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Understanding the economy-wide impacts of CAP decoupling: An assessment of alternative CGE model specifications

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Abstract

The paper analyses the consequences of decoupling farm support for Scottish agriculture and the wider Scottish economy. The analysis is carried out using three types of dynamic computable general equilibrium models: A recursive dynamic model and two forward-looking CGE models, one assuming physical capital is sector-specific, the other assuming such capital is mobile between sectors. The essential difference between the recursive dynamic and forward-looking models is the way in which farm households are assumed to responds to shocks. In particular, in the recursive dynamic case households only respond to past behaviour while with the forward-looking model the households equate returns across the various assets they own. Decoupling is simulated by introducing a production subsidy to land. The results illustrate that the difference between the backward-looking and the two forward-looking models lies in the response of households in the first number of years after the shock and that this can lead to different outcomes in the long-run between the three model types. Systematic sensitivity analysis suggests that the results of the backward-looking model are more uncertain, especially in later years, compared to the two forward-looking models. Future research should be aimed at improving the calibration of the models.

Keywords: Decoupling, Common Agricultural Policy, CGE model.

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1. Introduction

There are a growing number of studies which explore the economy-wide impacts of decoupling agricultural support, some of them based on computable general equilibrium modelling approaches (Gelan and Schwarz, 2008; Gohin, 2006; Philippidis, G., 2010; Törmä, 2010). However the way in which decoupling has been simulated in these models varies widely. As a consequence, it is difficult to assess the consistency of empirical results from the studies or identify policy implications.

A related, even more fundamental, issue in comparing findings from previous CGE studies of decoupling is that the nature of the underlying model used in the analysis often varies. In particular the models embody different assumptions on the way farm households respond to decoupled payments, thereby influencing model outcomes. While much emphasis tends to be placed by authors on the sensitivity of their results to model parameters and closure rules, there is often little reflection on the appropriateness of the form of model used. This is critical in the case of policy instruments such as decoupling which can affect farm production decisions in a number of ways including through changes in relative output, input prices and the value of land, increased household income, and, critically, changes in farm investment behaviour, (Sckokai and Anton, 2005; Sckokai, P. and Moro, D., 2009).

This paper adds to the literature by comparing the impacts of decoupling from two very different CGE models: a standard dynamic recursive CGE model (Thurlow, 2008) and a less common forward-looking dynamic model. The latter is based on optimal control theory, and assumes perfect foresight on behalf of economic agents (Devarajan and Go, 1998; Vellinga, 2008). Drawing on the theoretical review, the paper discusses the advantages and disadvantages of each alternative specifications focussing in particular on their potential for simulating the impacts of decoupled agricultural support.

The database for calibrating each version of the model is a detailed SAM for Scotland with a disaggregated agricultural sector. In particular, the SAM includes 29 production sectors (9 of which are farm types), 31 commodities (11 of which are agricultural commodities), and three types of factors (labour, capital and land) with the land factor distinguishing between 4 different categories based on the Macaulay Land Classification System. Households in the SAM are disaggregated into urban, rural farm and rural non-farm categories.

The results indicate that the economic impact from decoupling are larger in the forward-looking model version, as economic agents are assumed to react to subsidy changes by adjusting their investment and consumption plans. In comparison, the recursive version of the model give rise to smaller responses as the agents adjust their behaviour only after (or as) shocks impact on the economic variables that affect them directly. There are also qualitative differences in some of the results between the two model versions for some production sectors. Section 2 discusses the previous studies of decoupling, followed by a comparison of the key differences between backward and forward looking CGE models in Section 3. The data and creation of the disaggregated social accounting matrix is discussed in Section 4 along with an overview of the farm sector and the CAP in Scotland. Section 4 also provides details of the simulations used in the analysis. Section 5 presents the results, comparing first patterns of investment between the two types of model, and then other aggregate and farm sector related results. It also reports on findings from a preliminary systematic sensitivity analysis in order to indicate differences in the robustness of the findings across model versions and between types of variables. Section 6 concludes and describes the agenda for future research.

2. Review of previous approaches to modelling decoupling and empirical findings

This section reviews how modellers have previously tried to simulate the impact of decoupling CAP support and considers empirical findings in relation to the "coupled" effects of Single Farm Payments (SFPs). As is well recognised, there are, from a theoretical perspective various reasons for doubting that such payments are fully decoupled (that is, have no impact on production). These include the impact of SFPs on risk attitudes, liquidity, creditworthiness, land prices, land use requirements, expectations, wealth, farm work decision-making, and investment decisions. It follows that the economic representation of the decoupling process and the extent to which the models capture adjustments in farmer behaviour is crucial to modelling the effects of decoupling.

Balkhausen et al. (2008) provides a review of previous attempts at modelling decoupling in the European Union (EU). Eight simulation models are considered: AGLINK, AG-MEMOD, CAPRI, CAPSIM, ESIM, FAPRI, GOAL and GTAP. All of these are partial equilibrium (PE) models except GTAP (a very widely used global model) and GOAL. Most of these models incorporate a two-stage land allocation decision process (e.g. crops/grass, then individual crops, and the authors consider the inclusion (or non-inclusion) of roughage and other crop-livestock links as crucial to the modelling of coupling. AGLINK, AG-MEMOD and FAPRI use an explicit 'coupling factor'; most of the others assume that land allocation follows total (market and subsidy) returns, with decoupling effects coming from a switch from crops ('grandes culture') to fodder and pasture. The coupling factors for the 2003 Reform taken from or assumed/estimated for all the above models range from 100 (full coupling) to 0 (full decoupling), i.e. AGLINK (6%), AG-MEMOD ("30% of Agenda 2000"), CAPRI (100%), CAPSIM (100%), ESIM (100%, or 0% in "old" version), FAPRI (15%), GTAP (100%), GOAL (0%). In GTAP study, subsidies are treated as fully coupled to area allocation, while the GOAL baseline assumes that direct payments capitalise 100% into land prices, and that SFPs have no effect on area allocation.

Helming et al, (2010) provide an alternative review of how decoupling has been modelled. Only one of the twelve models reviewed by these authors was a CGE model - LEITAP - which, the authors note has been "extended to include a recursive dynamic version with endogenous technological change by specifying a relation between investments and productivity change". In relation to the how decoupling was simulated in the various models, Helming et al. conclude that two decoupling implementation mechanisms predominate: decoupled payments are implemented either as (1) direct payments being linked to land (i.e. per hectare lump sum transfers) or (2) decoupling factors attached to produced quantities and representing the degree of (de-) coupling of direct payments assumed by the researcher." In

LEITAP, decoupled direct payments are modelled as payments linked to land. Törmä and Lehtonen (2010) and Philippidis (2010) in their CGE analyses of decoupling on the Finnish and Spanish economies respectively also follow this approach. This, it is recognised tends to promote adjustments in agriculture and thus reduces potential for land abandonment.

From an empirical perspective, von Witzke et al. (2010) conclude that "Single Farm Payments under the new CAP actually do have significant production effects", i.e. actual coupling remains strong. In contrast, Helming et al. (2010) conclude that "the production effects of decoupled payments …. are in general very small". The exception, they argue, is the effect of decoupled payments on land markets. Decoupled payments tend to be capitalized into higher land values which increase land rents and prices. This in turn could lead to more land remaining in agricultural use. It follows that, in terms of feeding through to the wider economy, impacts are driven primarily through factor market adjustments.

While some of the CGE models described above are static (one period) models (E.g. Frandsen et al, 2002; Gohin, 2006; Philippidis, 2010) others have been extended by allowing period to period updating of key model parameters, either endogenously or exogenously, and then solving the model recursively in each period (E.g. LEITAP (Nowicki et al, 2009); GEMRUR (Törmä and Lehtonen, 2010)). Such so-called dynamic recursive models are becoming increasing common as they allow adjustment processes to be incorporated in a simple way and thus time paths to new equilibrium to be assessed. However they lose some consistency with microeconomic theory, in that actors are treated as myopic, solving 1-period problems rather than treating them as if they are solving an overall dynamic optimisation problem. Inter-temporal forward-looking CGE models address this limitation but, to the authors' knowledge have yet to be used to consider the impact of decoupling. This paper addresses this gap in the literature.

3. Comparison of backward and forward-looking CGE models[2]

This section summarises the key theoretical differences between forward-looking and backward-looking CGE models and then describes the models used in the analysis.

3.1 Theoretical structure

As noted above, standard static or recursive dynamic CGE models are simplistic in relation to how they treat household behaviour. In particular, they treat agents as passive in the sense that they only respond to past developments. In contrast, in forward-looking models economic agents anticipate future developments and act accordingly so as to restore the arbitrage conditions between the returns of the different assets they own. From a theoretical perspective, the outcome of a Solow-Swan (Solow, 1956) and Ramsey growth model (1926) represent examples of a recursive and forward-looking model respectively. Suppose, for example, that in a forward-looking model there is an exogenous shock that leads to an increase in households' income allowing them to consume more. For a one-sector model (Blanchard and Fisher, 1989) the Keynes-Ramsey rule can be expressed as:

[2] An appendix with the equations of the models is available upon request.

$$\frac{\frac{d}{dt}U'(C(t))}{U'(C(t))} = \rho - MP^K(t) + \delta$$

where $U'(C(t))$ is marginal utility dependent on the level of consumption, ρ is the rate of time preference, $MP^K(t)$ is the marginal product of physical capital or the return on physical capital and δ is the rate of depreciation of physical capital. This equation states that the return on consumption (the left hand side of the equation) is equal to the return on capital (the right hand side). If farm households start to consume more an imbalance is created. The representative farm household will want to decrease consumption to allow more resources be invested in capital that will ultimately lead to a higher return on capital. This will lead to higher future levels of output and allows for more investment and consumption. Eventually the capital stock will be larger and the return on capital will again be equal to the return on consumption.

In contrast, in a recursive dynamic model the representative farm household would be assumed to be passive and only looks at past developments. As her income increases, she will have more resources available for investment and consumption. She too will increase investment and consumption in response to the shock, but, in the long run, to a lesser extent than the agent with perfect foresight.

The two figures below illustrate the differences between the two types of model by showing patterns of consumption and physical capital stock over time in response to the exogenous shock that leads to an increase in households' income. As expected, consumption is lower initially, but higher in the long-term for the forward-looking (FL) model, compared to the backward-looking (BL) model.

Figure 1: Consumption levels over time for the backward-looking and forward-looking model after an increase in farm households' income (including base run values).

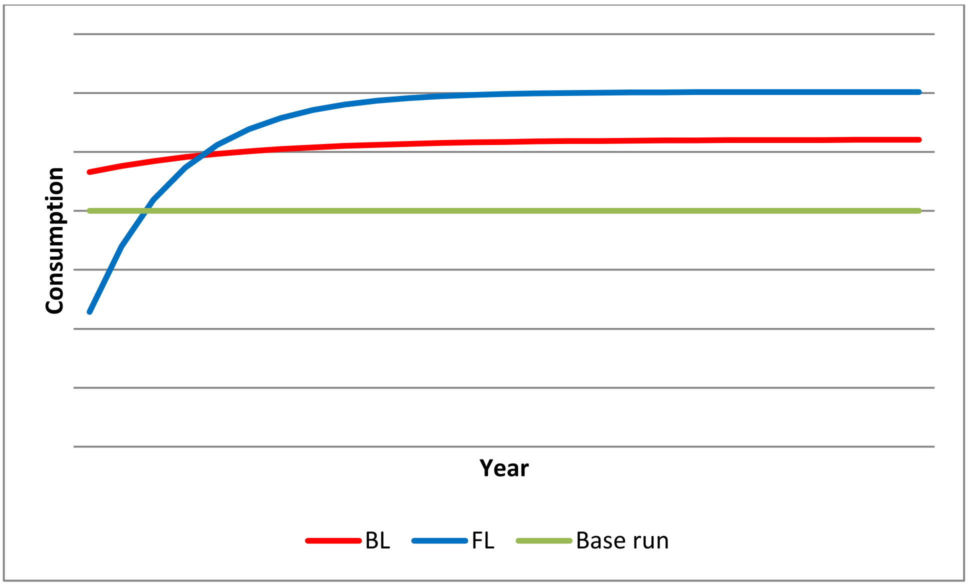
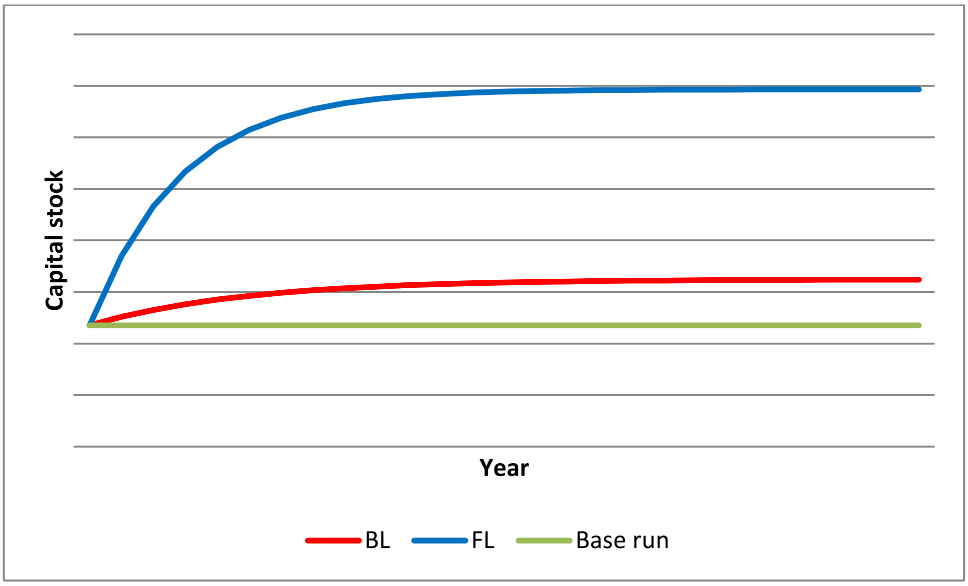


Figure 2: Stock of physical capital levels over time for the backward-looking and forward-looking model after an increase in farm households' income (including base run values).



Thus it is argued that a backward-looking model is not capable of picking up the behaviour of households that is focussed on equating the returns on the various assets it possesses (in effect arbitrage conditions), now and in the future. Subtle changes in the very short-term can be observed for a forward-looking model that may even lead to different outcomes in the long-term, compared to the solution of a backward-looking model. Thus, as the decoupling of agricultural support may induce farm households to adjust their investment plans, the two types of CGE models will produce different outcomes.

3.2 Model Descriptions

As is always the case in CGE modelling, a lot of choices have to be made regarding the particular specification of each of the type of CGE model. These include decisions in relation to how to model the labour market, external trade as well as capital investment. The recursive dynamic model used in this paper is based on Thurlow (2008), which essentially is a dynamic version of the IFPRI standard model (Lofgren, 2002) with the solution of a static version of the model corresponding to the first period solution of the recursive dynamic model. The forward-looking model is based on Devarajan and Go (1998) and Vellinga (2008). The core of the models is the same for both types of model. A formal description of the model equations and list of variables and model parameters are available from the authors on request.

For all versions of the model we assume labour is mobile between sectors, there is no government or foreign debt and the model is investment driven. For the backward-looking model it is assumed that capital is sector-specific and this is also initially assumed in one of the forward-looking models (FL-CM). However, this assumption is relaxed and another version of the forward-looking model is used based on the assumption that capital is mobile between sectors (FL-CSS). The latter model allows for capital to transfer instantaneously to sectors where it can be more productive after a shock occurring to the economy.

4. The Social Accounting Matrix (SAM) with disaggregated agricultural sector for Scotland 2007

4.1 The 2007 Scotland SAM

The agricultural and food industry sector are often represented as one row and one column in the national datasets including input-output tables. This coarse representation is an important reason for the limited application of CGEs for analysis of the CAP (Ferrari et al, 2012). A comprehensive study of the effects of CAP reform requires a disaggregated detail of the agriculture and agri-food sectors. For this purpose, we developed the Social Accounting Matrix for the Scotland for the year 2007 with highly disaggregated agricultural sectors, a database including 9 raw agricultural farm types and 4 processed food and drink sectors. Overall, there are 29 production sectors and 31 commodities in AGRISAM07. Detailed sectors and commodities in the AGRICSAM07 can be seen in Appendix B.

The SAM includes three factors: labour, capital and land, with 4 different types of land use according to the Macaulay LCA classification. The economic agents within the SAM are: Farming Households; Non-Farm Rural Households; Urban Households; Scottish Government; UK government; the Rest of UK; and the Rest of World. There are also other accounts for Trade Margins, Taxes, Subsidies, Savings/Investment, Imports and Exports.

An initial (aggregate SAM) was first formed by combing information form the 2007 Scottish supply and use tables[3] plus other data sources such as Scottish Government public expenditure reports (SG, 2009) on institutional transfers. The schematic form of the SAM plus aggregate values in the base year, 2007, are presented in Table 1.

This was then disaggregated so as to emphasise the Scottish agriculture sector using secondary data. In particular, the disaggregation of the agriculture production sector was mainly based on data from Farm Accounting Survey (FAS). The accounts for land were disaggregated from the capital account also using data from the FAS. In contrast, the disaggregation of the agricultural commodity and household accounts was based on data from the Living Costs and Food Survey (LCFS)[4].

[3] http://www.scotland.gov.uk/Topics/Statistics/Browse/Economy/Input-Output/Downloads

[4] A technical document describing the SAM construction process can be obtained from the authors upon request.

Table 1: Scotland Macro SAM, million pounds, 2007.

	Activity	Commodity	Value added	HH	Scottish Gov.	UK Gov	Capital	The rest of UK	The rest of world	Margin	Total
Activity		202,074									202,074
Commodity	102,710			75,034	27,638	1,107	21,349	34,093	19,001	15,302	296,231
Value added	98,435										98,435
HH			98,435		4,261	12,647					115,343
Scottish Gov.				1,849		34,042					35,891
UK Gov	928	13,114		25,878							39,920
Capital				12,582	3,992	-7,876		10,148	2,503		21,349
The rest of UK		44,241									44,241
The rest of world		21,504									21,504
Margin		153,02									15,302
Total	202,074	296,231	98,435	115,343	35,891	39,920	21,349	44,241	21,504	15,302	

Source: own elaboration

Table 2 shows the total value-added for primary agriculture and food and drink industry activities within the SAM. Agriculture is shown to have provided 1.8% and the food and drink industry 2.95% of the 9.8 billion value-added produced by the Scottish Economy in 2007.

Table 2: Agri-food value added and share of total, million pounds and percentage, 2007.

	Agriculture		Food		Scottish economy
	£m	(%)	£m	(%)	£m
Labour	435	(0.70)	1,824	(2.95)	61,907 (100)
Capital	1,335	(3.65)	1,083	(2.97)	36,528 (100)
Value added	1,770	(1.80)	2,907	(2.95)	98,435 (100)

Source: Own elaboration

In terms of output, agriculture represents 1.2% of total domestic supply while the food industry 3.8%. The structure of agricultural production and the food industry in Scotland is presented in Table 3. In terms of value of domestic production, “Others” (23% of agricultural production) and “General Cropping” (20% of agricultural production) represent the key activities within agriculture. Within the food industry, “production of other food and drink” is the dominant activity with the highest production value (70% of food production).

Table 3: Share of production value over agriculture or food production, percentage, 2007

Agricultural production sectors (farm types)	%	Food and drink industry activity	%
Cereals	10.59	Meat processing	13.56
General cropping	20.23	Fish, fruit & vegetable processing	12.81
Dairy	16.87	Prepared animal feed	3.41
Specialist sheep (LFA)	2.43	Production of other food and drink	70.21
Specialist beef (LFA)	10.55	Total	7,577 (£m) (100%)
Cattle and Sheep (LFA)	5.96		
Lowland Cattle &Sheep	2.00		
Mixed	8.41		
Others	22.96		
Total	2,464 (£m) (100%)		

Source: Own elaboration

In terms of exports, the agriculture and food industry represent 2% and 11%, respectively, of total Scottish exports, especially "Production of other food and drink" representing 8% of total Scottish export. In terms of share of exports, 38% of agricultural production is exported to rest of UK and rest of World. For food and drink industry, it is in highly export-oriented. In 2007, 28% of all Scottish output is sold within Scotland; further 45% is sold in the rest of the UK, whilst the remaining 27% is exported to the rest of the world. "Other food and drink" is the most export oriented commodity as only 12% of total Scottish output is sold domestically, while the remaining 88% is exported. "Food and drink" is a growing industry with, even during the recent economic crisis, exports of food and drink overseas increasing by 28% from £3.5 billion in 2007 to £4.5 billion in 2010, mainly due to increase in drink exports (Scottish Government, 2012).

4.2 The CAP in Scotland

When introducing Single Farm Payment (SFP), Member States had three options. The value of payments could be based on, either (i) the support received by the individual farmer during a reference period (historical model); (ii) a flat rate (regional model), or (iii) a mixture between these two models (hybrid model) (Ferrari et al, 2012). With the 2003 CAP reform, Scotland opted for the first choice, i.e. to calculate SFP entitlement based on historic subsidy receipts from 2000 to 2002. The expectation is that as part of the 2013 CAP reform process, SFPs will be required to be redistributed across Scotland so as to be constituent with the regional model approach.

In Scotland, SFP is accounted for approximately 81% of total agricultural subsidies in 2007 (Scottish Government, 2010). Furthermore, in 2008, average per farm received £35,474 SFP, accounting for 92% of Farm Business Income (FBI) (SG, 2010), though the share of subsidies over FBI varies significantly according to the activity (Table 4). It is obvious that farming activities in Less Favourite Area (LFA) are the most supported activities with subsidies representing nearly twice of FBI (subsidies could not offset losses).

Table 4: Share of all subsidies over FBI in Scotland, percentage, 2007.

Agricultural activity	%
Cereals	56.62
General cropping	53.23
Dairy	45.44
Specialist sheep (LFA)	184.95
Specialist beef (LFA)	199.31
Cattle and Sheep (LFA)	209.33
Lowland Cattle &Sheep	178.12
Mixed	122.57

Source: Own elaboration, data from (Scottish Government, 2010)

4.3 The model simulations

The different versions of the model are solved using GAMS (Meeraus et al., 2006). Of the subsidies given to the various farm types through product subsidies, totalling £537 million, 30%, or 161 million pound, is provided additionally to the farm types as a subsidy to the land. As a first step in analysing these types of subsidies, the land subsidy is equally distributed over the 4 types of land. This approach to simulating decoupling is similar to that followed by Helming, (2010), Törmä and Lehtonen (2010) and Philippidis (2010).

5. Results

In the first section (Section 5.1) the results for the simulation with the land subsidy to production are discussed for the three types of models. A welfare analysis focussing on equivalent variant is subsequently discussed in that section. At the end of the section the difference between the backward- and forward-looking model results is dealt with. A systematic sensitivity analysis is carried out in Section 5.2.

5.1 Results of the Simulations

The introduction of a subsidy creates a distortion compared to the situation where such a subsidy does not exist. Every tax and subsidy is distortionary and creates a deadweight loss. Dependent on the circumstances, this loss can be small or large, but there is a loss. The distortion of the land subsidy to production is reflected by the decrease in real GDP for all three models. It decreases more for the backward-looking (Figure 3) than for the two forward-looking models (Figure 4). The trend for the backward-looking model is downward, while for the two forward-looking models there is a relatively sharp decrease and then gradual recovery over time of real GDP.

Figure 3: Real GDP for backward-looking model (ratio values with respect to base run).

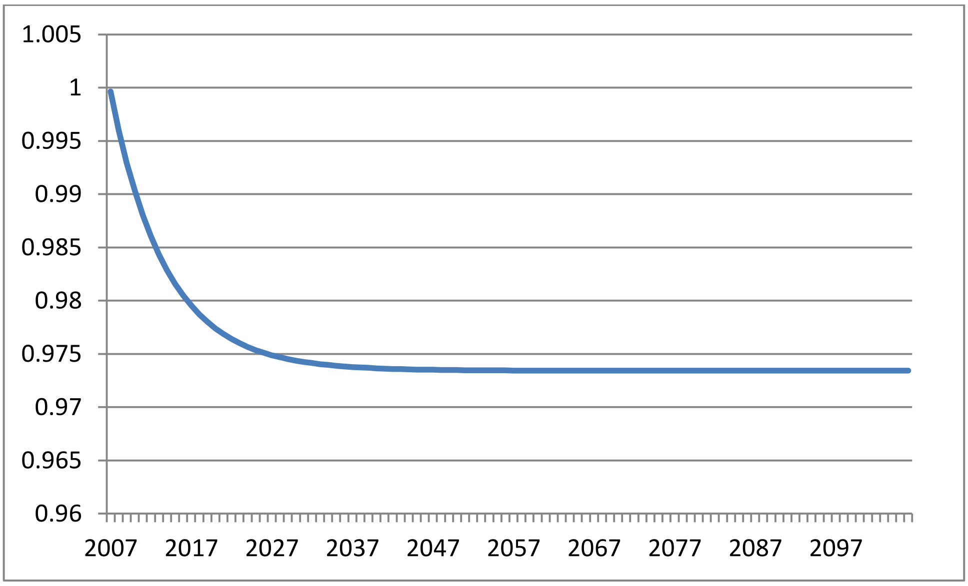
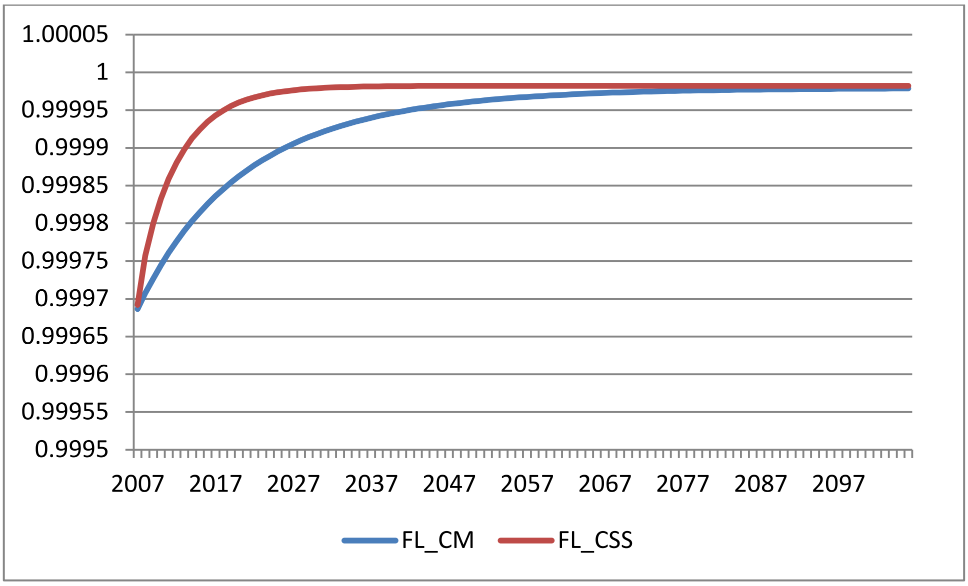


Figure 4: Real GDP for the forward-looking models (ratio values with respect to base run).



The deadweight loss in the backward-looking model is much larger than in the case of the two forward-looking models. A possible explanation of this could be that behaviour of the economic agents is passive in the case of backward-looking, while the active behaviour with the forward-looking models mitigates the detrimental effects of the subsidy.

As farmers are indirectly subsidies by the government through the land subsidies, rents on land increase more than three-fold as shown in the next figures:

Figure 5: Land rent income in the backward-looking model (ratio values with respect to base run).

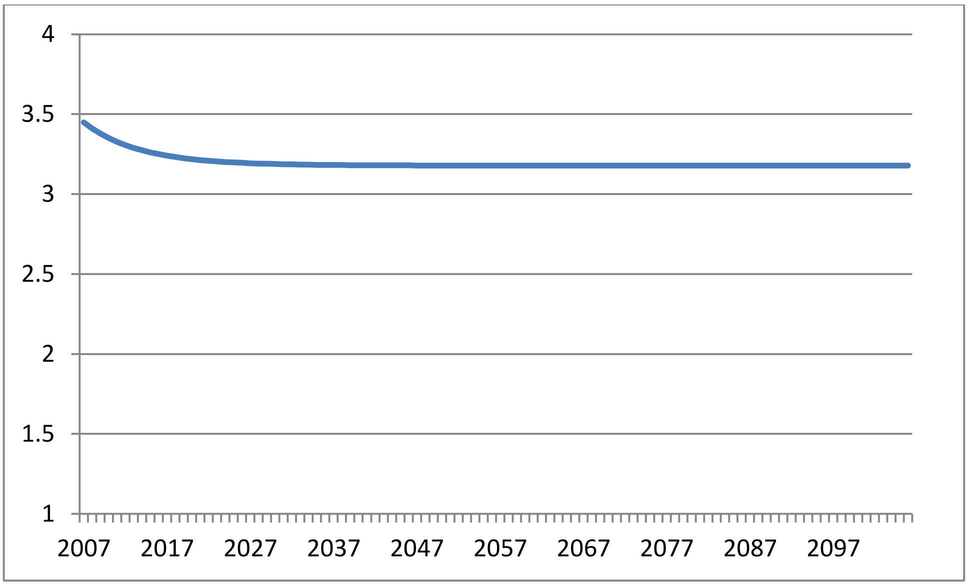
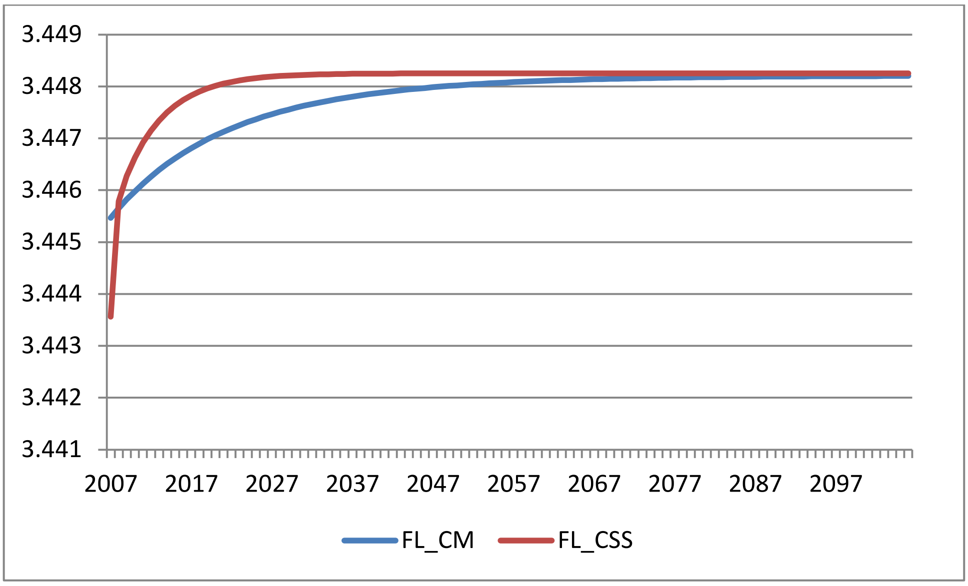
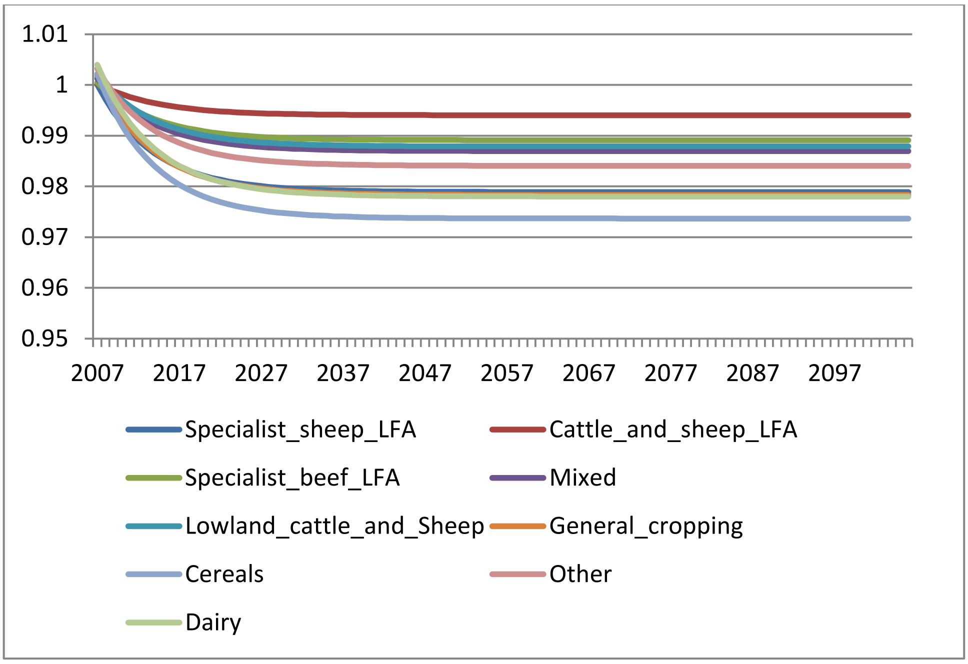


Figure 6: Land rent income in both forward-looking models (ratio values with respect to base run).



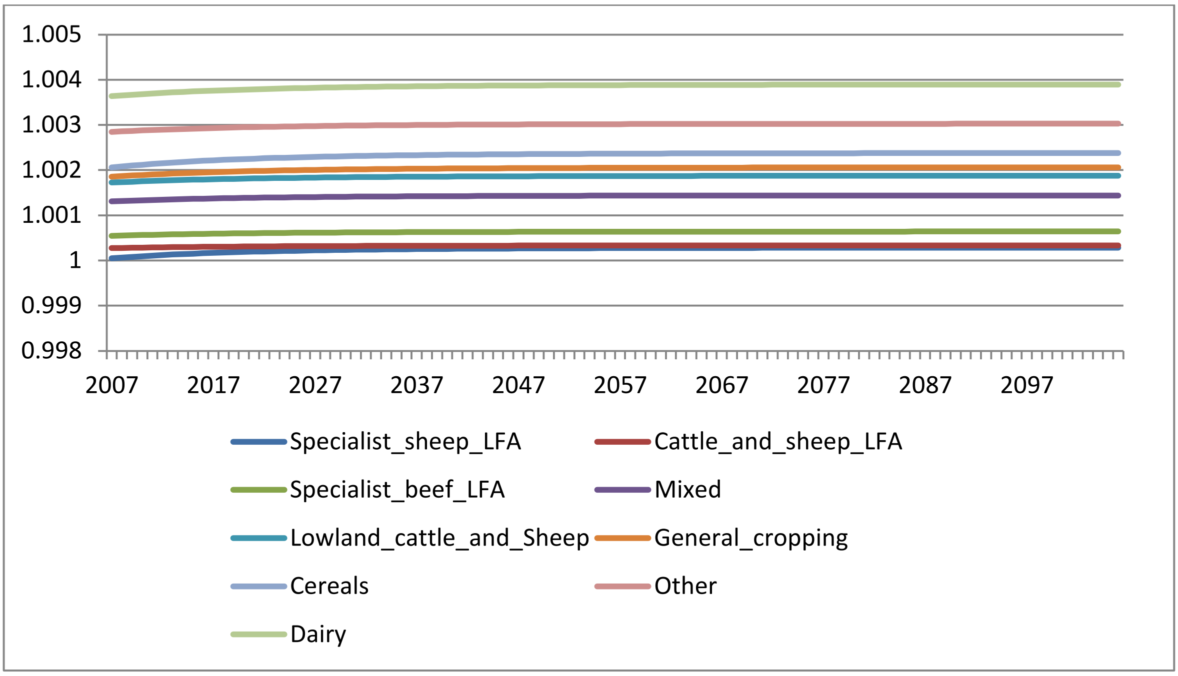
The output of the farm types decreases for the backward-looking model as less capital accumulation takes place. This is because farm households save more, but also consume more and this has a negative effect on investment in the physical capital stock (see Figure 7).

Figure 7: Output for all farm types with backward-looking model (ratio values with respect to base run).



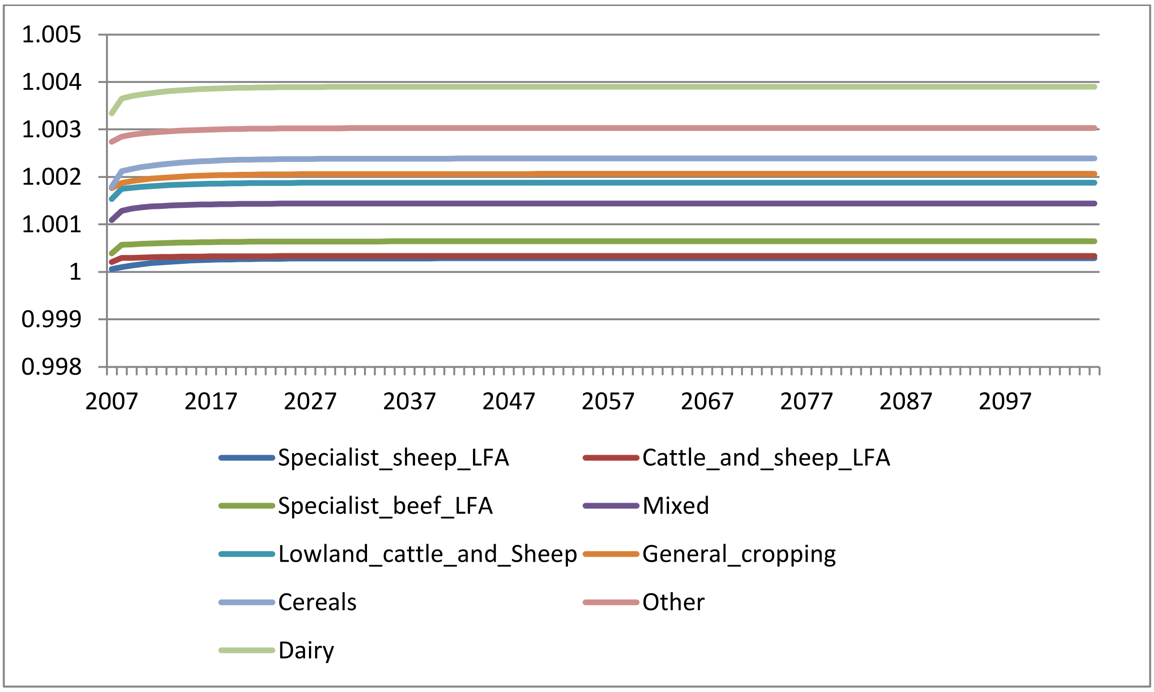
In contrast, for the two forward-looking models, output of the farm types increases as farm households keep investing in capital. Figure 8 compares the output results from the forward-looking model with mobile capital with that where capital is sector-specific.

Figure 8: Output for all farm types for forward-looking model with mobile capital (ratio values with respect to base run).



Notice the upward movement in the early years with the forward-looking model and capital sector-specific. This upward movement is not visible in the capital mobile version of the forward-looking model as capital can be reshuffled in the early years and put in use by those farm types where it is the most productive.

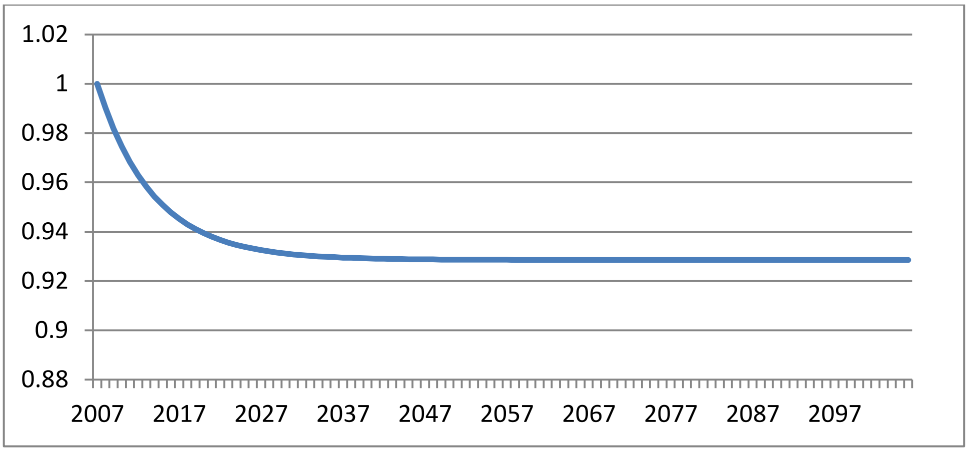
Figure 9: Output for all farm types for forward-looking model with sector-specific capital (ratio values with respect to base run).



The three downstream sectors which rely heavily on inputs from the farm sectors benefit most from all 20 non-agricultural sectors following decoupling (except for the backward-looking model after the initial years). Similar results are found for the fish, fruit and vegetable processing sector and the other food sector. Sectors which provide inputs to the farm sectors (that is, the upstream sectors) also fare well although to a lesser extent (for example the animal feed and chemical sector).

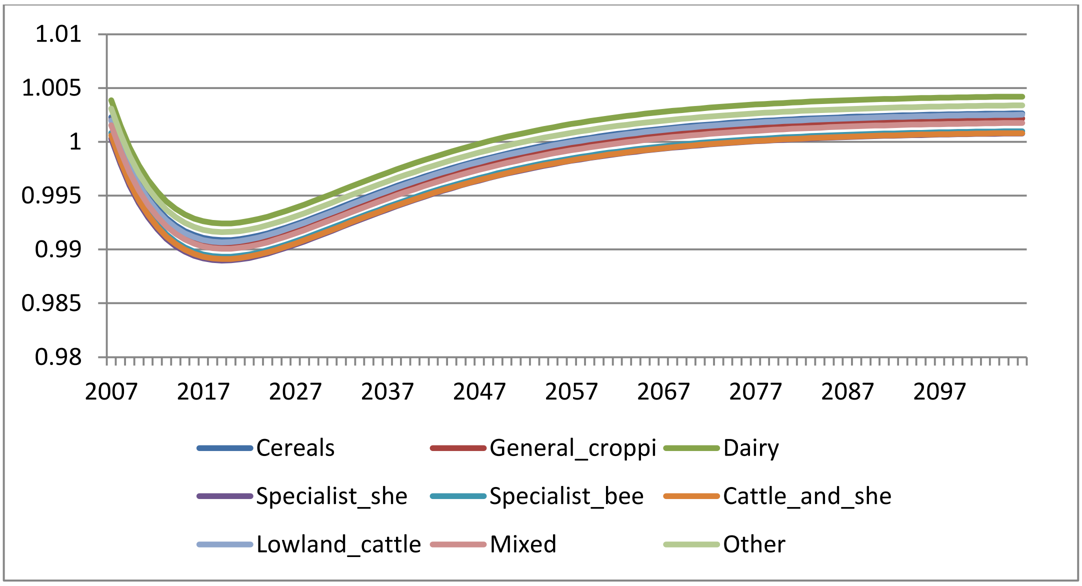
Part of the income of farmers is saved and invested in capital. To illustrate, for the backward-looking model, Figure 10 shows the evolution of capital stock owned by cereal farm types:

Figure 10: Capital stock in cereals farms and owned by farm households for the backward-looking model (ratio values with respect to base run – ratio value is also valid for all other agriculture farm types).



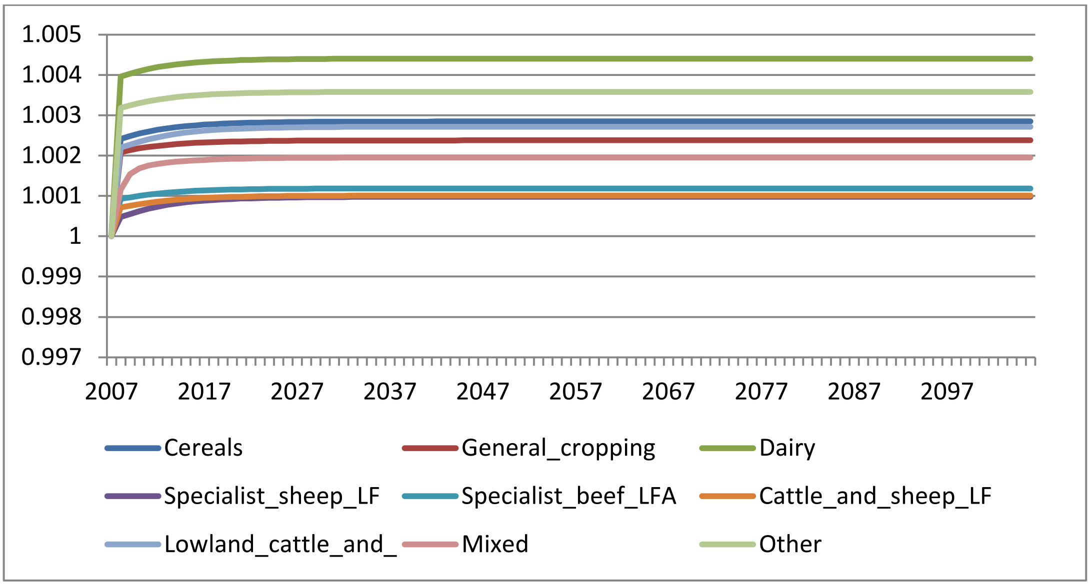
The capital stock decreases over time and in the long-term will be lower than the base run value. This is not the case for the forward-looking model with capital mobile between sectors. The following figure shows the stock of capital owned by farmers.

Figure 11: Capital stock for all farm types for the forward-looking model with capital mobile (ratio values with respect to base run).



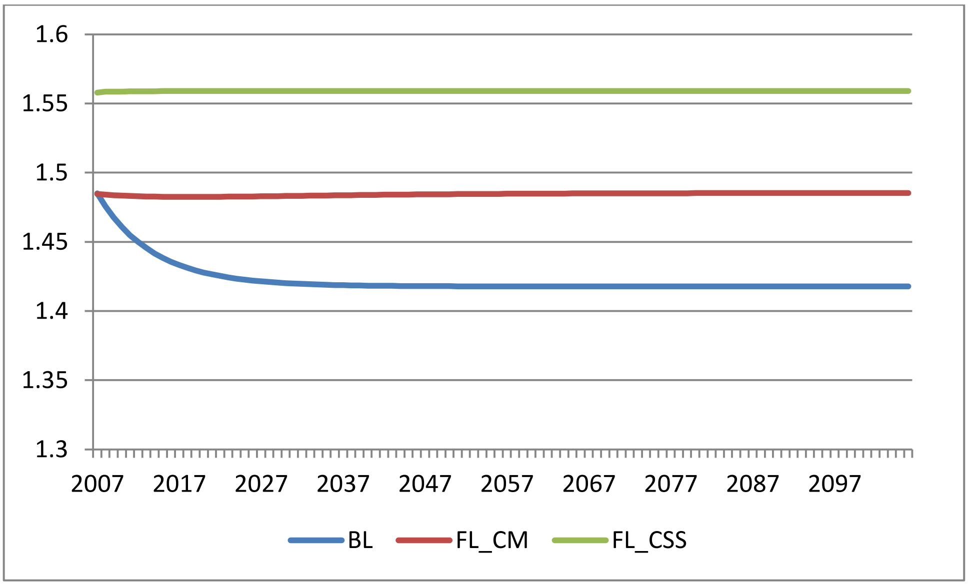
As capital is mobile between sectors there is an initial reshuffling of capital to the most productive sectors after the shock occurs. After a while investment increases and capital stocks increase again. In this particular simulation, in the very short-term and in the long-term the stock of capital is higher than in the base run. For the forward-looking model with capital sector-specific we have an increase in the stock of capital for all farm types:

Figure 12: Capital stock for farm types in the forward-looking model with capital sector-specific (ratio values with respect to base run).



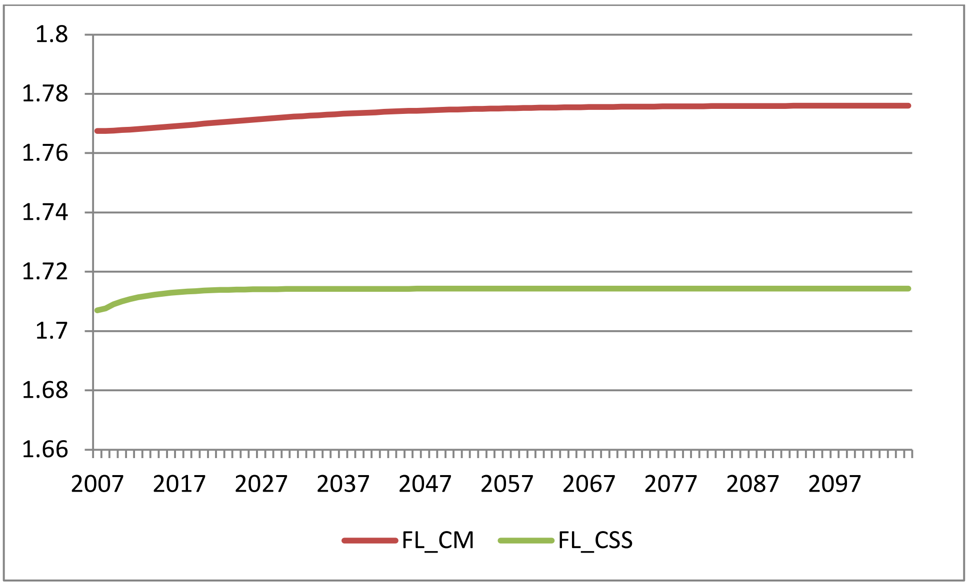
A land subsidy to agricultural farm types increases farm households' total income, but only indirectly (Figure 13).

Figure 13: Total income of farm households over time (ratio value with respect to base run).



This is mainly due to the increase in rent farmers receive (see Figure 5): The fixed factors of production benefit the most from the subsidies provided by the government. As rent income increases more for the forward-looking model with capital sector-specific, compared to the forward-looking model with mobile capital (see Figure 6), the ratio is higher for the former than the latter.

Figure 14: Consumption expenditures for farm households with forward-looking models (ratio values with respect to base run).



The level of consumption rises more in the forward-looking model with mobile capital as it allows capital to be employed in those sectors that are more productive. In the early years there is no need to invest much to allow for increased consumption. With capital sector-specific the capital stock in those sectors first have to be built up, which means that the benefits arrive later. It should be noted that the value of consumption for the other two household types (rural non-farm and urban) has decreased for all three model types.

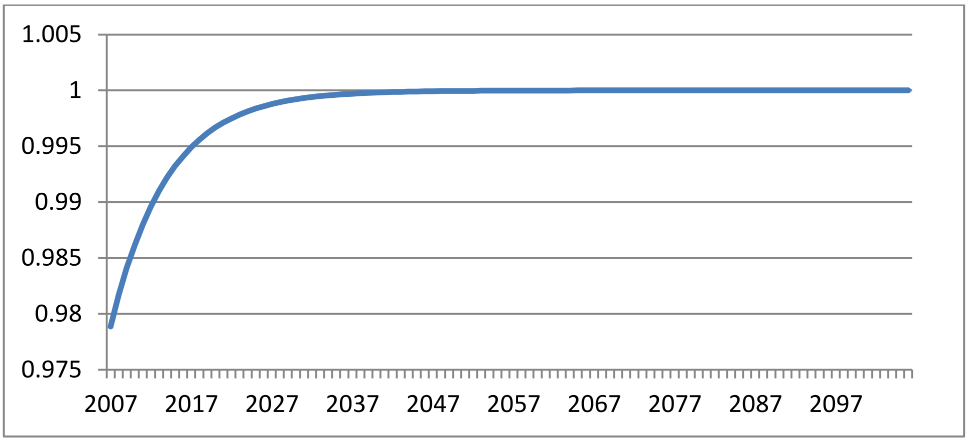
Table 5 shows the welfare effects of the decoupling simulation, in terms of equivalent variation for all household types. The equivalent variation is negative for the farm households for the three model types indicating that the farm households are willing to pay to have the policy (the land subsidy to production) change taking place. The non-farm and urban households are worse off as a result of the simulation.

Table 5: The value of equivalent variation for the three simulations and the three household types (thousands of pounds).

	EV Farm households	EV Non-farm Rural households	EV Urban households
BL	-710	1,635	2,500
FL-CM	-1,222	246	289
FL-CSS	-1,132	195	236

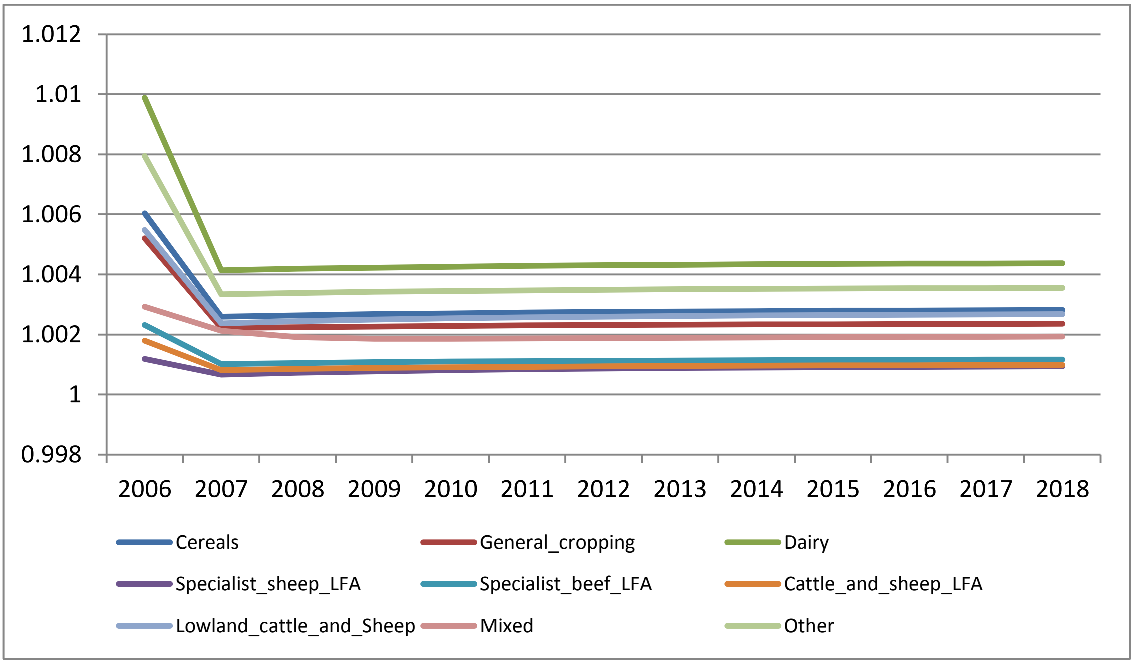
Finally, in terms of investment, as noted above, farm households' consumption in the backward-looking model is high in initial years but decreases over time. As a consequence, initial investment is lower than the base run values for investment. As an example, Figure 17 shows the level of investment for the cereals farms. In later years the level of investment is slightly lower than in the base run. This pattern is the same for all other agricultural farm types.

Figure 15: Level of investment in cereals farms by farm households for the backward-looking model (ratio values with respect to base run - also for all other agriculture farm types).



In the forward-looking models consumption of farm households increases in the early years, but not as much as in later years. This leaves room for investment and all levels of investment increase compared to the base run for the forward-looking model with capital sector-specific (Figure 18). In other words, compared to the backward-looking model, farm households restrain themselves to enjoy higher levels of consumption in the future through the build-up of capital to achieve higher output levels. This effect is not picked up by the backward-looking model.

Figure 16: Level of investment by farm types with forward-looking model (ratio values with respect to base run).



5.2 A Systematic Sensitivity Analysis

To take into account the uncertainty of certain parameter values a systematic sensitivity analysis is conducted based on uncertainty in the CET exponent for all the farm types. The CET coefficients are taken as random variables with mean 1.5 for all farm types. It is assumed that these values are drawn from a normal distribution with values between 1.5±0.3. The following three figures show the level of real GDP with upper and lower bounds, which are plus/minus one standard deviation creating a 68.2% confidence interval around the average value for the three model types. See DeVuysta and Preckel (2007) and Preckel et al. (2010) for details.

Figure 17: Real GDP over time for backward-looking model.

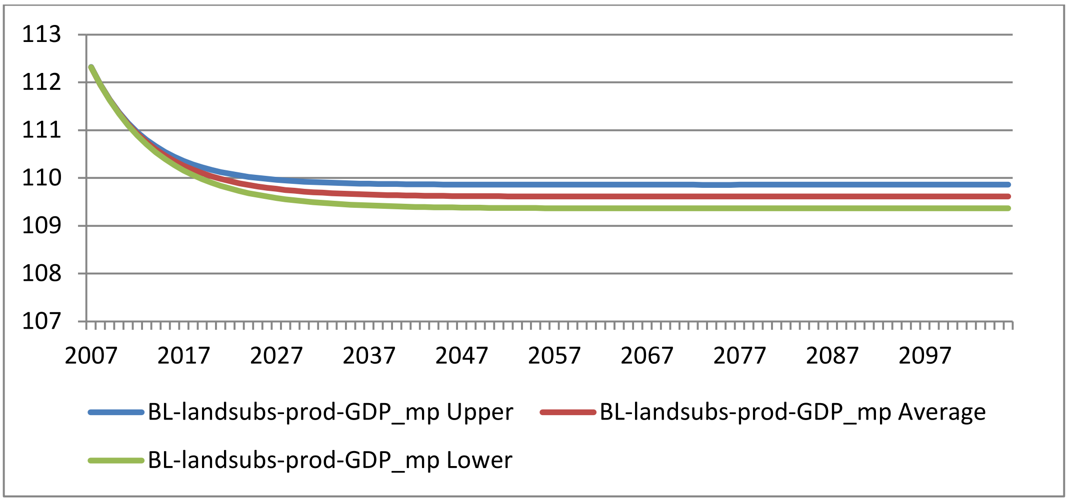


Figure 18: Real GDP over time for forward-looking model with capital mobile.

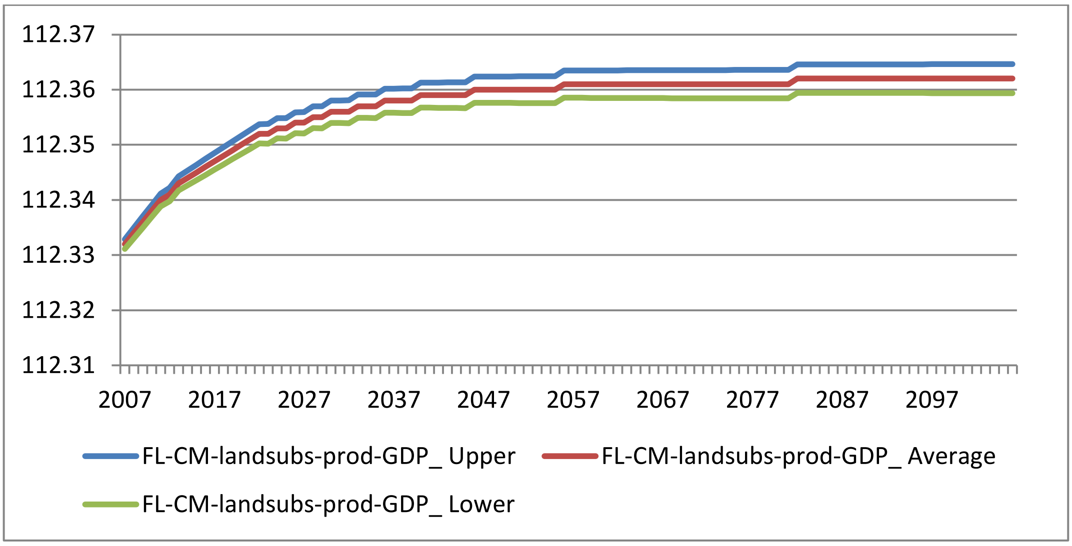
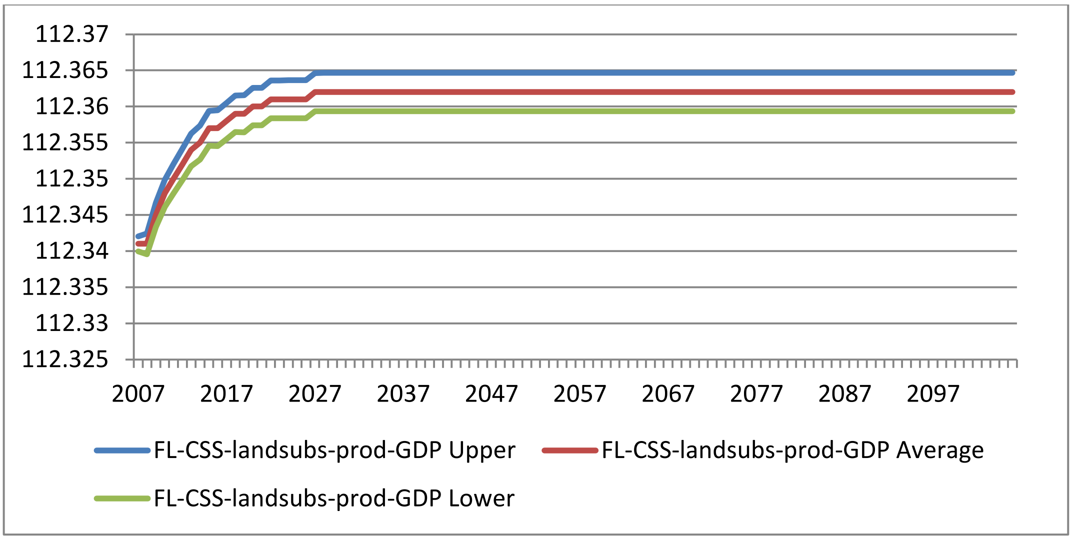


Figure 19: Real GDP over time for forward-looking model with capital sector-specific.



6. Concluding Remarks

This paper has explored the impact of decoupling agricultural support using two different types of CGE model – one backward-looking with farm households assumed myopic, the other forward-looking, allowing farm households to anticipate future developments and act accordingly so as to restore the arbitrage conditions between the returns of the different assets they own. Decoupled payments are modelled as subsidies to land. In both cases, the results show that such support increases farm households' welfare at the expense of rural non-farm and urban households. Agricultural farm types see an increase in output and also down-and upstream sectors experience production increases.

The predicted behaviour of farm households postponing consumption to increase higher levels of future consumption has been observed with for the forward-looking model due to the fact that in forward-looking models households adjust consumption and investment to equate returns on assets. Such behaviour is ignored in a backward-looking model where instead households are assumed to take decisions based on past developments. As such, the outcomes of the two types of CGE models differ in both the short-run and the long-run. In particular, recursive dynamic models that ignore the arbitrage conditions that underlie the forward-looking model can under-or overestimate the actual results. The same is true for static models. As the solution of a static model is the first period solution of a dynamic model, it will not pick up the effects of arbitrage conditions, let alone, future developments when capital accumulation is taken into account. If households do make decisions based on future development, forward-looking models are more appropriate to use to analyse the effects of policy reforms like decoupling within the CAP. Adjustments in the forward-looking model with capital mobile between sectors may overstate what actually would be observed after a policy change. On the other hand, sector-specific forward-looking models ignore adjustments to the capital stock that take time, but will make capital more useful also in other sectors. Therefore, their long-term results may be understated.

The results of the paper are preliminary and call for further theoretical analysis that focuses on the adjustments in both types of models. As is always the case with CGE models, the calibration of the model could be improved as many parameter values have been selected without a proper justification. The use of Systematic Sensitivity Analysis would help overcome this limitation.

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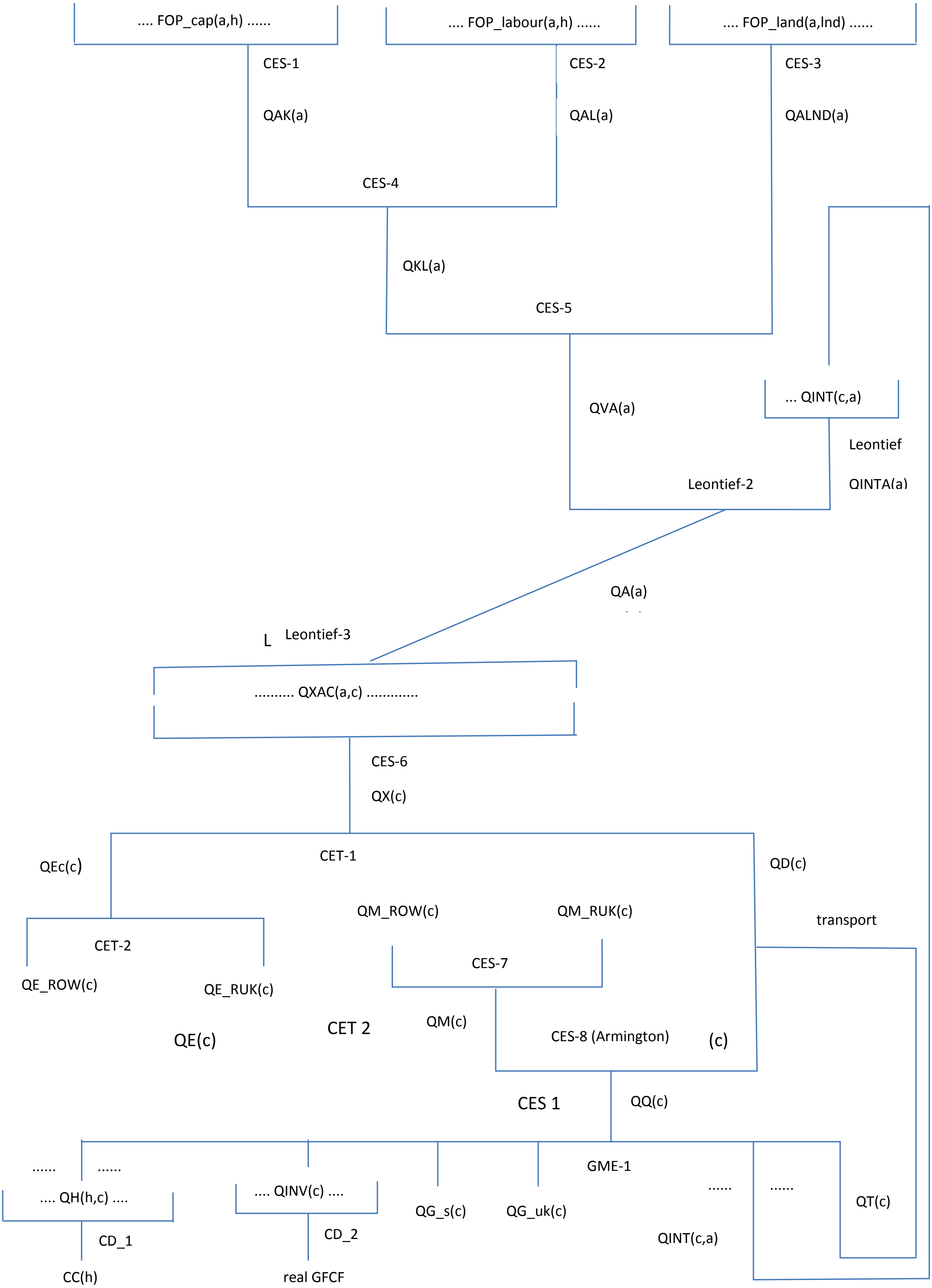
Appendix A: Production functions and flows of the model.



Appendix B: Sectors and commodities in the AGRISAM07

Sectors in the SAM		**SIC (2003)**	**Commodities in the SAM**	
Cereals	A1	01(part)	Cereals	C1
General Cropping	A2	01(part)	Potatoes	C2
Dairy	A3	01(part)	Other Crops	C3
Specialist Sheep (LFA)	A4	01(part)	Horticulture	C4
Specialist Beef (LFA)	A5	01(part)	cattle	C5
Cattle and Sheep (LFA)	A6	01(part)	Sheep	C6
Lowland Cattle &Sheep	A7	01(part)	Pigs	C7
Mixed	A8	01(part)	Poultry	C8
OTHER	A9	01(part)	Milk	C9
			Other Livestock	C10
			Miscellaneous	C11
Forestry	A10	02	Forestry	C12
Fishing and Mining	A11	05,10-14	Fishing and Mining	C13
Meat processing	A12	15.1	Meat processing	C14
Fish, fruit & vegetable processing	A13	15.2,15.3	Fish, fruit & vegetable processing	C15
Prepared animal feed	A14	15.7	Prepared animal feed	C16
Other food	A15	15.4,15.5,15.6, 15.9, 15.81-15.89	Other food	C17
Coke, refined petroleum & nuclear fuel	A16	23	Coke, refined petroleum & nuclear fuel	C18
Chemical	A17	24.1-24.6	Chemical	C19
Manufacture of machinery	A18	29,30	Manufacture of machinery	C20
Other Manufacturing	A19	16-22,24.7,25-28, 31-37	Other Manufacturing	C21
Electricity, gas and hot water	A20	40	Electricity, gas and hot water	C22
Water	A21	41	Water	C23
Construction	A22	45	Construction	C24
Wholesale & retail	A23	50,51,52	Wholesale & retail	C25
Hotels, catering & pubs etc	A24	55	Hotels, catering & pubs etc	C26
Transport and communication	A25	60-64	Transport and communication	C27
Finance and business	A26	65-67,70-74	Finance and business	C28
Public admin	A27	75	Public admin	C29
Education, health and social work	A28	80,85	Education, health and social work	C30
Other services	A29	90-93,95	Other services	C31