Structural Forecasts for the Danish Economy Using the Dynamic-AAGE Model

Philip D. Adams

Lill Andersen
E-mail: lth@foi.dk

Lars-Bo Jacobsen

Paper prepared for presentation at the X^th^ EAAE Congress
'Exploring Diversity in the European Agri-Food System',
Zaragoza (Spain), 28-31 August 2002

STRUCTURAL FORECASTS FOR THE DANISH ECONOMY USING THE DYNAMIC-AAGE MODEL

By Philip D. Adams

Centre of Policy Studies, PO Box 11E, Monash University, Victoria 3800, Australia

Lill Andersen and Lars-Bo Jacobsen

Danish Institute of Food Economics, Rolighedsvej 25, DK-1958 Frederiksberg C, Denmark

E-mail lth@foi.dk

Abstract

We describe how an applied dynamic general equilibrium model of the Danish economy has been developed to generate structural forecasts. The forecasts provide a microeconomic picture that is consistent with a macroeconomic scenario and the other inputs. We provide an overview of the inputs required to generate the forecasts and of the forecast methodology. Finally, we present aspects of the forecasting results.

Keywords:

1. Introduction

The Dynamic-AAGE model is the dynamic version of the Agricultural Applied General Equilibrium (AAGE) model of the Danish economy. Both models are maintained at the Danish Institute of Agricultural and Fisheries Economics. Each solution of Dynamic-AAGE produces a picture of the Danish economy at a high level of detail for a particular year. The model can also produce a sequence of annual solutions, linked together by ensuring, for example, that the quantities of opening capital stocks in any year equal the quantities of closing stocks in the previous year.

Supprimé : 57

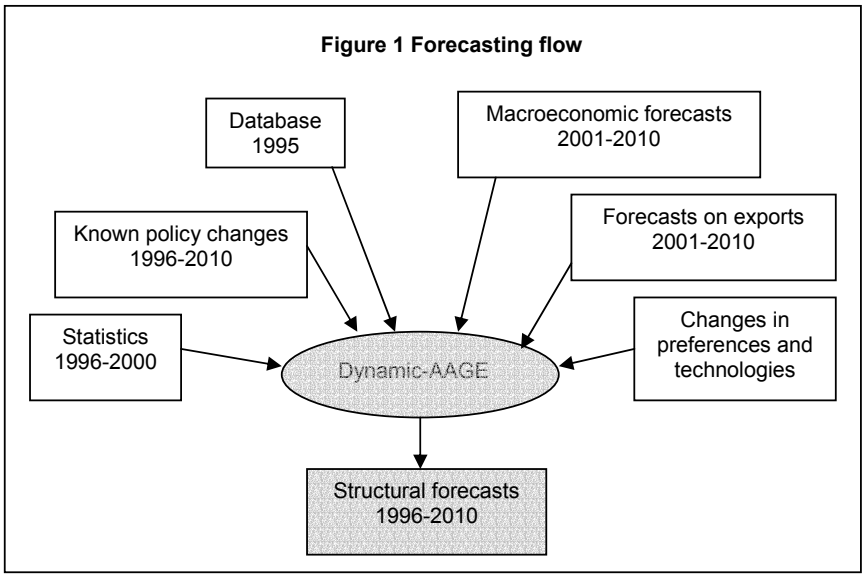
Traditionally, applied general equilibrium (AGE) models like Dynamic-AAGE have been used to answer "what if" questions such as: how different would an economy look in a specified year if a policy change, or some other disturbance, had occurred in some preceding year. Typically there has been no emphasis on forecasting how the economy would look in the year of interest in the absence of the shock, or on tracing the economy's adjustment path from the time when the shock occurred to the year of interest. However, in recent years, the MONASH AGE model of the Australian economy has been used to make realistic forecasts for the economy at a high level of detail over periods of policy relevance (say up to 10 years)[1].

Supprimé : the

Supprimé : stat

The Dynamic-AAGE model has now been developed to generate structural forecasts for the Danish economy, and in this paper we present the first set of Dynamic-AAGE forecasts. Since the starting point for the forecasts is a database reflecting the year 1995, the forecast period covers the years from 1996 to 2010. Figure 1 illustrates the inputs required to provide the forecasts.

Figure 1 Forecasting flow



[1] MONASH is a large-scale AGE model of the Australian economy built and maintained at the Centre of Policy Studies. MONASH is fully documented in Dixon and Rimmer (2000). Some examples of recent MONASH forecasts, and a description of the forecasting methodology, can be found in Adams and Parmenter (2000).

In addition to the database the forecasts require [2]

- Statistics for the historical period from 1996 to 2000 including national accounts statistics, international trade statistics and agricultural statistics;
- Forecasts for the future period from 2001 to 2010 supplied by the Danish Economic Council and taken from a paper prepared by the Danish Institute of Food Economics (FOI);
- 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;
- Inclusion of known policy changes in the entire forecast period like changes in the minimum acres 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.

Later, in Section 5, we review aspects of the first set of Dynamic-AAGE forecasts. In the next three sections we review the inputs: Section 2 outlines the theoretical structure of the Dynamic-AAGE model, our forecasting methodology is outlines in Section 3, while Section 4 reviews the inputs on macroeconomics and exports. Finally, Section 6 contains conclusions.

Supprimé : MMRF

2. The Dynamic-AAGE model

This section has two parts. In Section 2.1, we review the AAGE model, concentrating on the modelling of markets, prices and demand. A very brief description of the solution procedure is given at the end of this section. The dynamic mechanisms are described in Section 2.2.

2.1 Overview of AAGE

There are five types of agents recognised in AAGE: industries, capital creators, households, governments, and foreigners. The model's current database identifies 50 industries producing 56 commodities (see Appendix A). For each industry there is an associated capital creator. The capital creators each produce units of capital that are specific to the associated industry. There is a single representative household and a government sector. Finally, there are foreigners, whose behaviour is summarised by export demand curves for Danish products, and by supply curves for international imports.

Supprimé : MMRF

Supprimé : are identified

The nature of markets and prices

AAGE determines supplies and demands of commodities through optimising behaviour of agents in competitive markets. Optimising behaviour also determines industry demands for labour and capital.

The assumption of competitive markets implies equality between the producer's price and marginal cost in each industry. Demand is assumed to equal

[2] The static data set is documented in Jacobsen (1996).

supply in all markets other than the labour market (where excess supply conditions can hold).

Demands for inputs to be used in the production of commodities

AAGE recognises two broad categories of inputs: intermediate inputs and primary factors. Firms in each industry are assumed to choose the mix of inputs, which minimises the costs of production for their level of output. They are constrained in their choice of inputs by nested production technologies.

Household demands

The representative household buys bundles of goods to maximise a utility function subject to a household expenditure constraint. The bundles are combinations of imported and domestic goods. A Keynesian consumption function determines household expenditure as a function of household disposable income.

Demands for inputs to capital creation and the determination of investment

Capital creators for each industry combine inputs to form units of capital. In choosing these inputs, they cost minimise subject to technologies similar to that used for current production; the only difference being that they do not use primary factors. The use of primary factors in capital creation is recognised through inputs of the construction commodity.

Governments' demands for commodities

The government demands commodities. In AAGE, there are several ways of handling these demands, including: (i) endogenously, by a rule such as moving government expenditures with household consumption expenditure or with domestic absorption; (ii) endogenously, as an instrument which varies to accommodate an exogenously determined target such as a required level of government deficit; and (iii) exogenously.

Foreign demand (international exports)

Three categories of exports are defined: traditional, which are the main exported commodities, non-traditional and special export commodities (see Appendix A). Traditional export commodities face individual downward-sloping foreign demand schedules. The commodity composition of aggregate non-traditional exports is treated as a Leontief aggregate. Total demand is related to the average price via a single downward-sloping foreign demand schedule. The third category of exports comprises commodities for which special individual modelling is required.

Demand for foreign imports

For all industries, AAGE includes the standard Armington specification for imported and domestically produced inputs. This assumes that users of domestic and imported commodity i regard them as imperfect substitutes. The Armington assumption is also used in input demands for industry investment and in household demands for consumption.

2.2 From AAGE to Dynamic-AAGE

There are three types of inter-temporal links incorporated into Dynamic-AAGE: physical capital accumulation, financial asset accumulation and a lagged adjustment process.

Physical capital accumulation

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:

$$K_{t+1}(i) = (1 - DEP(i)) \times K_t(i) + I_t(i) \qquad (1)$$

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 (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

$$\frac{K_{t+1}(i)}{K_t(i)} - 1 = F_{it}[EROR_t(i)] \qquad (2)$$

where

$EROR_t(i)$ is the expected rate of return on investment in industry i in year t; and

$F_{it}[\,]$ 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.

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 is 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

Supprimé : *MMRF*

Supprimé : only

Supprimé : current unit

Supprimé : s

the income balance, the model takes into account the net interest and dividend payments on the net external debt.

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.

Lagged adjustment process

Dynamic-AAGE includes a lagged adjustment process that relates to the operation of the labour market in year-to-year policy simulations.

In comparative static analysis, one of the following two assumptions is made about the real wage rate and employment, either:

1. the real wage rate adjusts so that any policy shock has no effect on aggregate employment; or
2. the real wage rate is unaffected by the shock and employment adjusts.

Supprimé : instantaneously

We allow for a third, intermediate position, in which real wages can be sticky in the short run but flexible in the long-run, and employment can be flexible in the short-run but sticky in the long-run. For year-to-year policy simulations, it is assumed that the deviation in the real wage rate increases through time in proportion to the deviation in aggregate employment from its basecase-forecast level. The coefficient of adjustment is chosen so that the employment effects of a shock are largely eliminated after about ten years. This is consistent with macroeconomic modelling in which the NAIRU is exogenous.

3. Forecasting Methodology

Algebraically, Dynamic-AAGE takes the form

$$F(X) = 0 \qquad (3),$$

where F is an m-vector of differentiable functions of n variables X, with n>m. In simulations with (3), given an initial solution for the n variables that satisfies (3), we compute the movements in m variables (the endogenous variables) away from their values in the initial solution caused by movements in the remaining n – m variables (the exogenous variables). In year-to-year simulations the changes in the values of the exogenous variables are measured from one year to the next. If the initial solution is for year t then our first computation creates a solution for year t+1. This solution can in turn become an initial solution for a computation that creates a solution for year t+2. In such a sequence of annual computations, links between one year and the next are recognised by ensuring, for example, that the quantities of closing capital stocks in the year t-1 computation are the quantities of opening stocks in the year t computation.

In forecasting with Dynamic-AAGE, we impose on the model a large amount of information from specialist external forecasting agencies. The model is then used to trace out the implications of those external forecasts for the industrial structure of the economy

Supprimé : ¶

Many of the variables tied down in the forecasting simulation would normally be endogenous in AGE simulations. But in the forecasting simulation

they are exogenous, and a corresponding number of variables that would normally be thought of as exogenous are endogenous. We give three examples, two macroeconomic and one microeconomic.

1. The externally supplied macroeconomic forecasts include growth in factor inputs (aggregate employment and aggregate investment) and in aggregate real Gross Domestic Product (GDP). Hence, aggregated factor-saving/using technical change is implied (i.e., is endogenous).
2. The macroeconomic forecasts include aggregate private consumption and household disposable income (HDI). Hence, the propensity to consume out of HDI must be made endogenous.
3. The SJFI forecasts include export volumes for selected agricultural commodities. To accommodate these, the model must be free to project shifts in export demand schedules.

Supprimé : 2015-16

4. Exogenous variables 1996 to 2010

In generating our forecasts we begin from the latest Dynamic-AAGE database which reflects the year 1995. The first forecast simulation takes us through historical time from 1995 to 1996. We continue forecasting through historical time until we reach the year 2000. At this point we enter future time.[3] Accordingly, the variables presented in this section are separated into two parts: one referring to the historical period 1995 to 2000; the other referring to the future period 2000 to 2010.

4.1 Macroeconomic inputs

For the historical period the main data source is the national accounts published by Statistics Denmark supplemented by financial statistics published by the Central Bank. For the forecast period the primary source is forecasts published by the Danish Economic Council. Accordingly, both the amount of data and the levels of details differ in the two periods and so does the split between exogenous and endogenous variables. For example, the national accounts statistics include data on total compensation of employees and the government's income tax revenue. Therefore, we treat these variables as exogenous in the historical period by freeing up the wage rate and the income tax rate. In the forecast period we swap exogenous and endogenous variables.

Table 1 shows our forecasts for selected macroeconomic variables over the periods 1995 to 2000 and 2000 to 2010. All of these forecasts are either directly imposed or are implied by exogenous inputs as described above.

Supprimé : 2015-16

1995-2000 was a period of relatively high GDP-growth; the annual average being 2.8 per cent. Real private consumption grew at an average annual rate of 1.8 per cent, while the average annual rate of growth of real investment was high. In the forecast period we expect lower real GDP-growth, and the trend switches so that private consumption grows faster than GDP, while investment grows slower than GDP. In the forecast period real GDP grows slower than in the historical period because aggregate employment growth slows down and becomes slightly negative compared to an annual average growth rate of 1.1 per cent in 1995-2000.

[3] From a forecasting viewpoint, history finishes and the future starts in the last year for which national accounts data are available. At the time of writing, this was the year 2000.

Table 1: Macroeconomic Forecast

	Variable	1995 to 2000	2000 to 2010
	---------- average annual growth rates ----------		
1.	Real private consumption (C)	1.8	2.3
2.	Real investment (I)	6.7	1.3
3.	Real public consumption (G)	1.5	0.8
4.	International export volumes (X)	6.5	3.7
5.	International import volumes (M)	6.7	3.5
6.	Real GDP (Y)	2.8	1.8
7.	Labour supply	0.1	-0.1
8.	Aggregate employment	1.1	-0.1
9.	Aggregate capital stock	2.3	2.3
10.	GDP deflator	2.7	1.5
11.	Price of land	1.8	2.2
12.	Rental rate on capital	4.1	0.5
13.	Nominal wage	4.0	3.6
14.	Producer real wage	1.3	2.1
15.	CPI	1.9	1.3
16.	Terms of trade	1.3	-0.1
17.	Real devaluation of exchange rate	-2.2	-0.5
	---------- per cent, end of period ----------		
18.	Unemployment/labour supply	5.7	5.1
19.	Net external debt/GDP	12.3	-3.7
20.	Public debt/GDP	54.6	38.0

4.2 Assumptions for Exports

In Dynamic-AAGE, three categories of exports are distinguished: traditional, non-traditional and special exports. For traditional exports, the model specifies individual demand functions. Traditional exports include commodities, which have export shares in total sales greater than 40 per cent. For non-traditional export, the model adopts a bundle approach. A single export demand schedule explains movements in export demand as a function of an export price index. The index equals the weighted average of individual non-traditional export prices.

The third category of exports comprises commodities for which special individual modelling is required. At present, *C45. Wholesale trade*, *C47. Transport services*, and *C49. Transport and communication* are treated as special exports. The first two commodities are not true exports; they consist mainly of margin sales to facilitate exports of other commodities. Exports of transport and communication consist primarily of Danish water-transport services used outside Denmark, and charges imposed by Danish telephone companies and the Danish postal company on foreign communications companies for distributing incoming phone calls and mail within Denmark. Exports of these commodities will be incentive to changes in cost competitiveness in Denmark.

With this classification, traditional exports comprise 67 per cent, non-traditional exports 15 per cent, and special exports 18 per cent of total exports in 2000.

Table 2: Assumptions for Export Volumes
(average annual growth rates)

Industry	Commodity	1995 to 2000	2000 to 2010
Traditional export commodities			
1.	Cereal	-0.6	6.5[(a)]
10.	Hunting and fur farming etc.	4.6	1.2
11.	Horticulture	5.4	1.2
14.	Fishing	2.8	1.0
15.	Extraction of oil and gas	11.5	-12.5[(a)]
16.	Cattle-meat products	-4.4	2.6
17.	Pig-meat products	3.4	1.8
19.	Fish products	1.1	1.1
22.	Dairy products	1.4	1.2
23.	Starch, chocolate products etc.	4.1	3.0
29.	Textile, wearing apparel and leather	6.5[(a)]	4.9
32.	Oil refinery products	6.4	4.9
33.	Basic chemicals	6.1	4.9
35.	Agricultural chemicals nec	6.9	4.9
37.	Metal products	4.8	4.9
38.	Machinery & non-transport equipment	7.3	4.9
39.	Transport equipment	10.2	4.9
Special export commodities			
45,47,49		9.2	2.9
Non-traditional export commodities			
2-4,6,8,9,13,18,20,21,24,26-28,30,31,34,36,40,41,43,46,48,50		6.4	3.4

(a) Calculated within the model.

In the forecast we target both the total non-traditional export volume, the volumes of traditional exports, and the volumes of special exports. Table 2 shows the average annual growth rates of the three categories of exports in the periods 1995-2000 and 2001-2010. In the historical period the sources are the international trade statistics and the agricultural statistics published by Statistics Denmark. In the forecast period we use the broad forecasts calculated by the Danish Economics Council supplemented by calculations done by the Danish Institute of Agricultural and Fisheries Economics concerning agricultural exports.[4]

5. Projections for industry output 2001-2010

Table 4 gives output forecasts for the 50 industries distinguished in the model. The rank of each industry in the future forecast period (2000 to 2010) is shown in the first column. The industries with the worst growth prospects are *14 Extraction of coal, oil and gas*, and the two quota industries *6 Meat cattle and milk producers* and *13 Fishing* and related industries. The industries with the best

[4] See Frandsen and Jensen (2000).

growth prospects are *37 Machinery and non-transport equipment, 32 Basic chemicals* and *38 Transport equipment.*

Table 3: Industry Output
(average annual growth rates)

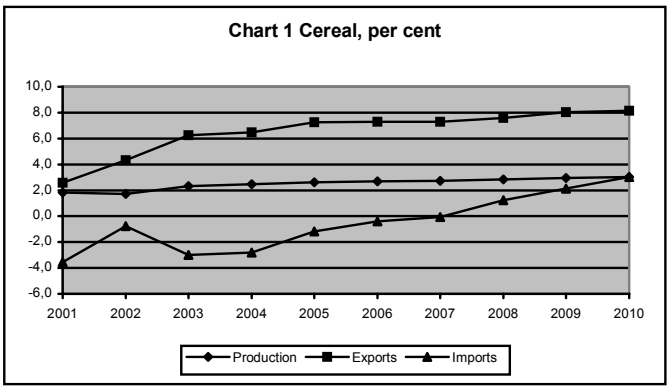
Supprimé : *16*

Rank		Industry	1995 to 2000	2000 to 2010
18	1	Cereal	1.1	2.5
28	2	Oil seeds	-2.7	2.0
21	3	Potatoes	1.9	2.4
24	4	Sugerbeets	2.8	2.3
48	5	Roughage	-0.1	0.0
47	6	Meat cattle and milk producers	0.0	0.2
39	7	Pigs	1.6	1.1
16	8	Poultry	3.8	2.7
34	9	Hunting and fur farming, etc.	2.7	1.6
36	10	Horticulture	2.6	1.4
41	11	Agricultural services, etc.	1.4	1.0
17	12	Forestry	3.6	2.6
49	13	Fishing	-5.5	0.0
50	14	Extraction of coal, oil and gas	2.1	-8.0
46	15	Cattle-meat products	-0.6	0.2
38	16	Pig-meat products	1.7	1.2
11	17	Poultry-meat products	5.5	3.3
40	18	Fish products	0.0	1.1
7	19	Processed fruit and vegetables	3.5	3.8
20	20	Processed oils and fats	3.3	2.4
45	21	Dairy products	0.3	0.4
31	22	Starch, chocolate products, etc.	1.4	1.9
26	23	Bread, grain mill and cakes	2.6	2.0
44	24	Bakery shops	0.5	0.5
19	25	Sugar factories and refineries	3.2	2.5
24	26	Beverage production	2.2	2.3
29	27	Tobacco manufacture	2.8	1.9
12	28	Textile, wearing apparel and leather	-0.5	3.2
32	29	Manufactured wood and glass products	3.4	1.8
37	30	Paper products and publishing	1.7	1.4
8	31	Oil refinery products	3.7	3.7
2	32	Basic chemicals	4.5	4.3
14	33	Fertiliser	1.9	2.7
4	34	Agricultural chemicals nec	4.6	4.2
35	35	Non-metallic building material	3.6	1.6
5	36	Metal products	3.5	4.1
1	37	Machinery & non-transport equipment	6.0	4.6
3	38	Transport equipment	6.9	4.2
9	39	Electricity	4.0	3.6
30	40	Gas	3.2	1.9
15	41	Steam and hot water	2.4	2.7
33	42	Construction	5.0	1.6
13	43	Motor vehicles service	3.5	3.2
27	44	Wholesale trade	3.6	2.0
43	45	Retail trade	0.6	0.7
23	46	Freight transport	3.9	2.3
10	47	Financial and property services	4.5	3.5
6	48	Transport and communication services	6.3	3.8
42	49	Public services	1.5	0.8
25	50	Dwelling ownership	1.5	2.1

1 Cereal (ranked no. 18)

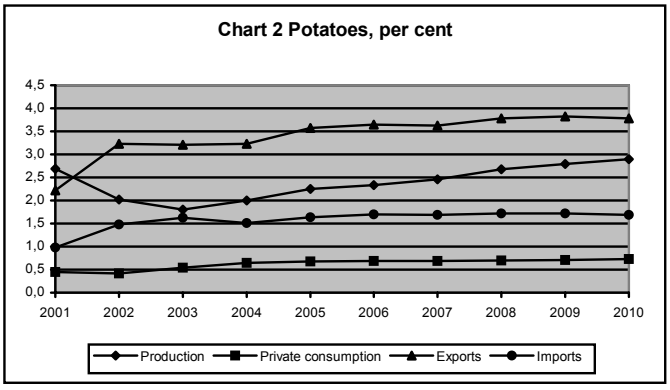
The cereal industry is like other agricultural industries regulated through the common agricultural policy in the EU (CAP). When calculating forecasts for the cereal industry we take into account the hectar premiums and the set aside requirements. In 2000, nearly half of the output of the cereal industry was sold as feed grain to the pigs industry (industry 7). Of the rest, 20 per cent was exported. Imported cereals accounted for almost 12 per cent of the local market.

The cereal industry is characterised by substantial international competition implying that the domestic price of cereal is virtually fixed at the world market price level. In the forecast period we assume that the world market price grows slower than the domestic GDP deflator. Therefore, the domestic price of cereal also grows slower than the GDP deflator such that the growth prospects for cereal production are above those of the economy as a whole. Since the production of pigs grows slower than the production of cereal, an increasing proportion of total cereal production is exported in the forecast period, cf. Chart 1.



3 Potatoes (ranked no. 21)

Unlike the other primary agricultural industries, a significant proportion (around 20 per cent) of the production of potatoes is sold to households for consumption. The bulk of the remaining sales go to *19 Processed fruit and vegetables* and to exports (25 per cent of total sales).



Potato production is forecast to grow at an average annual rate of 2.4 per cent. This relatively high rate is primarily due to good export prospects (cf. Chart 2). Private consumption of potatoes is forecast to expand at the rate of 0.6 per cent. This is below total private consumption, which is forecast to growth at an average annual rate of 2.3 per cent (Table 1). Potatoes, however, has a relatively low expenditure elasticity in consumption, causing growth in consumption demand for this product to be less than growth in total consumption.

6 Meat cattle and milk producers (ranked no. 47)

This industry produces two products, cattle for slaughter and milk, which are produced in fixed proportions. Cattle are sold to *15 Cattle-meat products.* Milk is sold either fresh or for manufacturing to *21 Dairy products.* About 8 per cent of meat cattle are exported. Meat cattle face some import competition on local markets, but imports of milk are negligible.

Production in this industry is constrained by a quota on the production of milk. The quota will increase by annually 0.5 per cent over three years in 2006-8 as part of the reform of the CAP. In the rest of the forecasting period the quota will remain at its current level, implying zero change in meat cattle and milk production.

7 Pigs (ranked no. 39)

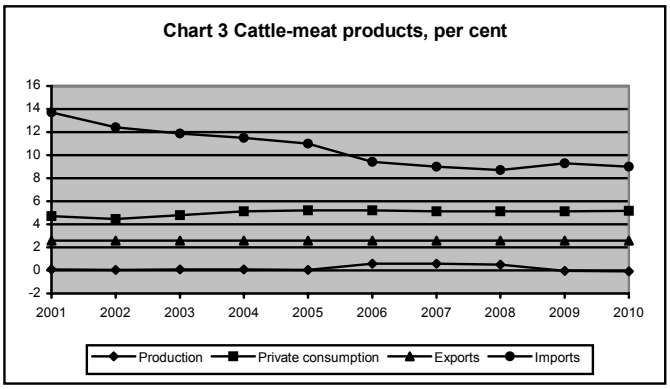
This is the largest primary agricultural industry. Nearly all of its production goes to the downstream manufacturing industry (*16 Pig-meat products*). Although the industry does not export directly, it is highly exposed to export competition via its connection to the export-oriented pig-meat industry.

In line with our forecast for *16 Pig-meat products,* we expect the annual rate of production growth for pigs to fall from 1.6 per cent per annum in the period 1995 to 2000, to 1.1 per cent in the period 2000 to 2010.

The dynamics matches those of the pig meat industry.

15 Cattle-meat products (ranked no. 46)

This industry purchases meat cattle for slaughter and for further processing. Most of its production is exported, with only about 40 per cent destined for the local market (mainly household consumption). The share of imports in the local market is over 40 per cent.

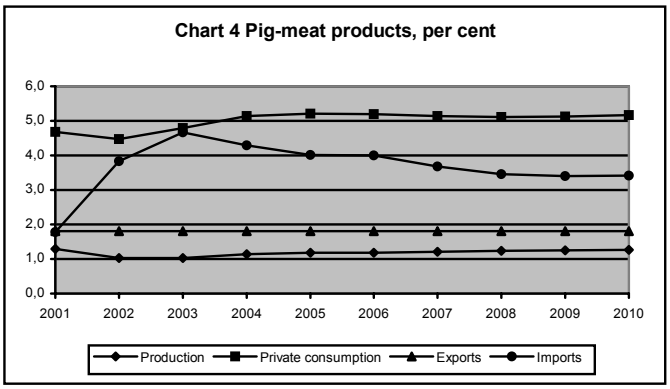


Between 1995 and 2000, exports of cattle meat fell at an average annual rate of 4.4 per cent (Table 2). However, meat production fell by only 0.6 per cent, as domestic producers were able to increase their share of the local market. In our forecasts, we assume a recovery in export growth, but little change in production. This reflects, in the main, the milk quota that restricts production of milk and cattle for slaughter. With exports rising and little change in production, import penetration is forecast to increase, cf. Chart 3.

16 Pig-meat products (ranked no. 38)

This is, by far, the largest meat processing industry. It is highly export oriented, with 64 per cent of its production being exported. In 2000, 16 per cent of production was sold to consumption. This share has fallen from 18 per cent in 1995 due to increased import penetration.

We expect this trend to continue in the forecast period such that production grows at an annual average rate of 1.2 per cent while import grows at 3.7 per cent on average (Chart 4). In making this forecast, we assume that exports will grow by 1.8 per cent per annum (Table 2). Hence, increased import penetration as well as relatively poor export prospects combine to generate lower production growth in the forecast period compared to the historical period.



17 Poultry-meat products (ranked no. 11)

Poultry meat is mainly produced for export. Most domestic demand is met from imports.

Production of poultry meat is forecast to grow at an average annual rate of 3.3 per cent. This is considerably below its historical rate of growth, but is above the forecast growth rates of other meat producers. The reason for this is that poultry meat is treated as a non-traditional export commodity such that we forecast exports of poultry meat to increase in line with the forecast growth rate of non-traditional exports, namely at an annual rate of 3.4 per cent.

6. Conclusions

In this paper, we have reviewed the dynamic relationships as well as the dynamic data used in the Dynamic-AAGE model. We have described the method for producing detailed forecasts of the industrial structure of the economy using the model. We have outlined the inputs from specialist macroeconomic

forecasters and from own analyses as well as the assumptions on changes in preferences of households and technologies of industries. Finally, we have described the structural forecasts from 2001 to 2010 industry-by-industry. In this section we focus on two issues: first what is the role of the structural forecasts, and second how may the forecasts be improved.

The structural forecasts may be seen as a supplement to traditional macroecoomic forecasts: they provide a microeconomic picture that is consistent with the macroeconomic scenario. We think that structural forecasts may be of interest to a wide range of groups, including decision makers concerned with the prospects for particular industries.

Moreover, structural forecasts form the basis for any "what if" question: how different would the economy look year-by-year if a policy change, or some other disturbances, occur in a particular year.

Our structural forecasts may be improved in two directions. First the quality of the inputs may be improved, and second the quality of the modelling may be improved. Improving the quality of inputs includes

- more recent macroeconomic forecasts that take into account the development of the world economy in 2001;
- scenarios on changes in preferences of households and production technologies based upon trends in Denmark. This requires that we calculate such trends for a relatively long historical period using Dynamic-AAGE;
- more industry-specific expertise. One way to reach such expert knowledge is to form expert groups that can both provide industry-specific inputs and judge the quality of the industry-specific output of the forecasting,

Improving the quality of the modelling may relate to

- households' preferences;
- inclusion of different types of labour;
- updating of the external debt;
- industry-specific parameters such as export elasticities.

These improvements are topics for future research. Hopefully, we are able to address some of the issues as part of ongoing projects while other issues are so comprehensive that they form large research projects in their own right.

References

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 Institute of Agricultural and Fisheries Economics, Copenhagen

Adams, P.D. and B.R. Parmenter (2000), "Forecasting the Australian Economy: The Role of the MONASH Model", chapter 5 in Abelson, P. and R. Joyeux (eds.), *Economic Forecasting*, Allen and Unwin, Sydney.

Danmarks Nationalbanks statistik over renter og kurser.

Danmarks Statistiks Landbrugsstatistik.

Danmarks Statistiks Nationalregnskabsstatistik.

Danmarks Statistiks Udenrigshandelsstatistik.

Dixon, P.B. and M. Rimmer (2000), *MONASH: A Dynamic Multi-sectoral Model of the Australian Economy*, in preparation, Centre of Policy Studies, PO Box 11E, Monash University, Victoria 2800, Australia.

Frandsen. S.E. and H.G. Jensen (2000) "Den globale udvikling og konsekvenser for dansk production og eksport af fødevarer", Udredning for Fødevareministeriets "Idegruppe".

Frandsen, S.E., J.V. Hansen and P. Trier (1994), "A General Equilibrium Model for Denmark with Two Applications", Economic and Financial Modelling, 1, pp. 105-138.

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, L-B (1996), "En landbrugsspecifik input-output tabel for Danmark", report number 91, Danish Institute of Agricultural and Fisheries Economics, Copenhagen.

Jacobsen, L-B and S.E. Frandsen (1999), "Analyse af de Sektor-og Samfunds-Økonomiske Konsekvenser af en Reduktion i Forbruget af Pesticider i Dansk Landbrug", Report number 104, Danish Institute of Agricultural and Fisheries Economics, Copenhagen.

Ministry of Finance (2000) "The Danish economy".

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

Det Økonomiske Råd (1999) "Dansk økonomi, efterår 1999".

Appendix A: Commodities and Industries in the 1995 AAGE database

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

*Sectors using land for production. # Commodities classed as traditional export commodities (producers of traditional export commodities face individual downward-sloping world-demand schedules for exports).