Endogenous yields and decomposition of yield and activity related income indicators

- Wolfgang Britz, February 2010 -

Background and motivation

The behavioral model underlying the CAPRI supply model is a two-stage decision problem. In the first stage, farmers decide at given prices about input and output coefficients per ha and head, where the latter for crops comprise the main yields. From these input and output coefficients, gross margins are calculated at given prices which enter a second optimization problem where the optimal composition of these activities – crop areas and herds – are determined, along with some further decision variables such as share of mineral and organic fertilizer or the feed mix for animals. So far, input and output coefficients from the baseline were used in scenarios, neglecting the effect of updated prices in simulations. Instead, we tried to capture the effect of prices on farming intensity by two technology variants (T1, T2) which have their own set of input and output coefficients. A suitable parameterization of quadratic costs steers the substitution between high and low yield variants.

However, simulation tests revealed, e.g. during the training session in Seinajöki, that the yield elasticities implied by the substitution between the technology variants were rather low. Test to find a suitable solution based on changing the technology variant (T1,T2) related cost function parameters turned out be not promising. Whereas it is possible to render the high yield variant more responsive to price changes so that its acreage expands more in relative terms compared to the low yield variant when price changes, the parameterization is somewhat hard to tune. Additionally, it is then also reacting more pronounced to any other change impacting on the gross margins e.g. stemming from updated premiums or changing in land rents, which lead to implausible reactions. So in the end, it became evident that we need to introduce an additional element which is discussed in some detail below. It consists of iso-elastic function rendering input and output coefficients for each crop a function of prices.

The new code and requires ~5 secs per iteration for all NUTS2 regions with endogenous yields for cereals and oilseeds. The effect on the yields is much more predictable then before, and clearly, especially when introducing changes which impact on the whole sector (such as set-aside or WTO), the price changes are lower compared to previous versions.

Linked to the discussion of the price responsiveness of yields is the question how to decompose changes of yields or income indicators for regional and product aggregates. Such a decomposition eases policy impact analysis. A technical solution know embedded in the post model reporting is outlined in the last section of the paper.

Endogenous yields based on price elasticities

Let Y denote yields and j production activities Yield react via iso-elastic functions to changes in output prices

$$\log(Y_j) = \alpha_j + \varepsilon_j \log(p_o)$$

The current implementation features yield elasticities for cereals chosen as 0.3, and for oilseeds and potatoes chosen as 0.2. These estimates might be somewhat conservative when compared e.g. with Keeney & Hertel 2008(a,b). However, in CAPRI they relate to small scale regional units and single crops, and to European conditions which might be characterized by a combination of higher incentive for extensive management practises and dominance of rainfed agriculture where water might be a yield limiting factor.

Currently, the code is set up as to only capture the effect of output prices. However, in order to spare calculation of the constant terms α, the actual code implemented in "endog_yields.gms" change the yields iteratively in between iterations t , using relative changes:

$$Y_{j,t} = Y_{j,t-1}^{\left[\varepsilon_j \log \frac{p_{o,t-1}}{p_t}\right]}$$

Decomposition

The idea behind the decomposition is to analyze which factors drive the change in yields and income indicators using growth rates. Take for example the market income of cereals per ha at EU level. Its change in a simulation against the baseline depends on the change in prices and the change in yields. The change in yields in turns depends on the effect of the yield elasticity, the change in the shares of low and high technology variants, the change in the regional shares and, in weights of low and high yielding regions. And finally, the share of high and low yielding cereals such as soft what and rye in the total aggregate might change. When interpreting the results, it is often useful to understand the contribution of the different factors.

The screenshot below shows an example. All results shown are always expressed in the absolute value and the units used in the result set.

The columns are defined as follows:

- *Result*: Final result from the simulation – in the example below, average EU27 cereals yields increase by 8.57%.
- *Effect of endogenous IO coefficients*: Result calculated by using the final IO coefficients, but keeping all other factors (technology shares, prices, regional weights, activity levels) at trend levels – in the example below, market revenues per ha would have gone up by 1.55% if only the yields had adjusted.
- *Effect of technology shares*: Result calculated by only updating the technology shares, but keeping all other factors (IO coefficients, prices, regional weights, activity levels) at trend levels – in the example below, intermediate input costs would have increased by 0.2% of only the share of low and high yielding variants had changed.
- *Effect of prices*: Result calculated by only updating the prices shares, but keeping all other factors (IO coefficients, technology shares, regional weights, activity levels) at trend levels – in the example below, the Gross Value Added at producer prices would have increased by 23.62% if only the input and output prices had changed.
- *Effect of regional composition*: Result calculated by only updating the activity levels shares, but keeping all other factors (IO coefficients, technology shares, activity levels) at trend levels
- *Effect of other factors*: Difference between the start values and result, after all other effects above had been accounted for. Comprises the multiplicative cross-effects of the different effects, the effect of changed premiums in the case of the MGVA, and of change in the activity aggregate composition.

It should be mentioned that we do not have information about the premiums paid in the baseline, so that the results shown for the modified Gross Value Added need to be interpreted keeping in mind that premiums might have changed. The same holds for the case where the scenario change yields or inputs per ha as part of the scenario description.

		MTR_RD						MTR_RDNOPIL1					
		Result	Effect of endogenous IO coefficients	Effect of changed technology shares	Effect of prices	Effect of changed regional composition	Effect of other factors	Result	Effect of endogenous IO coefficients	Effect of changed technology shares	Effect of prices	Effect of changed regional composition	Effect of other factors
Cereals	Yield [kg or 1/1000 head/ha or head]	5510.02 0.00%	5510.01 0.00%	5510.00 0.00%		5510.01 0.00%	5510.00 0.00%	5674.34 2.98%	5605.74 1.74%	5518.89 0.16%		5511.60 0.03%	5568.11 1.05%
	Market revenues [Euro/ha or head]	841.19 0.00%	841.17 0.00%	839.59 0.00%	839.60 0.00%	839.59 0.00%	839.59 0.00%	913.31 8.57%	854.19 1.55%	840.86 0.15%	883.17 5.19%	839.77 0.02%	853.67 1.68%
	Intermediate inputs [Euro/ha or head]	655.18 0.00%	655.18 0.00%	655.18 0.00%	655.18 0.00%	655.18 0.00%	655.18 0.00%	667.84 1.93%	661.95 1.03%	656.50 0.20%	655.18 0.00%	653.69 -0.23%	661.23 0.92%
	Gross Value added at producer prices [Euro/ha or head]	186.01 0.00%	185.99 0.00%	184.41 0.00%	184.43 0.00%	184.41 0.00%	184.41 0.00%	245.47 31.97%	192.24 3.36%	184.36 -0.03%	228.00 23.62%	186.07 0.90%	192.44 4.35%
	Gross Value added at producer prices plus premiums [Euro/ha or head]	465.15 0.00%	465.13 0.00%	463.55 0.00%	463.57 0.00%	463.55 0.00%	463.55 0.00%	296.76 -36.20%	243.93 -47.56%	236.05 -49.08%	279.68 -39.67%	238.00 -48.66%	243.49 -47.47%

The code is implemented in „reports\yield_change_decomp". The table can be found in the GUI under "farm\decomposition".

References

Keeney R. & Hertel T. (2008a), YIELD RESPONSE TO PRICES: IMPLICATIONS FOR POLICY MODELING, Working Paper #08-13, August 2008, Dept. of Agricultural Economics, Purdue University

Keeney R. & Hertel T. (2008b), The Indirect Land Use Impacts of U.S. Biofuel Policies: The Importance of Acreage, Yield, and Bilateral Trade ResponsesGTAP Working Paper No. 52, 2008