GOBIERNO DE ARAGON
Departamento de Ciencia,
Tecnología y Universidad

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CENTRO DE INVESTIGACIÓN Y TECNOLOGÍA
AGROALIMENTARIA DE ARAGÓN

QUANTIFYING POTENTIAL TRADE DISTORTION FROM THE SINGLE FARM PAYMENT

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Documento de Trabajo 09/01

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Quantifying Potential Trade Distortion from the Single Farm Payment [1]

I. Introduction

Despite numerous setbacks stemming from the conflicting political interests of the (then) 15 EU member states, on 26th June 2003, a mid-term review (MTR) 'compromise' agreement for the common agricultural policy (CAP) was finally reached. From 2005 onwards, farmers are eligible for a lump-sum 'single farm payment' (SFP) to (i) replace the array of existing 'partially decoupled' payments and (ii) compensate for further support price reductions. Importantly, the SFP is independent of farm production ('fully decoupled'), although subject to farmer compliance with food safety and animal welfare standards (if engaging in agricultural activity), or maintenance of the land in good agricultural and environmental condition (if leaving the land idle).[2]

By fashioning a more contemporary approach to pillar 1 funding, the European Commission argues that the SFP fulfils a number of key criteria lacking in the 'old' market regimes. More specifically, in the context of the Lisbon Strategy, the SFP bestows greater transparency, is more adept at transferring resources to farmers and reduces the bureaucratic burden of administering EU agricultural support. Moreover, the payment is, in principle, classed as non trade distorting (more below) and serves as a useful tool upon which further policy measures (i.e., cross compliance) can be based. In addition to 'cornerstone' cereals and livestock activities, this 'model' of support has been adopted for sugar, tobacco, olive oil, fruit and vegetables and wine, whilst other sectors will undoubtedly follow suit.

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[1] The authors acknowledge the the Department of Environment, Food and Rural Affairs (DEFRA) of the UK Government for financial assistance provided on an earlier version of this research.

[2] It should be noted that there is no definitive definition of 'decoupling' in the literature. The approach adopted here is the WTO's administrative definition contained in paragraph 6, Annex 2 (green box) of the Uruguay Round Agreement on Agriculture.

Notwithstanding, criticisms remain relating to CAP equitability, and consequently, its social acceptability. Such concerns will constitute a serious topic of debate within the ‘CAP Health Check’ in 2008, whilst longstanding unease over EU budgetary spending (particularly in agriculture), has prompted a full EU spending review, which will be concluded in 2009. Looking slightly further ahead, the future of pillar 1 funding will depend on the extent to which the SFP fulfils the criteria mentioned above, and the relative importance attached to each.

Focusing on the criterion of trade distortion, the EU argues that divorcing payments from production (i.e., decoupling) renders the SFP as ‘production neutral’ and thereby non trade distorting. Consequently, the EU claims that the SFP qualifies for ‘green box’ status and is thereby exempt from WTO disciplines.[3] In this context, the 2003 MTR reforms partly served as a pre-emptive measure to both mitigate against potential difficulties from the expiration of the Peace Clause (Article 13 – Uruguay Round Agreement) and minimise the impact of anticipated amber and blue box reductions.

In this paper we reassess the relationship between EU agricultural policy and its concomitant impact on trade, employing a heavily modified EU/CAP version of the Global Trade Analysis Project (GTAP) computable general equilibrium (CGE) model. As a primary aim, we seek to improve the treatment of the SFP in the modelling literature, employing the same ‘production neutrality’ restriction as imposed in the seminal work of Frandsen *et al.* (2003). We validate our characterisation of the SFP in the context of other studies whilst our treatment also renders estimates of land idling, which is not considered in the aforementioned study. In a second set of experiments, we respond to the observation (Gohin, 2005) that in practice, only a proportion of the SFP is recapitalised into agricultural land. This implies that a remaining proportion is consolidated within other ‘value added’ components of agricultural production (i.e., capital and

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[3] This hypothesis is, however, by no means unanimously supported in the literature (see for example, Swinbank, 2005).

labour). By varying the allocation of the SFP across land, labour and capital factors in agriculture, we aim to quantify the potential trade distortionary and growth impacts, and by implication, assess the status of the SFP as a green box policy.

The remainder of the paper is structured as follows. In the next section, we examine the representation of the SFP in the relevant literature and the implications for further research. In section III, we discuss the modelling improvements made to our CAP variant of the GTAP model. In section IV, we describe the data aggregation, the scenario design and discuss our results. Section V concludes.

II. Literature Review

There are many partial equilibrium characterisations (CAPRI, GOLD, FAPRI, AGLINK, ESIM, AGMEMOD) which facilitate evaluation of domestic policy reform scenarios across highly disaggregated agricultural sectors. On the other hand, global CGE models more comprehensively capture gross bilateral trade links between countries/regions, and are consequently the favoured approach when examining the relationship between domestic and international markets. Given our objective of measuring trade distortions on world markets from EU agricultural policy, in this study we favour the CGE modelling approach.

Examining the agricultural modelling literature, Frandsen et al. (2003) examine the representation of the SFP in CGE models, also noted in this journal by Balkhausen et al, (2008). To characterise the SFP, the authors implement a homogeneous (or uniform) land subsidy on all primary agricultural using sectors reflecting the fact that the payment is tied to a ‘registered’ land area and does not favour any specific on-farm activity. Employing the criterion of production neutrality (i.e., decoupling) to evaluate their model treatment, the authors compare supply responsiveness across sectors from removal of all ‘coupled’ EU15 agricultural support, with an alternative scenario where in addition to removing support, the SFP is implemented. Since the registered (productive) land endowment is exogenously fixed by region and is specific to agricultural sectors, estimates of EU15 supply responsiveness and trade closely converge in both scenarios (i.e., production neutral), whilst 'cross-commodity effects'[4] are eliminated as all agricultural activities receive the same per unit subsidy. To summarise, (i) the payment is fully decoupled from agricultural production; (ii) coupled to registered agricultural land and; (iii) is recapitalised into the value of land. This characterisation has been adopted in a number of recent multiregional CGE studies on EU farm policy in the context of Enlargement (e.g., Jensen and Frandsen 2004) and the WTO Doha round (e.g., Walsh *et al.* 2005).

One disadvantage of this modelling treatment is linked to the exogenous treatment of the land factor. Implicitly, this modelling assumption supposes that the level of 'productive' land within the registered area remains unchanged. In practice, the only pre-requisite for receipt of the SFP is that the land must be maintained in good agricultural and environmental condition, such that farmers facing higher marginal costs/lower crop margins, may merely 'idle' the land and receive the payment. In addition, a uniform land payment implies reduced relative profitability on certain arable crops (compared with the Agenda 2000 package), which may encourage a decline in, or even abandonment of, production. The analysis is further complicated by recent land use trends in favour of biofuels production as a response to greater demands for alternative energy sources. Notwithstanding, we would expect to see some degree of land idling from the decoupling of EU farm support, something which, to the best of our knowledge, has not been estimated endogenously in any modelling study to date. We revisit these issues in our characterisation of the SFP.

A further comment relates to the existence of rational 'non-price' decision making considerations, which may in fact render the SFP as production distorting. For example, if farmers are guaranteed a lump sum payment, those with decreasing absolute risk with respect to

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[4] If a direct payment only favoured certain agricultural activities, farmers would respond to the ensuing relative change in market prices, leading to a different pattern of production compared with if the policy had never existed. These are known as cross commodity effects.

wealth will have a propensity to undertake a riskier set of production decisions than they might have done had the payment not existed (Frandsen *et al.* 2003). Furthermore, the calculation of the SFP is based on the farmer's average entitlements over a base period (2000-2002), which if periodically revised, would provide the farmer an incentive to maintain abnormally high levels of current production with the expectation that it will bestow positive benefits in the future.[5] Whilst recognising the potential production distortion, unless one resorts to subjective assumptions regarding region-wide farmer behaviour, neither 'non-price' mechanism can be transparently conceived within a price dependent deterministic framework. Consequently, as in Frandsen et al. (2003), in this paper we abstract from such considerations.

Finally, on the relationship between land premiums and agricultural rents, Gohin (2005) notes that, "statistics from Eurostat show that rents for agricultural land are still much lower than (Agenda 2000) per hectare direct payments" (Gohin 2005, pp5) and also cites similar US studies which show that only 30-40% of US direct support payments in 1997 were capitalised into land rents. He postulates that such observations may be motivated by market imperfections which delay the transmission of payments into higher land rents, or rigid leasing agreements in some EU member states which offer limited possibilities to renegotiate the terms of the contract. Alternatively, farmers may, "perceive these new direct payments as a reward for their labour and thus resist to fully transmit these payments to landowners" (Gohin 2005, pp6), or the wealth induced effects of the SFP may even encourage greater on-farm capital investment. On the basis of this evidence, and in contrast with the approach adopted in Frandsen *et al.*, (2003), the SFP should be conceived (at least partly) as a labour/capital subsidy. Moreover,whilst the registered (productive) land area is fixed, labour and capital are not necessarily bound to agriculture, which implies that increased returns on these factors from the SFP could imply a production effect.

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[5] In the context of the CAP health check, it is probable that the 'historic' SFP model which favours the 'old' EU members may be replaced by a flat rate model favoured by the accession members. This model promotes a more equitable distribution of farm payments and consequently addresses a longstanding criticism of the CAP.

Thus, in the second part of this paper, we examine the implications of this modelling assumption on supply responsiveness and trade.

III. A Modified EU/CAP Variant of the GTAP Model

Model Description

Employing neo-classical multistage budgeting and weak separability, final demands for goods and services by the ‘regional household’ are subdivided into private, public and investment (savings) expenditures, permitting the use of different elasticiy of substitution estimates in each level of the nest structure. Production activities are assumed perfectly competitive with constant returns to scale. Production levels are ‘demand driven’ via market clearing equations, where intermediate and primary factor demands are also broken into separate nests based on Hicksian multistage cost-minimising optimisation.

We improve the standard model characterisation of agricultural factor and input markets following the work of Keeney and Hertel (2005). Thus, to capture the observed rigidity between agricultural/non-agricultural markets leading to wage and rent differentials, labour and capital allocation is controlled through a constant elasticity of transformation (CET) function:

$$QO_{i,r} = A_{i,r}\left[\delta_{i,j,r} QOAGR_{i,r}^{\rho_i} + (1-\delta_{i,j,r}) QONAGR_{i,r}^{\rho_i}\right]^{\frac{1}{\rho_i}} \qquad \sigma_i = \frac{\rho_i}{1-\rho_i} \qquad (1)$$

where $\delta_{i,r}$ is a CET share parameter; $A_{i,r}$ is a scale parameter; and ρ_i is an elasticity parameter. Maximising revenue subject to the CET function (4), yields the allocation of capital and labour factor ‘i’ to the agricultural (QOAGR) and non-agricultural (QONAGR) sectors, where the elasticity of transformation (σ_i) determines the degree of labour/capital supply responsiveness to relative price changes between using sub-sectors.[6] In addition, CES substitution possibilities (based on elasticity estimates from Keeney and Hertel (op. cit.)) are now modelled between

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[6] The CET elasticity of transformation which controls the passage of labour and capital between primary agricultural and non-primary agricultural usage, is calibrated to econometric central estimates of factor supply elasticities to agriculture in the literature (Keeney and Hertel, 2005).

primary factors and intermediate inputs, whilst in the livestock sectors, the composition of intermediate feed usage is now also price sensitive.[7]

In the standard model, land is exclusively employed in primary agricultural sectors, and 'sluggishly' allocated across all using sectors 'j', by a single CET elasticity. This implies that land is equally substitutable between all agricultural activities. In this study, we remove this restrictive assumption by following a similar treatment to the OECD's Policy Evaluation Model (OECD, 2003). Employing a three-stage weakly separable CET revenue maximisation problem, agricultural sectors are grouped into nests according to the ease of substitutability of land (see appendix). As we descend down the nest, the CET elasticity doubles, implying easier substitution of land between competing agricultural uses. To maintain equilibrium, market clearing equations between sluggish primary factor demands ($QFE_{i,j,r}$) and supplies ($QOES_{i,j,r}$) are implemented for each using sector 'j':

$$QFE_{i,j,r} = QOES_{i,j,r} \tag{2}$$

In the context of the literature review in section II, credible analysis of CAP policy analysis necessitates explicit incorporation of the relevant EU agricultural policy instruments (production quotas, CAP budget, SFP and 'coupled' support removal, set aside, intervention prices and stock purchases). Consequently, we employ the latest developments in the literature to extend the standard representation to incorporate these model features.[8]

A final model feature is the addition of biofuels into the model code and data. In the context of current land use trends, this extension is necessary to improve the credibility of land idling estimates from adoption of the SFP. We employ a specially adapted version 6 GTAP data

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[7] In the standard GTAP model, a Leontief function characterises the combination of intermediate input and primary factors. This implies that, for example, the intensiveness of fertiliser application on land cannot alter with a policy change, or that competing feeds are not substitutable in livestock sectors. In our model, both these unrealistic restrictions are removed. In each case, the substitution elasticities are calibrated to OECD central values of Allen partial elasticities (Keeney and Hertel, 2005).

[8] A detailed description of the CAP modelling can be gained from the corresponding author upon request.

(Taheripour *et al.*, 2008) which includes biodiesel (based on oilseeds) and two bioethanol (based on grains and sugarcane) activities. The private demand nest of the model is adopted to allow for substitution possibilities between petroleum and biofuels demand. To capture the key driver of biofuel usage, we shock the world crude oil price by 250%, which corresponds to the oil price rise since the 2001 benchmark year. The elasticities of substitution values in the private demands nest were chosen to recreate historical EU27 biodiesel and US grain bioethanol output increases betwen 2001 and 2006 (Birur *et al*, 2008).

To ensure a general equilibrium, large systems of ‘clearing’ equations are introduced to the factor, input and commodity markets. Accounting identities check that regional households and producers remain on their budget and cost constraints respectively and household expenditures equal household incomes (i.e., tax/tariff revenues and ownership of factors of production). Moreover, we assume a long run time horizon implying zero profits in all production sectors and full employment prevails in all labour (i.e., wages are fully flexible) and capital markets. Finally, to apportion investment demands across regions, a fictitious agent, known as the ‘global bank’, collects global investment funds (all regions’ savings) and disburses them based on fixed regional investment shares. Once the model structure is formalised and calibrated to our chosen aggregation in the benchmark year, specific macroeconomic or trade policy scenario questions may be addressed by imposing exogenous *shocks* to key policy variables (i.e., changes to tax/subsidy rates, labour supply, technical change variables etc.). The model responds through the interaction of economic agents in each market, where an outcome is characterised by a new set of interdependent equilibria.

Econometric Estimation of Land Supply Functions

To incorporate a treatment of land idling, we need a procedure to derive estimates of land supply functions in each region. In this study, we follow the non-linear specification of Tabeau et al (2006), to relate land area and price:

$$\text{Area} = \text{a} - \frac{\text{b}_0}{(\text{C}_0 + \text{Pr}\,ice^{p})} \qquad (3)$$

where ‘a’ is the asymptote of the function representing the maximum potential available land for agricultural purposes; ‘b_0’, ‘C_0’ and ‘p’ are estimable parameters. For the econometric estimation, data on potential agricultural areas and yields developed by the International Institute for Applied System Analysis (IIASA, 2007) and FAO (2007) are employed. More specifically, yields and area data for 4 different levels of land suitability across 23 crop types are available for each region (92 observations).

In an initial step, these observations are sorted in descending order of yields and the corresponding potential area is accumulated. Given the nature of data available, which aggregates raw information on geographical grid cells into types of suitability for different crops, the ‘total accumulated potential area’ for agricultural activity is larger than the conceptual asymptote or ‘maximum available (agricultural) land area’ (i.e. the same grid-cell can be suitable for alternative crops). Accordingly, the supply function is re-scaled, assuming that the ‘total accumulated land area’ corresponds to the actual maximum available land area (i.e. the distribution of the accumulated area is proportional to the distribution of the available land along the range of yields). The ‘maximum available land area’ (or asymptote) for each country is calculated (using data by IIASA and FAO) as the remaining land *excluding* bodies of water, closed forest ecosystems, other land protection schemes and land employed for housing and infrastructure.

Making the rational behavioural assumption that the most productive land is employed initially, the marginal cost of land increases, which reflects the increased conversion cost of additional units of marginal land. Accordingly, we define the price of land as the reciprocal of the potential yield (1/yield). We normalise all prices by dividing by the minimum price in each country-sample (i.e. each yield is divided by the maximum sample yield), which leads to normalized prices above 1 and yields between 0 and 1. This scaling helps to infer the relative suitability of each country for each crop, while from an econometric standpoint it accelerates convergence to a solution.

The empirical land supply equation becomes:

$$R\_Area_j = 1 - \frac{b}{C_0 + R\_Price_j^p} + \varepsilon_j \qquad (4)$$

where the sub-index j refers to each of the 92 observations available for each country/region; R_Area is the relative accumulated area for observation j; R_Price is the relative land price for observation j; b, C0 and p are parameters to estimate, with b = b_0/a; and finally, ε_j is the error term, which is assumed to be normally distributed, N(0,σ). Equation (4) is estimated by Weighted Maximum Likelihood (a suitable method for non-linear models). To improve the fit of the estimated function to the original data, we assign higher weights to those observations with greater $R\_Price_{j.}$

The location of each country/region on its land supply curve is the use ratio (R_Area_C) of agricultural land use in 2000/2001 to maximum available land area measure discussed above. Substituting calculated land use ratio estimates (R_Area_C) into equation (4) and re-arranging, the ‘current relative price’ (R_Price_C) is obtained. The point elasticity of the land supply function at these coordinates can then be expressed as:

$$E^S = \frac{\partial R\_Area}{\partial R\_Price} \bullet \frac{R\_Price_C}{R\_Area_C} = \frac{\hat{b} \cdot \hat{p} \cdot R\_Price_C^{\hat{p}}}{(\hat{C}_0 + R\_Price_C^{\hat{p}})\left(\hat{C}_0 + R\_Price_C^{\hat{p}} - \hat{b}\right)} \qquad (5)$$

where the circumflex over the parameters indicates the estimated coefficients.[9]

In the model framework, equation (4) is inserted directly into the model code, where prices in the 2001 benchmark data can be calibrated given knowledge of the remaining parameters and land use ratio. To validate the correct implementation of the land supply function, we check that

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[9] A full list of parameter estimates, standard errors, mean log-likelihood values, land use ratios and point elasticities for each of the 87 regions of the GTAP version 6 database is available from the authors on request.

calculated land supply elasticities from a simple shock are in close proximity to the point elasticities calculated in equation (5).

Modelling the SFP with endogenous land functions and 'idling'

The model is 'demand driven', where land supply to each agricultural sector 'j' reacts, subject to a transformation elasticity, to changing market clearing conditions. Figure 1 presents the supply (marginal factor cost) and demand (marginal revenue product) for *productive* land in a given agricultural sector 'j'. In the model, there are two land prices: the pre-subsidy price (P_S) and the post-subsidy land price (P_A). Thus, in the benchmark, the land subsidy per unit is P_S – P_A. In the model, the CES land demands are motivated by the farmer's demand curve (mrp_A), where at land usage L_1 the farmer's land price is P_A, whilst the pre-subsidy price for land is $P_{S.}$

[Figure 1 Here]

The effect of converting coupled domestic support (including benchmark land subsidies) into a uniform land payment increases the land subsidy per unit for the majority of sectors in comparison with the benchmark.[10] This implies a fall in P_A (now $P_A{}'$) as the post-subsidy land supply curve shifts to the right (mfc_A – $mfc_A{}'$), and an increased uptake of land by farmers at co-ordinates L_2, $P_A{}'$. With greater land usage, there is a movement along the seller's supply curve (mfc^M) from price P_s to $P_s{}'$ (reflecting the increased recapitalisation of land values from the SFP). Given that the uniform subsidy rate in most land using sectors 'j' increases, this leads to a higher regional (pre-subsidy) capitalised value of land in comparison with 2001.

In policy terms, greater land use represents an unrealistic outcome given the possible relationship between the SFP and greater land idling highlighted in section II. Moreover, the SFP is tied to a registered land area, which suggests that EU farmers are unlikely to cultivate new

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[10] The benchmark year for the GTAP data is 2001, which coincides with the Agenda 2000 package. GTAP data land subsidies (which are predominantly in the cereals and oilseeds sectors) cover (*inter alia*) payments on set-aside, hectare premiums, extensification premiums and agro-environmental schemes. The introduction of a uniform land payment will increase the per unit subsidy for most agricultural uses (and therefore land usage), whilst decreasing per unit subsidies and land usage in wheat, other grains, and oilseeds sectors. This is a realistic outcome and links with the discussion on land idling and relative crop profitability at the end of section II.

(marginal) land from outside the scheme. To prevent marginal land uptake from the SFP, we implement an upper 'kink' at the current land use point on the regional (pre-subsidy) supply function in each EU region as shown in Figure 2. Thus, summing over all sectors 'j', regional land usage rises coupled with a quantitative restriction on the aggregate (pre-subsidy) supply curve, manifests itself as an increase in land prices ($P_1 - P_2$).

[Figure 2 here]

A remaining problem is to estimate potential land idling. We employ a two-step procedure where we first endogenously estimate percentage reductions in the land endowment (i.e., land idling) from removal of those components of coupled support to be included within the SFP. In a second simulation, we rerun the same set of shocks including both uniform land payments (SFP) and exogenous negative land idling shocks to a Hicks-neutral land productivity variable. The productivity shocks in the second simulation are equal to the endogenously calculated land abandonment estimates in the first simulation, such that 'productive' agricultural land and supply response remains unchanged (i.e., production neutral).

IV. Data Aggregation, Scenario Design and Results.

Data Aggregation and Scenario Design

From the perspective of EU focused studies, a key advantage of the GTAP 6 database is that it offers a full disaggregation of the 27 member states. However, given the degree of modelling complexity, our chosen regional aggregation is limited to the largest three EU15 economies (France, Germany, UK), and 'composite' regions for the remaining EU15 members, the '2004 accession group' and the '2007 accession group'. To examine the effects of our approach on non-EU members, we include the USA, with the 'rest of the world' region capturing 'residual' production and trade flows. Given the focus on agriculture and food, all crops, livestock and food sectors are disaggregated within the database, with remaining sectors aggregated into 'raw materials', 'manufacturing' and 'services' (see Figure 3).

[Figure 3 here]

Figure 4 details the list of policy shocks imposed in our two step procedure (i.e., experiments 1a and 1b), where in the latter, we also include the SFP and negative exogenous land productivity shocks.[11]

[Figure 4 here]

Results – Experiment 1

In this section, our aim is to briefly focus on the predictive credibility of our representation of the SFP in the context of other modelling studies. In particular, we draw the reader's attention to our estimates of land idling and to the adherence to the principle of production neutrality, as employed in Frandsen *et al* (2003).

In Table 1, we show the impacts of simulations 1a and 1b on regional land usage and 'real' land prices, represented as the aggregate (regional) seller's price over all sectors 'j' deflated by the retail price index. In simulation 1a, eliminating coupled support (including Agenda 2000 land subsidies) dampens productive land demand (some of which is left idle) and reduces the aggregate land price. Given that econometrically estimates land supply elasticities differ across EU regions, land abandoment and concomitant aggregate land price falls in simulation 1a are non uniform across EU members.

In the EU15, 'idling' estimates range between 15.4% (UK) and 19.9% and 23.8% (Germany and France respectively), whilst real land rents fall by as much as 41.9% in France compared with the 2001 benchmark.[12] In the 2004 accession member states, the removal of coupled land support leads to small land abandonment estimates. This is because the benchmark year represents a pre-EU membership period where coupled land payments were considerably lower.

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[11] Note that we do not incorporate any 'Health Check' proposals in our scenarios – only approved policy measures are included.

[12] A perceived disadvantage of the 'standard' GTAP model is that land prices fall by unrealistically high magnitudes due to exogeneity of the land factor (i.e., no land idling). Experiments conducted by the authors show that prices fall by almost twice the magnitude compared with our endogenous land specification.

In the 2007 accession members (AC2), agricultural sectors face net taxes on their usage of productive land in the benchmark year, which explains why (i) there is no land abandonment when the distortion is removed[13] and (ii) the land prices *increase* slightly.

[Table 1 Here]

In simulation 1b (Table 1), the recapitalisation of the SFP leads to considerable real land price rises in all EU regions (compared with 2001). Given that both ‘accession’ regions have little or no land subsidy in 2001, the largest increases in land prices occur in these regions.

[Table 2 here]

Table 2 presents agro-food supply responsivenes results under simulation 1b. The magnitude of these estimates reflect (i) comparative levels of commodity support and protection in the AC12 and EU15 regions in 2001 prior to market enlargement;[14] (ii) the pattern of each countries’ import trade, (iii) the size of the Armington (trade) elasticity estimates and (iv) the impacts of the oil price rise on increased biofuel demand. Moreover, in the EU15, the removal of coupled support is uneven across EU15 members, where for example, output reductions in ‘oilseeds’ and ‘ocrops’ sectors in the EU9 (see Table 1) reflect eliminations in significant coupled olive oil and tobacco payments respectively (mainly in Greece, Italy and Spain).[15] Table 2 shows reductions in ‘wheat’ and ‘other grains’ production due to reductions in coupled support as well as a land substitution effect in favour of oilseeds production for biodiesel demand. Similarly, in the USA (ROW), ‘other grains’ (sugarcane) production increases 6.2% (3.5%) to meet increasing bioethanol demand. In the livestock and meat sectors, the removal of EU15 coupled support and

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[13] The removal of a net tax (in simulation 1a) has the same effect as increasing a net subsidy in that it will *increase* land uptake. Since we assume that land in each EU member cannot rise above a registered area, the corresponding uptake of land will not occur. Thus, in scenario 1b, with no compensating positive change in land to offset the effects of the tax removal (vis-à-vis a compensating negative change in land in the EU25 regions to offset the effects of the subsidy removal), the supply responsiveness in the AC2 regions displays lower accuracy than the remaining EU25 regions.

[14] In 2001, EU15 domestic support (PSE) is considerably higher than in the AC12.

[15] Although the reduction in oilseeds production in the EU9 is mitigated partly by increased biofuels demand.

tariff protection, leads to competitive output gains in the AC12.[16] Similar trends are also observed for rice (both sectors), processed sugar and dairy, whilst EU15 raw milk and raw sugar quotas remain binding.

[Table 3 here]

In Table 3 we validate our characterisation of the SFP based on the behavioural assumption of production neutrality. Comparing simulations 1a and 1b shows highly convergent patterns of supply responsiveness in all agricultural sectors with, and without, the SFP implemented. In the AC2, there are outliers because of the benchmark taxes on land usage. However, this has a very minor impact on EU27 production, where non-EU region supply responsiveness remains unchanged (Table 3).

Results – Experiment 2

As noted by Gohin (2005), the capitalisation of the SFP into land carries a time lag. Thus, within a medium to long run simulation framework, estimated land values cannot fall below the 2001 benchmark levels. Accordingly, in simulations 21b (22b), we implement 80% (60%) of the SFP into land with 6.67% (13.33%) of the SFP totals uniformly distributed across agricultural sectors on each of capital, unskilled- and skilled-labour.[17]

[Table 4 here]

The underlying result is that there is a high sensitivity of land rental rates to differing assumptions of SFP recapitalisation into the land factor. Under 80% and 60% recapitalisation, real rental rates fall dramatically compared with the 2001 benchmark. Notwithstanding, EU27 member land rental rates still rise in simulations 21b and 22b since the ‘ratio’ of the land subsidy to the value of land remains larger than in the 2001 benchmark. Indeed, with low (negative)

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[16] Red meat’ sectors are highly protected (meatpro) and rely on significant domestic support (catshp) in the form of suckler cow, special cow, slaughter, extensification, ewe and goat premiums. A comparison of our EU15 aggregate sectoral results with other studies of the MTR in the literature (see Gohin, 2005, Table 1), shows that the results for cereals, wheat, beef, pork/poultry and milk compare favourably with partial equilibrium studies.

[17] 60% capitalisation into land is the minimum level which guarantees that land prices in *all* EU regions increase relative to the 2001 benchmark, whilst 80% is chosen as a half way point between 60% and full capitalisation.

benchmark land subsidy ratios in the AC10 (AC2), even under 60% SFP land recapitalisation, land prices increase significantly compared with 2001 (81.2% and 53.9% in the AC10 and AC2 respectively). On the other hand, in Germany, the land subsidy ratio in simulation 22b is very close to the benchmark level with the result that the land price remains static. Furthermore, a region with a large SFP budget allocation as a proportion of the regional value of land will witness greater percentage point reductions in real land prices as we reduce the level of SFP capitalisation. Comparing between scenario 1b and scenario 22b, the largest percentage point falls are in the AC10 (-55.7%), the UK (-50.8%) and France (-47.5%).

[Table 5 here]

Estimates of the impacts on supply responsiveness are calculated relative to simulation 1b (production neutral) and are presented in Table 5. The recapitalisation of the SFP into non-agricultural specific factors, attracts greater labour and capital to the primary agricultural sectors leading to increased supply responsiveness relative to simulation 1b. The variations in sectoral supply response reflect differing general equilibrium demand elasticities, which are largely influenced by the magnitudes of the Armington substitution elasticities, the relative pattern of trade and the size of the policy shocks.[18] In the EU15, the largest production distortions occur in the wool sector, although these percentage increases reflect changes from a small production base. Notwithstanding, in cereals and oilseeds sectors, production distortions are as large as 9.2% (wheat), 5.8% (oilseeds) and 5.7% (ograins). Elsewhere, in ‘vegfrunuts’ and ‘catshp’ sectors, production is estimated to rise by up to 4.1% and 2.9% respectively under conditions of 60% SFP recapitalisation into land.[19] In the AC12, there is a greater intensity of land use in

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[18] Variations in supply responsiveness are *not* affected by differing factor intensities since in the GTAP data these are assumed uniform across using agricultural sectors (due to lack of secondary data sources).

[19] In this analysis, we maintain production quotas in milk and sugar sectors. The results show that these remain binding across all simulations.

primary agriculture. Consequently, reduced SFP capitalisation into land, moderates EU27 supply response increases compared with the EU15.

An important advantage of the CGE model approach over PE representations, is that it captures the ‘second round’ effects of increased availability of primary agricultural intermediate inputs on downstream food production. Clearly, EU27 food production increases less markedly, since the SFP is solely bestowed on EU primary agricultural activities, although the results show notable production increases in both downstream meat sectors. As expected, in the non-EU regions, there is a (slight) negative trend in primary agricultural and food processing production.[20]

[Table 6 here]

Tables 6 and 7 examine the corresponding trade distorting impacts. Increased EU supply responsiveness from greater SFP recapitalisation into agricultural labour and capital, has a direct impact on EU export potential. Examining Table 6 under 60% land recapitalisation, there are significant EU27 export increases (or distortions) in wool (23.2%), wheat (14.6%), plants (10.3%), ocrops (10.0%), ograins (6.6%) and oilseeds (6.4%). Equally, in the primary agricultural and downstream meat sectors, exports increase between 4-6% compared with simulation 1b. In addition, greater EU agro-food production leads to increased domestic substitution of imported goods. Examining Table 7, there are notable import falls in crops (e.g., cereals, oilseeds and ocrops), and livestock and meat imports. Greater intra-EU self sufficiency leads to reduced trade opportunities for non-EU regions resulting in falling exports (Table 6) and output (Table 5), and greater import substitution (Table 7)

[Table 7 here]

With detailed gross bilateral trade and protection data, the model provides useful estimates of weighted changes in world prices. In the context of our experiment, this feature provides a

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[20] It should be noted that the percentage reductions are calculated from large production bases.

useful measure of the trade distortionary impact on world prices from the SFP scheme. World price estimates in Table 8 exhibit falls in comparison with simulation 1b, due to increased supply of EU exports on world markets with EU exports. Under 60% land recapitalisation, our experiment reveals ‘upper limit’ price falls in each of ocrops (1.8%), ograins (1.5%), wheat (1.4%), oilseeds (1.3%) and vegfrunuts (1.0%). In livestock sectors, corresponding price falls are observed in catshp (1.3%) and pigspoultry (1.2%), whilst in both meat sectors, world price falls are more moderate (0.7%).

[Table 8 here]

Table 9 shows the impacts on agricultural and macro-economic growth in each of the regions of our aggregation. Any noted previously, greater recapitalisation into agricultural labour and capital factors encourages increased employment of these factors within agriculture, with the effect that the agricultural economy in the EU27 regions shows signs of growth compared with simulation S1b. The biggest impact occurs in France (up to 4% agricultural growth), whilst EU27 agricultural growth is recorded at 2.3% above simulation 1b. In our general equilibrium model, it is possible to capture the opportunity cost of reduced resource usage in (non subsidised) non-food sectors and losses in comparative advantage. Table 9 shows that EU macroeconomic performance suffers, although the small magnitude of this effect reflects the minor role that agriculture plays in the EU economy. Logically, the opposite effect occurs in the non-EU regions, where greater resource reallocation into competitive non-food sectors leads to greater comparative advantage and higher macroeconomic growth.

V. Conclusions

In this paper, we evaluate contemporary EU agricultural policy employing a computable general equilibium (CGE) characterisation, which captures the interrelationships between domestic and international agro-food markets, and ‘upstream’ and ‘downstream’ agro-food activities. As an initial aim, we set out to improve the existing characterisation of the SFP in the applied trade literature. Following the seminal work of Frandsen *et al.*, (2003), we impose the modelling restriction of ‘production neutrality’ within a two-step approach, whilst significantly improving their treatment to accomodate endogneous land functions and land idling estimates.

Firstly, we show that assuming 100% recapitalisation of the SFP into the registered agricultural land factor, the model predicts significant increases in land values. Secondly, comparing estimates of supply responsiveness in both steps, we show good convergence (i.e., production neutral) in the EU25, whilst in the AC2, convergence was slightly less convincing due to the existence of net land *taxes* in the benchmark data. This slight distortion was not found in Frandsen et al. (2003) since their experiment only applied to the EU15 regions. Thirdly, with application of the MTR reforms and accounting for land usage in biofuels activities, we estimate that France and Germany may idle as much as 23.8% and 19.9% of their registered land area compared with 2001, whilst for the EU27, our corresponding estimate is 14.7%. If a multilateral trade agreement is finally reached, greater market access commitments could imply even greater land idling in comparatively uncompetitive EU agricultural markets.

As a secondary aim of this paper, we examine the extent to which the single farm payment (SFP) may potentially distort production and trade in agro-food markets. The policy implication of our analysis rests on the European Commission’s assertion that the SFP is a green box policy tool (i.e., production neutral). In the context of evidence by Gohin (2005), we examine the extent to which a less than 100% recapitalisation of the SFP to the land factor may render the policy as production and trade distorting. More specifically, we run two experiments where a proportion of the SFP is recapitalised into the value of agricultural labour and capital factors.

The results clearly show that greater recapitalisation of the SFP into non agriculture specific factors (i.e., labour and capital) results in noticeable production and trade distortion effects in EU27 cereals, oilseeds and cattle and sheep. Consequently, we estimate that compared with the production neutral version of the SFP, world prices in a number of primary agricultural commodities deteriorate by up to 2%.

Whilst the land recapitalisation rate (i.e., 60% and 80%) is slightly crude, we justify this approach on the grounds that very little data is currently available on the transfer of SFP land premiums into prices. Notwithstanding, from the perspective of improving export led growth for poorer developing countries whose main source of income is based on primary agricultural exports, our results paint a worrying picture. Moreover, for proponents of the SFP 'model' of CAP support, our findings bring into question, at the very least, the European Commission's notion that the SFP is a green box policy.

VII. References

Balkhausen, O., Banse, M. and Grethe, H. (2008) Modelling CAP Decoupling in the EU: A Comparison of Selected Simulation Models and Results, *Journal of Agricultural Economics*, Volume 59, Issue 1, Page 57-71

Birur, D.K., Hertel, T.W. and Tyner, W. (2008) Impact of Biofuel Production on World Agricultural Markets: A Computable General Equilibrium Analysis, GTAP Working Paper No.53.

DEFRA (2007). Trade and Policy Division, Department of Environment Food and Rural Affairs (DEFRA), UK Government.

FAO (2007) http://faostat.fao.org/site/377/default.aspx

Frandsen, S.E., Gersfelt, B. and Jensen, H.G. (2003) Decoupling Support in Agriculture, Impacts of Redesigning European Agricultural Support. *Review of Urban and Regional Development Studies* 15(2): 106-131.

Gohin, A. (2005) Assessing the Impacts of the 2003 CAP Mid Term Review. 8th Conference on Global Economic Analysis, Lübeck, Germany, June 9th-11th 2005, https://www.gtap.agecon.purdue.edu/resources/download/2239.pdf)

IIASA (2007) http://www.iiasa.ac.at/Research/LUC/SAEZ

Jensen, H.G. and Frandsen, S.E. (2004) Impacts of the Eastern Europe Accession and the Mid-Term CAP Reform. In *Agricultural Policy Reform and the WTO: Where Are We Heading?*, ed. G. Anania, M.E. Bohman, C.A. Carter, McCalla A.F. Edward Elgar, London.

Keeney, R. and Hertel, T. (2005). GTAP-AGR: A Framework for assessing the implications of Multilateral changes in Agricultural Policies. GTAP Technical Paper 24, Purdue University, https://www.gtap.agecon.purdue.edu/resources/tech_papers.asp

OECD (2003). The Effects of Quantitative Constraints on the Degree of Decoupling of Crop Support Measures. Directorate for Food Agriculture and Fisheries http://www.oecd.org/dataoecd/14/3/34996009.pdf (accessed July 25th 2007)

Swinbank, A. (2005) Developments in the Doha Round and WTO Dispute Settlement: Some Implications for EU Agricultural Policy, *European Review of Agricultural Economics*, 2005, 32(4), pp551-561.

Tabeau, A., Eickhout, B. and van Meijl, H. (2006) Endogeneous agricultural land supply: estimation and implementation in the GTAP model. 9th Annual Conference on Global Economic Analysis. Addis Ababa, Ethiopia.

Taheripour, F., Birur, D.K., Hertel, T.W. and Tyner, W. (2008) Introducing Liquid Biofuels into the GTAP Database, GTAP Research Memorandum No.11, Revised May 1, 2008.

Walsh, K., Brockmeier, M. and Matthews, A. (2005). Implications of Domestic Support Disciplines for Further Agricultural Trade Liberalisation. *Journal of International Agricultural Trade and Development* 3(2).

VII. Appendix - 3 Level CET land allocation nest:

In Figure A1, the highest land substitutability (bottom nest) is between ‘wheat’, ‘other grains’ and ‘oilseeds’. Reduced land substitutability in the second nest is modelled between ‘cereals oilseeds and protein crops’, COP, (i.e., composite of ‘wheat’, ‘other grains’ and ‘oilseeds’), ‘primary sugar’ (SUG) and each of the livestock and raw milk sectors, (simplified in the diagram as a single sector ‘LVSK’). In the top nest, the lowest land substitutability is between the composite ‘field crops and pasture sectors’ (FCP), ‘other crops’ (OCR) and ‘vegetables fruits and nuts’ (VFN) sectors. The elasticity of transformation value is taken from the GTAP-AGR model (=0.25), which has been calibrated to econometric estimates of land supply to agriculture (Keeney and Hertel, 2005). In lower nests, we merely double and quadruple the elasticity respectively. The <u>bottom</u> level transformation elasticity is therefore equal to the ‘standard’ GTAP CET value (=1), which implies that land mobility in this model variant is lower than in the standard GTAP model.

Figure A1: 3 Nested Land Allocation Structure in the Modified GTAP Model

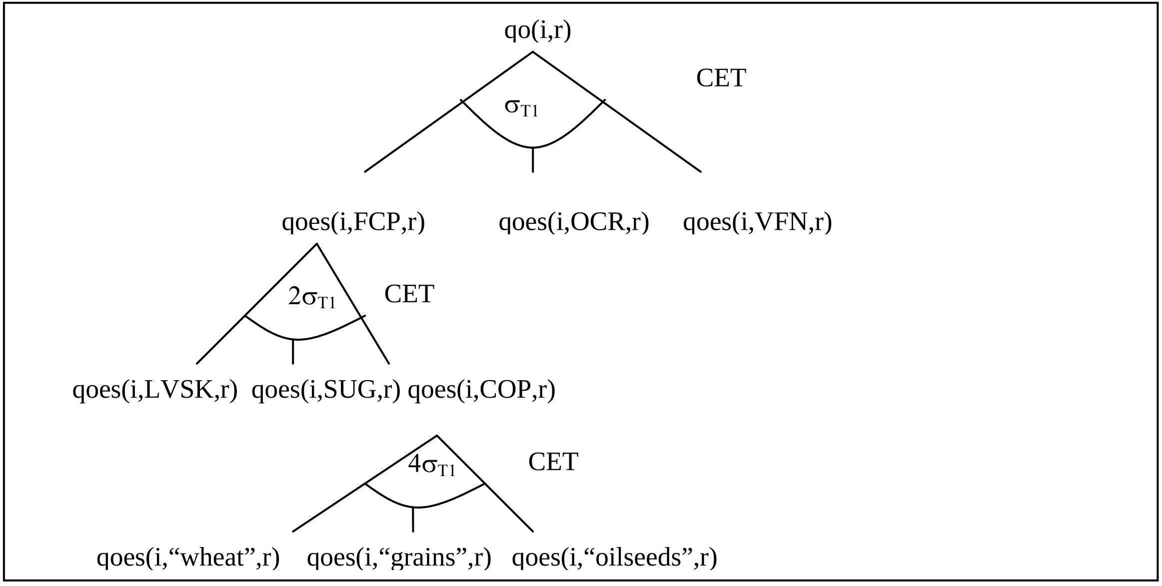

Figure 1: The Impact of an Increased Subsidy on the Land Factor in each Sector ‘j’

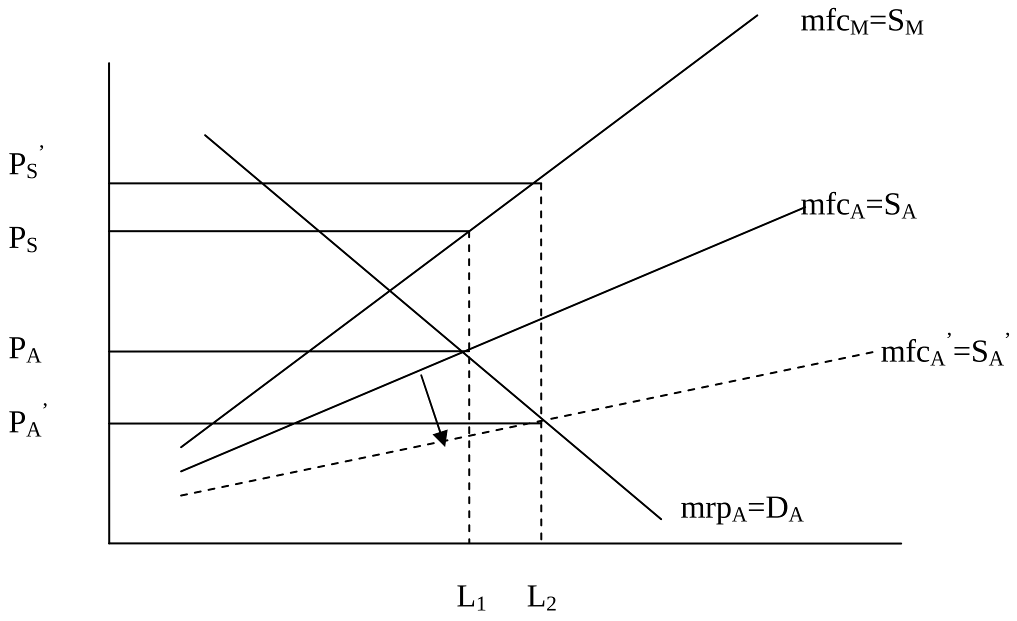

Figure 2: The Kinked Regional Land Supply Curve in each EU27 Region

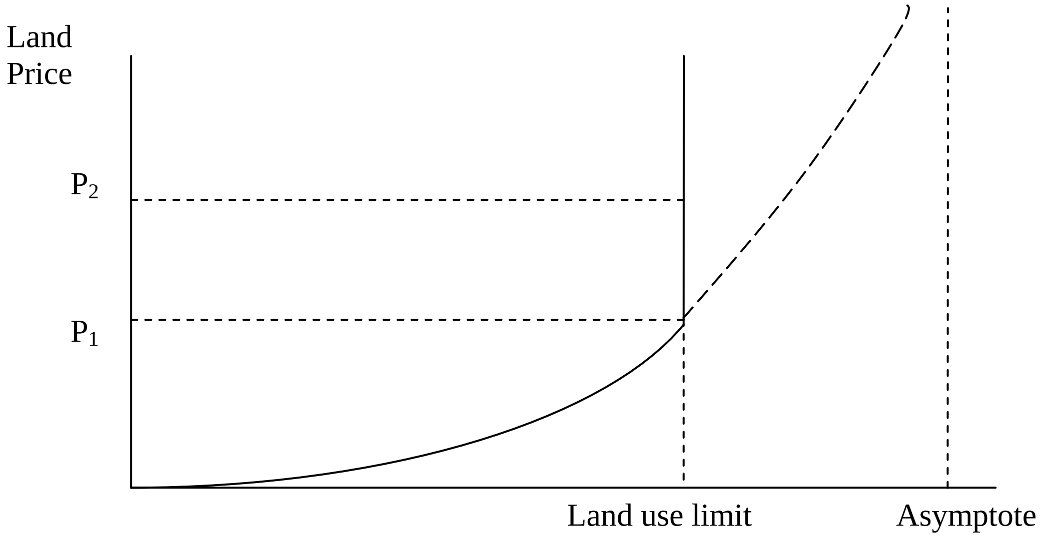

Figure 3: Aggregation of Regions and Sectors

I. Chosen Sectoral Aggregation (23 GTAP Sectors in bold)

Rice (rice) – paddy rice; **Wheat** (wheat) – soft and durum wheat; **Other Grains** (ograins) – rye, sorghum, barley, oats, maize, millet, other cereals; **Vegetables, Fruit and Nuts** (vegfrunuts)– all vegetables, fruits and nuts; **Oilseeds** (oilseeds) – oilseeds and oleaginous fruits; **Sugar** (sugar) – sugar cane and beet; **Plant Based Fibers** (Plants) – raw vegetable materials used in textiles; **Other Crops** (ocrops) – seeds, live plants, flowers, beverage and spice crops, unmanufactured tobacco, plants used in perfumery, pharmacy, insecticidal, fungicidal or similar purposes; cereal straw and husks, fodder and forage crops; other raw vegetable materials; **Cattle and Sheep** (catshp) – live bovine cattle, sheep and goats for fattening, horses, asses, mules; **Pigs and Poultry** (pigspoultry) – live swine and poultry for fattening, other animals; eggs, honey, snails and frogs legs; **Raw Milk** (milk) – dairy and other cows; **Wool** (wool) – animal materials used in textiles; **Meat processing** (meatpro) – red meat products (bovine, sheep and goat); edible offals and animal oils and fats; **Other meat processing** (omeatpro) – white meat products, edible offals and animal oils and fats; **Vegetable oils and fats** (vegoilsfats) – Oils of: Coconuts, cottonseeds, groundnuts, oilseeds, olives, palmkernels, rice brans, rape and mustard, soyabeans, sunflower seeds; and fats; **Dairy** (dairy) – all dairy products; **Rice processing** (ricepro) – milled rice; **Sugar processing** (sugarpro) – Refined sugar, sweeteners; **Other Food Processing** (ofoodpro) – prepared and preserved sea food products, vegetables and fruits, bakery and confectionary products, pastas and flours; **Beverages and Tobacco** (bevstobac) – Cigarettes, Cigars etc., Wines and Spirits, Beer; **Biodiesel from oilseed crops** (Biodiesel); **Bioethanol from grain crops** (**Bioethanol1); Bioethanol from sugar cane** (Bioethanol2); **Crude Oil** (Oil); **Petroleum and coal products** (Oil_Prods**); Raw materials** (rawmat) – Coal, oil, gas, minerals; **Manufacturing** (mnfcs) – Textiles; wearing apparel; leather, wood and paper products and publishing; chemical, rubber and plastic products; ferrous metals; Other metal products; motor vehicles and parts; transport equipment; electronic equipment; machinery and parts. **Services** (svces) – Utilities (Gas, water, electricity); construction; trade services; transport (air, sea, road); communications; financial services; insurance; other business services; recreation and other services; dwellings; public administration/defence/health, education.

II. Chosen Regional Aggregation (9 GTAP Regions in bold)

France, Germany, UK, EU3 (Austria, Netherlands, Sweden), **EU9** (Belgium, Denmark, Finland, Greece, Ireland, Italy, Luxembourg, Portugal, Spain); **AC10** (Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia)**; AC2** (Bulgaria, Romania), **USA**, **Rest of the World** (ROW)

Figure 4: Policy Assumptions Shaping the Scenarios

Scenario Assumptions

1. Uruguay Round Commitments (+)
- Enforce developed country commitments (export subsidy limits, applied tariff levels)
- Complete developing country commitments (export subsidy limits, applied tariff levels)

2. EU Enlargement to 27 Members (+)
- Remove border protection between existing and 'new' member states.
- Impose common external tariff for all new EU members of the customs union.

3. Additional Trade Policy shocks (+)
- Chinese Accession

4. Crude Oil Price Shock

5. Agenda 2000 (A2000) commitments and the Mid Term Review (MTR) up to 2013
- Modelling of CAP mechanisms (CAP budget, modulation, quotas, set-aside, intervention prices)
- Reduction of intervention prices under A2000 and MTR reforms
- Imposition of set-aside for the 'new' EU member states
- Milk quota adjustments under the MTR. Sugar quota unchanged.
- Removal of ALL coupled support in the AC12 and MTR agreed components of coupled support (#) in the EU15.
- CAP budget including the implementation of Modulation funding and the UK Rebate mechanism.
- (Scenario 1b only) Full implementation of the SFP based on the 2013 budgetary ceiling limits from the 2007-2013 budgetary framework agreement(#) and land idling shocks.

\+ = All tariff shocks account for the binding overhang

\# = data taken from DEFRA (2007)

(In simulation 1b, the productive land reduction is modelled as a negative exogenous shock)

Table 1: Land market estimates in simulation 1 (%)

Simulation 1a							
	FRA	**DEU**	**UK**	**EU3**	**EU9**	**AC10**	**AC2**
Productive land usage	-23.8	-19.9	-15.4	-13.5	-17.4	-1.1	0.0
Real land prices	-41.9	-36.4	-34.8	-12.4	-19.8	-2.0	2.1
Simulation 1b							
	FRA	**DEU**	**UK**	**EU3**	**EU9**	**AC10**	**AC2**
Productive land usage	-23.8	-19.9	-15.4	-13.5	-17.4	-1.1	0.0
Real land prices	64.4	32.4	82.0	68.0	74.8	134.5	91.2

Table 2: Agro-food supply responsiveness estimates in simulation 1 (%)

Simulation 1b

	EU15					AC12		NONEU	
	FRA	DEU	UK	EU3	EU9	AC10	AC2	USA	ROW
Rice	-2.0	-5.1	-3.2	-1.7	-6.1	90.5	7.1	-3.0	0.0
Wheat	-7.7	-6.3	-1.6	-3.7	-6.0	-10.4	-0.6	-7.1	1.6
Ograins	-4.2	-4.1	-2.3	-1.9	0.4	-1.3	-1.6	6.2	-0.3
Vegfrunuts	-4.3	-7.0	1.6	0.4	1.8	-2.0	0.2	-1.6	-0.2
Oilseeds	68.0	73.0	5.6	24.4	-27.4	2.3	4.0	1.7	-2.0
Sugar	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.5	3.5
Plants	4.2	1.4	2.4	1.1	3.7	-5.6	-1.0	0.0	1.0
Ocrops	1.7	-1.2	3.5	4.3	-5.1	-17.3	-0.3	-1.2	0.6
Catshp	-9.4	-6.3	-6.0	-13.7	-7.9	27.6	5.5	-0.9	0.1
Pigspoultry	-0.4	-0.9	-0.5	-0.3	-1.1	1.6	0.3	-1.0	0.0
Milk	1.5	1.5	1.5	1.5	1.5	0.0	0.0	-0.7	-0.5
Wool	2.8	-2.0	-1.5	-4.2	3.1	-0.7	-0.3	1.8	-1.0
Meatpro	-7.4	-6.6	-1.5	-13.5	-5.6	66.6	-0.1	-0.9	0.1
Omeatpro	-1.7	-3.2	-1.7	0.9	-1.2	4.9	-9.0	-1.0	-0.1
Vegoilsfats	3.7	0.2	-0.1	4.5	-9.8	-1.5	6.3	-1.6	1.5
Dairy	-0.5	0.9	0.4	1.7	0.9	13.7	7.3	-0.7	-1.3
Ricepro	-0.3	-1.9	-4.0	-0.5	-2.6	21.6	3.5	-1.2	0.0
Sugarpro	-0.4	-0.2	0.2	-0.4	-0.1	1.5	9.6	-0.5	-0.3
Ofoodpro	0.3	-0.6	0.2	1.1	-1.0	-2.4	1.2	-0.5	0.1
BevsTobac	0.1	-0.2	0.1	1.5	-0.7	-1.2	-0.5	-0.5	0.2

(All comparative percentage estimates in this paper are calculated as: ((S1b% - S1a%)/(100+S1a%))*100)

Table 3: Primary Agricultural Supply Responsiveness – Simulation 1a vs. 1b (%)

	EU15					AC12		NONEU	
	FRA	DEU	UK	EU3	EU9	AC10	AC2	USA	ROW
Rice	0.0	0.6	0.4	0.3	0.0	-0.6	-0.2	0.0	0.0
Wheat	0.1	0.3	0.1	0.4	0.1	0.1	0.3	0.1	0.0
Ograins	0.0	0.1	0.1	0.2	0.1	0.2	0.5	0.0	0.0
Vegfrunuts	0.0	0.0	0.0	0.1	0.0	0.2	-0.1	0.0	0.0
Oilseeds	0.2	0.1	0.1	0.5	0.0	-0.3	-1.2	0.0	0.0
Sugar	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Plants	-0.1	0.3	0.3	0.3	0.1	-0.5	-1.3	0.0	0.0
Ocrops	0.0	0.1	0.1	0.2	0.0	-0.1	-0.3	0.0	0.0
Catshp	0.1	0.2	0.0	0.4	0.1	0.1	0.2	0.0	0.0
Pigspoultry	0.1	0.3	0.0	0.4	0.1	-0.1	0.6	0.0	0.0
Milk	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wool	0.0	0.3	-0.2	0.1	0.1	-1.0	-0.7	0.0	0.0

(All comparative percentage estimates in this paper are calculated as: ((S1b% - S1a%)/(100+S1a%))*100)

Table 4: Percentage changes in the land market compared to the Benchmark (%)

Simulation 1b							
	FRA	**DEU**	**UK**	**EU3**	**EU9**	**AC10**	**AC2**
Productive land usage	-23.8	-19.9	-15.4	-13.5	-17.4	-1.1	0.0
Real Rental Rate	64.4	32.4	82.0	68.0	74.8	134.5	91.2
Simulation 21b							
	FRA	**DEU**	**UK**	**EU3**	**EU9**	**AC10**	**AC2**
Productive land usage	-23.8	-19.9	-15.4	-13.5	-17.4	-1.1	0.0
Real Rental Rate	40.7	16.0	56.7	51.1	53.2	106.7	72.3
Simulation 22b							
	FRA	**DEU**	**UK**	**EU3**	**EU9**	**AC10**	**AC2**
Productive land usage	-23.8	-19.9	-15.4	-13.5	-17.4	-1.1	0.0
Real Rental Rate	16.9	0.4	31.3	31.8	31.6	78.8	53.7

Table 5: Agro-food Supply Responsiveness Compared with Simulation 1b (%)

	S21b (80%) vs. S1b (100%)				**S22b (60%) vs. S1b (100%)**			
	EU15	EU27	USA	ROW	EU15	EU27	USA	ROW
Rice	2.5	1.5	-0.1	0.0	4.6	2.6	-0.4	-0.1
Wheat	4.1	3.5	-1.1	-0.6	9.2	7.6	-2.5	-1.2
Ograins	3.4	2.9	-0.4	-0.3	5.7	4.3	-1.5	-0.7
Vegfrunuts	2.6	2.4	-0.7	-0.2	4.1	3.9	-1.7	-0.5
Oilseeds	3.4	3.0	-0.3	-0.4	5.8	5.2	-1.5	-0.6
Sugar	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0
Plants	4.9	3.2	-0.1	-0.1	8.5	5.5	-0.6	-0.2
Ocrops	2.5	2.2	-0.5	-0.8	4.6	4.1	-1.1	-1.5
Catshp	1.8	1.6	-0.1	-0.1	2.9	2.6	-0.6	-0.2
Pigspoultry	1.6	1.5	-0.1	-0.1	2.1	2.0	-0.3	-0.4
Milk	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wool	10.6	6.7	-0.7	-0.2	19.8	9.6	-1.2	-0.4
Meatpro	1.4	1.0	-0.1	-0.1	1.9	1.5	-0.5	-0.2
Omeatpro	1.0	0.7	-0.1	-0.2	1.3	1.1	-0.6	-0.4
Vegoilsfats	0.2	0.2	-0.1	-0.1	0.5	0.5	-0.1	-0.1
Dairy	0.2	0.2	0.1	0.0	0.2	0.2	0.3	-0.1
Ricepro	0.4	0.2	-0.1	0.0	0.7	0.4	-0.1	0.0
Sugarpro	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0
Ofoodpro	0.1	0.1	0.0	0.0	0.2	0.2	-0.1	-0.1
BevsTobac	0.1	0.0	0.0	0.0	0.1	0.1	0.0	0.0

Table 6: Global agro-food exports compared with simulation 1b (%)

	S21b (80%) vs. S1b (100%)				**S22b (60%) vs. S1b (100%)**			
	EU15	EU27	USA	ROW	EU15	EU27	USA	ROW
Rice	5.7	4.9	-0.2	-0.6	11.0	9.3	-0.3	-1.0
Wheat	8.2	7.7	-1.3	-2.0	15.4	14.6	-2.3	-3.6
Ograins	5.3	4.4	-0.3	-0.6	7.4	6.6	-0.6	-1.1
Vegfrunuts	4.1	3.2	-1.0	-1.5	4.7	5.0	-1.9	-2.8
Oilseeds	4.8	4.4	-0.5	-0.9	7.2	6.4	-1.0	-1.7
Sugar	0.7	0.8	-0.2	-1.1	1.5	1.6	-0.5	-2.1
Plants	5.7	5.5	-0.3	-0.6	10.8	10.3	-0.5	-1.4
Ocrops	5.2	4.4	-2.7	-2.8	10.5	10.0	-4.9	-5.2
Catshp	3.5	2.5	-1.9	-0.9	6.6	5.7	-3.4	-1.6
Pigspoultry	2.2	1.9	-0.7	-0.8	4.1	3.8	-1.4	-1.4
Milk	1.6	1.6	-1.9	-1.4	2.1	2.0	-3.6	-2.5
Wool	12.6	12.1	-2.3	-0.9	24.2	23.2	-4.4	-1.5
Meatpro	3.9	3.4	-0.6	-0.7	6.4	6.0	-1.0	-1.2
Omeatpro	2.4	2.2	-1.3	-1.3	5.0	4.5	-2.3	-2.5
Vegoilsfats	0.8	0.8	-0.3	-0.2	1.7	1.6	-0.6	-0.5
Dairy	0.2	0.2	-0.4	-0.3	0.3	0.4	-0.9	-0.6
Ricepro	0.7	0.6	-0.2	-0.1	1.2	1.2	-0.3	-0.1
Sugarpro	0.0	0.0	-0.3	-0.1	0.3	0.3	-0.5	-0.1
Ofoodpro	0.2	0.3	-0.3	-0.2	0.4	0.4	-0.6	-0.4
BevsTobac	0.3	0.3	-0.1	-0.1	0.5	0.5	-0.2	-0.2

Table 7: Global agro-food imports relative to simulation 1b (%)

	S21b (80%) vs. S1b (100%)				**S22b (60%) vs. S1b (100%)**			
	EU15	EU27	USA	ROW	EU15	EU27	USA	ROW
Rice	-0.8	-0.6	-0.4	0.1	-1.0	-1.0	0.4	0.1
Wheat	-0.7	-0.6	-0.5	0.6	-1.2	-1.0	0.9	1.2
Ograins	-0.5	-0.4	0.4	0.2	-1.3	-0.9	0.7	0.4
Vegfrunuts	-0.7	-0.6	0.2	0.2	-1.1	-0.9	0.2	0.4
Oilseeds	-1.2	-1.2	-0.2	0.1	-2.1	-2.0	0.4	0.1
Sugar	-0.4	-0.4	0.2	0.3	-0.7	-0.7	0.3	0.5
Plants	0.1	0.0	0.3	0.3	0.2	0.0	0.5	0.6
Ocrops	-3.2	-3.2	0.6	0.8	-5.7	-5.6	1.1	1.5
Catshp	-1.4	-1.3	0.6	0.7	-2.6	-2.5	1.1	1.3
Pigspoultry	-1.3	-1.3	0.1	0.3	-2.5	-2.2	0.2	0.5
Milk	-1.3	-1.0	1.1	0.8	-1.5	-1.2	2.2	1.5
Wool	-0.7	-0.5	0.7	0.3	-1.9	-1.4	1.5	0.5
Meatpro	-0.9	-0.8	0.2	0.3	-1.6	-1.6	0.4	0.5
Omeatpro	-0.4	-0.3	0.9	0.5	-1.0	-0.9	1.6	1.0
Vegoilsfats	-0.5	-0.3	0.4	0.1	0.0	-0.8	0.8	0.1
Dairy	0.0	0.0	0.3	0.2	0.1	0.0	0.7	0.3
Ricepro	0.1	0.1	0.0	0.0	0.1	0.1	0.1	0.1
Sugarpro	-0.1	-0.1	0.0	0.0	0.3	0.3	0.1	0.0
Ofoodpro	-0.1	-0.2	0.1	0.1	0.3	-0.4	0.2	0.1
BevsTobac	0.1	0.1	0.2	0.1	0.1	0.1	0.4	0.2

Table 8: Agro-food World Prices Relative to Simulation 1b (%)

	S21b vs S1b	S22b vs S1b		S21b vs S1b	S22b vs S1b
Rice	-0.063	-0.115	Milk	-0.029	-0.036
Wheat	-0.736	-1.391	Wool	-0.113	-0.218
Ograins	-0.921	-1.537	Meatpro	-0.499	-0.691
Vegfrunuts	-0.669	-0.966	Omeatpro	-0.521	-0.679
Oilseeds	-0.933	-1.312	Vegoilsfats	-0.126	-0.234
Sugar	-0.099	-0.115	Dairy	-0.069	-0.146
Plants	-0.107	-0.202	Ricepro	-0.036	-0.071
Ocrops	-0.978	-1.805	Sugarpro	-0.038	-0.099
Catshp	-0.911	-1.322	Ofoodpro	-0.162	-0.299
Pigspoultry	-0.725	-1.192	BevsTobac	-0.045	-0.092

Table 9: Agricultural and economic output relative to simulation 1b (%)

	Primary agricultural production		Real economic growth	
	S21b vs S1b	S22b vs S1b	S21b vs S1b	S22b vs S1b
UK	1.256	2.892	-0.056	-0.087
Germany	1.098	2.078	-0.049	-0.063
EU3	0.901	1.761	-0.022	-0.050
France	2.210	4.134	-0.085	-0.137
RoEU15	1.301	2.594	-0.073	-0.103
AC10	1.656	2.431	-0.099	-0.252
AC2	0.352	0.938	-0.139	-0.186
EU15	1.252	2.507	-0.062	-0.098
EU27	1.162	2.315	-0.063	-0.105
USA	-0.699	-1.369	0.059	0.104
ROW	-0.586	-0.946	0.008	0.013