Organic production in a dynamic CGE model – Effects of the 2003 reform of the CAP

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Abstract

Concerns about the impact of modern agriculture on the environment have in recent years led to an interest in supporting the development of organic farming. Besides environmental benefits, the aim is to encourage the provision of "multifunctional" properties of organic farming such as rural amenities and rural development that are spill-over benefits additional to the supply of food.

In this paper we modify an existing dynamic general equilibrium model of the Danish economy to specifically incorporate organic farming. In the model and input-output data each primary agricultural sector and each secondary food industry has been split into two separate industries: one producing organic products, the other producing conventional products. The substitution nests in private consumption have also been altered to enable pair wise substitution between organic and conventional products.

To receive specific subsidies for organic production the current regulation requires organic farmers to produce using organic methods for a period of five years. Failing to do so will mean that received subsidies during the period must be paid back thus practically forcing farmers to retain the organic authorization even though it might be economically optimal to withdrawn from organic farming in the current year. This means that the return to land can vary substantially between conventional and organic farming in the short run. To introduce this concept into the model we develop a theory that describes the dynamic time path of land allocation between organic and conventional farming. Agricultural land is treated explicitly as a stock and there is a stock accumulation relationship for land and an explicit modelling of the rate of stock accumulation (i.e. land investment based on expected returns). While returns can differ between conventional and organic farming in the short run we assume the land allocation adjust within organic farming to equalize return for all usage of organic land in each year. The same apply for conventional land.

We use the empirical model to illustrate the land allocation theory by constructing a long term forecast for the development of the Danish economy. Moreover we simulate the effect of the recently agreed 2003 reform of the Common Agricultural Policy (CAP).

1. Introduction with Background on organic production in Denmark.

For a number of years the Danish Research Institute of Food Economics (FOI) has conducted research in the area of organic farming using a static general equilibrium model of the Danish economy - the Agricultural Applied General Equilibrium model (AAGE). In 2001 the model was enhanced to describe the dynamic time path of the Danish economy. In relation to organic farming this presented some specific challenges since a standard assumption of the model is to assume that agricultural land is reallocated among land-using sectors so that land rental are equalized in each time period. The legislative requirement for organic farmers adds some sluggishness to the land allocation process thereby implying that land rental can vary across sectors in the short run. Therefore, the model is modified so that it describes the dynamic time path of land allocation such that different land rentals in conventional and organic farming are possible in the short to medium run but converging in the longer run.

To illustrate the functioning of the model, the consequences for Danish agriculture of the 2003 reform of the Common Agricultural Policy (CAP) are evaluated against a structural forecast for the Danish economy until 2022.

The remainder of this paper is organised as follows. Section 2 provides some background to organic farming in Denmark. Section 3 provides an overview of the theoretical structure of the AAGE model. Section 4 gives an overview of the principles behind the structural forecast for the Danish economy and the details of the macroeconomic forecast. Section 5 describes the agricultural specifics in the forecast and the policy scenario as well as the consequences of the CAP reform for the agricultural sector. Section 6 concludes.

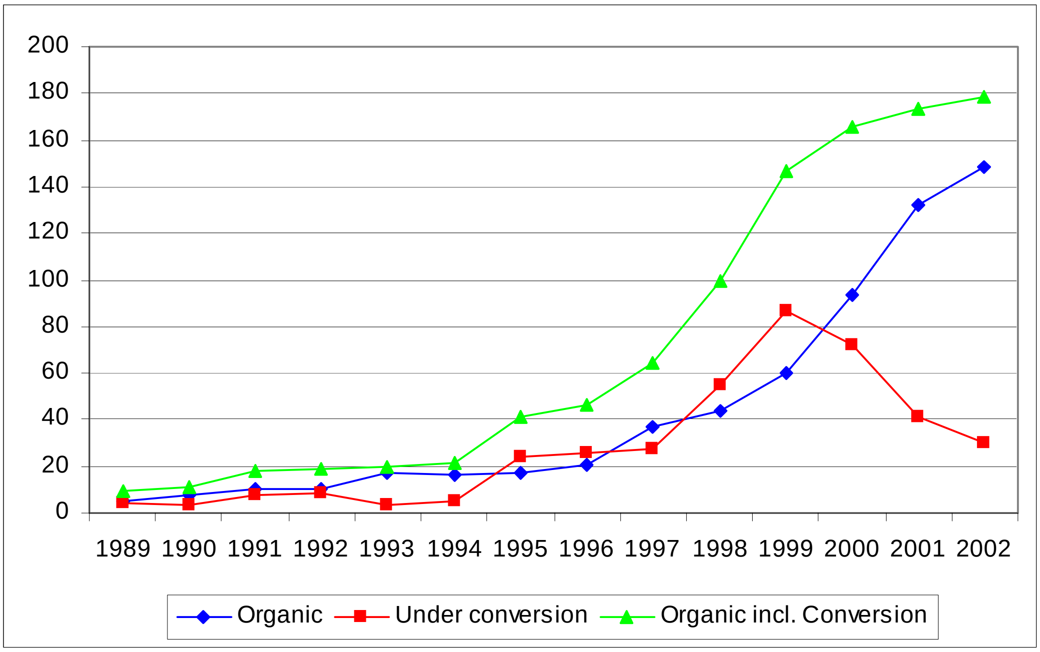
2. Organic production in Denmark

Organic production in Denmark takes place on authorised organic farms. The use of land by organic farms can be divided into organic land (land that has been through a 3-year conversion period), land under conversion, and land that is not yet farmed according to the organic principles. Organic farmers receive specific subsidies for using an environmental friendly production technology and they are required to use such technology for a period of at least five years, otherwise subsidies received during the period must be paid back. In practice this forces the farmer to retain his organic authorization even though it might be economically optimal withdraw from organic farming in the current year.

The figure below shows the development in organic and conventional land use on organic farms. During the period 1989 to 1994 organic land almost triples in size (from 5,500 to 16,400 hectares) and the total land farmed according to organic principles doubles (from 9.600 to 21.100 hectare). From 1994 to 1999 there is a huge interest in converting into organic farming. The development in conversional land in this period increases from 16,400 in 1994 to 148,300 in 2002. The fall in conversional land from 1999 has the effect of levelling out the total organic land area (incl. conversional) to 178,400 hectares in 2002.

In future years, a downward trend can be expected caused by a mismatch between supply and demand for organic products. This applies especially for the organic milk production as will be explained further below.

Figure 2.1 Development of organic land, 1,000 hectares.



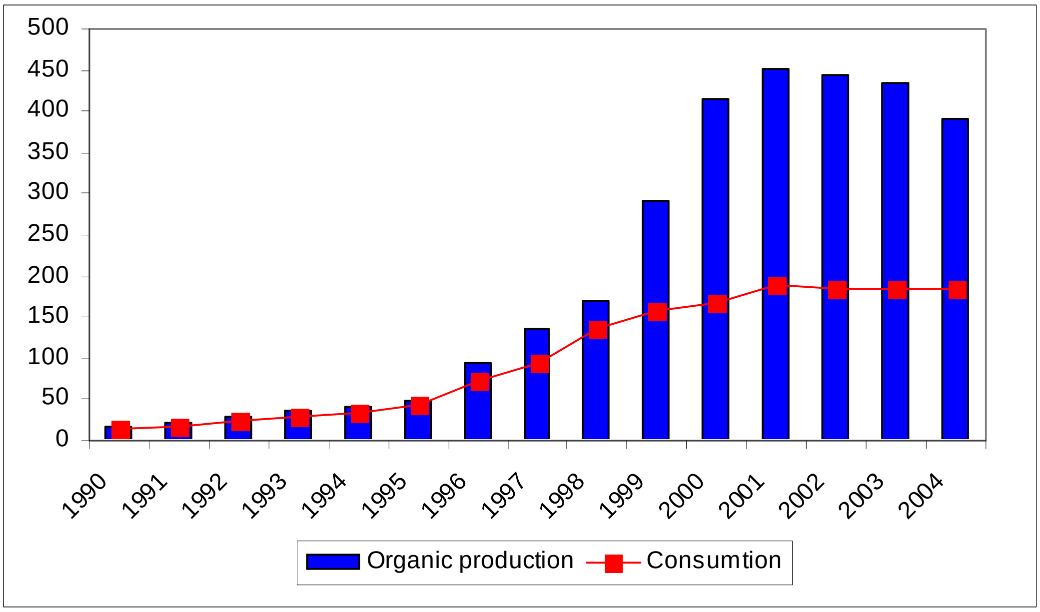
Source: Statistics Denmark

The predominant organic production is organic milk production. Around 10 percent of total milk production is produced organically, thus representing not only a large production share in organic terms but also compared to conventional production. The development in production and consumption of organic milk is shown in fig 2.2, where consumption data has been transformed into raw-milk equivalents. The growth in production of organic milk was modest in the beginning of the nineties, whilst the production expanded rapidly in the period 1995 to 2000.

The correspondence between production and consumption are close in the first half of the nineties. Even though the figure shows a rapid increase in the consumption of organic milk in the period 1995 to 2001, it is also clear that the development has resulted in a situation where approximately 60 percent of organic milk production has not been sold as organic from the year 2000 and onwards.

The organic producers supply their milk to predominantly one company (ARLA) according to contracts with a guaranteed mark-up over conventional milk prices. This mark-up over conventional prices poses an additional cost to the dairy industry for the fraction of production that they cannot market as organic products. If the industry sees no possibilities to sell these products as organic in the near future it should be expected that some adjustment to the contracts between the dairy industry and the individual milk producers must occur.

Figure 2.2 Production and consumption of organic milk, mill. kg.



Source: Own calculation based on Statistics Denmark, 2004 is an estimate

As of 1991 there have been several changes to the contracts between ARLA and the milk producers of which some have had the intentional effect of lowering the economic benefit to the organic milk producers so as to achieve a better balance in the organic milk market. The latest change was ARLA's termination of all contracts with organic milk producers in 2003 with the aim of negotiating new contracts that will allow for a better correspondence between supply and demand. From the above figure it is seen that the production of organic milk shows a slight downward trend from its peak in 2001, while consumption is unchanged.

This surplus production situation is not an isolated Danish phenomenon. The Dairy Industry Newsletter (2003) estimates that some 40 percent of the total organic milk production in the EU is in surplus. The problem is largest in Denmark, Austria and the UK (60, 50 and 50 percent surplus respectively) while in Germany, Netherlands and France the surplus production is estimated to 25, 20 and 15 percent, respectively.

3. Data, model and theory of land allocation

The 2001 extension of the AAGE model consisted of adding three dynamic relationships to the model: physical capital accumulation, financial asset accumulation, and a lagged adjustment process related to the labour market. Now a fourth dynamic relationship has been added to the model, namely the physical organic land accumulation process. In this section a brief overview of the first three dynamic relationships is provided while the organic land accumulation process is explained more carefully since this is the novel feature of the model. Before describing the model however we will briefly comment on the data requirements.

3.1 Data

The static data are based upon an input-output table compiled by FOI. This involves disaggregating the agricultural cost and supply structure into 19 conventional and organic sectors producing 21 conventional and organic agricultural commodities. Moreover the processing industries are also disaggregated into the processing of conventional and organic products respectively[1].

The dynamic data set consists of data relating to the dynamic relationships: capital accumulation, net external debt accumulation and government debt accumulation. The primary source for data on capital stocks and depreciation rates is Statistics Denmark. The value and composition of Denmark's net external debt is obtained from the external debt statistics compiled by the Central Bank of Denmark. The trade balance is calculated based upon static data, while data relating to the income balance is part of the dynamic data set. Interest, dividend and transfer flows are obtained from Statistic Denmark's national account statistics (accounts with the rest of the world). The government's debt constitutes the central, local and state government's and social security funds' debt net of deposits with the central bank, this data are part of the public finances data published by Statistics Denmark[2].

Extending the model with a dynamic specification of land accumulation requires data on the value of land, stock of land and land investment in the initial year. The value of land is calculated from the assumption that the 1995 core database constitutes a long run equilibrium for land allocation. Assuming that we know the long run return to land we can calculate the value of land. In the initial year the stock of land is set equal to the value of land and the investment in land is calculated from official data on land movement between conventional and organic usage.

The scenarios in this paper are based on data for 2002, data that are produced from a simulation using the AAGE model to update the database from 1995 to 2002. In this database the long run equilibrium conditions do not necessarily hold.

3.2 Overview of the model

The AAGE model of the Danish economy has over the years evolved from a static model in the ORANI type of tradition (Horridge et. al 1993) with specific key features of a detailed specification of agricultural production (Frandsen og Jacobsen 1999). In 2001 dynamics was implemented into the model (Adams 2001) in a Monash type of tradition (Dixon and Rimmer 2002).

The static part of the model consists of 68 goods producing industries that produce 76 commodities (appendix A), which can be used for either consumption or production. The primary factors of production are land, capital and labour. Hence, the production takes place

[1] The compilation of the agricultural specific input-output table is documented in Jacobsen (1996) while the organic input-output disaggregation is documented in Jacobsen (2002).

[2] The compilation of the dynamic dataset is described in Adams et. al (2002).

according to a nested CES technology (appendix B), which uses intermediate goods and primary factors as inputs. Four additional types of agents demand the output from the goods producing industries: households, a government sector, investment industries, and a foreign sector.

There is assumed to be a constant population of identical households. Each household maximises a Stone Geary utility function where only the luxury components of each commodity composite enters into a Cobb-Douglas utility function. This specification gives rise to fixed budget shares for spending on luxuries. The aggregate expenditure level may be determined via the average propensity to consume out of disposable income.

The government sector consumes goods, invests in capital, collects taxes, subsidises production, make transfers to households, accumulates debt, and pay interest.

Commodities are divided into two groups: traditional exports and non-traditional exports. Producers of traditional export goods face downward-sloping foreign demand schedules, whereas foreign demand for non-traditional exports is related to the average price of those goods. It is assumed that the foreign sector supplies the same types of goods as is being produced domestically, and that imports are imperfect substitutes for domestic supplies for all types of domestic agents (the Armington specification).

All agents are assumed to be price takers, with producers operating in competitive markets, which prevent the earning of pure profits. In equilibrium demand equals supply for each type of domestically produced commodity and primary factor of production.

Each primary agricultural sector and each secondary food industry has been split into two separate industries: one producing organic products, the other producing conventional products. The substitution nests in private consumption have also been altered to emphasise the pair wise substitution between organic and conventional products.

Dynamic relationships: *Physical capital accumulation Investment*

It is assumed that investment undertaken in year *t* becomes operational at the start of year *t+1*. Under this assumption, capital in industry *i* accumulates according to:

$$K_{t+1,i} = (1 - DEP_i) \times K_{t,i} + I_{t,i} \tag{3.1}$$

where:

$K_{t,i}$ is the quantity of capital available in industry *i* at the start of year *t*;

$I_{t,i}$ is the quantity of new capital created for industry *i* during year *t*; and

DEP_i is the rate of depreciation in industry *i*, treated as a fixed parameter.

Given a starting point value for capital in $t=0$, and with a mechanism for explaining investment through time, equation (3.1) can be used to trace out the time paths of industry capital stocks.

Investment in industry *i* in year *t* is explained via a mechanism of the form

$$\frac{K_{i,t+1}}{K_{i,t}} - 1 = F_{i,t}[EROR_{i,t}] \qquad (3.2)$$

where
$EROR_{i,t}$ is the expected rate of return on investment in industry *i* in year *t*; and
$F_{i,t}[\ ]$ is an increasing function of the expected rate of return with a finite slope.

The expected rate of return in year *t* can be specified in a variety of ways. In Dynamic-AAGE two possibilities are allowed for, static expectations and forward-looking model-consistent expectations. Under static expectations, it is assumed that investors take account only of current rentals and asset prices when forming current expectations about rates of return. Under rational expectations the expected rate of return is set equal to the present value in year *t* of investing $1 in industry *i*, taking account of both the rental earnings and depreciated asset value of this investment in year *t+1* as calculated in the model.

Dynamic relationships: *Financial asset accumulation*
The financial asset accumulation consists of net government debt and the economy's net holdings of foreign liabilities.

Since the economy engages in international trade it may accumulate external debt. The debt is updated over time by the balance on the current account. The balance on the current account is the sum of the balance on the trade account and the income account. The trade accounts are determined as the total value of exports less imports. The balance on the income account is the value of income received from foreigners less the value of income paid to foreigners. Income is the sum of interest, dividend, and transfers received/paid. In explaining movements in the income balance, the model takes into account the net interest and dividend payments on the net external debt. It is assumed that (i) interest and dividend payments accrue on the basis of the average net debt at the start and end of the year, (ii) the composition of the net debt in terms of different types of financial instruments is fixed, and (iii) transfers, interest rates, and foreign dividend rates are exogenously given, whereas the rate of return on Danish equities is calculated as a weighted average of the rates of return in all industries.

Over time the government's annual budget balances determine the government debt. The budget balance is calculated within the model as the difference between government revenue and expenditure. In explaining movements in the budget balance, the model takes into account the net interest payments on the stock of government debt.

Dynamic relationships: *Lagged adjustment process*

The lagged adjustment process relates to the operation of the labour market. It allows the real wage to be sticky in the short run such that employment adjusts to accommodate this stickiness in the event of any policy change. In the long run employment is sticky and the real wage adjusts. In between, employment and the real wage both adjust.

Dynamic relationships: *land allocation*

AAGE identifies two principal ways of farming: organic and conventional. Each farming praxis uses land allocated into 6 different farming enterprises. Moreover, organic farming also produces in 3 non-land-using farm enterprises and conventional farming in 4 non land-using enterprises.

AAGE allows for two broad treatments of allocation of farmland. The first relates to the use of the model in a comparative static fashion where the land rentals and allocation of land adjust such that rentals are equal in all uses of land.

The second broad treatment of allocation and rental of land involves explicit specifications of land use and rentals in a year-to-year fashion. While the assumption of equal rentals may be suitable for the long run analysis, it is unrealistic to assume equal rentals of land between organic and conventional sectors in year-to-year simulations. Instead, we assume the existence of a long run normal rate of return to land, and that farmers are willing to allocate more land to a farming praxis (organic or conventional) if the expected return to land using that praxis is above the long run normal return, and allocate less land to a farming praxis in response to change in return to land below long run return.

Hence we need to introduce a theory covering allocation/investment decision based on expected return to land.

In each year, we assume that the stock of organic and conventional land is given by decision in previous years, while the allocation is decided in each year to equalize return to land within the organic and conventional sector separately.

Agricultural land is treated explicitly as a stock and a stock accumulation relationship exists for conventional and organic land and together with an explanation of the rate of stock accumulation (i.e., of land investment). The stock of land available for production of organic or conventional products in year t+1 (N_{t+1}) is the stock at the start of the year t (N_t) plus decided investment in land in year t (Y_t). That is, land accumulates according to:

$$N_{k,t+1} = N_{k,t} + Y_{k,t} \qquad k \in ORCO \tag{3.3}$$

Where the set ORCO contains two aggregate elements of all conventional (CONV) and organic (ORG) enterprises and $Y_{k,t}$ is the period t decided invest- or disinvestments in organic and conventional land, respectively.

Given a starting point value in t=0, N_0, and with a mechanism for explaining net investment through time, equation (3.3) can be used to trace out the time path of land used for conventional and organic production purposes.

Assuming that the aggregate stock of land is exogenously given by ($\overline{N_t}$)

$$\sum_{k \in ORCO} N_{k,t} = \overline{N}_t \qquad ORCO = \{CONV, ORGI\} \tag{3.4}$$

it follows from (3.4) that an investment in organic land will lead to a disinvestment in conventional land of equal size. Also since (3.4) ensures that the sum of conventional and organic land is equal to total land available we only need to introduce a theory for either conventional or organic land. Hence we will drop the subscript k in the following.

It is convenient to define the ratio between the expected return and the long-run normal return to land as

$$M_t = \frac{E_t}{R_N} \tag{3.5}$$

Where E_t is the expected return and R_N is the long run normal return to land (assumed exogenous). The expected rate of return varies between conventional and organic farming while the long run normal rate of return is the same and this is the rate that the rate or return in land is assumed to converge to in both farming sectors over time.

The growth of the organic or conventional farmland area is given by

$$G_t = \frac{Y_t}{N_t} \tag{3.6}$$

Where Y is the investment, i.e. the amount of land moving in or out of a sector and N is the total amount of land employed for a given purpose. We then define a function that determines the growth of land in each industry as a function of *M*

$$G_t = f(M_t)$$

Where $f(M_t)$ have the following properties

$$\lim_{M \to \infty} f(M) = n$$
$$f(1) = 0$$
$$\lim_{M \to 0} f(M) = -1$$

In other words the growth rate is limited upwards by a positive constant n and a lower limit of –100 pct. and there is no growth when the expected rate of return is equal to the normal rate of return.

F is specified by a simple logistic curve relating the growth to M by

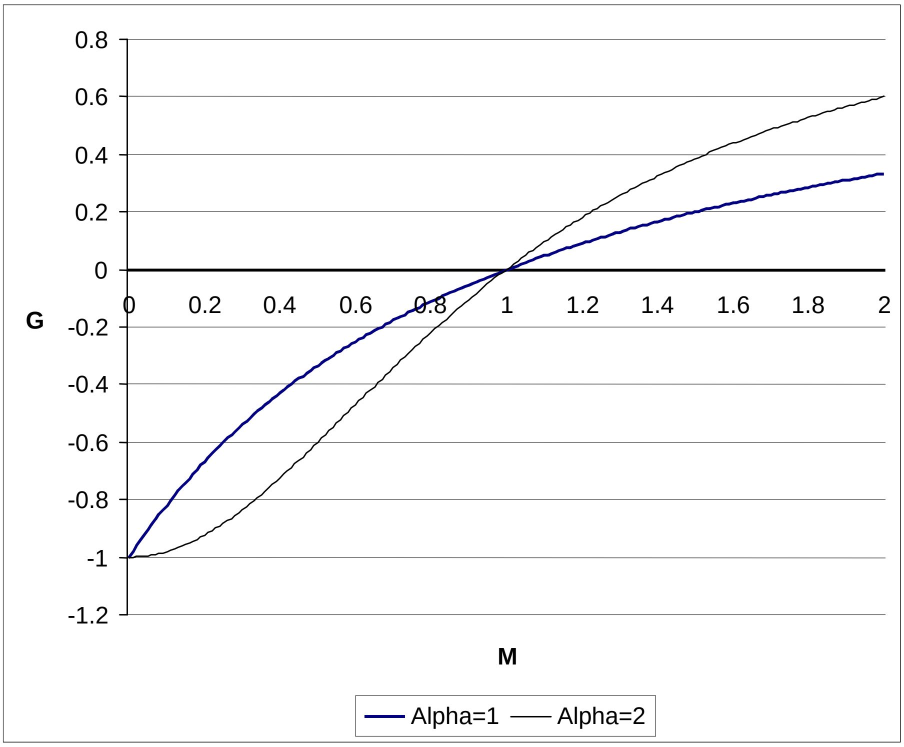
$$G_t = \frac{M_t^a - 1}{1 + M_t^a} \tag{3.7}$$

The specification in (3.7) has the above mentioned properties, though it should be noted that

$$\lim_{M \to \infty} f(M) = 1$$

That is, no matter what the values of M or α are, the growth rate is always constrained upwards to a maximum of 100 percent. The parameter α controls the steepness and curvature and thus the growth G for a given M. The function is shown below for two alternative values for α.

Figure 3.1 $f(M_t)$ for α equal one and two.



The expected rate of return to land E_t is assumed to be an average of the expected rate of return in the previous period $E_{k,t-1}$ and the actual rate of return in the present period R_t. This implies that "landowners" are both conservative and myopic.

$$E_t = (1 - a)E_{t-1} + aR_t \tag{3.8}$$

The larger is a the less importance do landowner attach to their previous expectations and the more importance do they attach to the actual rate of return, e.g. if $a = 1$ then expectations are static in nature.

The actual rate of return is defined by the ratio between the rental price of land P_t and the asset price of land π_t:

$$R_t = \frac{P_t}{\pi_t} \tag{3.9}$$

The asset prise of land is determined as the ratio between the average rental rate across sectors and the long run normal rate of return to land:

$$\pi_t = \frac{P_t^{avg}}{R_N} \tag{3.10}$$

Where

$$P_t^{avg} = \sum_{k \in ORCO} N_{k,t} \times P_{k,t} \qquad ORCO = \{CONV, ORGI\} \tag{3.11}$$

that is a land weighted average of the conventional and organic return to land.

The dynamic land specification is implemented into the TABLO model code by linearsation of equations (3.3)-(3.11) and appropriate selection and calibration of data. The two figures below show the development in organic land for the same "Bad news" scenario[3] for organic agriculture but with different parameter settings relating to the expectation equation in (3.8) and the logistic relation in (3.7).

[3] This "Bad news" scenario is a simplified version of the structural forecast introduced in section 4 and 5. It has been simplified to solve the many simulations in the shortest possible time.

Figure 3.2 Organic land with α =0.5 while a varies.

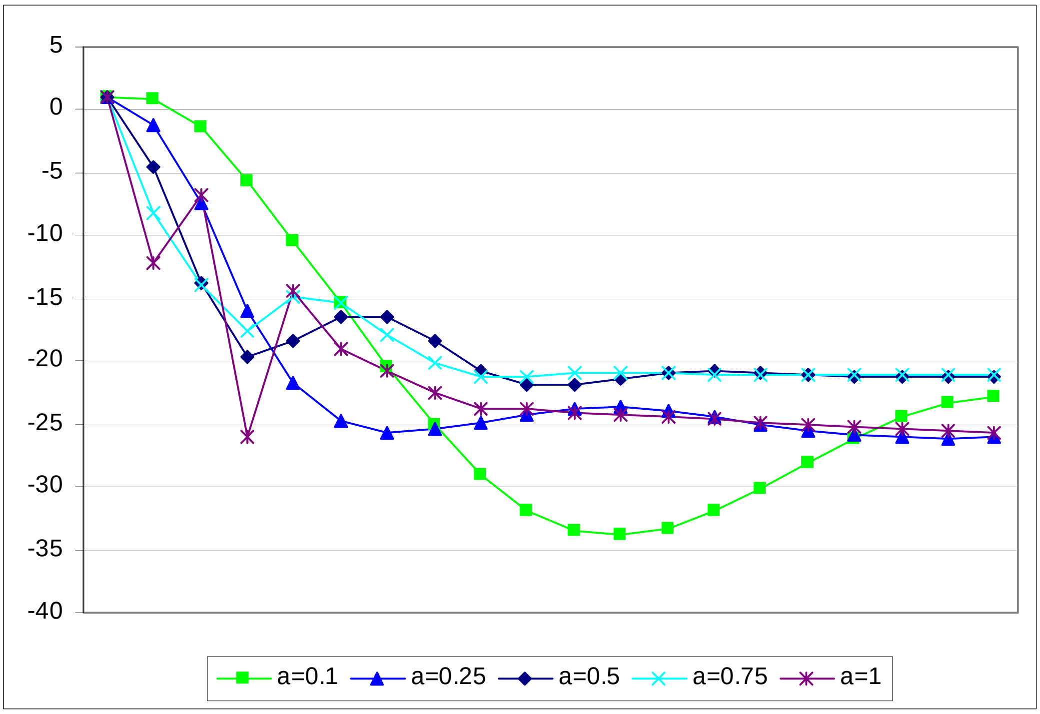
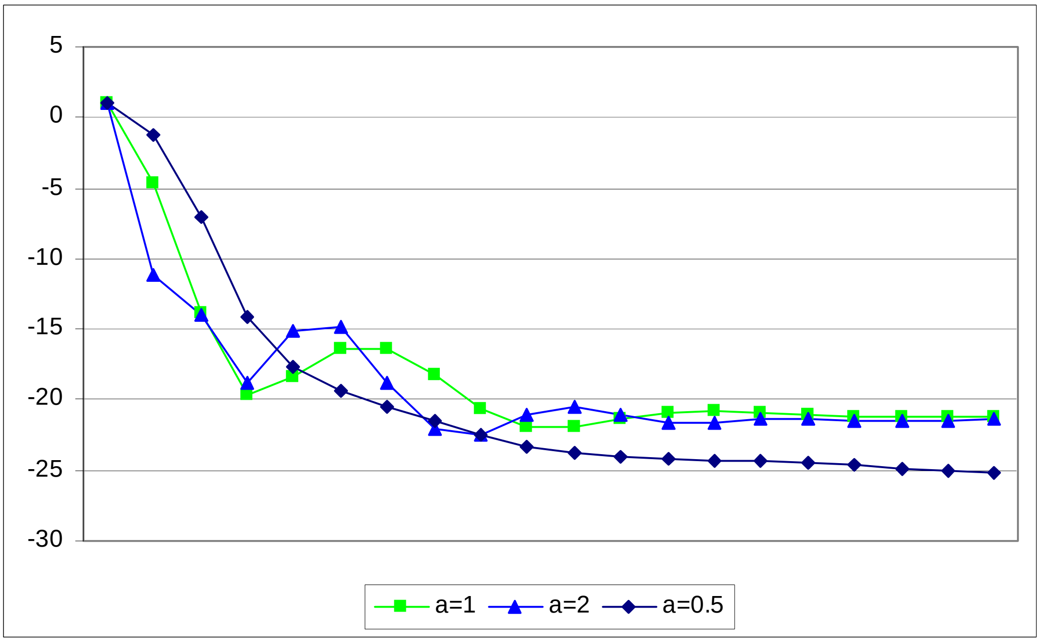


Figure 3.2 Organic land with a=0.5 while α varies.

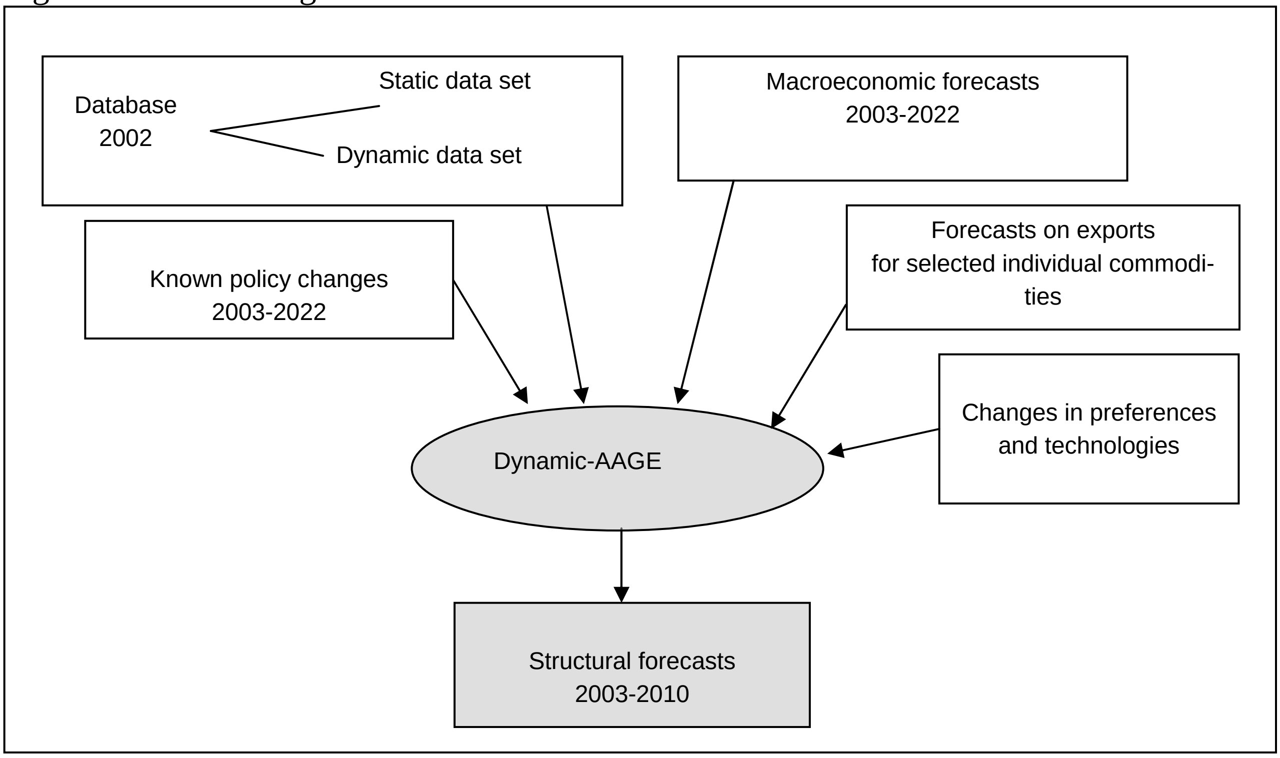


4. Structural forecast for the Danish economy

This section gives an overview of the methodology and data requirements behind the structural forecast for the Danish economy for the period 2003-2022 as well as the resulting macroeconomic forecast.

The starting point for the forecasts is a database reflecting the year 2002[4], the forecast period covers the years from 2003 to 2022. Figure 4.1 illustrates the inputs required to provide the forecasts.

Figure 4.1 Forecasting flow.



In addition to the database, which is split into a static and dynamic set of data, the forecasts require[5]:

- Forecasts for the future period from 2003 to 2006 supplied by the Danish Economic Council and assuming average yearly growth rates thereafter;

- Assumptions for changes in preferences of households and the production technologies of industries based on numbers used with the MONASH model supplemented by own analyses;

[4] This database is the result of a dynamic simulation updating a 1995 database to 2002.
[5] The static data set is documented in Jacobsen (1996) and the dynamic dataset is documented in Adams et.al (2002)

- Inclusion of known policy changes in the entire forecast period such as changes in the minimum acreage requirement and the reform of the EU Common Agricultural Policy (Agenda 2000).

The forecasts provide a microeconomic picture that is consistent with the macroeconomic scenario and the other inputs. These forecasts may be of interest to decision makers in business and policy. Also, they serve as a realistic base case from which to calculate answers to traditional “what if” questions like the CAP reform scenario below.

The following section will focus on the macroeconomic side of the forecast for the Danish economy, whereas forecast for agricultural related sectors and specifically organic sectors will be dealt with in combination with the CAP reform scenario in section 5. The macro economical impact of the CAP reform is negligible why they are dealt with here. The other sectors of the Danish economy are not dealt with either in this paper.

4.1 Macro forecast

Table 1 shows our forecasts for selected macroeconomic variables over the period 2003 to 2022. All of these forecasts are either directly imposed or are implied by exogenous inputs as indicated in the table. The macro forecast from the Danish Economic Council spans the period until 2006. Thereafter average yearly growth rates for the exogenous macro variable are assumed.

Table 4.1 Macroeconomic forecast 2203 to 2022

	Variable		average annual growth rates, percent
1.	Real private consumption*		1.81
2.	Real investment*		1.46
3.	Real public consumption*		0.79
4.	International export volumes*		3.44
5.	International import volumes*		3.44
6.	Real GDP		1.50
7.	Labour supply*		0.01
8.	Aggregate employment		-0.01
9.	Aggregate capital stock*		1.91
10.	GDP deflator		2.08
11.	Price of land		3.43
12.	Rental rate on capital		1.68
13.	Nominal wage		3.57
14.	Producer real wage		1.47
15.	CPI (Numeraier)*		1.98
16.	Terms of trade		-0.41
17.	Real devaluation of exchange rate*		0.00
17.1	Exchange rate		1.23
		percent, 2003	percent, 2022
18.	Unemployment/labour supply	4.74	5.11
19.	Net external debt/GDP	16.64	11.43
20.	Public debt/GDP	41.50	39.47

*) Exogenously given in the forecast.

The assumed development in the GDP demand components leads to an average real GDP growth of 1.5 percent per year. Consumption is assumed to grow faster (1.8) than GDP because households' disposable income grows faster while the average propensity to consume out of disposable income is approximately constant. The reason for the disposable income to grow faster than real GDP is that the nominal wage is expected to increase by 3.6 percent per year on average while aggregate employment is approximately fixed.

In the longer run investment are assumed to grow by the same rate as real private consumption, but since investment declines by 5.9 percent in the first year of the simulation the calculated average per annum for investment over the forecast is only 1.5 percent.

In the first four years of the forecast the public consumption increases vary between 0.8-1.1 percent per year. From 2007 and onward it is assumed that public consumption increases by 0.75 percent per year.

During the 20 years of consideration the contribution to GDP growth from the net volume of international trade is small. In the first four years of the forecast exports growth varies between 1.2-4.1 percent and imports between 0.2-4.4. From 2007 and onwards it is assumed that both increase by 3.5 percent per year. This requires an appreciation of the exchange rate.

The shock applied in the first four years implies that the current account runs a small deficit and therefore the net external debt worsens throughout the forecast period since real aggregate imports and exports grow at the same rates in the longer run. The effect, however is so small that the net external debt as a fraction of GDP falls from 16.6 in 2002 to 11.4 percent in 2022.

In the forecast we assume a small increase in labour supply and a small decrease in employment leading to a small increase in the unemployment rate (from 4.7 percent in 2000 to 5.1 percent in 2022).

Since employment is assumed to be approximately constant throughout the forecast period the labour market is tight which puts an upward pressure on the real wage. Therefore, the growth rate of the producer real wage, defined as the nominal wage deflated by the price of GDP, increases by 1.5 percent on average in the forecast. With an average inflation of 2 percent per year the nominal wage is calculated to grow by 3.6 percent per year on average.

In the forecast the capital stock growths faster than GDP implying an increasing capital-to-GDP ratio such that the marginal product of capital decreases and the real rental rate on capital decreases implying an increase in the nominal rental rate of increases by 1.7 percent on average. This is less than the increase in the price of land and labour which are approximately fixed in supply.

Agricultural land is used as an input into the production of crop products and is fixed in supply. Since production increases throughout the forecast the marginal product of land increases. In the beginning of the forecast land prices increase 3-5 percent per year while in the longer run the price of land stabilizes at annual increases of approximately 2.9 percent. This gives an annual average growth rate of the nominal land price of 3.4 percent in the forecast period.

Since 1997 there has been surplus on the government account. We expect this development to continue throughout the forecast period resulting in a debt reduction from 45 percent of GDP in 2002 to 39 percent in 2022.

5. Agricultural results: Baseline and the 2003 CAP reform policy scenario

In June 2003, the European Council agreed on a new reform strategy for the CAP. The main elements of the reform relevant for this analysis are the changed timeframe and modalities concerning the dairy sector as already agreed upon in the AGENDA2000 reform. The other relevant reform element is the decoupling of direct support.

5.1 Scenario implementation

When implementing the baseline forecast various industry and commodity specific shocks are applied, but in the context of this paper we will restrict ourselves to a short explanation of the shocks applied in the context of the CAP reform scenario and the consequences it has for the baseline forecast shocks. There is one important exception to this. As mentioned in section 2, more than 60 percent of the organic milk produced is not processed and sold as organic. In the baseline we assume that the market for organic milk will balance within the first eight years[6].

The baseline shocks that are relevant in the context of the policy scenario are listed in the second column (Baseline) of table 5.1. These relate to the remainder of the AGENDA2000 reform of the CAP, namely an intervention price cut for butter and skimmed milk powder over the years 2006-7 and compensatory payments to the dairy sector implemented over the same period. Moreover, the shocks reflect the decision to increase the dairy quota by 1.5 percent over the years 2005-7.

The Danish implementation of the 2003 reform of the CAP is basically an alteration of the timing and magnitude of the remaining AGENDA2000 changes and a decoupling of the direct support. The intervention price cut and the compensatory payments are strengthened and brought forward by one year while the increase in the dairy quota is postponed by one year. The major policy initiative in the 2003 reform is the decoupling of the direct support to farmers. In Denmark the reform will be implemented as a full decoupling of all support

[6] In the initial database, this surplus production enters the conventional dairy industry in a CES nest with conventional milk and is processed into conventional dairy products. In the baseline, the conventional industry purchases of organic milk are eliminated by shocking a cost-neutral twister such that the conventional industry lowers their purchases of organic milk.

except that male animal premium and sheep premium will only be decoupled by 25 and 50 percent, respectively.

Table 5.1. CAP changes in the baseline and in the policy scenario

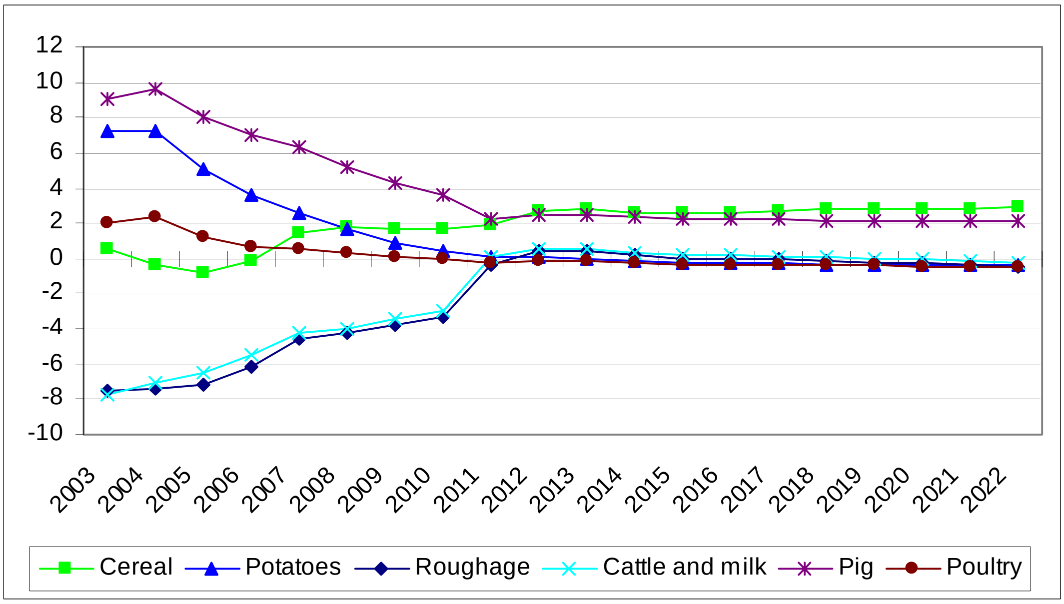
Year	Baseline	Policy – 2003 CAP reform
2004		• Intervention price cut on butter by 1/3 of 15 percent and skimmed milk powder by 1/4 of 25 percent • Compensation payments to dairy quota
2005	• Intervention price cut on butter and skimmed milk powder by 1/3 of 15 percent • Compensation payments to dairy quota • Increasing the dairy quota by 1/3 of 1.5 percent	• Intervention price cut on butter by 1/3 of 15 percent and skimmed milk powder by 1/4 of 25 percent • Compensation payments (dairy quota premium) • Decoupling of hectare premiums • 25 percent decoupling of special male premium • 50 decoupling of sheep premium • 100 percent decoupling of other animal premiums and dairy quota premium • Modulation of direct support by 3 percent
2006	• Intervention price cut on butter and skimmed milk powder by 1/3 of 15 percent • Compensation payments to dairy quota • Increasing the dairy quota by 1/3 of 1.5 percent	• Intervention price cut on butter by 1/3 of 15 percent and skimmed milk powder by 1/4 of 25 percent • Compensation payments(dairy quota premium) but decoupled • Increasing the dairy quota by 1/3 of 1.5 percent • Modulation of direct support by 1 percent
2007	• Intervention price cut on butter and skimmed milk powder by 1/3 of 15 percent • Compensation payments to dairy quota • Increasing the dairy quota by 1/3 of 1.5 percent	• Intervention price cut on skimmed milk powder by 1/4 of 25 percent • Modulation of direct support by 1 percent • Increasing the dairy quota by 1/3 of 1.5 percent
2008		• Increasing the dairy quota by 1/3 of 1.5 percent

The actual implementation of the policy reform is to neutralize first the baseline shocks referred to in table 5.1 since these are all altered as a part of the policy scenario, and then to implement the shocks referred to in the third column of table 5.1.

5.2 Results

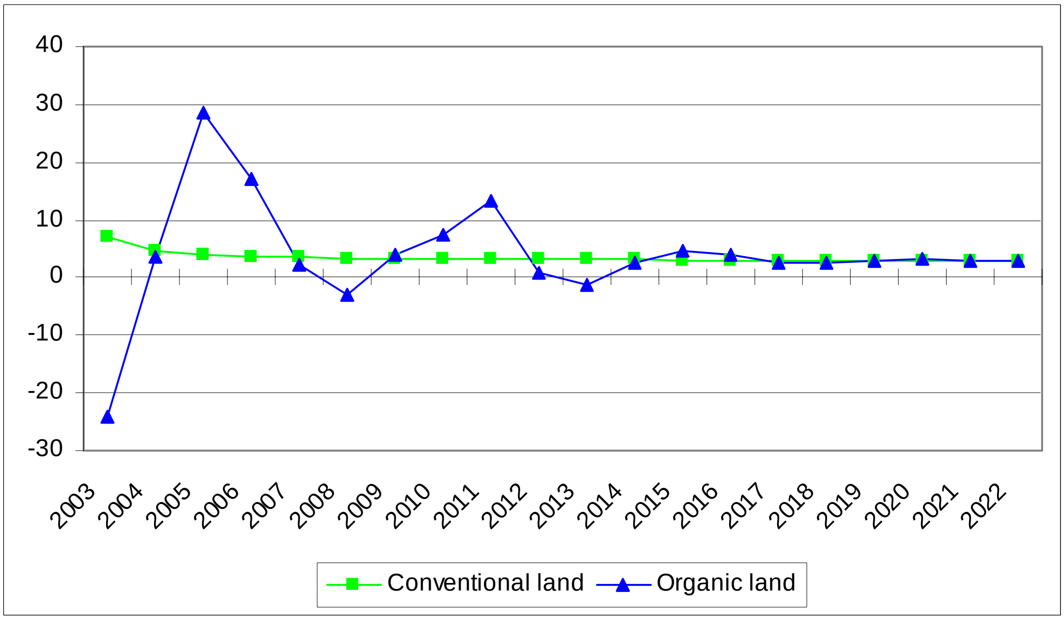
For organic agriculture, the most important shock in the baseline is the assumption that the market for organic fresh milk will balance during the period 2003-2010. This requirement results in negative annual growth rates for organic milk production and the closely related production of roughage (c.f. figure 5.1). Also the price of organic milk and hence the land rental will fall as a result of the reduced demand for milk. Lower land rental leads to lower unit costs in the other organic enterprises and hence they have the potential to expand production. Cereal production is hardly affected in the first couple of years even though cereals are an important input into the dairy sector. The reason is that lower cereal prices benefits the pig and poultry sectors resulting in a net positive impact on cereal production.

Figure 5.1 Forecasting industry output for selected agricultural industries, percent per year.



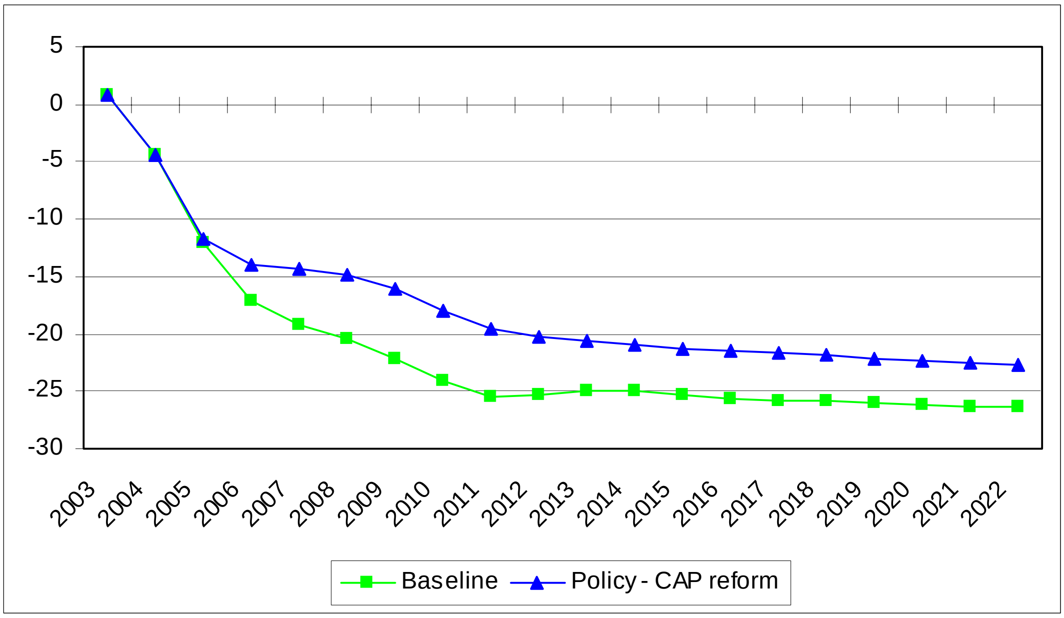
The annual changes in land rentals in the baseline are depicted in figure 5.2. Organic land accounts for less than 10 percent of total land use wherefore the annual changes are much more volatile compared to conventional land rentals. In the longer run the two land rentals converge to a common growth rate.

Figure 5.2 Changes in the land rental, percent per year.



The accumulated fall in the amount of land used for conventional production purposes amount to 26 percent (c.f. figure 5.3). This sharp decrease is explained by the above mentioned required balance in the market for fresh organic milk and the fact that organic milk initially accounts for more than 60 percent of the total organic agricultural production.

Fig 5.3 Organic agricultural land 2003-2022, accumulated percentage change.



The CAP reform implies a decoupling of agricultural support, where all land receives premiums irrespective of the use of land. The result is that the premium to land used for the production of cereals will be lower after the reform, whereas for instance there will be premium to grassland after the reform where none was paid before. The reform is expected to have a positive impact on the total organic land area, because the relative profitability is improved by the fact that organic farming is characterised by a relatively high fraction of grassland and relatively lower fraction of land with cereal. The expected impact on land allocated to organic purposes amounts to an increase of around 4 percent compared to the baseline c.f. figure 5.3.

The remaining figures in this section show the accumulated percentage change in the policy scenario as compared to the baseline, i.e. the accumulated effect in the policy scenario has been isolated from the baseline.

As expected, the increased profitability for organic farmers caused by the CAP reform affects organic production positively. The expected impact ranges from an increase of a little less than 0.8 percent to a good 4,5 percent c.f. figure 5.4. It is interesting to note, though, that decoupling agricultural support has a negative impact on organic cereal production in the first few years. This is because decoupling lowers the premium to land allocated to organic cereal production. The positive effect of decoupling on production in the other organic sectors, however, offsets the negative effect for cereal production in the longer run.

Figure 5.4 CAP-reform: change in organic plant production, accumulated percentages change

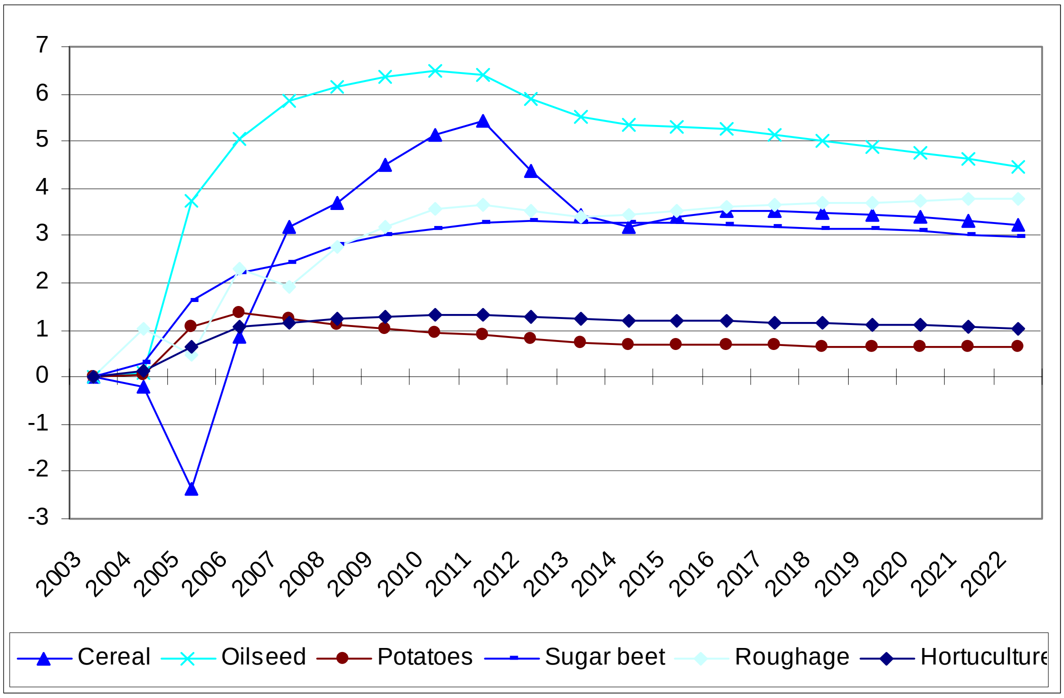
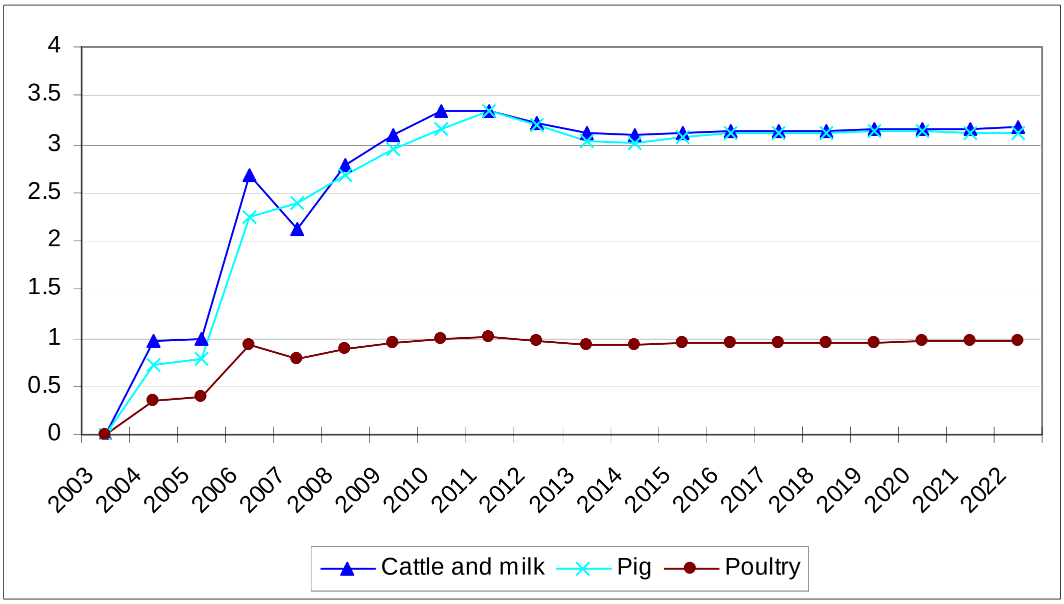


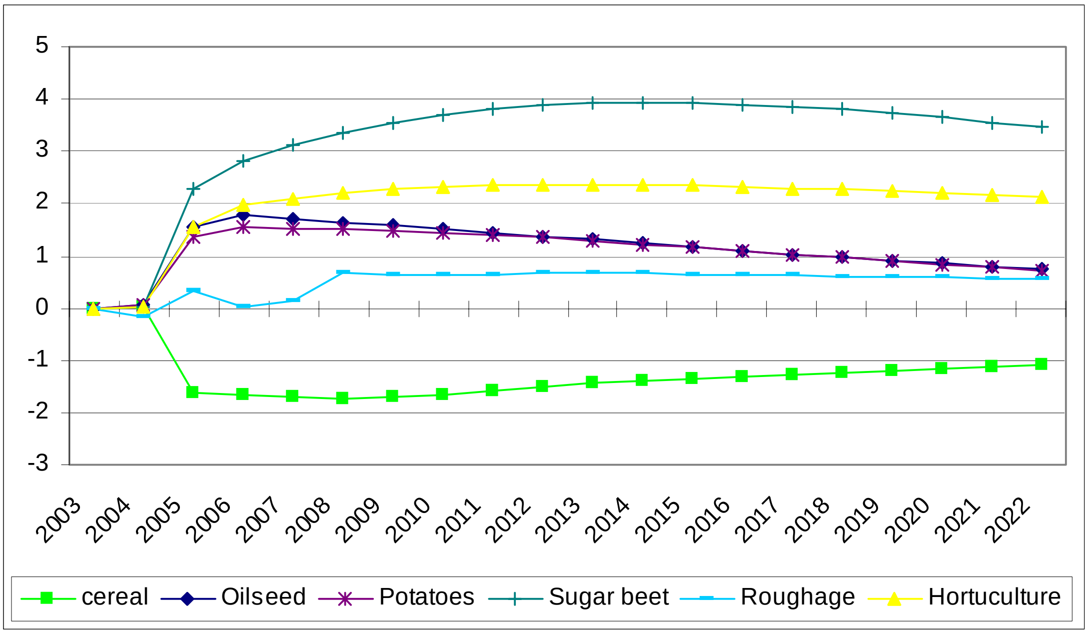
Figure 5.5 CAP-reform: change in organic animal production, accumulated percentages change



Organic animal production benefits from the CAP reform through lower input prices for fodder products (cereals and roughage). The expected increase in production in the long run ranges from a 1 percent increase in the poultry sector (as compared to the baseline) to an increase of good 3 percent in the cattle/milk and pig sectors in the longer run c.f. figure 5.5.

The CAP reform is also expected to affects the conventional farmers in much the same way as the organic farmers. The reform is expected to lower the production of cereals in the longer run by 1 percent while increasing production in the other land-using conventional sectors (between 0.5 percent to some 3.5 percent). c.f. figure 5.6.

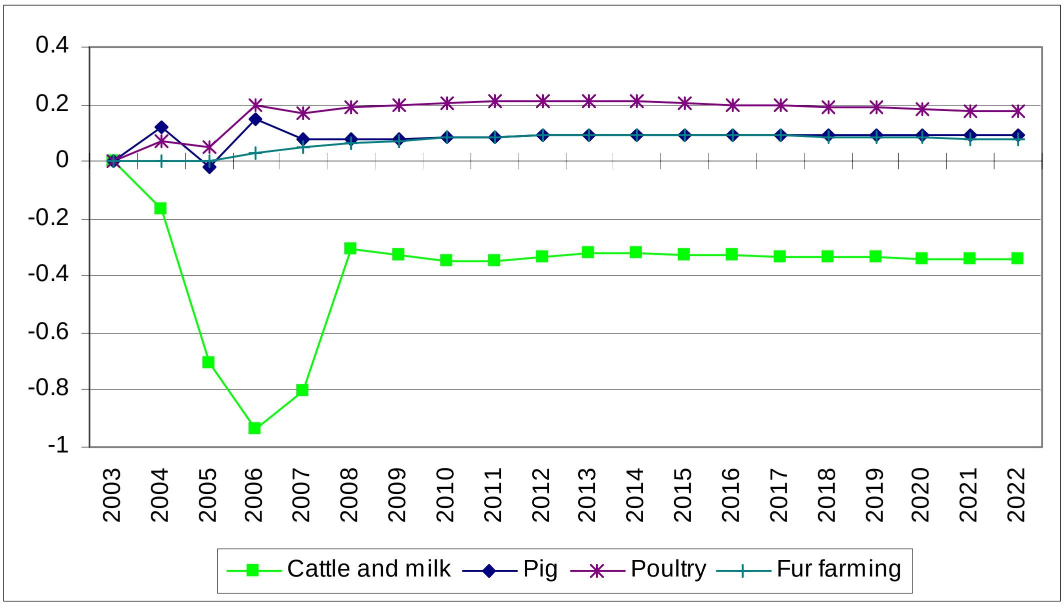
Figure 5.6 CAP-reform: change in conventional plant production, accumulated percentages change



The CAP reform is expected to increase conventional production of pig, poultry and fur farming caused by its impact on fodder products. The conventional cattle/milk sector, on the other hand is negatively affected by the reform. The reason is that both the conventional and the organic sectors compete for dairy quota rights. Moreover the organic sector is relatively better off by the reform due to the relatively higher proportion of grassland. As a result, the production in the conventional sector decreases by almost one percent during the first four years, the sector then regains some production resulting in a decrease in production of almost 0.4 percent in the longer run.

The main reason why the conventional dairy sector exhibits the observed production pattern in the years 2005-2008 is the delay of the quota introduction defined in the 2003 CAP reform. In the baseline new quota rights are introduced in the period 2005-2007 in the CAP reform they are introduced in the period 2006-2008. This means that in the policy scenario some quota rights are taken away in 2005, they are unchanged in 2006 and 2007 and increased in 2008 as compared to the baseline.

Figure 5.7 CAP-reform: change in conventional animal production, accumulated percentages change



The reform is expected to enhance profitability and to lower the prices of organic products. Hence consumption of organic products is also expected to increase as a result of the CAP reform. The AAGE model describes consumption of food products in four broad consumption groups: Bread/cereals, meat, dairy products and vegetables. Consumption of these four groups is broken down into organic and conventional components in a CES nesting structure. The CAP reform is expected to increase the consumption of bread, cereals and vegetables by one percent in the longer run while the consumption of meat and dairy products is expected to increase by 3 and 4 percent, respectively.

The CAP reform results in generally lower prices of agricultural products. Therefore it is also expected that the consumption of conventional products will increase as a result of the reform, but less so because the prices are affected less compared to organic prices.

The consumption of bread/cereals and vegetables increases by 0.1 percent, consumption of meat products increases by 0.75 percent in the longer run, and dairy product consumption increases by little more than 3 percent in the longer run c.f. figure 5.9. As expected all effects are of a smaller magnitude compared to the corresponding results for organic consumption c.f. figure 5.8

Figure 5.8 CAP-reform: change in organic consumption, accumulated percent.

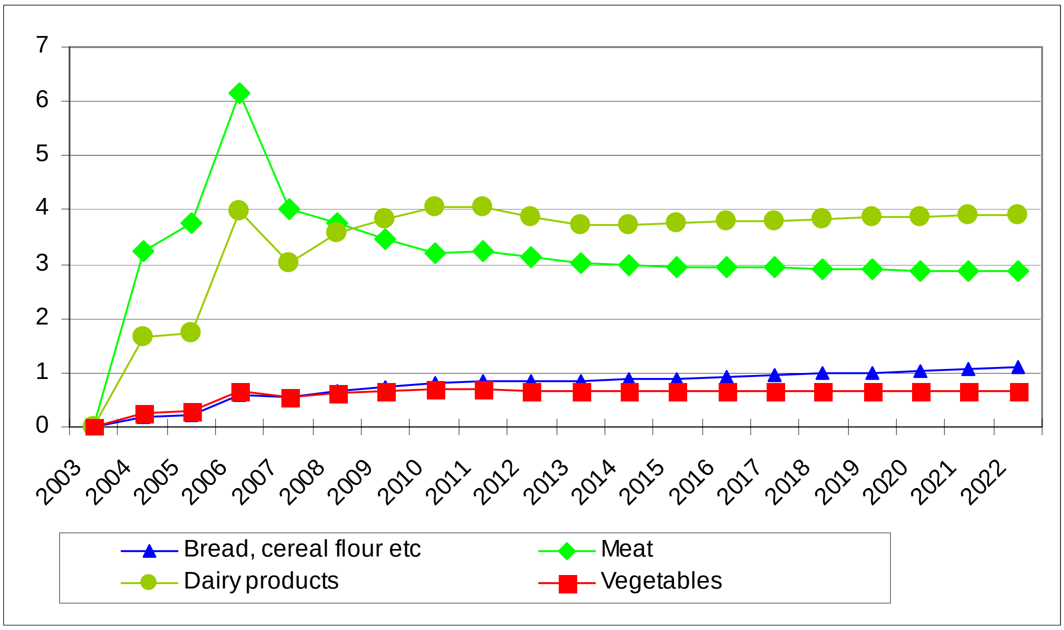
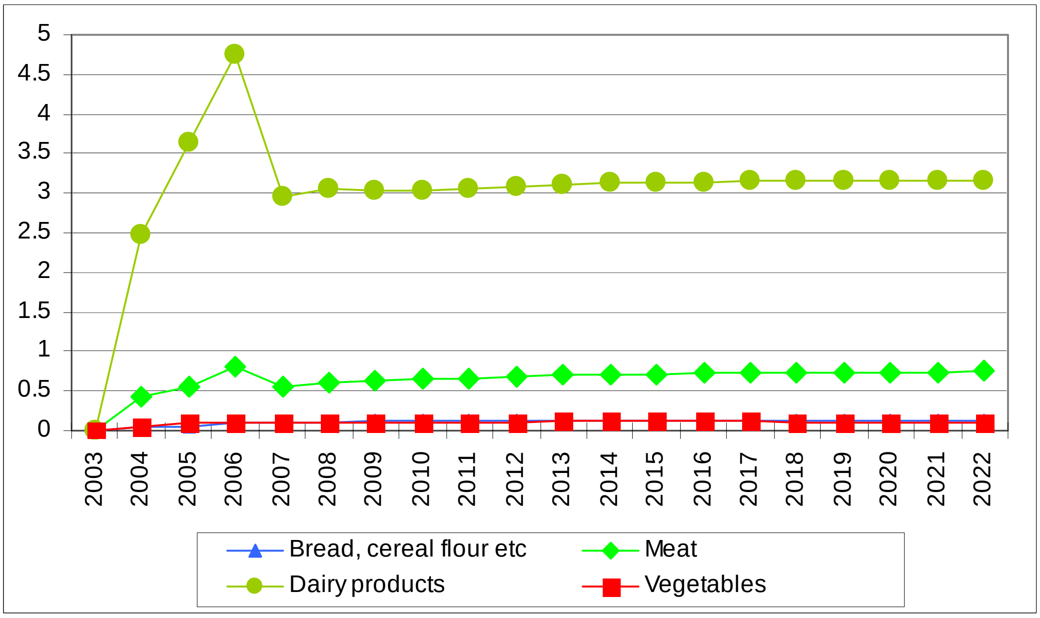


Figure 5.9 CAP-reform: change in conventional consumption, accumulated percent.



NB: The curve for bread, cereal etc. is hidden behind the curve for vegetables

6. Conclusion

This paper has explored the development of a dynamic specification of the allocation of land for organic and conventional purposes. The specification is necessary because the allocation of land based on the principle that land moves to ensure equal return to land in each period is unrealistic in the presence of a legislation that hinders the mobility of land between conventional and organic usage. The implemented theory of land allocation allows for difference in the return to land in the short run but forces the return to equalize over time between organic and conventional land.

The model was used for analyzing the effects for Denmark of the 2003 reform of the European Common Agricultural Policy (CAP). The CAP reform benefits all agricultural sectors excerpt conventional cereal and dairy production. The reason for the falling cereal production is the decrease in premium to land used for cereal production. Conventional milk production declines because the reform benefits the organic farmers relatively more because of a higher fraction of grassland in organic farming.

This paper represents the first simulation undertaken using a model with the dynamic land specification and there is still room for further improvements. The implemented land specification allows for adaptive and static expectation, but since the capital specification also allows for rational expectations an obvious enhancement would be to allow for rational expectations in the dynamic land specification as well.

Another possible enhancement to the analysis would be to investigate the possibilities of linking the dynamic AAGE model with the static GTAP model with a full analysis of the 2003 CAP reform.

References

(Horridge et. al 1993), *ORANI-F: A General Equilibrium Model of the Australian Economy.* Economic and Financial Computing – Volume 3 Number 2 Summer 1993.

Adams, Andersen and Jacobsen (2002) *Structural forecast for the Danish Economy using the Dynamic-AAGE Model.* Report number 133. Available from the Danish Research Institute of Food Economics.

Adams, P.D (2000), "Dynamic-AAGE: A Dynamic Applied General Equilibrium Model of The Danish Economy Based on AAGE and MONASH models", Report number 115. Available from the Danish Research Institute of Food Economics.

Dixon and Rimmer (2002). *Dynamic General Equlibrium Modellingfor Forecasting and Policy – A Practical Guide and Documentation of Monash.* North Holland, Elsevier Science Amsterdam The Netherlands.

Frandsen and Jacobsen (1999) Analyser af de sektor- samfundsøkonomiske konsekvenser af en reduktion i forbruget af pesticider i dansk landbrug, SJFI report no. 104. Available from the Danish Research Institute of Food Economics.

Harrison W. Jill and K.R. Pearson (1996), "Computing solutions for Large General Equilibrium Models Using GEMPACK", Computational Economics, Vol 9, pp. 83-127.

Jacobsen, Lars-Bo (1996). *En landbrugsspecifik input-output tabel for Danmark.* Rapport nr. 91. Statens Jordbrugs og Fiskeriøkonomiske Institut.

Jacobsen, Lars-Bo (2001). *Potentialet for økologisk jordbrug – Sektor- og samfundsøkonomiske beregninger*. Rapport nr. 121. Statens Jordbrugs og Fiskeriøkonomiske Institut.

Jacobsen, Lars-Bo, *Økologi I dansk økonomi – Konstruktion af en økologispecifik input-output table.* Working Paper no. 16/2002 Available from the Danish Research Institute of Food Economics.

Pearson, K.R. (1998), "Automating the Computation of Solutions of Large Economic Models", Economic Modelling, Vol. 7, pp. 385-395.

Appendix A

Table A.1 Industries and commodities in Organic-AAGE.

		Industries			Commodities
*#	1-2	Cereal	*	1-2	Cereal
*#	3-4	Oil seeds	*	3-4	Oil seeds
*#	5-6	Potatoes	*	5-6	Potatoes
*#	7-8	Sugerbeets	*	7-8	Sugerbeets
*#	9-10	Roughage	*	9-10	Roughage
*	11-12	Meat cattle and milk producers	*	11-12	Meat cattle
*	13-14	Pigs	*	13-14	Milk
*	15-16	Poultry	*	15-16	Pigs
	17	Hunting and fur farming, etc.	*	17-18	Poultry
*#	18-19	Horticulture		19	Hunting and fur farming, etc.
	20	Agricultural services, etc.	*	20-21	Horticulture
	21	Forestry		22	Agricultural services, etc.
	22	Fishing		23	Forestry
	23	Extraction of coal, oil and gas		24	Fishing
*	24-25	Cattle-meat products		25	Extraction of coal, oil and gas
*	26-27	Pig-meat products	*	26-27	Cattle-meat products
*	28-29	Poultry-meat products	*	28-29	Pig-meat products
	30	Fish products	*	30-31	Poultry-meat products
*	31-32	Processed fruit and vegetables		32	Fish products
	33	Processed oils and fats	*	23-34	Processed fruit and vegetables
*	34-35	Dairy products		35	Processed oils and fats
*	36-37	Starch, chocolate products, etc.	*	36-37	Dairy products
*	38-39	Bread, grain mill and cakes	*	38-39	Starch, chocolate products, etc.
*	40-41	Bakery shops	*	40-41	Bread, grain mill and cakes
*	42-43	Sugar factories and refineries	*	42-43	Bakery shops
	44	Beverage production	*	44-45	Sugar factories and refineries
	45	Tobacco manufacture	*	46-47	Beverage production
	46	Textile, wearing apparel and leather		48	Tobacco manufacture
	47	Manufactured wood and glass products		49	Textile, wearing apparel and leather
	48	Paper products and publishing		50	Manufactured wood and glass products
	49	Oil refinery products		51	Paper products and publishing
	50	Basic chemicals		52	Oil refinery products
	51	Fertiliser		53	Basic chemicals
	52	Agricultural chemicals nec		54	Fertiliser
	53	Non-metallic building material		55	Agricultural chemicals nec
	54	Metal products		56	Non-metallic building material
	55	Machinery and non-transport equipment		57	Metal products
	56	Transport equipment		58	Machinery and non-transport equipment
	57	Electricity		59	Transport equipment
	58	Gas		60	Electricity
	59	Steam and hot water		61	Gas
	60	Construction		62	Steam and hot water
	61	Motor vehicles service		63	Construction
	62	Wholesale trade		64	Motor vehicles service
	63	Retail trade		65	Wholesale trade
	64	Freight transport		66	Retail trade
	65	Financial and property services		67	Freight transport
	66	Transport and communication services		68	Financial and property services
	67	Public services		69	Transport and communication services
	68	Dwelling ownership		70	Public services
				71	Dwelling ownership
				72	Coal imports
				73	Manure
				74	Fungicide
				75	Insecticides
				76	Herbicide

* Both conventional and organic product/production. # Land using industries

Appendix B Nesting structure