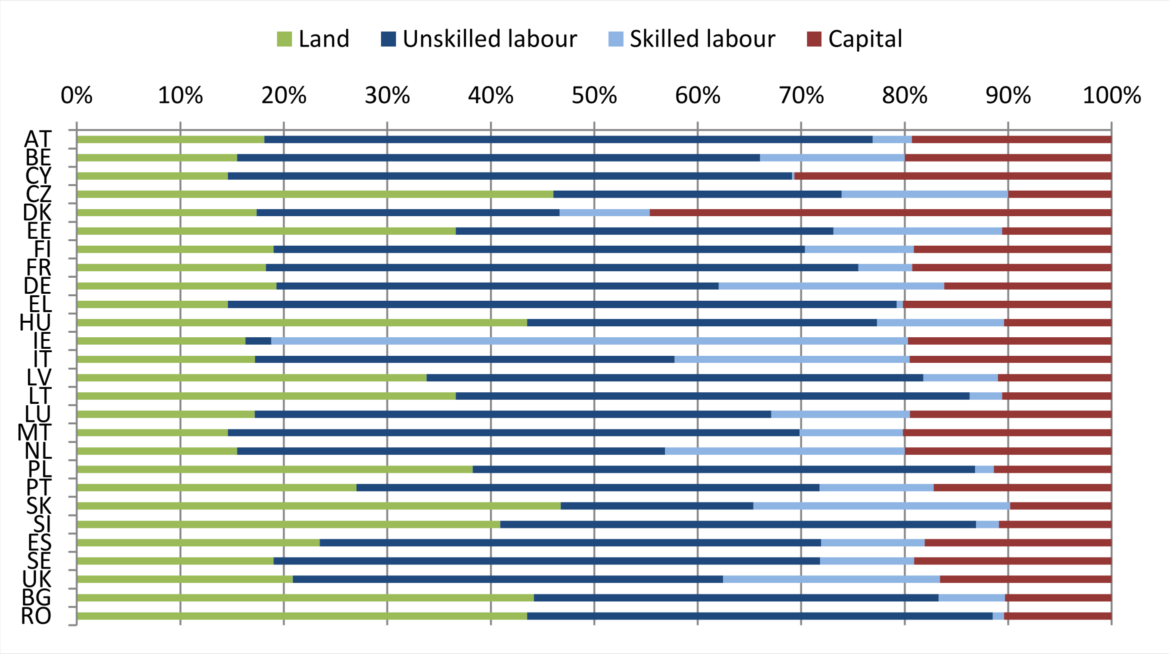
In experiment 1, 100% of decoupled payments are linked exclusively to the land factor, which is tantamount to assuming they are decoupled.[10] In experiments 2 and 3, different coupling options are explored.

In experiment 2, a middling degree of coupling is implemented. As a starting point, estimates are taken from the literature on the share of decoupled payments capitalised into the value of land (see Table 2), which range from 4% to 18%. The remaining 82% to 96% of payments are then distributed as a uniform subsidy payment across the GTAP database classification of all four factors of production (i.e., land, unskilled- and skilled-labour and capital) in the agricultural sectors. Thus, in effect, remaining decoupled payments are distributed as a function of the primary factor share in agricultural sectors in each region (Figure 3).

Finally, in experiment 3, decoupled payments are distributed as a function of the primary factor share in agricultural sectors in each region, i.e., uniform payment rate across all four primary factors of production (Figure 4).

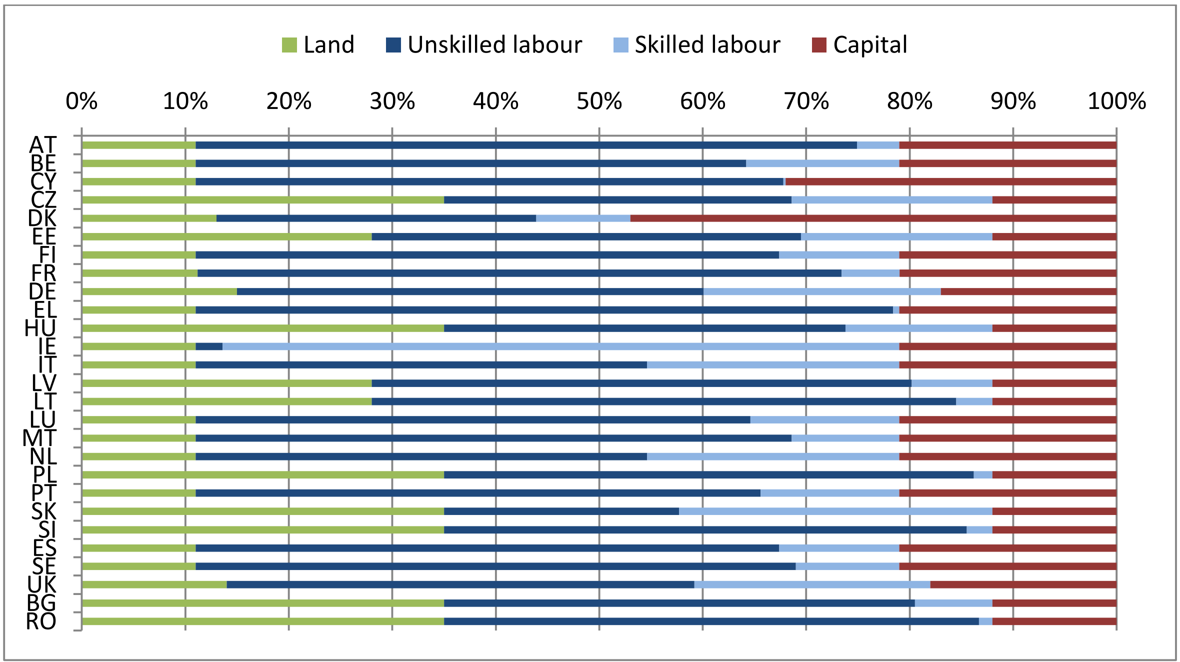
[10] MAGNET has an endogenous land supply function such that changes in decoupled payments on land under this configuration will still have "some" degree of coupling effect on output.

Figure 3. Coupling factors from literature review (Experiment 2)



Note: (i) Croatia is assumed to have the same allocation as Slovenia; (ii) Malta and Cyprus land allocations are assumed the same as Greece, whilst land allocations for Slovenia, Romania and Bulgaria are based on midpoint estimates from the literature. Source: Authors' calculation from Ciaian and Kancs (2012), Michalek et al. (2014) and GTAP database v9.

Figure 4. Coupling factors from GTAP primary factor shares (Experiment 3)



Source: Authors' calculation from GTAP database v9.

3.4 Results

Due to the vast number of results generated from models of this scale, the focus is strictly on the production response, price effects and trade distortion impacts arising from different coupling factors. The majority of results are presented for the EU28, whilst some consideration is also given to the impact on non EU regions. To aid the exposition, the subtotals facility of Harrison et al. (2000) is employed. This tool allows the modeller to calculate the part-worth of the resulting endogenous variable change that corresponds to a specific exogenous shock, or pre-specified group of exogenous shocks.[11] In this study, which combines economic, population, biophysical and CAP implementation shocks, such a feature is useful for understanding the impact of different coupling factors on medium term horizon simulation results.

3.4.1 Agricultural and food production

Table 10 shows the changes in agricultural and food sector outputs for the EU28 over both time periods (2007-2013-2020) under each of the three experiments. The output changes are the result of the varied (and sometimes conflicting) effect of changes in real GDP growth, land productivity, population, factor endowments, world prices and CAP implementation changes. In the period up to 2013, it is noted that in experiments 2 and 3, real sectoral output is generally above that of experiment 1.

Decoupled payments in the EU28 rise over the 2007-2013 period.[12] As a result, in experiments 2 and 3, agricultural production increases relatively more, since with higher decoupled subsidies attributed to labour and capital combined with the assumption of perfect mobility of capital and labour between agricultural and non-agricultural sectors, more capital and labour enter agriculture. By extension, given the vertical relationship with downstream processing, the food sectors also expand further in experiments 2 and 3. As expected, the greater is the degree of decoupled support committed to the non-agricultural specific land factor, the higher is the supply response (although to 1 decimal place, experiments 2 and 3 produce practically identical results).

In the 2013-2020 period, reductions in decoupled support due to the CAP budget cuts as well as direct payment "greening" (i.e., 30% of decoupled payment treated as pillar 2 agri-environmental payments) leads to the reverse effect as the reduction in subsidies to non-land factors generates an outflow of labour and capital factors from agriculture, leading to output falls. Once again, agriculture (and by extension) food output falls are greater in this period, the higher is the assumed degree of coupling. Examining the end point (2020) for aggregate primary agriculture and food processing production in the EU28, the index values are more or less the same across the three experiments (i.e., higher production in the first period is offset by larger output contractions in the second period).

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[11] Employing the terminology of Harrison et al. (2000), for a simplistic function Z=F(X,Y), where Z is endogenous and X and Y are exogenous, GEMPACK calculates the change in the separate values of the first derivatives corresponding to X and Y within the total derivative dZ, accumulated over all the steps specified within the model algorithm. Furthermore, the part-worths of each exogenous variable are calculated based on the GEMPACK assumption that the rate of progression in the set of exogenous shocks along the path is proportionally linear.

[12] It should be noted that the rise is not uniform across individual member states. As noted in sub-section 3.2, the 2004 and 2007 accession members received greater support in recognition of their gradual incorporation within the CAP. Owing to the implementation of the health check reforms, additional decoupled support in the 'older' members was largely granted to France, Italy and Spain.

Table 10. EU28 agriculture and food output (2007=100)

	Experiment 1		Experiment 2		Experiment 3	
	2013	**2020**	**2013**	**2020**	**2013**	**2020**
wheat	101.4	101.8	102.9	101.4	102.9	101.1
other grain	100.7	101.3	102.3	100.8	102.4	100.7
oils	104.8	98.6	107.8	97.7	107.8	97.5
sugar	99.9	97.1	99.9	96.5	99.9	96.5
fruits & vegetables	103.0	103.6	105.3	103.4	105.3	103.3
other crops	101.0	102.9	102.6	101.9	102.7	101.7
cattle & sheep	97.4	96.1	99.0	96.1	99.0	96.0
pig & poultry	99.9	99.1	102.4	102.5	102.5	102.4
raw milk	101.3	101.1	101.6	99.4	101.6	99.4
PRIMARY AGRICULTURE	**101.0**	**101.0**	**102.8**	**101.0**	**102.8**	**100.9**
meat	99.3	101.3	100.7	102.4	100.7	102.3
dairy	101.5	105.1	101.8	104.1	101.8	104.0
sugar	99.0	100.1	99.2	100.9	99.2	100.9
crude vegetable oil	110.6	99.8	112.9	99.8	112.9	99.7
vegetable oil	97.3	96.3	97.6	96.0	97.6	96.0
other food & beverages	101.2	106.1	101.4	106.1	101.4	106.1
FOOD & BEVERAGES	**101.0**	**104.9**	**101.5**	**104.8**	**101.5**	**104.8**

Table 11 results support the discussion relating to Table 10. In the case of experiment 1 (all decoupled support on land, i.e., fully decoupled), the production impacts are extremely muted in both periods.[13] On the other hand, the greater is the assumed degree of coupling (experiments 2 and 3), the stronger is the magnitude of the output rise (2007-2013) and fall (2013-2020) in each period.

Table 11. Changes in EU28 agriculture and food output (%)

	Experiment 1		Experiment 2		Experiment 3	
	2013	**2020**	**2013**	**2020**	**2013**	**2020**
wheat	0.2	-0.1	1.0	-2.3	1.1	-2.5
other grain	0.3	-0.1	1.1	-1.8	1.2	-1.9
oils	0.5	-0.2	1.7	-2.9	1.8	-3.1
sugar	0.0	-0.1	0.0	-1.1	0.0	-1.1
fruits & vegetables	0.3	-0.1	1.3	-1.7	1.3	-1.9
other crops	0.2	-0.1	0.9	-1.7	0.9	-1.8
cattle & sheep	0.1	0.0	0.4	-1.8	0.4	-1.9
pig & poultry	0.0	0.0	0.6	-1.4	0.7	-1.4
raw milk	0.0	0.0	0.1	-0.9	0.1	-0.9
meat	0.0	0.0	0.4	-1.1	0.5	-1.1
dairy	0.1	0.0	0.1	-0.7	0.2	-0.7
sugar	0.0	0.0	-0.1	-0.6	-0.1	-0.6
crude vegetable oil	0.2	-0.2	1.0	-1.8	1.1	-1.9
vegetable oil	0.0	0.0	0.2	-0.4	0.2	-0.4
other food & beverages	0.0	0.0	0.1	-0.2	0.1	-0.2

The EU output impacts depicted in Table 11 are further disaggregated by member state. Thus, in Table 12 are presented the subtotal primary agricultural output changes corresponding to changes in decoupled support expenditures for a selection of member states. The selection of countries is based on those "original" members that receive no further decoupled support over the period 2007-2013 (i.e., Germany and Ireland); original member states that benefit from additional decoupling under the CAP health check reforms of 2008 (France, Italy, Spain); and New Accession members (Poland).

[13] That the production response is not completely zero, is due to the fact that the regional land supply function in MAGNET is endogenous. Thus, there is an expansion/contraction effect in that (*ceteris paribus*) a relative rise in the total decoupled payment induces an expansion/contraction in total agricultural land area, resulting in a corresponding rise/fall in agricultural output.

For any given region, the general picture is that, as expected, the supply response becomes stronger when comparing across the three experiments. Thus, in experiment 1 (all support tied to land), changes in output are of a much lower magnitude than in experiment 3 (standard GTAP allocations). Examining the signs on the output changes in both periods, one observes that for the 2007-2013 period, in France, Italy, Poland and Spain, output rises, whilst for Germany and Ireland there are (slight) contractions in output. As a new accession member, Poland received additional CAP support. In the case of France, Italy and Spain, further decoupling under the auspices of the CAP health check generates additional net-CAP expenditures, whilst Germany and Ireland find themselves at a relative competitive disadvantage as no further decoupled support is bestowed. In the second period (2013-2020), CAP budget reductions result in uniform primary agricultural reductions in the selection of all member states.

A comparison of the supply response between the regions is rather more difficult. For example, examining the decoupled payment allocation assumptions in Figures 2 and 3, one concludes that Poland has the lowest supply responsiveness, since the proportion of decoupled support tied to the land factor is highest. On the other hand, Poland received the highest increase in CAP support in the period 2007-2013 (just over two billion euros). Thus, the magnitude of the output changes is largely driven by both the absolute size of decoupled support expenditure shock and the relative size of the shock compared with the value of agricultural factors.[14] Indeed, the relative shock size is an important determinant in the case of Ireland in the period 2013-2020, where the reduction in decoupled support expenditures accounts for 12% of the value of agricultural factors – the highest of all the regions.

In the non-EU regions, agriculture and food production varies over the time horizon of our three experiments (Table 13). These changes in non-EU region output in agriculture and food are not, however, significantly driven by different assumed degrees of coupling in the EU. More precisely, it is the behavioural assumption of labour and capital mobility between agricultural and non-agricultural uses (experiments 2 and 3) that drives the results in the non EU regions. Thus, in regions with high rates of compound GDP growth (i.e., China, India, Mercosur), rapid growth and industrialisation with associated changes in real incomes and food demand patterns, draws more labour and capital away from primary agriculture, with the result that global output of food and agriculture falls slightly in experiments 2 and 3, compared with experiment 1. Once again, one observes that the results in experiments 2 and 3 are practically identical.

[14] The output changes from decoupled expenditure shocks is also driven by the pattern of each EU region's trade with other EU and non-EU regions (i.e., the implicit import demand elasticities from the Armington function), the degree of openess of its agricultural sector, and the relative importance of the primary agricultural sector within the broader macroeconomy.

Table 12. Changes in primary agriculture output for selected EU28 member states (%)

2007-2013																		
	Experiment 1						**Experiment 2**						**Experiment 3**					
	DE	**FR**	**IE**	**IT**	**PL**	**ES**	**DE**	**FR**	**IE**	**IT**	**PL**	**ES**	**DE**	**FR**	**IE**	**IT**	**PL**	**ES**
wht	-0,4	0,0	-0,1	0,2	2,6	-0,2	-1,7	1,3	-0,2	0,8	6,5	1,9	-1,8	1,4	-0,2	0,9	6,6	2,2
grain	-0,2	-0,1	0,0	0,0	1,4	0,0	-1,2	0,8	-0,2	0,4	4,1	1,4	-1,2	0,8	-0,3	0,4	4,2	1,6
oils	-0,1	-0,1	0,0	0,2	2,9	0,0	-0,9	1,4	-0,1	1,0	7,0	1,8	-1,0	1,5	-0,1	1,0	7,2	2,0
sug	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
hort	-0,3	0,1	-0,2	0,1	2,1	0,0	-1,5	1,3	-0,6	0,4	4,7	1,5	-1,6	1,3	-0,6	0,4	4,8	1,8
crops	-0,2	0,1	-0,1	0,1	2,7	0,0	-1,0	1,0	-0,3	0,5	6,3	1,3	-1,0	1,1	-0,3	0,5	6,5	1,5
cattle	-0,1	0,0	0,0	0,0	1,7	0,0	-0,9	0,7	-0,3	-0,1	5,9	0,8	-0,9	0,8	-0,4	-0,1	6,0	0,9
pigpoul	0,1	0,1	0,0	0,0	0,1	0,0	-1,0	0,8	-0,5	0,1	4,7	0,9	-1,0	0,8	-0,5	0,1	4,8	1,0
milk	-0,1	0,1	0,0	0,0	0,0	0,0	-0,4	0,7	-0,1	0,2	0,0	0,0	-0,5	0,8	-0,1	0,2	0,0	0,0
2013-2020																		
	Experiment 1						**Experiment 2**						**Experiment 3**					
	DE	**FR**	**IE**	**IT**	**PL**	**ES**	**DE**	**FR**	**IE**	**IT**	**PL**	**ES**	**DE**	**FR**	**IE**	**IT**	**PL**	**ES**
wht	-0,4	-0,1	0,1	-0,2	-0,8	0,0	-2,1	-2,6	-12,8	-2,1	-2,5	-3,2	-2,1	-2,7	-13,3	-2,2	-2,6	-3,8
grain	-0,2	0,0	0,0	-0,1	-0,5	0,0	-1,7	-1,7	-9,5	-1,4	-1,5	-2,5	-1,7	-1,8	-10,0	-1,4	-1,6	-2,9
oils	-0,2	-0,1	0,1	-0,2	-0,7	-0,1	-2,4	-3,4	-15,4	-2,7	-2,5	-3,4	-2,5	-3,6	-16,1	-2,8	-2,5	-3,8
sug	-0,2	-0,1	0,0	0,0	-0,1	0,1	-1,5	-1,3	-1,8	-0,1	-0,5	-1,5	-1,5	-1,4	-1,8	-0,1	-0,5	-1,8
hort	-0,4	-0,2	0,1	-0,2	-0,7	0,0	-2,2	-2,8	-9,8	-1,5	-1,2	-2,5	-2,2	-2,9	-10,2	-1,5	-1,2	-3,0
crops	-0,3	-0,1	0,0	-0,1	-0,9	0,0	-2,5	-2,1	-6,2	-1,5	-2,1	-2,3	-2,5	-2,2	-6,5	-1,6	-2,2	-2,7
cattle	-0,1	0,0	0,0	0,0	-0,2	0,0	-1,5	-1,4	-10,9	0,0	-1,1	-1,3	-1,5	-1,5	-11,4	0,0	-1,1	-1,5
pigpoul	0,0	0,0	0,0	0,0	0,0	0,0	-1,6	-1,6	-9,4	-0,4	-1,5	-1,4	-1,6	-1,7	-9,9	-0,4	-1,6	-1,7
milk	-0,2	0,0	0,0	0,0	-0,1	0,0	-1,4	-0,9	-7,6	0,0	-0,5	-0,3	-1,4	-0,9	-8,0	0,0	-0,5	-0,4

Note: wheat (wht); other grain (grain), oils (oils), sug (sugar), hort (fruits & vegetables), crops (other crops), cattle (cattle & sheep), pigpoul (pig & poultry), milk (raw milk).

Table 13. World agriculture and food output by region (2007=100)

2013	EU28	NorthAme	Mercosur	Russia	China	India	Japan	Rest	World
Experiment 1									
Agri	101.0	104.5	117.4	106.1	130.0	113.4	98.0	117.1	**114.1**
Food	101.0	104.2	120.0	108.8	141.9	134.6	98.6	119.4	**111.5**
Experiment 2									
Agri	102.8	106.2	115.4	105.1	125.7	111.7	99.0	116.2	**113.4**
Food	101.5	104.6	119.2	108.9	137.4	133.0	98.9	119.4	**111.4**
Experiment 3									
Agri	102.8	106.2	115.3	105.1	125.7	111.7	99.0	116.2	**113.4**
Food	101.5	104.6	119.2	108.9	137.4	133.0	98.9	119.4	**111.4**
2020	**EU28**	**NorthAme**	**Mercosur**	**Russia**	**China**	**India**	**Japan**	**Rest**	**World**
Experiment 1									
Agri	101.0	109.2	134.3	114.5	163.8	126.3	93.5	139.0	**129.9**
Food	104.9	115.1	145.0	120.3	194.9	180.2	98.4	146.9	**128.2**
Experiment 2									
Agri	101.0	111.5	130.8	110.6	154.8	124.2	96.3	137.2	**128.1**
Food	104.8	115.8	143.5	121.2	179.6	177.1	99.3	147.3	**127.4**
Experiment 3									
Agri	100.9	111.5	130.8	110.6	154.8	124.2	96.3	137.3	**128.1**
Food	104.8	115.8	143.5	121.2	179.6	177.1	99.3	147.3	**127.4**

3.4.2 Land rents

In Table 14 are presented the changes in nominal land rents in each of the three experiments. In experiment 1, the entire decoupled support is capitalised into the value of land, which in the EU, is highly inelastic in supply. Moreover, in experiment 1 there are minimal output effects, such that total agricultural land demand remains largely unchanged. Examining Table 15, between 2007 and 2013, the recapitalisation of land rents due to rises in the aggregate decoupled payment is 6.2% in experiment 1. As the payment becomes more coupled in experiments 2 and 3, rises in EU agricultural output generate rises in land demand leading to higher land rents, although this effect is offset by the reduced proportion of decoupled payments capitalised into the land factor. Thus, agricultural land rents rises by 4.2% and 3.8% in experiments 2 and 3, respectively.

Table 14. World land rent by region (2007=100)

	Experiment 1		Experiment 2		Experiment 3	
	2013	**2020**	**2013**	**2020**	**2013**	**2020**
EU28	98.2	71.7	97.0	79.4	96.6	79.8
NorthAme	97.5	85.6	98.6	87.1	98.6	87.1
Mercosur	103.5	90.1	103.0	90.4	103.0	90.4
Russia	104.0	85.9	103.7	85.0	103.7	85.0
China	177.3	238.4	164.6	226.5	164.6	226.6
India	240.6	420.7	230.6	420.9	230.6	421.0
Japan	79.4	47.3	80.8	49.7	80.8	49.7
Rest	103.1	92.6	102.7	93.4	102.7	93.4

In the period 2013-2020, the changes in rents in Table 14 reflect two (conflicting) effects which are highlighted in Table 15. Firstly, there is the reduction in decoupled payments due to CAP budget cuts. Secondly, there is the effect of green direct payments, modelled as a payment linked to land (i.e, agri-environmental payment).

The first effect (i.e., CAP budget cut) depresses land rents by -15.7%, -8.0% and -7.1% in experiments 1 to 3, respectively. As expected, the fall in land rents is lessened, the greater is the assumed degree of coupling.

The second effect (i.e., greening) inflates land rents by 10.3%, 13.3% and 14.1% in experiments 1 to 3, respectively, as increases in land subsidies also draws in more agricultural labour and capital in experiments 2 and 3, which increases output and generates even higher derived demand for land.

Table 15. Changes in EU28 land rent (%)

	CAP "non-greening" decoupled expenditure	CAP "greening" decoupled expenditure
Experiment 1		
2007-2013	6.2	-
2013-2020	-15.7	10.3
Experiment 2		
2007-2013	4.2	-
2013-2020	-8.0	13.7
Experiment 3		
2007-2013	3.8	
2013-2020	-7.1	14.1

The changes in land rents by member state in both periods corresponding to the CAP subtotals are presented in Table 16. In the period 2007-2013, in France, Italy, Poland and Spain, under higher degrees of coupling (from experiment 1 to 3), less of the decoupled payment expenditure increase is capitalized into land prices. This price effect outweighs the land demand effect as agricultural output rises more in these regions with higher degrees of coupling (see Table 12). In the case of Germany and Ireland, assuming more coupling, less of the decoupled payment expenditure decrease in these regions depresses land prices (i.e., *ceteris paribus*, relative *rises* in land rents as the degree of coupling is higher). In these two regions, the contraction in German and Irish agricultural output is such that reductions in land demand lead to net land rent falls. In the period 2013-2020, the changes in the rents follow the same trends which are reported in Table 15 for the EU28 aggregate.

Table 16. Changes in land rent for selected EU28 member states (%)

	non-greening	greening	non-greening	greening	non-greening	greening
2007-2013						
	Experiment 1		**Experiment 2**		**Experiment 3**	
DE	-1,9	-	-2,9	-	-3,0	-
FR	7,9	-	4,1	-	3,6	-
IE	-0,1	-	-0,4	-	-0,4	-
IT	4,7	-	1,9	-	1,6	-
PL	20,6	-	14,1	-	13,7	-
ES	11,8	-	7,8	-	6,8	-
2013-2020						
	Experiment 1		**Experiment 2**		**Experiment 3**	
DE	-14,7	9,6	-8,1	4,7	-7,5	5,5
FR	-21,0	13,8	-10,5	10,4	-9,0	12,8
IE	-22,1	14,6	-11,6	15,9	-10,1	19,0
IT	-16,4	10,7	-6,8	6,7	-5,8	7,9
PL	-13,0	6,5	-8,5	1,1	-8,1	1,4
ES	-19,7	12,7	-11,3	7,2	-9,4	10,6

3.4.3 EU and world prices

The market price effects in each of the experiments are presented in Table 17. As a general observation, in experiment 1 by 2020 market prices have fallen the most in the three experiments, whilst in experiment 3 (most coupled), market prices have fallen the least. On the one hand, if the projected rate of labour and capital growth by region is faster than the increase in agricultural output, then under the conditions of experiment 1, more labour or capital becomes sectorally trapped, resulting in lower wages or rents.[15] The relative fall in factor prices is passed along in the form of lower market

[15] Or put another way, workers (or the owners of capital) are prepared to accept a lower wage (rent) before seeking employment in non-agricultural sectors.

prices (assuming perfect price transmission). If non land factors are mobile (as in experiments 2 and 3), then they can simply move out of agriculture to 'other' non-agricultural uses with more ease.

Table 17. EU28 agriculture and food market prices (2007=100)

	Experiment 1		Experiment 2		Experiment 3	
	2013	2020	2013	2020	2013	2020
wheat	98.0	77.4	98.4	83.9	98.4	84.1
other grain	97.4	76.7	97.2	82.8	97.2	82.9
oils	100.6	77.4	100.6	83.3	100.5	83.5
sugar	110.3	73.5	113.3	79.5	113.3	79.7
fruits & vegetables	95.6	75.9	94.9	82.9	94.8	83.0
other crops	96.1	76.7	96.0	83.7	95.9	83.8
cattle & sheep	99.6	79.2	99.6	85.1	99.6	85.2
pig & poultry	97.0	77.2	95.5	81.6	95.4	81.7
raw milk	96.6	75.4	96.6	83.0	96.6	83.2
PRIMARY AGRICULTURE	**97.1**	**76.7**	**96.8**	**83.1**	**96.7**	**83.3**
meat	98.1	79.9	97.7	82.0	97.7	82.1
dairy	98.3	80.8	98.3	82.6	98.3	82.6
sugar	99.8	81.6	100.3	82.5	100.3	82.5
crude vegetable oil	102.1	78.3	102.4	81.9	102.4	81.9
vegetable oil	98.7	83.3	98.7	84.0	98.7	84.0
other food & beverages	99.1	83.4	99.0	83.9	99.0	83.9
FOOD & BEVERAGES	**98.8**	**82.3**	**98.7**	**83.3**	**98.7**	**83.4**

An additional factor for the lower market price falls in experiments 2 and 3 (vis-à-vis experiment 1) is the impact on land rents. As discussed above, the lower land rental rate falls, the higher is the degree of assumed coupling of decoupled support.

Table 18. World agriculture and food market prices (2007=100)

	Experiment 1		Experiment 2		Experiment 3	
	2013	2020	2013	2020	2013	2020
wheat	98.0	79.0	99.6	85.1	99.6	85.2
other grain	98.9	82.4	100.8	87.8	100.7	87.8
oils	100.2	82.3	102.0	88.6	102.0	88.6
sugar	102.1	87.1	105.3	95.1	105.3	95.1
fruits & vegetables	98.2	82.6	100.7	89.2	100.6	89.2
other crops	102.3	93.5	103.7	100.6	103.7	100.7
cattle & sheep	96.1	77.4	97.5	81.8	97.5	81.8
pig & poultry	87.3	63.7	100.8	97.7	100.8	97.7
raw milk	100.3	87.9	102.4	95.3	102.4	95.3
meat	93.1	71.7	95.0	77.0	95.0	77.0
dairy	95.7	77.1	96.1	78.9	96.1	78.9
sugar	95.0	75.8	95.9	78.0	95.9	78.0
crude vegetable oil	93.7	69.1	95.0	72.6	95.0	72.6
vegetable oil	92.2	71.2	92.8	72.6	92.8	72.6
other food & beverages	95.5	77.8	95.8	78.7	95.8	78.7

Table 18 shows the evolution of world prices to 2020 under each of the three experiments. The main observation is that world prices in experiments 2 and 3 are relatively higher when compared with experiment 1. In part, this reflects the drop in global supply of agriculture and food in experiments 2 and 3 (compared with experiment 1), which has inflated world prices. In addition, there are cost push factors due to the relatively higher export prices of EU agriculture and food commodities (see Table 17).

3.4.4 Trade

The changes in intra-EU trade, extra-EU exports and extra-EU imports are shown in Table 19 for the period up to 2020. On the one hand, as economies grow, real incomes also rise, generating (ceteris paribus) greater import demand. On the export side, depending on the combination of relatively faster or slower rates of growth across EU and non-EU regions, in terms of GDP, factor endowments and land productivities, this can erode or consolidate EU trade competitiveness. Comparing experiments 2 and 3 with experiment 1, by 2013, both intra-EU trade and extra- EU exports rise more, whilst extra-EU imports fall more. By 2020, intra-EU trade and extra-EU exports remain higher in experiments 2 and 3, although the gap with experiment 1 is smaller than in 2013. Similarly, extra-EU imports in experiments 2 and 3 remain below that of experiment 1 although in primary agriculture, the gap is also smaller.

Table 19. EU28 trade patterns (2007=100)

	Intra-EU trade		Extra-EU exports		Extra-EU imports	
	2013	2020	2013	2020	2013	2020
Experiment 1						
Agri	100.1	98.4	107.5	118.8	103.8	106.4
Food	99.8	101.4	92.9	92.9	130.3	171.6
Experiment 2						
Agri	103.1	99.5	118.0	125.4	97.5	105.5
Food	100.5	101.7	95.6	96.4	125.8	160.4
Experiment 3						
Agri	103.1	99.3	118.1	124.7	97.4	105.9
Food	100.5	101.6	95.6	96.3	125.8	160.6

Table 20. Changes in EU28 trade patterns (%)

	Intra-EU trade		Extra-EU exports		Extra-EU imports	
	2007-2013	2013-2020	2007-2013	2013-2020	2007-2013	2013-2020
Experiment 1						
Agri	0.3	-0.1	1.0	-0.3	-0.7	0.3
Food	0.0	0.0	0.1	-0.1	-0.1	0.1
Experiment 2						
Agri	1.5	-2.3	4.3	-7.6	-2.9	5.7
Food	0.3	-0.8	0.6	-1.5	-0.7	1.9
Experiment 3						
Agri	1.6	-2.4	4.5	-8.0	-3.1	6.0
Food	0.3	-0.8	0.6	-1.6	-0.7	2.0

The motivation for these comparative trends between the three experiments is clearly shown in Table 20. The two periods have two conflicting effects. In experiments 2 and 3, rising levels of overall decoupled support to the EU28 in the 2007 to 2013 period generate greater increases in EU28 output (Table 11 and Table 12). It leads to rises in intra-EU trade and extra-EU exports, and falls in extra-EU imports, compared with experiment 1. In the 2013-2020 exactly the opposite occurs as a consequence of the fall in decoupled payments resulting from the CAP budget cuts.

4 Conclusions

Assessing potential coupling factors of decoupled payments remains a critical issue, both from a theoretical and empirical perspective. Beyond political sensitiveness, the literature reveals different coupling channels such as the capitalisation in land rents and land sale prices, farmers' risk behaviour, credit accessibility, uncertainty about future policies and labour use. Through all these channels, European decoupled payments influence directly and indirectly farm decisions and output. For each of these channels relevant literature introducing theoretical and empirical assessments has been evaluated with the aim of deriving plausible behavioural parameters that enable an improved representation of decoupled payments in economic simulation models.

Most of the available literature uses conceptual methodologies to evaluate such a representation rather than empirical and numerical approaches. Other studies are based on surveys collecting farmers' intentions and thus are more qualitative in nature. In addition, empirical studies are generally based on case studies using farm level data of a specific region, either at member state or regional level, or a specific type of production. Absence of data and aggregation challenges jeopardise the emergence of a common procedure to generalize estimated values. Furthermore many of the studies focus on specific aspects of decoupled payments such as the implementation of payment regimes, eligibility criteria or base period. Beyond these methodological challenges, the progressive and dynamic implementation of the CAP is a central obstacle when comparing different empirical analysis results.

The most comprehensive studies reveal an average capitalisation rate of support into land value that varies between 4 and 18% across the EU member states. The remaining 82 to 96% of decoupled payments seem to be coupled to production via channels other than land. Based on a thorough review of the literature, and given the difficulty in quantifying the part-worth of different coupling channels, the proposed approach in this document which caters for heterogeneous member state land markets, may be to split the allocation of decoupled payments. On the one hand, a proportion is committed to land as a function of the capitalisation rate into the rental value, whilst a second tranche is distributed uniformly across all factors, reflecting a balance of different coupling channels. Conducting a sensitivity analysis of the degree of coupling, three experiments were compared consisting of a full allocation to the land factor (experiment 1), an allocation to land following member states capitalisation rates in the literature combined with a uniform distribution of support across all primary factors (experiment 2) and a distribution of the payment as a function of the factor shares in land using (agricultural) sectors (experiment 3). Under a CAP baseline akin to that of Boulanger and Philippidis (2015a), a comparison of output and trade, and to a lesser extent, the price trends between different payment allocation structures reveals differences in the model results. In addition to the degree of coupling, differences between experiments also reflect the assumption governing the degree of mobility of agricultural capital and labour.

Notwithstanding, it appears that the difference in coupling between that suggested in the literature review and the most coupled option (experiment 3, based exclusively on GTAP factor shares) does not produce significantly different output and price results in MAGNET. It is however recommended to adopt a moderate degree of coupling (experiment 2) when modelling decoupled payments. That said, dynamic and heterogeneous implementations of decoupled payments are not considered in this study, nor are those mechanisms addressing a better distribution of support across the EU through external and internal convergence tools. Furthermore decoupled payments for agricultural practices beneficial for the climate and the environment are omitted. In view with the growing emphasis given to CAP "greening" and more targeted decoupled payments, additional research is necessary.

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List of abbreviations

AgMIP	Agricultural Model Intercomparison and Improvement Project
CAP	Common Agricultural Policy
CGE	Computable General Equilibrium
EU	European Union
FADN	Farm Accountancy Data Network
FAIR	Federal Agricultural Improvement and Reform
GAECs	Good Agricultural and Environmental Conditions
GDP	Gross Domestic Product
GTAP	Global Trade Analysis Project
JRC	Joint Research Centre
MAGNET	Modular Applied GeNeral Equilibrium Tool
MFF	Multiannual Financial Framework
MTR	Mid-Term Review
OECD	Organisation for Economic Co-operation and Development
PE	Partial Equilibrium
SAPS	Single Area Payment Scheme
SMRs	Statutory Management Requirements
SPS	Single Payment Scheme
SSP	Shared Socio-economic Pathway
UAA	Utilised Agricultural Area
URAA	Uruguay Round Agreement on Agriculture
WTO	World Trade Organization

List of tables

List of figures

LB-NA-28253-EN-N

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