EC4MACS

Uncertainty Treatment

The CAPRI Agricultural Model

European Consortium for Modelling of Air Pollution and Climate Strategies - EC4MACS

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1. Introduction

Quantitative modelling is subject to a variety of uncertainties basically due to a certain error probability in all human decisions. They may be grouped in various ways, for example

- Structural uncertainty applies if the model structures represent an inappropriate simplification of reality, for example because it rests on untenable assumptions
- Coding uncertainty refers to the fact that nearly all computer code includes a certain number of errors.
- Parameter uncertainty refers to the error probability in the specification of model parameters, however they are determined.
- Data uncertainty in a narrow sense refers to the ex post data base of models that usually rely on some kind of statistical information to specify the starting point of modelling
- Exogenous input uncertainty is similar to data uncertainty but refers to the inputs for future years to be simulated.

While **structural uncertainty** cannot be denied, it is usually difficult to quantify. A simplification in the current structure of CAPRI is that dynamics are not explicitly accounted for but only enter indirectly through the expert information used in the CAPRI baseline. Simulations for future points in time are handled in a comparative-static manner. Future projections years are thus considered to be in economic equilibrium and unaffected by short run fluctuations of weather, macroeconomic drivers or oil prices, for example. In this way, the projections can only capture the average outcomes under typical conditions. Furthermore, any disequilibria along the path towards a new equilibrium are not accounted for. This is a considerable simplification. It has been adopted because the experience of the earlier CAPRI DYNASPAT project (http://www.ilr1.uni-bonn.de/agpo/rsrch/dynaspat/dynaspat_e.htm) showed that the use of a so-called partial adjustment mechanism (which is capable to represent lags in economic behaviour) has involved higher cost than benefits. The problem was simply that the increase in complexity from adding a yearly resolution to a model with hundreds of regions led to a considerable increase in computing time and time for checking the results. The only option to check for structural uncertainty from a neglect of the dynamics would be to compare CAPRI results with those from a dynamic agricultural sector model that would be more aggregated in terms of the regional resolution. However, the most relevant models of this type (AGLINK[1] or FAPRI[2]) have been used already to obtain expert information on selected variables for the CAPRI baseline.

Coding errors are easy to detect if they cause program infeasibilites or grossly implausible results. Unfortunately, some programming errors are not fatal and sometimes may go undetected for years. This is a very difficult type of uncertainty for quantification and it suggests a good dose of scepticism towards any new "findings" that will be common standard in experienced modelling teams. The likelihood of these kind of errors decreases with good programming standards and EC4MACS benefits from the fact that other projects ("CAPRI-RD") have identified such quality improvements as a separate working package[3].

Data uncertainty is common to all models. Indeed the CAPRI system treats all statistical data in the first steps of the establishment of the model database as potentially erroneous "raw data". A specific procedure checks them for completeness and internal consistency and at each database update significant revisions compared to the last Eurostat release (the key data source for CAPRI) are investigated for plausibility. Nonetheless, it is certain that some percentage of erroneous data has passed through all security measures and another percentage of initially correct data may have been distorted through the application of wrong adjustment procedures. As the CAPRI baseline procedure partly relies on statistical analysis of past data, such ex post data errors would also affect the projections into the future, in particular if there are large errors in the most recent data. In addition to mechanical outlier detection routines and careful checking of results, an additional safeguard against erroneous data comes from the use of the same database and baseline in several projects. As data errors are sometimes leading to surprising characteristics of the baseline projections the probability of detecting those increases with the number of analyses based on those data. Multi-purpose modelling systems may have some advantages therefore over single-purpose modelling systems. In the same way an organised consultation process (as stimulated through EC4MACS) with national experts, usually more familiar with their national data than the developers of EU wide modelling systems, turned out to be helpful to detect data errors and thereby reduce data uncertainty.

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1 OECD (2007) *Documentation of the AGLINK-COSIMO model*, Working Party on Agricultural Policies and Markets, Directorate for Food, Agriculture and Fisheries, Committee for Agriculture, Organization for Economic Cooperation and Development, AGR/CA/APM(2006)16/FINAL, 14.5.2007, Paris.

2 See on the FAPRI website http://www.fapri.iastate.edu/models/

3 See work package #7 on http://www.ilr1.uni-bonn.de/agpo/rsrch/capri-rd/wps.htm.

Parameter uncertainty and **exogenous input uncertainty** differ from the earlier sources of uncertainty as there is usually no unambiguous “best” choice, such that they have been investigated on the basis of CAPRI results in more detail.

2. Exogenous input uncertainty

2.1. Macro assumptions

The CAPRI baseline relies importantly on the expert inputs from other modelling systems, for the key agricultural variables mostly from the AGLINK modelling system, which has used in turn a certain set of macro assumptions. In the context of EC4MACS, however, these macro assumptions had to be aligned with those of the PRIMES energy model. To achieve this alignment a so-called “pre-simulation” has been carried out. More precisely the demand functions have been shifted to account for the differences in population and GDP growth assumptions between AGLINK and PRIMES and CAPRI has been solved for the revised market equilibrium. Given that EU Member States are linked through the Common Market it is the aggregate EU27 shift in demand that determines the price changes and then adjustments in national supply quantities and activity levels.

In year 2020, the GEME3/PRIMES assumptions are basically consistent with the initial CAPRI assumptions (inherited from AGLINK) in terms of population, but GDP needs to be increased by 2.3% which translates into a demand shift of about 1.15% with an income elasticity of 0.5 (variable, depending on product and country). By contrast, in 2050 the main agricultural expert source in the combination of FAO and IFPRI. Compared to their assumptions, population needs to be increased by 7.8% and GDP decreased by 9.5%. However, considering an income elasticity of 0.5, for example, this gives an *increase* in demand of +7.8% - 0.5*9.5% ~ 3.1% which is a bit stronger than the correction in 2020. Only a part of this demand shift will trigger additional EU production, the rest stimulates demand for imports and thereby further dampens the effects of macro changes on EU herd sizes (which are the key output of CAPRI for GAINS). The resulting effects of aggregate demand shifts of about 2% (2020) to 3% (2050) is shown in the following Table 1. It may be checked that the demand shift effects are rather small in the cattle sector (usually less than 0.5%) but may be somewhat stronger (up to 4% in single countries, in particular of EU12) for other poultry, pigs and sheep. Note, however, that compared to the strong growth in herd sizes expected in the baseline for some Member States (+40% in Poland and Spain for pigs), a macro correction of 3% does not represent a major uncertainty.

Table 1: Impacts of modified macro assumptions on herd sizes in EU27 Member States [1000 hds or %] in year 2020 (except where indicated otherwise)

	Hens		Other poultry		Pigs		Sheep		Dairy cows		Other cattle	
	before	after	before	after	before	after	before	after	before	after	before	after
Belgium-Lux.	12134	**+1.3%**	16285	**+1.4%**	7489	**+1.1%**	161	**+1.4%**	616	**+0.3%**	1623	**+0.2%**
Denmark	3937	**+2.0%**	23723	**+0.9%**	11242	**+1.4%**	107	**+1.7%**	491	**+0.3%**	693	**+0.2%**
Germany	38680	**+2.0%**	117563	**+1.2%**	29541	**+1.3%**	2047	**+2.1%**	3568	**+0.4%**	4928	**+0.2%**
Greece	13206	**+1.5%**	14900	**+0.9%**	544	**+1.6%**	11129	**+1.4%**	134	**+0.3%**	429	**+0.2%**
Spain	53940	**+2.0%**	142796	**+1.3%**	22396	**+1.5%**	20789	**+1.5%**	992	**+0.5%**	6658	**+0.2%**
France	61503	**+1.8%**	184655	**+1.3%**	16694	**+1.4%**	8508	**+1.6%**	3403	**+0.4%**	12718	**+0.3%**
Ireland	3331	**+1.6%**	9655	**+1.3%**	1196	**+1.5%**	3313	**+1.8%**	1145	**+0.2%**	4506	**+0.2%**
Italy	71692	**+1.9%**	79280	**+1.4%**	10273	**+1.5%**	8138	**+1.1%**	1861	**+0.4%**	5249	**+0.4%**
Netherlands	28829	**+1.4%**	45039	**+0.7%**	9249	**+1.4%**	1640	**+2.1%**	1607	**+0.3%**	1541	**+0.4%**
Austria	4716	**+2.1%**	10114	**+1.4%**	3010	**+1.5%**	330	**+1.7%**	499	**+0.3%**	1174	**+0.4%**
Portugal	8973	**+1.7%**	25337	**+1.2%**	1840	**+1.3%**	2212	**+1.3%**	262	**+0.3%**	1170	**+0.2%**
Sweden	3968	**+2.0%**	10418	**+1.2%**	1660	**+1.3%**	252	**+1.5%**	336	**+0.3%**	749	**+0.2%**
Finland	2793	**+2.1%**	8317	**+1.4%**	1201	**+1.5%**	68	**+1.6%**	235	**+0.4%**	483	**+0.4%**
United Kingdom	45406	**+1.8%**	166445	**+2.2%**	3793	**+2.5%**	18971	**+3.5%**	1767	**+0.7%**	6888	**+1.4%**
Cyprus	1152	**+0.9%**	3428	**+2.9%**	403	**+3.4%**	681	**+1.1%**	24	**+0.3%**	31	**+0.6%**
Czech Republic	9979	**+1.2%**	27630	**+3.0%**	2415	**+2.9%**	55	**+1.2%**	222	**+0.6%**	321	**+0.8%**
Estonia	631	**+1.3%**	1121	**+2.9%**	256	**+2.9%**	23	**+0.5%**	74	**+0.4%**	60	**-0.5%**
Hungary	10057	**+1.7%**	30362	**+3.2%**	2919	**+3.4%**	1194	**+1.1%**	189	**+0.5%**	158	**+0.7%**
Lithuania	2753	**+1.6%**	3408	**+2.7%**	632	**+3.2%**	24	**+1.8%**	339	**+0.4%**	175	**+0.6%**
Latvia	1070	**+1.8%**	1	**+4.0%**	180	**+3.7%**	34	**+1.8%**	130	**+0.4%**	122	**+1.5%**
Malta	270	**+1.8%**	523	**+3.5%**	54	**+3.6%**	13	**+1.3%**	8	**+0.4%**	10	**+0.7%**
Poland	43197	**+1.7%**	100243	**+3.1%**	14750	**+3.2%**	234	**+1.3%**	1673	**+0.5%**	1872	**+0.9%**
Slovenia	879	**+1.3%**	5841	**+3.1%**	177	**+3.7%**	158	**+1.5%**	104	**+0.7%**	273	**+1.1%**
Slovac Republic	5003	**+1.5%**	9535	**+3.0%**	467	**+3.3%**	233	**+1.2%**	107	**+0.6%**	131	**+0.9%**
Bulgaria	4986	**+2.1%**	4412	**+2.4%**	141	**+2.2%**	1496	**+0.5%**	337	**-0.3%**	453	**-0.7%**
Romania	24950	**+0.4%**	24604	**-0.5%**	2612	**+2.9%**	9236	**+1.1%**	1165	**+0.1%**	1381	**+0.1%**
EU27 (2020)	458033	**+1.7%**	1065634	**+1.7%**	145134	**+1.7%**	91045	**+1.9%**	21286	**+0.4%**	53796	**+0.4%**
EU27 (2050)	412915	**+2.7%**	1452433	**+1.3%**	164619	**-0.8%**	100272	**+3.0%**	17590	**-0.3%**	53271	**-0.0%**

2.2. WTO agreements

The current CAPRI baseline does not include a successful conclusion of the Doha round. As the ultimate outcome is quite uncertain, its effect may only be assesses based on some assumptions of the details of such a WTO deal. Key proposals are the so-called revised draft modalities (http://www.wto.org/english/tratop_e/agric_e/agchairtxt_dec08_a_e.pdf) of chairperson Falconer from December 2008. A stylised interpretation of these proposals in a CAPRI simulation would mainly affect the other cattle and sheep sectors (decline of about 3%) whereas the pig, poultry, and the dairy sectors are less affected, due to the lower initial protection. It is also noteworthy that the Falconer proposals included the possibility for countries to declare some of their products as "sensitive" to shield them from large tariff cuts if they were prepared to increase market access for imports through enlarged tariff rate quotas. This mechanism has dampened the price cuts for beef, pork, poultry meat, butter and cheese relative to sheep meat (assumed "non sensitive"). Furthermore, the presence of "sensitive" products in a likely Doha agreement also permits to speculate about a post Doha WTO round that would further dismantle the remaining protection of the EU livestock sector. If such a follow up agreement was anticipated (entirely plausible for a horizon up to 2050), we might expect so further decline in the EU livestock sector (that has not been simulated yet).

According to the CAPRI green house gas accounting, the decline in the cattle sector would reduce CH4 emissions in EU27 by 2.4%, N2O by 1.1% and aggregate greenhouse gas emissions from agriculture by 1.6%. Note however that this neglects the compensating increase in production in other world regions such that the global effects are unknown.

Table 2: Stylised impacts in year 2020 of a WTO agreement along the line of Chairperson Falconer's Draft Modalities of December 2008 [1000 hds or %]

	Hens		Other poultry		Pigs		Sheep		Dairy cows		Other cattle	
	reference	Doha	reference	Doha	reference	Doha	reference	Doha	reference	Doha	reference	Doha
Belgium-Lux.	12098	**+0.8%**	15881	**-1.3%**	7522	**-0.0%**	161	**-3.2%**	625	**-0.8%**	1630	**-3.5%**
Denmark	3949	**+0.2%**	23722	**-0.7%**	11244	**-0.3%**	104	**-4.0%**	505	**-0.4%**	678	**-3.3%**
Germany	38680	**+0.3%**	117551	**-1.1%**	29443	**-0.3%**	2047	**-4.1%**	3660	**-0.7%**	4861	**-2.9%**
Greece	13134	**+0.4%**	15279	**-1.0%**	544	**-0.5%**	11030	**-2.4%**	135	**-0.5%**	446	**-3.8%**
Spain	54278	**+0.2%**	142335	**-1.3%**	25053	**-0.3%**	20529	**-2.6%**	984	**-0.7%**	6759	**-4.1%**
France	61417	**-0.1%**	194462	**-1.4%**	16560	**-0.4%**	8304	**-2.6%**	3389	**-0.9%**	12716	**-3.4%**
Ireland	3322	**+0.7%**	9608	**-0.7%**	1180	**-0.3%**	3383	**-3.7%**	1137	**-0.5%**	4498	**-2.8%**
Italy	71751	**+0.2%**	78921	**-1.3%**	10211	**-0.4%**	8099	**-1.4%**	1843	**-0.7%**	5272	**-3.9%**
Netherlands	28797	**+0.3%**	44775	**-1.1%**	9342	**-0.3%**	1565	**-4.4%**	1625	**-0.7%**	1424	**-2.5%**
Austria	4575	**-0.2%**	10997	**-1.5%**	3062	**-0.3%**	330	**-3.2%**	502	**-0.6%**	1173	**-2.9%**
Portugal	9063	**+0.2%**	23847	**-1.0%**	1928	**-0.3%**	2221	**-2.2%**	272	**-0.6%**	1151	**-3.5%**
Sweden	3968	**+0.3%**	10183	**-1.0%**	1680	**-0.2%**	248	**-3.8%**	339	**-0.6%**	755	**-3.2%**
Finland	2786	**+0.0%**	8279	**-1.4%**	1202	**-0.5%**	63	**-3.6%**	238	**-0.7%**	485	**-3.7%**
United Kingdom	45357	**-0.4%**	165448	**-2.0%**	3887	**-1.1%**	18849	**-4.9%**	1772	**-0.8%**	6846	**-3.6%**
Cyprus	1061	**+0.2%**	3510	**-1.8%**	398	**-0.4%**	690	**-1.2%**	23	**-0.3%**	31	**-3.2%**
Czech Republic	10128	**+0.1%**	27524	**-1.1%**	2579	**-0.1%**	55	**-0.2%**	219	**-0.4%**	306	**-3.9%**
Estonia	571	**+0.2%**	1144	**-1.3%**	297	**+0.4%**	23	**-1.4%**	72	**-0.2%**	65	**-1.0%**
Hungary	9773	**-0.1%**	33197	**-1.7%**	2913	**-0.3%**	1145	**-1.6%**	197	**-0.3%**	160	**-2.8%**
Lithuania	2758	**+0.1%**	3407	**-1.5%**	655	**-0.6%**	24	**-2.1%**	319	**-0.3%**	178	**-1.5%**
Latvia	984	**-0.1%**	1	**-1.7%**	180	**+1.6%**	34	**+0.5%**	131	**+0.3%**	126	**+0.1%**
Malta	300	**+0.1%**	440	**-1.6%**	54	**-0.4%**	11	**-0.9%**	6	**-0.4%**	8	**-3.1%**
Poland	43188	**+0.1%**	99623	**-1.2%**	15992	**-0.0%**	233	**-1.7%**	1768	**-0.3%**	1993	**-3.9%**
Slovenia	817	**+0.2%**	6093	**-1.2%**	194	**-0.6%**	158	**+0.6%**	106	**-0.4%**	268	**-3.9%**
Slovac Republic	4994	**+0.2%**	9584	**-1.3%**	439	**-0.7%**	234	**-1.8%**	113	**-0.6%**	127	**-4.5%**
Bulgaria	4939	**-2.0%**	4088	**-2.1%**	156	**-0.3%**	1493	**-2.5%**	342	**-0.3%**	474	**-1.8%**
Romania	24168	**-1.8%**	25983	**-1.4%**	2607	**-0.1%**	9132	**-0.8%**	1192	**-0.3%**	1334	**-0.6%**
EU27	456858	**-0.0%**	1075881	**-1.4%**	149322	**-0.3%**	90165	**-2.8%**	21515	**-0.6%**	53762	**-3.4%**

3. Parameter uncertainty

Parameter uncertainty has been investigated for three issues that all are related to a particular methodological innovation in the course of the EC4MACS project.

3.1. Weights for EFMA information relative to parameter trends

EC4MACS has triggered a revision of the methodology to project mineral fertiliser consumption in CAPRI. As uncertainty is usually considered larger in new model components this has been investigated in more detail and some additional background information will be given.

The past versions of CAPRI derive fertiliser projections from trend based forecasts of basically two parameters describing changes in the fertiliser management of farmers:

- NAVFAC: Reflects the partial availability of nutrients from manure relative to mineral fertiliser. In many EU15 countries this factor (typical value: 0.6) was trending upwards, reflecting efficiency improvements in fertiliser management, be it autonomous or enforced through more stringent environmental legislation.
- NUTFAC: This reflects the fact that farmers tend to apply more fertiliser than needed, even after accounting for partial availability of nutrients from manure. We may often observe in MS15 that their NUTFACs (typical value: 1.2) are slightly trending downwards whereas those from MS12 are often more irregular and sloping upwards, mirroring some catching up in fertiliser application after the turmoil of the transition phase.

The current trend based approach has some drawbacks. First of all the trends are sometimes very weak or estimated with a high standard error. The second point is more important. Since a few years there are contacts to EFMA (European Fertiliser Manufacturers Association) which is known to possess a network of national experts. So far it has been used in an ad hoc way only (manual corrections of trend estimated NUTFACs/NAVFACs).

The new solution adopts some principles from the ex post data consolidation in CAPRI. The EFMA projections are considered to be of high quality, but the national EFMA experts may nonetheless be wrong. Therefore, they are treated as a priori information and deviations are penalised, but permitted.

The other source of information for projections comes, as before, from the current trends on NUTFACs/NAVFACs that are now treated as a priori information as well, rather than being imposed strictly. The compromise solution depends on the weights specified for each type of information.

A sensitivity analysis has been carried out to investigate the influence of this specification. The first set of weights has attributed a very high confidence in the EFMA information (column “EFMA” in the following table), the second a very high confidence in the statistical parameter trends (column “param trends”) and finally the results of a compromise specification is shown. In this case the relative EFMA weight has been specified higher for EU15 countries than for EU12 countries, assuming that EU15 national experts are on average very experienced.

It may be seen that differences between the EFMA projections and the CAPRI forecasts based on parameter trends only are sometimes remarkable. Note also that the “compromise” solution is not simply a weighted average of columns two and three. If the changes in activity levels, both from the crop and livestock sectors, suggest a crop “need” close to the EFMA projections, these will tend to prevail. If, on the contrary, changes in activity levels imply a crop “need” (net of manure deliveries) that is far away from the EFMA expectations, feasibility of the fertiliser calibration may require stronger deviations from EFMA.

Table 3: Differences in fertiliser projections for 2020 depending on the weights for EFMA projections compared to parameter trends in the CAPRI baseline [1000 t or %]

	2004 base year	EFMA	2020 param trends	compromise
Belgium-Lux.	162	**-20.0%**	**-5.6%**	**-11.8%**
Denmark	204	**+2.0%**	**-13.3%**	**-8.0%**
Germany	1790	**-4.3%**	**+32.0%**	**+22.4%**
Greece	235	**-17.1%**	**-16.8%**	**-17.0%**
Spain	1024	**+0.3%**	**+8.5%**	**+7.3%**
France	2284	**-1.7%**	**+13.0%**	**+8.0%**
Ireland	352	**-16.3%**	**+8.1%**	**-2.6%**
Italy	689	**-7.2%**	**-4.1%**	**-6.9%**
Netherlands	270	**-12.0%**	**-1.3%**	**-4.2%**
Austria	102	**+36.5%**	**+53.0%**	**+37.5%**
Portugal	88	**-6.7%**	**-9.4%**	**-6.7%**
Sweden	169	**+23.8%**	**+17.5%**	**+20.1%**
Finland	160	**+3.0%**	**+4.3%**	**+4.2%**
United Kingdc	1072	**-3.4%**	**-12.4%**	**-7.7%**
Cyprus	9	**+12.6%**	**-22.3%**	**-21.2%**
Czech Repub	293	**+2.8%**	**+5.5%**	**+3.4%**
Estonia	29	**+55.6%**	**+45.4%**	**+54.5%**
Hungary	340	**+16.0%**	**+25.8%**	**+25.0%**
Lithuania	117	**+43.1%**	**+22.8%**	**+32.2%**
Latvia	38	**+158.2%**	**+29.3%**	**+50.2%**
Malta	1	**-12.8%**	**-53.7%**	**-36.4%**
Poland	931	**+32.4%**	**+18.0%**	**+29.0%**
Slovenia	62	**-11.2%**	**-20.5%**	**-14.2%**
Slovac Repub	90	**+6.2%**	**+27.3%**	**+12.1%**
Bulgaria	135	**+33.6%**	**+29.6%**	**+29.6%**
Romania	238	**+94.0%**	**+94.0%**	**+94.0%**
EU27	10883	**+4.4%**	**+13.1%**	**+11.1%**

3.2. Weights for national expert information

Another major improvement mentioned in the progress report for year 2009 has been the incorporation of some national expert information. More precisely this refers to national projections on the key animal categories for the country in question (like the number of dairy cows). The coverage is still very limited as so far none of the large Member States or any of the New Member States has provided national projections. Nonetheless, it is interesting to see what a difference the national expert information makes in the current implementation. As was the case for the EFMA information on fertilisers, the national expert information receives implicit weights through the specification of standard errors for this information. Furthermore, the weight may be increased depending on whether related series are also modified by expert supports. For example, national projections on the increase in the pigs herd size will have a larger impact if it is assumed that a related series (say the production of piglets) is increasing with the same rate. By contrast, applying default assumptions for the related series may tie the projections of the pigs herd size indirectly to the default trends for piglet production, thus failing to acknowledge the expert information to a significant degree.

Table 4 shows that the current implementation may significantly change the results compared to a zero weight alternative, but that on the EU15 level these changes are hardly visible, except for sheep and other cattle. One reason for this is that the national expert information apparently does not systematically change the results upwards or downwards, which is reassuring: It supports the view that overall, national expert information does not systematically "distort" the results in one direction. The other reason is of course that so far expert information is only included for some of the smaller[4] EU15 Member States (with animal types affected highlighted with bold font).

Table 4: Differences in projections for year 2020 depending on whether national expert information is weighted nonzero ("with") or completely discarded ("without") [% against base year]

	Hens		Other poultry		Pigs		Sheep		Dairy cows		Other cattle	
	with	without	with	without	with	without	with	without	with	without	with	without
Belgium-Lux.	-0.4%	-0.9%	+12.9%	+12.5%	+24.3%	+22.9%	-4.0%	-4.0%	**+1.4%**	**-7.2%**	**-12.4%**	**-6.2%**
Denmark	**+7.2%**	**-0.8%**	**+28.7%**	**+28.9%**	**+2.0%**	**+5.2%**	**+1.6%**	**-3.5%**	**-12.7%**	**-11.2%**	**-23.7%**	**-37.6%**
Germany	-16.0%	-16.0%	+22.4%	+22.4%	+17.2%	+17.1%	+1.3%	+1.3%	-15.0%	-15.0%	-35.2%	-35.2%
Greece	-9.0%	-9.8%	+12.5%	+2.7%	**-34.8%**	**-11.0%**	**-5.3%**	**+0.2%**	**-10.0%**	**-8.8%**	**+0.6%**	**-6.4%**
Spain	**-4.5%**	**+5.2%**	**+27.0%**	**+26.3%**	**+25.5%**	**+15.9%**	**-11.9%**	**+1.7%**	**-10.1%**	**-6.5%**	**+4.5%**	**+29.4%**
France	-2.0%	-2.3%	+15.5%	+15.3%	+15.8%	+14.9%	-11.9%	-11.9%	-13.7%	-13.7%	-4.6%	-4.6%
Ireland	**-10.7%**	**+1.3%**	**-10.8%**	**+20.6%**	**-9.1%**	**+21.0%**	**-24.1%**	**+14.4%**	**-0.3%**	**-3.3%**	**-3.6%**	**+9.1%**
Italy	+19.1%	+18.3%	-5.1%	-9.2%	**+10.5%**	**+14.1%**	**+0.5%**	**-0.7%**	**-8.5%**	**-1.7%**	**-5.8%**	**-5.7%**
Netherlands	-7.6%	-4.5%	+2.5%	+10.2%	**+1.8%**	**-2.8%**	**+13.4%**	**-9.9%**	**+8.2%**	**-8.4%**	**-10.7%**	**-16.6%**
Austria	-13.0%	-13.2%	+16.7%	+16.5%	+7.0%	+6.5%	+3.7%	+3.7%	-9.3%	-9.3%	-16.3%	-16.3%
Portugal	+10.1%	+10.2%	-2.7%	-6.5%	**-8.9%**	**-18.2%**	**-11.7%**	**-4.1%**	**-17.9%**	**-12.9%**	**+0.3%**	**+14.0%**
Finland	**-13.2%**	**-16.1%**	**+13.3%**	**+25.0%**	**-4.9%**	**+13.6%**	**+6.7%**	**-52.9%**	**-25.4%**	**-28.6%**	**-12.7%**	**-40.2%**
Sweden	-16.3%	-16.3%	+15.8%	+15.7%	-5.2%	-5.2%	+0.1%	+0.1%	-15.0%	-15.0%	-23.5%	-23.5%
United Kingdom	-1.7%	-1.7%	+23.6%	+24.3%	**-1.6%**	**-16.4%**	-8.4%	-7.5%	-15.1%	-15.0%	-2.6%	-2.3%
Czech Republic	-7.6%	-7.6%	+33.4%	+33.4%	+3.5%	+3.3%	-45.7%	-45.7%	-47.8%	-47.8%	-59.4%	-59.4%
Estonia	-44.5%	-44.5%	+2.3%	+2.3%	+13.3%	+13.4%	-28.6%	-28.4%	-37.3%	-37.3%	-48.6%	-48.7%
Hungary	-39.4%	-39.5%	+10.8%	+10.7%	+1.8%	+1.7%	-2.5%	-2.6%	-33.4%	-33.4%	-49.2%	-49.2%
Lithuania	-27.4%	-27.4%	+16.4%	+16.4%	+9.5%	+9.5%	-32.3%	-32.2%	-31.3%	-31.3%	-49.7%	-49.8%
Latvia	-34.4%	-35.1%	+9.8%	+9.8%	-13.7%	-12.0%	+1.8%	+3.5%	-19.9%	-23.4%	-14.0%	-15.0%
Poland	-9.8%	-9.8%	+29.0%	+29.0%	+38.2%	+38.1%	-24.8%	-24.8%	-34.1%	-34.1%	-13.4%	-13.5%
Slovenia	-32.3%	-32.4%	+18.8%	+18.6%	-10.8%	-10.7%	+91.1%	+91.4%	-17.6%	-17.6%	-6.5%	-6.5%
Slovac Republic	-19.3%	-19.3%	+31.8%	+31.7%	-57.6%	-57.7%	-19.1%	-19.1%	-28.7%	-28.7%	-42.2%	-42.2%
Romania	-28.7%	-28.8%	+12.6%	+12.3%	-12.0%	-13.8%	+23.3%	+22.6%	-20.0%	-17.5%	-28.0%	-26.1%
Bulgaria	-39.6%	-39.6%	-16.9%	-17.0%	-70.4%	-70.4%	-43.4%	-42.6%	-9.0%	-9.1%	+20.2%	+19.9%
Cyprus	-14.2%	-14.5%	+25.3%	+22.0%	+14.3%	+18.0%	+38.1%	+42.6%	-4.6%	-4.3%	+8.5%	+9.1%
Malta	-26.1%	-79.8%	-19.2%	-80.5%	+2.5%	-82.9%	+67.7%	-80.2%	+28.3%	-32.4%	+10.4%	-46.9%
EU27	-6.9%	-5.8%	+17.0%	+17.1%	+13.2%	+11.8%	-7.0%	-1.4%	-15.0%	-15.5%	-10.7%	-7.3%
EU15	-1.5%	+0.1%	+15.7%	+16.0%	+12.9%	+11.4%	-8.7%	-2.3%	-10.5%	-11.2%	-9.0%	-5.2%

4 The expert support for pigs in the UK is an ad hoc fix for an evident structural break in the historical series that suggests that the speed of the decline of UK pigs production has considerably decreased after 2003.

3.3. Minimal weights for extrapolations in long run projections

As a part of the CAPRI baseline methodology long run information from FAO and IFPRI has been gradually introduced after 2020 when moving beyond this horizon by defining the target values (supports) for the projections to be a weighted average between this long run information and an extrapolation of the baseline up 2020. When the projection year moves towards 2050, the weight for extrapolated information decreases, such that by 2050, the final projection is strongly pulled towards the long run information from FAO/IFPRI. This tends to give projections that gradually approach the long run sources, for example as in the case of pork production in Sweden (see Fig 1).

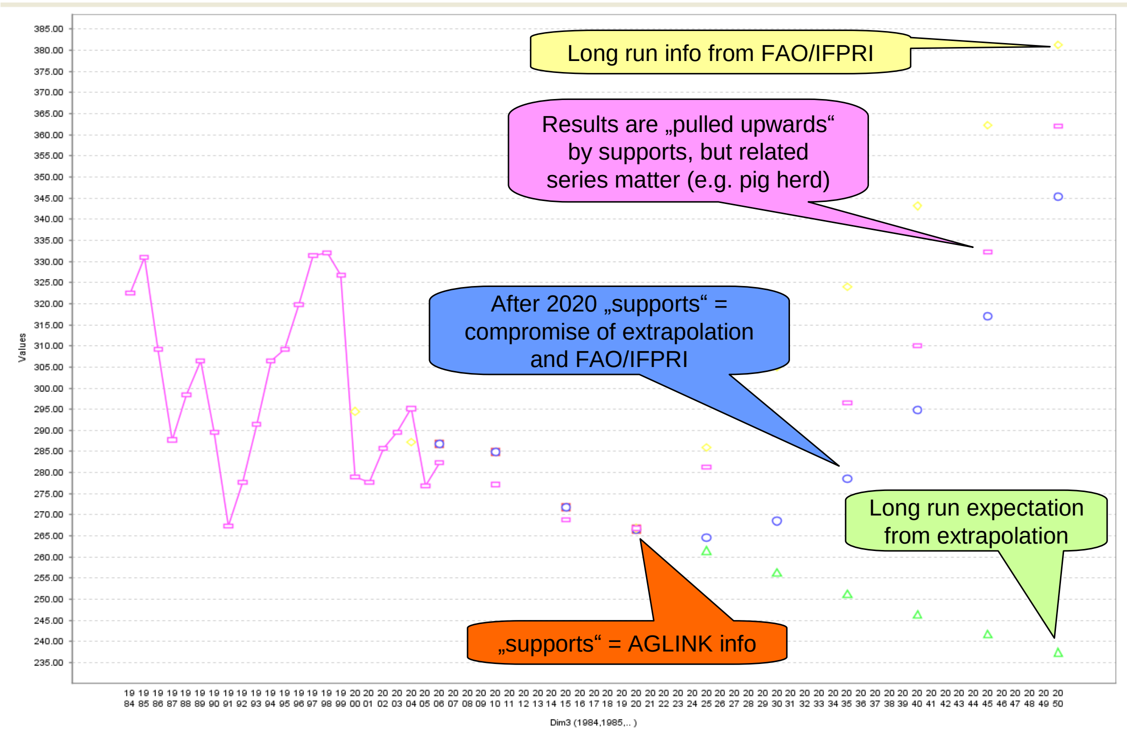

Figure 1: Pork production in Sweden as an example for merging medium run and long run a priori information in the CAPRI outlook

The example has been chosen because historical trends and AGLINK projections on the one hand and long run expectations point into different projections. This is quite typical because medium run forecasts often give a stronger weight to recent production trends, often indicating a stagnating or declining production in the EU, whereas the long run studies tend to focus on the global growth of food demand in the coming decades. It is thus entirely plausible that there will be turning points in the future evolution of agriculture.

A careful look at the figure also reveals that even in 2050, the supports (blue dots) come close to this long run information (yellow dots), but do not attain it completely. This is the case because we have retained a weight of 25% for the extrapolation for several reasons: First of all FAO, one of the two sources of long run projections, only provided information for EU15 and EU10 but not at the Member State level such that the extrapolation may add some national particularities (but IFPRI has national information). Furthermore, the extrapolation weight prevents extreme swings in the evolution of some series that may appear implausible. On the other hand this may be considered an unnecessarily conservative approach. Thus, this is another matter of judgement rather than clear superiority such that the following Table 5 checks for the differences in the projected animal herds depending on whether the remaining weight for the extrapolation is set to 0% or 25%. For intermediate years between 2020 and 2050 the differences are smaller, according to the gradual shifts in the weighting scheme explained above. As the basic uncertainty is qualitatively similar in EU15 and EU12 countries this sensitivity analysis has been carried out for EU15 countries only.

Table 5: Differences in projections depending on the remaining weight of extrapolated information (0% or 25%) compared to the long run expert information [% change against base year]

	Hens		Other poultry		Pigs		Sheep		Dairy cows		Other cattle	
	0% wgt	25% wgt	0% wgt	25% wgt	0% wgt	25% wgt	0% wgt	25% wgt	0% wgt	25% wgt	0% wgt	25% wgt
Belgium-Lux.	+1.6%	+1.9%	+138.2%	+112.8%	+7.5%	+21.1%	+8.0%	+3.8%	-37.4%	-27.3%	-11.3%	-12.4%
Denmark	+15.0%	+15.6%	+70.3%	+80.0%	+52.3%	+9.4%	+42.8%	+33.4%	-25.8%	-25.6%	-29.5%	-25.8%
Germany	-63.1%	-46.4%	+37.1%	+87.7%	+36.9%	+46.2%	-12.1%	-11.3%	-37.6%	-38.4%	-39.1%	-43.2%
Greece	+7.8%	+1.7%	+19.9%	+19.9%	-14.5%	-19.0%	+7.1%	+2.3%	-34.4%	-28.1%	-24.2%	-18.9%
Spain	-24.0%	-18.6%	+55.1%	+62.9%	+54.1%	+58.7%	+9.9%	+3.5%	-36.5%	-29.7%	+15.9%	+22.8%
France	-13.2%	-11.7%	+53.3%	+44.4%	+21.1%	+26.9%	-31.2%	-27.4%	-33.8%	-34.1%	-2.8%	-3.5%
Ireland	-29.3%	-30.0%	-8.3%	-11.3%	-11.4%	-12.9%	+36.5%	+16.3%	-26.3%	-12.2%	+15.3%	+11.0%
Italy	-13.1%	-0.7%	+62.8%	+46.3%	+7.8%	+10.3%	+2.5%	+2.4%	-29.7%	-25.7%	-13.2%	-11.8%
Netherlands	+21.0%	+10.3%	+60.4%	+49.6%	+16.2%	+15.1%	-8.4%	-0.8%	-33.6%	-24.7%	-23.3%	-18.1%
Austria	+18.2%	+5.8%	+66.3%	+54.4%	+47.5%	+41.5%	+41.5%	+33.3%	-22.4%	-20.9%	-31.6%	-33.7%
Portugal	-20.1%	-13.1%	+40.9%	+32.8%	-9.2%	-13.2%	+11.4%	+4.9%	-38.2%	-34.5%	-10.0%	-4.1%
Finland	-3.6%	-10.8%	+52.2%	+48.9%	+9.4%	+8.1%	+66.6%	+56.4%	-24.2%	-29.2%	-30.7%	-30.0%
Sweden	-41.0%	-28.5%	+27.1%	+58.7%	+38.7%	+25.3%	+24.4%	+15.5%	-27.2%	-29.2%	-48.2%	-47.9%
United Kingdom	-22.8%	-17.5%	+30.4%	+38.8%	+29.4%	+22.2%	+19.7%	+2.6%	-27.9%	-29.1%	-6.0%	-4.3%
EU15	-18.1%	-13.2%	+48.8%	+53.2%	+31.3%	+31.2%	+7.3%	-0.0%	-32.6%	-30.2%	-9.3%	-8.9%

It may be seen that the choice of this parameter has considerable importance for the long run projections at the MS level. For the EU15, the sensitivity is less marked, except in the case of the sheep herd where the strong effect in the UK remains clearly visible also at the aggregate level.