


## Modelling the Impact of 2003 CAP Reform on Crop Production: The case of Durum Wheat in Italy

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*LA) within the AG-MEMOD model of the agri-food sector in Italy. The paper shows how the model generates impacts when alternative policy scenarios (Agenda 2000 vs. LA) are specified. As major evidence of this impact in the Italian case, the crop sector is dealt with in detail. In particular, the case of supplementary payments for durum wheat clarifies how the reform may specifically affect Mediterranean agriculture and how alternative specifications of the regime switch in durum wheat support relevantly influence the impact.*

**Keywords:** Common Agricultural Policy, Italian Agriculture, Commodity Market Models

**EconLit Classification:** Q110, Q180

### Introduction

This paper presents the results emerging from the application of baseline and alternative Common Agricultural Policy (CAP) scenarios into the Italian econometric country model, developed as part of the AG-MEMOD EU research project<sup>1</sup>. The Italian AG-MEMOD model is an econometric, dynamic, multi-product partial equilibrium model including some main commodities of Italian agriculture (Esposti and Lobianco, 2004). This model is a part of the EU AG-MEMOD composite model that consists of a combination of all Member States' models running together. Therefore, the model aims to represent all the cross-commodity and cross-country effects induced by an external change and, in particular, by changes in the CAP support to any commodity. This structure allows replicating all the complex direct and indirect implications of the recent CAP reform.

The dynamic character of the model allows for multi-annual projections over time. Projections may be generated for all endogenous variables, as far as projections of the relevant exogenous variables are included. Alternative policy scenarios, in fact, refer to alternative specifications of the projections for these latter variables, policy variables included, which are assumed fully exogenous. Two main policy scenarios are com-

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pared: the CAP according to Agenda 2000 (also called the *baseline scenario*) and the CAP as reformed by the Luxembourg Agreement in June 2003 (also called the *alternative* or *LA scenario*). The effect of this reform is displayed by comparing results emerging from the two scenarios, the rest of exogenous variables remaining the same. Projections generated by the model are expected to correctly identify the direction and the intensity of the changes induced by the CAP reform on each commodity market.

The paper is organised as follows. The second section comments the major characteristics and the general structure of the Italian AG-MEMOD model, also discussing the general methodology here followed to estimate the model equations. The third section describes the CAP scenarios here adopted. For the LA scenarios, alternative specifications about the durum wheat supplementary payments are introduced. The fourth section presents the 2010 projections generated by the model under the alternative CAP scenarios. The final section summarizes the main results and provides a short comparison of the AG-MEMOD model results with other studies concerning the impact of the CAP reform on Italian agriculture.

## **The Italian AG-MEMOD model**

### ***The AG-MEMOD modelling approach***

According to the general AG-MEMOD modelling strategy, the EU aggregate model is built by combining the EU country models, which are, in turn, obtained by merging single commodity sub-models. Rest of the world variables (namely world market prices and WTO agreements) are entered exogenously, whereas aggregate components of the Economic Accounts for Agriculture (EAA), such as inputs use, income, etc., are directly derived for any country by the respective commodity models (Esposti and Lobianco, 2004).

Therefore, to achieve the overall EU model, the first stage implies the estimation of commodity country models in parallel across the EU countries. Commodity models across countries are based on a common template and are estimated on historical data using the same variables definition and data sources. A set of common exogenous variables (including macrovariables, policy measures and key-prices) enters any commodity market. Once estimated, all the country commodity markets are translated into GAMS format and solved, that is for any commodity the “supply and use” identity is imposed by computing the closing variable (imports or exports). Then, all solved country models can be combined into one aggregate EU GAMS model which is in turn solved by imposing the supply and use identity in any market through the EU closing variable (i.e., EU net export) (Chantreuil and Levert, 2003).

For any commodity, a country model is explicitly linked to the other countries through a price transmission relationship, where a EU key-price drives price formation in any country. The EU key-price is usually set as the price observed in the most important national market for that commodity. So, for any commodity a key-market is identified (Esposti and Lobianco, 2004). Moreover, in any country, commodity models may be linked among them on either the supply or demand side, according to land allocation behaviour, technical relations or to complementarity/substitutability on the demand side. Figure 1 depicts the general rules for the integration and closure of any country and EU commodity model. Eventually, this modelling strategy aims to

emphasize at the maximum possible extent the cross-country and cross-commodities effects of any external change, policy variables included, in such a way to have a more realistic and complex representation on how markets react to CAP reforms.

In fact, commodity market models are dynamic for the presence of lagged variables among regressors. Therefore, any country model in GAMS format, as well the combined EU model, can generate projections of the model endogenous variables, by feeding the model with projections of the exogenous variables, using the estimated parameters and imposing the markets closure for any projected year. These projections are generated by solving the estimated model in a recursive way for the projection period; that is, the equilibrium in a period is the starting point to solve the next equilibrium. Since policy (CAP) measures belong to the vector of exogenous variables, these projections are generated over a set of alternative values of these measures, in other words over a set of alternative policy scenarios. The comparison of the endogenous variables projections, as well as of derivative variables, across these alternative scenarios provides evidence on the impact of policy reform.

Since the major purpose of AG-MEMOD model is to evaluate the 2003 CAP reform, the aggregate EU model includes 23 commodities also called GOLD commodities. Grains (or Cereals): soft and durum wheat, barley and maize; Oilseeds: rapeseed, soybeans and sunflower seed (seed, oil and meal use); Livestock: cattle-beef, pig, broiler, other poultry and sheep; Dairy-milk products: fluid milk, cheese, butter, whole milk powder and skim milk powder. By combined EU model we refer to the aggregation of 9 country models, that is Italy, Belgium (including Luxembourg), Finland, France, Germany, Greece, Netherlands, Spain, UK, covering about 85% of the value of EU-15 agricultural output. None of the currently missing countries (Austria, Denmark, Ireland, Portugal, Sweden) is a "major" agricultural producer, so their exclusion should not imply relevant biases in the generated projections.

#### ***Structure of the commodity market sub-models***

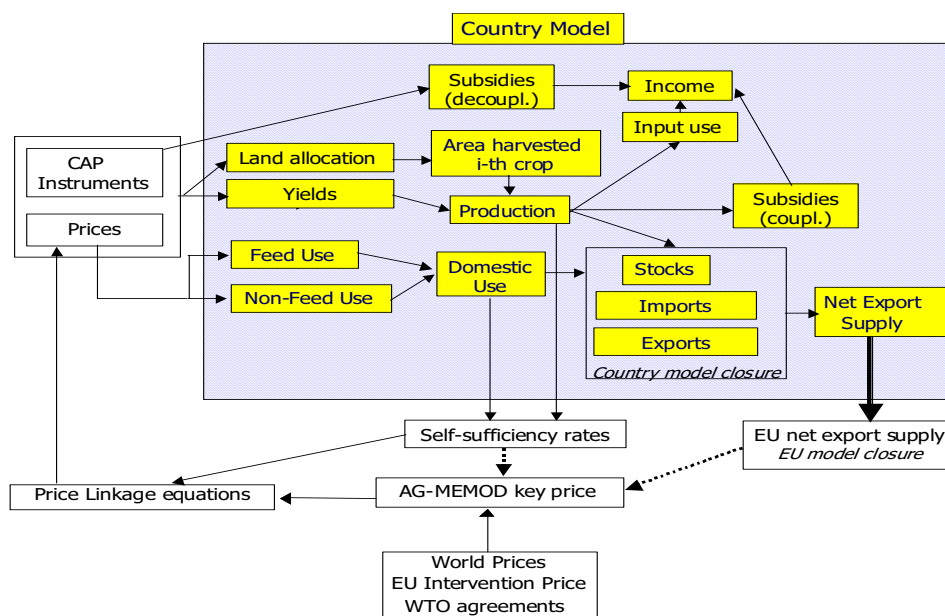
Any commodity model (for any country) is formed by a set of either behavioural equations and identities. The behavioural equations allow estimating and projecting the key endogenous variables in the respective market; the identities represent the market closure conditions. As example, the Annex lists and describes in implicit form the estimated behavioural equations for any specific commodity in the crops sector, and also reports the estimates for a limited number of equations, where durum wheat variables appear as depended variables.<sup>2</sup> These equations can be grouped in three sets according to their theoretical justification: supply side, demand side, price and stock formation; a market closure equation (identity) completes the model. Finally, a further set of equations is estimated to reconstruct the major components of the EAA from the commodity models estimate (see Esposti and Lobianco, 2004, for more details). Here, we just discuss the general characters of the crops model mainly to emphasize the inclusion of those variables representing cross-commodity and cross-countries relations, as well as of the relevant policy instruments.<sup>3</sup>

The basic assumption in the crop sub-models is that land allocation is a three-steps decision process driven by prices, CAP payments and yields. Producers first settle on the total land allocated to cereals (grains) and oilseeds groups. Then, in a second stage, this total area is allocated to each crop within these main groupings where wheat is considered as a single aggregate crop. Finally, in the third stage, the total wheat area is allo-

cated between soft and durum wheat. This allocation behaviour is driven by the expected returns associated to any group and specific crop. This expected return depends on the current and lagged real prices and on the current direct (coupled) payments. Supply is finally obtained by adding an yield equation for any crop commodity; here, yield depends on the amount of cultivated land (taking into account possible diminishing returns), on the trend yield (taking into account exogenous technological progress), and on market prices.

On the demand side, for both cereals and oilseeds the model admits two different uses: the food use and the animal feed use. These two demand components are modelled separately. The food use demand may be specified, when needed, within a demand system and depends on the population level, on the national *per capita* GDP, on own commodity market lagged and/or current price and on lagged and/or current prices of all possible complements and substitutes. The distinctive feature of the feed use demand equations is the inclusion, besides prices, of feed demand indices expressing feed-using agricultural activities, namely meat and milk production. For oilseeds, the feed demand side is more complex since it explicitly models the crushing demand depending on the lagged prices of crushing products (oils for food use and meals for feed use) and of the original seeds. Therefore, for any oilseeds three different prices and markets are specified, that is seed, oil and meal.

For any modelled commodity, a third group of equations, modelling ending stock, export or import levels, is included and estimated depending, among others, on current year prices, production and domestic use, and the level of the beginning stocks (that is,



**Figure 1.** Integration and closure of the any (crop) commodity country and EU model within AG-MEMOD (dot lines identify exogenous effects on price formation, i.e. not linked to country model closure)  
 Source: AG-MEMOD Project

lagged ending stocks). However, as mentioned, to make all these estimated (endogenous) variables satisfy year-by-year the country supply and use identity, for any market there exists one endogenous variable that closes the model and thus is obtained by the supply and use identity. Generally these non-estimated closure (residual) variables are imports. Among crops, we use exports as closing variable only for durum wheat, as Italy is currently a net exporter of this commodity.

The building of any commodity model is completed by an equation making the commodity price endogenous, that is an equation describing how market price is formed. We use price linkage equations to account for the relations among Members States markets, and between European Union and the rest of the World. Therefore, in the usual case where Italy is not the key-market, the price formation equations include as regressor the respective key-market price and, when needed, the lagged key-price, the Italian and key-market self-sufficiency rates, the EU market intervention price. The exceptional case is durum wheat, where Italy itself is the key-market.<sup>4</sup> Then the price formation equation links the durum wheat Italian price, which is also the EU key-price, directly to the durum wheat world market price.

#### ***The Italian case: main characters***

In such a way, the Italian AG-MEMOD model describes the equilibrium formation in the above mentioned (GOLD) commodity markets. However, the Italian agri-food sector shows some specificity that may be appreciated by looking at the Italian share within EU for the different agricultural commodities (table 1). Italy accounts for just 12% of the value of animal productions within the EU, and for 18% for the value of crops. However, within these general categories we can observe great variations. Italy covers about 55% of durum wheat production, 25% for all fruits and, among these, more than 30% for both wine grapes and olives.

Table 2 shows that in the last decade, since the 1992 McSharry Reform, the soft wheat cultivated area has dramatically decreased by about 42%. On the contrary, it remained almost constant for fruits and vegetables and, above all, it increased for durum wheat (about +10%), with a consequent increase of the respective positive trade balance. Actually, durum wheat is the commodity on which the higher shock is expected upon the introduction of the CAP Reform, as its harvested area remained artificially high with respect to the declining tendency observed in other cereals, due to the higher support granted through the *per ha* supplementary payments.

For this main reason, durum wheat has been largely emphasized as the most critical sector in simulating the impact of the CAP reform in Italy (AgriSole, 2004) and is of specific interest here. Firstly, it is the major, if not the only, Mediterranean character within the EU-15 AG-MEMOD model. Secondly, durum wheat is a key crop in Italy and, in particular, in Southern regions. Not only Italy accounts for more than 50% of durum wheat cultivated area in the EU-15; durum wheat also covers almost 50% of cereals cultivated area in Italy, and it is highly concentrated (about 75% of cultivated area) in the Southern regions. Finally, durum wheat has been largely supported by the CAP until the 2003; thus, the full decoupling of the durum wheat supplementary payment (still 313€/ha in 2004) raises several objections about the future of this crop, particularly in Southern Italy (AgriSole, 2004), as respective yields and prices by themselves often make it not competitive with other crops (for instance, soft wheat).

**Table 1.** Share of Italian agriculture on EU-15 value of output, various products (1993 - 2002)

	1993	1996	1999	2002
Crops	19%	18%	19%	18%
Cereals	14%	13%	14%	14%
Durum Wheat	65%	58%	55%	52%
Industrial crops	10%	9%	10%	9%
Forage plants	13%	11%	12%	12%
Fruits	30%	26%	27%	27%
Olive oil	44%	38%	40%	32%
Wine	27%	27%	28%	28%
Vegetables	16%	17%	16%	15%
Animal products	12%	12%	12%	12%
Milk	10%	11%	11%	12%
Cattle	11%	12%	13%	13%
Poultry	18%	17%	15%	16%

Source: EUROSTAT

**Table 2.** Cultivated area of main groups of crops in Italian agriculture, 1992-2003 (thousands of Ha)

	1992	1995	1998	2001	2003
Cereals	4225	4225	4068	4113	4127
Soft Wheat	988	859	698	625	577
Durum Wheat	1530	1623	1629	1664	1689
Vegetables	501	408	364	459	457
Fruits (incl. olives+wine grapes)	2871	2738	2697	2720	2661

Source: ISTAT

**Model estimation: some notes**

The parameters of the behavioural equations outlined above, are estimated using annual data for the period 1979-2000. These annual data are obtained mostly from EUROSTAT's, namely New-Cronos and AgrIS databases. The EUROSTAT standard is always adopted in the definition of the model variables. For those variables for which EUROSTAT data are not available or not practical, other reliable sources are considered, such as FAO and OECD databases or national/governmental sources of official agricultural statistics (INEA, ISMEA, etc.). The projections of exogenous variables up to 2010 come from FAPRI and, for EU policy and macro variables, from the appropriate EU Commission documents.

For any equation, the appropriate specification is selected in order to obtain results fitting well with prior economic assumptions and expected behaviours and with acceptable statistical goodness of fit. When possible, flexible theory-consistent specifications are adopted to not impose *ex-ante* restrictions especially on preferences and technology. As a consequence, either linear or log-linear specifications are used. On the original

specification, some simple empirical adjustments are introduced by adding trends and dummies, which can assume different economic meaning according to the equation. The trend is usually aimed to allow for structural tendencies that are not taken into account by the other regressors; for example, a trend term included in the yield equations is mainly aimed to proxy technological progress. Time dummies are introduced mainly in those equations where relevant changes in the Common Agricultural Policy could have generated structural breaks. Very often, we introduce a time dummy for 1993 to admit a structural break in the dependent variables induced by the MacSharry Reform.

For some equations, the parameters estimation is obtained using Ordinary Least Squares (OLS). In many cases, however, this estimator could generate biased results. As mentioned, linkages may exist among several equations either because the error terms may be correlated across different equations or because the dependent variable of one equation also appears as explanatory variable in other equations, that is simultaneity across equations occurs. In particular, when a demand system is specified, we adopt a Seemingly Unrelated Regression (SUR) estimation using the iterated Zellner procedure, to take into account cross-correlation of the error terms. Simultaneity is then admitted, on the crops supply side, between commodity yield and land allocation equations and, in price formation, between price linkage equations, stocks formation and exports (imports) equations. When simultaneously is assumed, the system of equations is estimated through a 3SLS (Three Stage Least Squares) estimator.<sup>5</sup>

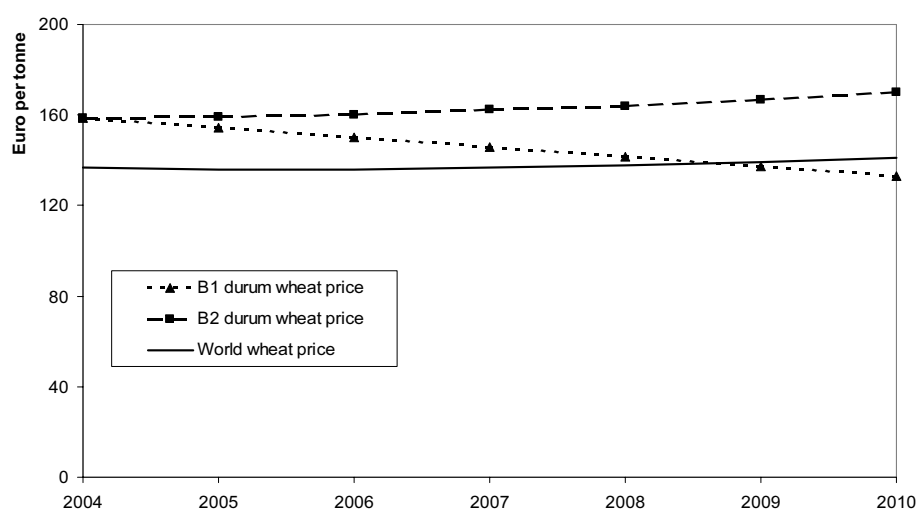
## **CAP scenarios and the case of durum wheat**

### ***Baseline scenario***

This section describes the exogenous variables projections under the baseline scenario. A relevant part of these projections are indeed common to the baseline and the alternative (LA) scenarios. In fact, the underlying macroeconomic variables and the world market prices projections are the same across the two scenarios. Moreover, both scenarios do not make assumptions about the outcome of the WTO Doha Development Round thus the existing Uruguay Round Agreement on Agriculture (URAA) is assumed to prevail in both cases for the whole projection period; nor do they incorporate the accession of new members on the 1<sup>st</sup> of May 2004. Therefore, the only difference between the two scenarios concerns the projections of CAP measures. The baseline scenario incorporates the Agenda 2000 reform of the CAP and assumes a no-change regime until 2010; the assumptions about the CAP as agreed under 'Agenda 2000' are outlined in Binfield *et al.* (2003a and 2003b). As mentioned, world market prices are assumed exogenous in the AG-MEMOD model for all commodities; their projections come from FAPRI *World Situation and Outlook 2003* (FAPRI, 2003a), which includes a review of the background to these projections (see also Esposti and Lobianco, 2004, for details). In contrast, projections of prices on EU key-markets under both the baseline and LA scenarios are endogenously generated by solving the EU combined model.

A critical aspect in generating the simulation results under AG-MEMOD framework is related to the role of commodity key-prices, since they are the driving-forces behind this multi-commodity and multi-country equilibrium modelling. Here, we try two alternative specifications of the only Italian key-price, that is durum wheat price, to be interpreted as "limit cases" (the worst and best cases) of all possible intermediate specifications of price formation (see Annex for details about the equation alternative specifica-

tions). In both cases, price is driven by the world market price, assumed fully exogenous. However, in one case (Vers. 1 or Baseline 1/B1), the EU net export of durum wheat does not affect price formation which is also affected by a slightly negative time trend. In the other case (Vers. 2 or Baseline 2/B2), the negative time trend is excluded while the lagged EU net export (approximating the EU self-sufficiency rate) is included among regressors of the durum wheat price formation equation, thus shifting price upwards. Figure 2 displays the projections of the world market price together with the two mentioned baselines of the durum wheat price showing a significant different pattern over the projection period.



**Figure 2.** Wheat price projections: alternative baseline durum wheat price projections (B1 vs. B2) and wheat world market price

Source: Our elaboration on Italian AG-MEMOD model

### *Alternative scenarios*

The policy reform introduced and examined under the alternative scenarios are those CAP measures contained in the Final Presidency Compromise Document of the Council of the European Union, on 26 June 2003, also called Luxembourg Agreement (thus, LA) (Council of the European Union, 2003). Under the Luxembourg Agreement and the negotiations that followed, a very wide range of possible implementation scenarios can be envisaged. What is examined here, however, is the most extreme implementation scenario allowed under the LA, i.e. all direct payments (with the exclusion of supplementary payments for durum wheat) under Agenda 2000 are fully decoupled at the earliest possible date. Member State choices vis-à-vis the implementation of the LA may actually deviate significantly from the maximum decoupling scenario analysed here. However, the present analysis serves primarily to illustrate the effects of the chosen scenario and the analytical capacity of the AG-MEMOD model. Anyway, an analysis of the impact of the actual LA implementation choices made by any Member States is possible with the AG-MEMOD model, as such political choices have been already formally defined. In fact, this possibility is exploited here for the durum wheat production in Italy.<sup>6</sup>



The LA essentially modifies the CAP as it applies to cereals, oilseeds, livestock and dairy sub-sectors. Concerning crops, from January 2005, cereals and oilseeds arable aid payments are decoupled from production. In durum wheat, the supplementary premium is gradually reduced by about 15% from 2004/05 to 2006/07. According to the national choices, it may be fully or only partially (60%) decoupled, with the additional introduction of a durum wheat quality premium (40€/ha) for traditional production areas (art. 72-74 of COM(EU) No 1782/2003). It follows that for any crop commodity the impact of the LA will be observed starting from year 2005, and the impact results will be here displayed accordingly. Due to their intrinsic complexity, in the present analysis no attempt is made to incorporate cross-compliance, modulation or other specific elements of the Luxembourg Agreement.

To enter the LA in the country commodity models, the Single Farm Payment (SFP) is therefore applied in all countries from 2005 with the maximum amount of decoupling agreed at the Luxembourg Council. Unlike previous policy instruments, the Single Farm Payment is not driven by levels of various farming activities, though the land would have to be maintained in 'good agricultural condition'. Thus, the LA affects the commodity models by changing the expected gross returns, through reduction in intervention price, when it applies, and through reduction of direct payments or premiums. However, the analysis of farmer response has shown that these payments are still likely to be somewhat supportive of farming activity (Dewebre *et al.*, 2001; Westhoff and Binfield, 2003; Binfield *et al.*, 2003b); in other words they may still have a residual supply inducing effects. So, although decoupling is assumed to be full, we assume farmers still associate part of the decoupled payment to the original production; as residual supply inducing effect we thus alternatively assume that 30% or 10% of the SFP actually remains associate to the original commodity, as *ad valorem* equivalent direct payments (see Westhoff and Binfield, 2003, and Binfield *et al.*, 2003b, for more details on the theoretical motivation of this assumption). The comparison between 30% and 10% residual effect shows how it plays, as wanted, a sort of incentive to maintain higher production levels.

As mentioned, performing a more detailed analysis of the durum wheat case with respect to the CAP reform implementation is of major interest here. The CAP reform has paid specific attention and reserved specific measures to this commodity. We already mentioned the decoupling of the supplementary payment and the introduction of a quality premium *ex art. 72*; in addition, Italy decided to apply in 2005 the optional *bonus* (quality) premium *ex art. 69*, thus adding a further coupled payment for durum wheat currently estimated at 50€/ha. With specific reference to durum wheat, the LA scenarios are thus distinguished in three groups.<sup>7</sup> Scenario 1 assumes that the durum wheat supplementary payment is fully decoupled and quality premiums *ex art. 69* and *72* (40€/ha+50€/ha) are paid; this scenario is the closest to the actual and current implementation of the CAP reform in Italy. Scenario 2 assumes that the supplementary payment remains fully coupled but quality premiums are skipped. Scenario 3 assumes that the supplementary payment is only partially decoupled (60%) and quality premiums are activated. Any of these contains four sub-scenarios generated by the alternative specifications of the durum wheat price formation according to the mentioned hypotheses (Vers. 1 and 2) and by assuming alternatively 30% or 10% residual supply inducing effect of the decoupled payment. Table 3 summarizes the whole set of scenarios here adopted.

**Table 3.** Description of the whole set of adopted CAP scenarios (DW = durum wheat)

	Decoupling of arable aid payments	Residual supply inducing effect	DW supp. payment decoupling	DW price	DW quality premium <i>ex art.</i> 72-74	DW quality premium <i>ex art.</i> 69
<b>BASELINE</b>						
B1	NO	NO	NO	Vers. 1	NO	NO
B2	NO	NO	NO	Vers. 2	NO	NO
<b>LA SCENARIO 1</b>						
S1_1_a	Full	30%	YES	Vers. 1	YES	YES
S1_1_b	Full	10%	YES	Vers. 1	YES	YES
S1_2_a	Full	30%	YES	Vers. 2	YES	YES
S1_2_b	Full	10%	YES	Vers. 2	YES	YES
<b>LA SCENARIO 2</b>						
S2_1_a	Full	30%	NO	Vers. 1	NO	NO
S2_1_b	Full	10%	NO	Vers. 1	NO	NO
S2_2_a	Full	30%	NO	Vers. 2	NO	NO
S2_2_b	Full	10%	NO	Vers. 2	NO	NO
<b>LA SCENARIO 3</b>						
S3_1_a	Full	30%	60%	Vers. 1	YES	YES
S3_1_b	Full	10%	60%	Vers. 1	YES	YES
S3_2_a	Full	30%	60%	Vers. 2	YES	YES
S3_2_b	Full	10%	60%	Vers. 2	YES	YES

## Results

### *Crop sector*

Table 4 reports the major results emerging from simulating the impact of mentioned CAP scenarios on very aggregate variables concerning the crop commodities under study, that is cereals and oilseeds.<sup>8</sup> Major interest is on the supply side, that is on land allocation and yields and, consequently, on overall production. This latter effect on total production may eventually generate significant changes in the sectoral trade balance, that is net export.

However, before analysing the main effects on the supply side, it is interesting also to understand how prices behave since they only transmit on the demand side the impacts of the reform. As mentioned, prices in the AG-MEMOD model are driven by the EU key-prices, which are in turn somehow linked to world market prices. So, here major interest is on understanding the behaviour of the only Italian key-price, that is durum wheat price. In this respect, a clear evidence emerges by comparing the two alternative specifications of the baseline scenario (B2 vs. B1) since they only differ by how price formation is modelled, the CAP measures being fixed at the Agenda 2000 regime in both cases. Since both baseline projections indicate an higher growth of EU demand than supply for durum wheat, the durum wheat price in B2 is significantly higher than in B1 (see figure 2). Due to higher price, B2 shows a significantly higher harvested area and production for cereals (+17% for both with respect to B1) and this also strongly reflects on net export, higher in B2 by about 40%. The impact of these differences in

durum wheat price between B2 and B1, on the contrary, is null on oilseeds production. These effects of price are fully confirmed in sign, as expected, in any comparison between analogous alternative scenarios, where price formation is the only difference (that is comparison between S\*<sub>1</sub>\* and S\*<sub>2</sub>\* scenarios). However, in magnitude we observe quite small differences in terms of CAP Reform impact between the baselines; in other words, though price formation specification strongly matters in how baseline behaves, the CAP impact is essentially the same regardless the baseline.

Beyond these price effects, the variation observed between the alternative scenarios and the respective baselines and across alternative scenarios can be fully attributed to the CAP reform and implementation. As expected, the reform causes a significant reduction of cereals harvested area ranging between 11% and 23% (so in any case higher than 10%), and a corresponding reduction in production (between 10% and 23%) and, more intensely, in net export (between 24% and 72%). On the contrary, the impact on oilseeds is by large much smaller: the reduction in harvested area does not vary very much across scenarios and amounts to about 0,5%, as well as the corresponding reduction in production, while net export reduction is limited to 2%-3%.

**Table 4.** The impact of the CAP reform: 2010 % variation with respect to the respective baseline scenario (B1 or B2) in the crop sectors

	Harvested area: cereals	Harvested area: oilseeds	Production : cereals	Production: oilseeds	Net export: cereals	Net export: oilseeds
<b>BASELINE</b>						
B2 wrt B1	17.35	0.00	17.31	0.00	41.56	0.00
<b>LA SCENARIO 1</b>						
S1_1_a	-20.00	-0.47	-19.75	-0.38	-38.23	-2.35
S1_1_b	-23.21	-0.60	-22.83	-0.49	-44.19	-3.02
S1_2_a	-17.04	-0.47	-16.04	-0.38	-62.30	-2.35
S1_2_b	-19.78	-0.60	-18.55	-0.49	-72.08	-3.02
<b>LA SCENARIO 2</b>						
S2_1_a	-13.30	-0.47	-12.59	-0.38	-24.38	-2.35
S2_1_b	-16.51	-0.60	-15.62	-0.49	-30.25	-3.02
S2_2_a	-11.33	-0.47	-10.26	-0.38	-39.86	-2.35
S2_2_b	-14.07	-0.60	-12.73	-0.49	-49.48	-3.02
<b>LA SCENARIO 3</b>						
S3_1_a	-16.08	-0.47	-15.55	-0.38	-30.10	-2.35
S3_1_b	-19.29	-0.60	-18.60	-0.49	-36.01	-3.02
S3_2_a	-13.70	-0.47	-12.64	-0.38	-49.12	-2.35
S3_2_b	-16.44	-0.60	-15.14	-0.49	-58.81	-3.02

Source: Our elaboration on Italian AG-MEMOD model

It is interesting to compare the S\*<sub>1</sub>\*<sub>a</sub> with the S\*<sub>1</sub>\*<sub>b</sub> counterparts, as the differences between them depends on how intense supply residual inducing effect of full decoupling is assumed. The observed differences go in the expected direction: a lower residual effect (10%) implies a greater reduction in harvested area (thus, also in produc-

tion and net export) in both cereals and oilseeds. However, again, the difference is much larger for cereals, since it amounts to about 2-3% in both harvested area and production with respect to the baseline, while it is just 0,15% and 0,10%, respectively, in oilseeds.

Further differences across alternative scenarios are, as mentioned, only due to the different implementation of the reform with respect to the specific durum wheat measures (S1\_\*\_\* with respect to S2\_\*\_\* and S3\_\*\_\* counterparts). In aggregate terms, these differences are not particularly relevant, in the case of oilseeds (they are actually null), while become particularly important for cereals, thus confirming how durum wheat matters in the Italian crop sector. Comparing the full coupling (S2\_\*\_\*) with the full decoupling *plus* quality premiums (S1\_\*\_\*) options about the durum wheat supplementary payment, the difference (with respect to the baseline) in terms of harvested area and production ranges between 6% and 7%. Partial decoupling with quality premiums (S3\_\*\_\*) provides, as expected, in-between results. This evidence confirms that the implementation of the durum wheat specific measures of the CAP reform may actually be, in the Italian case, one of the most crucial issue in the application of the reform itself.

#### ***Evidence for durum wheat***

Table 5 reports in details the impact of the reform on the durum wheat sector. It firstly makes explicit how the different specification of the price formation in the baseline (B1 and B2) strongly affects the results. This generates several expected effects. On the one hand, demand decreases significantly (by 16%) passing from B1 to B2 while production increases, though this effect is much less relevant. In fact, higher price induces more harvested area (23%), which, however, implies a reduction of yields (12%), thus partially offsetting the former effect. The combination of lower demand and an higher supply eventually generates a reduction in import (3%) and a significant increase of export (32%), thus a strong increase in durum wheat net export.

Again, however, our major interest is on the effect of the reform on durum wheat production in Italy, despite the significantly different possible behaviour of the respective price. Firstly, since all alternative scenarios are compared in table 5 (as in table 4) with the respective baseline (that is with the same specification of the price formation), and since the durum wheat price (as any key-price) is only driven by exogenous variables, for no scenario there is any variation in demand with respect to the baseline, and all the effects of the CAP reform are observed on the supply side.

Secondly, on the supply side, the effect of decoupling is normally a little larger for durum wheat with respect to the other cereals. Harvested area reduction ranges between 11% and 26%; this strong effect is only partially counterbalanced by yields increase, ranging between 9% and 16%, thus letting the reduction of production at a still significant level. Since demand is not affected by decoupling, this reduction on the supply side can be fully observed in trade balance: a slight increase in import (lower than 2%) but, above all, a significant decline in export (between 3% and 20%), whose large variation is mainly determined, as expected, by the different specifications of the price formation equation.

Within this large impact, the effect of a different specification of the supply inducing effect (30% vs. 10%) is, as before, quite limited since the harvested area shows a greater reduction in latter case by just about 3% with respect to the baseline. Even in this case, the impact on land allocation is partially offset by a corresponding increase in yields,

such that the overall implication of this residual effect in terms of production and import-export is almost negligible. Again, on the contrary, more remarkable is the variation induced by how the specific measures for durum wheat are implemented. *Ceteris paribus*, the difference between full decoupling (with quality premiums) and full coupling of the supplementary payment ranges between 7% and 10% in harvested area, whereas it is 4%-5% for yields, obviously moving in the opposite direction. Thus, full decoupling of supplementary payments may generate up to a 9% larger reduction of durum wheat export with respect to the baseline. The intermediate scenario (full decoupling with quality premiums) confirms how modulating the decoupling scheme of the supplementary payment may significantly attenuate the strong impact of the CAP reform on the Italian durum wheat supply.

**Table 5.** The impact of the CAP reform: 2010 % variation with respect to the respective baseline scenario (B1 or B2) in durum wheat (DW)

	DW Harvested area	DW Yield	DW demand	DW Import	DW export
<b>BASELINE</b>					
B2 wrt B1	23.60	-12.16	-15.84	-3.09	32.07
<b>LA SCENARIO 1</b>					
S1_1_a	-22.94	13.62	0.00	1.70	-17.69
S1_1_b	-26.09	15.75	0.00	1.98	-20.55
S1_2_a	-18.56	15.51	0.00	0.91	-6.93
S1_2_b	-21.11	17.94	0.00	1.07	-8.14
<b>LA SCENARIO 2</b>					
S2_1_a	-13.83	8.90	0.00	0.84	-8.76
S2_1_b	-16.98	11.03	0.00	1.07	-11.13
S2_2_a	-11.19	10.13	0.00	0.34	-2.56
S2_2_b	-13.74	12.56	0.00	0.45	-3.40
<b>LA SCENARIO 3</b>					
S3_1_a	-17.61	10.86	0.00	1.19	-12.32
S3_1_b	-20.77	12.99	0.00	1.43	-14.90
S3_2_a	-14.25	12.37	0.00	0.56	-4.26
S3_2_b	-16.80	14.79	0.00	0.69	-5.26

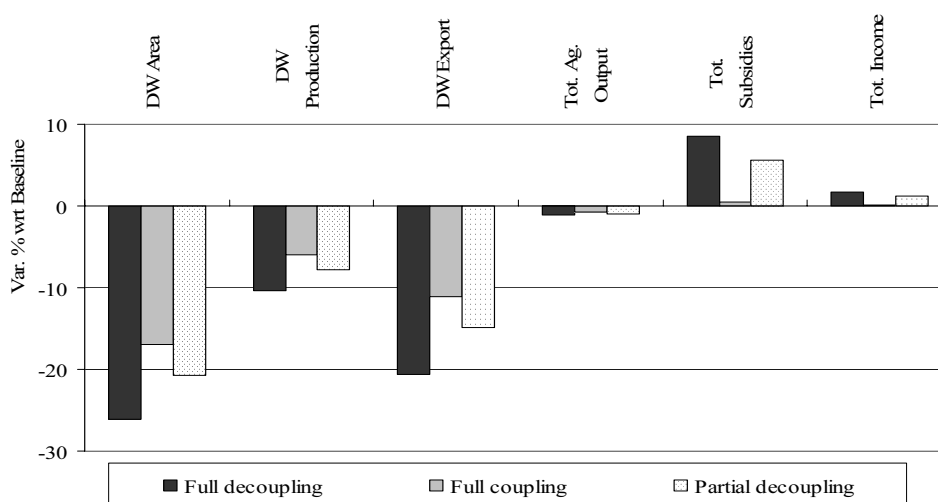
Source: Our elaboration on Italian AG-MEMOD model

### Some final remarks: results overview and comparison with other models

Figure 3 summarizes the impact on selected variables of the alternative policy scenarios with respect to the respective baseline. For any group of scenarios (1, 2 and 3) relating to coupling-decoupling device of the durum wheat supplementary payment, the maximum impact is reported. It also displays the % variation of some major elements of the Economic Accounts for Agriculture (EAA) derived from the commodity models under the three CAP reform scenarios<sup>9</sup>. According to our simulations, the CAP reform causes a slight reduction in the value of agricultural output, ranging between 0,6% and 1,1%, and a more intense (but still small) reduction in input use, ranging between 1,9%

and 3,4%. In addition, the change in support regime also normally generates a slight increase in overall subsidies, up to 8,5%.<sup>10</sup> Eventually, these effects offset in the calculation of the agricultural (i.e., self-employment) income, which is expected to remain almost unchanged with respect to the baseline since it ranges between a +1,8% and a -0,2% change.<sup>11</sup>

From figure 3 it also clearly emerges that the impact on durum wheat area is expected to be quite large, although significantly attenuated by yield increase thus generating a limited impact on production (< 10%). Nevertheless, the effect on trade is particularly relevant: a slight increase of import (<2%) and, above all, a large decline of durum wheat export (>10%). The role of national choices in attenuating these effect is also remarkable; for instance, partial decoupling would reduce the negative impact on durum wheat area and export by about 5%.<sup>12</sup> This is also evident when the total (i.e., aggregated over the whole agricultural sector) impact on output and income is considered. Though the aggregate effect is small, it still differs according to the alternative implementation of the durum wheat specific measures; in particular, it affects the total amount of subsidies delivered to the Italian agriculture, thus confirming how relevant durum wheat is also in this respect.



**Figure 3.** Maximum effect of alternative decoupling devices of the durum wheat supplementary payment with respect to the respective baseline (% variation)

Source: Our elaboration on Italian AG-MEMOD model

To assess the robustness and reliability of the model projections summarized above, it can be useful to compare the most important results with evidence emerging from other studies and approaches about the impact of the CAP reform on EU and Italian agriculture.<sup>13</sup> Results obtained within the AG-MEMOD model can be compared with the projections presented by the Commission using a similar approach, thus also similar to the FAPRI approach and results (European Commission, 2003; FAPRI, 2003b). However, the EC simulation does not emphasize the country specific effects of the reform, which are, on the contrary, of major interest here. At the EU-15 level, the impact of the reform as reported by the Commission indicates a 0,9% and 1% decline of cereals

and oilseeds cultivated area, respectively. More specifically, a 5,5% decline in durum wheat area is expected. In AG-MEMOD (Esposti and Lobianco, 2004), the EU projected decline is 2% for cereals and 6% for oilseeds, thus implying a more intense impact of the reform especially in these latter crops.

Another interesting comparison can be attempted with the OECD report (OECD, 2004) about the impact of the 2003 CAP reform. The OECD analysis is carried out with both the PEM approach and the AGLINK model. Despite the methodological differences among the two, both refer to the EU-15 as one aggregate bloc, thus missing the relevant distributional effect of the reform across member states. Most results generated by the two approaches are quite similar. At the EU aggregated level, the PEM suggests a 2,5% reduction in cereals harvested area and a 2,8% reduction for oilseeds. The AGLINK results admit different evidence according to the decoupling scheme, but no major differences emerge with maximum or minimum decoupling, at least for cereals. About 0,5% reduction in cultivated area for wheat and coarse grains is reported, while for oilseeds this reduction is only observed with minimum decoupling, but it is negligible. It is also important to notice that also in the AGLINK model the decoupling of payments is entered by assuming some residual effect on production as a sort of *ad valorem* equivalent with respect to the fully coupled support case (see also Dewbre *et al.*, 2001 and van Tongeren *et al.*, 2001).

Other interesting studies concern the CAPMAT approach suggesting an 8% reduction of wheat area at the EU-15 level, the CAPSIM study indicating a 25% reduction of durum wheat area (only -1% for soft wheat) at EU level, and the INEA study with cereals production falling by 30% in several countries, Italy included. All these studies are reviewed in details by ESPON (2004); they represent interesting references even because suggest similar impacts of the reform, though significant divergence emerge just in the expected reduction of the wheat area, with particular uncertainty on durum wheat. However, even these studies usually focus on the EU as a whole, therefore they can be hardly compared to the Italian results here reported. A little more detailed is the WEMAC (World Econometric Modelling of Arable Crops) model, that includes an EU aggregate with also some details about the major EU agricultural countries (Italy included)<sup>14</sup> and makes also more explicit the relation between the EU and world markets,<sup>15</sup> but only concerns cereals and oilseeds. Also in this case, however, the expected impact of decoupling is limited, with a 2,6% and 6,8% reduction in soft wheat and durum wheat harvested area (Benjamin *et al.*, 2003).

However, what will really happen to wheat area and, above all, to durum wheat cultivation at the national level should be more expressly evaluated within country-specific models. In October 2004 the AIS (Italian Association of Seed Producers) estimated a reduction of the Italian durum wheat production ranging between 20% and 30% which is not far from results here presented (AgriSole, 2004). Moreover, using a Positive Mathematic Programming (PMP) approach, Arfini (2004) has recently calculated the possible impact of the reform on Italian land allocation. His results are not so different to what obtained in our AG-MEMOD projections. According to different decoupling devices (partial vs. full decoupling), he obtains a reduction of cereals cultivated area ranging between 9% and 13%. Also for oilseeds the results are not particularly different. Though his results suggest a +1% increase in oilseeds harvested area, both approaches essentially signal that the CAP reform is not expected to affect oilseeds land allocation very much. The effects of the reform on the aggregate EAA figures are similar. Arfini

suggests a 4% decline in the value of crops output compared to about 1% decline generated by the AG-MEMOD model.

### Notes

- <sup>1</sup> AG-MEMOD is the acronym of the project entitled “Agricultural sector in the Member State and EU: econometric modelling for projection and analysis of EU policies on agriculture, forestry and the environment”, Contract No. QLK5-CT-2000-00473 funded by European Commission under the Research Programme: “Quality of Life and Management of Living Resources”, Key Action 5.4 support for Common Policies, priority area 5.4.2 CAP Measures and Related Activities. The partnership includes 24 research teams; more details about the project and partnership can be found at the AG-MEMOD web-site: <http://www.tnet.teagasc.ie/agmemod>.
- <sup>2</sup> An exhaustive presentation of the complete econometric model with the explicit functional specifications of the estimated equations can be found in Berloni et al. (2002) and Esposti and Lobianco (2004).
- <sup>3</sup> Here, we skip the description of the livestock part of the Italian model (including four sub-models: cattle and beef meat, pig and pig meat, sheep and lamb meat, poultry meat, the latter divided in broiler and other poultry) and of the dairy model. These are quite complex models. However, the focus, here, is on crops and in particular on durum wheat, since for them much higher impacts are expected. Anyway, all details also on these parts of the Italian AG-MEMOD model, as well as on the respective results can be found in Esposti and Lobianco, 2004.
- <sup>4</sup> The Italian durum wheat price is used as leading price also in the WEMAC model (Benjamin et al. 2003).
- <sup>5</sup> The estimation of all behavioural equations is run with the software TSP 4.5. The whole Italian AG-MEMOD model includes 176 estimated equations. A complete description of variables definition, data sources, equations specification, estimation techniques, parameter and elasticity estimates and inference can be found in Berloni et al. (2002). However, information about the estimated equations concerning the EAA calculations, as described in Esposti and Lobianco (2004) and Tabeau and van Leeuwen (2003), are available at the website <http://www.agmemod.org/italy/>. All this material is also available upon request.
- <sup>6</sup> A fully detailed description of the CAP revision under the LA, as well as of all possible implementation options, is reported in Binfield et al. (2003b). The official document concerning the CAP reform is COM(EU) No 1782/2003, mainly concerning full decoupling and single farm payments, whose detailed rules for the implementation are described in COM(EC) No 795/2004. Finally rules for the implementation of cross-compliance, modulation and the integrated administration and control system are defined in COM(EC) No 796/2004.
- <sup>7</sup> These scenarios do not necessarily correspond to real possible options admitted by the reform. Nevertheless, they represent extreme cases that well stress the whole range of possible impacts of the reform itself.
- <sup>8</sup> Sections 4.1 and 4.2 present projections of the model endogenous variables up to 2010. Since most variable are updated to 2002 or to 2003, projections generally refer to the 2003-2010 or 2004-2010 period, though policy impacts are mainly displayed by comparing 2010 projections among scenarios. Complete projections are partially reported in Esposti and Lobianco (2004) and can be provided upon request. Due to space limit, the



model results here described only refer to the crop sector and with major emphasis on durum wheat.

- <sup>9</sup> The links between the AG-MEMOD model variables and the EAA components, as well as the modelling methodology used to derive them, have been taken from Tabeau and van Leeuwen (2003). The calculations of all the EAA components concerning the Italian model, together with the estimated equations to compute them and the complete set of their projections, are described and reported in Esposti and Lobianco (2004). However, we do not aim to draw conclusions from the aggregate results in terms of specific farm level effects, as these impacts (as well as farm specific aspects of the reform, such as modulation) would require a detailed farm level modelling and can not be achieved within commodity market models as the AG-MEMOD approach.
- <sup>10</sup> The EAA distinguish the total subsidies to agriculture in two components, namely 'subsidies on products' and 'subsidies on production'. Here we aggregate these two components in one amount of 'Total subsidies'. It must be also noticed that the current AG-MEMOD model does not include any budgetary ceiling for the decoupled payments, although it is actually imposed by the CAP reform. Thus, the introduction of this budgetary constraint in the model, and its consequent feedback on projections, could represent a relevant future improvement of the approach.
- <sup>11</sup> Here, agricultural income is meant in nominal terms; thus, a constant nominal income actually implies a slowly reducing income in real terms (Esposti and Lobianco, 2004).
- <sup>12</sup> Other scenarios (i.e., national choices) on art.69 could be tested in future research since quality premiums may largely vary from just 40€/ha (no art.69 payments) up to 220€/ha (as the regulation admits up to 180€/ha ex art.69).
- <sup>13</sup> All mentioned studies rely on partial equilibrium models but some of them are synthetic models not estimated models (see van Tongeren et al., 2001, for a detailed review).
- <sup>14</sup> Unfortunately specific results for Italy of the WEMAC model have been not published. Also the FAPRI-GOLD model (Binfield et al., 2003b) specifically models Italy. As for WEMAC, however, this country disaggregation is introduced just to better generate EU aggregate results; so country results are not provided. In addition, the FAPRI-GOLD model for Italy is a synthetic model not an econometric one.
- <sup>15</sup> It must be noticed that in both AGLINK and WEMAC models, world prices are endogenous since the EU aggregates affect price formation at the world market level. This does not hold in the AG-MEMOD approach, although it should be reminded that the AG-MEMOD model is linked to the FAPRI-Missouri EU GOLD model and allows for the incorporation of the impact of global supply and demand developments on EU agricultural markets (FAPRI, 2003a; Hanrahan, 2001).
- <sup>16</sup> Although feed demand is almost negligible for durum wheat, it is still included to maintain consistency with the other crop productions.

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## APPENDIX

## Structure of the Italian AG-MEMOD model (cereals and oilseeds)

Table A.1. List of behavioural equations of crop sub-models

Equations	Total Cereals Total oilseeds	Soft wheat Durum wheat Barley Maize	Rapeseed Sunflower seed Soybean	Rape oil Sun oil Soy oil	Rape meal Sun meal Soy meal
Area harvested	X	X (only durum wheat)			
Share on total area		X (soft+ durum wheat)	X		
Yield		X	X		
Production				X	X
Food <i>per capita</i> demand		X			
Food <i>per capita</i> demand (share)				X	
Feed demand		X			X
Crush demand			X		
Stocks		X	X	X	X
Imports		X (only durum wheat)			
Exports		X (excl. durum wheat)	X	X	X
Price formation		X	X		

The general (implicit) form of these equations is described as follows:

*Supply side*

We assume that land allocation is a three-steps decision process. Producers first determine the total land allocated to cereals or grains (*g*) and to oilseeds (*o*). Secondly, this total area is allocated to any of the *n,m* crops belonging to the two groups respectively, where wheat is a single aggregate. Thirdly, total wheat area is allocated between soft and durum wheat.

In the first decision step, the total harvested area at year *t* of cereals ( $ah_{g,t}$ ) and oilseeds ( $ah_{o,t}$ ) is determined as follows:

$$(1a) \quad ah_{g,t} = f(er_{g,t}, er_{o,t}, ah_{o,t}, v_t)$$

$$(1b) \quad ah_{o,t} = f(er_{g,t}, er_{o,t}, ah_{g,t}, v_t)$$

where  $er_{g,t}$  and  $er_{o,t}$  are the expected *per ha* returns for cereals and oilseeds, respectively, and  $v_t$  is a vector of exogenous variables which can have an impact on the harvested area (namely, the set aside rate and a linear trend). The expected returns for the two commodity groups are calculated as weighted sum of the expected returns  $er_{i,t}$  of any of the *i*-th crop belonging to the group plus the *per ha* compensation or payment ( $C_{g,t}$  or  $C_{o,t}$ ):

$$(2a) \quad er_{g,t} \equiv \sum_i \alpha_i \cdot er_{i,t} + C_{g,t}, \quad \text{where } \sum_i \alpha_i = 1, \quad \forall i=1, \dots, n$$

$$(2b) \quad er_{o,t} \equiv \sum_i \alpha_i \cdot er_{i,t} + C_{o,t}, \quad \text{where } \sum_i \alpha_i = 1, \quad \forall i=1, \dots, m$$

where  $\alpha_i$  is the lagged share on total group area. The expected return  $er_{i,t}$  is the three-years weighted sum of the trend return (that is, the product of the trend yield  $ty_{i,t}$  by the

market price  $p_{i,t}$ , where the trend yield is estimated by regressing the observed yield on a deterministic trend):

$$(3) \quad er_{i,t} \equiv \sum_{L=2}^0 \beta_{t-L} \cdot ty_{i,t-L} \cdot p_{i,t-L}, \quad \text{where } \sum_L \beta_{t-L} = 1$$

where  $\beta_{t-L}$  is 0.5, 0.3 and 0.2 for  $L = 0, 1$  and  $2$  respectively.

The second decision step involves the allocation of land among the  $n, m$  crops of the cereals-oilseeds group, respectively. This allocation is modelled as share equation as follows:

$$(4) \quad sh_{i,t} = f(er_{g,t} / er_{i,t}, v_t) \quad \text{or} \quad f(er_{o,t} / er_{i,t}, v_t)$$

where  $sh_{i,t}$  is the  $i$ -th crop share on total group area, and  $v_t$  again includes the set aside rate and a linear trend. It follows that land allocated to any  $i$ -th crop is derived as an identity:

$$(5) \quad ah_{i,t} \equiv sh_{i,t} \cdot ah_{g,t} \quad \text{or} \quad ah_{i,t} \equiv sh_{i,t} \cdot ah_{o,t}$$

In equations (4) and (5) wheat is considered as a single aggregate. Therefore, a durum wheat (DW) area equation is estimated:

$$(6a) \quad ah_{DW,t} = f(er_{DW,t}, er_{g,t}, er_{o,t}, v_t)$$

to allow for the calculation of the consequent soft wheat (SF) area as:

$$(6b) \quad ah_{SW,t} \equiv ah_{Wheat,t} - ah_{DW,t}$$

The supply side of the model is completed by the yield equation, which is written, for any  $i$ -th cereals crop, as follows:

$$(7) \quad y_{i,t} = f(ty_{i,t}, ah_{i,t}, p_{i,t-1}, (ah_{g,t} + ah_{o,t}))$$

whereas for any oilseeds crop is:

$$(8) \quad y_{i,t} = f(ty_{i,t}, ah_{i,t})$$

Therefore, the *per hectare* yield  $y_{i,t}$  depends on the calculated trend yield, the harvested area and, for cereals, on lagged own price and on the total area allocated to cereals and oilseeds. Total production ( $qp$ ) for any  $i$ -th crop can be derived by multiplying estimated yield and area.

#### Demand side

On the demand side, *per capita* food (non-feed), crush and feed demand is modelled using the following general functional forms:

◆ Food (non-feed) use (cereals)

$$(9) \quad qd_{nfeed,i,t} = f(p_{i,t}, v_t)$$

where  $qd_{nfeed,i,t}$  and  $p_{i,t}$  are the *per capita* food demand and price for  $i$ -th commodity, respectively, and  $v_t$  is a vector of other variables (*per capita* GDP, lagged feed demand, other prices)

◆ Feed demand (cereals and oilseeds meals)

$$(10) \quad qd_{feed,i,t} = f(p_{i,t}, p_{m,t}, \gamma_{i,t})$$

where  $qd_{feed,i,t}$  is the *per capita* feed demand for  $i$ -th commodity,  $p_{i,t}$  and  $p_{m,t}$  are the own and other feed prices, and  $\gamma_{i,t}$  is a feed demand index.

◆ Crush demand (oilseeds)

$$(11) \quad cr_{i,t} = f(cm_{i,t}, cr_{i,t-1})$$

The *per capita* crush demand of  $i$ -th oilseed depends on a crushing margin  $cm_{i,t}$

relating the own (oils and meals) price with the price of the original seeds.

◆ Oils demand (seeds oils)

$$(12) \quad qd_{tot,i,t} = f(p_{i,t}, p_{m,t}, gdp_t)$$

Seeds oil demand is calculated as *share* of the total *per capita* oils-fats expenditure in a demand system that includes the three vegetable oils and butter;  $gdp_t$  indicates the *per capita* GDP,  $p_{i,t}$  and  $p_{m,t}$  are the own and other oil prices. Multiplying the estimated share by the expenditure we obtain the respective oil demand.

Finally, total demand (food+feed) can be derived for any commodity multiplying by population and summing the above components.

*Trade, stocks and price formation*

In any commodity model, for modelling imports, exports and stock level equations we use the following general functional forms:

$$(13) \quad im_{i,t} = f(qp_{i,t}, qd_{tot,i,t}, st_{i,t}, st_{i,t-1}, v_t)$$

$$(14) \quad ex_{i,t} = f(qp_{i,t}, qd_{tot,i,t}, im_{i,t}, st_{i,t}, st_{i,t-1}, p_{i,t})$$

$$(15) \quad st_{i,t} = f(qp_{i,t}, st_{i,t-1}, p_{i,t}, pol_{i,t})$$

where  $im_{i,t}$ ,  $ex_{i,t}$  and  $st_{i,t}$  are imports, exports and ending stocks respectively for the  $i$ -th commodity, while  $p_{i,t}$ ,  $qp_{i,t}$  and  $qd_{tot,i,t}$  are price, production and the total demand, respectively;  $Pol_{i,t}$  is a vector of possibly relevant policy variables (mainly, intervention prices), while  $v_t$  may include other variables as time trend, dummy and production losses. It must be also reminded that for any commodity, one the three equations above is not estimated but calculated from the domestic supply and demand identity, thus playing as the model closing (market clearing) variable.

When the Italian market is not the EU key-market, the  $i$ -th commodity price  $p_{i,t}$  in Italy is estimated through the price linkage equation:

$$(16) \quad p_{i,t} = f(p_{key,i,t}, v_{i,t})$$

where  $p_{key,i,t}$  is the EU key-price and  $v_{i,t}$  is a vector of variables which could have an impact on the Italian price (mainly, the Italian self sufficiency rate and the key-market self sufficiency rate). For oilseeds the world price is directly used in the price formation equation since no EU key-price exists for these products.

For durum wheat, the Italian price is considered the key-price. In this case, the equation describing the price formation is written as:

$$(17) \quad p_{DW,t} \equiv p_{key,DW,t} = f(p_{world,DW,t}, v_{DW,t})$$

where  $p_{world,DW,t}$  is the durum wheat world price, and  $v_{DW,t}$  is a vector of variables which could affect the durum wheat Italian price. In particular, as further explanatory variables we admit the durum wheat price at time  $(t-1)$ , the EU durum wheat net export at time  $(t-1)$ , as a proxy of the EU self-sufficiency rate, and a time trend. In fact, as mentioned, two different alternative specifications of equation (17) are used in running the model: with the lagged price and time trend and without the EU durum wheat net export as regressor (Vers. 1), without the lagged price and time trend and with the EU net export (Vers. 2).

*Selected (durum wheat) equation estimates*

Here, we just report the estimates for a limited number of equations, where durum wheat variables appear as depended variables. Standard error are reported in parenthesis below the parameters point estimate. Yield and area equations are estimated

simultaneously, as well as price formation, import and stocks equations, using an 3SLS estimator. The other equations are estimated with an OLS estimator.

- DURUM WHEAT AREA HARVESTED

$$DWAHAIT = \frac{1096,02}{(806,48)} + \frac{0,0006}{(0,0003)} * DWEGRIT + \frac{0,0003}{(0,0004)} * G3EGRIT + \\ + \frac{0,0001}{(0,0002)} * O3EGRIT - \frac{11,50}{(5,36)} * GRSARE5 + \frac{6,69}{(16,79)} * TREND$$

$$R^2 = 0,533$$

- DURUM WHEAT TREND YIELD

$$DWYHTIT = \frac{-84,13}{(17,50)} + \frac{0,0435}{(0,0088)} * TREND$$

$$R^2 = 0,4219$$

- DURUM WHEAT YIELD

$$DWYHAIT = \frac{4,91}{(2,60)} + \frac{1,11}{(0,952)} * DWYHTIT + \frac{0,0001}{(0,0001)} * DWPFRIT(-1) - \frac{0,0014}{(0,0006)} * \\ * (G3AHAIT + O3AHAIT) + \frac{0,0008}{(0,0012)} * DWAHAIT - \frac{0,4600}{(0,2368)} * DUMMY$$

$$R^2 = 0,484$$

- DURUM WHEAT FEED DEMAND<sup>16</sup>

$$DWUFEIT = \frac{509,39}{(429,99)} - \frac{0,297}{(0,327)} * WHFINIT - \frac{0,0003}{(0,0001)} * DWPFRIT - \frac{0,0001}{(0,0002)} * SWPFRIT$$

$$R^2 = 0,259$$

- DURUM WHEAT NON FEED PER-CAPITA DEMAND

$$DWUFCIT = -\frac{25,38}{(36,59)} + \frac{0,0002}{(0,0001)} * SWPFRIT - \frac{0,0001}{(0,0001)} * DWPFRIT + \frac{0,0514}{(0,0280)} * \\ * RGDPICIT + \frac{9,19}{(2,22)} * DUMMY$$

$$R^2 = 0,718$$

- DURUM WHEAT ENDING STOCKS

$$DWCCTIT = \frac{9777,49}{(5129,23)} + \frac{0,4289}{(0,1534)} * DWCCTIT(-1) + \frac{0,2686}{(0,1295)} * DWSPRIT - \\ - \frac{0,0091}{(0,0043)} * DWPFRIT - \frac{306,49}{(132,03)} * TREND$$

$$R^2 = 0,679$$

- DURUM WHEAT LOSS

$$DWLSDIT = -\frac{10,12}{(15,06)} + \frac{0,9741}{(0,0416)} * (DWSPRIT - DWSPRIT(-1))$$

$$R^2 = 0,987$$

- DURUM WHEAT IMPORT

$$DWSMTIT = \frac{0,0773}{(0,1737)} * (DWUDCIT + DWCCTIT + DWLSDIT - DWSPRIT - DWCCTIT(-1)) + \\ + \frac{60,38}{(6,96)} * TREND$$

$$R^2 = 0,291$$

• DURUM WHEAT PRICE FORMATION EQUATION

Vers. 1

$$\text{DWPFRIT} = \frac{15064,10}{(9479,94)} + \frac{35,33}{(18,17)} * \text{DWPM DIT} + \frac{0,6591}{(0,1399)} * \text{DWPFRIT}(-1) - \frac{348,52}{(119,34)} * \text{TREND}$$

$$R^2 = 0,703$$

Vers. 2

$$\text{DWPFRIT} = \frac{28844,6}{(3627,67)} + \frac{106,91}{(7,09)} * \text{DWPM DIT} - \frac{2,99}{(0,7651)} * \text{DWUXNE5}(-1) - \frac{21937,40}{(2099,66)} * \text{DUMMY}$$

$$R^2 = 0,586$$

• CLOSING VARIABLE (Identity): DURUM WHEAT EXPORT

$$\text{DWXTIT} = \text{DWSPRIT} + \text{DWCCTIT}(-1) + \text{DWSMTIT} - \text{DWUDCIT} - \text{DWCCTIT} - \text{DWLSDIT}$$

Legend:

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DUMMY	Dummy variable (=1 from 1993)
DWAHAIT	Durum wheat area harvested
DWCCTIT	Durum wheat ending stocks
DWCCTIT(-1)	Durum wheat beginning stocks
DWEGRIT	Durum wheat expected real gross returns
DWLS DIT	Durum wheat loss
DWPFRIT	Durum wheat real price
DWPM DIT	Durum wheat world real price (converted in national currency)
DWSMTIT	Durum wheat imports
DWSPRIT	Durum wheat production
DWUDCIT	Durum wheat total demand
DWUF C IT	Durum wheat non feed <i>per capita</i> demand
DWUFEIT	Durum wheat <i>per capita</i> demand
DWUXNE5	Durum wheat EU net exports
DWXTIT	Durum wheat exports
DWYHAIT	Durum wheat yield
DWYHTIT	Durum wheat trend yield
G3AHAIT	3-cereals total area (wheat as a single aggregate)
G3EGRIT	3-cereals expected real gross returns
GRSARE5	Cereal set-aside rate
O3AHAIT	3-oilseeds total area
O3EGRIT	3-oilseed expected real gross returns
RGDPCIT	Real <i>per capita</i> GDP
SWPFRIT	Soft wheat real price
TREND	Time trend
WHFINIT	Wheat feed demand index

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Note: (-1) indicates the variable at time (t-1)