Norwegian
Aggregate
Model

Documentation of NAM

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Introduction

> "I think it should be generally agreed that a model that does not generate many properties of actual data cannot be claimed to have any 'policy implications'..."
> Clive.W. J. Granger (1992)

Norwegian Aggregate Model (NAM) is a dynamic econometric model of the Norwegian macro economy. The data bank of the model consists of quarterly time series for the real economy (including emission of climate gases), wages and prices, interest rates, credit, government income and expenses and a banking module (e.g., income statement and balance sheet variables of the macrobank).

NAM can be used to analyze the current situation of the Norwegian macro economy, as an aid for medium term macroeconomic forecasting, and to quantify the dynamic responses to shocks from the world economy, or from policy changes and structural changes in the domestic economy. The model integrates real and financial sectors and has been used as a framework for scenario analysis, in connection with stress-testing of the Norwegian banking system.[1]

NAM has it roots in a long standing interest in the methodology of macroeconometric model building (frame *Lineages of NAM*). In 2013, it was decided to make NAM a transferable model – from model producer to model user. Since then, for more than two decades interaction with model users has influenced how NAM has been developed. This process has been particularly important in the work with the adaptive capability of the model.

Because NAM is an empirical explanatory model project, the implications for modelling of the structural changes that take place in the real world, cannot be put to one side for long periods of time, if damage to model performance and relevance is to be avoided.

Therefore, monitoring of model performance and continuous model development, are necessary for maintaining the model's ability to generate many of the properties of the economic data from the real world. A more complacent attitude towards model maintenance would allow the forces of structural change to generate new gaps between the model's explanation and the actual data (unopposed, so to speak). The consequences is that a model left unattended may soon become defunct.

Of course, the realities of awareness and maintenance have been recognized by those who have worked practically with model building. Lawrence Klein, one of the founding fathers of macroeconometric modelling, put it this way:

> By the time a system has been designed to give explicit display to a variable that has appeared to be important, the econometrician may

[1] https://www.finanstilsynet.no/en/publications/risk-outlook-reports/risk-outlook—june-2024/.

> find that some new variable, formerly submerged in aggregation, is now important. ... Every two or three years the model must be revised to keep it up to date. Klein (1962, p.269)

Several time series in the NAM data bank go back the the late 1970s. The means that the data period covers several shocks to the macroeconomic system: The Norwegian banking crisis in 1991, the international financial crisis in 2008 and the Covid-19 pandemic. Over this period value added creation has become increasingly integrated with the petroleum producing sector. This has made the activity level of the economy more open to the effects of changes in the price of oil and other energy products. For example, when price of oil plummeted in 2015 it lead to a reduction in investments in petroleum that had consequences to the total economy.

The corona virus pandemic that broke out in the winter of 2020 had huge negative consequences worldwide. For the producers and users of econometric models it brought to the forefront the question about how the relationships that normally govern the behaviour of firms and households may been changed (temporarily of permanently) by the Covid-19 pandemic and by the policy responses.

While it is a given thing that maintenance of the model's relevance and explanatory power requires frequent smaller or larger re-specifications, it is also true that important features of the model have been found to be relatively stable and robust over time. In that practical and empirical sense they represents structural model features. The framework used to model the supply side of the Norwegian economy is an example one such a feature. In this part of the model, the assumption of monopolistically competitive firms is combined with a model of wage formation that captures important aspects of the national system of wage formation in Norway. Taken together these modules imply a determination of the nominal path of the economy which is distinctly different from the implications of natural rate models that make use of price and wage Phillips curves, see e.g., Bårdsen and Nymoen (2003,2009), Kolsrud and Nymoen (2014).

Another example of relative structure, from the demand side of the model, is the determination of private consumption expenditure. In models that represent a continuation of the new classical counter revolution in macroeconomics, namely DSGE models with a RBC core, the key relationship is the consumption Euler equation, Wren-Lewis (2018), Muellbauer (2016), Boland (2014, Ch. 6.3) among others.

Lineages of Norwegian Aggregate Model, NAM

NAM originated from the early econometric assessment of wage-and price formation in Nymoen(1989a,1989b,1991) , further developed in Bårdsen et al. (1998), Bårdsen and Fisher (1999), Bårdsen and Nymoen (2003), and the monetary transmission model of Bårdsen and Klovland (2000).

Early versions of the model were presented in Bårdsen and Nymoen (2001) and Bårdsen et al. (2003), while a more complete version can be found in Bårdsen and Nymoen (2009a). NAM builds on the methodological position presented in the book on macroeconometric modelling by Bårdsen et al. (2005). It has been a transferable and operational model since 2006, when regular updates of data bases and model specification began.

Users of NAM includes Finanstilsynet (The financial supervisory authority of Norway) and the two peak organizations in Norwegian working life: LO (Norwegian Confederation of Trade Unions) and NHO (Confederation of Norwegian Enterprise)

However, over the last three decades and longer, the econometric evidence in Norwegian data has been not supported the consumption Euler equation as an empirical econometric model. The evidence has been much more supportive of empirical version of a dynamic consumption function, but where there are other arguments in the function than just income. For example, the well documented role of total household wealth in the Norwegian consumption function (Brodin and Nymoen (1992) and Boug et al. (2020)) implies that there are important channels of joint influence between aggregate demand, GDP, the market for residential housing and, demand for loans and credit.

In this documentation, which is updated frequently, the main (and longest) chapters contains the listing of the variables of the model and, detailed estimation results and identities for the variables that are definitions. They are to be understood as references for the interested model-user and model builder.

The other (and shorter) chapters are meant as as an introduction to the models economic interpretation, and as a guide to practical use of the model.

Chapter 2 therefore gives an introduction to the main practical aspects of NAM usage (for analysis and forecasting) and chapter 3 gives an overview of NAM's modular structure.

In Chapter 3, we commence with the main accounting relationships of the Norwegian national accounts, i.e., how they are represented in terms of NAM variables. Thereafter the endogenous components of the aggregate supply (and imports) and aggregated demand are presented, see chapter 3.1 - 3.3.

Value added creation and consumption of produced goods has emission of climate gases as a consequence. In subchapter 3.4 NAM's framework for endogenization of CO2 emissions from Norwegian economic activity is explained.

In Chapter 3.5, the wage-price module is briefly explained. As just noted, the basic assumption used in the modelling of the supply of goods and services is the assumption of monopolistic competition. Combined with the principle that the nominal wage level is adjusted in a system of collective agreements, this theoretical framework implies that increases in aggregate demand will as a rule lead to both higher GDP and to higher imports, while the price level will be relatively unresponsive in the short-run. Conversely, a drop in demand will in the main, and as a rule, be equilibriated by quantity changes rather than by price changes.

Exceptions to this normality in wage and price setting occur in periods when firms choose to increase margins, or when wage coordination looses its foothold and give way to market forces. Such developments have been correlated with very high activity levels, and with correspondingly very low unemployment rates. As a consequence, the general picture of the "price curve" in NAM is that it has the classical "L-shape", see e.g. Forder (2014, Ch. 1).

There are two main measurements of unemployment in Norway, the registered unemployment percentage and the labour force survey rate. NAM has both of them as endogenous variables. The number of wage earners employed in the private business sector and in the government sector are of course important for the development of the two unemployment rates. NAM endogenizes the number of employed persons as well as the labour force (see Chapter 3.6).

NAM includes modules for several asset and credit markets (e.g. the market for foreign exchange and the housing market) and their main price and yield indicators. These are surveyed in Chapter 3.7 - 3.11. Government incomes and expenses are represented as a separate module, see Chapter 3.12.

In section 3.13 the banking module of the model is presented. It contains model equations for variables in the income and statement and valance sheet of the banking sector as a whole, which we refer to as the macrobank.

In Chapter 4 the endogenous and exogenous variables of NAM are listed and defined, while the detailed estimation results of the modular structure are given in Chapter 5.

Building an empirical model involves a long list of decisions about theory, data and method which have strong implications for the properties of the operational model. Although it is not necessary to know a lot about how NAM has been build in order to use it, it may nevertheless be of interest to assess the principles followed in the model development process, and not just the end-product of the process. With that in mind, Appendix B addresses several methodological aspects of empirical macroeconomic model building.

Appendix C goes into more detail about the underlying theoretical view about the supply-side of the Norwegian economy, and why the specifications of wage and price formation in particular are important for several of the total model properties of a macroeconometric model.

2

Using NAM in practice

In this chapter, we give a characterization of NAM, in terms of size and coverage (of the economy), and we provide a few examples of how NAM can be used in analyses of the Norwegian economy, for scenario analyses and forecasting.

2.1 Model size

The August 2025 version of the model contains around 330 endogenous variables, when the banking module is included, and circa 290 without it. Because of the modular structure, the number of variables can also be changed by a model user, who can tailor her version of the model by including og excluding optional blocks.

About 50 percent of the endogenous variables are determined by estimated model equations. This means that there is a number of identities and definitions in the model. Some of them are important and take care of internal consistency, e.g., between total supply (GDP plus imports) and total demand, as mentioned above. Other variables are represented by definitions because of easy reporting of aggregates, like total employment and total and net household wealth, and of headline variables like Mainland-Norway GDP and unemployment (number of persons and in percent of the labour force). Among the exogenous variables, a large part is made up of indicator and step dummies for structural breaks in the estimation period. These variables are automatically generated in the data construction part of the program file that is used to run NAM for forecasting and other purposes. The main exogenous variables that need careful consideration by the model user when doing forecasting are the variables that represent the foreign sector, the oil sector and the public sector (government administration). The growth in the Norwegian population (age interval 15-74) is an important exogenous variable, e.g., for the modelling of labour supply.

One example of a policy variable that can be treated as endogenous in the the model is the monetary policy interest rate. A model user can change the status of that interest rate from endogenous to exogenous, and to solve the model conditional on for example Norges Banks's interest rate forecast.

Due to considerable fiscal policy independence, created through an epoch of large revenues to the government from petroleum sector, there is no hard fiscal policy rule in Norway. However, this does not mean that fiscal policy can be regarded as entirely discretionary. Since the start of the new millennium there has been a rule that link the governments use of "oil money" to the normal rate of the return from the "oil-fund".[1]

[1] Formally The Government Pension Fund Global. The fund goes back to the start of the 1990s. Today it is the world's largest pension fund. See for example http://www.nbim.no/en/

The real meaning of fiscal policy independence is therefore that the government can choose itself to adhere to such a rule, it is not forced by the markets, or by international institutions, to adopt a ruled based fiscal policy. Hence, it makes sense to keep government expenditures as non-modelled variables, and to use the projections from the government budgets to formulate a baseline for forecasting.

Investments in petroleum production and transportation is clearly economy endogenous, and with the oil price as one important explanatory factor. However, we have not been able to model oil investments in a way that would be of much use for forecasting. Hence, investment in production and transportation of oil and gas production is and important exogenous variable in the model.

2.2 NAM in EViews

As already mentioned NAM can be used to analyze the current situation of the Norwegian macro economy, as an aid for medium term macroeconomic forecasting, and to quantify the dynamic responses to shocks from the world economy, or from policy changes and structural changes in the domestic economy.

All these model usages have practical sides to them (data input, model estimation and simulation, reporting) that need to be tackled. In the case of NAM, these tasks are solved by operating a single program file in the computer program package Eviews.[2]

The operational NAM Eviews program file creates the database, estimates all the equations of the model, solves the model by simulation and graphs and tabulates output from model simulations. A baseline (or default) of the NAM-Eviews file is prepared four times a year by the model developers,[3] and is transferred to model users, who can adapt the file to fit their own model usage and needs.

This chapter contains more about the practical aspects the Eviews program file used to solve NAM for forecasting and for analysis of the Norwegian macro economy.

NAM is implemented as a program file (recognized by the filename extension ".prg") in the econometric software package Eviews.[4] The current version of NAM runs on EViews 14 (and EViews 12 and 11).

The NAM prg-file serves several functions. The first is to load a number of files with quarterly data that are needed to estimate the model's equations, and to complete the model with definition relationships. Model data bank maintenance and regular updates all series, is a main task connected to keeping NAM as a relevant and operational model. This is the task of the model developer. The model user do not need to spend time "getting the the data

Figure 2.1 shows how the top section of a NAM-prg file typically may look after it has been opened in Eviews. The DASHBOARD-PART in particular contains "switches" which sets the workfile range, concretely %STARTWF and %ENDWF.into the model". It is taken care of automatically in the NAM-prg file.

In the example shown, the workfile range is set to 1966q1-2040q4. This means that the earliest start of any time series can be is the first quarter of 1966, and the end quarter of any (long) time series can be the fourth quarter of 2040.

The third switch sets the final period of the estimation period. Naturally it is a switch that a model user will often want to change, for example to investigate how sensitive the model solution (i.e., dynamic simulation) is to the sample period used. In this case, %STOP is set to 2025q2. The fourth switch is %FSTART, which sets

[2]For information about EViews, see http://www.eviews.com/home.html.
[3]Usually after a new release of new quarterly national accounts
[4]EViews is provided by IHS Global Inc. See http://www.eviews.com/home.html.

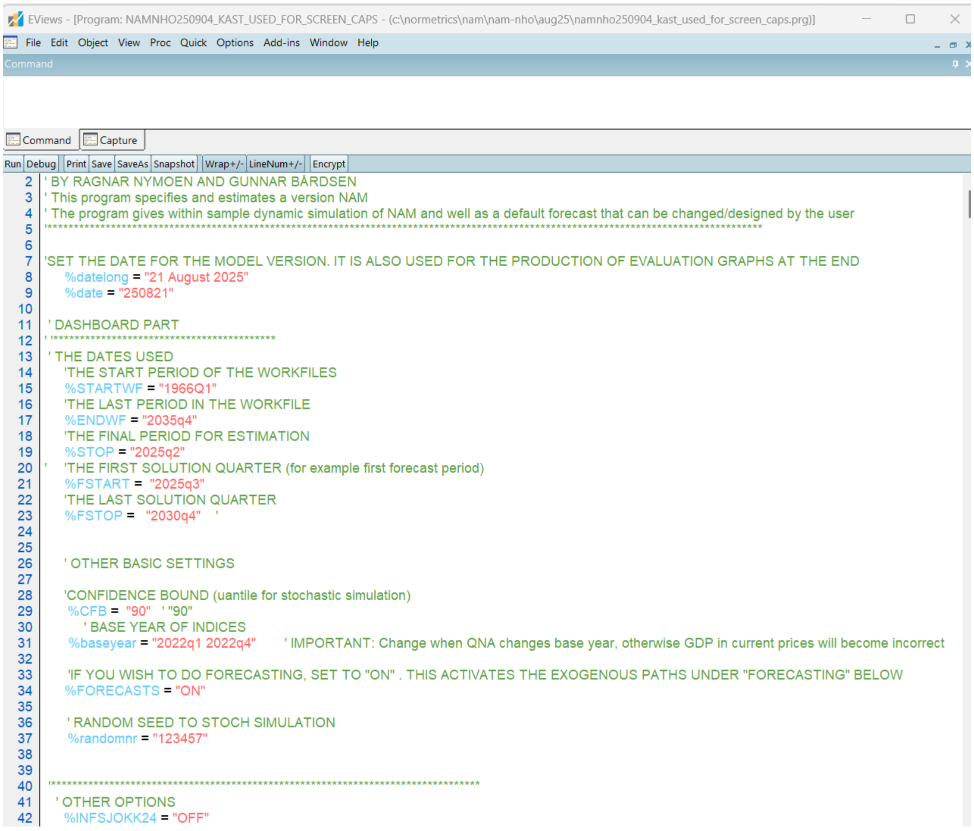


Figure 2.1: Screen capture of the first lines of a NAM-prg file. Showing *Dashboard* with main switches for e.g. estimation sample length and start and stop of simulation period. Note: In Eviews a line with comments begins with '.

the start quarter if the model is used for forecasting. Since %STOP = "2025q2" and %FSTART = "2025q3" in this example, the forecast will be based on a sample that ends one quarter before the start of the simulation start in 2018q4. %FSTOP = "2035q4" sets the last period of the forecast period to the fourth quarter of 2035. %FSTOP must be a quarter within the range of the workfile.

I NAM, the default is that forecasts are based on stochastic simulations. This means that forecast intervals (variously known as fan charts) will be part of the output. The switch %CFB = "90" sets confidence degree of the forecast to 90 percent if the error terms of the model are approximately normally distributed. As the screen capture shows, this is placed under the heading OTHER BASIC SETTINGS where we also find %baseyear which sets the base year of the price indices of the model. The default is to keep this switch unchanged between changes in the base year of the (quarterly) National accounts, as noted in the comment to the left of the switch.

Lastly in the screen capture in Figure 2.1 we find swithes that control model simulation. By specifying "%FORECASTS = ON", the NAM-prg file will execute a user-determined forecasting script where the exogenous variables are projected over the period specified with %FSTART and %FSTOP on the dashboard,in this example from 2025q3 to 2035q4. NAM is then simulated dynamically (and stochastically) over that period, the forecasted series (with confidence bounds) become stored in the workfile. Tables with the forecasts and graphs are also produced (see below).

The switch under the headline RANDOM SEED TO STOCH SIMULATION makes sure that the same set of random numbers are “re-used” for the model’s error terms between round of model simulations. Typing in a new number, so called

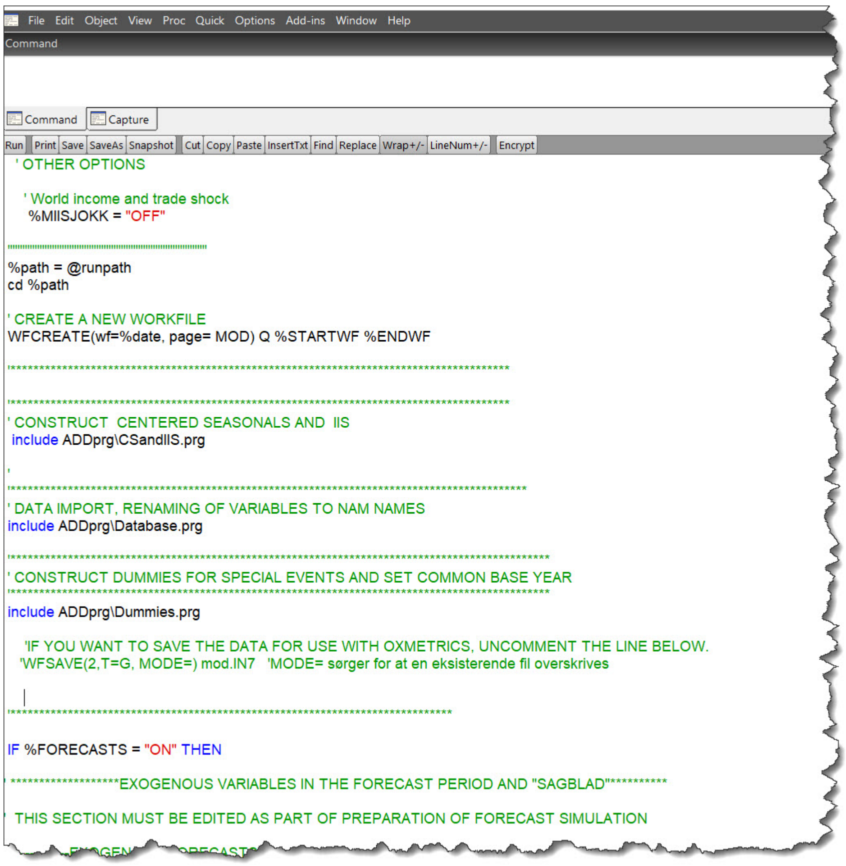


Figure 2.2: Screen capture of the section of a NAM-prg file with data input, creation of variables leading up to the section where exogenous model variables are projected.

random seed, will will generate a new set of random error terms. Most user will leave this switch unchanged.

In user-made versions of the NAM-prg files, there can be be other switches as well, usually placed below the OTHER OPTIONS headline. Often, such switches are used to activate (or deactivate) code for scenario analyses. In the example in Figure 2.1, there is only switch for scenario analysis, it is %INFSJOKK24, and is set to OFF in this screen-capture.

Figure 2.2 shows how a user will typically find the next main section of a NAM-prg file. First, for technical reasons, there are two lines:

```
%path = @runpath
cd %path
```

at the main NAM-prg file expects to find "child" prg-files in subdirectories to the same main directory (and is therefore best left unchanged).

The next two lines:

```
' CREATE A NEW WORKFILE
wfCREATE(wf=%date, page= MOD) Q %STARTWF %ENDWF
```

create the Eviews workfile (file extension *wf*), with the range specified in the dashboard part.

The lines that begin with *include* run Eviews prg files in the subdirectory *ADDprg*. The first file, CSandIIS.prg generates (centered) seasonals and indicator variables for all the observations in the workfile. These indicators are used in the construction dummies for special events and for structural breaks. Unused indicators are deleted when all the dummy variables have been created.

Database.prg is the main file for data import. The data files that are loaded here are either recognized directly as EViews databases, or they can be transformed to such databases.[5]

The file *varnames.prg* holds the variables names of all the main variables of the model. The list of variable names corresponds to the variable names in Chapter 4 and is useful for creating legends in plots and tables.

In *Dummies.prg* the dummies mentioned above is constructed, and the now redundant full set of indicator variables from the CSandIIS.prg stage is deleted from the workfile.

Usually a user will not need to consider the content of the mentioned *prg* files, although the files are open for inspection, and they can be modified. Instead, the user will want to focus on the exogenous variables and how they are extended (projected) over the forecast horizon set in the dashboard. Therefore, when the %FORECAST switch has been set to "ON", the next section which will be executed is the EXOGENOUS part of the NAM-prg, as indicated by the last lines in screen capture in Figure 2.2. In chapter 2.4 we show a few examples of how the EXOGENOUS part of the program file can be edited.

When a NAM-prg file has been executed successfully, the NAM-workfile appears on the computer screen. The upper left corner of the workfile may look like Figure 2.3. In this screen-capture, only data series objects are visible, they are indicated by the time-plot icon and their variable names. The first variable in this workfile is A, which is total exports in million kroner in fixed prices. You can check that out in Chapter 4, which contains a list of NAM variables and how they are defined.

[5]The file format in7/bn7 of the *OxMetrics* econometric software is an example of a format which is recognized as a database, Doornik and Hendry (2018a,b), Hendry and Doornik (2014). , http://www.oxmetrics.net/ .

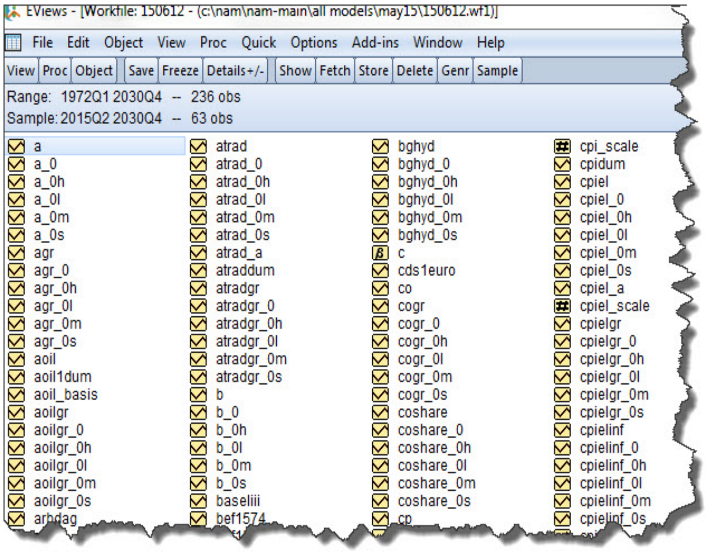


Figure 2.3: Screen capture of section of an Eviews workfile produced by running a NAM-prg file.

Note that the screen-capture shows that there is not one single *A* variable object in the workfile. There are several. This is because after execution of the NAM-prg file, the model has been solved. The solution may be have been a within sample simulation or a dynamic forecast. Scenario analysis is a third purpose, as mentioned above.

I Figure 2.3 a workfile that has been generated for forecasting is shown. In the screen-capture, *A_0* is the time series with the deterministic solution for *A*. Another example is *A_0m*, which holds the mean of a large number of stochastic simulations of the model, for example 1000 repetitions in this case.

In most cases, the mean of the stochastic simulation (e.g., *A_0m*) will be close to, but not identical with the deterministic solution (e.g. *A_0)*. The purpose for stochastic simulation is to obtain estimates of the degree of uncertainty of the results. Forecast uncertainty is used to construct forecast graphs with prediction intervals. In addition, simulation that takes parameter estimation uncertainty into account, is needed to construct confidence intervals for dynamic multipliers (the dynamic responses of endogenous variables with respect to a change in an exogenous variable).

EViews conventions and programming language
Inevitably, although one can achieve a lot by running a ready-made NAM-prg file, and then work with the data objects (and other objects) in the workfile by using the EViews menu system, you will want to learn about naming conventions, functions and basic programming commands in EViews. There is a good online help system, and both basic and advanced manuals are provided with EViews.

2.3 Within sample simulation

Within sample simulation of the model can usually be done easily by re-setting the dashboard switches for simulation start and stop. For example if the sample period of the model data base ends in 2025(2), a dynamic within simulation can start in 2025(1), or in any earlier period and end in 2025(2).

Starting the simulation in in 2025(2) will only produce a 1-step forecast so it is not really dynamic. Nevertheless such a 1-period simulation can be useful for detecting large outliers in 2025(2), which one would then consider to control for when forecasting conditional on 2025(2). To produce a genuine dynamic simulation we can set the %FSTART switch to for example 2020(1). Running the NAM program file will solve the model for the period 2020(1) to 2025(2). Figure 2.4 shows a screen capture after such a simulation. The the two graphs show the annual growth rate in Mainland Norway (left) and the unemployment percentage.

The dashed lines represent the upper and lower bounds of approximate 90 % confidence regions for the simulated values. Since the simulation period includes the COVID-19 era it may not be surprising that there are quarters in the simulation period where the actual values of GDP growth and of the unemployment rate is outside their respective confidence regions. However, by and large, the simulated solutions of these two endogenous variables seems to be acceptably well adapted to the data of the simulation period.

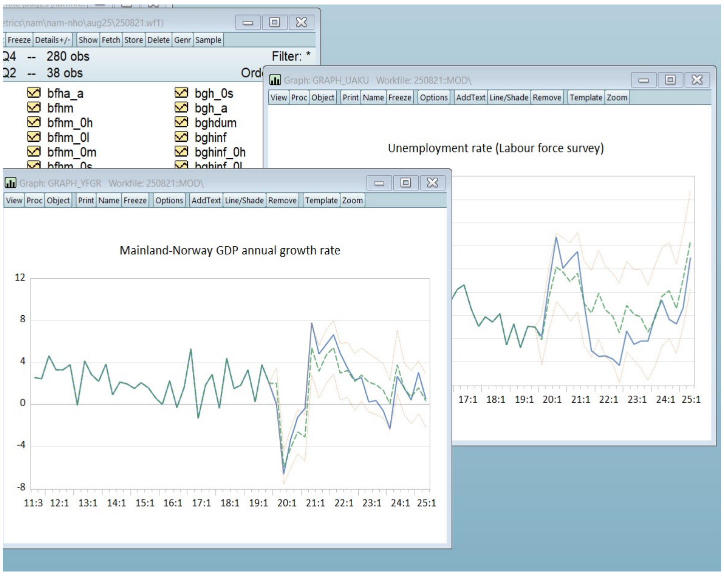


Figure 2.4: Screen capture of two graphs with within sample simulation results, produced by running a NAM-prg file with %FSTART set to 2020q1 and %FSTOP to 2025q2.

2.4 Forecasting

A rather usual purpose of model simulation is to forecast the endogenous variables, and to report the results in the form of graphs and tables, sometimes with information about the estimated degree of forecast confidence.

Technically speaking, model based forecasting is just like dynamic simulation. In practice there is however an important difference since within sample dynamic simulation make use of observed data for the exogenous variables, while forecasting is based on extrapolation of the model exogenous variables into the future, the forecasting period.

Assume that we want to forecast the endogenous variables of the model with period $T+1$ as the first forecast period, $T+2$ as the second, and with $T+H$ as the last forecast period. In Figure 2.1, showing the dashboard part of the program file, the lines:

```
' THE FIRST PERIOD TO FORECAST (SIMULATE)
%FSTART = "2025q3"
'THE LAST PERIOD TO FORECAST
%FSTOP = "2030q4"
```

set $T+1$ to 2025q3 and $T+H$ to 2030q4.[6]

For these setting to work:

1. All endogenous variables must have values until 2025(2) (no missing values for that quarter or earlier),and

2. all exogenous variables must have values from 2025(3) to 2030(4).

If 1. or 2. fails, Eviews will issue an error-message (about "missing values" and "not being able to solve") when the NAM-prg file is run.

Hence, a necessary (first) step in any model based forecast is to update the time series of the endogenous variables, so that the forecast can be conditional on a time period T (which is 2019(3) in our example). In the forecasting literature, the period that we condition on is often called the the date of forecast origin.[7]

In the NAM program file, the section called *Database.prg* automatically updates the majority of the endogenous variables to T. However, a few variables will in practice always be impossible to update automatically, simply because the data is not there yet to be harvested at the time of the completion of the model update. Therefore, after *Database.prg* has been run, a handful of the endogenous variables will have their last observation in $T-1$ or even earlier, and not in period T. This practical side of forecasting is known as the *ragged edge problem.* In the NAM-prg file, there is a separate section where the ragged edge problem is fixed. Although the ragged edge problem can be technically solved by the model producer, it needs to be checked by the forecaster, since expert knowledge often can improve these starting values for the model based forecasts.

While the endogenous variables must have values up to and including period T, a H-period ahead model based forecast requires values of the exogenous variables for the period $(T+1)$,$(T+2)$,...$(T+H)$. The NAM-prg file, contains a section where the model user can either code her projection for the exogenous variables with the aid of Eviews command, or ready made projections can be added to the NAM workfile (from imported files with "taylor-made" forecast for exogenous variables).

Figure 2.5 shows some lines of code where the exogenous variable for export market growth (EMI) is projected over the forecast period with the aid of annual growth rates. We see that the first period is 2025q3. Routinely, all exogenous projections fills in the whole workfile range, although the normal published forecast horizons will be much shorter. The motivation for choosing a relatively long solution period when working with the forecast preparation may be that it is of interest to check that the model gives sensible solutions also for the period after the end of the horizon of the published model forecast.

After the NAM-prg file has been run with the forecast switch "ON", the EViews workfile contains forecasts for all the model's endogenous variables. The forecasts

[6]EViews understands both 2019(4) and 2019q4.

[7]It may be the case that an endogenous variables enter with two or more lags, and not with a single lag anywhere in the model. Such a variable only needs to be updated to period $T-1$. But this is rare, and in practice it is just as well to update all endogenous variables to period T.

```
' Export market indicator (EMI)

SMPL 2025q3 2025q4
EMI= EMI(-4)* (1.021)    ' Statistics Norway Economic (2/2025) Trends 2.1 percent four quarter growth
SMPL 2026q1 2026q4
EMI= EMI(-4)*(1.019)
SMPL 2027q1 2027q4
EMI= EMI(-4)*(1.027)
SMPL 2028q1 2028q4
EMI= EMI(-4)*(1.031)
SMPL 2029q1 2029q4
EMI= EMI(-4)*(1.03)
SMPL 2030q1  %ENDWF
EMI= EMI(-4)*(1+0.03)    ' 'Technical projection
SMPL @ALL
```

Figure 2.5: Screen capture showing lines with code in the EXOGENOUS part of a NAM-prg file.

can be inspected in several different ways. Numerically, by using the Eview menu system to show the forecasted time series, for example *A_0* and *A_0m* as mentioned above, or by the use of graphs and in tables.

In the standard version of the NAM-prg file, some figures are produced default as graph-object in the workfile (.wf). Figure 2.6 is an example of a graph-object. It shows the forecasts of four variables, in two rows with figures.

The first row contains graphs for the same two variables as in Figure 2.4, namely Mainland Norway GDP growth and the unemployment percentage, but it is forecasts that are shown rather than within sample simulation. The second row contain forecasted growth percentages of two other endogenous variables: The total number of employed persons and the consumer price index (i.e. CPI-inflation).

In Figure 2.4 the forecasts are plotted together with the actual values of the variables taken up to the date of origin of the forecasts, In this example 34 quarters with actuals have been plotted in the figures, but this can easily bu changed by the model[8]

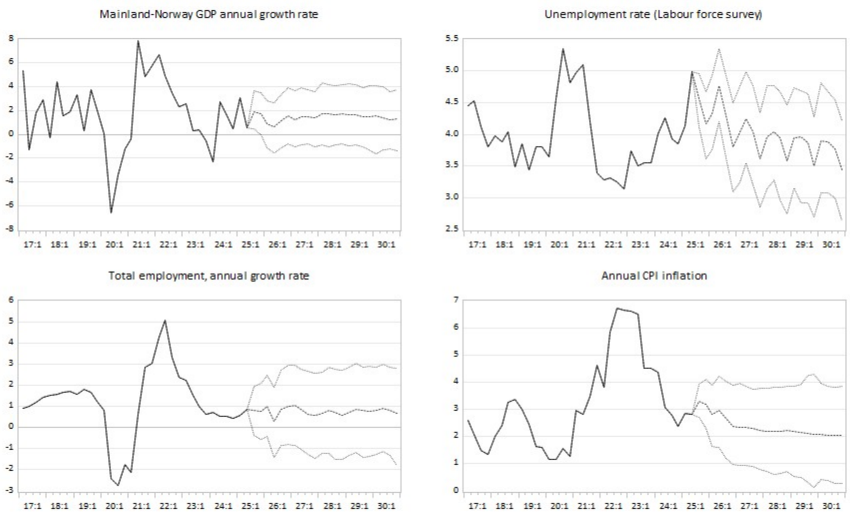
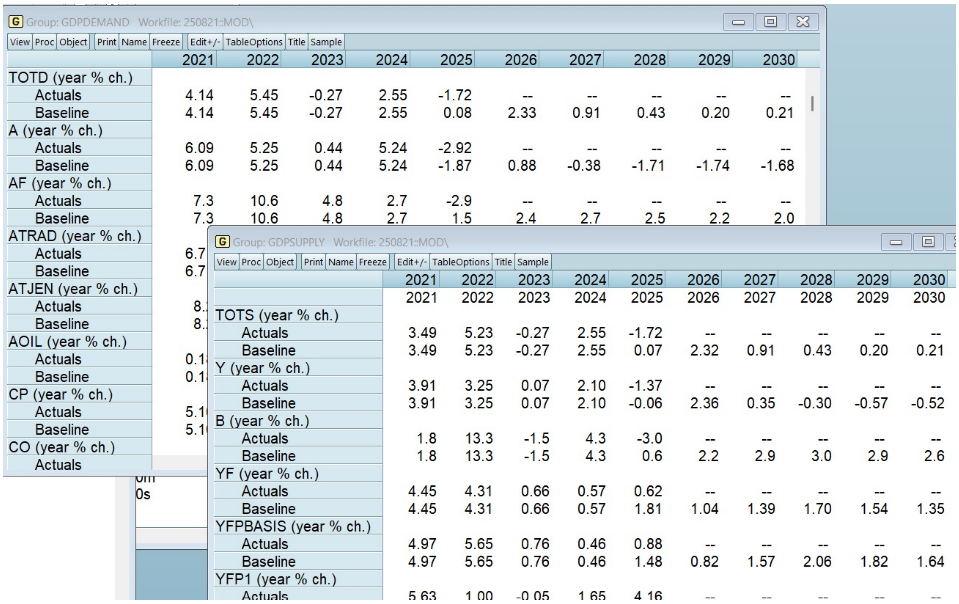


Figure 2.6: Example of NAM. Forecast start is 2025q1 and the last forecast period is 2030q4. The point forecasts are shown in the dashed line graphs together with approximate 95 percent confidence regions as dotted lines.

[8]By editing figuresandtables.prg in the ADDprg folder.

That the start of the forecasts in 2025q3 is also seen by the appearance of three lines: The middle line is the mean of the simulated forecasts (i.e. a *_0m* series in the workfile), while the two dotted lines indicate the upper and lower bounds of the 90 % forecast intervals (they can be found as *_0h* and *_0l* series in the workfile).

The workfile contains several more graphs of individual variables and of groups of variables. And new plots can easily be constructed from the data files in the NAM-workfile. The NAM-workfile also produces tables annual numbers for the variables.



Group: GDPDEMAND Workfile: 250821::MOD\

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
TOTD (year % ch.)										
Actuals	4.14	5.45	-0.27	2.55	-1.72	--	--	--	--	--
Baseline	4.14	5.45	-0.27	2.55	0.08	2.33	0.91	0.43	0.20	0.21
A (year % ch.)										
Actuals	6.09	5.25	0.44	5.24	-2.92	--	--	--	--	--
Baseline	6.09	5.25	0.44	5.24	-1.87	0.88	-0.38	-1.71	-1.74	-1.68
AF (year % ch.)										
Actuals	7.3	10.6	4.8	2.7	-2.9	--	--	--	--	--
Baseline	7.3	10.6	4.8	2.7	1.5	2.4	2.7	2.5	2.2	2.0
ATRAD (year % ch.)										
Actuals	6.7									
Baseline	6.7									
ATJEN (year % ch.)										
Actuals	8.									
Baseline	8.									
AOIL (year % ch.)										
Actuals	0.1									
Baseline	0.1									
CP (year % ch.)										
Actuals	5.1									
Baseline	5.1									
CO (year % ch.)										
Actuals										

Group: GDPSUPPLY Workfile: 250821::MOD\

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
TOTS (year % ch.)										
Actuals	3.49	5.23	-0.27	2.55	-1.72	--	--	--	--	--
Baseline	3.49	5.23	-0.27	2.55	0.07	2.32	0.91	0.43	0.20	0.21
Y (year % ch.)										
Actuals	3.91	3.25	0.07	2.10	-1.37	--	--	--	--	--
Baseline	3.91	3.25	0.07	2.10	-0.06	2.36	0.35	-0.30	-0.57	-0.52
B (year % ch.)										
Actuals	1.8	13.3	-1.5	4.3	-3.0	--	--	--	--	--
Baseline	1.8	13.3	-1.5	4.3	0.6	2.2	2.9	3.0	2.9	2.6
YF (year % ch.)										
Actuals	4.45	4.31	0.66	0.57	0.62	--	--	--	--	--
Baseline	4.45	4.31	0.66	0.57	1.81	1.04	1.39	1.70	1.54	1.35
YFPBASIS (year % ch.)										
Actuals	4.97	5.65	0.76	0.46	0.88	--	--	--	--	--
Baseline	4.97	5.65	0.76	0.46	1.48	0.82	1.57	2.06	1.82	1.64
YFP1 (year % ch.)										
Actuals	5.63	1.00	-0.05	1.65	4.16	--	--	--	--	--

Figure 2.7: Screen-capture from a NAM workfile showing two group objects with forecasted growth percentages of total supply (TOTS) and total demand (TOTD) and their components. The forecasts has been transformed from quarterly data to annual data before tabulation. The variables names are explained in Chapter 4.

These tables are can often be useful when working with forecasts, to get an overview of forecasts without all the short run varition. Figure 2.7 shows an example, where the annual growth percentages on the "supply side" and the "demand side" of GDP (the tables are labelled GDPSUPPLY and GDPDEMAND).

2.5 Policy and scenario analysis

A main purpose of macroeconomic model building is to quantify the effect of changes in one or more exogenous variables on the endogenous variables of the model. Policy analysis addresses the likely effects of a change in a variable that can be changed by economic policy. More generally it is also of interest to quantify the effect of other exogenous events, such as reduced income in the countries that represent Norway's main trading partners, increased international interest rates and so on. We can loosely refer to analysis of this type as scenario analysis.

As is well known, the reliability of policy analysis hinges on the assumption that there is no systematic feed-back from the endogenous variables to the model-exogenous variables in the analysis. Formally this assumption is called "one-way Granger causality", meaning that a change in the exogenous variable should affect the endogenous variables, but that these changes should not feed-back on the variable that are subject to shock in the analysis.

Another assumption needed to validate policy-analysis is that the parameters of the model have a certain degree of *invariance* with respect to the shock that we focus on, see e.g., Nymoen (2019, Chapter 8) We discuss both Granger non-causality, and the role of parameter invariance in Appendix B.

Heuristically, policy analysis is done by first specifying both a reference path and "shock" path for the non-modelled variables that we want to study the effects of. The model is then simulated (solved) two times: First with the reference-paths for the exogenous variables, and then with the shock-paths. The effects on the endogenous variables can be read off by comparing the solutions corresponding to the two paths of the exogenous variables. With the aid of EViews the two simulations can be be

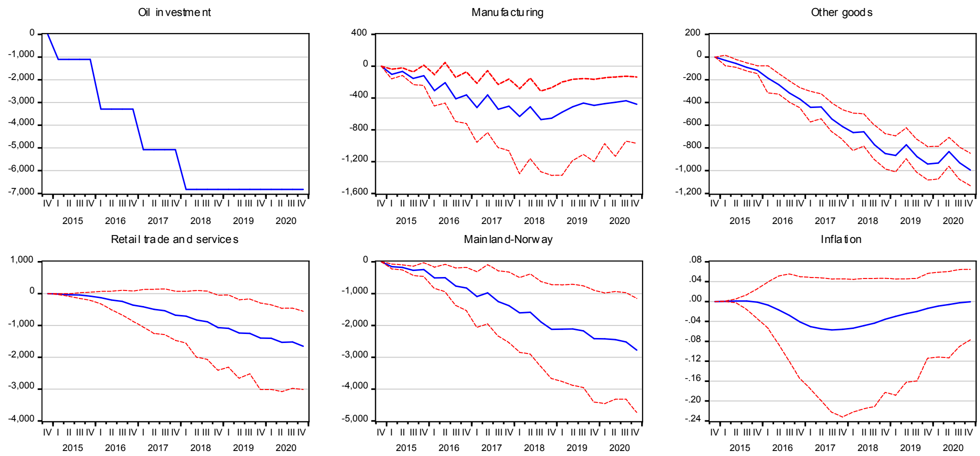


Figure 2.8: The effects of reduced capital formation in oil and gas production and transportation on Mainland-Norway GDP: Value added in three production sectors and inflation. The units on the vertical axes are million kroner in 2012 prices, except for the inflation graph where the units are percentage points. The distance between the red (or dotted) lines represent 95 % confidence intervals.

automatized, and the results can also be plotted or tabulated by a few commands that can be included in the NAM-prg file. As simple example of this NAM usage NAM, we look at a reduction in "oil investments", which in the model is represented by the variable *JOIL1*.

JOIL1 is probably "exogenous enough" to be a relevant focus variable to shock. Although one can imagine oil companies reconsidering investment plans should a reduction lead to markedly lower the wage costs for example, such an event is not very likely. Hence, one-way Granger causality seems to a tenable assumption.

The graph to the right in the first row of panels in Figure 2.8 shows the deviation between the reference and the shock-path of *JOIL1*. Oil investments are reduced gradually by around 7 billion kroner over a two year period. This is a large reduction, although the level of investment would still be at level comparable with 2008-2010.

The other graphs in Figure 2.8 show the responses in a few of the endogenous variables of NAM. Mainland-Norway GDP is negatively affected, but we see that the reduction is less than the investment reduction. The interpretation is that imported investment goods is reduced when *JOIL1* falls, and that Norwegian producers are predicted to be able to adjust (to some extent) to the weakening of demand from oil-investments. The graph shows that effects are still "building up" at the end of the simulation period though

Value added in both manufacturing and in production of other goods are negatively affected, as the graphs show. As can be expected, the private service sector is least affected among the three private sectors in the model. Finally we note that there is a small negative effect on Norwegian inflation. Why this is reasonable is discussed in the chapters about wage and price formation below.

Formally the dynamic responses shown in Figure 2.8 are model parameters. We can therefore use stochastic simulation to quantify the parameter estimation uncertainty. The distance between the red (or dotted) lines represent 95 % confidence intervals. Based on this simulation we therefore conclude that the effects on GDP and to of the sector's value added are statistically significant different from zero.

Nymoen (2023) used NAM in an counterfactual scenario analysis,of the Norwegian macro economy with and without COVID-19, and compared the results with those obtained by use of other models and methods.

3

The Modular Structure

In this chapter, the different sectors and sub-models of NAM are discussed. We start with the main national accounts relationships in NAM, cf. chapter 3.1. The two first sub-chapters document how we have modelled the components of the general budget equation of the Norwegian economy, i.e., the components of aggregate demand (domestic demand and exports) and of aggregate supply (domestic GDP and imports).

The modelling of domestic GDP (supplied) needs to be consistent with the assumption made about the labour market and of wage formation. The key to reconciliation is to assume imperfect competition in both product and labour markets. GDP produced by domestic (Mainland-Norway) firms will then in general be a function of aggregate demand and of relative prices set by domestic and foreign firms. Domestic prices, and the domestic price level, will in turn be affected by unit labour costs. The average nominal wage compensation is modelled as regulated by collective agreements firm and worker side representatives.

Nominal wage and price formation (including import prices) are discussed in chapter 3.5 and hours worked, employment and unemployment i chapter 3.6.

Since Norway is a small open economy, the market for foreign exchange is of great importance for macroeconomic stability and dynamics, cf. chapter 3.7. Chapter 3.8 discusses the role of the housing pricing in the macroeconomy and then presents the economic theoretical framework for the housing price module and the close integration between the marked for residential housing and the credit and debt generation process. In section 3.9 the other components of total household wealth are brought into the picture, namely gross and net financial wealth.

NAM has a relatively rich representation of the interest rates, which is introduced in chapter 3.10. The last section presents the modelling of stock exchange prices (ch. 3.11) and of general government (ch. 3.12).

3.1 National accounts relationships

The Norwegian gross domestic product (GDP) in market values (measured in fixed prices (NOK million)) is the NAM variable *Y*. In the model, it given by the identity:

$$Y = YF + YOIL1 + YOIL2 + YUSF \tag{3.1}$$

where:

- *YF* is GDP of Mainland-Norway in market values
- *YOIL1* and *YOIL2* represent the valued added in the petroleum sector (production and transportation respectively)

- *YUSF* is the value added in international shipping.

A list with all variable names and definitions are found in Chapter 4.

Mainland-Norway GDP is also given by an identity in the model:

$$YF = YFbasis + AVGSUB \tag{3.2}$$

where *YFbasis* is GDP of Mainland-Norway in basic values and *AVGSUB* is the difference between taxes and subsidies on products ("net product taxes" for short).[1] From equation (3.1) and (3.2), we understand that there is no product taxes or subsidies in the petroleum sector and in international shipping (i.e., *YOIL1*, *YOIL2* *YUSF*). In the model, *YFbasis* is further decomposed as:

$$YFbasis = YFPbasis + YO \tag{3.3}$$

where *YFPbasis* is value added in the private business sector in basic values and *YO* is value added in general government.

There are three private business sectors:

- Manufacturing and mining, *YFP1*,
- production of other goods (which includes the construction sector), *YFP2*, and
- service activities (including retail trade), *YFP3*.

Hence, we define *YFPbasis* as:

$$YFPbasis = YFP1 + YFP2 + YFP3 \tag{3.4}$$

The total supply of goods and services, the NAM variable *TOTS*, is the sum of total GDP and total imports, *B*:

$$TOTS = Y + B \tag{3.5}$$

When we substitute in from the relationships above, we see that *TOTS* can be expressed as:

$$TOTS = B + YFbasis + YOIL1 + YOIL2 + YUSF + AVGSUB \tag{3.6}$$

and, even more detailed as:

$$TOTS = B + YFP1 + YFP2 + YFP3 + YO + YOIL1 + YOIL2 + YUSF + AVGSUB \tag{3.7}$$

The composition of total supply is also illustrated in Table 3.1, on the right hand side of that table.

As Table 3.1 reminds us, total supply in the national accounts is identical to total demand, NAM-variable, *TOTD*. It is defined in the model by the identity:

$$TOTD = CP + CO + J + JL + A \tag{3.8}$$

where:

- *CP* is private consumption expenditure
- *CO* is government (public) consumption expenditure

[1] In the model code, AVGSUB is defined as AVGSUB = LAVGSUB/PYF where LAVGSUB is net product taxes in current prices and PYF is the deflator of GDP in Mainland-Norway.

Table 3.1: Total supply (TOTS) and total demand (TOTD) in NAM. Constant prices (NOK million). Chapter 4 contains the detailed variable definitions

Total Supply	**TOTS**	≡ **TOTD**	**Total Demand**
Imports	*B*	*CP*	Private consumption
Gross Domestic Product	*Y*	*CO*	Public consumption
-Value added Mainland Norway	*YF*	*J*	Gross capital formation
Manufacturing	*YFP1*	*JO*	-Public investments
Other products	*YFP2*	*JBOL*	-Investments in housing
Private service & retail	*YFP3*	*JFPN*	-Private business investments
Net product taxes	*AVGSUB*	*JOIL*	-Petroleum investments
Government	*YO*	*JUSF*	-Intern. shipping
-Value added petroleum sector	*YOIL1*	*JL*	Changes in inventories
	YOIL2	*A*	Exports
-Value added intern. shipping	*YUSF*	*ATRAD*	-Traditional
		ATJEN	-Services
		ASKIP	-Ships and platforms
		AOIL	-Oil and gas

- J is gross formation of fixed capital (i.e., investments)
- JL is changes in inventories, and statistical error in the national accounts.
- A is total exports

As shown in Table 3.1, exports A and investments J consist of several components. For gross capital formation we have:

$$J = JO + JBOL + JFPN + JOIL + JUSF \tag{3.9}$$

where:

- *JO*:Gross capital formation in general administration ("public investments").
- *JBOL*: Gross capital formation in residential housing
- *JFPN*: Gross capital formation in the private business sector
- *JOIL*: Gross capital formation in the petroleum sectors.
- *JUSF*: Gross capital formation in international shipping

In the national accounts, and in the model, *JOIL* is made up of two variables:

$$JOIL = JOIL1 + JOIL2 \tag{3.10}$$

where *JOIL1* is investments in petroleum production and in pipeline transportation, while *JOIL2* is investments in services incidental to oil and gas. In the data, *JOIL1* is much larger than *JOIL2*.

Another disaggregation on the demand side in the current version of the model is for exports, which is given by

$$A = ATRAD + ATJEN + AOIL + ASKIP, \tag{3.11}$$

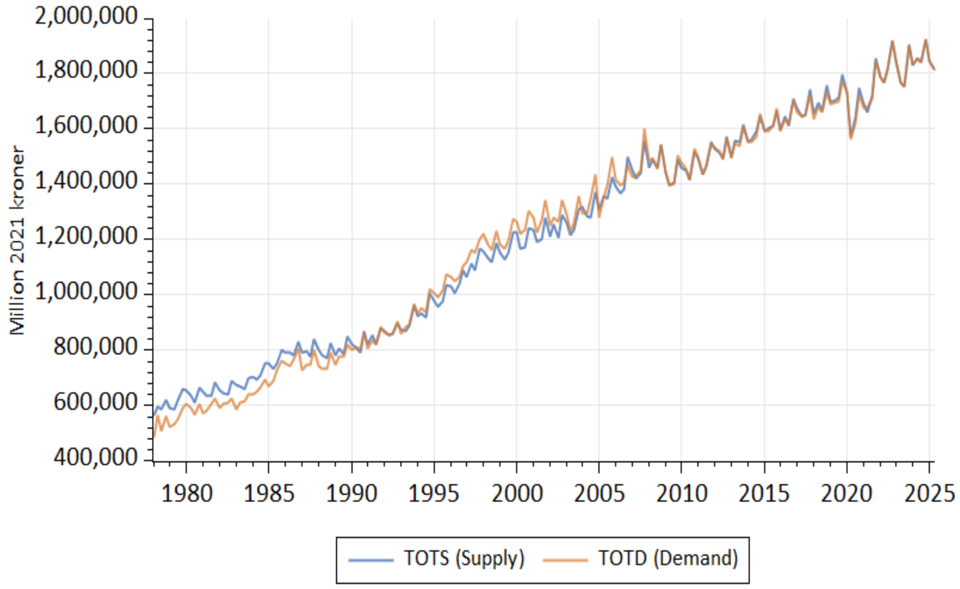


Figure 3.1: Total demand ($TOTD$) and total supply ($TOTS$) in the National accounts data using equation 3.8 and (3.5)

where $ATRAD$ and $ATJEN$ are exports of traditional goods and of service activities respectively. $AOIL$ is exports of oil and natural gas and $ASKIP$ is exports of ships and of oil and gag platforms, see section 3.2.4.

When we use national accounts data to compute time series for $TOTS$ and $TOTD$ according to the above identities, e.g., (3.7) and (3.8), we get the plots of the two variables shown in Figure 3.1. Ideally, the two graphs should be right on top of each other, which they are not. On second thoughts, an exact equivalence can only be expected to hold for data in current prices. Since we use data in fixed prices, which involves complex ways of deflating the data to be in units of million kroner in a common base year, some anomalies must be expected.

The deviations from the ideal of $TOTS \equiv TOTD$ are also likely to become larger the "further away" we are from the base year. In Figure 3.1 the base year is 2022, and we see that the anomalies are much larger early in the time period than for years right before and right after 2022. That said, the plot also show that the anomalies are small for quite long time periods, e.g., from 2009 to 2025. This is of importance in practice, since in the solution of the model we impose the equivalence between $TOTD$ and $TOTS$ in order to determine the variable denoted JL (changes in inventories) as endogenous in the model.

Hence, one of the identities of the model is:

$$JL = TOTS - CP - CO - J - A. \tag{3.12}$$

When we note that $TOTS, CP, CO, J$ and A are determined elsewhere in the model, we see that using (3.12) to determine JL, secures that the equivalence between $TOTD$ and $TOTS$ will hold in all time periods of a model solution.

This way of closing the model has important implications. First, as noted, it secures that accounting identity $TOTS \equiv TOTD$ holds in the model solution. Second, it means that in principle GDP and its components are determined from the supply side, and not directly from the demand side.

Nevertheless there is a strong relationship between the aggregate demand of the economy and the valued added generated by manufacturing and the other private business sectors of the model. But this is an indirect relationship implied by the assumption of monopolistic competition in the product markets. It is not a mechanical relationship. For that reason, one indication of how well balanced supply and demand are in a practical solution of NAM is given by the absolute or relative magnitude of JL in the solution. If the solution gives a path for JL which is noticeably trending for example, there may be reason for inspecting the model input or equations, in order to obtain a revised solution path with closer correspondence between the supply and demand sides of the economy (cf. chapter 3.3.6).

In NAM, the main focus is on the determination of national account variables in fixed prices (i.e., volume variables). However, a range of headline variables are also given as current price variables. For example, GDP for Norway in current prices is denoted LY and is defined as:

$$LY = PYF \cdot YF + PYOIL1 \cdot YOIL1 + PYOIL2 \cdot YOIL2 + PYUSF \cdot \ YUSF, \quad (3.13)$$

where PYF is the deflator of YF in (3.3). PYOIL1, PYOIL2 and PYUSF are the deflators of the corresponding fixed price variables in Table 3.1.

Disposable income for Norway is therefore given by:

$$YDNOR = \ LY + RUBAL - LKDEP, \quad (3.14)$$

where $LKDEP$ is capital depreciation in current prices and $RUBAL$ denotes the net incomes from abroad ("rente og stønadsbalansen").

The trade surplus of Norway is in NAM defined by:

$$\begin{aligned} LX &= PATRAD \cdot ATRAD + PATJEN \cdot ATJEN + PAOIL \cdot AOIL \quad (3.15) \\ &+ PASKIP \cdot ASKIP - PB \cdot B, \end{aligned}$$

where $PATRAD$, $PATJEN$, $PAOIL$ and $PASKIP$ are the deflators (price indices) of the export categories, and PB is the price index of total imports. The current account of Norway is given by:

$$LXR = LX + RUBAL. \quad (3.16)$$

Net lending, $NFIN$, is given by the identity:

$$NFIN = \ LXR + NCAPTR + NPAT, \quad (3.17)$$

where $NCAPTR$ is net capital transfers to abroad and $NPAT$ is net acquisition of patents, licenses etc.

3.2 Components of aggregate demand

Figure 3.2 shows graphs of the main components of aggregate demand that were introduced above. Over the period shown (1978(1)-2025(2)), private consumption expenditure, CP, has consistently been the largest component of domestic demand. However, in the graph, CP is overshadowed by total exports, A, which to a large part is due to the base year 2022, when the price level of petroleum products were (unusally high). Consumption in general government (CO) has been the third largest component of aggregate demand, for the length of the period.

The other components are a good deal smaller. Looking at the 2000s, gross capital formation in the private business sector ($JFPN$) is largest in this group,

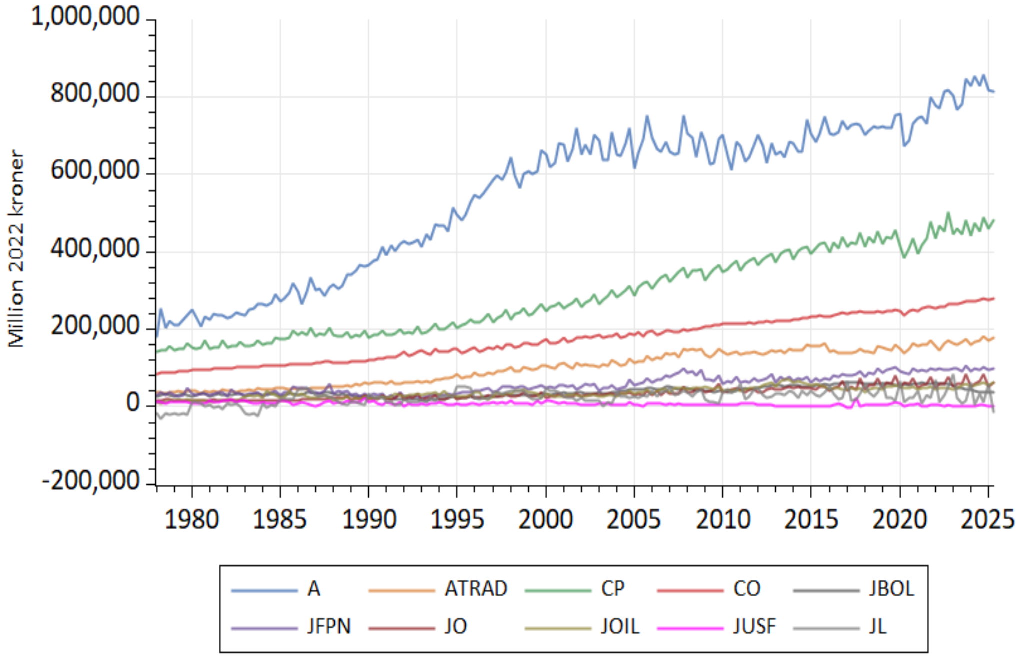


Figure 3.2: The main components of aggregate demand, cf. Table 3.1.

followed by investment in petroleum production and transportation ($JOIL$). Residential housing ($JBOL$) and public investments (JO) have the same size, approximately. It is interesting to note that capital formation in the petroleum sector has the same magnitude as $JBOL$ and JO, for most of the time period shown in the figure.

3.2.1 Private consumption expenditure

As just noted, consumer expenditure is currently the largest component of spending in the Norwegian economy, The specification of the model equation for CP is therefore important for the overall properties of the model. This is because, in the model, domestic firms react to changes in demand in two ways: By adjusting production (and hence demand for labour input and services provided by different forms of capital) and the price they put to the market for their product.

The modelling of private consumption expenditure is anchored in a long-run relationship between private consumption expenditure, income and household wealth.

The empirical identification of wealth as a separate factor in the Norwegian consumption function goes back to the evidence from the re-specification of the consumption function after the housing and banking crisis of the early 1990s. Brodin and Nymoen (1992) established the basic relationship,which has been been confirmed in several later studies.

In the current version of NAM, the long-run relationship is:

$$\ln(CP) = 0.78 \ln(\frac{YDCD}{CPI}) + 0.17 \ln(\frac{WEALTHH}{CPI}) + \mu_C \tag{3.18}$$

where CP denotes private consumption expenditure, $YDCD$ is disposable income after subtraction of dividend payments.[2]. CPI is the consumer price index.

[2] $YDCD = YD - RAM300$ where YD is private disposable income and $RAM300$ is dividend

$WEALTHH$ denotes household wealth, and is defined as:

$$WEALTHH = BFH - BGH + PH \cdot HK \tag{3.19}$$

where BFH and BGH denote gross financial wealth and debt by households, PH is the housing price index variable of the model, and HK denotes the housing stock (in fixed prices).

Support for the long-run relationship (3.19) is also found in two recent research papers on the Norwegian consumption function. Jansen (2013) reported an elasticity of 0.7 for income and an elasticity of 0.1 for real wealth. In Boug et al. (2020), estimates of 0.83 and 0.17 are reported. As the detailed estimations results shows, the sample start of the estimation period is 1978(1), meaning that the sample spans more than forty years.

In those papers, consumption was defined as real consumption excluding expenditures on health services and housing, which can explain why the elasticities are numerically different from (3.19). On the other hand, the differences are not very large, which goes to show that the main relationship is robust to the exact operational definitions of the variables.

Banking crisis and consumption modelling
As noted by Hofmann (2004), among others, the period after financial marked deregulation (mid 1980s) and the Norwegian banking crisis in 1989-90 was a probably driven by positive feed-back between housing prices and accommodating bank lending.

The impacts that such a process might have on private consumption expenditure were first modelled by Brodin and Nymoen (1992) in the form of a cointegrating relationship between real consumption, real disposable income and a measure of household wealth that include the stock of residential housing capital, evaluated at marked prices (rather than at the price the price index of new construction costs). Subsequent offerings by Eitrheim et al. (2002) and Erlandsen and Nymoen (2008) confirmed an empirical relationship between housing prices and consumption, as a wealth effect.

As noted above, the empirical relationship in (3.18) has been reasonably stable over more than two decades, and the link between housing prices and aggregated demand that it captures, has international empirical support (cf. e.g., Goodhart and Hofmann (2007), Aron et al. (2012)).

Because (3.18) is interpreted as a long-run relationship, one important question is how it is maintained over long data samples, cf. Eitrheim et al. (2002). The seminal paper of Campbell (1987) pointed out that the rational expectations permanent income hypothesis (RE-PIH) implied that (Granger) causation should run from the savings rate to income growth, which became known as the *Saving for a rainy day hypothesis*[3]. Conversely, the "Keynesian position" is that it is consumption that equilibrium corrects directly, while income is only indirectly affected and mainly though the labour marked and thus the wage income component of $YDCD$. The estimation results in section 5.2.4 strongly support that consumption reacts to an equilibrium correction term defined in accordance with (3.18).

If we introduce the simplifying notation: c (log consumption), y (log disposable income), w (log total wealth) the estimated dynamic model equation can be written

payments. Dividend payment have been influenced by changes in the tax system, for example in 2006

[3]Of course, as pointed out Boug et al. (2020), the RE-PIH is already contradicted empirically by the significance of wealth in the long-run relationship.

as:

$$\begin{aligned}\Delta c_t &= -0.23(c_t - 0.78 y_{t-1} - 0.17 w_{t-1}) + 0.35\Delta y_t + 0.41\Delta c_{t-4} \quad (3.20)\\ &+ 0.23\Delta b_{fhm,t} + \textit{seasonal dummies}\end{aligned}$$

showing that log consumption equilibrium corrects quite significantly (the t-value of the -0.23 coefficient is -5.5) but also that habit formation is a strong feature of the model equation (the sizeable coefficient of Δc_{t-4}).

The model equation also includes a short effect of the variable b_{fhm} which is the (log) of the real value of the financial wealth component $BFHM$ (cash deposits etc.)

The components of private disposable income
In NAM, private disposable income, YD, is defined as follows:

$$\begin{aligned}YD &= DRIFTH + LOENNH + RAM300 + RENTEINNH\\ &\quad -RENTEUTH + RESINNTH - SKATTH + YDORG\end{aligned}$$

$DRIFTH$ is income from operating surplus, $LOENNH$ is wage income, $RENTEINNH$ is interest payments and $RENTEUTH$ are interest expenditure. $RAM300$ is revenue in the form of dividends paid. $RESINNTH$ represents miscellaneous revenues (including transfers from the government). $SKATTH$ denotes taxes paid on income and wealth, and $YDORG$ is disposable income for non-profit institutions serving households (NPISH).
$RAM300$ and $YDORG$ are exogenous variables in NAM. The other components of private disposable income are endogenous variables in the model.

3.2.2 Business investments

The estimated equation in chapter 5.2.8 is for gross capital formation in the private business sector of the Norwegian mainland economy (non-oil), $JFPN$. The results show that the current and lagged changes in GDP in Mainland-Norway have a strong impact on the change in $LOG(JFPN)$). The finding that gross capital formation is strongly related to GDP growth is quite standard in empirical macro, and it represents a version of the acceleration principle.

That the relationship includes the lags of GDP growth rates is particularly interesting. This is what we would expect to find if firms have excess capacity and non-increasing cost curves, as discussed in chapter C.3. In that case, positive sales opportunities will first lead to increased production (towards full capacity), and second to realization of investment plans in order to increase capacity again.

Another interesting right hand side variable in the relationship is the profit-to-investment ratio $(YDFIRMS/PYF)/JFPN(-1)$, where $YDFIRMS$ is a constructed measure of the disposable income of firms, and PYF denotes the deflator of value added in the mainland economy. Interest payments on existing debt is one important component of $YDFIRMS$. Hence, if the interest rate level is raised, this is negative for firms' ability to finance capital formation.

In addition to the effect of the interest rate level that operates through the profits-to-investments ratio, the estimated equation in section in Chapter 5.2.8 includes the real interest rate, This (traditional) variable gets a negative coefficient, which is however statistically insignificant.

3.2.3 Investment in housing

In the Norwegian Quarterly National Accounts, there is a close link between housing starts (HS) and gross capital formation ($JBOL$). Consequently the main "housing investment" variable modelled in NAM is housing starts (measured in thousand units). The estimated equation for housing starts is reported in chapter 5.2.6 and the technical transition equation from housing chapter (HS) to investments is reported in chapter 5.2.7.

A main result in chapter 5.2.6, is an estimated positive long-run effect of the price relativity PH/PA on housing starts. PH is the nominal housing price index, and PA is the Norwegian equity price index. Hence, if there is a secular risen in the price of residential housing relative to the stock market index equity, investors will look to the building sector for profit opportunities, resulting in higher output in the form of housing starts. High PH/PA can also be expected to be associated with high housing demand, which is positive for the construction business in general. The importance of the real house price level for housing starts means that residential housing investments become closely related to the model for the housing market, and to the credit supply to private households, cf. section 3.8.

In addition to relative housing price, section 5.2.6 documents that the number of housing starts depends on the national wage level (affecting construction costs) and private household income (a demand factor) as two particular long-run determinants of housing starts.

3.2.4 Exports

As noted above, there are four export categories:.

- AOIL: Exports of oils and natural gas, fixed prices, Mill kroner
- ATJEN: Exports of services, fixed prices, Mill kroner
- ATRAD:Exports of traditional goods, fixed prices, Mill kroner
- ASKIP: Exports of ships and oil platforms, fixed prices, Mill kroner

Total exports, A, is a the sum of the four components:

$$A = ATRAD + ATJEN + AOIL + ASKIP$$

The graphs in Figure 3.3 show that exports of oil and natural gas accounted for the bulk of the increase in total exports between 1980 and the end of last millennium. Early in the 2000s, export of oil and gas peaked, and it has since been on a decline. This trend into a "post-oil" era for the Norwegian economy, is expected to continue. $AOIL$ is a non-modelled (exogenous) variable in NAM, while the three others are endogenous. As shown in Figure3.3, $ASKIP$ is a small component of total exports and is modelled by a simple autoregressive model. The exports of traditional goods ($ATRAD$) and services ($ATJEN$) paly much larger roles, and we therefore comment in more detail on the treatment given to these two variables.

Although convention and the principles of the national accounts lead us to categorize exports as demand side variables, they are mainly determined by firms decisions. As already mentioned, a main assumption in NAM is that firms (as a tendency) have excess capacity and that unit costs of production tend to fall within the capacity range. In theory therefore, firms will be ready to expand production and export

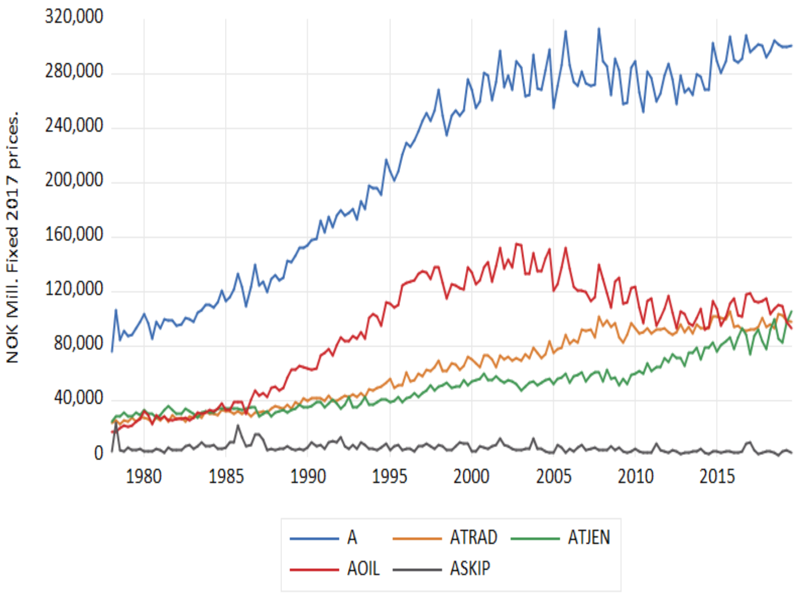


Figure 3.3: Total exports and its components

more goods if the possibility presents itself. Such possibilities depend on for example income growth in foreign countries, and the costs level in Norway compared to the cost of trading partners.

In line with this, the estimated equation for $ATRAD$ in 5.2.1 has the (international) marked indicator (EMI) and the real-exchange rate as the long-run determinants. Hence, the estimated long-run relationship is:

$$\begin{aligned} LOG(ATRAD) &= -0.6 * LOG(PATRAD/(PPIKONK \cdot CPIVAL)) \\ &+ 0.7LOG(EMI) + Constant \end{aligned} \tag{3.21}$$

where $PATRAD$ denotes the price index of tradition exports (the deflator in the national account), $PPIKONK$ is an index of foreign producer prices and $CPIVAL$ is the effective nominal exchange rate (i.e., NOK per unit of foreign currency).

Hence, $PATRAD/(PPIKONK \cdot CPIVAL)$ is an indicator of "price competitiveness" in terms of the price of Norwegian exports relative to the foreign price level. The estimated long-run elasticity of this variable has the expected negative sign.

The estimated long-run elasticity of the export marked indicator EMI is positive, but below unity. This result implies that in order to maintain a constant share of the secular increase of the export market, the real price of exports (in foreign currency) needs to be reduced (a type of currency depreciation in real terms). The detailed estimation results in section (5.2.1) show that, traditional exports is adjusting fast to increased demand (increase in EMI).

The estimation results in section (5.2.2), show that the equation for exports of services shares many features with the the model equation for traditional exports. In particular, the long-run relationship for $ATJEN$ is:

$$\begin{aligned} LOG(ATJEN) &= -0.7LOG(PATJEN/(PPIKONK \cdot CPIVAL)) \\ &+ 0.8LOG(EMI) + Constant. \end{aligned} \tag{3.22}$$

On the other hand, there is no indication that Norwegian exports of services was directly impacted by the sharp fall in oil investments in the same was as traditional exports: The $ACOST$ variable is insignificant when added to the model equation for $ATJEN$ in section (5.2.2). The model equations for the two endogenous export price indices $PATJEN$ and $PATRAD$ are documented in section 5.4.26 and 5.4.27 below.

3.3 Components of aggregate supply

Figure 3.4 shows the different supply components as shares of total supply ($TOTS$). GDP of Mainland-Norway (YF) represents by far the largest component, with a share that varies between 60 and 70 percent over the sample period. The share of private Mainland-Norway (YFP) has been relatively stable over the period, with a 50 % share of total supply, only dipping a little below lower during the period when value added in oil and natural gas extraction and related services ($YOIL$) peaked at 30 percent of $TOTS$.

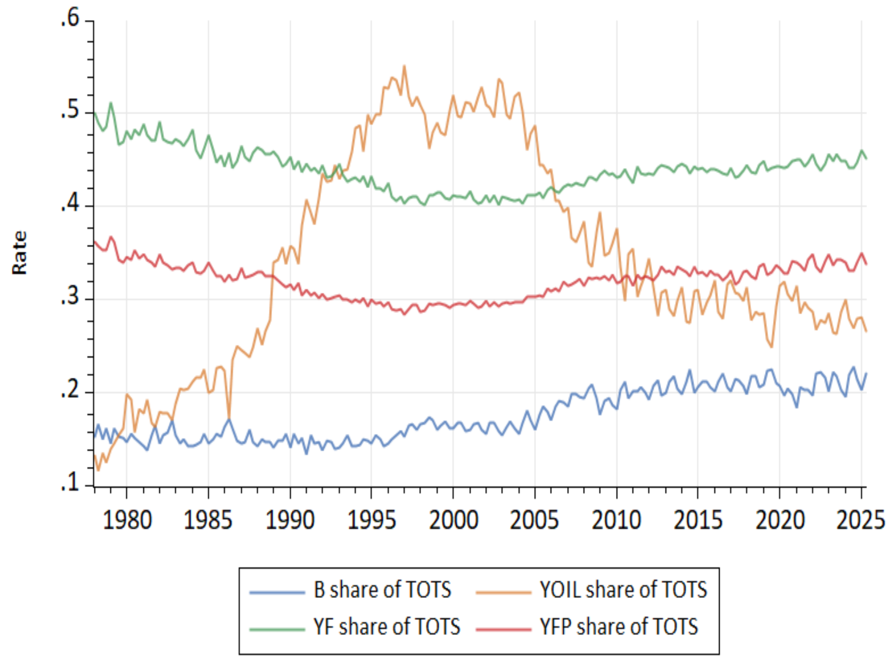


Figure 3.4: Import, oil and Mainland-Norway components of total supply $TOTS$

The share of imports (B) in total supply was stable until the early 2000s, and has increased to a level just above 20 % quite recently.

3.3.1 Mainland-Norway GDP and total GDP

All the components shown in Figure 3.4 are endogenous in NAM. For example YF, valued at market prices, is given by:

$$YF = YFP1 + YFP2 + YFP3 + (LAVGSUB/PYF) + YO \tag{3.23}$$

where the three first terms make up *YFP* in Figure 3.4, and YO is value added in government administration.[4]

Total GDP is given by:

$$Y = YFP1 + YFP2 + YFP3 + (LAVGSUB/PYF) + YO + YOIL1 + YOIL2 + YUSF \tag{3.24}$$

YO, and $YOIL$ are modelled as functions of their counterparts on the demand side: CO in the case of YO, and $AOIL$ in the case of $YOIL$. These two equations are technical relationships. For imports and the three components of private Mainland GDP the model equations have a clearer economic interpretation. We now comment on those relationships.

3.3.2 Imports

In the current version of NAM, the foreign part of aggregate supply is represented by a simple import function. The main characteristic is that there are separate import propensities for different demand variables, see Chapter 5.3.6 for the detailed weights.

3.3.3 Value added in manufacturing

As mentioned above, the basic assumption made about producer behaviour is monopolistic competitive. An implication is that product prices are set as mark-ups on marginal costs, and that firms in general have capacities that matches the demand for their products. Price setting is discussed together with wage formation in section 3.5 below.

Section 5.3.1 contains the detailed estimation results for the dynamic model equation for value added in manufacturing and mining, $YFP1$. The static long-run relationship implied by the estimation results is (omitting the constant to save space):

$$ln(\text{YFP1}) = \underset{(8.4)}{0.5}\,(ln(\text{DOMD} + \text{ATRAD} + \text{JOIL1})) - 0.4ln(\text{W1COST}), \tag{3.25}$$

where the demand variable is DOMD + ATRAD + JOIL1, with t-value in parenthesis below the estimated coefficient. The interpretation is that all other factors held constant, a one percent permanent increase in $DOMD$ increases value added by $0.5\frac{DOMD}{DOMD+ATRAD+JOIL1}$ percent.

The righ-hand side variable W1COST represents unit labour cost in Norwegian manufacturing relative to the foreign price level:

$$\text{W1COST} = \frac{\text{WCFP1}}{\text{ZYFP1 CPIVAL PPIKONK}},$$

where WCFP1 is wage cost per hour and ZYFP1 is average wage productivity.[5] If this relativity permanently increases, the profitability of manufacturing in Norway will be suffer, all other factors equal. The coefficient -0.4 is therefore an elasticity with the expected negative sign. However, we were not able to obtain a t-value of this coefficient, which is therefore have been imposed.

[4] As already noted LAVGSUB is net product taxes and and subsidies.

[5] CPIVAL and PPIKONK have been explained in the sub-chapter about aggregate demand

3.3.4 Value added in production of other goods

The supply sector called production of other goods, *YFP2* has the value added of the building and construction sector as an important component. The detailed results for the model equation is found in section 5.3.2, while the solved out static long-run solution (omitting deterministic terms) is:

$$\begin{aligned} ln(\text{YFP2}) = \underset{(7.1)}{0.29} ln(\text{YFP2}^d) - \underset{(2.6)}{0.10} ln(\text{WCFP2}/(\text{ZYFP2 PYFP2})) \\ + \underset{(10)}{0.28} ln(\text{EMI})) \end{aligned} \tag{3.26}$$

The long run elasticity with respect to relative wage costs is seen to be −0.10. The variable $ln(\text{YFP2}^d)$ is the domestic demand indicator, It is an weighted average of different capital formation variables: $\text{YFP2}^d = 0.3JBOL + 0.2JFPN + 0.3JO + 0.3JOIL$.

3.3.5 Value added in private service production and retail trade

Section 5.3.3 shows the estimation results for value added in the private service producing sector, which also includes retail trade. Value added in this sector is larger than the two others taken together.

The implied long-run relationship is:[6]

$$\begin{aligned} ln(\text{YFP3NET}) = \underset{(20)}{0.94} ln(\text{DOMD}) + \underset{(4.5)}{0.2}\, ln(0.5\text{ATRAD} + (\text{ATJEN})) \\ - \underset{(2.5)}{0.16} ln(\text{WCFP3}/(\text{ZYFP3 PYFP3})), \end{aligned} \tag{3.27}$$

where we note that the elasticity with respect to domestic demand ($DOMD$) is higher than for the two others, YFP1 and YFP2.

In summary: The three private business sector equations have in common that both demand factors and relative labour costs are explanatory variables for value added. The differences are more in terms of the operational definitions of the demand and cost variables. The estimation result that are in line with economic intuition in that

3.3.6 Balancing total demand and total supply

As noted above, NAM incorporates the national principle that total supply, $TOTS$, equals total demand, $TOTD$. $TOTS \equiv TOTD$ can be expressed as the identity (3.12) above. It is convenient to reproduce it here as:

$$JL \equiv Y + B - CP - CO - J - A, \quad \text{consequence of } TOTS \equiv TOTD)$$

where change in stocks (inventories) is denoted JL as defined above, together with the other variables in the relationship. Because the variables on the right hand side of this equation are "already" endogenous, the consequence of $TOTS \equiv TOTD$ is that JL is an endogenous variable in NAM. In its turn, it means that NAM is not characterized as a model with "demand determined GDP". For that to be a correct statement, JL would have to be exogenous, allowing Y to be determined by:

$$Y = C + CO + J + A - B + JL.$$

[6]From the data definitions: YFP3NET is YFP3NET = YFP3 - YFP3OIL where YFP3OIL is value added in services incidental to oil and gas extraction, and YFP3 is total valued added in private service activities and retail.

Or, more precisely, one of the (value added) components of Y would need to be endogenized in that way, in order for the model to "respect" the accounting identity $TOTS \equiv TOTD$. However, in the national accounts, JL is more precisely defined as changes in stocks and statistical discrepancies. This means that JL is a kind of residual in the accounts. Therefore it is natural to treat it in a similar manner in the model, and let it be determined "residually" in the identity $JL \equiv Y + B - CP - CO - J - A$.

In practice, this means that for example NAM forecasts are not based on exogenous assumptions about JLs, contrary to the practice when forecasting with models that are demand determined (in the meaning made precise above). Instead, JL is forecasted from the model, together with the other endogenous variables, and $JL \equiv Y + B - CP - CO - J - A$ holds in the forecasts as well as in the data.

This means that, in forecasting, it is important to keep and eye on the forecasts for JL. For example, a forecast where JL is much larger in proportion to GDP than has been normal historically, it should probably be reviewed and maybe adjusted (change the exogenous projections and/or the behavioural equations (by use of add-factors)). Hence, the suggestion is to use for example JL/Y as as an indicator of the "goodness" of the forecast (in the meaning of being a reasonable forecast).

In the national accounts data, JL is typically positive. Over the period 1990q1-2018q4, the mean of $(JL/Y)100$ was 3.5% and ranged between a maximum of 7.7% and a minimum of 0.5%. As practical guide line for good solution path for the model may therefore be that the simulated $((JL/Y)100$ should lie well inside that range, and be without a clear drift.[7]

3.4 Climate gas emissions from economic activity

Total climate gas emissions (1000 tons CO_2 equivalents) from Norwegian economic activity, $CO2\_TOTAL\_UTS$, is an endogenous variable in NAM. It is given by the definition:

$$CO2\_TOTAL\_UTS = CO2\_Y\_UTS + CO2\_HOUS\_UTS \tag{3.28}$$

where CO2_Y_UTS denotes emission from the business sector and $CO2\_HOUS\_UTS$ denotes emission from households.

CO2_Y_UTS is the sum of three components:

$$\begin{aligned} CO2\_Y\_UTS = {} & CO2\_YF_UTS + CO2\_YOIL1\_UTS \\ & + CO2\_YUSF\_UTS \end{aligned} \tag{3.29}$$

where CO2_YF_UTS denotes emissions from Mainland Norway value added production, CO2_YOIL1_UTS is from petroleum production and CO2_YUSF_UTS is from international shipping.

CO2_YF_UTS is defined by:

$$\begin{aligned} CO2\_YF\_UTS = {} & CO2\_YFP1\_UTS + CO2\_YFP2\_UTS \\ & + CO2\_YFP3\_UTS + CO2\_YO\_UTS \end{aligned} \tag{3.30}$$

where the variables on the right hand side are emissions from value added production in manufacturing (YFP1), production of other goods (YFP2), private service production (YFP3) and general government administration (YO).

[7] In NAM, the definition variable is $JLOFY = (JL/Y)100$

Two other aggregates that are of interest relate to emissions from economic activities that are covered by the international quota system ("KVOTE") and emissions that are regulated by domestic policies ("INNSATS"):

$$CO2\_KVOTE\_UTS = CO2\_YFP1\_UTS + CO2\_YOIL1\_UTS \tag{3.31}$$

$$\begin{aligned} CO2\_INNSATS\_UTS = & \; CO2\_YFP2\_UTS + CO2\_YFP3\_UTS \\ & + CO2\_YO\_UTS + CO2\_HOUS\_UTS \end{aligned} \tag{3.32}$$

Emissions from business sectors are endogenized with the aid of emission intensities, which are in their turn modelled as local trends.

CO2_HOUS_UTS, climate emissions from households is modelled in a similar way, by multiplying an appropriate intensity with consumption expenditure (in fixed prices).

Although the approach to climate emission modelling is simple, it may be useful in analysis of the consequences for emission of different scenarios for emission intensities, for example.[8]

3.5 The wage-price module

The specification of model equations for nominal wage setting has important implications for the properties of macroeconometric models, see Nymoen (2021). In the development of NAM, one priority has therefore been to use specifications that are broadly consistent with the national system for wage setting in Norway. Collective bargaining about pay and working conditions is one of the mainstays of the system.

Wage coordination and pattern wage bargaining

It is not unusual, nowadays, to come across positive evaluations of the Norwegian wage formation, because it has proven itself over time as as a system that has "good macro properties", see eg., OECD (2018),(2019). Wage coordination is a keyword in such assessments, because in current thinking coordination plays an important role in macroeconomic stabilization. One way that one can seek to reach coordination in practice is trough pattern wage bargaining, which has been common in Europe, but in different forms, and with different degrees of success in terms of actual coordination reached.In Norway, a small open economy, where it is custom to regard the manufacturing industry as the wage-leader or front-runner in the pattern of annual wage bargaining rounds.

Historically, the wage-leader model was one of several initiatives to curb inflation in the post-war period, in a situation with full employment and with a commitment to free collective bargaining, Aukrust (1977), Meade (1982), Forder (2014) among others. Similar systems were developed in Sweden (Edgren et al. (1969)), France (Courbis (1974)) and the Netherlands (Driehuis and de Wolf (1976)).

It has always been understood that the capitalist market economy has consequences for wage-setting. In particular that in order to attract investors to an industry, the rate of return on capital could not deviate too much from the required rate of return that existed in capital markets. Or, which amounts to the same thing: the actual wage-share should not deviate too much from a normal wage-share.

This premise may has different consequences for an industry that operates in a highly competitive product market, with a completely flat demand schedule, and

[8]Technically, the assumptions made about the value of the drift parameters in the emission intensity equations of the model.

another which faces a downward sloping demand schedule. In the so called "Norwegian model of inflation", Aukrust (1977) this was captured by the the distinction between exposed industries, which faced though competition from foreign firms, and sheltered industries, which in the main sold their product in the domestic market.

Aukrust pointed out that in the exposed industries, because product price and productivity could be assumed to be exogenous trends, and putting the foreign exchange rate to one side, it was up to the wage-setters in the exposed industries to make sure that the wage-share and the return to capital became "right". Hence, it was wage formation which was seen as the corrective mechanisms that would make the wage level fluctuate around a growth path determined by product price and average labour productivity, which Aukrust dubbed the main-course.

In the sheltered sectors, Aukrust argued, the situation was very different: Firms could compensate demands for higher wages by adjusting their product prices, and thereby maintain a stable wage-share. However, this would results in higher costs of living, which would give rise to demands for compensation by workers in both sectors of the economy, potentially disrupting the relationship between the wage level in the exposed industry and the main-course.

Clearly, this is an an example of rather poor coordination in wage setting. Better coordination would be the result if consensus was achieved about having the exposed sector, which for simplicity can be thought of as the manufacturing sector, in the role as wage-leader, and the exposed sector acting as wage-followers. Such a system would make it easier to maintain wage-share stability in the manufacturing industry. It would reduce the risk of wage-price, or wage-wage, spirals popping up. Moreover, if the followers were loyal to the system, they would, on average, get the value of a much higher productivity growth than if they broke out of the system of pattern bargaining (to use current terminology)

Of course, Aukrust did not invent the Norwegian version of the wage-leader model. His contribution was to "put into model form", and with many simplifications, a system that had existed for a long time, as a practical way of arranging the annual rounds of collective wage negotiations, Nymoen (2017). As noted above, similar developments took place in many others, and still today the manufacturing sector signs the leading collective agreements in several other European countries, see Knell and Stiglbauer (2009).

However, in a theoretical contribution, Calmfors and Seim (2013) challenge the conventional wisdom that such pattern bargaining produces wage restraint. They show theoretically that wage restraint depends on the monetary policy regime and the size of the leading sector. This serves as a reminder that wage bargaining has a clear institutional dimension, and that institutions change over time, cf. Soskice (1990), Camarero et al. (2016). The possibility of a connection between monetary policy regimes and the system of wage and price setting has also been analysed by Cuikerman and Lippi (1999), Iversen (1999), Soskice and Iversen (2000) and Holden (2005), among others.

More generally, a system of pattern wage bargaining represents is an advanced product of civilization. Disruption of such institutions can occur due to changes elsewhere in the economy, or in the wider society. Exactly because of its importance for the macroeconomic performance, structural breaks in wage setting can be have rich consequences and should be be carefully monitored.

A flow chart view of pattern bargaining

Figure 3.5 gives a graphical illustration of a national system of wage formation of characterized by wage-leadership and wage-followership: The wage levels W_b and

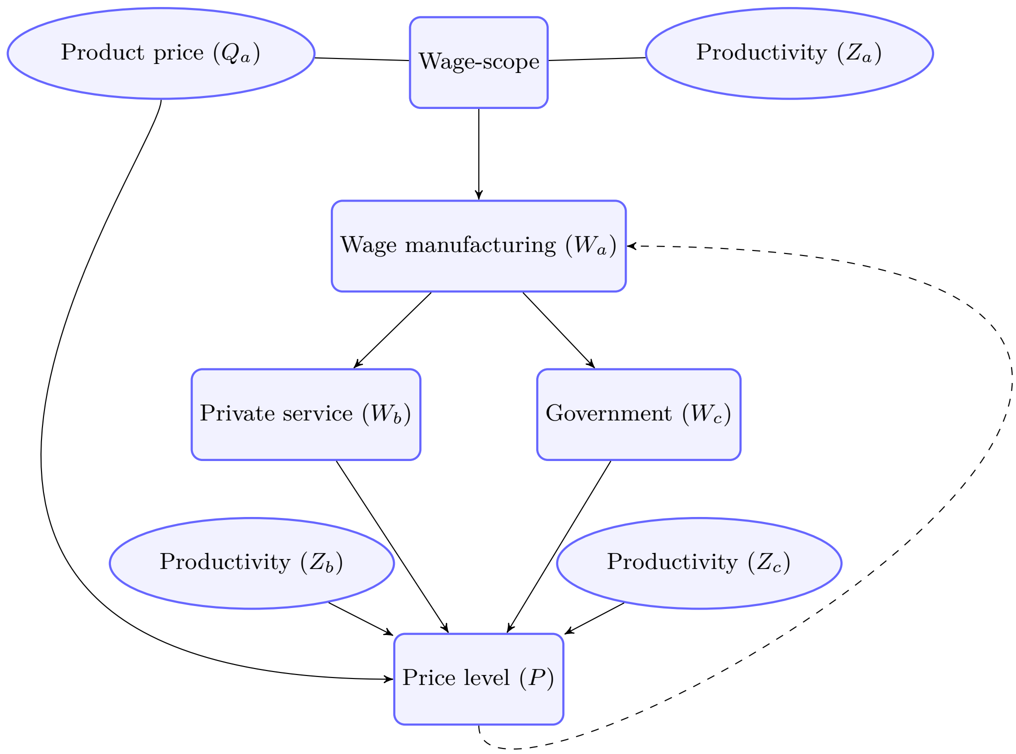


Figure 3.5: Wage and price level formation with one wage-leader, manufacturing (subscript a), and two wage-followers one private (subscript b) and the government sector (subscript c).

W_c are directly linked to the wage level, W_a, and since there are no feed-back from W_b or W_c to W_a, that wage is the compensation level in the front-runner sector. W_b and W_c are the wage level of the wage-following sectors. For concreteness we have dubbed the front-runner "manufacturing", and the wage-followers have been dubbed private service (production) and government (administration).

The wage level in the wage-leading sector, W_a is er explained by Wage-Scope in manufacturing, which is driven by two factors: The product price Q_a, and labour productivity, Z_a.

$$\text{Wage-Scope} = Z_a \cdot Q_a,$$

Conceptually, wage-scope is the same as Aukrust's main-course variable. Empirically the wage-scope is increasing with time. Hence, if the manufacturing wage W_a, as a rule, is set as a function of the Wage-Scope, the wage level will also trend upwards. However, both market forces and institutions can have an influence on the functional relationship. If W_a begins to drift away from the wage-scope, the return on capital in the manufacturing sector can either become too high, or too low, compared to the required rate that secures a stable flow of investments in capital, technology and product innovation. If W_a is too high compared to the wage-scope, the return to capital may become too low to attract investments in capacity, new product development and technology. This consequence is likely to be understood by the bargaining parts. Conversely, if W_a becomes under-regulated relative to the wage-scope, the conception of fairness of the wage, which is important in reaching a collective agreement between equally powerful partners, is likely to lead to wage compromises that correct the previous under-regulation.

What comes out of this is the idea that if the return on capital moves away from a normal level, forces will we set in motion that directs W_a back towards the level which is consistent with the required rate and a normal wage-share. Hence, one main premise of the system is that firms and workers are able, through collective bargaining, to reach compromises about annual wage adjustments that balance the concerns about required profitability, and about fairness in the workers' share of the wage-scope. The theory does not depend on the normal (i.e., equilibrium) wage-share being a completely invariant parameter. On the contrary, the model needs to be able to adjust the normal wage-share when required. Historically, adjustments have taken place, either through compromise (collective rationality) or through conflict, to e.g., changed global marked conditions (higher required return to capital for example), danger of mass unemployment due to negative external shocks (not limited to manufacturing), or changes in labour market conditions and institutions.

Having established W_a from the wage-scope and the normal wage-share, it takes on the role of a wage norm which is followed in other bargains. This step might work in practice, because the maintenance of wage relativities is another dimension of fairness that influence actual wage negotiations. In Figure 3.5, we indicate that the norm might (first) regulate the wage (W_b) in the private service sector. Next, the wage in government administration (W_c) is adjusted to maintain a normal relativity to W_a.

Hence, labour productivity in the two wage-following sectors do not influence (W_b,W_c). However, productivity does influence by how much prices are adjusted (i.e., mark-up price setting), as indicated by the lines from the two productivity nodes to the node label Price level.

In practice, the variable used to represent the domestic price level, P, is a consumer price index. In a small open economy, P depends directly on foreign prices, and that link is represented by the line from the Q_A-node to the node for P in the figure. In the empirical model, we need to be more realistic, and we use an import price index in the econometric modelling of P.

There are other important aspects of price setting that become hidden in a stylized diagram. For example, since a large part of the cost of providing public is financed by taxes, the impact of W_c and Z_c on the domestic price level is much smaller than from unit labour costs in private service production, and from the prices of imported consumer products. Hence, most of the inflation driving forces are on the left-hand side of the figure, rather than on the right-hand side.

Another remark is that the lines in the graph may give the impression that one-way causation is a defining characteristic of the system. Again, that would be an over-simplification. Specifically, the model must (to be realistic) allow cost-of-living considerations to enter the picture, as they are always relevant in real world wage setting. We have indicated a feed-back loop by the dashed line from the P-node to the W_a-node. It can be interpreted in two different ways. First, it can represent a short-run effect (ie., between the change in cost of living and the change in W_a). Second, it can represent a long-run effect (ie., P is a variable in the cointegrating relationship for W_a). The two interpretations have different implications for the properties of the system (including its stability).

Finally, there are additional linkages and feed-back mechanisms that can be empirically relevant: The agreement in the manufacturing sector may regulate the wages of public sectors works directly, as indicated by the dashed line. There may for example be mutual causation between W_b and W_c (not drawn in the graph).

Results of econometric treatment of wage setting in manufacturing started to appear in the late 1980s, and indicated that nominal wage adjustment contributed significantly to the maintenance of a stable-wage share, see Nymoen (1989b), Johansen (1995a) among others. Several years later, Gjelsvik et al. (2020), using advanced econometric methods, found support for relative stability of the pattern of wage bargaining, in particular with respect to the change in monetary policy early in the new millennium and to the increased labour immigration inflow from EU/EFTA countries, North America, Australia and New Zealand and non EU Eastern Europe (measured in percent of the population ages 15-74). The wage module of NAM has been specified to be broadly consistent with the empirical results in Gjelsvik et al. (2020), and in Dalnoki (2020) who used annual data from 1970 and drew the same conclusion about the relative permanency of the pattern wage-setting system.

Pattern wage bargaining in NAM

The wage-setting module of NAM, and the associated model equations for price adjustments, can be seen as a particular special case of an Incomplete Competition Model (ICM) of the supply side. Appendix C gives a self-contained introduction to ICM, with emphasis on the implications this modelling approach for the medium term equilibrium properties of a complete macro model. One main implication is that the medium term equilibrium is implied to be more responsive to shocks to the product and labour markets than if wage and price are modelled by Phillips curves, which is the custom in macro models, even today.

Hence, while we can maintain the idea about an equilibrium rate of unemployment in NAM, the equilibrium can be seen as being influenced by aggregate demand. It is not a natural rate of unemployment, or a NAIRU, in the usual meaning of these terms. The natural rate/NAIRU equilibrium is determined by supply-side parameters and in such a way that only one inflation rate (think of it as given by foreign inflation for simplicity) is consistent with the natural-rate/NAIRU. In NAM, there is in principle a region of equilibrium unemployment rates that are consistent with the same steady-state inflation rate.

In NAM, a system with pattern wage formation has been implemented for the main production sectors of the model. The estimated wage equation is documented in chapter 5.4.10. Abstracting from dynamic and deterministic terms, the implied static long-run equation for $WFP1$ can be simplified to:

$$ln(\text{WFP1}(1+\text{T1FP1})) = -0.12ln(\text{UAKU}) + ln(\text{PYFP1}\cdot\text{ZYFP1}) + \text{Const} \quad (3.33)$$

where T1FP1 is the payroll tax-rate, UAKU is the unemployment percentage (labour force survey), PYFP1 is the value added deflator in manufacturing (basic values) and ZYFP1 denotes average labour productivity for wage earners. Hence, with reference to the flow-chart and the concept of wage-scope above, the counterpart in (3.33) to Q_a is $PYFP1$ while Z_a is represented by ZYFP1 in NAM.

The estimated log-run elasticity with respect to unemployment is -0.12, which is of the same magnitude that have been estimated for this type of model with Scandinavian data. The implication is that if there is a lasting shift in the unemployment rate, the wage-share in the manufacturing sector will become reduced, all other things equal.

(3.33) has the hourly wage cost (WCFP1) on the left hand side. The implication is the wage long-run elasticity with respect to the payroll tax-rate (T1FP1) is -1. Hence, if there is a permanent increase in the payroll tax-rate, the nominal hourly wage is adjusted (over a period of time) so that the hourly wage-cost becomes unaffected.

The long-run relationship in (3.33) is used to define an equilibrium correction mechanism (ECM) in wage formation. In stylized form, the estimated dynamic wage equation is (t-values in brackets below estimated coefficients):

$$\begin{aligned}\Delta_4 ln(\text{WFP1})_t = &-\underset{(-5.7)}{0.23}\{ln(\text{WFP1}(1+\text{T1FP1}))_{t-4} - ln(\ \text{PYFP1}\cdot\text{ZYFP1})_{t-4} \\ &- 0.12 ln(\text{UAKU})_{t-4}\} \qquad (3.34)\\ &+ \underset{1.8}{0.25}(\Delta_4 ln(\text{CPI})_{t-1} - \pi^*_{t-1}) + \underset{(3.9)}{0.17}\Delta_4(ln(\text{PYFP1})_t + ln(\text{ZYFP1})_t) \\ &+ \text{other terms.}\end{aligned}$$

The ECM-term is found in the two first lines of the equation. The estimated adjustment coefficient is -0.23, with t-value of -5.7. The second term is the difference between the lagged inflation rate and the variable π^*, which represents the inflation target. With reference to the flow-chart diagram, the lagged inflation variable in (3.34) corresponds to to the dashed line from the P-node to the W_a-node.

The last term in (3.34) is the change in the wage-scope (main-course), variable:

$$\Delta_4(ln(\text{PYFP1})_t + ln(\text{ZYFP1})_t.$$

The estimated short-run coefficient of the main-course variable is 0.17, which is markedly smaller than the long-lung elasticity of +1. (cf. in (3.33)). Hence, the pass-trough from the exchange rate to wage growth is far from complete in the short term.[9]

As explained above, NAM can be used to mimic PWB as a (positive) model of wage formation. In line with this, the dynamic wage equation for ‘Production of other goods’ takes the following simplified form:

$$\begin{aligned}\Delta ln(\text{WFP2})_t = &-\underset{(-22)}{0.53}\{ln(\text{WFP2}) - ln(\text{WFP1})\} + \underset{(69)}{0.9}\Delta ln(\text{WFP1})_t \\ &- \underset{(-6.7)}{0.08}\Delta_3 ln(\text{WFP2})_{t-1} + \text{other terms.} \qquad (3.35)\end{aligned}$$

Taken together, the estimated adjustment coefficient -0.53 and the coefficient 0.9 of $\Delta ln(\text{WFP1})_t$ imply a strong relationship between the two wage rates. The detailed results are found in chapter 5.4.11.

The wage equation of the third private business sector, ‘Private service production’ has a similar structure (cf. chapter 5.4.12):[10]

$$\begin{aligned}\Delta ln(\text{WFP3})_t = &-\underset{(-19)}{0.41}\{ln(\text{WFP3}) - ln(\text{WFP1})\} + \underset{(58)}{0.8}\Delta ln(\text{WFP1})_t \\ &- \underset{(-10)}{0.15}\Delta_3 ln(\text{WFP3})_{t-1} + \text{other terms.} \qquad (3.36)\end{aligned}$$

[9] The specification has several common features with the equation in Nymoen (1989a), which was an early attempt to model quarterly wage dynamics in the manufacturing industry in equilibrium correction form. The sample was 1967(1)-1987(4), while (3.34) ws estimated on < sample that begins in 1996(1). In addition to different samples, there are major differences in the data measurement systems. For example, quarterly national accounts data on wage compensation was not available in 1989. Nymoen (1989a) therefore modelled a time series for wage earnings per hour in manufacturing prepared by the Norwegian Association of Employers. The equilibrium correction coefficient is -0.2 in (3.34) and was -0.1 in the 1989 journal article. The estimated long run elasticity with respect to the unemployment rate was -0.2 in Nymoen (1989a), and somewhat lower in magnitude in (3.33). The results we cite is from Table 2 in Nymoen (1989a)

[10] For technical reasons, an average wage rate for the two wage-followers, WFP23, is defined as an endogenous variable in the model.

Finally, for the hourly wage rate in the government sector, WO, the stylized estimated model is (chapter 5.4.14):

$$\begin{aligned}\Delta ln(\text{WO})_t = & -\underset{(-10)}{0.31}\{ln(\text{WO}) - ln(\text{WFP1})\} + \underset{(32)}{0.8}\Delta ln(\text{WFP1})_t \\ & - \underset{(-7.8)}{0.02}\, ln(\text{UAKU})_{t-1} + \underset{(4.3)}{0.15}\Delta_4 ln(\text{CPI})_{t-1} - \underset{(-8.8)}{0.20}\,\Delta_3 ln(\text{WO})_{t-1} \\ & + \text{other terms.} \end{aligned} \tag{3.37}$$

Again, there is strong relationship with the wage rate of the manufacturing sector, in spite of the many important differences between these two sectors of the economy. It is interesting that the model equation for $ln(\text{WO})_t$ contains the lags of the rate of unemployment and inflation as separate variables, indicating that both labour market tightness and cost of living changes changes can modify the relationship.

Price setting

As noted above, the underlying assumption on the production side of the economy is monopolistic competition. The theoretical implication for price setting is that firms adjust prices in order to maintain a normal profitability level. Of course, when adjusting their prices, firms must try to take the consequences for demand into account and therefore so called mark-up pricing is not absolute, but depends on the degree of product market competition. In technical terms, product demand is *elastic* if a one percent increase in the price leads to a large relative reduction in demand (almost horizontal demand schedule), and *inelastic* if demand change very little as a response to a price increase (almost horizontal demand schedule).

In economic theory a distinction is drawn between sectors characterized by elastic demand, which represent a limitation on the possibility of cost based pricing, and other sectors with relatively limited elasticity meaning that increased wage costs can be rolled over to prices without large consequences for firms' sales possibilities. Norwegian economists are accustomed to the dichotomy between competitive sectors and sheltered sectors, and in NAM we follow that custom by thinking of the manufacturing and mining sector as competitive and production of other goods and private service activities as sheltered.

The empirical model equations for the price index of value added in manufacturing PYFP1, is in 5.4.1, and for the two more "sheltered" sectors (production of other goods and private service production) are found in chapters 5.4.2 and 5.4.3.

The results show that PYFP1 adjusts in the short-term, to compensate increased wage-costs: However, the trend in PYFP1 is defined by the foreign price level (PPIKONK) in domestic currency. Hence there is no long-run mark-up of prices on wage cost in the manufacturing sector. The results for PYFP2 and PYFP3 are different, and imply that mark-up pricing creates links between wage costs and the price levels in the long-term.

There are other notable differences between the price equations. Price changes in the sheltered sectors, but not in manufacturing, are in part explained by energy prices (using electricity as the energy price indicator). In the equation for $PYFP3$ (private service production), there is a variable which captures that the mark-up can be increased in periods with a high degree of tightness in the labour market.

As noted above,the representation of wage and price formation is incomplete before a model equation is specified for the link between the import price index, the foreign price level and the exchange rate. In NAM, the estimated relationship is between the aggregate import price index, PB, an effective nominal exchange rate index (using trade data to construct the weights of the different bi-variate exchange rate), CPIVAL and a price index of foreign producer price indices (with the same trade weights), PPIKONK.

The estimated equation for PB in chapter 5.4.23 has the foreign producer price index (PPIKONK) and the effective exchange rate CPIVAL as the main drivers. The partial long-term elasticities are +1 for both variables. The short-run relationship to these variables is also strong, however the medium term pass through from the exchagne rate to import prices is incomplete in the estimated equation.

Based on the model equations for wage setting and value added price indices, and the import price model equation, the deflators of mainland Norway GDP in basic and market basic prices are explained in the model. As a final step in the wage-price module, headline CPI and CPIJAE (adjusted for energy and taxes) are modelled by conditioning on the mentioned GDP and import price deflators (cf. section 5.4.9), as well as on the energy component of CPI (CPIEL)[11].

In summary, the estimated wage equation show a large effect of cost-of-living compensation in the medium term, while the long-run trend level is mainly determined by the factors that affect profitability. The estimated price equations confirm that, with the exception of situations with very rapid demand growth, when firms can be tempted to adjust their margins up, there is no direct product demand effect on prices. Finally, the results from estimating dynamic models for import prices show that there is an element of pricing to market and that the medium term pass through from the exchange rate to import prices is incomplete.

3.6 Hours worked, employment and the rates of unemployment

If we take as a starting point that firms' outputs are strongly influenced by product market demand, it follows that firms' demand for labour input will be correlated with changes in product demand. In comparison, labour supply has a weaker connection with the product markets, at least in the medium term time perspective. Therefore, in particular increases in unemployment are typically conditioned by drops in product demand.

NAM contains model equations for these relationships. Demand for labour in mainland Norway (measured both in hours worked and in employed persons), is strongly related to the demand in import competing and export competing product markets. The public sector (government administration) is naturally a strong moderator of the aggregate relationship between product demand and employment. The estimated equations for hours worked and employed wage earners are reported in Chapter 5.6.1 - 5.6.10.

As noted above, wage income is the largest component or private disposable income, and a main factor behind aggregated domestic demand. In turn, hours worked affect wage income, as for example a one percent increase in real wage incomes can be achieved by both a one percent increase in the consumer real wage, and by a one percent increase in hours worked. Hence, product markets and labour markets have a tendency to be synchronized.

As already noted, there are two variables that measure the unemployment rate in NAM. The registered unemployment (UR) rate, and the Labour Force Survey

[11]CPIEL endogenous in the model, in a model equation that uses the electricity system price in NORPOOL as the conditioning variable

measure ($UAKU$). They are given by the two definition equations:

$$UR = \frac{REGLED \cdot 100}{AKUSTYRK} \tag{3.38}$$

$$UAKU = \frac{AKULED \cdot 100}{AKUSTYRK} \tag{3.39}$$

where the variable *REGLED* is the number of registered unemployed, and *AKULED* is the number of unemployed in the Labour Force Survey (AKU). The variable *AKUSTYRK* is the size of the Norwegian labour force, which is measured according to the Labour Force Survey.

In NAM, the two measures of unemployment, *REGLED* and *AKULED*, are modelled by separate model equations, see section 5.7.2 and 5.7.1. As can be expected, the driving factors of the two variables are overlapping. For example, employment growth affects both measures negatively, while the partial effect of population growth is to increase the number of unemployed persons.

In the model, there is a definition equation for the labour force:

$$AKUSTYRK = AKULED + AKUSYSS, \tag{3.40}$$

while *AKUSYSS*, which is the number of employed persons in the Labour Force Survey, is modelled by an econometric equation which is a bridge between how employment is measured in the National accounts data and in the Labour Force Survey (AKU). The model equation for *AKUSYSS* is found in section 5.7.4. One variable that intervenes between *AKUSYSS* and the National accounts data, is the number of short-term labour immigrants (*KAIER*). It is included in the National accounts data, but not in the Labour Force Survey measure of employment.

Next consider the employment rate, which in NAM is defined as:

$$SYSSRATE = \frac{N}{BEF1574} \cdot 100 \tag{3.41}$$

where N denotes the total number of employed persons in Norway and $BEF1574$ denotes the population in age group 15-74 years, by convention it is the population in working age.

The unemployment and employment rates tend to be correlated, but not perfectly. The two variables therefore represent different indicators of macroeconomic performance. They they may have different dynamics over the business cycle, and they may also react differently to changes in institutional factors.

3.7 The market for foreign exchange

As already mentioned the nominal exchange rate is important for the nominal path of the Norwegian economy. In addition, the foreign exchange marked (FEX) represents an asset market which has a large influence on the real economy. With nominal wage and price rigidity, changes in the nominal exchange rate affects the real exchange rate which is one determinant of aggregated demand of the open economy.

For most of the period since WW-2 Norway followed different variants of fixed exchange rate systems. After a period of transition during the 1990s, a regime with a floating exchange rate and inflation targeting was formally put into operation in 2001.

NAM is meant to represent the current monetary policy regime in Norway, where the interest rate, i, is the policy instrument, and is set with an aim to stabilize inflation and the business cycle. In the operation of such a regime, the exchange rate channels becomes important, because changes in the interest rate will normally lead to movements in the exchange rate, at least in the short-run.

A useful framework the modelling of the nominal exchange rate is the portfolio approach (or stock approach) to the market for foreign exchange, cf. Rødseth (2000, Ch. 1 and 2). In this model, two of arguments in the net supply function of currency are the nominal exchange rate, E_t, and the risk-premium, r_t^p.

E_t is defined as the number of kroner per unit of foreign currency, for example, kroner per USD. The risk premium can be defined as the difference between the domestic interest rate, i_t, and the foreign interest rate, i_t^f, adjusted for expectations about currency depreciation, $\delta_{t+1|t}^e$:

$$r_t^p = i_t - i_t^f - \delta_{t+1|t}^e. \tag{3.42}$$

A higher domestic interest rate normally pulls in the direction of currency appreciation. Within in the portfolio model, the explanation is that net supply of foreign currency reacts positively to the higher interest rate, all other factors held constant.

Graphically, the relationship can be illustrated by the downward sloping Ei-curve in Figure 3.6.[12] We can think of interest rate r_t^* in Figure 3.6 as the policy determined interest rate in period t.[13] If the Ei-curve in period t is the downward sloping line n the figure, the market determined exchange rate in period t becomes E_t^*.

However, since the FEX market is known for its volatility, the Ei-curve cannot be is expected to be in a stationary position one period after the other. In the figure, positive and negative (horizontal) shifts are indicated by the dashed lines.

In terms of the variables in the supply function currency that we have mentioned so far, a shift in the Ei-curve can be come about because of a change in the foreign interest rate, or because depreciation expectations suddenly have increased, or decreased. In a wider interpretation, which take into account that there are several more arguments in the supply function, there are also multiple factors that are likely to cause frequent shift in the Ei-curve.

With inflation targeting, the interest rate will not be changed to "cancel out" the shifts in the Ei-curve. Therefore, substantial volatility in the foreign exchange rate is a predictable and rational feature of the current policy regime.
As already noted, on a daily and monthly basis, the net supply of currency to the central bank can be put down do (speculative portfolio) management decisions. In the short-term, factors that determine the expected return on kroner denominated assets are thefore regarded as the driver of the nominal exchange rate. [14]

NAM is a quarterly model, and over a three-month period the flow of currency from foreign trade net-surplus may be large enough to have an impact of the net supply of foreign currency. In particular, a period of trade surplus (or expected positive trade balances) may be expected to lead to currency appreciation.

In the sample period that we use to model the nominal exchange rate, the price of North-Sea oil and gas, has been important as a driver of net exports, and it is therefore not surprising that it is confirmed as a factor that explains the exchange rate, cf. Chapter 5.5.1, which is in line with Akram (2019) and other studies.

[12]Theoretically, the negative slope of the EI-curve requires the same set of assumptions that imply a positive slope of the supply function of foreign currency, Rødseth (2000, Ch. 1 and 2). Uncovered interest rate parity represent a borderline case, UIP. Under the assumption of UIP. $i_t = i_t^f + \delta_{t+1|t}^e$, and a downward sloping Ei-curve then requires that $\delta_{t+1|t}^e$ is a negative function of E_t.

[13]This is a simplification. In practice it is a money market interest rate.

[14]Particular to Norway is that net demand of foreign currency (in practice of USD) is affected by tax revenue from petroleum production and by the operations of The Government Pension Fund Global.

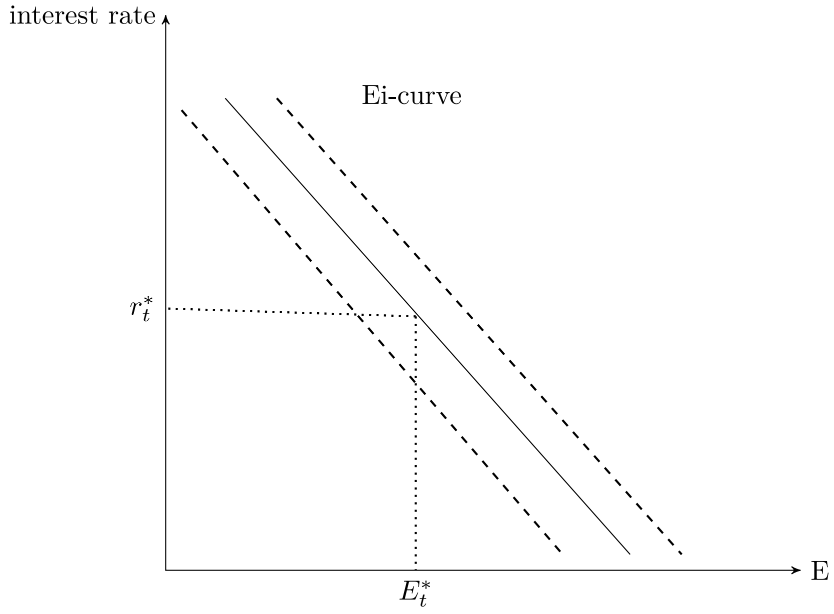


Figure 3.6: An Ei-curve shows equilibrium combinations of the interest rate and the nominal exchange rate in the FEX market.

We also find a statistically significant effect of the difference between a domestic and a foreign interest rate, as expected from the portfolio model.

Assets prices and the macro economy
Several asset prices are endogenous variables in NAM. They are of interest in they own regard, but even more so because of the several joint dependencies between asset prices and the real economy.

Above we have mentioned the importance of total wealth for aggregate demand conditions. The market for foreign exchange is another asset market with a huge macroeconomic influence, in particular in a small open economy like the Norwegian.

Chapter 3.8 presents how the price index of housing is modelled in NAM as an "inverted demand function" for housing. Because housing demand depends on the interest rate and on credit conditions there is also relationship between monetary policy and the housing and credit marked.

The price of equity is a factor in firms' investments decisions, cf. Chapter 3.2.2. In NAM, the stock exchange price index is modelled as function of foreign stock prices, see Chapter 3.11 and the detailed estimation results in 5.15.1 and 5.15.2.

3.8 Housing prices and credit to households

The housing market is another example of an asset market which is integrated with the real economy, as well as with the financial sector, and we next turn to housing prices.

3.8.1 Housing prices and the macro economy

NAM includes several channels of joint influence between housing prices, aggregated demand and Mainland-Norway GDP and credit growth.

Disposable income and lending rates to households influence household consumption directly. Lower lending rates to households and higher disposable income lead in the model to increased housing demand and higher house prices (below we comment the estimation results in more detail). As we have seen above, the model includes a wealth effect on private consumption, and the value of housing in the dominating wealth component. We have also noted above that increased housing starts, due to higher house prices, contributes, with a time lag, positively to housing investment and hence to aggregate demand. Increased building activity also has, after a while, a notable effect on the housing stock (and the total supply of housing services). An increased supply of housing reduces housing market pressures, all things equal.

It is also easy to imagine a two-way relationship between credit and housing prices. An increase/decrease in credit availability stimulates/depresses demand for housing (as well as other aspects of economic activity), because households and firms may be constrained in their borrowing as a result of information asymmetries. On the other hand, property is commonly used as collateral, indicating that increasing/falling prices (and expectations thereof) can influence credit availability positively/negatively.

In formal econometric investigation of an international data set, Hofmann (2004) documented that property prices appear to be an important determinant of the long-run borrowing capacity of the private sector, along with real GDP and the real interest rate. For Norwegian data, the same type of empirical relationship has recently been documented econometrically by Anundsen (2014).

As noted above, there is a continuous line of papers that have documented the empirical importance of housing prices on private consumption, see Brodin and Nymoen (1992), Boug et al. (2020) among others.

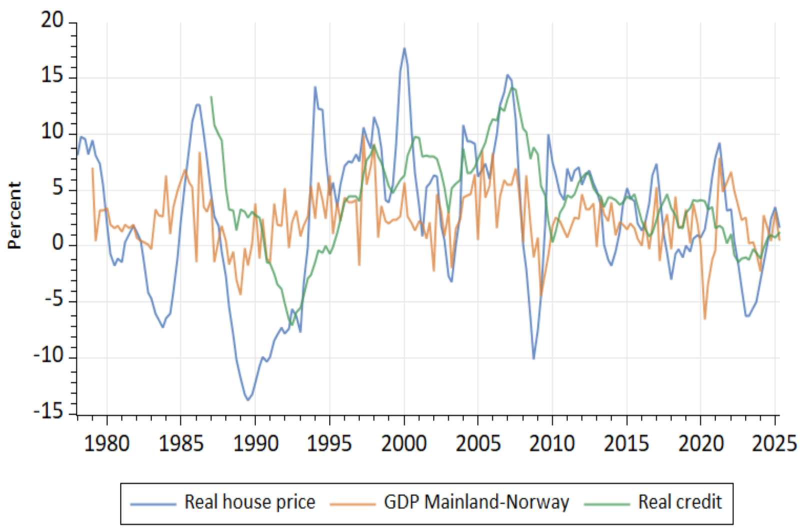


Figure 3.7: Four quarter percentage change: real house price index, real GDP Mainland-Norway and real credit (C2-indicator).

Figure 3.7 shows the four quarter growth rates in real housing prices together with real GDP growth and growth in real credit. A co-movement of housing prices and credit is clearly seen, with the house price index often turning before the credit variable, indicating that changes in house price growth could be a leading indicator for credit. The relationship between house prices and GDP growth is less clear and systematic, but the effect of the collapse of the housing market late in the 1980s is clearly seen in the GDP graph. The consequences of the fall in housing prices were not limited to the almost immediate reduction in consumption and increase in savings witch led to reduced GDP growth. As many households saw the value of their real wealth (dominated by residential capital) fall short of their mortgage (negative equity), financial consolidation set in (Eika and Nymoen (1992)) at the same time as demand for housing took a new downward turn. The consequences for the real economy of were seen in the labour market: the rate of unemployment rose to a level that has not been seen since before WW-II.

NAM aims to quantify several of the relationships between the financial sector, the real economy and asset markets in a way that can aid for example macroeconomic surveillance. First there is a two-way relationship between surges in bank lending and asset prices. This relationship may be stronger in the case of real estate (NAM presently includes housing and does not include commercial property) than with equity. Equity markets may be less stable than housing markets in the first place though, meaning that even empirically quite weak relationship between credit and equity prices have to be "kept in the picture" when the purpose is financial stability assessment.

When a combined bank lending/property boom occurs, there is an increased likelihood of financial fragility occurring, although the lags in the process can be quite long. Financial fragility or instability can have damaging consequences for the real economy even if a full blown banking crisis is avoided. First, since cost-trade is likely to increase, the required rate of return may increase which can lead to reductions or cancellation of planned real investments. Second, even before a liquidity crisis, financial firms may want to increase interest rates in order to maintain their solidity. If the household sector is highly leveraged, the response will typically be to increase savings and avoid default. As is well known empirically, the negative consequence for aggregate demand may then be sudden and large. It is an aim to represent such complex response scenarios in NAM.

3.8.2 Economic theory of housing price formation and credit

The most commonly used framework in econometric time studies of housing prices using time series data is the life-cycle model of housing, see e.g. the seminal contribution of Dougherty and Van Order (1982), which is well founded in standard theory. In this section, we follow the exposition in Anundsen (2014, Introduction). Starting from the assumption of a representative consumer that maximizes his lifetime utility with respect to housing services, and consumption of other goods, the following equilibrium condition can be shown

$$MRS = P_h \left[(1-\tau) - \frac{\dot{P}_c}{P_c} - \delta - \frac{\dot{P}_h}{P_h} \right]. \tag{3.43}$$

MRS is the marginal rate of substitution in consumption. P_h is the housing price and P_c is the price of the consumption good, τ is the marginal tax rate, and δ is the rate of depreciating housing capital. $\dot{P}_c$ and $\dot{P}_h$ denote time derivatives. (3.43) states that the marginal rate of substitution between housing and the composite consumption good is equal to what it costs to own one unit of a property. Since the housing market also contains a rental sector, market efficiency requires the following condition to be satisfied in equilibrium

$$Q = P_h \left[(1-\tau)i - \frac{\dot{P}_c}{P_c} - \delta - \frac{\dot{P}_h}{P_h} \right] \tag{3.44}$$

where Q_t is the real imputed rent on housing services. Hence, the price-to-rent ratio is proportional to the inverse of the user cost:

$$\frac{P_h}{Q} = \frac{1}{UC} \tag{3.45}$$

where the user cost, UC, is defined as

$$UC = (1-\tau)i - \frac{\dot{P}_c}{P_c} + \delta - \frac{\dot{P}_h}{P_h}. \tag{3.46}$$

The real imputed rent is unobervable, but two approximations are common. Either to let the imputed rent be proxied by an observable rent R, or to assume that it is proportional to income and the stock of housing. Relying on the first approximation, the expression in (3.45) would read:

$$\frac{P_h}{Q} = \frac{1}{UC} \tag{3.47}$$

while if we instead assume that the imputed rent is determined by the following expression:

$$Q = B_0 Y^{\beta_y} H^{\beta_h},\ \beta_y > 0 \text{ and } \beta_h < 0$$

where Y denotes regular income and H represents the housing-stock, (3.45) becomes

$$P_h = \frac{B_0 Y^{\beta_y} H^{\beta_h}}{UC} \tag{3.48}$$

The expressions represented by (3.47) and (3.48) are commonly used as starting points in econometric models of housing price formation.

While the first has been used extensively in the US, it is less common in Europe, since the rental market is relatively small in countries such as e.g., the UK and Norway, or they may be heavily regulated in many continental European countries, Muellbauer (2012). The expression in (3.48) is similar to an inverted demand equation, and we now have seen how it can be derived from a life-cycle model.

3.8.3 The empirical model of housing prices and credit

In NAM we take the inverted demand function (3.48) as the main theoretical reference. However, the stylized relationship need to be modified somewhat in order to become become part of a useful empirical model. First, we replace it with:

$$p_h = \beta_0 + \beta_y y + \beta_h h - \beta_x x \tag{3.49}$$

where p_h,y and h are natural logarithms of the corresponding variables P_h,Y and H, while x denote a vector of variables that may be additional empirical determinants of the demand for housing. The interest rate, and the other components in the expression for UC, belong to the x_t vector. Households' anticipations about their wage income, and the availability and cost of credit are other candidates for inclusion in the vector with additional determinants of the demand for housing services (see below).

As noted, one motivation to study the housing market in a macroeconomic context may be found in the theoretical literature on financial accelerators (see e.g. Bernanke and Gertler (1989) and Kiyotaki and Moore (1997)). The idea behind the financial accelerator is that imperfections in the credit markets necessitates the need

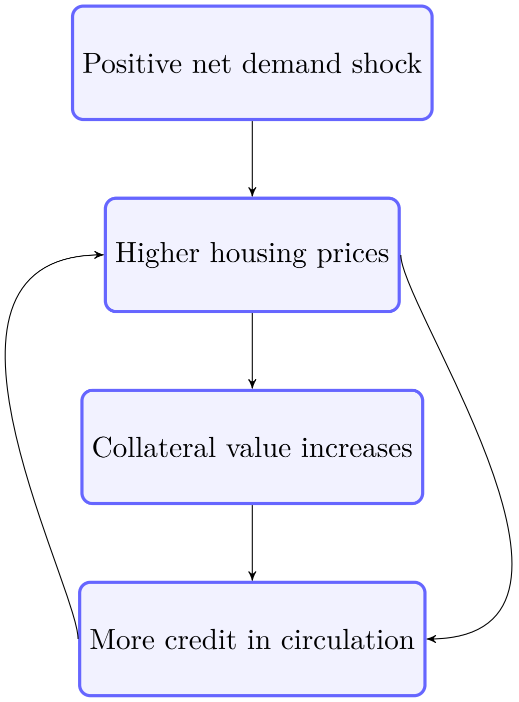


Figure 3.8: Two-way interaction between housing prices and credit

for collateral when a housing loan is granted. Consequently,these models demonstrate how imbalances in the financial markets may generate and amplify imbalances in the real economy, and vice versa.

Figure 3.8 illustrates the joint dependency between housing prices and credit. cf. Anundsen (2014, Ch. 1). Because the supply of housing is fixed in the short-run, a positive shock to the net demand of housing will quickly lead to higher prices in the housing market. Note that "shock" is interpreted widely in this context, and covers an increase in net demand which may be a response to model endogenous variables, the interest rate in particular. As noted above, increased property values if often recognized as increased collateral by banks and credit institutions, and the consequence may be that increased availability of credit can put further upward pressure on housing prices, as indicated in the figure.
The mutual positive relationship between credit and housing prices suggests framing the empirical modelling in a pair of relationships like

$$p_h = \beta_0 + \beta_d d + \beta_y y + \beta_h h - \beta_x x \tag{3.50}$$

$$d_h = \gamma_0 + \gamma_p ph + \gamma_2 y + \gamma_h h + \gamma_i ((1-\tau)i - \frac{\dot{P}_c}{P_c})) \tag{3.51}$$

In a world of credit marked imperfections and changing degrees of liquidity, it is possible that one or more of the factors in x_t operate in a non-linear way. For example, a relevant hypothesis is that households who have preference for liquidity will reduce their exposition in the housing market if the interest payment eats too deeply into disposable income. Such an "interest burden" effect is likely to be non-linear. In the empirical modelling we represent it by a threshold-function. When the interest payment rate is below the threshold, there is little effect of an increase in the interest rate. But on the threshold, an increase in interest rate payments can lead to large reduction in housing demand.

The following table lists the main variables in NAM that we have used in the empirical modelling of housing prices and credit to households (they are also listed in Chapter 4 along with the full set of variables)

Variable name	Description
PH	House price index
CPI	Consumer price index
$YDCD$	Disposable income to households
RLH	Interest rate of private credit to households
BGH	Gross debt in the household sector (total credit)
HK	Residential housing capital stock
$T2CAPH$	Tax rate.
HS	Housing starts (dwelling units)

Moreover, it is reasonable to interpret the theoretical framework as a theory of real house price and real-credit to households. In terms of NAM variables, the real variables referred to om the theory above are therefore: $P = PHN/CPI$ (real house price), $Y = YD/CPI$ (real disposable income to households) and $D = BGH/CPI$ (real credit to households). Housing stock, the variable named HK in NAM, is already a real variable, so we only simplify the notation by denoting the stock of housing capital by H in (3.48).

Using the variables in the NAM database, we measure the after tax real-interest rate $(1-\tau)i - \frac{\dot{P}_c}{P_c})$ as:

$$ri = (1 - T2CAPH)RLH - INF$$

where INF is the annual rate of inflation based on CPI.

In order to construct the liquidity variable mentioned above we have first created the interest rate payment from BGH and the quarterly interest rate (not RL which is an annualized interest rate). The ratio of interest payment to income is denoted $RUHYD$ below. We use a non-linear (logistic) transform of this variable:

$$rynl = \frac{1}{1 + \exp(-200(RUHYD - 0.13))}$$

which is like a step-indicator function, but with 0.13 as the threshold value (based on history, but it can be changed by the model user).

The results from econometric modelling give support of two cointegration relationships that are modifications of (3.50) and (3.51) along the lines just described:

$$log(PH/CPI) = 0.6log(BGH/CPI) + 1.6(log(YHP/CPI)) - log(HK)) - 0.2rynl \tag{3.52}$$

$$\begin{aligned} log(BGH/CPI) = {} & 0.95log(PH/CPI) - 0.95(log(YDCD/CPI) - log(HK)) \\ & - 0.1ri \end{aligned} \tag{3.53}$$

Chapter 5.9 contains the detailed results from estimating a simultaneous equations model for the growth rates of PH and BGH. The results confirm that the two variables are closely associated, in particular in the medium and long run perspective. The equilibrium correction terms based on (3.52) and (3.53) are both highly significant, confirming that the two are relevant cointegration relationships.

As a result, both credit and the housing price indices are predicted to grow more slowly when the cost of lending is increased. Moreover, a tightening of credit conditions (a negative credit shock) will cool down the housing market according

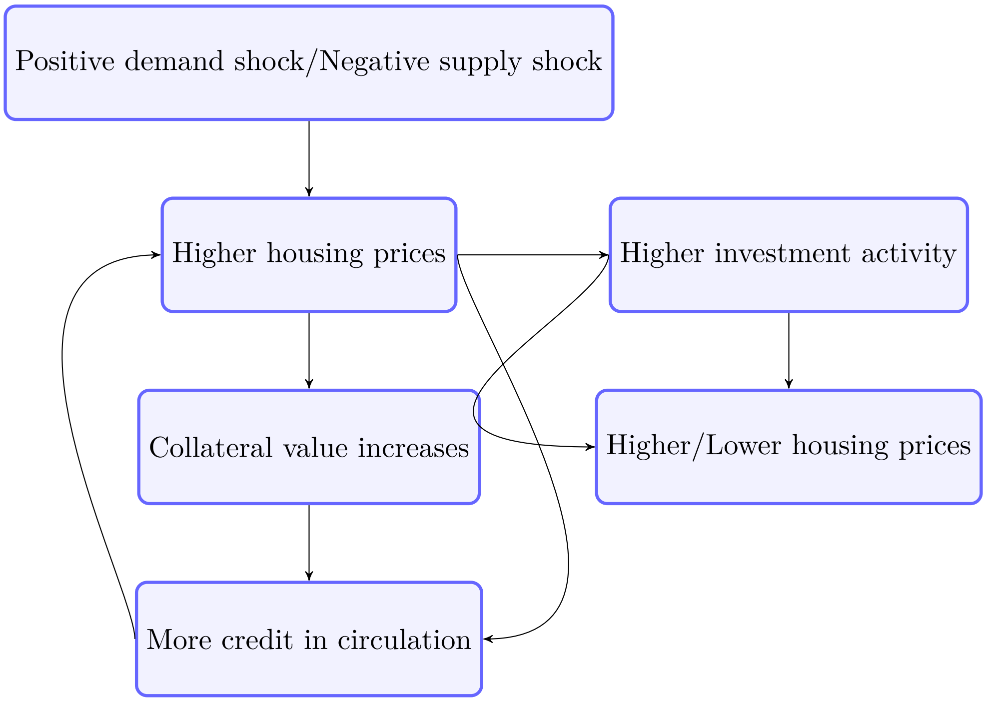


Figure 3.9: House price and credit system extended with effects of investments, which over a period of time will have a notable effect on the supply of housing services, cf section 3.2.3.

to our results. Conversely, a buoyant housing market can for long periods of time become self-propelled, since rising house prices can be used a collateral for credit to finance house purchases.

As noted, the econometric sub-model for PH and BGH is conditional on the housing stock. However, we have seen above that building activity is estimated to respond positively to increases in the real price of housing. When we take the effect on housing capital formation into account, we get the more complete picture in Figure 3.9, suggesting that there may be additional effects that can both increase or reduce the initial price hike after a positive demand shock. Higher investment activity will gradually increase housing supply, which will work in the direction of price reduction (and stabilization of the market). On the other hand, unless the effect on prices is quite large, the perceived total collateral value in the housing marked may still be increasing, also during a building boom caused by increase real price of housing. If that effect dominates in the medium run, we have a situation where demand is increasing in the price of the good. And upward sloping demand curves are not good news for market stabilization.

What this boils down to, is that the self-regulatory, stabilizing mechanisms in the housing and credit markets may be too few, and too weak, to support a strong belief in 'inherent stability' in the dynamic process between housing prices and credit. Hence, the discussion about housing market 'bubbles' versus fundamental drivers of house prices.

That said, supply growth is only one possible check on the credit-house price spiral. The price of credit, the real interest rate in our formulation, is another. If the interest rates is allowed to function as as equilibrating mechanism in the deregulated and liberalized capital market, both credit and capital formation are likely to develop more smoothly than they will do if the interest rate is decoupled from the capital markets. This is however exactly what might happen if the interest rate is used for activity control or (even more evidently) for exchange-rate targeting, see e.g., Anundsen et al. (2014).

However, in our model, there is a third check on housing demand, and that is the non-linear effect of interest payment. Empirically, when interest expenses pass a threshold value relative to private income, Norwegian households have increased their financial savings sharply. Financial consolidation may lead to a sharp fall in housing prices. Hence we finally have a stabilizing mechanism. But since financial consolidation also affects product marked demand, this check on house price growth also comes with a negative effect on the real economy.

Assets prices and the macro economy
Several asset prices are endogenous variables in NAM. They are of interest in they own regard, but even more so because of the several joint dependencies between asset prices and the real economy.

Above we have mentioned the importance of total wealth for aggregate demand conditions. The market for foreign exchange is another asset market with a huge macroeconomic influence, in particular in a small open economy like the Norwegian.

Chapter 3.8 presents how the price index of housing is modelled in NAM as an "inverted demand function" for housing. Because housing demand depends on the interest rate and on credit conditions there is also relationship between monetary policy and the housing and credit marked.

The price of equity is a factor in firms' investments decisions, cf. Chapter 3.2.2. In NAM, the stock exchange price index is modelled as function of foreign stock prices, see Chapter 3.11 and the detailed estimation results in 5.15.1 and 5.15.2.

Debt and credit indicator (C2)
The main variable representing household debt is NAM is BGH which is modelled jointly with the housing price index. BGH conforms to the calculation of interest payments in the income accounts in the Norwegian quarterly national accounts which will be incorporated in a later version of the model. BGH is also similar to, but not identical with, the C2-indicator for household credit, which is NAM variable $K2HUS$. The link between BGH and $K2HUS$ is taken care of by simple estimated relationship in Chapter 5.10.1.

For completeness, NAM also contains equations for C2 to firms, see chapter 5.10.2, and to Norwegian municipalities, see chapter 5.10.3.

3.9 Households' assets and wealth

The value of residential housing ($PH \cdot HK$) is a dominant asset in total household wealth, the second component is net financial wealth: $BFH - BGH$, where BGH is determined jointly with the housing price index as noted above. The gross amount of financial assets held by households (BFH) is defined as:

$$BFH = BFHM + BFHA + BFHR \tag{3.54}$$

where:

- BFHM: Household wealth: Money, bank deposits, bank securities and bonds.
- BFHA: Household wealth: Equity, pension and insurance entitlements.
- BFHR: Household wealth: Loans and other accounts receivable.

All the components above are financial variables that are integrated with the real economy, for example through household consumption and saving. The empirical model equations for the three components financial wealth are in chapter 5.14.

3.10 Interest rates

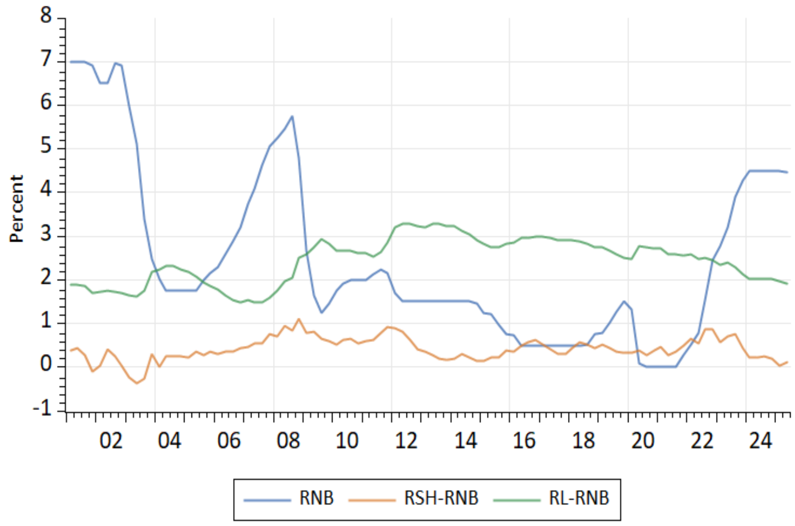


Figure 3.10: The policy interest rate (RNB); the difference between the interest rate on loans from Norwegian finance institutions to households and the policy rate (RL-RNB). The difference between the 3-month money market interest rate and the policy rate (RSH-RNB).

The interest rate level and the time structure of interest rates are formed by a combination of monetary policy and through market behaviour. In the case where Norges Bank forecasts inflation above the inflation target and a positive output-gap, the bank's projected interest rate will usually be adjusted upwards.[15] NAM includes an estimated "policy reaction function", see Chapter 5.11.7. This function has proven to be less stable than the theory of inflation targeting may have led us to believe. In the current version of the model, the function reflects the lasting impact of the financial crisis on monetary policy. In particular the estimation results show that the weight on inflation has been reduced to zero after the 2008q4. As a result, model users may find it practical to treat the policy interest rate as an exogenous variable in the model.

Money and credit markets usually respond to changes in monetary policy, and in this way the banks decisions affects interest rates paid on households' debt and on credit to non-financial firms. As documented above, these interest rates are important chains in the "transmission mechanism" of monetary policy in Norway under inflation targeting, also Bårdsen et al. (2003).

A high degree of liquidity in the Norwegian and international credit market represents the best climate for a smooth transmission of conventional monetary policy to market interest rates. Conversely, if the cost-of-trade increases in the capital market, liquidity is reduced. Loss of liquidity and trust means that the required rate of return will increase, even if the policy rate is kept constant or even reduced (in an attempt to counter reduced liquidity in the market with the use of

[15] In Norway, the key policy rate is the interest rate on banks' deposits up to a quota in Norges Bank. The official forecasts of the policy rate is published at http://www.norges-bank.no/en/price-stability/monetary-policy-meetings/key-policy-rate/ . The forecasts are adjusted in each monetary policy report.

conventional monetary policy). In such a situation there will be marked increases in difference between the 3-month money market rate and the policy rate. If the situation persists, the mortgage rate and the interest rate paid on credit to non-financial firm will also be pushed up, see e.g. Pedersen (2009)

Figure 3.10 shows evidence of a "cost-of-trade" driven increase in the difference between market interest rates and the policy rate, at least from mid-2007 to the outbreak of the international financial crisis in the autumn of 2008. The gap between the policy interest rate and the money market interest rate came down after (a short-lived) scare of major credit and job crisis also in Norway. Nevertheless, it was not until 2012 that this interest rate margin was reduced back to the pre-financial crisis level.

The estimated relationship between the policy interest rate (RNB) and the 3-month money market interest rate (RSH) is in Chapter 5.11.8. The results confirm that the risk-premium was temporarily affected during the financial crisis.

The evolution of the interest rate paid on loans to households and firms loans (NAM variable RL) also showed a market increase relative to the policy rate during the build-up to the international financial crisis. Unlike the money market rate, the gap between the market interest rate and the policy rate was not reduced right after the crisis was over. Instead it made a new jump in 2012. The increase in the interest rate margin for banks and other financial institutions has been interpreted as an adjustment to a post-crisis regulation regime with higher capital requirements than before, i.e., Basel-III. It is however not obvious that higher equity capital requirements need have a lasting impact on interest rate margins, see Admati et al. (2013). The equations for RLH (loans to households) and $RLBOLIGH$ (mortgage rate) have the same basic features, but with their own estimated coefficients.

Chapter 5.11.3 shows that in NAM RL is related to RSH, as expected, and to the yield (RBO) on 5-year Norwegian government bonds. The dependency of RL on RBO reflects the high degree of integration between different segments of the credit marked.

Table 5.11.1 and table 5.11.2 contain the estimated relationships between the 3-month rate and the 5-year and 10-year ($RBOTENY$) government bond yields. Judging by the results, the two bond rates appear to follow a well defined term structure of interest rates relationship.

3.11 Stock exchange price indices

As noted above, the stock exchange valuation of Norwegian companies is one of the factors that influence gross capital formation and credit to the private business sector.

In NAM, we model the MSCI equity price for Norway (PA) and the MSCI for the world (PAW). Concretely, we model the logarithm of PA conditional on the logarithm of PAW. We follow custom and regard $log(PAW_t)$ as a random walk with drift (meaning that we abstract from the diffusion term).

The drift term is regarded as consisting a risk-free rate plus a risk-premium and minus dividend yield. The risk free rate is typically set to 2 % - 3 %. For the risk-premium, the broad historical average of 5 % may seem to be very high given the current outlook for the growth of the world economy. For the same reason the usual dividend yield assumption of 4 % (1880-2014) now seems relatively optimistic.

Based on judgment we have settled for a drift term of 4 % (= 3 % + 3 % -2 %), meaning the the dependent variable is $\Delta log(PAW_t - 0.04)$. The estimation results in section 5.15.2 show that there is a stable positive autocorrelation in the series (with a coefficient of circa 0.3). The only covariate that we include in the present version of the model is the acceleration in international trade ($\Delta^2 log(EMI_t)$.

In section 5.15.1, the results for the Norwegian MSCI are reported. We find that $\Delta log(PA_t$ react one-for-one with $\Delta log(PA_t$, or even a little stronger, reflecting that the narrower Norwegian MSCI is more volatile than the world MSCI. We also find, as can be expected since our sample starts in 1985, that the Norwegian MSCI is influenced by the real price of oil.

3.12 Government revenues and expenses

In NAM, the total revenue (OFFIA) to general government is the sum of seven income components. The classification of incomes is given by the data provided by Statistics Norway.[16] Running expenses (OFFUB) consist of nine components. Total expense (OFFUF) in addition included the cost of capital acquisition and use of capital.

General government, net lending/borrowing ($OFFNFIN$) is defined as:

$$OFFNFIN = OIFFA - OFFUD \tag{3.55}$$

The detailed estimation results of the model equations of the revenue and expense components are found in chapter 5.17.

3.13 The banking module

In 2025 a banking module was added to NAM-FT, complete with variables that represent the income statement and balance sheet of the Norwegian banking sector as a whole — which we will refer to as *the macrobank*. Together with variables that represent non-performing loans and losses, which have been part of NAM-FT since 2016, the model of the macrobank makes out the banking module of NAM.

The bank module contains variables that represent the income statement, balance sheet, and capital adequacy of the Norwegian banking sector as a whole. Its inclusion enables more comprehensive analyses of the mutual interactions between the real economy and financial markets on one hand, and the banking sector on the other.

In terms of more specific usage, the extension provides an improved framework for macroeconomic scenarios, used by Finanstilsynet's[17] model based stress testing of Norwegian banks' capital adequacy and analyses of financial stability.

As mentioned above, the macrobank variables can be divided into income statement variables and balance sheet variables, as listed in Table 3.2.

One of the variables in the table has not been modelled and is therefore an exogenous variable in the model: It is BAAEKTRANS, *Other equity transactions*. The other 21 variables in Table 3.2 are endogenous variables in the model, either by estimated equations or by identities.

The number of econometric relationships is 14. These equations are documented in sub-chapter 5.18. Explanatory variables include both real economy and financial market variables. Seven of the variables in Table 3.2 are given by accounting identities. They are found in chapter 4, together with the other NAM variables that are given in by identities

[16]https:www.ssb.noenstatbanktable11130

[17]Financial Supervisory Authority of Norway

Table 3.2: Variables in the banking module from the banks' income statement and balance sheet. All variables are measured in NOK million.

Income statement		**Balance sheet**	
Interest income	BARI	**Assets**	
Interest expenses	BARK	Gross loans to personal customers	BAUTLPM
Net interest income	BANRI	Gross loans to non-financial corporations	BAUTLBM
Net commission and fee income and changes in the value of financial instruments	BAPROVI	Gross loans to other Norwegian and foreign customers	BAUTLREUT
Other income, including dividend received	BAAI	Gross loans to customers	BAUTL
Salaries, other costs and depreciation	BALOENNK	Fixed-income securities	BARENTVP
Operating profits	BADR		
Loan losses	BATAP	**Liabilities and equity**	
Pre-tax profits	BARESFS	Deposits from customers	BAINNSK
Profit after tax	BARES	Wholesale funding	BAMFIN
		Equity	BAEK
Payment of dividends etc.	BAUTB	Total assets	BAFVK
Other equity transactions	BAAEKTRANS		

Table 3.3 shows variables that are related to capital adequacy reporting and assessment. Two of the variables are exogenous in the model: 'Common Equity Tier 1 (CET1) capital requirement' and 'Dividends etc. as a share of profits after tax'. The first of these is mainly institutionally determined, currently between 18 and 10 percent. Payment of dividends is determined by the banks themselves. When the model is used for scenario-analysis the baseline scenario will involve an assumption about normal dividends.

The most important data sources are the banks' reported accounting figures (key figure reporting and ORBOF) and capital adequacy reporting (COREP). When using historical data, taken mainly from various publications from Statistics Norway, Norges Bank and Finanstilsynet, time series have been constructed for most of the variables in the banking module back to 1987.

Table 3.3: Variables in the banking module from the banks' capital adequacy reporting and other variables

Capital adequacy		**Other variables**	
CET1 capital	BARKK	Dividends etc. as share of profits after tax	BAUTBAN
Risk-weighted assets	BARWA	Problem loans in percent of gross lending, personal customer market	PLOANP
CET1 capital requirement	BAKRKK	Problem loans in percent of gross lending, corporate market	PLOANB
		Losses on loans in percent of gross loans, personal customer market	LOSSPERS
		Losses on loans in percent of gross loans, corporate market	LOSSBUSI

CET1 capital and Risk-weighted assets are measured in NOK million.
The other variables are ratios or stated in per cent.

So far, two feedback effects from the banking module to the other NAM-variables have been established. ‘Banks’ losses on loans to personal customers’ is an explanatory variable (with a negative sign) in the equation for ’gross debt in the household sector’, which in turn has an effect on the variables ’gross debt from domestic institutions held by households (C2)’ and ’banks’ gross loans to personal customers’.

‘Share of problem loans in the corporate market’ is an explanatory variable (with a negative sign) in the equation for ’gross debt from domestic institutions held by non-financial firms (C2)’, which in turn has an effect on the variable ’banks’ gross loans to non-financial firms’. Although the model extension is now included in the operational NAM-FT model, the development phase is not over. Ongoing efforts will focus on evaluation and further development, including the establishment of feedback effects from the banking module to other parts of NAM, as well as the quality assurance of historical data.

As noted, the banking module contains equations for problem loans as a share of banks’ loans to both personal borrowers and firms as well as equations for banks’ losses on loans to personal borrowers and firms. The problem loan equations and the equations for banks’ losses on loans to firms and households are estimated on data that also cover the Norwegian banking crisis in the early 1990s.

Non performing loans

Banks’ problem loans are defined as the sum of non-performing loans and performing loans that are loss impaired. The proportion of problem loans to personal borrowers depends on the real interest rate, interest burden, unemployment and change in Mainland (non-oil) Norway’s GDP. In the event of an increase in the interest burden and transition to unemployment, households’ liquidity position will tighten, impairing households’ debt-servicing capacity. A weak trend in activity levels for the Norwegian economy will lead to poorer debt-servicing capacity among households in subsequent periods. The impact of an increased interest burden and increased unemployment is stronger when the interest burden or unemployment is high than when the interest burden or unemployment is low. The proportion of problem loans to firms is determined by the real interest rate, interest burden, unemployment and oil price. Nonfinancial firms’ aggregate profits are reduced by higher debt interest rates and a lower oil price. In addition, banks’ share of problem loans to firms are sensitive to unemployment levels, since households’ income lapse resulting from high unemployment reduces firms’ profitability and hence their debt servicing capacity. The impact of an increased interest burden for firms and increased unemployment is, as in the case of households, particularly strong when the interest burden or unemployment approach and pass certain levels.

Loan losses

In the empirical model equation, banks’ losses on loans to personal borrowers increase when households’ interest burden rises. The effect is stronger if households’ interest burden is high initially than if it is low. In the model, banks’ losses on loans to firms is negatively related to GDP growth and to the oil price level. Losses are positively related to firms’ interest burden. The effect of an increased interest burden is stronger if the initial interest burden is high than if it is low.

In addition to the effects mentioned above, the model equations for problem loans and losses include estimated effects from the developments of housing prices and commercial property prices. This effect is highly non-linear. The tendencies of problem loans and losses to rise are mainly important in scenarios characterized by relatively long sequences of negative price changes on commercial property and on housing.

3.14 Price of commercial property

Commercial property is a source of income to the banking sector. But it also represents a huge risk factor. It is therefore a functional connectieon between the price of commercial property and the banking module.

The current version of the model makes use of the decomposition of $PCPO$ in terms of rent ($RENTCPO$) and yield ($YIELDCPO$):

$$log(PCPO_t) = log(RENTCPO_t) - log(YIELDCPO_t).$$

$RENTCPO$ and $YIELDCPO$ are modelled by econometric equations, see 5.18.17 for details. The main factors captured by the model of $RENTCPO$ are economic growth in mainland-Norway, the change in the stock price index and the rate of unemployment. In addition, as a long term feature, the rent level is linked to the nominal path of the Norwegian economy.

$YIELDCPO$ is a basically a function of the interest rate level, represented by RBO (5 year government bond). The change in the unemployment rate and the acceleration of housing prices are included as indicators of risk, and the model user can implement addition risk premium by the specification of add-factor for this equation.

4

Variable list

In this section we list the main NAM variables by name and a brief definition.

Endogenous variables are underlined. If an endogenous variable is a definition, the corresponding identity equation in the model is placed directly below the variable definitions.

For the variables that are endogenized with econometric equations, the reference to the chapter with the estimation results is included.

A Total exports. Fixed prices. Million kroner.
A = ATRAD + AOIL + ATJEN + ASKIP

AF Exports, Mainland-Norway. Fixed prices. Million kroner.
AF = ATRAD + ATJEN

AGR Growth in exports. Percent.
AGR = ((A - A(-4)) / A(-4))*100

AKUSTYRK Labour force, Labour force survey. Thousand persons.
AKUSTYRK = AKULED + AKUSYSS

AKULED Number of unemployed persons, Labour force survey. Thousand persons. Chapter 5.7.1

AKUSYSS Number of employed persons, Labour market survey. Thousand persons. Chapter 5.7.4.

ALDERPEN Number of old age pensioners. Chapter 5.8.1.

AOIL Exports of oil and natural gas, fixed prices. Million kroner.

AOILGR Growth in export of oil and gas. Percent.
AOILGR = ((AOIL - AOIL(-4)) / AOIL(-4))100

ARBDAG Number of working days per quarter.

ASKIP Exports of ships and oil plattforms. Fixed prices. Million kroner. Chapter 5.2.3.

ATJEN Exports of services, Fixed prices. Million kroner. Chapter 5.2.2.

ATRAD Exports of traditional goods. Fixed prices. Million kroner. Chapter 5.2.1.

ATJENGR Growth in export of services. Percent.
ATJENGR = ((ATJEN - ATJEN(-4)) / ATJEN(-4))*100

ATRADGR Growth in export of traditional goods. Percent.
ATRADGR = ((ATRAD - ATRAD(-4)) / ATRAD(-4))*100

B Total imports Fixed price. Million kroner. Chapter 5.3.6.

BAAEKTRANS Banks, other equity transactions. Million kroner.

BAAI Banks, other income including dividends. Million kroner. Chapter 5.18.1

BADR Banks, Banks, operating profits. Million kroner.
BADR= BARI-BARK + BAAI- BALOENNK + BAPROVI

BAEK Banks, equity. Million kroner.
BAEK = BAEK(-1) + (1 - BAUTBAN)BARES + BAAEKTRANS

BAFVK Banks, total assets. Million kroner. Chapter 5.18.2.

BAINNSK Banks, deposits from customers. Million kroner. Chapter 5.18.3.

BAKDIST Banks, difference between BARKKD and CET1 capital requirement (including buffer requirements). Percent.
BAKDIST = BARKKD - BAKRKK

BAKRKK Banks, CET1 capital requirement. Percent.

BALOENNK Banks, salaries other costs and depreciations. Million kroner. Chapter 5.18.4.

BAMAFVK Banks, wholesale funding as share of total assets. Percent.
BAMAFVK = BAMFIN/BAFVK

BAMFIN Banks, wholesale funding. Million kroner.
BAMFIN = BAFVK - BAINNSK - BAEK

BANRI Banks, net interest income. Million kroner.
BANRI = BARI - BARK

BANRI_FVK Banks, net interest income as share of total assets. Percent.
BANRI_FVK = (BANRI*4//BAFVK)100

BAPROVI Banks, net commissions and changes in value of financial instruments. Million kroner. Chapter 5.18.5.

BAPROVI_FVK Banks, net commissions and changes in value of financial instruments as share of total assets. Percent.
BAPROVI_FVK = (BAPROVI*4/BAFVK)*100

BARENTVP Banks, fixed income securities. Million kroner. Chapter 5.18.6.

BARES Banks, profits after tax. Mill NOK. Chapter 5.18.7.

BARES_BARKK Banks, profits after tax as share of CET1 capital. Percent.
BARES_BARKK = (BARES*4/BARKK)100

BARESFS Banks, pre-tax profits. Million kroner. Chapter 5.18.8. MILL NOK.

BARESFS_FVK Banks, earnings before tax as share of total assets. Percent.
BARESFS_FVK = (BARESFS*4/BAFVK)100

BARI Banks, interest income. Million kroner. Chapter 5.18.9.

BARI_FVK Banks, interest income as share of total assets. Percent.
BARI_FVK = (BARI*4//BAFVK)100

BARK Banks, interest expense. Million kroner. Chapter 5.18.10.

BARKK Banks, CET1 capital. Million kroner. Chapter 5.18.16.

BARKKD Banks, CET1 capital a share of risk weighted assets. Percent.
BARKKD = (BARKK/BARWA)*100

BARK_FVK Banks, interest expense as share of total assets. Percent.
BARK_FVK = (BARK*4//BAFVK)100

BARKK_FVK Banks, CET1 capital a share of total assets. Percent.
BARKK_FVK = (BARKK/BAFVK)*100

BARWA Banks, risk weighted assets. Million kroner. Chapter 5.18.11.

BARWA_FVK Banks, risk weighted assets as share of total assets. Percent.
BARWA_FVK = (BARWA/BAFVK)*100

BATAP Banks,loan losses. Million kroner. Chapter 5.18.12.

BATAP_FVK Banks, loan losses as share of total assets. Percent.
BATAP_FVK = (BATAP*4/BAFVK)100

BAUTB Banks, payment of dividends etc. Million kroner.
BAUTB = BARES*BAUTBAN

BAUTLBM Banks, gross loans to non-financial corporations. Mill NOK.

BAUTLPM Banks, gross loans to personal customers. Million kroner. Chapter 5.18.14.

BAUTLREUT Banks, gross loans to other Norwegian and foreign customers. Mill NOK. Chapter 5.18.15.

BASELIII Dummy for BASEL III regulatury regime.

BEF1564 Population, 15-64 years old. Thousand persons.

BEF1574 Population, 15-74 years old. Thousand persons.

BFH Household wealth, gross financial assets held by households. Million kroner.
BFH = BFHA + BFHM + BFHR

BGH Gross debt in the household sector, Million kroner. Chapter 5.9.

BGHINF Household debt growth.
BGHINF= (BGH/BGH(-4)-1)*100

BGHYD Debt income ratio in the household sector. Percent.
BGHYD = BGH*100/(YDCD+YDCD(-1)+YDCD(-2)+YDCD(-3))

BFHA Household wealth:Equity, pension and insurance entitlements. Million kroner. Chapter 5.14.2

BFHM Household wealth: cash, bank depostits, money market depostits bonds. Million kroner. Chapter 5.14.1

BFHR Household wealth: loans and other accounts receivable. Million kroner. Chapter 5.14.3.

CDS1EURO Europe bank sects CDS INDEX 5Y - CDS PREM. MID, EUROS.

CO Public consumption expenditure. Fixed prices. Mill. NOK

COGR Public consumption growth.
COGR = ((CO - CO(-4)) / CO(-4))*100

COSHARE Government consumption share of mainland Norway GDP.
COSHARE = CO/YF

CORG Consumption expenditure by NPISHs. Fixed prices, Million kroner.

CO2_HOUS_UTS Climate gas emissions from households, Mainland-Norway. Thousand tons CO_2 equivalents.
log(CO2_HOUS_UTS) = -log(1000)+1*log(CO2_HOUS_INT*(CP-CORG))

CO2_INNSATS_UTS Climate gas emissions non quota-system industries. Thousand tons CO_2 equivalents.
CO2_INNSATS_UTS = CO2_YFP2_UTS + CO2_YFP3_UTS +CO2_YO_UTS+CO2_HOUS_UTS

CO2_KVOTE_UTS Climate gas emissions quota-system industries. Thousand tons CO_2 equivalents.
CO2_KVOTE_UTS = CO2_YFP1_UTS +CO2_YOIL1_UTS

CO2_TOTAL_UTS Climate gas emissions in total. Thousand tons CO_2 equivalents.
CO2_TOTAL_UTS = CO2_Y_UTS +CO2_HOUS_UTS

CO2_Y_UTS Climate gas emissions from business. Thousand tons CO_2 equivalents.
CO2_Y_UTS = CO2_YF_UTS+CO2_YOIL1_UTS+CO2_YUSF_UTS

CO2_YF_UTS Climate gas emissions from business, Mainland-Norway. Thousand tons CO_2 equivalents.
CO2_YF_UTS = CO2_YF_UTS = CO2_YFP1_UTS + CO2_YFP2_UTS + CO2_YFP3_UTS+CO2_YO_UTS

CO2_YFP1_UTS Climate gas emissions, manufacturing. Thousand tons CO_2 equivalents.
log(CO2_YFP1_UTS) = -log(1000)+1*log(CO2_YFP1_INT*YFP1)

CO2_YFP2BA_UTS Climate gas emissions, construction. Thousand tons CO_2 equivalents.
log(CO2_YFP2BA_UTS) = -log(1000)+1*log(CO2_YFP2BA_INT*YRBA)

CO2_YFP2EGV_UTS Climate gas emissions, hydroelectric power production, gas and steam. Thousand tons CO_2 equivalents.
log(CO2_YFP2EGV_UTS) = -log(1000)+1*log(CO2_YFP2EGV_INT*YREGV)

CO2_YFP2FFA_UTS Climate gas emissions, fishing and aqua-culture. Thousand tons CO_2 equivalents.
log(CO2_YFP2FFA_UTS) = -log(1000)+1*log(CO2_YFP2FFA_INT*YRFFA)

CO2_YFP2JS_UTS Climate gas emissions, agriculture and forestry. Thousand tons CO_2 equivalents.
log(CO2_YFP2JS_UTS) = -log(1000)+1*log(CO2_YFP2JS_INT*YRJS)

CO2_YFP3VARE_UTS Climate gas emissions, retail trade and motor vehicle repairs. Thousand tons CO_2 equivalents.
log(CO2_YFP3VARE_UTS) = -log(1000)+1*log(CO2_YFP3VARE_INT*YRVRM)

CO2_YFP3TRAN_UTS Climate gas emissions, other services, transport activities excl. ocean transport. Thousand tons CO_2 equivalents.
log(CO2_YFP3VARE_UTS) = -log(1000)+1*log(CO2_YFP3VARE_INT*YRAT1)

CO2_YFP3UTRANVARE_UTS Climate gas emissions, other services, misc.. Thousand tons CO_2 equivalents.
log(CO2_YFP3UTRANVARE_UTS) = -log(1000)
+X*log(CO2_YFP3UTRANVARE_INT*(YFP3-YRVRM-YRAT1)

CO2_YOIL1_UTS Climate gas emissions, oil and gas production. Thousand tons CO_2 equivalents.
log(CO2_YOIL1_UTS) = -log(1000)+1*log(CO2_YOIL1_INT*YOIL1)

CO2_YO_UTS Climate gas emissions, general government administration. Thousand tons CO_2 equivalents.
log(CO2_YO_UTS) = -log(1000)+1*log(CO2_YO_INT*YO)

CO2_YUSF_UTS Climate gas emissions ocean transport. Thousand tons CO_2 equivalents.
log(CO2_YUSF_UTS) = -log(1000)+1*log(CO2_YUSF_INT*YUSF)

CO2_HOUS_INT Emission intensity, private households. Tons of CO_2 equivalents per million NOK consumption expenditure (fixed price).

CO2_YFP1_INT Emission intensity, manufacturing. Tons of CO_2 equivalents per million NOK value added (fixed price).

CO2_YFP2BA_INT Emission intensity, construction. Tons of CO_2 equivalents per million NOK value added (fixed price).

CO2_YFP2EGV_INT Emission intensity, hydroelectric power production, gas and water supply. Tons of CO_2 equivalents per million NOK value added (fixed price).

CO2_YFP2FFA_INT Emission intensity, fishing and aqua-culture. Tons of CO_2 equivalents per million NOK value added (fixed price).

CO2_YFP2JS_INT Emission intensity, agriculture and forestry. Tons of CO_2 equivalents per million NOK value added (fixed price).

CO2_YFP3VARE_INT Emission intensity, retail trade and motor vehicle repairs. Tons of CO_2 equivalents per million NOK value added (fixed price).

CO2_YFP3TRAN_INT Emission intensity, other services, transport activities excl. ocean transport. Tons of CO_2 equivalents per million NOK value added (fixed price).

CO2_YFP3UTRANVARE_INT Emission intensity,other services, misc.. Tons of CO_2 equivalents per million NOK value added (fixed price).

CO2_YOIL1_INT Emission intensity, oil and gas production. Tons of CO_2 equivalents per million NOK value added (fixed price).

CO2_YO_INT Emission intensity, general government administration. . Tons of CO_2 equivalents per million NOK value added (fixed price).

CO2_YUSF_INT Emission intensity, ocean transport. Tons of CO_2 equivalents per million NOK value added (fixed price).

CP Private consumption expenditure, housholds and NPISHs. Fixed prices. Million kroner. Chapter 5.2.4

CPGR Private consumption growth. Percent.
CPGR = ((CP / CP(-4)) - 1)*100

CPI Consumer price index. Chapter 5.4.9

CPIJAE Consumer price index adjusted for energy and taxes. Chapter 5.4.21

CPIJAEINF Growth rate of CPIJAE. Percent.
CPIJAEINF = ((CPIJAE / CPIJAE(-4)) - 1)*100

CPIEL Electricity price component of consumer price index. Chapter 5.4.22

CPIELINF Growth rate of CPIEL (energy part of CPI). Percent.
CPIELINF = ((CPIEL- CPIEL(-4)) / CPIEL(-4))*100

CPIVAL Nominal effective exchange rate index. Chapter 5.5.1

CR Real credit, C2. Fixed prices. Million kroner.
CR = (K2 / CPI)

CRGR CR, percentage change.
CRGR = ((CR / CR(-4)) - 1)*100

CRRATIO Credit rate (C2) households. Percent.
CRRATIO = (CR / (0.25*(YF+YF(-1)+YF(-2)+YF(-3))))*100

DAGPENG Number of unemployment benefit claimants. Thousand persons. Chapter 5.7.3.

DEPR CPIVAL percentage change. Percent.
DEPR = ((CPIVAL - CPIVAL(-4)) / CPIVAL(-4))*100

DEPREURO SPEURO change. Percent.
DEPREURO =((SPEURO - SPEURO(-4)) / SPEURO(-4))*100

DEPRUSD SPUSD change. Percent.
DEPRUSD =((SPUSD - SPUSD(-4)) / SPUSD(-4))*100

DJLOFY Changes of changes in stocks and statistical discrepancies as percent of GDP. Percent.
DJLOFY = (D(JL)/Y)*100

DOMD Domestic expenditure (demand). Fixed prices. Million kroner.
DOMD = CP + CO + JF

DRIFTH Private income from operating surplus. Million kroner. Chapter 5.12.2.

EMI Export market indicator index.

EMIGR Growth in export marked indicator EMI. Percent.
EMIGR = ((EMI / EMI(-4)) - 1)*100

EUROINF PCEURO change. Percent.
EUROINF = ((PCEURO - PCEURO(-4)) / PCEURO(-4))*100

FHSF Average working time for self-employed persons. Thousand hours. Chapter 5.6.11.

FHWFP Average working time for wage earners, private Mainland-Norway. Thousand hours.
FHWFP = TWFP/NWFP

FHWO Average working time for wage earners, government administration. Thousand hours.
FHWO = TWO/NWO

FHWOSJ Average working time for wage earners, oil and gas production and international transportation. Thousand hours.
FHWOSJ = TWOSJ/NWOSJ

HK Housing stock. Value of residential housing stock. Fixed prices. Million kroner. Chapter 5.16.

HPF Hours per full time equivalent wage earner, private business Mainland-Norway. Thousand hours.

IAR Inactivity rate.

$$IAR = \frac{(1 - (AKULED/(N + AKULED))}{SYSSRATE/100} - 1$$

HS Housing starts. Number of units. Chapter 5.2.6.

INF CPI inflation. Percent.
INF = ((CPIE - CPI(-4)) / CPI(-4))*100

INFJAE CPI-AET inflation. Percent.
INFJAE = ((CPIJAE - CPIJAE(-4)) / CPIJAE(-4))*100

IMR Gross labour immigration rate in percent of labour force. Percent.

J Total gross fixed capital formation (GFCF), fixed prices. Million kroner.
J = JO + JBOL+ JFPN + JOIL1 + JOIL2 + JUSF

JBOL Gross fixed capital formation (GFCF) in residential housing, fixed prices, Million kroner.

JBOLGR Residential housing investment growth. Percent.
JBOLGR = ((JBOL - JBOL(-4)) / JBOL(-4))*100

JF Total gross fixed capital formation (GFCF), Mainland-Norway. Fixed prices, Million kroner. Fixed prices.
JF = JBOL +JFPN +JO

JFP Gross fixed capital formation (GFCF), private Mainland-Norway. Fixed prices Million kroner.
JFP = JBOL +JFPN

JFPN Capital formation (GFCF) in private business Mainland-Norway. Fixed prices, mill. NOK, fixed prices. Chapter 5.2.8.

JFPNGR Private non-oil business investment growth. Percent.
JFPNGR = ((JFPN - JFPN(-4)) / JFPN(-4))*100

JL Changes in stocks and statistical discrepancies. Fixed prices. Million kroner.
JL = TOTS - CP - CO - J - A

JLOFY Changes in stocks and statistical discrepancies in percent of GDP.
JLOFY = (JL/Y)*100

JO Gross fixed capital formation (GFCF), general government. Fixed prices. Million kroner.

JOIL1 Gross fixed capital formation, production and pipeline transport. Firx prices. Million kroner.

JOIL2 Gross fixed capital formation, services incidental to oil and gas. Fixed prices. Million kroner.

JOIL Gross fixed capital formation (GFCF), oil and gass production and pipeline transportation (JOIL1), and related services (JOIL2), fixed prices. Million kroner.
JOIL = JOIL1 + JOIL2

JOILGR Growth in petroleum investments. Percent.
JOILGR = ((JOIL - JOIL(-4)) / JOIL(-4))*100

JUSF Gross fixed capital formation (GFCF), international shipping. Fixed prices. Million kroner.

KAIER Number of short term labour immigrants. Thousand persons.

KORRSPH Households' new deposits in pension funds. Million kroner.

K2 Gross debt from domestic institutions, C2-indicator. Million kroner.
K2 = K2IF+K2HUS+K2KOM

K2GR C2 change. Percent.
K2GR = ((K2 / K2(-4)) - 1)*100

K2HUS Gross debt from domestic institutions held by households, C2-indicator. Million kroner. Chapter 5.10.1.

K2HUSHINF Growth in C2 debt, households. Percent.
K2HUSINF= (K2HUS/K2HUS(-4)-1)*100

K2IF Gross debt from domestic institutions held by non-financial firms, C2-indicator. Million kroner.

K2IFINF Growth in C2 debt, non-financial firms. Percent.
K2IFINF= (K2IF/K2IF(-4)-1)*100

K2HUSYD C2-Debt income ratio in the household sector (percent).
K2HUSYD = K2HUS*100/(YDCD+YDCD(-1)+YDCD(-2)+YDCD(-3)

K2KOM Gross debt from domestic institutions held by local government, C2-indicator. Million kroner.

item[K2KOMINF] Growth in C2 debt, local government. Percent.
K2KOMINF= (K2KOM/K2KOM(-4)-1)*100

KONKINF Inflation in Norway's trading partners. Percent.
KONKINF = ((PCKONK - PCKONK(-4)) / PCKONK(-4))*100

LAVGSUB Net product taxes and subsidies. Million kroner. Chapter 5.13. [1]

LGRAD One minus equity rate requirement (on home buyers). Percent.

LKDEP Value of capital depreciation in Norway. Million kroner.

LOENNH Wage earnings income,households. Million kroner. Chapter 5.12.1.

LOSSBUSI Losses on loans in percent of gross loans, corporate market. Percent.

LOSSPERS Losses on loans in percent of gross loans, personal customer market. Percent.

LX Trade balance. Million kroner.
LX = PATRAD* ATRAD+ PATJEN* ATJEN + PAOIL*AOIL+PASKIP *ASKIP - PB*B

LXR Current account. Mill. NOK
LXR = LX + RUBAL

LYF GDP mainland Norway in market values. Fixed prices. Million kroner.
LYF = PYF*YF

LYFbasis GDP mainland Norway in basic values. Million kroner.
LYFbasis = YFPbasis*PYFPB+PYO*YO

LYFPbasis GDP private mainland Norway in basic values. Million kroner.
LYFPbasis = YFPbasis*PYFPB

LY GDP in market values. Million kroner.
LY = LYF+PYOIL1*YOIL1 + PYOIL2*YOIL2 + PYUSF*YUSF

[1] Note that this variable is in current prices. The variable AVGSUM mentioned in the section about accounting identities has for simplicity been defined as $LAVGSUM/CPI$.

N Total employment. Thousand persons.
N = NWFP + NWO + NWOSJ+ NSF

NCAPTR Norway's capital transfers to abroad, net. Million Million kroner.

NAH Net assets, households. Million kroner.
NAH = BFH-BGH+PH*HK

N Employment in Mainland-Norway. Thousand persons.
NF = NWFP + NWO + NSF

NFIN Norway's net lending, Million kroner. NFIN =LXR+NCAPTR + NPAT

NGR Annual change in employed persons. Percent
NGR = ((N - N(-4)) / N(-4))*100

NHOURS Length of normal working week. Hours.

NORPOOL Norwegian electricity price, NORPOOL, Oslo trading area. Kroner per MWh.

NPAT Norway's acquisitions of patents, licences etc., net, Million kroner.

NORPOOLINF NORPOOL change. Percent.
NORPOOLINF = ((NORPOOL- NORPOOL(-4)) / NORPOOL(-4))*100

NSF Self-employed persons. Thousand.

NWF Wage earners Mainland-Norway. Thousand.
NWF = NWFP + NWO + NSF

NWFGR Annual change in employed persons, Mainland-Norway. Percent
SERIES NWFGR = ((NWF - NWF(-4)) / NWF(-4))*100

NWFP1 Wage earners in manufacturing and mining. Thousand. Chapter 5.6.6.

NWFP2 Wage earners in production of other goods. Thousand. Chapter 5.6.7.

NWFP3 Wage earners in private service production and retail trade. Thousand. Chapter 5.6.8.

NWO Wage earners in government administration. Thousand. Chapter 5.6.9

NWFP Wage earners in private business Mainland-Norway Thousand.
NWFP = NWP1 + NWFP2 + NWFP3

NWFPGR Annual change in wage earners, business sector Mainland-Norway. Percent.
SERIES NWFPGR = ((NWFP - NWFP(-4)) / NWFP(-4))*100

NWOSJ Wage earners in petroleum production, transportation, and international transportation. Thousand. Chapter 5.6.10.

General government, revenues and expenses Million kroner. Chapter 5.17.

OFFIA1 Taxes income, wealth etc

OFFIA2 Taxes on goods and services

OFFIA3 Capital taxes

OFFIA4 Social security contributions

OFFIA5 Property income

OFFIA6 Administrative fees and sales of goods and services

OFFIA7 Current transfers

OFFUB1 Compensation of employees

OFFUB2 Use of goods and services

OFFUB3 Consumption of fixed capital and R&D

OFFUB4 Property expense

OFFUB5 Social benefits in kind

OFFUB6 Social benefits in cash

OFFUB7 Subsidies

OFFUB8 Current transfers

OFFUB9 Capital transfers

OFFJD1 Gross acquisitions of fixed assets and R&D

OFFJD2 Consumption of fixed capital and R&D (-)

OFFJD3 Net acquisitions of non-financial and non-produced assets

OFFIA General government revenue. Million kroner.
OFFIA = OFFIA1 + OFFIA2 + OFFIA3 + OFFIA4 + OFFIA5 +OFFIA6 + OFFIA7

OFFUB General government expenses. Million.
OFFUB = OFFUB1+OFFUB2+OFFUB3+ OFFUB4+OFFUB5+OFFUB6+ OFFUB7+OFFUB8+OFFUB9

OFFUD General government. Total expenses. Million kroner.
OFFUD = OFFUB+(OFFJD1 +OFFJD2+OFFJD3)

OFFNFIN General government, net lending/borrowing. Million kroner. (“netto-finansinvestering”).
OFFNFIN = OFFIA-OFFUD

PA MSCI equity price index, Norway. Chapter 5.15.1

PAINF Growth in MSCI equity price index, Norway. Percent.
PAINF= (PA/PA(-4)-1)*100

PATJEN Export price index, services. Chapter 5.4.26.

PATRAD Export price index, traditional goods. Chapter 5.4.27.

PAOIL Export price index, oil and gas. Chapter 5.4.28.

PASKIP Export price index, ships and oil platforms.

PAW MSCI index, world. Chapter 5.15.2.

PAWINF Growth in MSCI equity price index, world. Percent.
PAWINF= (PAW/PAW(-4)-1)*100

PB Import price index. Chapter 5.4.23.

PBINF Change in PB. Percent.
PBINF = ((PB - PB(-4)) / PB(-4))*100

PBREXR Import price relative to CPI.
PBREXR = (PB / CPI)*100

PCKONK Consumer price index, trade weighted. Chapter 5.4.24.

PCEURO Euro area consumer price index.

PCKNR Deflator of private consumption in the national accounts. Index.

PCPO Price of commercial property, office (high quality), Oslo. . Chapter 5.18.17

RENTCPO Rent on commercial property, office (high quality), Oslo. Kroner. Chapter 5.18.17.

YIELDCPO Yield, commercial property, office (high quality), Oslo. Percent. Chapter 5.18.17

PH House price index. Chapter 5.9.

PHINF Change in PH. Percent.
PHINF = ((PH - PH(-4)) / PH(-4))*100

PHCPI Real house price.
PHCPI = PH/CPI

PHCPIGR Change in PHCPI. Percent.
PHCPIGR = ((PHCPI - PHCPI(-4)) / PHCPI(-4))*100

PLOANB Problem loans in percent of gross lending, corporate market. Percent. Chapter 5.18.18.

PLOANP Problem loans in percent of gross lending, personal customer market. Percetn. Chapter 5.18.19.

PPIKONK Foreign producer price index. Chapter 5.4.25.

PPIINF Change in PPIKONK. Percent.
PPIINF = ((PPIKONK - PPIKONK(-4)) / PPIKONK(-4))*100

PYF GDP (market value) deflator Mainland-Norway, index. Chapter 5.4.8.

PYFINF Change in PYF. Percent.
PYFINF = ((PYF - PYF(-4)) / PYF(-4))*100

PYFB GDP (basic value) deflator Mainland-Norway, index. Chapter 5.4.7.

PYFPB GDP (basic value) deflator private Mainland-Norway, index. Chapter 5.4.5.

PYFP1 Value added basic value deflator, manufacturing and mining. Chapter 5.4.1

PYFP1INF Change in PYFP1. Percent.
PYFP1INF = ((PYFP1 - PYFP1(-4)) / PYFP1(-4))*100

PYFP2 Value added basic value deflator, production of other goods. Chapter 5.4.2

PYFP3 Value added basic value deflator, retail trade and private service production. Chapter 5.4.3

PYFP23 Value added basic value deflator, production of other goods retail trade and private service production. Chapter 5.4.4.

PYO Value added deflator, government administration. Chapter 5.4.6. O

PYOIL1 Value added deflator, oil and gas production.

PYOIL2 Value added deflator, pipeline transportation.

PYUSF Value added deflator international shipping.

RAM300 Dividend payments to households. Million kroner.

RBD Average interest rate on deposits, banks and other financial institutions. Percent. Chapter 5.11.11.

RBO Effective yield on 5-year government bonds. Percent. Chapter 5.11.1.

RBOTENY Effective yield on 10-year government bonds. Percent. Chapter 5.11.2

RBGH Interest rate per quarter on households' debt. Percent.

RBFH Interest rate per quarter on deposits by households. Percent.

RBOWFIVEY Actuarial five year real interest rate. Percent.
RBOWFIVEY = RBO- WHINF

RDIFFRL Loan rate, policy interest rate differential.
RDIFFRL = RL-RNB

RDIFFRSH Money market rate, policy interest rate differential
RDIFFRSH = RSH-RNB

RDIFFRLRSH Loan rate, money market interest rate differential.
RDIFFRLRSH = RL-RSH

REGLED Registered unemployment. Thousand persons. Chapter 5.7.2.

RENTEINNH Interest income, households and non profit organizations. Million kroner. Chapter 5.12.3.

RENTEUTH Interest expenses, households and non profit organizations. Million kroner. Chapter 5.12.4.

RESINNTH Miscellaneous income, households and non profit organizations. Million kroner. Chapter 5.12.5.

REXR Real exchange rate (Relative CPI).
REXR = ((CPIVAL*PCKONK) / CPI)

RIH Interest income on households'gross financial wealth. Million kroner.
RIH = RBFH*BFH

RL Average interest rate on loans from banks and other credit institutions. Percent. Chapter 5.11.3

RLH Average interest rate on loans to households from banks and other credit institutions. Percent. Chapter 5.11.4.

RLBOLIGH Average house loan interest rate (mortage rate) from banks and other credit institutions. Percent. Chapter 5.11.6.

RLIF Average interest rate on loans to non financial firms from banks and other credit institutions. Percent. Chapter 5.11.5.

RNB Norges Bank's policy rate. Percent.
Endogenous is an option for this variable.

RRL Real interest rate, households. Percent.
RRL = RL - INF

RRSH Real money market interest rates. Percent.
RRSH = RSH - INF

RSDIFF Money market interest rate differential.
RSDIFF = (RSH - RSW)

RSH 3-month money market interest rate (NIBOR). Percent. Chapter 5.11.8.

RSW 3-month foreign money market interest rate. Percent. Endogenous is an option for this variable, cf. Chapter 5.11.10.

RUBAL Net incomes and transfers to Norway from abroad ("Rente- og stønadsbalansen"). Million kroner.

RUH Quarterly interest payment on household debt. Million kroner.
RUH = RBGH*BGH

RUHK2 Quarterly interest payment on household debt, C2. Million kroner.
RUHK2 = RBGH*K2HUS

RUHYD Interest payment on household debt in percent of disposable income. Percent.
RUHYD = (RUH/(YDCD+RUH))*100

RUHK2YD Interest payment on household debt (C2) in percent of disposable income. Percent.
RUHK2YD = (RUHK2/(YDCD+RUHK2))*100

RW Euro area 10-year government benchmark bond yield. Percent. 5.11.9.

RWEALTHH Real value of household wealth. Million kroner.
RWEALTHH=WEALTHH/CPI

SAVINGPH SAVINGS, HOUSEHOLDS. Million kroner.
SAVINGPH = YDH -PCKNR(CP-CPORG) + KORRSPH

item[SAVINGPORG] SAVINGS, NPISHs. Million kroner.
SAVINGORG = YDORG -PCKNR(CPORG)

SAVINGPH PRIVATE SAVINGS. Million kroner.
SAVINGP = SAVINGPH + SAVINGPORG

SKATTH Taxes paid by households (income and wealth). Million kroner. Chapter 5.12.6.

SP Private savings rate.
SP=(SAVINGPH+SAVINGPORG)/YD

SPOILUSD Spot Brent oil price, USD per barrel. USD.

Oil price (SPOILUSD)! in variable list

SPUSD NOK/USD spot exchange rate.

NOK/USD exchange rate (SPUSD)! in variable list

SPEURO NOK/EURO spot exchange rate.

NOK/EURO exchange rate (SPEURO)! in variable list

SPORG NPISH savings rate.
SPH=SAVINGPORG/YDORG

SYSSRATE Employment rate. Percent.
$SYSSRATE = \frac{N}{BEF1574} \cdot 100$

T Total number of hours worked. Million hours.
T = TF + TWOSJ

TF Total number of hours worked, Mainland-Norway. Million hours.
TF = TWF + TSF

TWFP1 Hours worked, wage earners in manufacturing and mining. Thousand. Chapter 5.6.1.

TWFP2 Hours worked, wage earners in production of other goods. Million. Chapter 5.6.2.

TWFP3 Hours worked, wage earners in private service production and retail trade. Million. Chapter 5.6.3.

TILT Job creation programmes ("tiltak"). Thousand persons.

TOTD Total expenditure (demand). Fixed prices. Million kroner.
TOTD = CP + CO + J + A + JL

TOTLED Number of unemployed, including job creation programmes. Thousand persons.
TOTLED = REGLED + TILT

TOTS Total supply. Fixed prices. Million kroner.
TOTS = Y + B

TSF Hours worked by self employed. Million hours.
TSF = NSF*FHSF

TWFP Hours worked by wage earners in private business Mainland-Norway. Million hours. TWFP = TWFP1 +TWFP2 TWFP3

TWF Hours worked by wage earners in Mainland-Norway. Million hours.
TWF = TWFP + TWO

TWO Hours worked by wage earners in government administration. Million hours.

TWOSJ Hours worked by wage earners in petroleum production and in international shipping. Million hours.

T1FP1 Employment ("payroll") tax rate, manufacturing and mining.

T1FP23 Employment ("payroll") tax rate, production of other goods, services and retail trade.

T2CAPF Tax rate on income, firms.

T2CAPH Tax rate on capital income, households.

T3 Implicit economy wide indirect tax rate.

UAKU Unemployment, Labour Force Survey measure. Percent.
UAKU = (AKULED*100)/AKUSTYRK

UFOERE Number of persons receiving disability benefits from Nav. Person. Chapter 5.8.2

UR Registered rate of unemployment. Percent.
UR = (REGLED*100)/AKUSTYRK

US10Y Market yield on U.S.treasury securities at 10-year constant maturity, quoted on an investment basis. Percent. (FRED Database identifier: GS10)

VOLUSA Implicit volatility, stock option markets, USA.

WEALTHH Household wealth. MILL. NOK
WEALTHH=BFH-BGH+PH*HK

WF Wage per hour, Mainland-Norway. Kroner. Chapter 5.4.15.

WFINF Change in WF. Percent.
WFINF= ((WF / WF(-4)) - 1)*100

WFP Wage per hour, private sector Mainland-Norway. Kroner. Chapter 5.4.16.

WFP1 Wage per hour in manufacturing and mining. Kroner. Chapter 5.4.10.

WFP1INF Change in WFP1. Percent.
WFP1INF= ((WFP1 / WFP1(-4)) - 1)*100

WCFP1 Wage cost per hour in manufacturing and mining. Kroner.
WCFP1 =WFP1*(1+T1FP1)

WFP2 Wage per hour other commodity production. Kroner. Chapter 5.4.11.

WFP3 Wage per hour in private service production. Kroner. Chapter 5.4.12.

WFP23 Wage per hour in production of other goods and private service production. Kroner. Chapter 5.4.13.

WFP23INF Change in WFP23. Percent.
WFP23INF= ((WFP23 / WFP23(-4)) - 1)*100

WH Yearly wage per quarter, total economy (full time equivalent). Thousand kroner.

WHINF Change in WH. Percent.
WHINF= ((WH / WH(-4)) - 1)*100

WO Wage per hour in local and central administration. Kroner.

WOINF Change in WO. Percent.
WOINF= ((WO3 / WO(-4)) - 1)*100

WSHFP1 Wage-share manufacturing.
WSHFP1 = (WCFP1/(PYFP1*ZYFP1))

Y GDP in market values. Fixed prices. Million kroner.
Y = YF + YOIL1 + YOIL2 + YUSF

YD Private disposable income, households and NPISHs. Million kroner.
YD = YDH + YDORG

YDCD Private disposable income net of dividend payments. Million kroner.
YDCD = YD-RAM300.

YDFIRMS Disposable income of firms. Million kroner.
YDFIRMS = (1-T2CAPF)(PYFPB*(YFP1+YFP2+YFP3) +LAVGSUB - (WFK*(1+T1FK))*(TWFP) -0.6*LKDEP -(RLIF/100)(K2IF*0.25)).

YDH Household disposable income. Million kroner.
YDH = DRIFTH + LOENNH + RENTEINNH - RENTEUTH + RAM300 + RESINNTH - SKATTH

YDNOR Disposable income for Norway. Million kroner.
YDNOR = LY+RUBAL-LKDEP

YDORG Disposable income for NPISHs (part of YD). Million kroner.

YDREAL Real disposable income for households and NPISHs.
YDREAL = YD/CPI

YDREALGR Real disposable income growth for households and ideal organizations.
YDREALGR = ((YDREAL - YDREAL(-4)) / YDREAL(-4))*100

YF GDP mainland Norway, market values. Fixed prices. Million kroner.
YF = YFP1+YFP2+YFP3+YO+(LAVGSUB/PYF)

YFbasis GDP mainland Norway, basic values. Fixed prices. Million kroner.
YFbasis = YFP1+YFP2+YFP3+YO

YFPbasis GDP private sector mainland Norway, basic values. Fixed prices. Million kroner.
YFPbasis = YFP1+YFP2+YFP3

YFGR Real GDP growth, Mainland-Norway. Percent.
YFGR = ((YF - YF(-4)) / YF(-4))*100

YFP1 Value added in manufacturing and mining basic value. Fixed prices. Million kroner. Chapter 5.4.1

YFP1GR Gross product growth, manufacturing. Percent.
YFP1GR = ((YFP1 - YFP1(-4)) / YFP1(-4))*100

YFP2 Value added in production of other goods, basic value. Fixed prices. Million kroner.

YFP2GR Gross product growth, production of other goods. Percent.
YFP2GR = ((YFP2 - YFP2(-4)) / YFP2(-4))*100

YFP3 Value added (gross product) in service sector and retail. Basic values. Fixed prices. Million kroner.
YFP3 = YFP3NET + YFP3OIL

YFP3GR Gross product growth, retail sales and private production of services. Percent.
YFP3GR = ((YFP3 - YFP3(-4)) / YFP3(-4))*100

YFP3NET Value added in in private service activities and retail trade, netof YFP3OIL, basic value. Fixed prices. Million kroner.

YFP3OIL Value added services incidental to oil and gas extraction, FIXED PRICES, basic value. Fixed prices. Million kroner.

YGR Real GDP growth. Percent.
YGR = ((Y - Y(-4)) / Y(-4))*100

YO Value added in government administration. Fixed prices. Million kroner.

YOIL1 Value added in oil and gas production.Fixed prices. Million kroner.

YOIL2 Value added in gas pipeline transportation. Fixed prices. Million kroner.

YOIL Value added in oil and gas production and pipeline transportation.Fixed prices. Million kroner.
YOIL = YOIL1 + YOIL2

YOIL1GR Gross product growth, in oil and gas production. Percent.
YOIL1GR = ((YOIL1 - YOIL1(-4)) / YOIL1(-4))*100

YUSF Value added international shipping. Fixed prices. Million kroner.

ZYFP1 Labour productivity in manufacturing and mining. Fixed prices. Kroner per hour.

ZYFP2 Labour productivity in production of other goods. Fixed prices. Kroner per hour.

ZYFP3 private service activities and retail trade. Fixed prices. Kroner per hour. [2]

ZYF Labour productivity mainland Norway. GDP in fixed basic values divided by total hours worked. Fixed prices. Kroner per hour.
ZYF = (YFPbasis+YO) / (TWFP+TSF+TWO))

ZYFGR Change in ZYF. Percent.
ZYFGR = ((ZYF / ZYF(-4)) - 1)*100

[2] In principle, ZYFP1, ZYFP2 and ZYFP3 are given by definitions (e.g., ZYFP1=YFP1/TWFP1). However, small deviations in the measurement system means that they are pragmatically treated as “estimated identities” (that are not reported).

ZYFP Labour productivy private mainland Norway. Fixed prices. Kroner per hour.
ZYFP = YFPbasis / (TWFP+TSF))

ZYO Labour productivity government administration. Fixed prices. Kroner per hour.
ZYO = YO / TWO

5

Estimation results

5.1 Identification, estimation and specification

The model contains blocks with simultaneous equations, for example for housing prices and credit. For these sub-systems identification can be addressed in the two well known steps: First, identification of the cointegration relationships, and second, of the short-run dynamics, cf. Hsiao (1997). Estimation can also be done in two steps: First the coefficients of the identified cointegration relationships case be estimated by FIML. Second, treating the coefficient estimates as known, the short run model equations can be estimated by FIML, 2SLS or OLS (if the structure is recursive).

The rest of the model consists of single equation modules estimated by OLS, and the interpretation is that agents form and act on contingent plans, represented as conditional expectation functions. The parameters of interest of these equations are therefore regression parameters, and they are identified. Survey based measures of expectations are counted as part of the information set that we can condition on in order to specify empirical model equations.

The results are reported with explicit transformations of the original data series in section 4. Instead of the conventional mathematical expressions the transformations are given in Eviews code. The Eviews User's Guides[1] give the details, but examples of the most used transformations are listed in Table 5.1.

Table 5.1: Mathematical and EViews expressions for a time series variable X_t

Math. expression	EViews expression
X_t, X_{t-1},X_{t-4},	X or X(-1) or X(-4)
$ln(X_{t-1})$	LOG(X(-1)
ΔX_t, ΔX_{t-1},$\Delta_4 X_t$	D(X) or D(X(-1)) or D(X,0,4)
$\Delta ln(X_{t-1})$	DLOG(X(-1)) or DLOG(X(-1)),0,1)
$\Delta_4 ln(X_{t-1})$	DLOG(X(-1),0,4)
$\frac{1}{l}\sum_{t-j-i}^{l} X_{t-j-i}$	$@movav(X_{t-j,l}$

EViews is not case sensitive, meaning that LOG(X) can be written as log(X), but also as LOG(x). Sometimes, the variables in the estimated equations are more complicated transformations, or functions of the data series. In these cases, there are notes to the tables with estimations results, and there may also be be a text box below the table with additional information about the variables.

[1]See Eviews (2014) and Eviews (2016) ,

Most of the equations include an intercept, which is denoted *Constant* in the tables with estimations results. There are many equations with seasonal dummies, denoted by Si, for quarter i. There are also centered versions of the seasonals in use (centered in the sense that they sum to zero over the four quarters of the year). The centered dummies are denoted CSi.[2]

Three other indicator variables that are common across model equations are KNRBREAKQ1, KNRBREAKQ2 and KNRBREAKQ3, which capture breaks in the seasonal pattern in many series, commencing in 2015q1.

A set of dummies is related to the Covid-19 pandemic. They are denoted by COVIDQj, where j represents the "covid-quarter", for example COVIDQ5 is 1 in 2021q1 and zero elsewhere. In the tables with estimation results, a "composite" Covid-dummy is written COVID, and the weighs of each "covid-quarter" are then specified in the notes part of the table.

The war in Ukraine has affected many economic processes that are of importance for the Norwegian economy. Therefore the model includes an indicator variables UKRW which is 1 i 2022Q1 and zero in all other quarters.

[2]Specifically: CSi is 0.75 in quarter $i = 1$ of a year, and -0.25 in the other quarters, $(i = 2, 3, 4)$

5.2 Components of aggregate demand

5.2.1 Exports of traditional goods

Table 5.2: Dependent Variable: DLOG(ATRAD). LS estimation. Sample size: 152 (1988Q1 2025Q4).

	Coefficient	Std. Error	t-Statistic	Prob.
DLOG(EMI)	0.622374	0.071160	8.746122	0.0000
DLOG(EMI(-1))	0.37763	0.121842	5.387	0.0077
DOG(ATRAD(-1))	-0.303652	0.054201	-5.602316	0.0000
DLOG(PATRAD/(PPIKONK*CPIVAL))	-0.810903	0.085353	-9.500626	0.0000
$ECM_{ATRAD}(-1) - \mu_{ECM}$	-0.071166	0.030745	-2.314769	0.0221
Constant	-0.001416	0.002670	-0.530183	0.5968
ATRADUM	1.007054	0.153493	6.560903	0.0000
UKRW(-1)	-0.100020	0.032788	-3.050517	0.0027
CS1	-0.071463	0.008957	-7.978081	0.0000
CS2	-0.069379	0.007760	-8.940907	0.0000
CS3	-0.090958	0.008069	-11.27300	0.0000
Adjusted R-squared	0.745970	S.D. dependent var	0.063377	
S.E. of regression	0.031943	Akaike info criterion	-3.986212	
Log likelihood	312.9521	Hannan-Quinn criter.	-3.905396	
F-statistic	50.26876	Durbin-Watson stat	2.177293	

Notes:
$ECM_{ATRAD(-1)} = LOG(ATRAD(-1)) + 0.4LOG(PATRAD(-1)/(CPIVAL(-1) \cdot PPIKONK(-1)))$
$-0.7LOG(EMI)$
μ_{ECM} is the mean of ECM_{ATRAD}. UKRW is 1 in 2022q1. Else 0.

5.2.2 Exports of services

Table 5.3: Dependent Variable: DLOG(ATJEN). LS estimation. Sample size: 139 (1988Q1 2022Q3).

	Coefficient	Std. Error	t-Statistic	Prob.
DLOG(EMI)	0.895406	0.153324	5.839946	0.0000
DLOG(PATJEN/(PPIKONK*CPIVAL))	-0.464387	0.119165	-3.897008	0.0002
D3LOG(ATJEN(-1))	-0.691439	0.046015	-15.02630	0.0000
$ECM_{ATJEN}(-1) - \mu_{ECM}$	-0.271298	0.035821	-7.573614	0.0000
0.014784	0.004163	3.550901	0.0005	
COVID	-0.145605	0.017880	-8.143404	0.0000
R-squared	0.709050	Mean dependent var	0.00.0410	
S.E. of regression	0..041131.041	Akaike info criterion	-3.577626	
F-statistic	62.88726	Durbin-Watson stat	1.804333	
Prob(F-statistic)	0.000000			

Notes:
$ECM_{ATJEN} = log(ATJEN(-4)) + 0.69LOG(PATJEN/(PPIKONK \cdot CPIVAL))$
$-0.77LOG(EMI)$
μ_{ECM} is the mean of ECM_{ATJEN}
$COVID = COVIDQ2 + 2COVIDQ3 + COVIDQ4 + COVIDQ5$

5.2.3 Exports of ships, oil platforms and airplanes

Table 5.4: Dependent Variable: DLOG(ASKIP). LS estimation. Sample size: 167 (1980Q1 2021Q3)

	Coefficient	Std. Error	t-Statistic	Prob.
LOG(ASKIP(-1))	0.382789	0.061972	-6.176849	0.0000
CS1	-0.076793	0.097554	-0.787186	0.4326
CS2	0.041785	0.097702	0.427679	0.6696
CS2	-0.020600	0.098288	-0.209586	0.8343
Constant	3.278564	0.537471	6.099986	0.0000
R-squared	0.194325	Mean dependent var 0.001607		
S.E. of regression	0.431636	Akaike info criterion	1.066343	
F-statistic	10.22551	Durbin-Watson stat	2.028557	

5.2.4 Private consumption

Table 5.5: Dependent Variable: DLOG(CP). LS estimation. Sample size: 192 (1978Q1 2025Q4)

	Coefficient	Std. Error	t-Statistic	Prob.
ECM_{CP}	-0.217212	0.038684	-5.615068	0.0000
DLOG(YDCD/CPI)	0.352488	0.046248	7.621664	0.0000
DLOG(CP(-4))	0.408379	0.047390	8.617355	0.0000
DLOG(BFHM/CPI))	0.235261	0.058523	4.019955	0.0001
Constant	0.048937	0.008741	5.598239	0.0000
CS1	-0.059461	0.007198	-8.260651	0.0000
CS2	-0.027929	0.003947	-7.075634	0.0000
CS3	-0.026653	0.004249	-6.272409	0.0000
CPDUM	1.000972	0.110910	9.025084	0.0000
R-squared	0.915946	Mean dependent var	0.006908	
Adjusted R-squared	0.912272	S.D. dependent var	0.055346	
F-statistic	249.2720	Durbin-Watson stat	2.335638	

Notes:
$ECM_{CP} = LOG(CP(-1)) - 0.78LOG(YDCD(-1)/CPI(-1))$
$-0.17LOG((WEALTHH(-1)/CPI(-1))$
CPDUM=-0.04II1980q2-0.04II1981q+0.04II1986q2-0.132COVIDQ2+0.05COVIDQ3

5.2.5 Consumption expenditure by NPISHs

Table 5.6: Consumption expenditure by NPISHs. DLOG(CORG). LS estimation. Sample size: 79 (2002Q1 2023Q2)

	Coefficient	Std. Error	t-Statistic	Prob.
LOG(YDORG/PCKNR)	0.679816	0.017299	39.29770	0.0000
DLOG(YDCD/CPI)	0.305480	0.052976	5.766366	0.000
$COVID$	-0.208944	0.017601	-11.87134	0.0000
Constant	3.139836	0.166904	18.81219	0.0000
Adjusted R-squared	0.952983	S.D. dependent var	0.160776	
S.E. of regression	0.034862	Akaike info criterion	-3.837156	
F-statistic	781.3536	Durbin-Watson stat	0.806885	

Notes:
$COVID = COVIDQ2 + COVIDQ3 + COVIDQ4 + COVIDQ5$
$COVIQ6 + 0.5COVIDQ7$

5.2.6 Housing starts

Table 5.7: Dependent Variable: DLOG(HS). LS estimation. Sample size: 138 (1990Q1 - 2024Q2)

	Coefficient	Std. Error	t-Statistic	Prob.
Constant	0.655505	0.426877	1.535582	0.1271
DLOG(HS(-1))	-0.167166	0.057497	-2.907388	0.0043
DLOG(HS(-4))	0.355148	0.056305	6.307527	0.0000
DLOG(HS(-5))	0.252457	0.054557	4.627437	0.0000
DLOG(PH(-3)/CPI(-3))	1.605544	0.362592	4.427958	0.0000
LOG(HS(-1))	-0.392636	0.051333	-7.648860	0.0000
@movav(YDC(-1)/CPI(-2)),4)	0.228943	0.043022	5.321579	0.0000
@movav(RUH(-2),2)/@movav(YDCD(-2),2)*HSSTEP	-0.789778	0.304062	-2.597426	0.0105
HSDUM	0.969572	0.101680	9.535550	0.0000
CS1	-0.120261	0.026830	-4.482334	0.0000
R-squared	0.769586	Mean dependent var	-0.002667	
Adjusted R-squared	0.753385	S.D. dependent var	0.195176	
S.E. of regression	0.096925	Akaike info criterion	-1.760050	
Log likelihood	131.4434	Hannan-Quinn criter.	-1.673850	
F-statistic	47.50232	Durbin-Watson stat	1.947019	

Notes:
$HSDUM$ composite dummy, given in program code.
$HSSTEP$ step dummy,given in program code.

5.2.7 Gross capital formation, housing

Table 5.8: Dependent Variable: DLOG(JBOL). LS estimation. Sample size: 107 (1995Q1 2021Q3)

	Coefficient	Std. Error	t-Statistic	Prob.
DLOG(HS)	0.212583	0.015688	13.55055	0.0000
DLOG(HS(-1))	0.183330	0.020039	9.148769	0.0000
LOG(JBOL(-1)-β_{HS}LOG(HS(-2))-μ)	-0.043752	0.015824	-2.764908	0.0068
β_{HS}	1.394989	0.241136	5.785080	0.0000
μ	2.213762	2.177627	1.016594	0.3119
JBOLDUM	0.991137	0.101311	9.783093	0.0000
CS1	-0.033239	0.007452	-4.460297	0.0000
CS2	0.017563	0.006953	2.525870	0.0131
CS3	0.027467	0.006477	4.240658	0.0001
R-squared	0.823672	Mean dependent var	0.007271	
S.E. of regression	0.021718	Akaike info criterion	-4.079569	
Durbin-Watson stat	2.242143			

Notes:
$JBOL$: composite dummy, given in the program code.

5.2.8 Gross capital formation, private business

Table 5.9: Dependent Variable: DLOG(JFPN). LS estimation. Sample size: 139 (1988Q1 2022Q3)

	Coefficient	Std. Error	t-Statistic	Prob.
(LOG(JFPN(-1)/(YDFIRMS/PYF))+0.75)	-0.184560	0.033901	-5.444062	0.0000
DLOG(JFPN(-1))	-0.519425	0.037976	-13.67767	0.0000
RLIF(-1)-@PCY(PYF(-1)	-0.005767	0.001667	-3.458649	0.0007
D4LOG(YFPBASIS)	0.813714	0.203509	3.998407	0.0001
DLOG(YFPBASIS(-4))	0.926790	0.132762	6.980834	0.0000
JFPNDUM	1.001224	0.085928	11.65191	0.0000
R-squared	0.834359	Mean dependent var	0.004353	
S.E. of regression	0.064182	Akaike info criterion	-2.605156	
Durbin-Watson stat	1.87596			
Notes:				
JFPNDUM is given in the EViews program file				

5.3 Components of aggregate supply

5.3.1 Value added in manufacturing

Table 5.10: Dependent Variable: DLOG(YFP1). LS estimation. Sample size: 163 1981Q3 2022Q1)

	Coefficient	Std. Error	t-Statistic	Prob.
$YFP1_{ECM}$(-1)	-0.104135	0.028935	-3.598983	0.0004
D2LOG(EMI))	0.135396	0.053487	2.531385	0.0124
DLOG(DOMD)+ DLOG(DOMD(-2))	0.173770	0.059732	2.909151	0.0042
DLOG(JOIL1)	0.042560	0.013187	3.227456	0.0015
DLOG(YFP1(-1))	-0.135908	0.054681	-2.485443	0.0140
DLOG(ARBDAG)	0.573733	0.051411	11.15969	0.0000
f(SPOILUSD)	0.134879	0.041053	3.285470	0.0013
Constant	0.422332	0.117572	3.592108	0.0004
CS1	0.039663	0.010919	3.632539	0.0004
CS2	-0.016137	0.010930	-1.476412	0.1419
CS3	0.008730	0.012510	0.697844	0.4864
KNRBREAKQ1	-0.022542	0.008857	-2.545045	0.0119
COVIDQ8	-0.066142	0.020741	-3.188883	0.0017
R-squared	0.932966	Mean dependent var	0.001902	
S.E. of regression	0.019867	Akaike info criterion	-4.923078	
F-statistic	173.9716	Durbin-Watson stat	2.341751	

Notes:
$YFP1_{ECM} = log(YFP1) - 0.5log(YFP1_{DEM}) + 0.4log(YFP1_W)$
$YFP1_{DEM} = DOMD + ATRAD + JOIL1$
$YFP1_W = WCFP1/(ZYFP1)(CPIVAL\dot{P}PIKONK)$
$f(SPOILUSD) = DLOG^{-}(SPOILUSD)\dot{\sum}_{i=1}^{4} JOIL1(-i)/J(-i)$
$DLOG^{-}(x) < 0$ if $x > 0$, else $DLOG^{-}(x) = 0$

5.3.2 Value added production of other goods

Table 5.11: Dependent Variable: DLOG(YFP2). LS estimation. Sample size: 175 (1981Q3 2025Q1)

	Coefficient	Std. Error	t-Statistic	Prob.
LOG(YFP2(-1))	-0.422467	0.057918	-7.294178	0.0000
LOG($YFP2_W$)	-0.048081	0.019349	-2.484899	0.0140
LOG($YFP2_J$(-1))	0.169086	0.030598	5.525979	0.0000
LOG(EMI)	0.096134	0.016700	5.756583	0.0000
DLOG(DOMD)	0.185128	0.103847	1.782705	0.0765
DLOG(YFP2(-4))	0.224794	0.057223	3.928392	0.0001
DLOG(ARBDAG)	0.429590	0.063330	6.783336	0.0000
Constant	2.581675	0.445549	5.794369	0.0000
CS1	0.027318	0.015838	1.724859	0.0864
CS2	-0.029821	0.019826	-1.504120	0.1345
CS3	0.090995	0.016410	5.545036	0.0000
R-squared 0.934491	Mean dependent var	0.005563		
S.E. of regression	0.026693	Akaike info criterion	-4.348038	
F-statistic	233.9492	Durbin-Watson stat	1.974344	

Notes:
$YFP2_W = WCFP2/(ZYFP2 * PYFP2)$
$YFP2_J = 0.3JBOL + 0.2 * JFPN + 0.3JO + 0.2JOIL$

5.3.3 Value added in private service production

Table 5.12: Dependent Variable: DLOG(YFP3NET). LS estimation. Sample size: 145 (1989Q1 2025Q1)

	Coefficient	Std. Error	t-Statistic	Prob.
LOG(YFP3NET(-1))	-0.476432	0.062663	-7.603101	0.0000
LOG($YFP3_W$)	-0.074708	0.026684	-2.799699	0.0059
LOG(DOMD(-1)	0.520129	0.074009	7.027881	0.0000
LOG(0.5ATRAD(-1)+ATJEN(-1))	0.447809	0.067367	6.647265	0.0000
DLOG(DOMD)	0.408982	0.073559	5.559919	0.0000
DLOG(0.5ATRAD+ATJEN	0.094373	0.022682	4.160782	0.0001
D3LOG(YFP3NET(-1)	-0.188314	0.043864	-4.293138	0.0000
DLOG(YFP3NET(-1)	-0.231340	0.043680	-5.296254	0.0000
DLOG(YFP3NET(-4)	0.155047	0.051707	2.998580	0.0033
DLOG(ARBDAG)	0.289054	0.039550	7.308512	0.0000
Constant	-1.203266	0.193050	-6.232911	0.0000
CS1	0.030569	0.009155	3.339065	0.0011
CS2	0.068565	0.008753	7.833437	0.0000
CS3	0.054183	0.009621	5.631510	0.0000
KNRBREAKQ1	-0.015585	0.006274	-2.484010	0.0143
KNRBREAKQ2	-0.025615	0.005637	-4.544243	0.0000
KNRBREAKQ3	-0.053072	0.015585	-3.405253	0.0009
COVID	0.035165	0.008260	4.257325	0.0000
R-squared	0.926581	Mean dependent var	0.007336	
S.E. of regression	0.013437	Akaike info criterion	-5.683843	
F-statistic	117.1891	Durbin-Watson stat	2.204569	

Notes:
$YFP3_W = WCFP3/(ZYFP3 * PYFP3)$

$YFP3DEM = 0.85 * log(DOMD) + 0.15 * log(EMI))$
$COVID = COVIDQ1 + 3COVIDQ2 + COVID5 - COVIDQ6)$

5.3.4 Value added in government administration

Table 5.13: Dependent Variable: DLOG(YO). LS estimation. Sample size: 89 (2000Q1 2022Q1)

	Coefficient	Std. Error	t-Statistic	Prob.
DLOG(CO)	1	-	-	-
(LOG(YO(-1))-0.91*LOG(CO(-1)))	-0.261715	0.053347	-4.905921	0.0000
DLOG(CO(-1))	0.880474	0.030698	28.68161	0.0000
Constant	0.307024	0.132053	2.325009	0.0226
CS1	-0.010316	0.002927	-3.524620	0.0007
CS2	0.010784	0.002886	3.737071	0.0003
CS3	0.008270	0.002850	2.902076	0.0048
COVIDQ4	-0.020251	0.009240	-2.191629	0.0312
R-squared	0.900893	Mean dependent var	0.003477	
S.E. of regression	0.009300	Akaike info criterion	-6.430954	
F-statistic	121.2011	Durbin-Watson stat	2.192982	

5.3.5 Value added in ocean transportation

Table 5.14: Dependent Variable: LOG(YUSF). LS estimation. Sample size: 98 (2000Q1 2024Q2)

	Coefficient	Std. Error	t-Statistic	Prob.
DLOG(CO)	1	-	-	-
LOG(YUSF(-1))	0.390069	0.077376	5.041211	0.0000
LOG(YUSF(-4))	0.532029	0.073519	7.236612	0.0000
Constant	0.694820	0.209971	3.309128	0.0013
COVIDQ1	-0.650884	0.107572	-6.050657	0.0000
COVIDQ2	-0.354657	0.124042	-2.859172	0.0053
COVIDQ3	-0.515415	0.118339	-4.355403	0.0000
COVIDQ4	-0.453712	0.116437	-3.896629	0.0002
COVIDQ5	-0.054680	0.109285	-0.500343	0.6181
R-squared	0.955265	Mean dependent var	9.167880	
Adjusted R-squared	0.951786	S.D. dependent var	0.486860	
S.E. of regression	0.106903	Akaike info criterion	-1.555676	
Log likelihood	84.22813	Hannan-Quinn criter.	-1.470324	
F-statistic	274.5515	Durbin-Watson stat	1.328408	

5.3.6 Imports

Table 5.15: Dependent Variable: D4LOG(B). LS estimation. Sample size: 100 (2000Q1 2024Q4)

	Coefficient	Std. Error	t-Statistic	Prob.
D3LOG(B(-1))	0.197831	0.050565	3.912413	0.0002
DLOG(BDEM)	1.051726	0.112795	9.324223	0.0000
LOG(B(-4))	-0.337028	0.078093	-4.315717	0.0000
LOG(BDEM(-4))	-0.455496	0.085040	-5.356276	0.0000
LOG(PB/PYF)	-0.161519	0.058496	-2.761188	0.0070
(CRISIS09Q1+CRISIS09Q4)	-0.077860	0.021344	-3.647864	0.0004
COVID	-0.080479	0.018636	-4.318474	0.0000
Constant	-1.815366	0.378217	-4.799795	0.0000
R-squared	0.813430	Mean dependent var	0.029303	
S.E. of regression	0.029153	Akaike info criterion	-4.155900	
F-statistic	57.30182	Durbin-Watson stat	1.921847	

Note:
$BDEM = 0.32CP + 0.34JOIL1 + 0.66JUSF + 0.45JFPN$
$+0.24ATRAD + 0.21ATJEN + 0.12CO + 0.32JO + 0.23JBOL + 0.02AOIL$
$COVID = (COVIDQ2 + 0.2COVIDQ3 + 0.4COVIDQ2 + 0.5COVIDQ4 + 1.0COVIDQ5)$
The import weights are from "Boks 2.2" in Konjunkturtendensene 1/2025

5.4 Wage and price system

5.4.1 Value added deflator in manufacturing and mining

Table 5.16: Dependent Variable: DLOG(PYFP1). OLS estimation. Sample size: 173 (1982Q1 2025Q1)

	Coefficient	Std. Error	t-Statistic	Prob.
LOG(PYFP1(-1)/(PPIKONK(-1) CPIVAL(-1)))	-0.029954	0.010574	-2.832862	0.0052
DLOG(WCFP1/ZYFP1)	0.139752	0.038468	3.632967	0.0004
DLOG(WCFP1(-1)/ZYFP1(-1))	0.104714	0.036211	2.891756	0.0044
DLOG(PYFP1(-1))	-0.411950	0.057369	-7.180738	0.0000
DLOG(PYFP1(-2))	-0.228079	0.055126	-4.137409	0.0001
DLOG(PPIKONK CPIVAL)	0.372891	0.095473	3.905716	0.0001
PYFP1DUM	1.001140	0.122509	8.171973	0.0000
UKRW(-3)	0.104586	0.027524	3.799829	0.0002
S2	0.010549	0.004139	2.548389	0.0118
S2	0.031602	0.004753	6.648126	0.0000
KNRBREAKq2	-0.030363	0.010481	-2.896804	0.0043
KNRBREAKq3	0.028188	0.009894	2.849018	0.0050
R-squared	0.555575	Mean dependent var	0.009554	
S.E. of regression	0.026595	Akaike info criterion	-4.354746	
		Durbin-Watson stat	1.871449	

Notes:
$PYFP1DUM$ is given in the code of the Eviews program file

5.4.2 Value added deflator in production of other goods

Table 5.17: Dependent Variable: DLOG(PYFP2). OLS estimation. Sample size: 121 (1995Q1 2025Q1)

	Coefficient	Std. Error	t-Statistic	Prob.
(LOG(WCFP2(-1))-LOG(ZYFP2(-1)) -LOG(PYFP2(-1)))	0.171422	0.040872	4.194163	0.0001
DLOG(WCFP2/ZYFP2)	0.396895	0.065183	6.088898	0.0000
DLOG(WCFP2(-1)/ZYFP2(-1))	0.229539	0.054232	4.232549	0.0000
DLOG(PPIKONK)	0.848175	0.244937	3.462826	0.0008
DLOG(NORPOOL)	0.055745	0.008566	6.507540	0.0000
PYFP2DUM	0.899663	0.094825	9.487610	0.0000
S1	-0.134000	0.020322	-6.593777	0.0000
S2	-0.045542	0.017575	-2.591317	0.0108
Constant	0.164952	0.033479	4.927019	0.0000
R-squared 0.719559	Mean dependent var	0.010671		
S.E. of regression	0.033840	Akaike info criterion	-3.862906	
F-statistic	35.92133	Durbin-Watson stat	2.101185	

Notes:
$PYFP2DUM$ is given in the code of the Eviews program file

5.4.3 Value added deflator private service activities

Table 5.18: Dependent Variable: DLOG(PYFP3). OLS estimation. Sample size: 121 (1995Q1 2025Q1)

	Coefficient	Std. Error	t-Statistic	Prob.
(LOG(WCFP3(-1))-LOG(ZYFP3(-1)) -LOG(PYFP3(-1)))	0.148884	0.042945	3.466824	0.0008
LOG(PYFP3(-1)/PYFP1(-1))	-0.049845	0.016256	-3.066368	0.0027
DLOG(WCFP3/ZYFP3)	0.180274	0.030428	5.924671	0.0000
DLOG(PYFP3(-1)/PYFP3(-3))	-0.210023	0.051713	-4.061326	0.0001
$(1/(0.5UAKU + 0.5UAKU(-1)))^2$	0.056752	0.039616	1.432563	0.1548
S1	-0.015596	0.003568	-4.370857	0.0000
S3	-0.019605	0.002754	-7.119663	0.0000
PYFP3DUM	1.036715	0.225714	4.593046	0.0000
KNRBRFEKq1	0.027936	0.004440	6.291500	0.0000
KNRBREAKq2	-0.012832	0.005613	-2.286229	0.0241
Constant	0.104749	0.024578	4.261995	0.0000
R-squared	0.674179	Mean dependent var	0.006603	
S.E. of regression	0.010683	Akaike info criterion	-6.161247	
F-statistic	25.51974	Durbin-Watson stat	1.911859	

Notes:
$PYFP3DUM$ is given in the code of the Eviews program file

5.4.4 Value added deflator in private production of other goods and service activities and private services.

Table 5.19: Dependent Variable: LOG(PYFP23). OLS estimation. Sample size: 121 (1995Q1 2025Q1)

	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-0.000644	0.001904	-0.338571	0.7355
LOG(PYF2)	0.224141	0.004026	55.66988	0.0000
LOG(PYF3)	0.786	-	-	-
R-squared	0.999185	Mean dependent var	-0.378586	
S.E. of regression	0.007542	Akaike info criterion	-6.920264	
F-statistic	145817.3	Durbin-Watson stat	2.010601	

5.4.5 Deflator of private Mainland-Norway GDP (basic value)

Table 5.20: Dependent Variable: LOG(PYFPB). OLS estimation. Sample size: 101 (2000Q1 2025Q1)

	Coefficient	Std. Error	t-Statistic	Prob.
LOG(PYFP1)	0.161574	0.004759	33.94965	0.0000
LOG(PYFP2)	0.161108	0.002027	79.47481	0.0000
LOG(PYFP3)	0.6774	-	-	-
Constant	-0.004723	0.000948	-4.983506	0.0000
R-squared	0.999764	Mean dependent var	-0.293933	
S.E. of regression	0.003187	Akaike info criterion	-8.630033	
F-statistic	207988.0	Durbin-Watson stat	1.667312	

5.4.6 Value added deflator in government sector

Table 5.21: Dependent Variable: DLOG(PYO). OLS estimation. Sample size: 120 (1995Q1 2022Q4)

	Coefficient	Std. Error	t-Statistic	Prob.
DLOG(WO)-DLOG(YO/TWO)	0.113200	0.034167	3.313124	0.0013
KNRBREAKQ1	0.002538	0.004628	0.548398	0.5847
KNRBREAK2	0.046622	0.004790	9.733785	0.0000
KLNRBREAK3	-0.065309	0.004599	-14.19946	0.0000
CS1	0.013989	0.003994	3.502731	0.0007
CS2	0.004896	0.004796	1.020752	0.3102
CS3	-0.002806	0.007587	-0.369829	0.7124
Constant	0.010208	0.001236	8.259953	0.0000
R-squared	0.835534	Mean dependent var	0.0103410	
S.E. of regression	0.010442	Akaike info criterion	-6.397655	
Durbin-Watson stat	2.245198			

5.4.7 Deflator of Mainland-Norway GDP (basic value)

Table 5.22: Dependent Variable: LOG(PYFB). OLS estimation. Sample size: 87 (2000Q2 2021Q3)

	Coefficient	Std. Error	z-Statistic	Prob.
LOG(PYFP1/PYO)	0.190738	0.012354	15.43954	0.0000
LOG(PYFP2/PYO)	0.102156	0.008315	12.28599	0.0000
LOG(PYFP3/PYO)	0.206159	0.008755	23.54727	0.0000
LOG(PYO)	1	—	—	—
Constant	0.005372	0.002346	2.290000	0.0242
R-squared	0.998435	Mean dependent var	-0.314619	
S.E. of regression	0.009108	Akaike info criterion	-6.520538	
F-statistic	20629.17	Durbin-Watson stat	1.225245	

5.4.8 Deflator of Mainland-Norway GDP (market value)

Table 5.23: Dependent Variable: LOG(PYF). OLS estimation. Sample size: 188 (1978Q2 2025Q1)

	Coefficient	Std. Error	z-Statistic	Prob.
LOG(PYFP1/PYO)	0.153484	0.006970	22.02114	0.0000
LOG(PYFP2/PYO)	0.118320	0.004384	26.98612	0.0000
LOG(PYFP3/PYO)	0.541184	0.006020	89.90307	0.0000
LOG(PYO)	1	—	—	—
LOG(1+T3)	0.881848	0.055770	15.81235	0.0000
Constant	-0.101966	0.006606	-15.43516	0.0000
R-squared	0.999814	Mean dependent var	-0.663578	
S.E. of regression	0.006659	Akaike info criterion	-7.159576	
F-statistic	245895.1	Durbin-Watson stat	0.887209	

5.4.9 Consumer price index

Table 5.24: Dependent Variable: DLOG(CPI). OLS estimation. Sample size: 188 (1978Q2 2025Q1)

	Coefficient	Std. Error	z-Statistic	Prob.
ECM_{CPI}(-1)	-0.043193	0.004945	-8.733772	0.0000
DLOG(CPI(-4))	0.113608	0.028216	4.026412	0.0001
DLOG((WFP(-1)(1+T1FP1(-1))/ZYFP(-1))	0.019132	0.003424	5.587643	0.0000
DLOG(PCKONK)	0.312710	0.051813	6.035320	0.0000
DLOG(PCKONK(-1))	-0.123596	0.049609	-2.491394	0.0136
DLOG(CPIEL)	0.037151	0.002228	16.67348	0.0000
$(1/UAKU(-1))^2$	0.036007	0.002837	12.69396	0.0000
CPIDUM	1.030419	0.071065	14.49967	0.0000
S2	0.005102	0.000536	9.516351	0.0000
Constant	0.010745	0.001299	8.269835	0.0000
R-squared	0.932403	Mean dependent var	0.009140	
Adjusted R-squared	0.903051	Mean dependent var	0.009206	
S.E. of regression	0.002862	Akaike info criterion	-8.832781	
Durbin-Watson stat	1.632210			

Notes:
$ECM_{CPI} = LOG(CPI) - 0.5LOG(PB) - 0.5LOG(PY^*))$
$PY^* = PYFP1(1+T3))^{0.35}PYFP2(1+T3))^{0.05}PYFP3(1+T3))^{0.6}$
$CPIDUM$ is given in the code of the EViews program file.

5.4.10 Wage per hour in manufacturing and mining

Table 5.25: Dependent Variable: D4LOG(WFP1). OLS estimation. Sample size: 120 (1996Q1 2025Q4)

	Coefficient	Std. Error	t-Statistic	Prob.
$ECM_{WFP1}(-4)$	-0.225916	0.039617	-5.702503	0.0000
(D4LOG(CPI(-1))-π^*)	0.256144	0.140018	1.829359	0.0701
D4LOG(PYFP1)+D4LOG(ZYFP1)	0.166235	0.043000	3.865979	0.0002
DLOG(WFP1(-4))	-0.418846	0.053038	-7.897114	0.0000
WFP1DUM	0.999524	0.128770	7.762084	0.0000
Constant	-0.080586	0.012745	-6.322762	0.0000
S1	0.044201	0.008852	4.993629	0.0000
S2	0.089399	0.011451	7.807191	0.0000
S3	0.102751	0.012282	8.366259	0.0000
KNBREAKQ2	0.056043	0.010612	5.281200	0.0000
KNBREAKQ3	-0.113469	0.013355	-8.496706	0.0000
Adjusted R-squared	0.632652	S.D. dependent var	0.037593	
S.E. of regression	0.022785	Akaike info criterion	-4.638245	
F-statistic	21.49438	Durbin-Watson stat	1.852282	

Notes:
ECM_{WFP1} = LOG(WCFP1/(ZYFP1*PYFP1)+0.12LOG(UAKU)
WFP1DUM is given in the code of the Eviews program.
π^* represents the inflation target rate.

5.4.11 Wage per hour in other commodity production

Table 5.26: Dependent Variable: DLOG(WFP2). OLS estimation. Sample size: 210 (1972Q4 2025Q1)

	Coefficient	Std. Error	t-Statistic	Prob.
log(WFP2(-1)/WFP1(-1))	-0.584185	0.026414	-22.11610	0.0000
DLOG(WFP1)	0.898729	0.012944	69.43405	0.0000
D3LOG(WFP2(-1))	-0.082761	0.012414	-6.666835	0.0000
LOG(UAKU(-1))	-0.004086	0.001021	-4.001625	0.0001
WFP2DUM	1.000009	0.039277	25.46065	0.0000
Constant	0.019293	0.002033	9.489829	0.0000
KNRBREAKQ1	-0.086024	0.003156	-27.25947	0.0000
KNRBREAKQ3	-0.049242	0.003238	-15.20782	0.0000
Adjusted R-squared	0.992002	S.D. dependent var	0.089122	
S.E. of regression	0.007970	Akaike info criterion	-6.793465	
F-statistic	4321.631	Durbin-Watson stat	2.124561	
Notes:				
WFP2DUM is given in the code of the Eviews program.				

5.4.12 Wage per hour in private service production

Table 5.27: Dependent Variable: DLOG(WFP3). OLS estimation. Sample size: 210 (1972Q4 2025Q1)

	Coefficient	Std. Error	t-Statistic	Prob.
log(WFP3(-1)/WFP1(-1))	-0.398439	0.023634	-16.85870	0.0000
DLOG(WFP1)	0.768181	0.014525	52.88724	0.0000
D3LOG(WFP3(-1))	-0.157922	0.016086	-9.817167	0.0000
KNRBREAKQ3	0.018186	0.003428	5.305278	0.0000
WFP3DUM	1.043265	0.061101	17.07455	0.0000
Constant	0.002855	0.001357	2.102880	0.0367
Adjusted R-squared	0.980177	S.D. dependent var	0.069137	
S.E. of regression	0.009734	Akaike info criterion	-6.398225	
F-statistic	2067.891	Durbin-Watson stat	2.227510	
Notes:				
WFP3DUM is given in the code of the Eviews program.				

5.4.13 Wage per hour in other commodity and private service production (Technical relationship)

Table 5.28: Dependent Variable: LOG(WFP23). LS estimation. Sample size: 121 (1995Q1 2025Q1)

	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-0.003644	0.000511	-7.130851	0.0000
(LOG(WFP2)+LOG(WFP3))	0.420036	0.006835	61.45189	0.0000

5.4.14 Wage per hour in government administration

Table 5.29: Dependent Variable: DLOG(WO). LS estimation. Sample size: 210 (1972Q4 2025Q1)

	Coefficient	Std. Error	t-Statistic	Prob.
(LOG(WO(-1)-LOG(WFP1(-1)))	-0.312716	0.031358	-9.972349	0.0000
DLOG(WFP1)	0.830194	0.025974	31.96280	0.0000
D3LOG(WO(-1))	-0.204409	0.023696	-8.626212	0.0000
LOG(UAKU(-1))	-0.036006	0.006193	-5.813657	0.0000
D4LOG(CPI(-1))	0.148660	0.034393	4.322408	0.0000
DLOG(ARBDAG)	-0.046012	0.013446	-3.421936	0.0008
WODUM	1.016518	0.052032	19.53631	0.0000
CS1	-0.010899	0.002374	-4.591004	0.0000
S2	-0.011061	0.002701	-4.095416	0.0001
Adjusted R-squared	0.973821	S.D. dependent var	0.081393	
S.E. of regression	0.013169	Akaike info criterion	-5.779946	
Durbin-Watson stat	1.883188			

5.4.15 Wage per hour in Mainland-Norway

Table 5.30: Dependent Variable: LOG(WF). LS estimation. Sample size: 121 (1995Q1 2025Q1)

	Coefficient	Std. Error	t-Statistic	Prob.
LOG(WFP1)	0.119232	0.004016	29.68679	0.0000
LOG(WFP2)	0.097800	0.003031	32.27079	0.0000
LOG(WFP3)	0.482004	0.005831	82.66825	0.0000
LOG(WO)	0.300	-	-	-
R-squared	0.999997	Mean dependent var	5.553362	
S.E. of regression	0.000639	Akaike info criterion	-11.84995	
Durbin-Watson stat	0.735725			

5.4.16 Wage per hour in private Mainland-Norway

Table 5.31: Dependent Variable: LOG(WFP). LS estimation. Sample size: 121 (1995Q1 2025Q1)

	Coefficient	Std. Error	t-Statistic	Prob.
LOG(WFP1)	0.176823	0.004671	37.85927	0.0000
LOG(WFP2)	0.137365	0.003165	43.39623	0.0000
LOG(WFP3)	0.687	-	-	-
R-squared	0.999993	Mean dependent var	5.565150	
S.E. of regression	0.000915	Akaike info criterion	-11.13887	
Durbin-Watson stat	0.695545			

5.4.17 Wage per hour in oil and gas production and international transportation

Table 5.32: Dependent Variable: DLOG(WOSJ). OLS estimation. Sample size: 121 (1995q1 2025Q1)

	Coefficient	Std. Error	t-Statistic	Prob.
DLOG(WFP1)	0.491322	0.043443	11.30950	0.0000
LOG(WOSJ(-1)/WFP1(-1))	-0.070188	0.016193	-4.334387	0.0000
LOG(WOSJ(-1)-LOG(PYOIL1(-1)*YOIL1(-1)/TWOSJ(-1))	-0.034510	0.006338	-5.444978	0.0000
D3LOG(WOSJ(-1)	-0.538743	0.040115	-13.42984	0.0000
D4LOG(CPI(-1))	-0.256779	0.115762	-2.218158	0.0277
LOG(UAKU(-1))	-0.062739	0.014043	-4.467738	0.0000
WOSJDUM	0.998389	0.125415	7.960682	0.0000
CS2	-0.056102	0.008642	-6.491867	0.0000
CS3	-0.038316	0.006876	-5.572132	0.0000
Adjusted R-squared	0.916476	S.D. dependent var	0.089876	
S.E. of regression	0.025975	Akaike info criterion	-4.391926	
Sum squared resid	0.075564	Schwarz criterion	-4.183975	
F-statistic	165.5894	Durbin-Watson stat	1..93233	
Notes:				
WOSJDUM is given in the code of the Eviews program.				

5.4.18 Annual wage in total economy per full time equivalent wage earner

Table 5.33: Dependent Variable: LOG(WH/WH(-4)). LS estimation. Sample size: 117 (1996Q1 2025Q1)

	Coefficient	Std. Error	t-Statistic	Prob.
LOG(WF/WF(-4)))	0.952828	0.013755	69.26999	0.0000
LOG(ARBDAG/ARBDAG(-4))	0.803328	0.020344	39.48628	0.0000
COVIDQ1+COVIDQ2+COVIDQ4	-0.017048	0.003581	-4.760872	0.0000
COVIDQ5-COVIDQ6	0.031850	0.004366	7.294663	0.0000
0.824735	Mean dependent var	0.039952		
S.E. of regression	0.006585	Akaike info criterion	-7.174582	
Durbin-Watson stat	1.31816			

5.4.19 Annual wage in civil central administration per full time equivalent wage earner

Table 5.34: Dependent Variable: LOG(WHGSC). LS estimation. Sample size: 69 (2008Q1 2025q1)

	Coefficient	Std. Error	t-Statistic	Prob.
LOG(WO)	0.988657	0.013645	72.45696	0.0000
KNRBREAKQ1	0.022462	0.005526	4.064743	0.0001
KNRNREAKQ2	0.017799	0.006467	2.752399	0.0077
KNRBREAKQ3	-0.009463	0.007524	-1.257652	0.2132
Constant	-4.763210	0.183025	-26.02486	0.0000
LOG(ARBDAG)	0.987498	0.039534	24.97852	0.0000
0.993170	Mean dependent var	4.963181		
S.E. of regression	0.014580	Akaike info criterion	-5.535420	
856.8486	Durbin-Watson stat	1.857733		

5.4.20 Wage in local administration (annual wage)

Table 5.35: Dependent Variable: DLOG(WHGL). LS estimation. Sample size: 101 (2000Q1 2025Q1)

	Coefficient	Std. Error	t-Statistic	Prob.
DLOG(WHGSC)	0.664613	0.043920	15.13237	0.0000
DLOG(WHGL(-1))	0.335	-	-	-
WHGLDUM	0.664613	0.043920	15.13237	0.0000
KNRBREAKQ1	0.040069	0.004234	9.464796	0.0000
KNRBREAKQ2	0.007020	0.004869	1.441741	0.1526
KNRBREAKQ3	-0.036967	0.007332	-5.041766	0.0000
R-squared	0.827074	Mean dependent var	0.008993	
S.E. of regression	0.014025	Akaike info criterion	-5.647751	
Durbin-Watson stat	2.674822			

Notes:
WHGLDUM is defined in the code of the EViews program file.

5.4.21 CPI adjusted for energy and taxes

Table 5.36: Dependent Variable: DLOG(CPIJAE). LS estimation. Sample size: 159 (2000Q1 2022Q1)

	Coefficient	Std. Error	t-Statistic	Prob.
DLOG(CPI)	0.912510	0.028368	32.16666	0.0000
DLOG(CPIEL))	-0.033610	0.001733	-19.39344	0.0000
DLOG(CPIJAE(-1))	0.118661	0.025784	4.602123	0.0000
DLOG(CPIJAE(-4))	0.174002	0.043972	3.957134	0.0002
D(T3)	-0.053586	0.018322	-2.924738	0.0040
CPIJAEDUM	0.998881	0.059164	16.88318	0.0000
Constant	0.001042	0.000256	4.075712	0.0001
S1	-0.003714	0.000373	-9.960726	0.0000
S2	0.000394	0.000408	0.966165	0.3355
S3	-0.002092	0.000389	-5.372068	0.0000
COVIDQ8	-0.007337	0.001405	-5.223550	0.0000
Adjusted R-squared	0.957587	S.D. dependent var	0.006590	
S.E. of regression	0.001357	Akaike info criterion	-10.30023	
Log likelihood	829.8680	Hannan-Quinn criter.	-10.21401	
F-statistic	357.7310	Durbin-Watson stat	1.765621	

Notes:
$CPIJAEDUM$ is defined in Eviews program file.

5.4.22 Energy part of CPI.

Table 5.37: Dependent Variable: DLOG(CPIEL). LS estimation. Sample size: 63 (2006Q1 2021Q3)

	Coefficient	Std. Error	t-Statistic	Prob.
DLOG(NORPOOL)	0.234576	0.015978	14.68074	0.0000
DDLOG(CPIEL(-1))	0.176976	0.045079	3.925858	0.0002
R-squared	0.787168	Mean dependent var	0.014439	
S.E. of regression	0.058832	Akaike info criterion	-2.654451	
Durbin-Watson stat	2.559421			

5.4.23 Import price

Table 5.38: Dependent Variable: DLOG(PB). LS estimation. Sample size: 184 (1979Q2 2025Q1)

	Coefficient	Std. Error	t-Statistic	Prob.
DLOG(PB(-1)-DLOG(PB(-4))	-0.123770	0.027875	-4.440113	0.0000
(LOG(PB(-1))-LOG(CPIVAL(-1)*PPIKONK(-1)))	-0.299944	0.045532	-6.587581	0.0000
(LOG(PCKONK(-1)*CPIVAL(-1))-LOG(CPI(-1)))	-0.067868	0.013174	-5.151756	0.0000
(LOG(PPIKONK(-1)*CPIVAL(-1))-LOG(CPI(-1)))	-0.048671	0.011910	-4.086660	0.0001
DLOG(CPIVAL)	0.481254	0.048278	9.968439	0.0000
DLOG(PPIKONK)	0.658216	0.079774	8.250965	0.0000
log(SPOILUSD(-1)*SPUSD(-1))/PYF(-1))	0.003825	0.000499	7.661265	0.0000
PBDUM	1.001362	0.086776	11.53966	0.0000
S1	0.010169	0.002737	-3.715719	0.0003
S2	-0.009824	0.002851	-3.446198	0.0007
S3	-0.012809	0.002692	-4.758149	0.0000
R-squared	0.707001	Mean dependent var	0.008123	
Adjusted R-squared	0.690065	S.D. dependent var	0.022961	
S.E. of regression	0.012783	Akaike info criterion	-5.823528	
Log likelihood	546.7646	Hannan-Quinn criter.	-5.745628	
Durbin-Watson stat	1.981179			
Notes:				
$PBDUM$ is defind in the Eviews program file.				

5.4.24 Foreign consumer price index (trade weighted)

Table 5.39: Dependent Variable: D4LOG(PCKONK). LS estimation. Sample size: 104 (2000Q1 2025Q5)

	Coefficient	Std. Error	t-Statistic	Prob.
Constant	0.004633	0.000733	6.316765	0.0000
LOG(PCKONK(-1)/PPIKONK(-1)-μ	-0.034884	0.007618	-4.579411	0.0000
μ	0.313780	0.059659	5.259579	0.0000
DLOG(PCKONK(-4))	0.320103	0.059204	5.406772	0.0000
COVIDQ9	0.007582	0.002652	2.859191	0.0052
R-squared	0.785279	Mean dependent var	0.006396	
S.E. of regression	0.002343	Akaike info criterion	-9.218747	
F-statistic	71.68105	Durbin-Watson stat	1.648142	
Notes:				
PCKONKDUM is defined in the Eviews program file				

5.4.25 Foreign producer price index (trade weighted)

Table 5.40: Dependent Variable: DLOG(PPIKONK). LS estimation. Sample size: 133 (1990Q1 2023Q1)

	Coefficient	Std. Error	t-Statistic	Prob.
Constant	0.001409	0.000473	2.980770	0.0035
DLOG(PPIKONK(-1))	0.487903	0.034351	14.20332	0.0000
DLOG(SPOILUSD)	0.034563	0.002721	12.70403	0.0000
PPIKONKDUM	1.038155	0.112976	9.189151	0.0000
COVID5+COVIDQ7+COVIDQ8+COVIDQ9	0.026456	0.002790	9.482880	0.0000
UKRW(-1)+0.5*UKRW(2)-UKRW(-3)	0.024462	0.003427	7.138268	0.0000
CS2	0.001935	0.001018	1.900312	0.0597
Adjusted R-squared	0.876350	S.D. dependent var	0.014110	
S.E. of regression	0.004962	Akaike info criterion	-7.722915	
Log likelihood	520.5739	Hannan-Quinn criter.	-7.661098	
F-statistic	156.9212	Durbin-Watson stat	2.079809	

Notes:
UKRW is 1 in 2022q1. Else 0.
PPPIKONKDUM is defined in the Eviews script

5.4.26 Export price index, services

Table 5.41: Dependent Variable: DLOG(PATJEN). LS estimation. Sample size: 87 (2000Q1 2021Q3)

	Coefficient	Std. Error	t-Statistic	Prob.
Constant	0.017160	0.004695	3.654839	0.0005
DLOG(PPIKONK(-1))	0.495259	0.203888	2.429079	0.0174
DLOG(CPIVAL)	0.319563	0.106239	3.007967	0.0035
KNRBREAKQ2	-0.073087	0.011578	-6.312523	0.0000
DLOG(WF(1+T1FP1)/ZYF)	0.233653	0.050454	4.630998	0.0000
DLOG(EMI)	0.278048	0.097050	2.864996	0.0053
LOG(PATJEN(-1))-LOG(PPIKONK(-1)*CPIVAL(-1))	-0.088263	0.024411	-3.615678	0.0005
R-squared	0.461874	Mean dependent var	0.006167	
S.E. of regression	0.022867	Akaike info criterion	-4.523975	
F-statistic	11.44401	Durbin-Watson stat	2.123889	

5.4.27 Export price index, traditional goods

Table 5.42: Dependent Variable: DLOG(PATRAD). LS estimation. Sample size: 127 (1990Q1 2021Q2)

	Coefficient	Std. Error	t-Statistic	Prob.
LOG(PATRAD(-1))-LOG(PPIKONK(-1)*CPIVAL(-1))	-0.120499	0.031998	-3.765805	0.0003
LOG(WCFP1(-1))/ZYFP1(-1))	0.088494	0.027531	3.214271	0.0017
DLOG(PATRAD(-4)) 0.340220	0.068724	4.950503	0.0000	
DLOG(PPIKONK*CPIVAL)	0.625254	0.098135	6.371361	0.0000
DLOG(PPIKONK(-1)*CPIVAL(-1))	0.266965	0.102176	2.612792	0.0102
DLOG(WCFP1/ZYFP1)	0.077078	0.034717	2.220196	0.0284
D2LOG(SPOILUSD*SPUSD)	0.057021	0.010556	5.401913	0.0000
CS1	0.001652	0.006033	0.273834	0.7847
CS2	0.004787	0.006727	0.711576	0.4782
CS3	0.018279	0.006450	2.833998	0.0054
Constant	0.010994	0.010802	1.017708	0.3110
COVIDQ+COVIDQ6	-0.036147	0.016758	-2.157007	0.0331
R-squared	0.539521	Mean dependent var	0.004802	
S.E. of regression	0.022209	Akaike info criterion	-4.647312	
F-statistic	12.24907	Durbin-Watson stat	2.083429	

5.4.28 Export price index, oil and natural gas

Table 5.43: Dependent Variable: DLOG(PAOIL). LS estimation. Sample size: 168 (1980Q1 2021Q4)

	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-2.813466	0.187318	-15.01976	0.0000
DLOG(SPOILUSD*SPUSD)	0.686751	0.024088	28.51050	0.0000
LOG(PAOIL(-1)/(SPOILUSD(-1)*SPUSD(-1))	-0.459009	0.030483	-15.05775	0.0000
COVIDQ1+COVIDQ2	-0.250742	0.031808	-7.883074	0.0000
PAOILDUM1+PAOILDUM2	1.019639	0.061975	16.45254	0.0000
R-squared	0.891040	Mean dependent var	0.013490	
S.E. of regression	0.041793	Akaike info criterion	-3.482848	

Notes:
PAOIL1 and PAOIL2 are given in the NAM-prg file.
3 until 200q4 and 2.5 after that

5.5 Exchange rates

5.5.1 Nominal effective (trade weighted) exchange rate

Table 5.44: Dependent Variable: DLOG(CPIVAL). LS estimation. Sample size: 98 (2001Q1 2025Q2.)

	Coefficient	Std. Error	t-Statistic	Prob.
DLOG(CPIVAL(-1))	-0.286392	0.062066	-4.614342	0.0000
D(RSH)-D(RSW)	-0.045472	0.005286	-8.602161	0.0000
DLOG(SPOILUSD)	-0.087978	0.010852	-8.106753	0.0000
LOG(PAW(-4)/PAW(-5))	0.092566	0.023712	3.903806	0.0002
(RBOTENY-US10Y)	-0.007123	0.002142	-3.325236	0.0013
CPIVAL08Q4	0.049370	0.015896	3.105849	0.0026
CPIVAL19Q4	0.047496	0.013858	3.427441	0.0009
COVIDQ2	-0.064811	0.016277	-3.981831	0.0001
COVIDQ6	-0.022848	0.014044	-1.626920	0.1075
CPIVAL23Q2	0.051535	0.013916	3.703295	0.0004
R-squared	0.727940	Mean dependent var	0.001463	
Adjusted R-squared	0.676952	S.D. dependent var	0.025071	
S.E. of regression	0.013729	Akaike info criterion	-5.539588	
Log likelihood	265.5909	Hannan-Quinn criter.	-5.451624	
Durbin-Watson stat	1.742383			

Notes:
CPIVAL08Q4 is 1 in 2008q4, zero elsewhere. CPIVAL19Q4 is 1 in 2019q4, zero elsewhere.
CPIVAL23Q2 is 1 in 2023q2, zero elsewhere

5.5.2 Krone/euro nominal exchange rate

Table 5.45: Dependent Variable: DLOG(SPEURO). LS estimation. Sample size: 87 (2000Q1 2021Q3)

	Coefficient	Std. Error	t-Statistic	Prob.
DLOG((PCKONK*CPIVAL)/CPI)	1.007276	0.082884	12.15282	0.0000
D(RSH)-D(RSW)-DLOG(SPEURO(-1))100	-0.000982	0.000498	-1.971076	0.0520
D(SPOILUSD*(AOIL/Y)	-0.002518	0.001037	-2.428939	0.0173
DLOG(SPUSD)	-0.136559	0.046153	-2.958818	0.0040
R-squared	0.782598	Mean dependent var	0.002663	
S.E. of regression	0.012403	Akaike info criterion	-5.708355	
Durbin-Watson stat	1.81436			

5.5.3 Krone/USD nominal exchange rate

Table 5.46: Dependent Variable: DLOG(SPUSD). LS estimation. Sample size: 127 (1990Q1 2021Q3)

	Coefficient	Std. Error	t-Statistic	Prob.
DLOG((PCKONK*CPIVAL)/CPI)	1.183351	0.142236	8.319645	0.0000
D(RSH)	-0.006047	0.003727	-1.622797	0.1072
D(SPOILUSD*(AOIL/Y)	-0.009169	0.002170	-4.225770	0.0000
R-squared	0.590443	Mean dependent var	0.001940	
S.E. of regression	0.030588	Akaike info criterion	-4.113074	
Durbin-Watson stat	1.570078			

5.6 Hours worked and employment

5.6.1 Hours worked by wage earners. Manufacturing and mining

Table 5.47: Dependent Variable: DLOG(TWFP1). LS estimation. Sample size: 124 (1995Q1 2025Q4)

	Coefficient	Std. Error	t-Statistic	Prob.
Constant	0.417360	0.240198	1.737563	0.0849
DLOG(YFP1)	0.334909	0.045706	7.327485	0.0000
DLOG(ARBDAG)	0.609832	0.032851	18.56376	0.0000
LOG(TWFP1(-1))	-0.245182	0.026935	-9.102562	0.0000
LOG(YFP1(-1))	0.132844	0.026473	5.018063	0.0000
LOG(WFP11+T1FP1)/PYFP1)	-0.120004	0.017960	-6.681811	0.0000
Trend	-0.000260	8.83E-05	-2.946980	0.0039
TWFP1DUM	0.992848	0.115144	8.622623	0.0000
R-squared	0.978964	Mean dependent var	-0.001163	
S.E. of regression	0.013084	Akaike info criterion	-5.772493	
F-statistic	771.1888	Durbin-Watson stat	1.990149	
Notes:				
TWFP1DUM is defined in the program file				

5.6.2 Hours worked by wage earners. Production of other goods

Table 5.48: Dependent Variable: DLOG(TWFP2). LS estimation. Sample size: 124 (1995Q1 2025Q4)

	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-0.696710	0.299066	-2.329620	0.0216
DLOG(YFP2)	0.347151	0.039051	8.889673	0.0000
LOG(TWFP2(-1))	-0.333370	0.039843	-8.367100	0.0000
LOG(YFP2(-1))	0.307330	0.042026	7.312804	0.0000
LOG(WFP2+T1FP23)/PYFP2)	-0.087358	0.015950	-5.477176	0.0000
DLOG(ARBDAG)	0.695481	0.030774	22.59955	0.0000
TWFP2DUM	1.003958	0.115299	8.707429	0.0000
KNRBREAKQ1	-0.017146	0.006342	-2.703505	0.0079
S2	0.069101	0.007270	9.504687	0.0000
Trend	0.000745	0.000189	3.934016	0.0001
R-squared	0.973218	Mean dependent var	0.006996	
S.E. of regression	0.015195	Akaike info criterion	-5.458484	
F-statistic	460.2923	Durbin-Watson stat	2.072539	
Notes:				
TWFP2DUM is defined in the program file				

5.6.3 Hours worked by wage earners. Private service production

Table 5.49: Dependent Variable: DLOG(TWFP3). LS estimation. Sample size: 124 (1995Q1 2025Q5)

	Coefficient	Std. Error	t-Statistic	Prob.
DLOG(YFP3)	0.098194	0.027709	3.543800	0.0006
LOG(TWFP3(-1))	-0.208208	0.027704	-7.515309	0.0000
LOG(YFP3(-1))	0.170267	0.020397	8.347749	0.0000
LOG(WFP3+T1FP23)/PYFP3)	-0.177232	0.025171	-7.041229	0.0000
DLOG(ARBDAG)	0.574241	0.022806	25.17941	0.0000
TWFP3DUM	1.001650	0.085893	11.66155	0.0000
KNRBREAKq1	-0.023915	0.003696	-6.470408	0.0000
Constant	0.171737	0.043228	3.972794	0.0001
R-squared	0.986687	Mean dependent var	0.003647	
S.E. of regression	0.008528	Akaike info criterion	-6.628502	
F-statistic	1228.151	Durbin-Watson stat	1.974235	
Notes:				
TWFP3DUM is defined in the program file				

5.6.4 Hours worked in government administration

Table 5.50: Dependent Variable: LOG(TWO/TWO(-4)). LS estimation. Sample size: 101 (200Q1 2025Q1)

	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-9.181651	0.211497	-43.41271	0.0000
DLOG(YO)	0.451540	0.067014	6.738038	0.0000
LOG(YO(-1)/ARBDAG)	0.916756	0.013161	69.65764	0.0000
COVIDq5)	0.058470	0.018299	3.195175	0.0019
0.981253	Mean dependent var	5.554564		
S.E. of regression	0.018051	Akaike info criterion	-5.152421	
F-statistic	1692.390	Durbin-Watson stat	1.784387	

5.6.5 Hours worked in oil and gas and international transport

Table 5.51: Dependent Variable: DLOG(TWOSJ). LS estimation. Sample size: 141 (1990Q1 2025Q1)

	Coefficient	Std. Error	t-Statistic	Prob.
Constant	0.008217	0.005540	1.483246	0.1403
DLOG(YOIL1)	0.040338	0.020023	2.014599	0.0459
DLOG(ARBDAG)	0.383952	0.033607	11.42486	0.0000
DLOG(TWOSJ(-4))	0.199300	0.056269	3.541925	0.0005
LOG(TWOSJ(-1))-0.2LOG(YOIL1(-1)-0.02LOG(YUSF(-1))	-0.024310	0.015579	-1.560400	0.1210
KNRBREAKQ2	-0.027628	0.010900	-2.534697	0.0124
Adjusted R-squared	0.754240	Mean dependent var	-0.001443	
S.E. of regression	0.028257	Akaike info criterion	-4.253359	
Log likelihood	282.4896	Hannan-Quinn criter.	-4.199908	
F-statistic	82.86322	Durbin-Watson stat	2.216556	

5.6.6 Wage earners in manufacturing and mining

Table 5.52: Dependent Variable: DLOG(NWFP1).OLS estimation. Sample size: 120 (1996Q1 2025Q4)

	Coefficient	Std. Error	t-Statistic	Prob.
Constant	1.201488	0.168181	7.144002	0.0000
LOG(NWFP1(-1))-log(TWFP1/ARBDAG)	-0.118517	0.036345	-3.260926	0.0015
DLOG(NWFP1(-4))	0.208080	0.064532	3.224467	0.0016
CS1	-0.001829	0.002346	-0.779301	0.4374
CS2	0.005685	0.002522	2.254155	0.0261
CS3	0.009306	0.002594	3.587784	0.0005
R-squared	0.659738	Mean dependent var	-0.001100	
S.E. of regression	0.008929	Akaike info criterion	-6.550279	
F-statistic	44.20727	Durbin-Watson stat	1.138457	

5.6.7 Wage earners in production of other goods

Table 5.53: Dependent Variable: DLOG(NWFP2).OLS estimation. Sample size: 120 (1996Q1 2025Q4)

	Coefficient	Std. Error	t-Statistic	Prob.
Constant	2.227903	0.231624	9.618599	0.0000
LOG(NWFP2(-1))-log(TWFP2/ARBDAG)	-0.447126	0.046542	-9.607046	0.0000
DLOG(NWFP2(-4))	0.278746	0.064024	4.353753	0.0000
CS1	-0.001710	0.003021	-0.566182	0.5724
CS2	0.003234	0.003342	0.967654	0.3353
CS3	0.007632	0.003311	2.305523	0.0229
0.783891	Mean dependent var	0.007321		
S.E. of regression	0.011480	Akaike info criterion	-6.047698	
F-statistic	82.70230	Durbin-Watson stat	1.584506	

5.6.8 Wage earners in private service production

Table 5.54: Dependent Variable: DLOG(NWFP3).OLS estimation. Sample size: 120 (1996Q1 2025Q4)

	Coefficient	Std. Error	t-Statistic	Prob.
Constant	1.077750	0.180440	5.972904	0.000
LOG(NWFP3(-1))-log(TWFP3/ARBDAG)	-0.210116	0.035257	-5.959562	0.0000
DLOG(NWFP3(-4))	0.253058	0.074436	3.399663	0.0009
CS1	-0.001911	0.002419	-0.789944	0.4312
CS2	0.007202	0.002859	2.519153	0.0131
CS3	0.004090	0.002996	1.365402	0.1748
R-squared	0.621236	Mean dependent var	0.004275	
S.E. of regression	0.009289	Akaike info criterion	-6.471321	
F-statistic	37.39581	Durbin-Watson stat	1.530374	

5.6.9 Wage earners in government administration

Table 5.55: Dependent Variable: D4LOG(NWO). LS estimation. Sample size: 104 (2000Q1 2025Q4)

	Coefficient	Std. Error	t-Statistic	Prob.
LOG(TWO)	0.237485	0.031504	7.538199	0.0000
LOG(ARBDAG)	-0.155250	0.034791	-4.462335	0.0000
LOG(NWO(-1)	-0.291833	0.039141	-7.455928	0.0000
CS1	-0.008341	0.001473	-5.661298	0.0000
CS2	-0.000651	0.002195	-0.296358	0.7676
CS3	0.012759	0.003455	3.692895	0.0004
Constant	1.257118	0.215677	5.828700	0.0000
R-squared	0.455068	Mean dependent var	0.002633	
S.E. of regression	0.004955	Akaike info criterion	-7.712058	
Log likelihood	408.0270	Hannan-Quinn criter.	-7.639950	
F-statistic	13.50063	Durbin-Watson stat	2.082029	

5.6.10 Wage earners in oil and gas production and international transportation

Table 5.56: Dependent Variable: LOG(NWOSJ). LS estimation. Sample size: 127 (1990Q1 2021Q3)

	Coefficient	Std. Error	t-Statistic	Prob.
Constant	0.205093	0.094208	2.177012	0.0314
LOG(TWOSJ)	0.539562	0.089866	6.004081	0.0000
LOG(TWOSJ(-1))	-0.571621	0.090589	-6.310041	0.0000
LOG(TWOSJ(-3))	0.120484	0.043915	2.743577	0.0070
LOG(NWOSJ(-1))	0.876797	0.043908	19.96908	0.0000
DLOG(ARBDAG)	-0.377612	0.052259	-7.225783	0.0000
Adjusted R-squared	0.945960	Mean dependent var	3.918647	
S.E. of regression	0.029661	Akaike info criterion	-4.0499276	
F-statistic	423.6180	Durbin-Watson stat	2.213511	

5.6.11 Average working time for self employed

Table 5.57: Dependent Variable: DLOG(FHSF). LS estimation. Sample size: 106 (1995Q2 2021Q3)

	Coefficient	Std. Error	t-Statistic	Prob.
DLOG(FHWPF)	0.844403	0.008347	101.1615	0.0000
(COVIDQ5-COVIDQ6)	-0.029260	0.007147	-4.093892	0.0001
R-squared	0.979505	Mean dependent var	-0.001666	
S.E. of regression	0.007113	Akaike info criterion	-7.026019	
Durbin-Watson stat	2.323083			

5.7 Labour force and unemployment

5.7.1 Labour force survey unemployment)

Table 5.58: Dependent Variable: AKULED. LS estimation. Sample size: 139 (1988Q1 2022Q3)

	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-17.14568	6.449367	-2.658507	0.0089
D(D(N))	-0.179188	0.034913	-5.132332	0.0000
D(D(N(-1)))	-0.281577	0.039682	-7.095802	0.0000
D(D(N(-2)))	-0.357713	0.047574	-7.519078	0.0000
D(D(N(-3)))	-0.413406	0.057065	-7.244535	0.0000
D(N(-4))	-0.230830	0.064061	-3.603271	0.0005
DAKULED(-4))	0.398742	0.066088	6.033499	0.0000
AKULED(-1)	0.727327	0.048142	15.10780	0.0000
(BEF1574(-1)-N(-1))	+0.043381	0.008968	4.837374	0.0000
AKULEDDUM	0.993241	0.211453	4.697215	0.0000
CS1	7.950858	2.012633	3.950475	0.0001
(COVIDQ2+COVIDQ7)	-16.26778	6.286114	-2.587891	0.0108
R-squared	0.923689	Mean dependent var	100.8129	
S.E. of regression	5.970175	Akaike info criterion	6.500288	
F-statistic	127.0940	Durbin-Watson stat	2.042498	

Notes:
AKULEDDUM is defined in the program-file.
COVIDQ1 is 1 in 2020q1 and zero otherwise
COVIDQ7 is 1 in 2021q3 and zero otherwise

5.7.2 Number of registered unemployed

Table 5.59: Dependent Variable DLOG(REGLED). LS estimation. Sample size: 181 (1980Q1 2025Q1)

	Coefficient	Std. Error	t-Statistic	Prob.
LOG(AKULED)+LOG(AKULED(-1)+0.5LOG(AKULED(-2))	0.492483	0.006401	76.93393	0.0000
Constant	-1.787328	0.078760	-22.69342	0.0000
REGLEDUM	0.971527	0.027065	35.89606	0.0000
S1	0.135778	0.011271	12.04643	0.0000
R-squared	0.971387	Mean dependent var	4.195113	
S.E. of regression	0.065969	Akaike info criterion	-2.577415	
Durbin-Watson stat	0.975504			

Notes:
REGLEDUM is specified in the Eviews program file.

5.7.3 Number of unemployment benefits claimants.

Table 5.60: Dependent Variable: DAGPENG. LS estimation. Sample size: 53 (2012Q1 2025Q1)

	Coefficient	Std. Error	t-Statistic	Prob.
REGLED+TILT	0.648355	0.020634	31.42236	0.0000
DAGPENG(-1))	0.442801	0.021430	20.66264	0.0000
COVIDQ1	-49.28265	3.420794	-14.40679	0.0000
(COVIDQ3+COVIDQ5+COVIDQ6)	19.38416	2.301987	8.420622	0.0000
R-squared	0.988281	Mean dependent var	62.22771	
S.E. of regression	2.975709	Akaike info criterion	5.108430	
Durbin-Watson stat	1.743811			

5.7.4 Employment in Labour Force Survey

Table 5.61: Dependent Variable: AKUSYSS. LS estimation. Sample size: 139 (1988Q1 2022Q3)

	Coefficient	Std. Error	t-Statistic	Prob.
Constant	6.941370	3.889840	1.784488	0.0768
D(N-KAIER)	0.760515	0.038926	19.53754	0.0000
(AKUSYSS(-1)-N(-1)+23.5)	-0.094077	0.027577	-3.411433	0.0009
CS2	18.40044	1.960218	9.386935	0.0000
CS3	8.982437	2.032640	4.419100	0.0000
KNBREAKQ1	32.336	3.40257	9.50241	0.0000
KNBREAKQ2	-18.27520	3.170693	-5.763789	0.0000
KNBREAKQ3	-42.02415	3.472582	-12.10170	0.0000
KNBREAKQ3(-1)	-10.74899	5.779034	-1.859998	0.0653
AKUSYSSDUM	1.007635	0.092597	10.88193	0.0000
COVIDQ6	48.37682	7.665472	6.311003	0.0000
R-squared	0.907113	Mean dependent var	5.244604	
S.E. of regression	7.155106	Akaike info criterion	6.842753	
Durbin-Watson stat	1.958548			

5.8 Disabled and retired persons

5.8.1 Number of old age pensioners.

Table 5.62: Dependent Variable: DLOG(ALDERPEN). LS estimation. Sample size: 206 (1970Q1 2021Q3)

	Coefficient	Std. Error	t-Statistic	Prob.
(BEF1574/BEF1564-1)	0.004760	0.001061	4.486994	0.0000
AFPDUM	0.027016	0.001580	17.10309	0.0000
DLOG(ALDERPEN(-1))	0.798921	0.026541	30.10155	0.0000
COVIDQ7)	-0.011569	0.001577	-7.337455	0.0000
R-squared	0.999933	Mean dependent var	13.34569	
S.E. of regression	0.001576	Akaike info criterion	-10.05289	
Durbin-Watson stat	1.988732			

Notes:
AFPDUM is given in the program file

5.8.2 Number of disabled persons

Table 5.63: Dependent Variable: DLOG(UFOERE). LS estimation. Sample size: 114 (1996Q3 2025Q1)

	Coefficient	Std. Error	t-Statistic	Prob.
Constant	0.088581	0.026554	3.335932	0.0012
DLOG(UFOERE(-1))	0.341430	0.085599	3.988708	0.0001
DLOG(UFOERE(-2)	0.41319	0.08370	4.9364	0.0001
DLOG(N)	-0.073353	0.035774	-2.050465	0.0428
LOG(UFOERE(-1)/BEF1574(-1))	-0.019217	0.005981	-3.212893	0.0017
S1	-0.000552	0.000842	-0.654917	0.5139
S2	-0.004514	0.000981	-4.600979	0.0000
S3	-0.003440	0.001006	-3.419968	0.0009
R-squared	0.645727	Mean dependent var	0.003982	
S.E. of regression	0.003035	Akaike info criterion	-8.689922	
Log likelihood	503.3256	Hannan-Quinn criter.	-8.611995	

5.9 Housing prices and credit to households

Table 5.64: Dependent Variable: DLOG(PH/CPI). OLS estimation. Sample size: 141 (1989Q1 2024Q1)

	Coefficient	Std. Error	t-Statistic	Prob.
ECM_{PH}	-0.0701	0.01107	-6.3318	0.0000
DLOG(BGH/CPI)	1.1017	0.1360	8.0985	0.0000
DLOG(PH(-4)/CPI(-4))	0.2489	0.0633	3.9331	0.0001
DLOG(BGH(-4)/CPI(-4))	-0.8914	0.1540	-5.7878	0.0000
$1/(1+exp(-20(0.6\text{UAKU}+0.4\text{UAKU(-1)})-\text{THPHAKU}))$	-0.0061	0.0030	-2.024	0.0450
D(RL)	-0.0067	0.0026	-2.572	0.0112
$(1/RL(-1))^2$	0.1477	0.0385	3.8285	0.0002
LGRAD	0.1109	0.0273	4.0597	0.0001
PHDUM	1.0118	0.1738	5.8205	0.0000
CS1	0.0293	0.0052 5.6332	0.0000	
CS2	0.0295	0.0041	7.0680	0.0000
CS3	0.0104	0.0037	2.8022	0.0059
Constant	-0.1058	0.02646	-4.0009	0.0001
R-squared	0.7836	Mean dependent var	0.0064	
Adjusted R-squared	0.763350	S.D. dependent var	0.0289	
S.E. of regression	0.0145	Akaike info criterion	-5.600	
Log likelihood	407.85	Hannan-Quinn criter.	-5.4905	
F-statistic	38.632	Durbin-Watson stat	1.721891	

Notes:
$ECM_{PH} = LOG(PH(-1)/CPI(-1)) - 0.62LOG(BGH(-1)/CPI(-1))$
$-1.6(LOG(YDCD(-1)/CPI(-1)) - LOG(HK(-1)))$
$+0.21((1/(1+EXP(-200.0(RUH(-1)/(YDCD(-1)+RUH(-1))-THPHRUH)))$
PHDUM is given in the code of the EViews program file
The threshold parameters THPHRUH and PHPHAKU are also set in the Eviews program file

Table 5.65: Dependent Variable: DLOG(BGH). OLS estimation. Sample size: 141 (1989Q1 2024Q1)

	Coefficient	Std. Error	t-Statistic	Prob.
ECM_{BGH}	-0.012085	0.001860	-6.498965	0.0000
D3LOG(BGH(-1)/CPI(-1))	0.226472	0.011152	20.30809	0.0000
LGRAD(-1)	0.008456	0.004395	1.924008	0.0565
BGHDUM	1.034375	0.109123	9.478996	0.0000
LOSSPERS	-0.008933	0.003582	-2.494029	0.0139
CS1	-0.013934	0.001499	-9.295990	0.0000
CS2	0.005231	0.000860	6.082611	0.0000
CS3	-0.009915	0.000865	-11.46628	0.0000
Constant	0.001758	0.004056	0.433332	0.6655
R-squared	0.933655	Mean dependent var	0.015535	
Adjusted R-squared	0.929635	S.D. dependent var	0.013153	
S.E. of regression	0.003489	Akaike info criterion	-8.416684	
Log likelihood	602.3762	Hannan-Quinn criter.	-8.340198	
F-statistic	232.2016	Durbin-Watson stat	2.184136	

Notes:
$ECM_{BGH} = -0.95 * LOG(PH(-1)/CPI(-1)) + LOG(BGH(-1)/CPI(-1))$
$+0.95 * (LOG(YDCD(-1)/CPI(-1)) - LOG(HK(-1)))$
$+0.1RL(-1) * (1 - T2CAPH) - (CPI(-1) - CPI(-5)) * 100/CPI(-5))$
BGHDUM is given in the code of the EViews program file

5.10 Credit indicators

5.10.1 Credit to households (C2-indicator)

Table 5.66: Dependent Variable: DLOG(K2HUS). LS estimation. Sample size: 96 (2000Q1 2023Q4)

	Coefficient	Std. Error	t-Statistic	Prob.
LOG(K2HUS(-2)/BGH(-2))	-0.010097	0.005035	-2.005382	0.0479
DLOG(BGH)	0.554693	0.014707	37.71650	0.0000
DLOG(BGH(-1))	0.408138	0.013441	30.36626	0.0000
K2HUSDUM	1.006015	0.082725	12.16101	0.0000
R-squared	0.941346	Mean dependent var	0.018551	
S.E. of regression	0.001768	Akaike info criterion	-9.797018	
Log likelihood	474.2569	Hannan-Quinn criter.	-9.753828	
Durbin-Watson stat	1.478669			
Notes:				
K2HUSDUM is defined in the EViews program file				

5.10.2 Credit to non financial firms (C2-indicator)

Table 5.67: Dependent Variable:DLOG(K2IF/PYF). LS estimation. Sample size: 132 (1991Q2 2024Q1)

	Coefficient	Std. Error	t-Statistic	Prob.
Constant	0.016436	0.001088	15.10083	0.0000
ECM_{K2IF}	-0.072013	0.003839	-18.76028	0.0000
DLOG(PYF)	-0.985638	0.045845	-21.49923	0.0000
DLOG(K2IF(-1)/PYF(-1))	0.178615	0.029044	6.149736	0.0000
DLOG(YFPBASIS)	0.032648	0.012790	2.552521	0.0119
K2IFDUM	1.000992	0.054109	18.49950	0.0000
PLOANB(-2)	-0.001783	0.000202	-8.834112	0.0000
CS2	0.012187	0.001395	8.734181	0.0000
R-squared	0.927553	Mean dependent var	0.006454	
S.E. of regression	0.006419	Akaike info criterion	-7.200535	
Durbin-Watson stat	1.549325			
Notes:				
$ECM_{K2IF} = LOG(K2IF(-1)/PYF(-1)) - 1.1LOG(YF(-1))$				
$-0.44LOG(PA(-1)/PYF(-1))$				
K2IFDUM is defined in the EViews program file				
$CRISIS = CRISIS08Q4 - CRISIS09Q3 - CRISIS09Q4 - CRISIS10Q$				

5.10.3 Credit to local administration (C2-indicator)

Table 5.68: Dependent Variable: DLOG(K2KOM/PYF). LS estimation. Sample size: 135 (1988Q1 2021Q3)

	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-0.652743	0.187940	-3.473139	0.000
LOG(K2KOM(-1)/PYF(-1))	-0.038198	0.012472	-3.062606	0.0027
$f(YF)$	0.076636	0.022727	3.372041	0.0010
D4LOG(YF(-1))+D4LOG(YF(-2))	-0.133454	0.035602	-3.748458	0.0003
CRISIS08Q4+CRISIS09Q1	0.020503	0.011814	1.735482	0.0851
CS1	0.002834	0.003920	0.722865	0.4711
CS2	0.020112	0.003943	5.101074	0.0000
CS3	0.002127	0.003930	0.541140	0.5894
R-squared	0.370805	Mean dependent var	0.011364	
S.E. of regression	0.015996	Akaike info criterion	-5.375480	
10.69217	Durbin-Watson stat	1.627758		

Notes:
$f(YF) = LOG(YF + YF(-1) + YF(-2) + YF(-3) + YF(-4))$

5.11 Interest rates and treasury bond yields

5.11.1 5 year government bond, effective yield

Table 5.69: Dependent Variable: D(RBO). LS estimation. Sample size: 148 (1985Q3 2022Q2)

	Coefficient	Std. Error	t-Statistic	Prob.
RBO(-1)	-0.093356	0.042176	-2.213495	0.0285
RSH(-1)	0.047996	0.029887	1.605920	0.1105
US10Y(-1)	0.051107	0.021707	2.354437	0.0199
D(RSH)	0.376940	0.039048	9.653338	0.0000
D(YS10Y)	0.494364	0.061278	8.067582	0.0000
D(RBO)	0.094235	0.061543	1.531199	0.1279
CRISIS08Q4	-0.548800	0.257370	-2.132338	0.0352
Adjusted R-squared	0.568042	S.D. dependent var	0.444295	
S.E. of regression	0.292007	Akaike info criterion	0.415615	
Log likelihood	-24.75551	Hannan-Quinn criter.	0.464984	
Durbin-Watson stat	1.934403			

5.11.2 10 year government bond, effective yield

Table 5.70: Dependent Variable: D(RBOTENY). LS estimation. Sample size: 145 (1985Q3 2021Q3)

	Coefficient	Std. Error	t-Statistic	Prob.
$ECM_{RBOTENY}$	-0.076532	0.026608	-2.876333	0.0046
D(RBO)	0.870113	0.021765	39.97743	0.0000
D(RBO(-1))	-0.261408	0.071402	-3.661064	0.0004
D(RBOTENY(-1))	0.249744	0.080279	3.110955	0.0023
R-squared	0.926116	Mean dependent var	-0.079931	
S.E. of regression	0.106464	Akaike info criterion	-1.614820	
Durbin-Watson stat	1.899217			

Notes:
$ECM_{RBOTENY} = RBOTENY(-1) - RBO(-1) -$ Const

5.11.3 Average interest rate on total bank loans to the public

Table 5.71: Dependent Variable: D(RL). LS estimation. Sample size: 114 (1993Q2 2021Q3)

	Coefficient	Std. Error	t-Statistic	Prob.
ECM_{RL}	-0.297196	0.023659	-12.56163	0.0000
D(RSH)	0.613808	0.022276	27.55523	0.0000
RLDUM	0.968688	0.056771	17.06307	0.0000
CRISIS09Q1	-0.501724	0.122935	-4.081218	0.0001
R-squared	0.958448	Mean dependent var	-0.087719	
S.E. of regression	0.110585	Akaike info criterion	-1.523188	
Durbin-Watson stat	1.261738			

Notes:
$ECM_{RL} = RL(-1) - 0.19RBO(-1) - (1 - 0.19)RSH(-1) - BASELIII + \text{Const})$

5.11.4 Average interest rate on loans to households from banks and other credit institutions

Table 5.72: Dependent Variable: D(RLH). LS estimation. Sample size: 106 (1993Q2 2021Q3)

	Coefficient	Std. Error	t-Statistic	Prob.
ECM_{RLH}	-0.318794	0.021790	-14.63052	0.0000
D(RSH)	0.570221	0.021425	26.61438	0.0000
RLDUM	1.016758	0.054517	18.65041	0.0000
CRISIS09Q1	-0.755176	0.116979	-6.455660	0.0000
COVIDQ2	0.33	-	-	-
R-squared	0.964254	Mean dependent var	-0.086785	
Adjusted R-squared	0.962625	Mean dependent var	-0.090789	
S.E. of regression	0.105765	Akaike info criterion	-1.612325	
Durbin-Watson stat	1.514846			

Notes:
$ECM_{RLH} = RL(-1) - 0.21RBO(-1) - (1 - 0.21)RSH(-1) - BASELIII + \text{Const})$

5.11.5 Average interest rate on loans to non-financial firms from banks and other credit institutions

Table 5.73: Dependent Variable: D(RLIF). LS estimation. Sample size: 114 (1993Q2 2021Q3)

	Coefficient	Std. Error	t-Statistic	Prob.
ECM_{RLIF}	-0.304699	0.024201	-12.59052	0.0000
D(RSH)	0.618164	0.021794	28.36363	0.0000
RLDUM	0.935672	0.055780	16.77419	0.0000
CRISIS09Q1	-0.276935	0.121656	-2.276372	0.0248
R-squared	0.957749	Mean dependent var	-0.086659	
S.E. of regression	0.108613	Akaike info criterion	-1.55917	
Durbin-Watson stat	1.719276			

Notes:
$ECM_{RLIF} = RL(-1) - 0.21RBO(-1) - (1 - 0.21)RSH(-1) - BASELIII + \text{Const})$

5.11.6 Average mortgage interest rate , banks and other financial institutions

Table 5.74: Dependent Variable: D(RLBOLIGH). LS estimation. Sample size: 114 (1993Q2 2021Q3)

	Coefficient	Std. Error	t-Statistic	Prob.
$ECM_{RLBOLIGH}$	-0.351709	0.023783	-14.78841	0.0000
D(RSH)	0.527992	0.020217	26.11671	0.0000
RLDUM	0.929027	0.051815	17.92957	0.0000
CRISIS09Q1	-0.851952	0.110816	-7.687969	0.0000
COVIDQ2	0.37	-	-	-
R-squared	0.962084	Mean dependent var	-0.084275	
S.E. of regression	0.100724	Akaike info criterion	-1.710006	
Durbin-Watson stat	1.584376			

Notes:
$ECM_{RLHBOLIG} = RL(-1) - 0.25RBO(-1) - (1 - 0.25)RSH(-1) - BASELIII + \text{Const})$

5.11.7 Monetary policy interest rate

Note: This is not part of the default version of the operative model. It is kept here for reference and for use in scenario analysis

Table 5.75: Dependent Variable:D((RNBG). LS estimation. Sample size: 99 (2001Q2 2025Q4)

	Coefficient	Std. Error	t-Statistic	Prob.
RNB(-1)-IT-1.38	-0.050246	0.012063	-4.165096	0.0001
D(RNB(-1)	0.394115	0.039635	9.943742	0.0000
D(RSW)	0.193196	0.052837	3.656436	0.0004
D2LOG(UR)	-0.608625	0.075600	-8.050620	0.0000
RNBDUM	0.976282	0.081437	11.98822	0.0000
R-squared	0.894580	Mean dependent var	-0.030303	
S.E. of regression	0.147268	Akaike info criterion	-0.934439	
Durbin-Watson stat	2.094956			
Notes:				
IT= (@PCY(CPIJAE) -0.7 INFTARG)-RSW(-1)				

Additional notes

- @PCY(CPIJAE) is EVIEWS code for the annual
- RNBG is identical to RNB, the sight deposit
- NBCRIS is a step-dummy which is zero for

5.11.8 3-month money market rate

Table 5.76: Dependent Variable: D(RSH). LS estimation. Sample size: 98 (1997Q2 2021Q3)

	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-0.232442	0.062265	-3.733090	0.0003
RSH(-1))	-0.355300	0.066368	-5.353503	0.0000
D(RNB)	0.951006	0.024088	39.48048	0.0000
RNB(-1)	0.292658	0.062496	4.682828	0.0000
D(RSW)	0.253874	0.036599	6.936741	0.0000
RSW(-1)	0.152645	0.021235	7.188319	0.0000
RSHDUM	1.005181	0.168604	5.961771	0.0000
RSHSTEP1	0.449390	0.081148	5.537875	0.0000
RSHSTEP2	-0.361572	0.065038	-5.559429	0.0000
RSHSTEP3	0.354324	0.059212	5.983966	0.0000
R-squared	0.971491	Mean dependent var	-0.032041	
S.E. of regression	0.095087	Akaike info criterion	-1.771606	
F-statistic	333.1995	Durbin-Watson stat	2.036918	

Additional notes

- The codes for the indicator variables RSHDUM, RSHSTEP1, RSHSTEP2 and RSHSTEP3 are in the Eviews program file for NAM estimation and simulation.

5.11.9 5-year foreign government bond yield

Table 5.77: Dependent Variable: RW. NLS estimation. Sample size: 101 (1997Q1 2022Q2)

	Coefficient	Std. Error	t-Statistic	Prob.
(RW(-1)-RSW(-1)-1.32)	-0.056844	0.020441	-2.780950	0.0065
D(RSW)	0.197786	0.059866	3.303805	0.0014
D(RW(-1))	0.146262	0.069313	2.110178	0.0375
D(US10Y)	0.565213	0.052733	10.71833	0.0000
RWDUM	0.628361	0.126583	4.964046	0.0000
RWSTEP14Q2	-0.327519	0.132880	-2.464773	0.0155
Adjusted R-squared	0.673249	S.D. dependent var	0.315788	
S.E. of regression	0.180511	Akaike info criterion	-0.519260	
Log likelihood	33.22261	Hannan-Quinn criter.	-0.445886	
Durbin-Watson stat	1.783699			

RWDUM and RWSTEP14Q2 are defined in the Eviews program file

5.11.10 Short term foreign interest rate

Table 5.78: Dependent Variable: RSW. NLS estimation. Sample size: 124 (1995Q1 2025Q4)

	Coefficient	Std. Error	t-Statistic	Prob.
(RSW(-1)-YS10Y-0.6(DLOG(PCKONK)100-2)+2.1	-0.103343	0.014658	-7.050247	0.0000
CRISIS09Q1	-1.442602	0.215556	-6.692474	0.0000
Adjusted R-squared	0.694651	S.D. dependent var	0.374535	
S.E. of regression	0.206962	Akaike info criterion	-0.280834	
Durbin-Watson stat	1.827507			

5.11.11 Interest rate on deposits, banks and other financial institutions

Table 5.79: Dependent Variable: RBD. NLS estimation. Sample size: 91 (1999Q1 2021Q3)

	Coefficient	Std. Error	t-Statistic	Prob.
RL	1	-	-	-
(RBD(-1)-RL(-1))	0.700600	0.088931	7.878011	0.0000
(RBD(-2)-RL(-2))	0.215930	0.082959	2.602859	0.0109
Constant	-0.207197	0.081271	-2.549448	0.0125
COVIDQ2	0.450794	0.087786	5.135126	0.0000
R-squared	0.997497	Mean dependent var	2.505604	
S.E. of regression	0.087130	Akaike info criterion	-1.972819	
F-statistic	11556.75	Durbin-Watson stat	2.162641	

5.12 Income components (households)

5.12.1 Wage income to households

Table 5.80: Dependent Variable: LOENNH. LS estimation. Sample size: 61 (2010Q1 2025Q1)

	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-0.195777	0.080834	-2.421951	0.0185
WF*(TWF+TWOSJ)	1.031565	0.006374	161.8354	0.0000
R-squared	0.997752	Mean dependent var	12.88456	

5.12.2 Income from operating surplus to households

Table 5.81: Dependent Variable: $\Delta log(DRIFTH)$. LS estimation. Sample size: 55 (2002Q1 2021Q3)

	Coefficient	Std. Error	t-Statistic	Prob.
Constant	5.608006	1.712114	3.275486	0.0016
LOG(WFP23))	0.379733	0.083064	4.571602	0.0000
LOG(TSF)	0.560728	0.305209	1.837193	0.0703
CS1	-0.049966	0.031097	-1.606761	0.1145
CS2	-0.231194	0.034264	-6.747465	0.0000
CS3	0.167435	0.044568	3.756886	0.0005
R-squared	0.824220	Mean dependent var	10.19872	
S.E. of regression	0.073713	Akaike info criterion	-2.304365	
F-statistic	68.45820	Durbin-Watson stat	0.675224	

5.12.3 Income from interest, households

Table 5.82: Dependent Variable: RENTEINNH. LS estimation. Sample size: 79 (2002Q1 2021Q3)

	Coefficient	Std. Error	t-Statistic	Prob.
Constant	205.5144	82.69049	2.485345	0.0151
RIH	0.574945	0.009386	61.25389	0.0000
COVIDQ1+2COVIDQ2	710.9469	108.1707	6.572457	0.0000
R-squared	0.987178	Mean dependent var	4844.494	
S.E. of regression	237.1610	Akaike info criterion	13.81259	
F-statistic	2925.705	Durbin-Watson stat	0.379857	

5.12.4 Interest payments, households

Table 5.83: Dependent Variable: RENTEUTH. LS estimation. Sample size: 79 (2002Q1 2021Q3)

	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-242.8403	369.7301	-0.656804	0.5133
RUH	0.958068	0.014506	66.04802	0.0000
R-squared	0.982655	Mean dependent var	23552.41	
S.E. of regression	738.5497	Akaike info criterion	16.07224	
F-statistic	4362.341	Durbin-Watson stat	0.319352	

5.12.5 Miscellaneous revenues, households

Table 5.84: Dependent Variable: log(RESINNTH). LS estimation. Sample size: 79 (2002Q1 2021Q3)

	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-3.014961	0.627428	-4.805267	0.0000
LOG(X)	0.280534	0.013299	21.09397	0.0000
CS1	0.010382	0.038891	0.266945	0.7903
CS2	-0.055989	0.033253	-1.683747	0.0966
CS3	-0.058942	0.033209	-1.774853	0.0801
KNRBREAKQ2	0.180546	0.053272	3.389162	0.0011
RESINNTHDUM	-0.464526	0.081247	-5.717459	0.0000
R-squared	0.913684	Mean dependent var	10.15751	
S.E. of regression	0.103319	Akaike info criterion	-1.617551	
F-statistic	127.0244	Durbin-Watson stat	1.433890	

Notes:
$X = DAGPENG * WF(-1)) + LOG(UFOERE * WF(-4)) + LOG(ALDERPEN * WF(-1))$
RESINNTHDUM is specified in the program file

5.12.6 Taxes on income and wealth, households

Table 5.85: Dependent Variable: SKATTH. LS estimation. Sample size: 79 (2002Q1 2021Q3)

	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-1701.229	915.7335	-1.857777	0.0671
INNT	0.226010	0.003213	70.33360	0.0000
SKATTNED14*INNT	-0.015346	0.001350	-11.36583	0.0000
SKATTNED14*T2CAPH*RAM300	1	-	-	-
R-squared	0.995947	Mean dependent var	74703.10	
S.E. of regression	1267.481	Akaike info criterion	17.16469	
F-statistic	9337.930	Durbin-Watson stat	1.365824	

Notes:
$INNT = LOENNH + PENSJONH + RENTEINNH - RENTEUTH$
$+RESINNTH + DRIFTH$

Additional notes

- SKATTNED14 is a step dummy related to the general reduction in income tax ni 2014. Code is in the Eviews program file.

5.13 Net product taxes and subsidies

Table 5.86: Dependent Variable: LAVGSUB. LS estimation. Sample size: 49 (2010Q1 2022Q1)

	Coefficient	Std. Error	t-Statistic	Prob.
Constant	18143.31	2363.781	7.675546	0.00007
(YFPBASIS*PYFB)	0.148865	0.008251	18.04219	0.0000
CS1	-6266.679	848.5405	-7.385245	0.0000
CS2	360.3944	858.3264	0.419880	0.6767
CS3	-80.10713	855.6181	-0.093625	0.9259
COVIDQ3+COVIQ4-COVIDQ9	8950.099	1286.357	6.957707	0.0000
R-squared	0.971768	Mean dependent var	11.37413	
S.E. of regression	0.023668	Akaike info criterion	-4.530641	
F-statistic	276.5488	Durbin-Watson stat	1.710983	

5.14 Household sector financial assets

5.14.1 Bank deposits, bank securities and bonds.

Table 5.87: Dependent Variable: DLOG(BFHM). LS estimation. Sample size: 95 (1998Q1 2021Q3)

	Coefficient	Std. Error	t-Statistic	Prob.
LOG(BFHM(-1)/CPI(-1))	-0.095274	0.028468	-3.346714	0.0012
LOG(MAFYDCD(-1))	0.112236	0.048051	2.335772	0.0219
LOG(PA)	-0.015721	0.005637	-2.788955	0.0066
RBD(-1)-RL(-1))	0.025150	0.007435	3.382921	0.0011
(RBD(-1)/100)*(1-T2CAPH(-1))-INF(-1)/100	0.001194	0.000821	1.455606	0.1493
BEF1574/BEF1564	0.468034	0.170247	2.749148	0.0073
DLOG(BGH(-1))	0.547270	0.202291	2.705362	0.0083
Constant	-0.554834	0.214782	-2.583242	0.0115
CS1	-0.007735	0.003700	-2.090664	0.0396
CS2	-0.041782	0.002662	-15.69617	0.0000
CS3	0.033313	0.004176	7.976568	0.0000
COVIDQ1+COVIDQ2-COVIDQ6	0.015835	0.005117	3.094249	0.0027
R-squared	0.910049	Mean dependent var	0.016509	
S.E. of regression	0.008294	Akaike info criterion	-6.629069	
F-statistic	76.33826	Durbin-Watson stat	2.303985	

Notes:
$MAFYDCD = 0.4 * (YDCD/CPI) + 0.30 * (YDCD(-1)/CPI(-1)) + 0.2(YDCD(-2)/CPI(-2)) + 0.1(YDCD(-3)/CPI(-3))$

5.14.2 Equity, pension and insurance entitlements

Table 5.88: Dependent Variable: DLOG(BFHA). LS estimation. Sample size: 95 (1998Q1 2021Q3)

	Coefficient	Std. Error	t-Statistic	Prob.
LOG(BFHA(-1)/CPI(-1))	-0.082018	0.034891	-2.350694	0.0211
LOG(MAFYDCD)	0.173512	0.071881	2.413873	0.0180
DLOG(PAW)	0.209884	0.022283	9.419029	0.0000
LOG(PAW(-1))	0.030150	0.011853	2.543777	0.0128
DLOG(BGH)	0.518551	0.259904	1.995164	0.0493
D(RBO)	-0.008103	0.004000	-2.025738	0.0460
(RBD/100)*(1-T2CAPH)-INF(-1)/100	-0.002733	0.001082	-2.525978	0.0135
BEF1574/BEF1564	-0.737332	0.245452	-3.003977	0.0035
Constant	-0.159296	0.310685	-0.512724	0.6095
CS1	0.008092	0.005775	1.401176	0.1649
CS1	0.011400	0.003546	3.214437	0.0019
CS3	-0.000287	0.004845	-0.059229	0.9529
D(COVIDQ1)	-0.057175	0.008318	-6.873956	0.0000
R-squared	0.714972	Mean dependent var	0.019435	
S.E. of regression	0.011077	Akaike info criterion	-6.041304	
F-statistic	17.14088	Durbin-Watson stat	2.017466	

Notes:
$MAFYDCD = 0.4 * (YDCD/CPI) + 0.30 * (YDCD(-1)/CPI(-1)) + 0.2(YDCD(-2)/CPI(-2)) + 0.1(YDCD(-3)/CPI(-3))$

5.14.3 Loans and other accounts receivable

Table 5.89: Dependent Variable: DLOG(BFHR). LS estimation. Sample size: 95 (1998Q1 2021Q3)

	Coefficient	Std. Error	t-Statistic	Prob.
DLOG(BFHR(-4))	0.592075	0.063249	9.361051	0.0000
LOG(BFHR(-1)/CPI(-1))	-0.092856	0.028039	-3.311676	0.0014
LOG(BFHM(-1)/CPI(-1))	0.138673	0.049548	2.798738	0.0063
BEF1574/BEF1564	-0.666172	0.303108	-2.197804	0.0306
Constant	0.026390	0.114937	0.229608	0.8189
CS1	-0.002651	0.004636	-0.571956	0.5688
CS2	0.013214	0.004732	2.792391	0.0064
CS3	0.006480	0.004936	1.312836	0.1927
R-squared	0.681111	Mean dependent var	0.019687	
S.E. of regression	0.015796	Akaike info criterion	-5.377656	
F-statistic	26.54604	Durbin-Watson stat	1.708095	

5.15 Stock prices (MSCI)

5.15.1 MSCI equity price index, Norway

Table 5.90: Dependent Variable: DLOG(PA). LS estimation. Sample size: 123 (1985Q1 2015Q3)

	Coefficient	Std. Error	t-Statistic	Prob.
DLOG(PAW)	0.802748	0.096629	8.307501	0.0000
LOG(PA(-1)-log(PAW(-1))	-0.038841	0.024285	-1.599375	0.1121
LOG(SPUSD(-1) × SPOILUSD(-1) /PYF(-1))	0.015464	0.012845	1.203954	0.2307
D(RSH)	-0.027592	0.005944	-4.641659	0.0000
DLOG(SPUSD × SPOILUSD)	0.149498	0.030488	4.903500	0.0000
D(VOLUSA)	-0.004208	0.001047	-4.017257	0.0001
VOLUSA(-1)	-0.002800	0.000665	-4.212877	0.0000
PADUM	1.002068	0.130626	7.671261	0.0000
Constant	-0.037480	0.077893	-0.481168	0.6312
R-squared	0.797283	Mean dependent var	0.013933	
S.E. of regression	0.048097	Akaike info criterion	-3.169922	
F-statistic	65.38576	Durbin-Watson stat	1.739411	

Notes:
PADUM is defined is defined in the Eviews program file

5.15.2 MSCI equity price index, World

Table 5.91: Dependent variable: (DLOG(PAW)-0.01). LS estimation. Sample size: 142 (1986Q2 2021Q3)

	Coefficient	Std. Error	t-Statistic	Prob.
(DLOG(PAW(-1))-0.01)	0.524249	0.051358	10.20780	0.0000
DLOG(EMI/EMI(-1))	0.295653	0.108196	2.732572	0.0071
D(VOLUSA)	-0.006929	0.000551	-12.57485	0.0000
VOLUSA(-1)	0.000046	0.000146	0.025317	0.9798
R-squared	0.648761	Mean dependent var	0.005576	
S.E. of regression	0.037086	Akaike info criterion	-3.723364	
Durbin-Watson stat	2.157202			

5.16 Housing capital stock

Table 5.92: Dependent Variable: HK. LS estimation. Sample size: 127 (1990Q1 2021Q2)

	Coefficient	Std. Error	t-Statistic	Prob.
HK(-1)	0.992919	4.40E-05	22590.40	0.0000
JBOL	1	-	-	
Constant	4517.608	154.7801	29.18727	0.0000
CS1	-1007.587	81.96024	-12.29360	0.0000
CS2	189.1216	81.96033	2.307477	0.0227
CS3	150.8976	81.96704	1.840954	0.0681
R-squared	0.999999			

5.17 General government income and expenses

5.17.1 Taxes on income and wealth

Table 5.93: Dependent Variable: OFFIA1. LS estimation. Sample size: 79 (2002Q1 2021Q3)

	Coefficient	Std. Error	t-Statistic	Prob.
SKATTH	1	-	-	-
SKATTOIL	0.362656	0.008729	41.54850	0.0000
SKATTF	1	-	-	-
R-squared	0.854775	Mean dependent var	127994.1	
Adjusted R-squared	0.854775	S.D. dependent var	24907.52	
S.E. of regression	9491.861	Akaike info criterion	21.16683	
Sum squared resid	7.03E+09	Schwarz criterion	21.19683	
Log likelihood	-835.0900	Hannan-Quinn criter.	21.17885	
Durbin-Watson stat	0.375275			

Notes:
$SKATTOIL = PYOIL1YOIL1 + PYOIL2YOIL2 - WFP1(1 - T1FP1)TWOSJ)$
$SKATTF = T2CAPF(PYFPB(YFP1 + YFP2 + YFP3)$
$-(0.2WCFP1 + 0.8WCFP23)TWPF - 0.9LKDEP - (RL0.25/100)K2IF$

5.17.2 Taxes on goods and services

Table 5.94: Dependent Variable: OFFIA2. LS estimation. Sample size: 77 (2002Q1 2021Q3)

	Coefficient	Std. Error	t-Statistic	Prob.
LAVGSUB	1.085578	0.005519	196.7036	0.0000
CS1	597.7065	291.4244	2.050983	0.0438
CS2	336.5588	289.2950	1.163376	0.2484
CS3	359.6835	289.1357	1.243995	0.2174
Constant	56.95076	480.6459	0.118488	0.9060
R-squared	0.998121	Mean dependent var		81936.18
Adjusted R-squared	0.998019	S.D. dependent var		20253.06
S.E. of regression	901.3315	Akaike info criterion		16.50682
Sum squared resid	60117481	Schwarz criterion		16.65679
Log likelihood	-647.0195	Hannan-Quinn criter.		16.56690
F-statistic	9827.209	Durbin-Watson stat		0.281401

5.17.3 Capital taxes

Table 5.95: Dependent Variable: OFFIA3. LS estimation. Sample size: 27 (2015Q1 2021Q3)

	Coefficient	Std. Error	t-Statistic	Prob.
Constant	29.92593	5.150699	5.810070	0.0000

5.17.4 Social security contributions

Table 5.96: Dependent Variable: OFFIA4. LS estimation. Sample size: 23 (2016Q1 2021Q3)

	Coefficient	Std. Error	t-Statistic	Prob.
T1FP23*WF*TWF	1	-	-	-
CS1	13214.95	1015.341	13.01529	0.0000
CS2	-16639.50	1015.341	-16.38810	0.0000
CS3	-12490.18	1015.341	-12.30147	0.0000
Constant	35936.72	934.2186	38.46714	0.0000
R-squared	0.917263	Mean dependent var	63535.65	
S.E. of regression	5233.118	Akaike info criterion	20.03122	

5.17.5 Property income

Table 5.97: Dependent Variable: log(OFFIA5). LS estimation. Sample size: 78 (2002Q2 2021Q3)

	Coefficient	Std. Error	t-Statistic	Prob.
log(PAW)	0.247998	0.052641	4.711129	0.0000
LOG(SPOILUSD*SPUSD)	0.181044	0.047708	3.794826	0.0003
log(OFFIA5(-1))	0.617895	0.062383	9.904869	0.0000
CS1	0.195689	0.033170	5.899483	0.0000
CS2	-0.376559	0.033760	-11.15398	0.0000
CS3	0.120496	0.038280	3.147742	0.0024
Constant	3.440489	0.602310	5.712158	0.0000
COVIDQ2	-0.4	-	-	-
R-squared	0.939187	Mean dependent var	11.21124	
Adjusted R-squared	0.933395	S.D. dependent var	0.370134	
S.E. of regression	0.095524	Akaike info criterion	-1.764239	
F-statistic	162.1595	Durbin-Watson stat	2.605157	
Prob(F-statistic)	0.000000			

5.17.6 Administrative fees and sales of goods and services

Table 5.98: Dependent Variable: OFFIA6. LS estimation. Sample size: 79 (2002Q1 2021Q3)

	Coefficient	Std. Error	t-Statistic	Prob.
PYO*YO	0.180751	0.002188	82.60867	0.0000
Constant	762.3564	262.2805	2.906646	0.0048
COVID	-2614.178	423.1703	-6.177602	0.0000
R-squared	0.989801	Mean dependent var	21816.27	
S.E. of regression	675.5785	Akaike info criterion	15.90625	
F-statistic	3687.774	Durbin-Watson stat	1.675757	
Prob(F-statistic)	0.000000			
$COVID = COVIDQ2 + COVIDQ3 + COVIDQ6$				

5.17.7 Current transfers

Table 5.99: Dependent Variable: OFFIA7. LS estimation. Sample size: 79 (2002Q1 2021Q3)

	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-2779.605	706.8795	-3.932219	0.0005
PYF(-1)*YF(-1)	0.008091	0.001002	8.078686	0.0000
COVIDQ2	3045.136	320.8050	9.492173	0.0000
R-squared	0.878561	Mean dependent var	3030.968	
Adjusted R-squared	0.869886	S.D. dependent var	850.4242	
S.E. of regression	306.7587	Akaike info criterion	14.38177	
F-statistic	101.2840	Durbin-Watson stat	2.312386	
Prob(F-statistic)	0.000000			

5.17.8 Compensation of employees

Table 5.100: Dependent Variable: OFFUB1. LS estimation. Sample size: 55 (2008Q1 2021Q3)

	Coefficient	Std. Error	t-Statistic	Prob.
WO*(1+T1FP1)*TWO	1	-	-	-
CS1	-1674.958	583.3410	-2.871319	0.0059
CS2	729.5295	430.4588	1.694772	0.0962
CS3	1613.938	430.4588	3.749343	0.0005
CS4	3977.301	430.4588	9.239679	0.0000
R-squared	0.992739	Mean dependent var	107395.9	
S.E. of regression	1804.115	Akaike info criterion	17.90347	
Durbin-Watson stat	1.111878			

5.17.9 Use of goods and services

Table 5.101: Dependent Variable: OFFUB2. LS estimation. Sample size: 79 (2002Q1 2021Q3)

	Coefficient	Std. Error	t-Statistic	Prob.
CO*PYO	0.286793	0.002736	104.8254	0.000
Constant	600.9011	548.3375	1.095860	0.2767
CS1)	184.6575	379.6931	0.486333	0.6282
CS2	859.4499	379.8832	2.262406	0.0266
CS3	127.6005	379.7483	0.336013	0.7378
COVIDQ2	-4000	-	-	-
R-squared	0.993231	Mean dependent var	43963.00	
S.E. of regression	1185.165	Akaike info criterion	17.05435	
F-statistic	2714.634	Durbin-Watson stat	1.334591	
Prob(F-statistic)	0.000000			

5.17.10 Consumption of fixed capital and R & D

Table 5.102: Dependent Variable: OFFUB3. LS estimation. Sample size: 79 (2002Q1 2021Q3)

	Coefficient	Std. Error	t-Statistic	Prob.
JO*PYF	0.040353	0.024480	1.648428	0.1037
JO(-1)*PYF(-1)	0.055304	0.024073	2.297338	0.0246
JO(-2)*PYF(-2)+JO(-3)*PYF(3)	0.054527	0.018748	2.908483	0.0048
JO(-4)*PYF(-4)	0.040967	0.032000	1.280226	0.2046
JO(-5)*PYF(-5)	0.108402	0.027114	3.998013	0.0002
JO(-6)*PYF(-6)	0.121627	0.022904	5.310280	0.0000
JO(-7)*PYF(-7)	0.123868	0.022793	5.434383	0.0000
JO(-8)*PYF(-8)	0.079997	0.029293	2.730906	0.0080
R-squared	0.991355	Mean dependent var	21051.90«6	
S.E. of regression	760.3057	Akaike info criterion	16.20108	
Durbin-Watson stat	0.340337			

5.17.11 Property expense

Table 5.103: Dependent Variable: OFFUB4. LS estimation. Sample size: 71 (2002Q1 2019Q3)

	Coefficient	Std. Error	t-Statistic	Prob.
Constant	8261.251	365.2664	22.61706	0.0000
CS1	-260.7255	1040.589	-0.250556	0.8029
CS2	327.5033	1040.589	0.314729	0.7539
CS3	263.0033	1040.589	0.252745	0.8012
R-squared	0.001720	Mean dependent var	8258.254	
Adjusted R-squared	-0.042979	S.D. dependent var	3012.784	
S.E. of regression	3076.847	Akaike info criterion	18.95589	
Sum squared resid	6.34E+08	Schwarz criterion	19.08336	
Log likelihood	-668.9340	Hannan-Quinn criter.	19.00658	
F-statistic	0.038475	Durbin-Watson stat	0.048783	
Prob(F-statistic)	0.989827			

5.17.12 Social benefits in kind

Table 5.104: Dependent Variable: OFFUB5. LS estimation. Sample size: 71 (2002Q1 2019Q3)

	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-1214.331	226.7962	-5.354283	0.0000
0.25*(WH+WH(-1)+WH(-2)+WH(-3))*BEF1574	0.036456	0.000516	70.64421	0.0000
COVIDQ3	-2187.532	521.5981	-4.193903	0.0001
R-squared	0.985182	Mean dependent var	14329.15	
S.E. of regression	510.7892	Akaike info criterion	15.34703	
F-statistic	2526.449	Durbin-Watson stat	1.554296	
Prob(F-statistic)	0.000000			

5.17.13 Social benefits in cash

Table 5.105: Dependent Variable: OFFUB6. LS estimation. Sample size: 79 (2002Q1 2021q3)

	Coefficient	Std. Error	t-Statistic	Prob.
Constant	3650.335	1245.213	2.931494	0.0045
WF(0.5(REGLED+REGLED(-1))FHWPF	0.777832	0.203488	3.822490	0.0003
WF*FHWPF*(BEF1574)	0.131433	0.008623	15.24286	0.0000
WH(BEF1574-BEF1564)+WH(-1)(BEF1574(-1)-BEF1564(-1))	0.491190	0.055539	8.844053	0.0000
CS1)	-4738.141	574.0938	-8.253253	0.0000
CS2	2847.171	581.3459	4.897551	0.0000
CS3	2496.360	609.8091	4.093674	0.0001
COVIDQ4	7888.924	1836.992	4.294479	0.0001
COVIDQ7	5424.326	1909.718	2.840380	0.0059
R-squared	0.996453	Mean dependent var	96268.62	
S.E. of regression	1759.341	Akaike info criterion	17.87903	
F-statistic	2849.029	Durbin-Watson stat	1.454208	
Prob(F-statistic)	0.000000			

5.17.14 Subsidies

Table 5.106: Dependent Variable: OFFUB7. LS estimation. Sample size: 78 (2002Q2 2021Q3)

	Coefficient	Std. Error	t-Statistic	Prob.
Constant	2213.513	170.0497	13.01686	0.0000
PYFB*YFPBASIS	0.003954	0.000811	4.877214	0.0000
OFFUB7(-1)	0.890140	0.020889	42.61386	0.0000
CS1	658.0244	113.4452	5.800372	0.0000
CS2)	-1348.793	114.5257	-11.77721	0.0000
CS3	-2979.635	110.8826	-26.87199	0.0000
COVID	12442.37	325.4627	38.22978	0.0000
R-squared	0.993290	Mean dependent var	12555.62	
Adjusted R-squared	0.992723	S.D. dependent var	4032.312	
S.E. of regression	343.9756	Akaike info criterion	14.60448	
F-statistic	1751.736	Durbin-Watson stat	2.686508	
Notes:				
COVID = COVIDQ2-0.5COVIDQ3-0.45COVIDQ4				
+0.3COVIDQ4+0.1*COVIDQ6				

5.17.15 Current transfers

Table 5.107: Dependent Variable: OFFUB8. LS estimation. Sample size: 55 (2008Q1 2021Q3)

	Coefficient	Std. Error	t-Statistic	Prob.
OFFUB8(-1)	0.683583	0.065754	10.39600	0.0000
WF*TSF	0.32	-	-	-
CS1	-5082.771	848.2419	-5.992124	0.0000
CS2	1554.128	450.6306	3.448784	0.0012
CS3	3687.925	473.4783	7.789006	0.0000
CS4	-5684.446	446.3500	-12.73540	0.0000
(COVIDQ2+COVIDQ4)	7250.805	1393.160	5.204573	0.0000
COVIDQ7	4124.319	1969.484	2.094112	0.0416
R-squared	0.921927	Mean dependent var	21498.93	
S.E. of regression	1845.352	Akaike info criterion		17.99714
Durbin-Watson stat	2.637969			

5.17.16 Capital transfers

Table 5.108: Dependent Variable: OFFUB9. LS estimation. Sample size: 79 (2002Q1 2021Q3)

	Coefficient	Std. Error	t-Statistic	Prob.
Constant	1069.826	170.4091	6.277986	0.0000
CS1	-55.41275	183.4240	-0.302102	0.7634
CS2	269.7056	182.5630	1.477330	0.1438
CS3	572.2056	182.5630	3.134292	0.0025
(COVIDQ2+COVIDQ3+COVIDQ4)	12797.86	337.7110	37.89589	0.0000
R-squared	0.951611	Mean dependent var	1973.937	
S.E. of regression	569.8585	Akaike info criterion	15.58985	
F-statistic	363.8145	Durbin-Watson stat	0.831984	

5.17.17 Gross acquisitions of fixed assets and R & D

Table 5.109: Dependent Variable: OFFJD1. LS estimation. Sample size: 55 (2008Q1 2021Q3)

	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-774.3941	758.9631	-1.020332	0.3124
JO*PYF	1	-	-	
CS2	-430.9936	591.4554	-0.728700	0.4695
CS3	-368.3341	591.4554	-0.622759	0.5362
CS4	-108.9409	602.7223	-0.180748	0.8573
R-squared	0.983282	Mean dependent var	37915.85	
S.E. of regression	1564.844	Akaike info criterion	17.61891	
F-statistic	349.6759	Durbin-Watson stat	0.978295	
Prob(F-statistic)	0.000000			

5.17.18 Consumption of fixed assets and R & D

Table 5.110: Dependent Variable: OFFJD2. LS estimation. Sample size: 31 (2014Q1 2021Q3)

	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-21.41135	18.11326	-1.182081	0.2468
OFFUB3	-1.020065	0.000612	-1666.480	0.0000
R-squared	0.986629	Mean dependent var	-27804.39	
S.E. of regression	297.7373	Akaike info criterion	14.31324	
F-statistic	1549.510	Durbin-Watson stat	0.894844	
Prob(F-statistic)	0.000000			

5.17.19 Net acquisitions of non-financial and non-produced assets

Table 5.111: Dependent variable: OFFJD3. LS estimation. Sample size: 79 (2002Q1 2021Q3)

	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-762.2864	331.8370	-2.297172	0.0248
JO*PYF	0.009244	0.002565	3.604145	0.0006
COVIDQ3	-5777.626	398.3310	-14.50459	0.0000
R-squared	0.734648	Mean dependent var	-519.8354	
S.E. of regression	390.3099	Akaike info criterion	13.74286	
F-statistic	105.2058	Durbin-Watson stat	1.438918	
Prob(F-statistic)	0.014146			

5.18 The banking module

5.18.1 Banks, other income and dividend

Table 5.112: Dependent Variable: D(BAAI) . LS estimation. Sample size: 85 (2004Q1 2025Q1)

	Coefficient	Std. Error	t-Statistic	Prob.
(BAAI(-1)-BAAI(-4))	-0.628415	0.079793	-7.875522	0.0000
S.E. of regression	831.9817	Akaike info criterion	16.29719	
Durbin-Watson stat	2.344158			

5.18.2 Banks, total assets

Table 5.113: Dependent Variable: LOG(BAFVK) . LS estimation. Sample size: 129 (1993Q1 2025Q1)

	Coefficient	Std. Error	t-Statistic	Prob.
Constant	0.170993	0.003619	47.24278	0.0000
LOG(BAUTLBM+BAUTLPM)	1	-	-	
+BAUTLREUT+BARENTVP)	1	-	-	
R-squared	0.997174	Mean dependent var	14.70917	
S.E. of regression	0.041109	Akaike info criterion	-3.537451	
Durbin-Watson stat	0.582656			

5.18.3 Banks, bank deposits

Table 5.114: Dependent Variable: DLOG(BAINNSK) . LS estimation. Sample size: 129 (1993Q1 2025Q1)

	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-0.087833	0.022670	-3.874351	0.0002
(LOG(BAINNSK(-1)-c(1)LOG(BFHM(-1))	-0.142168	0.038890	-3.655667	0.0004
-(1-c(1))LOG(LY(-1))				
c(1)	0.714134	0.191776	3.723796	0.0003
DLOG(BFHM)	0.500384	0.232137	2.155555	0.0331
DLOG(LY)	0.095519	0.064163	1.488692	0.139
(RBD-RBO)	0.010311	0.003015	3.420503	0.0009
S1	0.012108	0.009292	1.303132	0.1950
S2	0.013359	0.012847	1.039822	0.3005
S3	0.001275	0.009534	0.133780	0.8938
R-squared	0.336297	Mean dependent var	0.015411	
S.E. of regression	0.027897	Akaike info criterion	-4.253409	
F-statistic	7.600482	Durbin-Watson stat	2.243210	

5.18.4 Banks, wages, salaries and other costs

Table 5.115: Dependent Variable: DLOG(BALOENNK) . LS estimation. Sample size: 141 (1990Q1 2025Q1)

	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-0.326470	0.099220	-3.290365	0.0013
LOG(BALOENNK(-1))	-0.114236	0.033568	-3.403133	0.0009
LOG(WCFP23(-1))-log(TWFP23(-1)))				
CS1	-0.147270	0.016625	-8.858395	0.0000
CS2	-0.075848	0.016633	-4.560053	0.0000
CS3	-0.075848	0.016633	-4.560053	0.0000
R-squared	0.424425	Mean dependent var	0.010089	
S.E. of regression	0.069571	Akaike info criterion	-2.458126	
F-statistic	25.07137	Durbin-Watson stat	2.705779	

5.18.5 Banks, proceed income,fees and losses/gains on securities.

Table 5.116: Dependent Variable: LOG(BAPROVI) . LS estimation. Sample size: 85 (2004Q1 2025Q1)

	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-4.547495	1.241201	-3.663785	0.0004
D3LOG(BAPROVI(-1))	-0.170972	0.064535	-2.649306	0.0097
RSW	-0.040022	0.019453	-2.057335	0.0429
DLOG(PA)	2.964285	0.344548	8.603409	0.0000
LOG(BAFVK(-1))	0.859223	0.080984	10.60974	0.0000
R-squared	0.735688	Mean dependent var	8.477757	
S.E. of regression	0.266492	Akaike info criterion	0.250079	
F-statistic	55.66822	Durbin-Watson stat	2.234455	

5.18.6 Banks, interest-bearing securities.

Table 5.117: Dependent Variable: DLOG(BARENTVP) . LS estimation. Sample size: 61 (2010Q1 2025Q1)

	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-0.116798	0.113747	-1.026816	0.3088
DLOG(K2IF)	0.929413	0.877506	1.059153	0.2940
LOG(BARENTVP(-1)/BAFVK(-1))	-0.057201	0.056694	-1.008936	0.3173
COVIDQ1	0.234400	0.059241	3.956714	0.0002
R-squared	0.252931	Mean dependent var	0.011893	
S.E. of regression	0.058378	Akaike info criterion	-2.780431	
6.432710	Durbin-Watson stat	2.226842		

5.18.7 Banks, earnings.

Table 5.118: Dependent Variable: BARES. LS estimation. Sample size: 85 (2004Q1 2025Q1)

	Coefficient	Std. Error	t-Statistic	Prob.
Constant	338.3692	58.09586	5.824325	0.0000
(1-T2CAPF)BARESFS^{+}	1	-	-	-
(1-T2CAPF)BARESFS^{-}	0	-	-	-
R-squared	0.989558	Mean dependent var	9855.245	
S.E. of regression	535.6173	Akaike info criterion	15.41641	
Durbin-Watson stat	1.229216			
Note: BARESFS^{+} $\equiv$ BARESFS ≥ 0, BARESFS^{-} $\equiv$ BARESFS < 0				

5.18.8 Banks, earnings before tax.

Table 5.119: Dependent Variable: BARESFS. LS estimation. Sample size: 85 (2004Q1 2025Q1)

	Coefficient	Std. Error	t-Statistic	Prob.
Constant	58.43825	25.03113	2.334623	0.0220
(BADR-BATAP)	1	-	-	-
COVIDQ2	-1796.134	229.4141	-7.829223	0.0000
COVIDQ3	2414.457	229.4141	10.52445	0.0000
R-squared	0.998677	Mean dependent var	12605.71	
S.E. of regression	228.0445	Akaike info criterion	13.73161	
F-statistic	30954.87	Durbin-Watson stat	1.869914	

5.18.9 Banks, interest rate income.

Table 5.120: Dependent Variable: D(BARI). LS estimation. Sample size: 85 (2004Q1 2025Q1)

	Coefficient	Std. Error	t-Statistic	Prob.
D(((1+RLIF/100)$^{0.25}$-1)(BAUTLMB/1000)	1265.497	99.16242	12.76186	0.0000
D(((1+RLH/100)$^{0.25}$-1)(BAUTLPM/1000)	139.5502	254.4314	0.548479	0.5848
R-squared	0.760179	Mean dependent var	910.6059	
S.E. of regression	1635.893	Akaike info criterion	17.66101	
Durbin-Watson stat	2.354520			

5.18.10 Banks, interest rate costs.

Table 5.121: Dependent Variable: D(BARK). LS estimation. Sample size: 85 (2004Q1 2025Q1)

	Coefficient	Std. Error	t-Statistic	Prob.
D(((1+RBD/100)$^{0.25}$-1)(BAINNSK/1000)	1326.557	193.5638	6.853332	0.0000
D(((1+RSH/100)$^{0.25}$-1)(BAMFIN/1000)	322.5297	120.8296	2.669293	0.0091
R-squared	0.774172	Mean dependent var	587.4169	
S.E. of regression	1325.162	Akaike info criterion	17.23971	
Durbin-Watson stat	1.910891			

5.18.11 Banks, risk weighted assets.

Table 5.122: Dependent Variable: BARWA. LS estimation. Sample size: 109 (1998Q1 2025Q1)

	Coefficient	Std. Error	t-Statistic	Prob.
Constant	345948.9	29840.34	11.59333	0.0000
BAUTLPM	0.483192	0.043189	11.18773	0.0000
BAUTLBM	1.444441	0.103545	13.94988	0.0000
BAUTLREUT	-0.112189	0.263701	-0.425439	0.6714
BARENTVP	-0.708359	0.112284	-6.308653	0.0000
BASMGULV	-199003.0	32743.05	-6.077716	0.0000
COVIDQ2	169623.3	78505.95	2.160643	0.0331
(CRISIS08Q4-CRISIS09Q1)	249135.3	53478.78	4.658583	0.0000
R-squared	0.984775	Mean dependent var	1906381.	
S.E. of regression	75525.19	Akaike info criterion	25.37288	
F-statistic	933.2866	Durbin-Watson stat	0.495520	
Note: BASMGULV is defined in the Eviews prg file.				

5.18.12 Banks, loan losses.

Table 5.123: Dependent Variable: BATAP. LS estimation. Sample size: 85 (2004Q1 2025Q1)

	Coefficient	Std. Error	t-Statistic	Prob.
Constant	331.2071	71.57836	4.627196	0.0000
(LOSSPERS/100)BAUTLPM	1	-	-	-
(LOSSBUSI/100)BAUTLBM	1	-	-	-
COVIDQ1	2765.546	659.9199	4.190730	0.0001
R-squared	0.807617	Mean dependent var	1436.096	
S.E. of regression	656.0265	Akaike info criterion	15.83353	
F-statistic	348.4314	Durbin-Watson stat	1.023675	

5.18.13 Banks, loans to firms.

Table 5.124: Dependent Variable: DLOG(BAUTLBM). LS estimation. Sample size: 81 (2005Q1 2025Q1)

	Coefficient	Std. Error	t-Statistic	Prob.
DLOG(K2IF)	1	-	-	-
UTLBM06Q4	0.044874	0.015452	2.904127	0.0049
UTLBM12Q1	-0.070624	0.015462	-4.567458	0.0000
CRISIS09Q1	0.149551	0.015462	9.671982	0.0000
UTLBM17Q1	-0.211036	0.015462	-13.64836	0.0000
CS1	0.013317	0.004984	2.671675	0.0093
CS2	0.000569	0.004855	0.117218	0.9070
CS3	0.002458	0.004855	0.506397	0.6141
R-squared	0.834666	Mean dependent var	0.014667	
S.E. of regression	0.015157	Akaike info criterion	-5.458286	
Durbin-Watson stat	2.074177			
Note: UTLBM06Q4, UTLBM12Q1, UTLBM17Q1 are defined in the Eviews prg file.				

5.18.14 Banks, gross loans to personal customers.

Table 5.125: Dependent Variable: DLOG(BAUTLPM). LS estimation. Sample size: 89 (2003Q1 2025Q1)

	Coefficient	Std. Error	t-Statistic	Prob.
(log(BAUTLPM(-1)/K2HUS(-1)) -c(1))	-0.045670	0.021436	-2.130539	0.0362
c(1)	0.44	0.07	6.04	0.00
DLOG(K2HUS)	1.198189	0.174038	6.884650	0.0000
CRISIS09Q1	0.176387	0.011253	15.67519	0.0000
UTLPM17Q1	-0.101379	0.011317	-8.957901	0.0000
CS1	0.006373	0.003477	1.832687	0.0705
CS2	0.008567	0.003311	2.587593	0.0115
CS3	0.005362	0.003309	1.620547	0.1090
R-squared	0.833148	Mean dependent var	0.017084	
S.E. of regression	0.010950	Akaike info criterion	-6.105278	
Durbin-Watson stat	1.739113			
Note: UTLPM17Q1 is defined in the Eviews prg file.				

5.18.15 Banks, gross loans to other Norwegian and foreign customers.

Table 5.126: Dependent Variable: DLOG(BAUTLREUT). LS estimation. Sample size: 69 (2008Q1 2025Q1)

	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-0.150806	0.116030	-1.299716	0.1985
DLOG(K2IF)	1.446980	0.655356	2.207930	0.0310
LOG(BAUTLREUT(-1)/K2IF(-1))	-0.084362	0.063069	-1.337611	0.1859
UTLPM17Q1	-0.243305	0.068541	-3.549752	0.0007
CS1	-0.023517	0.022428	-1.048568	0.2984
CS2	-0.047669	0.022879	-2.083499	0.0413
CS3	-0.028366	0.022591	-1.255645	0.2140
R-squared	0.320761	Mean dependent var	0.020320	
S.E. of regression	0.065360	Akaike info criterion	-2.5218976	
F-statistic	4.879776	Durbin-Watson stat	1.6114056	
Note: UTLPM17Q1 is defined in the Eviews prg file.				

5.18.16 Banks, CET1 capital.

Table 5.127: Dependent Variable: BARKK. LS estimation. Sample size: 85 (2004Q1 2025Q1)

	Coefficient	Std. Error	t-Statistic	Prob.
Constant	338.3692	58.09586	5.824325	0.0000
BARKK(-1)	1	-	-	-
BARES(1-BAUTBA)	0.476	0.153	3.11	-
R-squared	0.999	S.E. of regression	535.6173	

5.18.17 Price of commercial property, office

$PCPO$ is given by the identity $log(PCPO) = log(RENTCPO) - log(YIELDCPO)$, where RENTCPO is rent on commercial property and YIELDCPO denotes yield on commercial property

Table 5.128: Dependent Variable: DLOG(RENTCPO) . LS estimation. Sample size: 156 (1986Q2 2025Q1)

	Coefficient	Std. Error	t-Statistic	Prob.
Constant	0.020948	0.010238	2.046148	0.0425
DLOG(RENTCPO(-1))	0.643638	0.053042	12.13454	0.0000
LOG(PA /PA(-2))	0.030833	0.007400	4.166828	0.0001
LOG(YF/YF(-3))	0.167007	0.046670	3.578469	0.0005
(1/UAKU)	0.043935	0.017794	2.469070	
LOG(RENTCPO(-1))-LOG(PYF(-1))-0.45LOG(YF(-1)))	-0.015624	0.005044	-3.097326	0.0023
CS1	-0.003272	0.003459	-0.946018	0.3457
CS2	0.000800	0.003602	0.221961	0.8247
CS3	0.020847	0.005744	3.629571	0.0004
R-squared	0.715444	Mean dependent var	0.005958	
S.E. of regression	0.013398	Akaike info criterion	-5.731390	
F-statistic	46.19935	Durbin-Watson stat	1.958950	

Table 5.129: Dependent Variable: D(YIELDCPO) . LS estimation. Sample size: 101 (2000Q1 2025Q1)

	Coefficient	Std. Error	t-Statistic	Prob.
D(YIELDCPO(-1))	0.608971	0.071497	8.517407	0.0000
D(YIELDCPO(-4))	-0.193787	0.067332	-2.878090	0.0049
D(UAKU)	-0.110949	0.045237	-2.452592	0.0160
D(LOG(PH/PH(-1)))	-1.257354	0.495238	-2.538888	0.0127
(YIELDCPO(-1)-RSH(-1)-1.25)	-0.037252	0.009833	-3.788500	0.0003
R-squared	0.571236	Mean dependent var	-0.050916	
S.E. of regression	0.166004	Akaike info criterion	-0.705376	
Durbin-Watson stat	1.641164			

5.18.18 Non performing loans, private business market

Table 5.130: Dependent Variable: PLOANB . LS estimation. Sample size: 133 (1990Q4 2023Q4)

	Coefficient	Std. Error	t-Statistic	Prob.
PLOANB(-1)	0.781455	0.018445	42.36598	0.0000
UR	0.276199	0.045197	6.110955	0.0000
(1/(1+EXP(-100(UR(-1)-THPLBUR)))	0.821178	0.128567	6.387154	0.0000
1/(1+EXP(-1000(((RLIF/100)K2IF)/(PYF YF)-THPLBRSH)))	0.447655	0.100467	4.455745	0.0000
MADPCPO	-3.924538	1.025110	-3.828407	0.0002
PLOANBDUM	1.014724	0.065597	15.46902	0.0000
(COVIDQ1+COVIDQ2)	-1.697790	0.267166	-6.354801	0.0000
Constant	-0.179710	0.099548	-1.805263	0.0734
R-squared	0.993291	Mean dependent var	3.876711	
Adjusted R-squared	0.992918	S.D. dependent var	3.027865	
S.E. of regression	0.254802	Akaike info criterion	0.161185	
Log likelihood	-2.799410	Hannan-Quinn criter.	0.231489	
Durbin-Watson stat	2.065263			

Notes:
@PCY(PYF) is annual change in PYF in percent. MADPCPO is a definition:
MADPCPO = 0.25DLOG(PCPO)+0.25DLOG(PCPO(-1))+0.25DLOG(PCPO(-2))+0.15DLOG(PCPO(-3)) +0.1DLOG(PCPO(-4))+0.1DLOG(PCPO(-5))
PLOANBDUM is definied in the code of the Eviews programe file.

5.18.19 Non performing loans, private (non business) market

Table 5.131: Dependent Variable: PLOANP . LS estimation. Sample size: 133 (1990Q4 2023Q4)

	Coefficient	Std. Error	t-Statistic	Prob.
PLOANP(-1)	0.941017	0.008015	117.4123	0.00000
RL-@PCY(CPI)	0.038402	0.012532	3.064341	0.0028
1/(1+EXP(-2.0*(UR-THPLPUR)))	0.097291	0.048726	1.996693	0.0480
1/(1+EXP(-70.0*(RUH(-1)/YDCD(-1)-THPLPRUH)))	0.841139	0.050188	16.75983	0.0000
$1/(MADPH(-1)+0.1)^2$	0.000240	0.000128	1.873113	0.0633
PLOANPDUM	1.003102	0.047305	21.20499	0.0000
R-squared	0.996960	Mean dependent var	1.501696	
Adjusted R-squared	0.996865	S.D. dependent var	1.338401	
S.E. of regression	0.074943	Akaike info criterion	-2.307306	
Log likelihood	158.4359	Hannan-Quinn criter.	-2.263151	
Durbin-Watson stat	2.193852			

Notes:
MADPH is a definition:
MADPH = 0.25DLOG(PH)+0.25DLOG(PH(-1))+0.25DLOG(PH(-2))+0.15DLOG(PH(-3))
PLOANPDUM is definied in the code of the Eviews programe file.

5.18.20 Losses made on loans to the business sector

Table 5.132: Dependent Variable: LOSSBUSI . LS estimation. Sample size: 141 (1988Q4 2023Q4)

	Coefficient	Std. Error	t-Statistic	Prob.
LOSSBUSI(-1)	0.424540	0.034449	12.32366	0.0000
LOSSBDUM	0.972964	0.055828	17.42774	0.0000
D4LOG(YF)	-0.749951	0.256286	-2.926220	0.0040
MADPCPO(-1)	1.252404	0.523170	2.393877	0.0181
$1/(MADPCPO(-1)+0.116)^2$	0.001871	0.000414	4.520144	0.0000
$(1/(1+exp(-100((RLIF/100)K2IF)/(PYFYF)-THLBRSH)))$	0.226402	0.036896	6.136261	0.0000
DLOG((SPUSD SPOILUSD)/PYF)	-0.107185	0.045151	-2.373943	0.0190
CS1	-0.037717	0.014564	-2.589816	0.0107
Constant	-0.085820	0.035073	-2.446896	0.0157
R-squared	0.963656	Mean dependent var	0.215258	
Adjusted R-squared	0.961454	S.D. dependent var	0.371071	
S.E. of regression	0.072853	Akaike info criterion	-2.339045	
Log likelihood	173.9027	Hannan-Quinn criter.	-2.262560	1.926113
Durbin-Watson stat	1.690765			

Notes:
MADPCPO is a definition:
MADPCPO =0.25DLOG(PCPO)+0.25DLOG(PCPO(-1))+0.15DLOG(PCPO(-2)) +0.15DLOG(PCPO(-3))+0.10DLOG(PCPO(-4))+0.1DLOG(PCPO(-5))
In simulations, the lag length of MADPCPO can be adjusted to current accounting practice.
LOSSBDUM is given in the Eviews program file

5.18.21 Losses made on loans to private persons

Table 5.133: Dependent Variable: LOSSPERS . LS estimation. Sample size: 141 (1988Q4 2023Q4)

	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-0.009879	0.005931	-1.665541	0.0981
LOSSPERS(-1)	0.522030	0.029136	17.91716	0.0000
1/(1+EXP(-70.0(RUH(-1)/YDCD(-1)-THLPRUH)))	0.103972	0.023210	4.479625	0.0000
$(1/(MADPH+0.0558)^2)$	0.000071	0.000025	2.829718	0.0054
LOSSPDUM	1.044404	0.047997	21.75965	0.0000
R-squared	0.939659	Mean dependent var	0.047350	
Adjusted R-squared	0.937885	S.D. dependent var	0.110704	
S.E. of regression	0.027591	Akaike info criterion	-4.307852	
Log likelihood	308.7036	Hannan-Quinn criter.	-4.265360	
F-statistic	529.4687	Durbin-Watson stat	2.152239	

Notes:
MADPH is a definition:
MADPH = 0.25DLOG(PH)+0.25DLOG(PH(-1))+0.25DLOG(PH(-2))+0.15DLOG(PH(-3))
LOSSPDUM is given in the Eviews program file

Appendix A

Revision log, 2020-2026

16 March 2026 Variable TWPF renamed as TWFP. NWPF renamed as NWFP. Both to give better internal consistency with NWFP1, NWFP2 etc and TWFP1 and TWFP2 etc.
11 February 2026 Identify for Norway's net lending, *NFIN* added:

$$NFIN = LXR + NCAPTR + NPAT,$$

where *NCAPTR* is net capital transfers to abroad and *NPAT* is net acquisition of patents, licenses etc.
15 January 2026 Variable YDFIRMS (variable representing capital formation motivating income in private Mainland-Norway) re-defined with RLIF as the interest rate (replacing RSH). Improves internal logical consistency between model measurement system and model specification.
10 October 2025 Following a major revision and extension, NAM now includes:

1. A complete representation of the system of Pattern Wage Bargaining (PWB).
2. A module that represents the Norwegian banking sector as a whole, the *Macrobank*.

1 November 2024 The climate emission module has been replaced by a new and more detailed block. It is placed in a separate prg-file:
co2block_disaggregate_version.prg
in a (new) sub-folder Addmodule in the NAM-folder, for easier editiing and structuring by the model user.
13 March 2024 The (optional) equation for PCKONK (trade weighted foreign consumer price index) changed to cointegrated model (between PCKONK and PPIKONK).
15 May 2023 Services the wage-price module in the light of the rise in inflation. Small changes in the short run dynamics of the model equations for CPI and PYFP23.
11 December 2022 Re-modelled the relationship between product demand and input of hours, ie., conditional labour demand equation. The new relationship is more responsive to wage costs increases than earlier versions.
1 September 2022 Improved specification of model equations for ATRAD, CPI, PCKONK, PPIKONK, TWOSJ, NWO. In the new ATRAD equation the, ACOSTCUT variable became redundant. There is a composite dummy ATRADUM, made up of five indicator variables. From 1988, 1995 and 1996.
24 May 2022 Improved specification of model equations that link valued added in private business (YFP1, YFP2 and YFP3NET) to the set of explanatory variables (demand indicators and wages and prices).

14 May 2022 Minor changes in the model equations for $PYFP1$, CPI, and $CPIJAE$.
13 May 2022 Time series for value added deflators $PYFP1$ and $PYFP23$ for the period 1978q1-1995q4 are now from QNA.
28 April 2022 Revised specification of model equation for $PAOIL$ to better model the relationship during a period where the natural gas price rises faster than the oil price.
22 March 2022 Included impulse indicators for Covid-19 in all model equations where found significant. Hence the baseline simulation of NAM is now with corona effects. NAM-run file makes it easy to simulate a counterfactual without corona impulse indicators.
27 January 2022 Minor revisions of all model equations relating to general government expenses and revenues.
4 March 2021 Three new endogenous variables have been added to the model: The number of unemployment benefits claimants (DAGPEN), disabled persons (UFOERE) and the number of old age pensioners (ALDERPEN). Jointly, they contribute to improved modelling of household income and of government expenses.
21 February 2021 NAM now explains climate gas emissions from Norway. Emissions are measured in CO_2 equivalents and emissions from the business sector and private households are modelled separately.

4 December 2020 The export market indicator MII has become difficult to maintain, and has therefore been replaced with a new one named EMI (export market indicator). It is based on imports to Norway's main trading partners and uses weights constructed from Norwegian trade statistics.

All affected equations have been re-estimated with the new use of the EMI variable. MII is no longer part of the model.
25 May 2020 An indicator dummy (dubbed COVIDQ1) for the first quarter of 2020 has been added to equations where it was found to be statistically significant after extension of data set to include 2020q1.

The Covid-19 lock-down and the policy response to it has disrupted the normal relationship between the employment data and the number of registered unemployed. As a work-around, a new equation for REGLED has been included where the conditioning is on aggregate demand, instead of on employment.
29 January 2020 Revision of all estimation results resulted in several changes in detailed specifications of short run dynamics. But no changes that affected total model properties.

Appendix B

Empirical macroeconomic modelling

In this appendix several concepts of econometric modelling are discussed, from the perspective of specification of an empirical macroeconometric model. We also comment explains similarities and differences between NAM and other approaches to quantitative macro models, in particular DSGE (Dynamic Stochastic Equilibrium) models and VARs.

B.1 Theoretical and empirical models

We have already several times referred to NAM as an empirical econometric model. But how should we define empirical model in the first place? Obviously, an empirical model 'uses data', it contains numerical parameter values for parameters, and it can be used to produce numerical fitted values for endogenous values that can be compared to actuals.

But this descriptive definition is not enough to clearly delineate an empirical econometric model. The description could also fit a theoretical model with a specified functional form, and with coefficient values that are calibrated with the use of data. Such a model can also generate numbers, as a numerical solution, for the endogenous variable, by adding numbers for the disturbance that are drawn from a theoretical distribution with theoretically known (or calibrated) parameters.[1] Hence for a theoretical model of the relationship between Y and X we can write

$$\underbrace{Y_i}_{solution} = \underbrace{h(X_i)}_{calibrated} + shocks_i \tag{B.1}$$

where the disturbances are numbers generated with the aid of a random number generator calibrated to a known statistical distribution.

In (B.1), the shocks are part of the model, with postulated properties that are in principle independent of Y. For an empirical model of the relationship between Y and X, a similar decomposition between the 'systematic part' ($h(X_i)$) and the random part of the model can be made. But since the joint distribution of Y and X (the data generating process, DGP) is unknown to the empirical macroeconomic modeller, the aim is instead to construct an explanation of Y with the aid of sample observations (x_i, y_i) of the two variables. If we denote the explanation by $g(x_i)$, a

[1]Calibration is often used in practice, for example the variance parameter can be chosen with the purpose of matching the amplitude of the solution of Y_i.

function with parameters that are estimated from the data, we can write an empirical model as

$$remainder_i = \underbrace{y_i}_{observed} - \underbrace{g(x_i)}_{explained} \tag{B.2}$$

Hence, unlike the independent shock of a theoretical model, the remainder of an empirical model is a not a part of the model, and their properties are derived; they are not independently postulated as the shocks of a theoretical models are. This is a consequence of having 'passive data' or observational data rather than experimental data, see Hendry and Nielsen (2007, Ch. 11.1-2) and Bårdsen and Nymoen (2011, Kap. 8.1).

Despite its simplicity, the formulation in (B.2) is generic: Empirical econometric models are really decompositions of observed data rather than causal entities. At first sight, this may be seen as pulling the rug under the feet of the macroeconometric project. But we can nevertheless construct a viable approach to analysing data in a non-experimental research situation. Reverse causation (Y causing X), simultaneity (joint causation between Y and X) and spurious correlation (both Y and X caused by a third variable Z), are all possible relationships in the data that are consistent with (B.2). But finding empirically that there are significant elements of independent variation in X, and that this variation systematically changes Y, increases our confidence in the model. Likewise, if adding Z to the model does not affect the properties of the remainder, then we have reason to believe that it does not determine Y, and so on.

The characteristics of empirical econometric models can also be illustrated with the aid of the diagram in Figure B.1.

It illustrates the empirical model of as representing the combination of three different fields of knowledge and information: statistical theory, economic theory and observed data. In macroeconometric model building, at least for the purpose for medium-term analysis, institutions are also of great importance. But in order to avoid complicating the picture, we can subsume institutions in the circle labelled Economics (since economic theory has something to say about how institutions affect the macroeconomic variables) and in the Data circle (since it often is possible to obtain data about how institutions have changed during the the sample period)

Economic theory (Economics in the diagram) is vast field by itself, and econometric model construction will build on the theory that is judged to be most relevant for the purpose of a model building project. The chosen segment of economic theory suggest which variables are interrelated and in what ways, possibly the functional form (cf. $g(x_i)$ in (B.2)). The overview of the modules in chapter 3, and Appendix C (focusing on wage and price formation) gives several examples of how economic theory has been important in the specification process of NAM.

The data that we use are time-series observations, meaning that economic theory that indicate something about the dynamic specification of the model is particularly relevant. However, the available theory is often representing the behaviour of economic agents in a steady-state, and are therefore static. Historically, given the trends in time series data, this created the pit-fall of *spurious regression* in econometric time series modelling. But due to the advances in statistical theory at the end of the millennium, we are now able to make use of static (long-run) economic theory in dynamic models of non-stationary time series in a consistent way. The key-words here are unit-roots in individual time series, testable cointegration between two or more time series variables, and equilibrium correction models, as one important class of Empirical models that represent the intersection between Economics, Statistics

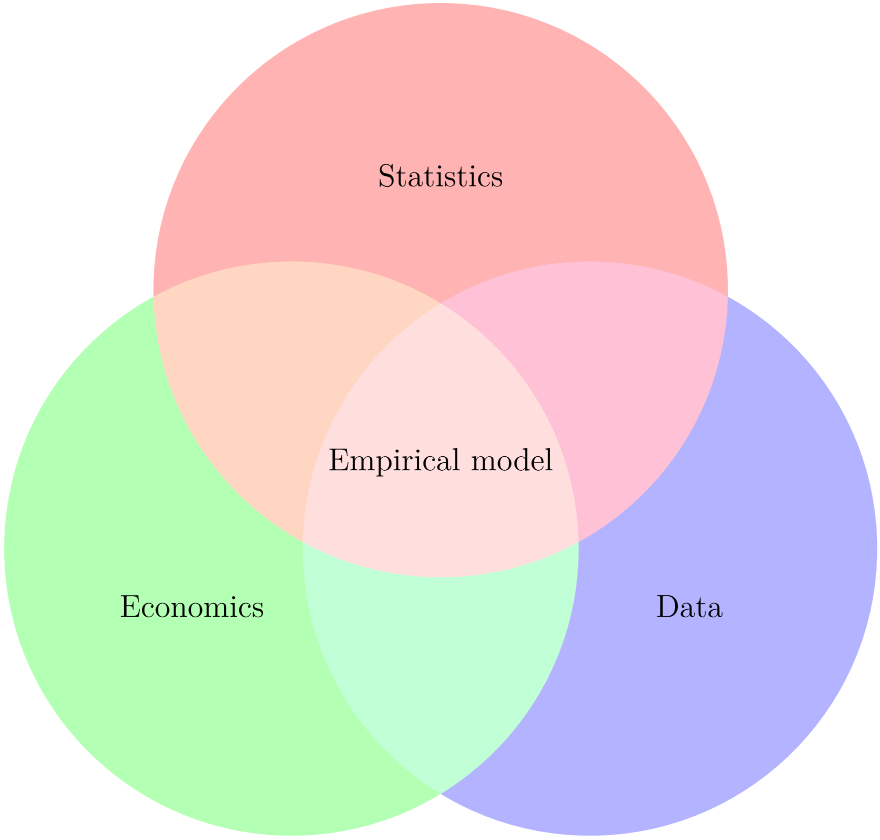


Figure B.1: Illustration of an empirical macroeconometric model as the intersection of information fields of statistical theory, economic theory and the information in observed data

and Data.

The profession's collective understanding of the causes and possible remedies of model limitations, both in forecasting or in policy analysis, has improved markedly over the last decades. The Lucas (1976) critique and the Clements and Hendry (1999) analysis of the sources of forecast failures with macroeconometric models are milestones in that process. Interestingly, the methodological ramifications of those two critiques are different: The Lucas-critique have led to the current dominance of representative agents based macroeconomic models. Hendry (2001), on the other hand, concludes that macroeconometric systems of equations, despite their vulnerability to regime shifts, but because of their potential adaptability to breaks, remain the best long-run hope for progress in macroeconomic forecasting. Since monetary policy can be a function of the forecasts, as with inflation forecast targeting, cf. Svensson (1997), the choice of forecasting model(s) is important.

The tradition of macroeconometric models that NAM belongs to aims to make coherent use of economic theory, data, and mathematical and statistical techniques. This approach of course has a long history in econometrics, going back to Tinbergen's first macroeconometric models, and have enjoyed renewed interest in the last decades. Recent advances in econometrics and in computing means that we now are much better tools than say 20 years ago, for developing and maintaining macroeconometric models in this tradition—see Garratt et al. (2006) for one recent approach.

B.2 Invariance and structure

A long standing aim of macroeconometric model building is that the model should contain invariant relationships, or at least as invariant as feasible see Haavelmo (1944, Chapter II). The caveat reminds us, in case we should forget, that there can be no such thing as a 100 percent invariant behavioural relationship in empirical economics. Sooner or later, like other products of civilization, even the most theoretically sound and relieably estimated relationships will break down. Therefore, a realistic target to set for economic model is a high degree of invariance, and in particular to avoid unnecessary low degree of invariance, by for example abstracting from the structural breaks that have occurred in the sample period.[2]

According to one dominant view, macroeconomic models that are "theory driven" and of the representative agent, intertemporal optimizing, type are said to have structural interpretations, with 'deep structural parameters' that are immune to the Lucas critique. However, when the model's purpose is to describe the observed macroceconomic behaviour, its structural properties are conceptually different. Heuristically, we take a model to have structural properties if it is invariant and interpretable—see Hendry (1995). Structural properties are nevertheless relative to the history, the nature and the significance of regime shifts. There is always the possibility that the next shocks to the system may incur real damage to a model with high structural content hitherto. The approach implies that a model's structural properties must be evaluated along several dimensions, and the following seem particularly relevant:

1. Theoretical interpretation.
2. Ability to explain the data.
3. Ability to explain earlier findings, i.e., encompassing the properties of existing modes.
4. Robustness to new evidence in the form of updated/extended data series and new economic analysis suggesting e.g., new explanatory variables.

Economic analysis (#1) is an indispensable guidance in the formulation of econometric models. Clear interpretation also helps communication of ideas and results among researchers, in addition to structuring debate. However, since economic theories are necessarily simplifying abstractions, translations of theoretical to econometric models must lead to problems like biased coefficient estimates, wrong signs of coefficients, and/or residual properties that hampers valid inference. The main distinction seems to be between seeing theory as representing *the* correct specification, (leaving parameter estimation to the econometrician), and viewing theory as a guideline in the specification of a model which also accommodates institutional features, attempts to accommodate heterogeneity among agents, addresses the temporal aspects for the data set and so on—see Granger (1999).

Arguments against "largely empirical models" include sample dependency, lack of invariance, unnecessary complexity (in order to fit the data) and chance finding of "significant" variables. Yet, ability to characterize the data (#2) remains an essential quality of useful econometric models, and given the absence of theoretical truisms, the implications of economic theory have to be confronted with the data in a systematic way.

[2]In practice this includes breaks in the data measurement system, due to e.g. changes in definitions or in data sources

We use cointegration methods on linearized and discretized dynamic systems to estimate theory-interpretable and idenitifed steady state relationships, imposed in the form of equilibrium-correction models. We also make use of an automated model-selection approach to sift out the best theory-interpretable and identified dynamic specifications. Hoover and Perez (1999), Hendry and Krolzig (2000) and Doornik (2009) have shown that automated model selection methods have a good chance of finding a close approximation to the data generating process, and that the danger of over-fitting is in fact (surprisingly) low. Conversely, acting *as if* the specification is given by theory alone, with only coefficient estimates left to "fill in", is bound to result in the econometric problems noted above, and to a lower degree of relevance of the model for the economy it claims to represent.

In order to develop scientific basis for policy modelling in macroeconometrics, a new model's capability of encompassing earlier findings should be regarded as an important aspect of structure (#3). There are many reasons for the coexistence of contested models for the same phenomena, some of which may be viewed as inherent (limited number of data observations, measurement problems, controversy about operational definitions, new theories). Nevertheless, the continued use a corroborative evaluation (i.e., only addressing goodness of fit or predicting the stylized fact correctly) may inadvertently hinder accumulation of evidence taking place. One suspects that there would be huge gains from a breakthrough for new standards of methodology and practice in the profession.

Ideally, empirical modelling is a cumulative process where models continuously become overtaken by new and more useful ones. As noted above, by useful we understand models that are relatively invariant to changes elsewhere in the economy, i.e., they contain autonomous parameters, see Haavelmo (1944), Johansen (1977), Aldrich (1989), Hendry (1995). Models with a high degree of autonomy represent structural properties: They remain invariant to changes in economic policies and other shocks to the economic system, as implied by #4 above.[3]

However, structure is likely to be (only) *partial* in two important respects: First, autonomy is a relative concept, since an econometric model cannot be invariant to every imaginable shock. Second, all parameters of an econometric model are unlikely to be equally invariant, and only the parameters with the highest degree of autonomy represent structure. Since elements of structure typically will be grafted into equations that also contain parameters with a lower degree of autonomy, forecast breakdown may frequently be caused by shifts in these non-structural parameters.[4]

B.3 The role of forecast performance in model evaluation

The view that forecast failures represent telling evidence against a macro model is still widely held and accepted. In the following we remind the reader that a strategy for model evaluation that puts a lot of emphasis on forecast performance, without taking into account the causes of forecast failure, runs a risk of discarding models that actually contain important elements of structure and relevance for policy analysis.

[3]see e.g., Hendry (1995, Ch. 2,3 and 15.3) for a concise definition of structure as the invariant set of attributes of the economic mechanism.

[4]This line of thought may lead to the following practical argument against large-scale empirical models: Since modelling resources are limited, and some sectors and activities are more difficult to model than others, certain euations of any given model are bound to have less structural content than others, i.e., the model as a whole is no better than its weakest (least structural) equation.

Importantly, Doornik and Hendry (1997) and Clements and Hendry (1999, Ch. 3) show that a main source of forecast failure is location shifts (shifts in means of levels, changes, etc.), and not shifts in the focus parameters in policy analysis, namely the derivative coefficients of endogenous variables with respect to changes in exogenous variables. Therefore, a rough spell in terms of forecasting performance does not by itself disqualify a model's relevance for policy analysis. If the cause of the forecast failure is location shifts, they can be attenuated *ex post* by intercept correction or additional differencing 'within' the model, Hendry (2004). With these add-ons, and once the break-period is in the information set, the model forecast will adapt to the new regime and improve again. Failure to adapt to the new regime, may then be a sign of a deeper source of forecast failure, of the form that also undermines the models relevance for policy analysis, Falch and Nymoen (2011). In general, without adaptive measures, models with high structural content will lose regularly to simple forecasting rules, see e.g., Clements and Hendry (1999), Eitrheim et al. (1999). Hence different models may be optimal for forecasting and for policy analysis, which fits well with the often heard recommendation of a suite of monetary policy models.

Structural breaks are always a main concern in econometric modelling, but like any hypothesis or theory, the only way to judge the significance of a hypothesized break is by confrontation with the evidence in the data. Moreover, given that an encompassing approach is followed, a forecast failure is not only destructive but represent a potential for improvement, if successful respecification follows in its wake, cf. Eitrheim et al. (2002). . In the same vein, one important intellectual rationale for DSGE models is the Lucas critique. If the Lucas critique holds, any "reduced-form" equation in a model is liable to be unstable also over the historical sample, due to regime shifts and policy changes that have taken place in the economy. Hence according to the Lucas-critique, parameter instability may be endemic in any model that fails to obey the Rational Expectations Hypothesis (REH), with the possible consequence that without integration of REH, the model is unsuited for policy analysis. However, as stated by Ericsson and Irons (1995), the Lucas critique is a possibility theorem, not a truism, and the implications of the Lucas critique can be tested, see also for example Hendry (1988), Engle and Hendry (1993) and Ericsson and Hendry (1999).

In Bårdsen et al. (2003) we have shown, by extensive testing of a previous version, that the Lucas critique has little force for our system of equations. This finding is consistent with the international evidence presented in Ericsson and Irons (1995) and Stanley (2000). On the basis of these results, our model is more consistent with agents adopting robust forecasting rules, in line with the analysis and suggestions of Hendry and Mizon (2010). In that case, the Lucas critique does not apply with any force, although the degree of autonomy remains an issue that needs to be evaluated as fully as possible, given the information available to us.

B.4 Reductionism and constructionism in economics

The macro economy is a large-scale system with joint-causality between variables as a dominant trait. Behind the neoclassical and New-Keynesian macroeconomics that has dominated the field for decades, is the position that the large scale macroeconomic system can be understood by working up from the small-scale. This is a kind of strong reductionism entails that the behaviour of the macro economy should be derived directly from microeconomics. It has been dominant since shortly after the WW2, and the DSGE models which came into fashion during the first decade of the

2000s are regarded as one of the successes of this school of economic thought.

Meanwhile, in the natural sciences the role of reductionism has been reconsidered. It still has its place (and probably with better reasons than in economics), but scientists are now aware of the fallacy in the belief that that the best way to understand any system is from bottom up. In a much cited paper entitled ‘More is different’ Anderson (1972) called this fallacy constructionism. Anderson thought it was uncontroversial to accept the proposition that there was a hierarchy to science, so that the elementary entities of science S_j obey the laws of science S_{j-1}. But he rejected the idea that any S_j field of scientific knowledge might be treated as “just applied S_{j-1}”. In economics that would mean that macro econometric modelling ought not to be seen as applied microeconomics. Instead, it would seem to lead logically to the position expressed by Lawrence Klein (1962, p.180) :

> Macroeconomics is an essentially different branch of economic theory, and similarly, econometric model construction in the field of aggregative economics has a few of its own distinctive characteristics.

Neither did the reductionist hypothesis imply constructionism. “The ability to reduce everything to simple fundamental laws does not imply the ability to start from those laws and reconstruct the universe” (Anderson (1972, p. 393). Instead, one must be open to new concepts and new laws as we move from ’low’ to ’higher’ in the hierarchy. The basis of this position was in particular the discovery of ‘emergent properties’ of physical systems: Sometimes the whole is more than the sum of its parts (“more is different”) and behaviour between the entities at the aggregate level cannot be explained by the behaviour at the component level. Examples of emergent behaviour in economics include dynamic macro models that display fluctuations between a full employment equilibrium and a depression equilibrium, see e.g., Anundsen et al. (2014), that aggregated saving may fall as a results of increased saving among all individual households and that productivity growth may be positively related to the degree of coordination in wage formation. While the natural sciences embraced the discovery of emergent behaviour and started to develop e.g. chaos theory to model it, the reductionist fallacy has continued to hold sway in macroeconomics. Nowhere is this more clearly expressed than in the strongly expressed view that macro models that are derived from neoclassical micro theory contain more structure, and are better suited for policy analysis than models that are based on theoretical and econometric analysis at the aggregate level. If economics is anything like the other quantitative sciences this view will at some point change to one that recognises that there are clear limits to what can be learnt from using neoclassical micro economic theory to specify the properties of the macroeconomic system.

B.5 The pros and cons of equilibrium modelling

In spite of taking a firm step away from constructionism, NAM is a model where the concept of equilibrium plays an important role. Specifically, we will usually assume that individual variables follow unstable paths, but we will also investigate closely the possibility that such non-stationary variables may be jointly stationary. In the simplest case in form of ratios that have well defines means that are independent of initial conditions. The means that in NAM, dynamics is represented as in part a manifestation of disequilibrium, and in part an equilibrium phenomenon.

In this section, we briefly address the paradox represented by inclusion of equilibrium dynamics when one of purposes of a macroeconometric model is to analyse scenarios where the macroeconomic stability is fragile (not an equilibrium situation). How can a model with with equilibrium correction nevertheless be useful for "disequilibrium analysis"?

The solution to the paradox is that although our purpose is the detection of e.g., financial and macroeconomic stress, fragility and disequilibrium, such an analysis requires that we, to begin with, have a relatively clear idea about what an equilibrium situation looks like. Otherwise there will be no operational, model based, way of identifying stress-dynamics from "normal" equilibrium dynamics.

A special version of NAM, dubbed NAM-FT, has been developed to aid the analysis of macro-financial stress of the Norwegian economy, see Finanstilsynet (2014, Theme II, pp. 69-78). As part of that analysis the model is used to produce solution time-paths for the future development of e.g., house prices, credit growth, problem loans, debt to income ratios, interest rate margins, debt leverage, loan and default rates, given a specified stress scenario. The value of the exercise is increased by comparison of any of these variables in the stress scenario with their historical and theoretical representative values, or (which is more usual) by a 'baseline solution which covers the same time period as the stress period. Based on the sets of future paths, one can construct graphs and summary statistics of key variables and ratios.

Not all differences between for example debt leverage levels and equilibrium leverage represent stress. Therefore, it makes sense for the baseline simulation to allow for disequilibria that are inherited from history at the start of the stress-test period. An equilibrium model will tell you that these disequilibria will disappear over the stress test period, and it is valuable to be able to separate equilibrating dynamics from system threatening stress dynamics. Hence, even though stress testing is about dis-equilibrium, the analysis will always be made relative to a path with normal equilibrium dynamics. This is why it is only a mild paradox that stress testing can be based on an a quantitative macroeconometric model with well defined equilibrium time paths for the variables of interest.

NAM offers at least three "handles" that can be used in the construction of financial stress scenarios. First, non-modelled (exogenous) variables can be changed from their typical non-stress time paths to typical stress values. For example, in a stress-scenario that represents a new financial crisis, international money market interest rates can plausibly be increased by a significant amount with reference to increased risk premia in required rates of return. In the same scenario, international demand for Norwegian exports will be damaged by reduced incomes in foreign countries, which will plausibly also make the oil price fall to a very low level.

Second, a situation with financial stress can lead to changes in the intercepts and autonomous growth rates that are parameters in the model's estimated equations. It has now become recognized that structural breaks of this type contribute to a large extent to the variation in economic time series. In the construction of NAM this aspect has been addressed explicitly and the model therefore includes a set of identified stress-indicator variables that are custom built to represent structural breaks that can characterize a plausible financial stress scenario. Some of the indicator variables have the property that they change the estimated long-run mean of estimated equilibrium relationships. With these stress-indicator variables activated in the model, the stress-test simulation will resemble regime-shift analysis, for example as with Markov Switching.

Neither of the two first tools for scenario design change the dynamics of NAM. A third class of interventions that can be made is therefore to change one or more speed-of-adjustment parameters. The result will be particularly striking if a parameter associated with equilibrium dynamics is set to zero in the stress scenario. Of course, in order not to become too speculative, such changes in the structure of the model needs to be careful motivated. On the other hand, it is also quite possible that a model that uses time series for a period where crises has not occurred end up being 'too optimistic' about the number of invariant equilibrium relationships.

However, the relevance and the plausibility of the predicted equilibrium dynamics can usefully be assessed and discussed by the stress-analyses team. For example, the assessment may bee that financial stress is already so far developed in the initial conditions that equilibrium correction is in decline. In fact, a scenario where equilibrium correction first dies away, and then comes back after a long crisis period need not be pure speculation. Recently, Anundsen (2014) has provided an analysis along these lines of the US subprime bubble. Again, the premise for this type of advanced analysis is that the relevant variables and parameters are clearly stated in the description of the stress scenario for the model used.

This is why it is only a mild paradox that stress testing can be based on an a quantitative macroeconometric model with well defined equilibrium time paths for the variables of interest. There is nothing in this position that contradicts the view that conventional equilibrium models can have made economists too readily accept that market economies are stable, thus failing to ask the fundamental question about how to design more stable systems, cf. Stiglitz (2014).

B.5.1 Equilibrium correction model. Not NAIRU model

NAM is a dynamic model which aims to represent the typical trends in many macroeconomic time series, so called unit-root non stationarity, but also the theoretically plausible (non-trending) steady-state relationships between non-stationary variables. NAM is therefore a so called equilibrium correction model (ECM). The equilibria can change due to for example institutions adapting to the changing environment. Together, this means that NAM allows for both unit-root non-stationarity, cointegrationg and structural breaks.

One of the variables in NAM that has a well defined equilibrium, steady-state, is the rate of unemployment. However, NAM is not a natural rate of unemployment type of of macro model, or,slightly more general, a NAIRU model. This follows from how we represent wage and price formation, which represents an important form of coordination of wage and prices through collective agreements, and their extension to the labour market, cf. chapter C.3. Unlike NAIRU macro models, where the rate of unemployment consistent with stable inflation is given as a single point on the real line, the theoretical properties of NAM implies that there is set of unemployment percentages (not a single number) that are consistent with a given constant inflation rate. [5].

B.6 The concept of a data generating process

Because there is a need to bridge the gap between economic theory and an empirical model, it follows that the properties of empirical models depend not only on the initial theoretical position or framework used. Instead, the properties of empirical models to a large extent depend on how they are have been formulated, selected and estimated, as well as by the data quality, institutional knowledge and (one would

[5]NAIRU is acronym for the Non Accelerating Inflation Rate of Unemployment. Rather inconsistently, empirical NAIRU models often provide estimates of the NAIRU which fluctuates much more than seems to be reasonable, given how labour market institutions have evolved

hope) the findings of previous studies. All these steps in model specification represents difficulties for the modeller and may lead to mis-specification in one dimensions or another.

It is well known that models can become mis-formulated by omitting important determinants. This can happen as a results of downright variable omission, or by misinterpreting a weakly exogenous variable as an instrumental variable rather than as an explanatory variable, cf. Castle et al. (2014) who show how this step can bias the results obtained for tests of the significance of lead-in-variables. Other cases of mis-formulation are mis-specification of dynamic reactions, inappropriate functional forms or not accounting for structural breaks.

However, to state that a model is mis-specified entails that there exists an object for which it is not the correct representation. In the following we refer to that object as the local data generating process (with the acronym LGDP), namely the process by which the variables under analysis were generated, including how they were measured, see Hendry and Doornik (2014, Ch. 1.1)

As the values of all major economic variables are announced regularly, it is easy to believe that a LDGP can exist. It is an interesting philosophical question whether the true generating mechanism can (ever) be completely described, but the usefulness of the concept does not hinge on the answer to that question. The main point is that once the real economic world, in its enormous, ever-changing, complexity, is accepted as a premise for macroeconomic modelling, it follows that the main problems of macroeconometrics are model specification and model evaluation, rather than finding the best estimator under the assumption that the model is identical to the data generating process.

The LDGP is changing with the evolution of the real world economy—through technical progress, changing pattern of family composition and behaviour and political reform. Sometimes society evolves gradually and econometric models are then usually able to adapt to the underlying real-life changes, i.e. the without any noticeable loss in "usefulness" Often, however, society evolves so quickly that estimated economic relationships break down and cease to be of any aid in understanding the current macro economy and in forecasting its development even over the first couple of years. In this case we speak of a changing local approximation in the form of a regime shift in the generating process, and a structural break in the econometric model. Since the complexity of the true macroeconomic mechanism, and the regime shifts also contained in the mechanism, lead us to conclude that any model will at best be a local approximation to the data generating process, judging the quality of, and choosing between, the approximations becomes central.

B.7 VARs, cointegrated VARs and structural models

The Vector autoregressive system, VAR, represents a common ground for multivariate dynamic econometric modelling. It can be rationalised theoretically by the theory of reduction of a high dimensional joint density function, Hendry and Doornik (2014, Ch. 6), or as a linearization and "discretization" of a structural system of differential equations, Bårdsen et al. (2004). Non-stationarity in the form of unit-roots is easy to integrate (as a restriction on the roots of the companion form matrix), and cointegration can be tested.

We will keep the rest of this section brief, as comprehensive treatments about the estimation of (cointegrated) VARS can be found many places—for example in Hendry (1995), Johansen (1995b, 2006), Garratt et al. (2006), Lütkepohl (2006), Nymoen (2019)—and only make some comments on issues in each step in the modelling process we believe merit further attention.

The relationship between the VAR and structural models, can be briefly presented as in the following three paragraphs.

B.7.1 The statistical system

Our reference point will often be a linearized and discretized approximation as a data-coherent statistical system representation in the form of a VAR:

$$\Delta \mathbf{y}_t = \mathbf{c} + \mathbf{\Pi} \mathbf{y}_{t-1} + \sum_{i=1}^{k} \mathbf{\Gamma}_{t-i} \Delta \mathbf{y}_{t-i} + \mathbf{u}_t, \tag{B.3}$$

with independent Gaussian errors $\mathbf{u}_t$ as a basis for valid statistical inference about economic theoretical hypotheses. We focus on potential unit-roots that are located at the zero frequency, which means that the rank of the $\mathbf{\Pi}$ matrix becomes central. If that matrix has full rank, all the variables in the VAR are $I(0)$ and the VAR is stationary.

Macroeconomic variables are however typically trending and therefore broad sense non-stationary. If a realistic model of the typical trend was deterministic, we could nevertheless maintain the $I(0)$ framework with reference to the Frisch-Waugh theorem. However, even though we will need the concepts of deterministic drift and of deterministic mean of a long-run relationship, the deterministic trend model alone is too restrictive to be useful in practice. Instead, we follow custom and use the stochastic trend mode. Hence, the usual situation is that that two or more variables in the VAR are $I(1)$, which implies that $\mathbf{\Pi}$ has reduced rank. However, if the rank is larger than zero, there is at least one cointegration relationships between the variables.

Given that the rank of $\mathbf{\Pi}$ has been determined, the statistical model (B.3) to provide the framework for hypothesis testing. However, it cannot be postulated directly, since the cointegrated VAR itself rests on assumptions. Hence, validation of the statistical model is an essential step: Is a model which is linear in the parameters flexible enough to describe the fluctuations of the data? What about the assumed constancy of parameters, does it hold over the sample that we have at hand? And the Gaussian distribution of the errors, is that a tenable assumption so that (B.3) can supply the inferential aspect of modelling with sufficient statistics. The main intellectual rationale for the model validation aspect of macroeconometrics is exactly that the assumptions of the statistical model requires separate attention, Johansen (2006),Spanos (2008) In practice, one important step in model validation is to make the hypothesized statistical model subject to a battery of misspecification tests using the OLS residuals $\hat{\mathbf{u}}_t$ as data.[6]

As pointed out by Garratt et al. (2006), the representation (B.3) does not preclude forward-looking behaviour in the underlying model, as rational expectations models have backward-looking solutions. The coefficients of the solution will be defined in specific ways though, and this entails restrictions on the VAR which can utilized for testing rational expectations, see Johansen and Swensen (1999, 2004) and Bårdsen and Fanelli (2015a).

Even with a model which for many practical purpose is small scale, it is usually too big to be formulated in “one go” within a cointegrated VAR framework. Hence,

[6]The distinction between the inferential and model validation facets of modelling is due to Spanos (2008), who conclusively dispels the charge that misspecification testing represents an illegitimate “re-use” of the data already used to estimate the parameters of the statistical model, see also Hendry (1995, p. 313-314).

model (B.3) for example is not interpretable as one rather high dimensional VAR, with the (incredible) long lags which would be needed to capture the complicated dynamic interlinkages of a real economy. Instead, as explained in Bårdsen et al. (2003), our operational procedure is to partition the (big) simultaneous distribution function of markets and variables: prices, wages, output, interest rates, the exchange rate, foreign prices, and unemployment, etc. into a (much smaller) simultaneous model of wage and price setting—the labour market— and several sub-models of the rest of the macro economy. An econometric rationale for specification and estimation of single equations, or of markets, subject to exogeneity assumptions, before joining them up in a complete model is discussed in Bårdsen et al. (2003), and also in Bårdsen et al. (2005, Ch. 2).

B.7.2 The overidentified steady state

The second step of the model building exercise will then be to identify the steady state, by testing and imposing overidentifying restrictions on the cointegration space:

$$\Delta \mathbf{y}_t = \mathbf{c} + \alpha\beta^{'}\mathbf{y}_{t-1} + \sum_{i=1}^{k} \mathbf{\Gamma}_{t-i}\Delta \mathbf{y}_{t-i} + \mathbf{u}_t,$$

thereby identifying both the exogenous common trends, or permanent shocks, and the steady state of the model.

Even though there now exists a literature on identification of cointegration vectors, it is worthwhile to reiterate that identification of cointegrating vectors cannot be data-based. Identifying restrictions have to be imposed *a priori*. It is therefore of crucial importance to have a specification of the economic model and its derived steady state before estimation. Otherwise we will not know what model and hypotheses we are testing and, in particular, we could not be certain that it was identifiable from the available data set

B.7.3 Third step: the dynamic SEM

The final step is to identify the dynamic structure:

$$\mathbf{A}_0\Delta \mathbf{y}_t = \mathbf{A}_0\mathbf{c} + \mathbf{A}_0\alpha\beta^{'}\mathbf{y}_{t-1} + \sum_{i=1}^{k} \mathbf{A}_0\mathbf{\Gamma}_{t-i}\Delta \mathbf{y}_{t-i} + \mathbf{A}_0\mathbf{u}_t,$$

by testing and imposing overidentifying restrictions on the dynamic part—including the forward-looking part—of the statistical system.

First, the estimated parameters and therefore the interpretation of the model dynamics are dependent upon the dating of the steady-state solution. However the steady-state multipliers are not—see Bårdsen and Fisher (1993, 1999)

Third, the economic interpretations of the derived paths of adjustment are not invariant to the identification of the dynamic part of the model, whereas the steady-state parts of the model are—again see Bårdsen and Fisher (1993, 1999).

In the next chapter we use the task of modelling wage-and-price and price formation as an example of how the methodology can be applied. The discussion will also serve as an introduction to the characteristics of the supply side of NAM, which has to do with how we model wage-price dynamics, and the role of wage and price setting in the determination of the medium term macroeconomic equilibrium.

Note that we use simultaneous equations model in a broad meaning here: The identified SEM may we be a recursive model strukture for example.

B.8 Relationship to dynamic stochastic general equilibrium models (DSGE)

At a certain technical level, there is a close relationship between DSGEs and NAM. In NAM, the reduced form is a (high dimensional) VAR with a well defined companion form representation.[7] The solution of a DSGE model, if it exists and is unique, is also a VAR, see Bårdsen and Fanelli (2015b). Hence, the principal difference between NAM and a DSGE is the respective identifying restrictions on the VAR.

Identification is a question of economic theory, and therefore the relevance and evaluation of the identifiable theory for the Norwegian economy remains a topical issue. For example, In NAM the steady state is not imposed *a priori*, but estimated as cointegrated relationships.

It should comes a no surprise that our position is that the theoretical framework used in the construction of NAM is of greater relevance for analysing the Norwegian macroeconomic system, than the general and microeconomic theoretical underpinnings of DSGEs. But apart from that position statement, there is no crusade against DSGEs, or other models or methodologies, in this documentation. Basically, all different methodologies currently on offer must be expected to be useful for some purpose, for some users.

At descriptive level, another difference is the direct modelling of the macroeconomic data in NAM, versus the "prepared" data modelled in DSGEs. In NAM the deviation from equilibrium is represented explicitly in the model, with estimated steady-state parameters, while in DSGEs the variables are usually filtered, representing deviations from steady-state paths. Since both types of models will be damaged by structural breaks in the equilibrium relationships, it seems better to have steady-state parameters explicitly in the model specification, to assess their significance and to monitor signs of breaks.

All in all, it is better to place NAM in the tradition of Structural Econometric Models (SEMs) tradition than as an 'deconstructed' DSGE model. Since one of the main usages of NAM is been specification and analysis of macroeconomic financial stress scenarios, it is interesting to note that economicsts at the Bank of England has recently used the SEM approach to develop a new framework for analysing money, credit and unconventional monetary policy, cf. Cloyne et al. (2015).

[7] The companion form is method of transforming a system of difference equations of higher order into first order, see e.g. Bårdsen and Nymoen (2014, Chap. 6.63).

Appendix C

Wage and price formation and medium term model properties

In this appendix, we show that the specifications of wage and price setting equations are important for the the medium term properties of a macro model. In order to simplify, we abstract from the pattern wage bargaining (wage-leader-followership) and think in terms of a single national wage and a business sector characterized by monopolistic competition. All our main conclusions do however carry over to a model with a wage norm setting sector, and pattern wage bargaining, suitably adapted.

C.1 The supply side of macro models

A main issue of an medium term empirical macro model is the specification of the supply side. This is well illustrated by the history of macroeconomic models.

The early models by Tinbergen and Klein were specified in accordance with the Keynesian view that, unless demand was greater than supply capacity at full employment, an increase in demand would lead to lower unemployment. The point made by the theory sometimes called the 'L-shaped' aggregate supply curve, was not that wages and prices were fixed, but that there were no determinate link between them and demand, see Forder (2014, Ch. 1.3). Viewed against this intellectual background, it is understandable that the medium-run macroeconometric models that were developed in many countries during the 1950s, 1960s and 1970s, were much more detailed about the demand side of the economy than about the supply-side. In hindsight it is however easy to see that this situation made the models vulnerable to real world shocks that could make the 'L-shaped' aggregated supply curve shift. Eventually, the problems experienced by trying to cope with the coexistence of stagnating real economic growth at the same time as inflation persisted, the phenomenon called to *stagflation*, led to a process of amendments and extensions of the models. Another important stimulus for change was the theoretical criticism which insisted that the 'demand driven models' should be replaced by equilibrium models which assumes that prices and wages continuously clear markets and that agents continuously optimize, see Wallis (1995, Ch. 2). This critique originated in the real business cycle school of thought, and later developed into modern neoclassical macroeconomics. As a response both real world problems, and the noted intellectual critique, macro modellers began to pay more attention to the representation of the supply side of the models.

As Nickell (1988) explained, the key parts of the supply-side are represented by those equations that describe the behaviour of firms, in particular price setting, and those that reflect the determination of wages. Important questions are then whether a model possesses a medium term *Non-Accelerating Inflation rate of Unemployment*, known by the acronym NAIRU, which is invariant to shocks to aggregate demand, but which may not be invariant to changes in institutional features of the labour marked.

Bårdsen and Nymoen (2009b) pointed out that it is often useful to be clear about the distinction between the steady-state rate of unemployment possessed by a macroeconomic model, and the NAIRU. A model may possess a steady-state rate of unemployment even if a NAIRU is not implied by the model. Technically, the existence of a model-determined steady-state rate of unemployment is secured if all the characteristic roots associated with the *final form equation* for the rate of unemployment are less than one in absolute value.[1]

Both the implied dynamics, and the steady-state of the rate of unemployment may well depend on parameters from outside the wage-and price-setting equations of the macroeconometric model. Bårdsen and Nymoen (2003) showed that the independence of the steady-state rate of unemployment of parameters from outside the wage-price sub-system can be tested without specifying the total model. If a test required us to specify the full model, the feasibility of testing the NAIRU-proposition (e.g. a vertical long-run aggregate supply schedule) would have been much less.

However, as discussed by Kolsrud and Nymoen (2014,2015), care must be taken in the specification of the wage-price sub-model used for the testing of NAIRU-properties. In particular, although the contrary is sometimes suggested, there is little that can be learned about NAIRU-properties from the estimation of static models of wage-and price setting. For one thing, the dynamic stability of the rate of unemployment "around" the estimated NAIRU is then taken for granted. We return to this point later in this chapter.

The importance of the wage- and price modelling for overall model properties also makes it interesting to use it as an illustration of the approach to econometric modelling that formulated in relatively general terms in the previous chapter.

Therefore, the rest of this chapter gives a relatively detailed example of a theoretical and econometric specification of the wage-price block of a (still stylized) macro model. The first step is the specification of the relevant economic theory to test. We next develop the theoretical relationships into hypotheses about cointegration, that can be tested in a statistical model and identified as steady state relationships, corresponding to Step 1 and 2 aboe. We also go through Step 3 in detail. Throughout the rest of the chapter we let lower-case letters denote natural logarithms of the corresponding upper-case variable names, so $x_t \equiv \ln(X_t)$.

C.2 The labour market as a social institution, implications for the specification of wage equations

Our starting point for the modelling of labour markets is the idea that firms and their workers are engaged in a partly cooperative and partly conflicting sharing of the rents generated by the operation of the firm. Wage formation in particular takes place in a social context where there is awareness of the co-existence of both conflict

[1] To account for complex roots, 'absolute value' should be interpreted to also include the modulus of complex root-pairs. See Wallis (1977) for the definition of the final form equation which in the linear in parameter case seems to have a close correspondence with the homogeneous part of the forecasting equation obtained for a variable which is endogenous in a system of linear difference equations. Nymoen and Sparrman (2015) uses this approach in a study of unemployment rate dynamics in a panel of OECD countries.

and common interests.[2] However, this characteristic also makes it difficult to model wage formation from the principle of individual rational choice, the level of analysis preferred by neoclassical economics.

The formulation of a theory of wage setting requires an assessment of not only self-interest among workers and firms, but also of compromise. As pointed out by Usher (2012), 'compromise' is then not just another way of talking about self-interest, and social, political and institutional forces are not merely cover-ups for imprecisely modelled individuals rational actions, they are among the fundamental determinants of decisions. In this view, even a full analysis of rational behaviour leads to an indeterminacy of wages, and other considerations had to be introduced to resolve it. The recognition among leading economists that there is an indeterminacy in the economic theory of wages goes back to the 1950s, see Forder (2014, Ch. 1.4) who cites Samuelson (1951, p. 312) and Hicks (1955, p. 390) and other leading theorists. The economic theory of supply and demand could set some limits to what wages can be set, but within those limits closer determination requires that other relationships are introduced.

A related, but perhaps more general critique is sometimes directed against the tradition in economics, especially in macroeconomics, that in nearly all respects the labour market is just like other markets. In the European legal tradition, the fundamental asymmetry in the relationship between the individual worker and employer was early pointed out, leading to the legitimate installation of labour market regulation (usually a combination of laws and collective agreements). One forceful critique of this type, coming from a leading economist, is Solow (1990), who made the point that notions of fairness are well developed on both sides of the market, and that there often is a shared understanding of partly common, partly conflicting, interests between firms and workers. Solow brought his arguments to bear on the notion of a stable "natural rate of unempolyment", which he wrote "has been given more widespread acceptance than it has earned". [3] Indeterminancy of wages also characterizes the Diamond-Mortensen-Pissarides (DMP) search and matching model. In the DMP model, the wage is usually determined in a Nash bargaining game. But is the wage logically equal to the Nash solution given the assumptions of the DMP model? As Hall (2005) pointed out, any wage in the bargaining is in principle consistent with private efficiency on the part of both the firm and the worker. In that sense, the equilibrium wage rate is only "set-identified". He then went on to analyze a solution where the real wage is fixed, which however is only one possibility of what in the DMP-literature is referred to as wage stickiness. [4]

While economists have difficulty determining wages theoretically, we observe that actual wage bargains are struck year after year, and that they are rationalized by considerations of profits, actual and required (to attract investments), cost of liv-

[2]Historically, the system of wage formation in Norway developed as a result of the lowering of the conflict level in Norwegian society that started a few years before WW-II and which continued in the post war decades. At the same time, the gradual development of a system of wage formation also contributed to the complicated process of conflict reduction.Reiersen (2024) analyses it as primarily driven by a change of strategy by the two main confederate organizations, from conflict to compromise and cooperation.

[3](Solow (1990, p. 5))

[4]Following Hall (2005), several papers have incorporated rigid wage setting in search models. For instance, Gertler and Trigari (2009) present a DMP model where the frequency of wage bargaining is constrained by Calvo (1983)) style lottery, leading to sticky wages. Blanchard and Galí (2010) combine a reduced form of search model with real wage rigidity with a New Keynesian model to study how this impacts monetary policy. Krogh (2015) generalizes the Hall-approach to a small open economy model where there is a non-trivial distinction between the consumer real wage and the producer real wage.

ing and relative wages (fairness). The importance of profits in wage formation, in particular, has been a staple of the literature based on studies of actual wage determination for decades (cf Forder (2014, Ch. 1.4), and covering different institutional arrangements. The same literature also confirms the general salience of fairness and the particular importance of adjustments of wages to compensate for changes in the cost of living.

These observed regularities give reason to believe that wage formation can be subject to econometric treatment, in particular as part of a macroeconometric model projects, see, Bårdsen et al. (2005, Ch 3-6), Bårdsen and Nymoen (2009a) and Bårdsen et al. (2012).

In line with the academic literature, we too represent wage formation theoretically by using a formal bargaining solution, in the next sub-chapter C.3. In order to avoid creating an unnecessary large gap to bridge, we specify a formal model that conforms to the Norwegian system with relatively strong confederate labour market organizations that take the role of setting a wage norm for the overall adjustments of nominal wages. In this system, it is understood that this form of 'rational' wage setting can (at best) secure a degree of international cost competitiveness that, in turn, makes it possible for the government (and central bank) to pursue a policy of high employment. In essence, this tripartite agreement represent a cornerstone in the Norwegian model of wage formation.

Linked up with an assumption of monopolistically competitive firms, it gives a version of the incomplete competition model, referred to as ICM in the following.

As just noted, a too literal interpretation of a formal bargaining model may lead us to believe that the wage level is well determined from theory, which it is not, as we have just noted. However, as long as we limit ourselves to use the formal bargaining solution as a way of organizing the various factors that are likely to influence the real world bargaining outcome, the danger of over-interpretation is not large.

However, there is another, more easy to see, shortcoming of the formal bargaining solution: Time plays no role in the theory and the derived relationships are static. Real world wage level adjustment in contrast, is almost always and everywhere gradual and non-instantaneous.

Therefore, the gap between the formal relationships of the theory and the empirical relationships that may be present in the data must be closed. This is where the methodology of the previous chapter comes in, and where the assumption about $I(1)$-ness in particular becomes an important part of the bridge between theory and data. This is because $I(1)$-ness allows us to interpret the theoretical wage and price equations as hypothesized cointegration relationships. In particular, an essential part of the bridge is the interpretation of the wage-norm 'determined' by the Nash-solution as a point of gravitation in an dynamic model of nominal wage and price changes. From that premise, a dynamic model of supply side in equilibrium-correction model (ECM) form follows logically.

C.3 An incomplete competition theory of wage and price setting

Although the model of perfectly competitive labour markets is still sometimes used as an 'easy to use' model for how the wage level is determined, that theory is not only incomplete, it is also unrealistic. Except perhaps for some epochs after the industrial revolution, when 'Manchester-liberalism' was the ruling principle. Then, each individual worker was left to agree their own wage and working conditions the best they could. Historically with very grim results.

The underlying reason for the impossibility of perfect competition and acceptable working conditions economics equality, is the asymmetry in the relationship between the individual worker and the employer. The recognition of this fact has led societies that belong to the European legal tradition in the direction of extensive labour market regulation, usually by the combined use of laws and collective agreements about wage compensation and working conditions, cf. Evju (2003).

In Norway, for a period of 80 years, collective agreements have played a comparatively large role in labour market regulations. In particular when it comes to wage formation.

Viable collective agreements in the labour market require a certain degree of sheltering against unwanted competition, hence the name incomplete competition theory. In our model, incomplete competition also refers to the product markets, since we assume that firms engage in monopolistic competition.

C.3.1 Firms' setting of a price target

We start with the assumption of a large number of firms, each facing downward-sloping demand functions. The firms are price setters, and equate marginal revenue to marginal costs. With labour being the only variable factor of production and constant returns to scale (see box), we have the price setting relationship for firm i

$$Q_i = \frac{El_Q Y_i}{El_Q Y_i - 1} \frac{W_i(1 + T1_i)}{Z_i}, \tag{C.1}$$

where $Z_i = Y_i/N_i$ is average labour productivity, Y_i is output and N_i denotes labour input. $W_i(1+T1_i)$ is the compensation paid per unit of labour paid by firm i. From now on we refer to W_i simply as the nominal wage rate. $T1_i$ represents a payroll tax rate.

$El_Q Y i$ denotes the absolute value of the elasticity of demand facing each firm i with respect to the firm's own price. In general, $El_Q Y_i$ depends on Q_i and on competing prices, set by both foreign and domestic firms. However, a common simplification is to assume that the demand elasticity is a constant parameter and that it is the same for all firms. As is well know, a formal condition for profit maximization is the elasticity is larger than one in absolute value, i.e., $El_Q Y_i > 1$.

Competition, capacity and pricing behaviour
The argument that product market competition will drive firms to use all their fixed capital leads to the conventional assumption of increasing marginal and average costs. However, neither theory nor evidence about how firms themselves perceive their cost curves (e.g. Blinder (1998), Keen (2011, Ch.5)) give particular reason to believe that a large percentage of industrial products is produced under conditions of markedly rising marginal costs. With no spare capacity a firm has no flexibility to take advantage of sudden, unexpected changes in the market. Excess capacity may thus be quite essential for survival in a market economy.
In this chapter we adopt the constant returns to scale assumption as a simple way of representing the, we believe, widespread phenomenon of non-increasing marginal costs. The hypothesis has strong implications for macroeconomics, since it entails that markets for industrial products clear mainly through quantity, rather than price.

In practice, even for quite narrowly defined industries, there is going to a be a productivity distribution at each point in time. However, for the purpose of this section, we assume that $Z_i = Z$ for all i. Under that simplifying assumption, it may be logical for the firms to take wage setting 'out of the competition' between them. Hence, we also set $W_i = W$, and we get the simple 'aggregate' product price equation:

$$Q = \frac{El_Q Y}{El_Q Y - 1}\frac{W(1+T1)}{Z} \tag{C.2}$$

C.3.2 Bargaining based wage-target (wage-norm)

In theory, as well as in practice, there are different ways of equalizing wage-costs between firms, including monopsony, wage laws (or a even a corporative state), or collective agreements between a employer organization (confedration of firms) and a labour union. We assume a framework with collective wage setting.

In the following we will assume that the utility of the firm-side organization is simply proportional to the real profit of the individual firm. Real profit is denoted by Π and is defined by $\Pi = (Y - W(1+T1)N/Q$. With the use of (C.2), the expression for real profits (Π) can be written as:

$$\Pi = Y - \frac{W(1+T1)}{Q}N = (1 - \frac{W(1+T1)}{Q}\frac{1}{Z})Y.$$

As noted above, we will assume at this point, that the wage rate W is settled in accordance with the principle of maximization of the Nash product:

$$(V - V_0)^{\mho}\Pi^{1-\mho} \tag{C.3}$$

where V denotes union utility and V_0 denotes the fall-back utility or reference utility. The corresponding break-point utility for the firms has been set to zero in (C.3), but for unions the utility during a conflict (e.g., strike, or work-to-rule) is non-zero because of compensation from strike funds. Finally $\mho$ represents the relative bargaining power of unions. It seems logical to assume that $0 < \mho < 1$, to rule out that one of the parties gets full bargaining power and the other gets none (which would lead to another type of wage formation).

We assume that union utility V depends on the consumer real wage of an unemployed worker and the aggregate rate of unemployment, thus $V(\frac{W}{P}, U, A_\nu)$ where P denotes the consumer price index.[5] The partial derivative with respect to wages is positive, and negative with respect to unemployment ($V'_W > 0$ and $V'_U \leq 0$). The last argument in the union utility function, A_ν, represents other factors in union preferences.

The fall-back or reference utility of the union depends on the overall real wage level and the rate of unemployment, hence $V_0 = V_0(\frac{\bar{W}}{P}, U)$ where $\bar{W}$ is the average level of nominal wages which is one of factors determining the size of strike funds. If the aggregate rate of unemployment is high, strike funds may run low in which case the partial derivative of V_0 with respect to U is negative ($V'_{0U} < 0$). However, there are other factors working in the other direction, for example that the probability of entering a labour market programme, which gives laid-off workers higher utility than open unemployment, is positively related to U.

[5]It might be noted that the income tax rate $T2$ is omitted from the analysis. This simplification is in accordance with previous studies of aggregate wage formation, see e.g., Calmfors and Nymoen (1990) and Nymoen and Rødseth (2003), where no convincing evidence of important effects from the average income tax rate $T2$ on wage growth could be found.

With these specifications of utility and break-points, the Nash-product, denoted $\mathcal{N}$, can be written as

$$\mathcal{N} = \left\{ V(\frac{W}{P}, U, A_\nu) - V_0(\frac{\bar{W}}{P}, U) \right\}^{\mho} \left\{ (1 - \frac{W(1+T1)}{Q}\frac{1}{Z})Y \right\}^{1-\mho}$$

or

$$\mathcal{N} = \left\{ V(\frac{RW}{P_q(1+T1)}, U, A_\nu) - V_0(\frac{\bar{W}}{P}, U) \right\}^{\mho} \left\{ (1 - RW\frac{1}{Z})Y \right\}^{1-\mho}$$

where $RW = W(1+T1)/Q$ is the producer real wage, and $P_q(1+T1) = P(1+T1)/Q$ is the so called *wedge* between the consumer and producer real wage, see Frame C.3.2.

Real-wage wedge and real-exchange rate Since we have already abstracted from an income tax-rate, the real-wage wedge is defined as

$$WEDGE =: \frac{W(1+T1)/Q}{W/P} = P(1+T1)/Q = P_q(1+T1)$$

where P_q is the relative price $P_q = \frac{P}{Q}$ as defined in the main-text.
P_q is in many ways the most interesting component of the wedge, because it is an endogenous variable in a macro model. Specifically, in the model we develop, P_q becomes proportional to the relative price between the domestic products and the price of imports denominated in domestic currency. Hence P_q is interpretable as a *real-exchange rate variable* (assuming that import prices in foreign currency is proportional to the price level abroad).

Note that, unlike many (standard) expositions of the so called bargaining approach to wage modelling, for example Layard et al. (1991, Chapter 7), there is no aggregate labour demand function—employment as a function of the real wage—subsumed in the Nash product. In this we follow Hahn and Solow (1997, Ch. 5.3), who see it as an important point that their theoretical treatment of wage formation is consistent with the fact that actual wage bargaining is usually over the nominal wage, and not over real-wages, let alone over employment.

In the following, we therefore define (industry) output Y to be a parameter in the Nash-product. The interpretation is that in the Norwegian system of wage setting, with collective bargaining as a mainstay, there exists a social contract (mutal understanding, respect and trust) where unions and employer confederations take the responsibility for regulation of the overall wage level, while demand management (and therefore the fixing of Y) is the responsibility of the government and the central bank. Although obviously simplified (one might say 'rose painted'), this characteristic nevertheless resounds well with the political and institutional set-up in Norway. Even OECD economists, so often sceptical towards collective bargaining and concerned about reduced labour market flexibility, now see things differently, for Norway.

> Rather than wages being determined by the relative bargaining strength of different sectors, the general wage level is set by the social partners first considering the wage increases that the traditional sector can "afford".[6]

[6]OECD (2012, p. 15)

Summing up our assumptions, and in particular with P_q , $\bar{W}$, U and Y regarded as parameters, maximizing $\mathcal{N}$ with respect to W is the same as maximizing with respect to RW. As noted, the economic interpretation we want to make is that the solution for the real-wage, represents the target (or norm) for the real-wage that the parties can reasonably agree on.

The first order condition for a maximum is given by setting the partial derivative of the log of the Nash-product with respect to RW to zero. Hence it is $\updownarrow\backslash(\mathcal{N})_{RW} = 0$ or:

$$\mho \frac{V'_W(\frac{RW}{P_q(1+T1)}, U, A_\nu)}{V(\frac{RW}{P_q(1+T1)}, U, A_\nu) - V_0(\frac{\bar{W}}{P}, U)} = (1-\mho)\frac{\frac{1}{Z}}{(1 - RW\frac{1}{Z})}. \tag{C.4}$$

In a symmetric equilibrium, $W = \bar{W}$, leading to $\frac{RW}{P_q(1+T1)} = \frac{\bar{W}}{P}$ in equation (C.4), the aggregate bargained real wage RW^b is defined implicitly as

$$RW^b = F(P_q(1+T1), Z, \mho, U), \tag{C.5}$$

or, using the definition

$$RW^b \equiv W^b(1+T1)/Q$$

we obtain the solution for the bargained nominal wage:

$$W^b = \frac{Q}{(1+T1)} F(P_q(1+T1), Z, U, \mho) \tag{C.6}$$

Equation (C.6) gives a framework for thinking about the arguments in a wage-norm generating function. That function's arguments include several main wage determining factors that are known from empirical studies of real world wage bargaining (see e.g., Forder (2014, Ch. 1.4)):

- Factors that influence profitability, namely productivity Z and the product price Q (as well as the payroll tax rate $T1$)
- The cost of living, through the wedge variable $P_q = P/Q$
- Indicators of labour market pressure, represented by U
- Relative bargaining power, as formally captured by the parameter $\mho$

Missing from the list is a relative wags, or a reference wage, as some conception of fairness of the wage always seem to be important in reaching an agreement, cf e.g. Solow (1990, Ch.1). Another important dimension that sinks below the horizon if we focus too closely on the Nash-solution, has to do with compromise and co-operation, as mentioned above.

To incorporate these important elements we could use the trick of postulating that a certain fraction of the wage-settlements reflect "hard-bargains", that are captured by the Nash-solution, and that another fraction reflects the emergence of cooperation as dominant strategy.[7] But we will not do that. Instead we will interpret a linarized version of (C.6) somewhat more loosely, than as a strict Nash-solution.

[7]Forming a linear combination of theories that by themselves are incomplete or unrealistic, is as old as the hills. For example: supplementing the consumption Euler-equation with consumption due to 'rule-of-thumb' behaving credit constrained households, or creating a 'hybrid New Keynesian Phillips Curve' by combining forward-looking price setters with backward-looking ones.

Letting lower-case latin letters denote logs of variables, the linearized equation for the wage-norm defined by (C.6) becomes: (C.6), gives:

$$w^b = m_w + q + (1 - \delta_{12})(p - q) + \delta_{13}z - \delta_{15}u - \delta_{16}T1. \tag{C.7}$$
$$0 \leq \delta_{12} \leq 1,\ 0 < \delta_{13} \leq 1,\ \delta_{15} \geq 0, \quad 0 \leq \delta_{16} \leq 1.$$

As noted, we open up to different interpretations of this equations. The constant term m_w, we interpret as a parameter that depends on bargaining power (as in the narrow interpretation), wage-setting institutions and the degree of coordination in wage formation, see Nymoen and Sparrman (2015)).

Below, when we get to the specification of the econometric model, we will see that the constant term m_w is interpretable as the mean of a long-run cointegrating equation for the wage level. Hence, also in an econometric interpretation, the parameters $\delta_1 j$ $(j = 2, 3, 5, 6)$ are long-run elasticities. [8]

The elasticity of the product price is set to one. Together with the relative price $(p-w)$, with elasticity $(1-\delta_{12})$ this secures that the equation that defines the long-run wage-norm is homogeneous of degree one. δ_{13} is the elasticity of the bargained wage with respect to a permanent change in labour productivity. An appealing restriction on this parameter, both in terms of economic theory and in term of econometric modelling (see below) is to set $\delta_{13} = 1$, see Nymoen (1989a,b). This restriction implies that the "profit-argument" in the wage function simply becomes $q + z$, which is often referred to as the (wage) *scope* variable.

We also need to comment on the wedge elasticity $(1 - \delta_{12})$, since, even though few would doubt that cost-of-living considerations are important in the process of reaching real-world wage agreements, the role if the real-wage wedge in a long-run equation like (C.6) is contested in the literature. In part, this is because theory (of the type we have used in this sub-chapter) fails to produce general implications about the wedge coefficient $(1-\delta_{12})$—it can be shown to depend on the specification of the utility function V and V_0 above (see, for example Rødseth (2000, Ch. 8.) for and exposition).

As can be seen in the line below (C.6), we restrict $(1-\delta_{12})$ to be non-negative and stricty less than one. This runs against the formal theoretical analysis in Forslund et al. (2008), stating that there can be no wedge effect in a model where the unions has bargaining power.[9] At one level, this result is an example of the point mentioned above, that from a carefully formulated theory, the 'no wedge' result can follow. However, the relevance of that degree of specificity is not so clear. In any case there seem to be little reason to impose $(1 - \delta_{12}) = 0$ without trying to test that restriction. When one estimate a long-run equation for wages in the traded goods sector (the part of the product market most exposed to foreign competition), it is not uncommon to find that the wedge coefficient can be set to zero after testing. This conforms with the common view that in these sectors, profitability and productivity are measured and observed at the plant and industry level, and the scope variable may then become the only telling long-run determinant of the wage level.

Hence, in econometric models of wage setting in manufacturing, the hypothesis of $\delta_{12} = 1$, is typically not rejected statistically. This means that the wedge variable can be omitted, supporting the view that the target nominal wage is linked one-to-one with the scope variable $q + z$ see e.g., Johansen (1995a) (Norway) and Nymoen and Rødseth (2003) (Nordic countries).

[8] The first subscript 1 is used to indicate that they are parameters in the first equation in the a two equation wage-price system. Using two subscripts may seem cumbersome at first, but they help keep track of the several re-parameterization of the model that we review below.

[9] See e.g. Forslund et al. (2008, Proposition 1)

However, in the sheltered sectors of the economy, negotiated wages may be linked to the general domestic prices level, and this may explain why econometric testing of the $(1-\delta_{12}) = 0$ is usually rejected when the aggregation level of the econometric analysis is higher.[10]

The impact of the rate of unemployment on the bargained wage is given by the elasticity $-\delta_{15} \leq 0$. Blanchflower and Oswald (1994) provided evidence for the existence an empirical law, stating that the value of $-\delta_{15}$, the slope coefficient of their *wage-curve*, is 0.1 more or less everywhere. Other authors have instead maintained that the slope of the wage-curve is likely to depend on the level of aggregation and on institutional factors. For example, one influential view holds that economies with a high level of coordination and centralization is expected to be characterized with a higher responsiveness to unemployment (a higher $-\delta_{15}$) than uncoordinated systems that give little incentive to solidarity in wage bargaining, Layard et al. (2005, Ch. 8). Finally, from the definition of the wedge, one could set $\delta_{16} = \delta_{12}$ but we keep δ_{16} as a separate coefficient to allow for partial effects of the payroll tax on wages.

As noted above, equation (C.7) is a general proposition about the negotiated intended wage. When the agreement is at the confederate level, we can speak of it as a wage-norm. It can serve as a starting point for describing wage formation in any sector or level of aggregation of the economy. In following we regard equation (C.7) as a model of the average wage in the total economy, and as explained above we therefore expect $(1 - \delta_{12}) > 0$, meaning that there is a wedge effect in the long-run wage equation.

That was a lot about the formulation and interpretation of a theory of the long-run wage. We now return to the long-run price equation, namely equation (C.2) which represents a price setting rule which is consistent with so called normal cost pricing. This hypothesis states that any procyclical fluctuations in the mark-up of prices over actual unit costs are merely side effects of fluctuations in productivity, cf. Barker and Peterson (1987, Ch. 13.5). Upon linearization we have:

$$q^f = m_q + (w + T1 - z) \tag{C.8}$$

where we use q^f as a reminder that this is a theoretical equation for firms' optimal price-setting.

C.3.3 NAIRU

Influential contributions like Layard et al. (1994) and Nickell et al. (2005) have made use of a two-equation system like (C.7) and (C.8) to argue that the equilibrium rate of unemployment is uniquely determined from the wage and price setting, i.e., the supply side of the model.

The main argument is easily (re)constructed by noting that $(w^b - q)$ from (C.7) can be written as

$$(w^b - q) = m_w + (1 - \delta_{12})(p - q) + \delta_{13} z - \delta_{15} u - \delta_{16} T1, \tag{C.9}$$

and $(w - q^f)$ from (C.8) can be written as

$$(w - q^f) = -m_q - (T1 - z) \tag{C.10}$$

Following our interpretation of the Nash real-wage, (C.9) represents the common real-wage norm coming out of the negotiations. Equation (C.8) on the other hand

[10] As will be shown in a later sub-chapter, the dynamic stability of the wage-share and the relative price of imports hinges on the long-run wedge coefficient.

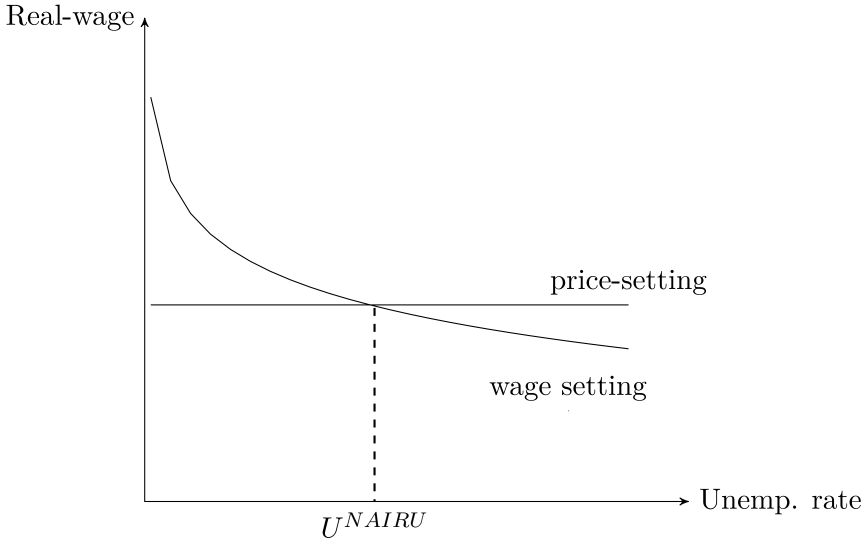


Figure C.1: Wage and price formation with a unique NAIRU.

gives the unilateral firm side real-wage target. Without further assumptions, the two real wage targets are not equal. In fact, we have no less than four endogenous variables: $(w - q^f)$, $(w^b - q)$, $(p - q)$ and u, but only two equations. The model is "under-determined". However, at this point a heuristical argument is invoked, saying that a medium-run equilibrium requires that the two wage rates to be identical. Assuming

$$(w^b - q) = (w - q^f) = (w - q)^{NAIRU} \tag{C.11}$$

will then let us solve the two equations for the NAIRU-rate of unemployment, u^{NAIRU}. As already noted, NAIRU which is acronym for the Non Accelerating Inflation Rate of Unemployment. The graphical representation is given in Figure C.1.

Equation (C.9) is the downward sloping curve labelled wage setting in Figure C.1, while (C.10) is the horizontal line named price-setting. The variables are assumed to be measured in their original units in the graphs, which is why the wage-setting curve is convex. Looking back at (C.9) and (C.10) we note that there are (still) three variables $(w - q)$, u and $(p - q)$ but only two equations. In the graph, this means that the position of the wage-curve (not the slope) will change whenever there is a movement in $p - q$. Hence, the solution for unemployment is not unique unless the wedge variable $(p - q)$ is determined from outside, for example by assuming that it is determined by a requirement about current-account balance.

Another problem with this model is that it is static. It can therefore have no implications about how wages and prices evolve outside the equilibrium. However, to make up for this weakness, the framework is backed-up by the mentioned heuristics which (in addition to the two real-wage targets must be equal) states that inflation will be non-constant (hence outside equilibrium and 'dynamic') in periods when $U_t \neq U^{NAIRU}$. As discussed by Kolsrud and Nymoen (2015), who look critically on the NAIRU-heuristics, it may have come to put too much weight *one* equilibrating mechanism, namely unemployment variations, and that there may be other adjustments processes that are also consistent with the long-run wage setting and price setting schedules.

However, all these problems can be resolved if we move from a static framework, to a genuinely dynamic model of wage and price formation. In doing so, we do not need to throw away anything of the above, about the economic theory of wage and price setting. Instead, we re-interpret them as hypotheses about identified long-run cointegrating equation, and next formulate dynamics that are logically consistent with those equations.

C.4 Cointegration and long-run identification

We first show how the two theoretical relationships (C.7) and (C.8) can be transformed into hypothesized relationships between observable time series. As noted above, our maintained modelling assumption is that the real-wage and productivity are $I(1)$ series. The rate of unemployment is assumed to be $I(0)$, possibly after removal of deterministic shifts in the mean.

Using subscript t to indicate period t variables, equation (C.7) defines w_t^b as an $I(1)$ variable. Next define:

$$ecm_t^b = rw_t - rw_t^b \equiv w_t - w_t^b.$$

Under the null-hypothesis that the theory is correct, the 'bargained wage' w_t^b cointegrates with the actual wage, hence $ecm_t^b \sim I\,(0)$, which is a testable hypothesis. We can write the long-run wage equation following from bargaining theory as:

$$w_t = m_w + q_t + (1-\delta_{12})\,(p_t - q_t) + \delta_{13} z_t - \delta_{15} u_t - \delta_{16} T1_t \; + ecm_t^b. \tag{C.12}$$

With reference to equation (C.8), a similar argument applies to price setting. The 'firm side' real wage can be defined as

$$rw_t^f \equiv w_t + T1_t - q_t^f = -m_q + z_t,$$

and the difference between the actual real wage and the real wage implied by price setting becomes

$$ecm_t^f = rw_t - rw_t^f = w_t + T1_t - q_t - \{-m_q + z_t\}.$$

Hence, the implied long–run price setting equation becomes

$$q_t = m_q + (w_t + T1_t - z_t) - ecm_t^f \tag{C.13}$$

where $ecm_t^f \sim I\,(0)$ for the equation to be consistent with the modelling assumptions.

The two cointegrating relationships (C.12) and (C.13) are not identified in general. But in several cases of relevance, identification is quite credible, see Bårdsen et al. (2005, p. 81). An one example, we consider a case which is relevant for an aggregated model of the supply side in an open economy. Equation (C.12) and (C.13) can then be combined with a definition of the consumer price index p_t,

$$p_t = (1-\zeta)\,q_t + \zeta pi_t + \eta T3_t,\; 0 < \zeta < 1, \quad 0 < \eta \leq 1, \tag{C.14}$$

where the import price index pi_t naturally enters. The parameter ζ reflects the openness of the economy.[11] Also, the size of the parameter η will depend on how much of the retail price basket is covered by the indirect tax-rate index $T3_t$. By substitution of (C.14) in (C.12), and of (C.13) in (C.14), the system can be specified in terms of w_t and p_t:

$$\begin{aligned} w_t = m_w + \left\{1 + \zeta\frac{\delta_{12}}{(1-\zeta)}\right\} p_t \qquad\qquad (C.15) \\ - \frac{\delta_{12}\zeta}{(1-\zeta)} pi_t - \frac{\delta_{12}\eta}{(1-\zeta)} T3_t + \delta_{13} z_t - \delta_{15} u_t - \delta_{16} T1_t \; + ecm_t^b \end{aligned}$$

[11] Note that, due to the log-form, $\zeta = is/(1-is)$ where is the import share in private consumption.

$$p_t = (1-\zeta)m_q + (1-\zeta)\left\{w_t + T1_t - z_t\right\} + \zeta pi_t + \eta T3_t - (1-\zeta)ecm_t^f \quad \text{(C.16)}$$

By simply viewing (C.15) and (C.16) as a pair of simultaneous equations, it is clear that the system is unidentified in general. However, for the purpose of modelling the aggregate economy, we choose the consumer price index p_t as the representative domestic price index by setting $\delta_{12} = 0$. In this case, (C.16) is unaltered, while the wage equation becomes

$$w_t = m_w + p_t + \delta_{13} z_t - \delta_{15} u_t - \delta_{16} T1_t + ecm_t^b \quad \text{(C.17)}$$

The long-run price equation (C.16) and the long-run wage equation (C.17) are identified by the order condition.

C.5 VAR and identified equilibrium correction system

The third stage in the operationalization is the equilibrium-correction system, where we follow Bårdsen and Fisher (1999). In brief, we allow wage growth Δw_t to interact with current and past price inflation, changes in unemployment, changes in tax-rates, and previous deviations from the desired wage level consistent with (C.17)

$$\begin{aligned}\Delta w_t - \alpha_{12,0}\Delta q_t = c_1 &+ \alpha_{11}(L)\Delta w_t + \alpha_{12}(L)\Delta q_t + \beta_{12}(L)\Delta z_t \\ &- \beta_{14}(L)\Delta u_t - \beta_{15}(L)\Delta T1_t \\ &- \gamma_{11} ecm_{t-r}^b + \beta_{18}(L)\Delta p_t + \epsilon_{1t},\end{aligned} \quad \text{(C.18)}$$

where Δ is the difference operator, the $\alpha_{1j}(L)$ and $\beta_{1j}(L)$ are polynomials in the lag operator L:

$$\begin{aligned}\alpha_{1j}(L) &= \alpha_{1j,1}L + \cdots + \alpha_{1j,(r-1)}L^{r-1},\ j = 1,2,\\ \beta_{1j}(L) &= \beta_{1j,0} + \beta_{1j,1}L + \cdots + \beta_{1j,(r-1)}L^{r-1},\ j = 2,4,5,6.\end{aligned}$$

The $\beta-$polynomials are defined so that they can contain contemporaneous effects. The order r of the lag polynomials may of course vary between variables and is to be determined empirically.

In the case where $\gamma_{11} < 0$, this formulation is an equilibrium correction model, known as ECM, for nominal wages, see Sargan (1964) and e.g., Nymoen (1991). The Phillips-curve version of wage dynamics, which for a long period of time become the American version of wage dynamics modelling, is derived by setting $\gamma_{11} = 0$—see Blanchard and Katz (1999).[12]

Although we regard the case of cost functions which are flat over wide intervals for output produced as the main case, it is possible that prices can rise as output rises. Feasible reasons for this include the inflexibility of supply in some markets within a certain time frame and firms exploiting high demand to set higher margins. To allow for such effects we let output above the trend exerts a (lagged) positive pressure on prices, measured by the output gap_t, indeed as in price Phillips-curve inflation models—see Clarida et al. (1999). In addition, product price inflation interacts with wage growth and productivity gains and with changes in the payroll

[12]Strictly speaking, in order to encompass the Phillips curve model, the specification should include the level of unemployment with a coefficient that may be negative in the case where $\gamma_{11} = 0$. However, since the purpose is not to compare different forms of nautl rate dynamics, we have dropped that extra notation.

tax-rate, as well as with corrections from an earlier period's deviation from the equilibrium price (as a consequence of e.g., information lags, see Andersen (1994, Ch. 6.3)):

$$\begin{aligned} \Delta q_t - \alpha_{21,0}\Delta w_t &= c_2 + \alpha_{22}(L)\Delta q_t + \alpha_{21}(L)\Delta w_t + \beta_{21}(L)\, gap_t \\ &- \beta_{22}(L)\Delta z_t + \beta_{25}(L)\Delta T1_t - \gamma_{22} ecm^f_{t-r} + \epsilon_{2t}, \end{aligned} \tag{C.19}$$

where

$$\begin{aligned} \alpha_{2j}(L) &= \alpha_{2j,1}L + \cdots + \alpha_{2j,(r-1)}L^{r-1},\ j = 1, 2, \\ \beta_{2j}(L) &= \beta_{2j,0} + \beta_{2j,1}L \cdots + \beta_{2j,(r-1)}L^{r-1},\ j = 1, 2, 5. \end{aligned}$$

Solving equation (C.14) for Δq_t (i.e., the equation is differenced first), and then substituting out in equations (C.18), and (C.19), the theoretical model condenses to a wage-price model suitable for estimation and similar to the early multiple equation equilibrium-correction formulation of Sargan (1980):

$$\begin{aligned} &\begin{bmatrix} 1 & -a_{12,0} \\ -a_{21,0} & 1 \end{bmatrix} \begin{bmatrix} \Delta w \\ \Delta p \end{bmatrix}_t = \begin{bmatrix} \alpha_{11}(L) & -a_{12}(L) \\ -a_{21}(L) & \alpha_{22}(L) \end{bmatrix} \begin{bmatrix} \Delta w \\ \Delta p \end{bmatrix}_t + \\ &\begin{bmatrix} 0 & \beta_{12}(L) & -\zeta\frac{\alpha_{12}(L)}{1-\zeta} & -\beta_{14}(L) & -\beta_{15}(L) & -\eta\frac{\alpha_{12}(L)}{1-\zeta} \\ b_{21}(L) & -b_{22}(L) & \zeta\alpha_{22}(L) & 0 & b_{25}(L) & \eta\alpha_{22}(L) \end{bmatrix} \begin{bmatrix} gap \\ \Delta z \\ \Delta pi \\ \Delta u \\ \Delta T1 \\ \Delta T3 \end{bmatrix}_t \\ &-\begin{bmatrix} \gamma_{11} & 0 \\ 0 & \gamma_{22} \end{bmatrix} \times \begin{bmatrix} 1 & -(1+\zeta d_{12}) & -\delta_{13} & \zeta d_{12} & \delta_{15} & \delta_{16} & \eta d_{12} \\ -(1-\zeta) & 1 & (1-\zeta) & -\zeta & 0 & -(1-\zeta) & -\eta \end{bmatrix} \begin{bmatrix} w \\ p \\ z \\ pi \\ u \\ T1 \\ T3 \end{bmatrix}_{t-r} \\ &+ \begin{bmatrix} e_1 \\ e_2 \end{bmatrix}_t, \end{aligned} \tag{C.20}$$

where we have omitted the intercepts to save space, and have substituted the equilibrium correction terms using (C.15) and (C.16) above. The mapping from the theoretical parameters in (C.18) and (C.19) to the coefficients of the model (C.20) is given by:

$$\begin{aligned} a_{12,0} &= \frac{\alpha_{12,0}}{1-\zeta} + \beta_{18,0}, \\ a_{21,0} &= (1-\zeta)\,\alpha_{21,0}, \\ a_{12}(L) &= \frac{\alpha_{12}(L)}{1-\zeta} + \beta_{18}(L), \\ a_{21}(L) &= (1-\zeta)\,\alpha_{21}(L), \\ b_{2j}(L) &= (1-\zeta)\,\beta_{2j}(L),\ j = 1, 2, 5, \\ d_{12} &= \frac{\delta_{12}}{1-\zeta}, \\ e_1 &= \epsilon_1, \\ e_2 &= (1-\zeta)\,\epsilon_2. \end{aligned} \tag{C.21}$$

The model (C.20) contains the different channels and sources of inflation discussed so far: Imported inflation Δpi_t, and several relevant domestic variables: the output gap, changes in the rate of unemployment, in productivity, and in tax rates. Finally the model includes deviations from the two cointegration equation associated with wage bargaining and price setting which have equilibrium correction coefficients γ_{11} and γ_{22} respectively. Consistency with assumed cointegration implies that the joint hypothesis of $\gamma_{11} = \gamma_{22} = 0$ can be rejected.

C.6 Economic interpretation of the steady state of the dynamic wage-price model

The dynamic model in (C.20) can be re-written in terms of real wages $(w - p)_t$ and a real exchange rates defined as $(pi - q)_t$, since $(p - q)_t \equiv (1 - \zeta)(pi - q)_t$.

C.6.1 Steady state of the wage-price system

Using a specification with first order dynamics, Bårdsen et al. (2005, Ch. 6) discusses several different aspects of this model. Most importantly, the dynamic system is asymptotically stable under quite general assumptions about the parameters, including for example dynamic homogeneity in the two equilibrium correction equations. The steady state is conditional on any given rate of unemployment, which amounts to saying that our core supply side model does rely on a particular level of the unemployment rate to given a well defined (and stable) steady-state. There is a stalemate in the dynamic "tug-of-war" between workers and firms that occurs for in principle, any given rate of unemployment, see Bårdsen and Nymoen (2003) and Kolsrud and Nymoen (2014) for proofs.

Since there are no new unit root implied by the generalized dynamics in equation (C.20) above, the asymptotic stability holds also for the version of the model with higher order dynamics. We therefore have the following important results: The dynamics of the supply side is asymptotically stable in the usual sense that, if all stochastic shocks are switched off, then $(pi_t - q_t) \rightarrow rex_{ss}(t)$, and $(w_t + T1_t - q_t) \rightarrow wq_{ss}(t)$, where $rex_{ss}(t)$ and $wq_{ss}(t)$ represent deterministic steady state growth paths of the real exchange rate and the producer real wage.

Generally, the steady-state growth paths depend on the steady state growth rate of import prices, and of the mean of the logarithm of the rate of unemployment, denoted u_{ss}, and the expected growth path of productivity $z(t)$. However, under the condition that $\delta_{13} = 1$, homogeneity of degree one with respect to productivity, which we have seen is implied theoretically by assuming bargaining power on the part of unions, $z(t)$ has a zero coefficient in the expression for rex_{ss}, which therefore is constant in the steady state. Moreover, assuming $\delta_{13} = 1$, the implied steady state wage share, $wq_{ss}(t) - z(t) = ws_{ss}$ which also is also a constant in steady state.

With $\delta_{13} = 1$, the implied steady-state inflation rate therefore follows immediately: Since $\Delta(pi_t - q_t) = 0$ in steady state, and $\Delta p_t = (1 - \zeta)\,\Delta q_t + \zeta \Delta pi_t$, domestic inflation is equal to the constant steady state rate of imported inflation,

$$\Delta p_t = \Delta pi_t = \pi. \tag{C.22}$$

The above implicitly assumes an exogenous, and for simplicity, constant, nominal exchange rate. For the case of of a floating exchange rate it might be noted that since

$$pi_t = e_t + pf_t,$$

where e_t is the logarithm og the nominal exchange rate, and the logarithm of index of import prices in foreign currency is denoted pf_t, the stability of inflation requires stability of Δe_t. This condition can easily be verified if the floating nominal exchange rate follows a random-walk process, e.g., $e_t = e_{t-1} +$ *drift* + *shock* where drift is a parameter (possibly, but not necessarily zero), and *shock* is a random variable with mean zero. Hence, an unstable nominal exchange rate level (customarily associated with freely floating exchange rate) does logically imply that the dynamic system of wq_t and rex_t becomes unstable. Nor nor does it imply unstable dynamics for the Δw_t, Δq_t and Δp_t.

It is only if Δe_t becomes an unstable process (due to endogenous responses) that the model of wage and price setting can become dynamically unstable. Hence the specification of the model for the market for foreign exchange, and how it interact with the rest of the model, is going to be an important step in the assessment of total model properties. In practice however, this is easily done by dynamic simulation of the complete NAM model.

C.6.2 The NAIRU revisited

The supply-side determined steady state has a wider relevance as well. For example, what does the model tell about the dictum, illustrated in Figure C.1 that the existence of a steady state inflation rate requires that the rate of unemployment follows the law of the natural rate or NAIRU?

As noted aboce, the version of this natural rate/NAIRU view of the supply side that fits most easily into our framework is the one succinctly expressed by Layard et al. (1994)

> 'Only if the real wage (W/P) desired by wage-setters is the same as that desired by price setters will inflation be stable. *And, the variable that brings about this consistency is the level of unemployment*'.[13]

Translated to our conceptual framework, this view corresponds to setting $ecm_t^b = ecm_t^f = 0$ in (C.12) and (C.13), with $\delta_{13} = 1$, and solving for the rate of unemployment that reconciles the two desired wage shares, call it u^{NAIRU} [14]

$$u^{NAIRU} = \frac{m_w + m_q}{-\delta_{15}} + \frac{1-\delta_{12}}{-\delta_{15}}(p-q) + \frac{1-\delta_{16}}{-\delta_{15}}T1,$$

which can be expressed in terms of the real exchange rate $(p - pi)$, and the two tax rates as:

$$u^{NAIRU} = \frac{-(m_w + m_q)}{\delta_{15}} + \frac{1-\delta_{12}}{\delta_{15}(1-\zeta)}\zeta(p-pi) + \frac{1-\delta_{12}}{\delta_{15}(1-\zeta)}\eta T3 + \frac{1-\delta_{16}}{-\delta_{15}}T1 \quad \text{(C.23)}$$

This is one equation in two endogenous variables, u^{NAIRU} and the wedge $(p - pi)$, so it appears that there is a continuum of u^{NAIRU} values depending on the size of the wedge, in particular of the value of the real exchange rate. It is however custom to assume that the equilibrium value of the wedge is determined by the requirement that the current account is in balance in the long run. Having thus pinned down the long run wedge as a constant equilibrium real exchange rate $\overline{(p-pi)}$, it follows that NAIRU u^{NAIRU} is determined by (C.23). If the effect of the wedge on wage claims is not really a long run phenomenon then $\delta_{12} = 1$ and u^w is uniquely determined

[13] Layard et al. (1994, p 18), authors' italics.

[14] Strictly, we take the expectation through in both equations.

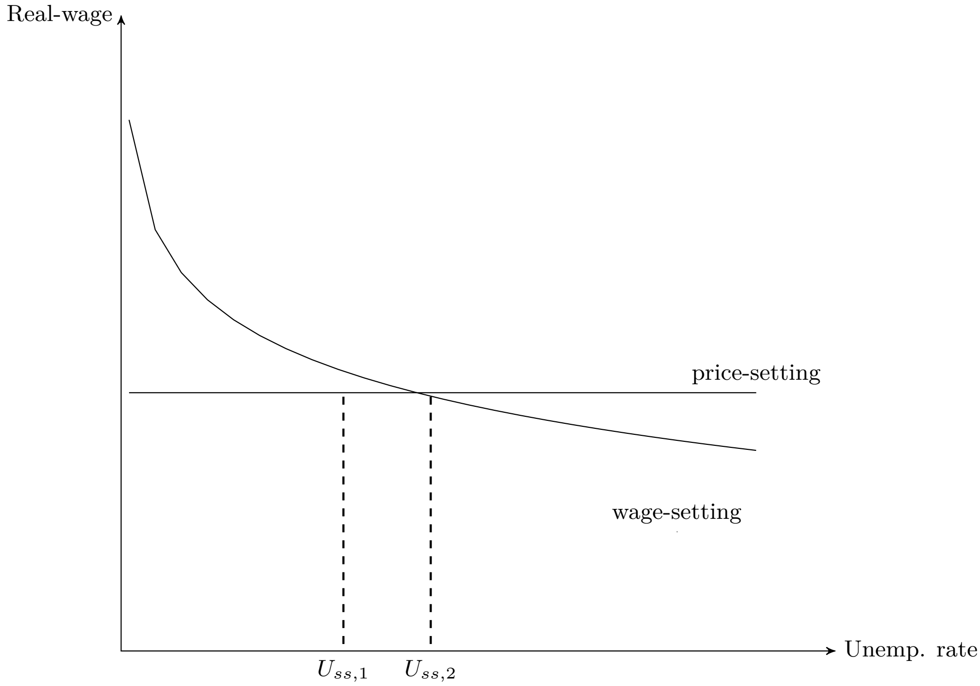


Figure C.2: Wage and price formation when there is no unique NAIRU, the case in NAM.

from (C.23), and there is no need for the extra condition about balanced trade in the long-run, see Layard et al. (2005, p. 33).

The last paragraph reminds us of the static model of the NAIRU rate of unemployment in sub-chapter C.3.3 above. In fact, the expression for u^{NAIRU} in (C.23) will indeed be identical to the expression for the NAIRU we noted could be obtained as the solution to the two static equations (C.9) and (C.10), and which we referred to as U^{NAIRU} in Figure C.1. Hence, Figure C.1 is consistent with a (very) *special case* of the dynamic model of wage and price setting.

Compare this to the asymptotically stable equilibrium consisting of $u_t = u_{ss}, \Delta p_t = \pi$ and $w_t + T1 - q_t - z_t = ws_{ss}$. Clearly, inflation is stable, even though u_{ss} is determined 'from the outside', and is not determined by the wage-and price-setting equations of the model. Hence the (emphasized) second sentence in the above quotation has been disproved: It is not necessary that u_{ss} corresponds to the NAIRU u^{NAIRU} in equation (C.23) for inflation to be stable with a well defined value in steady state.

Bårdsen et al. (2005, Ch 6) show which restrictions on the parameters of the system (C.20) that are necessary for $u_t \to u_{ss} = u^{NAIRU}$ to be an implication, so that the NAIRU corresponds to the stable steady state. In brief, the model must be restricted in such a way that the nominal wage and price setting adjustment equations become two conflicting dynamic equations for the real wage. Because of the openness of the economy, this is not achieved by imposing dynamic homogeneity. What is required is to purge the model (C.20) of all nominal rigidity, which is unrealistic on the basis of both macro and micro evidence.

As the estimation results will show, the strict form of dynamic homogeneity is not supported by the data used to estimate NAM, which is why we in Figure C.2 refer to the case of non-unique NAIRU as "the case in NAM". In Figure C.2 we use the same price-setting and wage-setting curves as in Figure C.1, but they are now interpreted as long-run cointegrating relationships, that are consistent with for example one steady-state rate of unemployment at $U_{ss,1}$, and another one at $U_{ss,2}$. In this model, variables that affect aggregate demand relatively directly, both foreign and domestic, can be among the determinants of the steady-state rate of unemployment, which also will depend on the efficiency of labour market institutions.

We have seen that the Layard-Nickell version of the NAIRU concept corresponds to a set of restrictions on the dynamic ICM model of wage and price setting. The same is true for the natural rate of unemployment associated with a vertical Phillips Curve Model, which we denote PCM.

This is most easily seen by considering a version of (C.18) with first order dynamics and where we abstract form short-run effects of productivity, taxes and unemployment ($\beta_{12} = \beta_{14} = \beta_{15} = 0$). With first order dynamics we have:

$$\Delta w_t - \alpha_{12,0}\Delta q_t = c_1 - \gamma_{11} ecm^b_{t-1} + \beta_{18}\Delta p_t + \epsilon_{1t},$$

and using (C.12) we can then write the wage equation as:

$$\begin{aligned}\Delta w_t = {} & k_w + \alpha_{12,0}\Delta q_t + \beta_{18}\Delta p_t - \mu_w u_{t-1} \\ & - \gamma_{11}(w_{t-1} - q_{t-1}) + \gamma_{11}(1-\delta_{12})(p_{t-1} - q_{t-1}) + \gamma_{11}\delta_{16}T1_{t-1} + \epsilon_{1t}\end{aligned} \tag{C.24}$$

where $k_w = c_1 + \gamma_{11} m_w$, and the parameter μ_w is defined in accordance with Kolsrud and Nymoen (1998,2014) as:

$$\mu_w = \gamma_{11}\delta_{15} \text{ when } \gamma_{11} > 0 \text{ or } \mu_w = \varphi \text{ when } \gamma_{11} = 0. \tag{C.25}$$

The notation in (C.25) may seem cumbersome at first sight, but it is required to secure internal consistency: Note that if the nominal wage rate is adjusting towards the long run wage curve, $\gamma_{11} > 0$, the only logical value of for φ in (C.25) is zero, since u_{t-1} is already contained in the equation, with coefficient $\gamma_{11}\delta_{13}$. Conversely, if $\gamma_{11} = 0$, so the the model of collective wage bargaining fails, it is nevertheless possible that there is a wage Phillips curve relationship, consistent with the assumed $I(0)$-ness of the rate of unemployment, hence $\mu_w = \varphi \geq 0$ in this case.

Subject to the restriction $\gamma_{11} = 0$, and assuming an asymptotically stable steady state inflation rate π, (C.24) can be solved for the Phillips-curve NAIRU u^{phil}:

$$u^{phil} = \frac{k_w}{\varphi} + \frac{(\alpha_{12,0} + \beta_{18} - 1)}{\varphi}\pi$$

which becomes a natural rate of unemployment, independent of inflation subject to dynamic homogeneity $\alpha_{12,0} + \beta_{18} = 1$.

However, the claim that u_t^{phil} represents an asymptotically stable solution must be stated with some care. As shown in e.g., Bårdsen and Nymoen (2003) $\gamma_{11} = 0$ is a necessary but not a sufficient condition. The sufficient conditions include $\gamma_{22} = 0$ in addition to $\gamma_{11} = 0$ and instead of equilibrium correction in wages and prices, dynamic stability requires equilibrium correction in the unemployment equation or in a functionally equivalent part of the model. A main lesson is that dynamic stability or lack thereof, is a genuine system property. Sources of instability in one part of the system can be compensated by stabilization in another part, and vice versa. A relatively complete discussion of the dynamic properties of the ICM and PCM versions of wage and price setting systems like ours, is found in Kolsrud and Nymoen (2014).

Returning to Figure C.2, if we assume that $U_{ss,1}$ represents an initial steady state situation, and $U_{ss,2}$ represents a new steady state after a shock, there must be a dynamic process that connects the two steady-states. Hence we must imagine

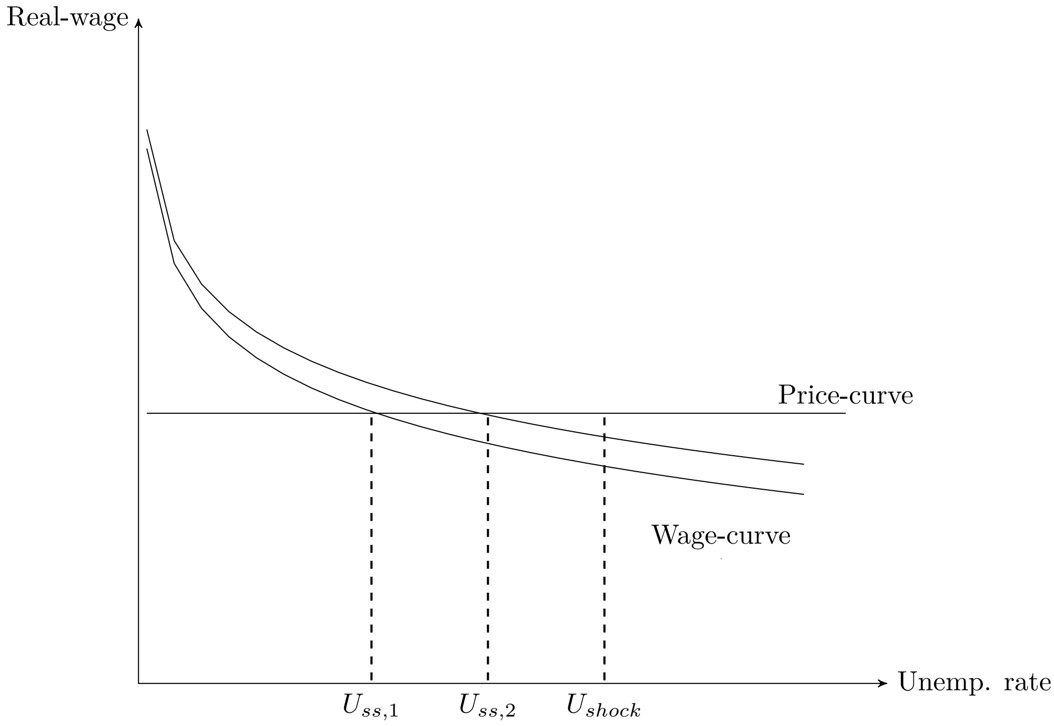


Figure C.3: Initial stationary situation in $U_{ss,1}$. After a shock to the product market, or the financial market, the economy is at U_{shock}. $U_{ss,2}$ indicates a new stationary state

that the wage-setting curve drifts way from its initial position, finally reaching its new stationary position after an adjustment period.

Figure C.3 illustrates a scenario where unemployment increases from $U_{ss,1}$ to U_{shock} because if a large shock to the economy. The labour market, and wage and price setting in particular is in disequilibrium, and a dynamic adjustment process begins. In a new steady-state situation, the wage-curve has become aligned to the steady state $U_{ss,2}$.

What is the mechanism that drives the adjustment of the wage-curve? As discussed by several authors, a plausible candidate is that a real depreciation of the exchange rate takes place. This is also the case in NAM, and in the next sub-chapter we give a demonstration of this point, by the use of a stylized model that can be solved by simulation to clarify the dynamic properties.

C.7 A simulation example

Even tough it is important theoretically that the "wage and price spiral" can be dynamically stable for a targeted fixed rate of unemployment, it also means that unemployment cannot in general be determined from the supply side, by only using the equations that represent the model of wage and price setting. In order to endogenize the rate of unemployment we clearly need to extend the dynamic wage-price system. In order to illustrate the properties of this system we calibrate the wage-price system of the in the last sub-chapter with values that are consistent with conditional dynamic stability. Hence we simulate the (stable case) of ICM version of the supply side model above.[15] The only change we make in the wage-price model is that we, for simplicity, let the long-run wage norm equation depend on the rate of unemployment rather than the log of unemployment.

As noted above, one implication of monopolistic competition is that production and aggregate GDP will become closely correlated with the factors that influence aggregate demand. As a consequence, those factors will also influence employment and unemployment. More generally, this principle is called Okun's law, and it is useful in expositions like ours since it allows us to write the aggregate demand (AD) relationship either in terms of "GDP from trend", or in terms of the unemployment rate (U_t).

A simple dynamic relationship between U_t and the log of the real exchange rate, which we denote rex_t in the simulation, is given by

$$U_t = c_u + \alpha U_{t-1} - \rho rex_{t-1} + \epsilon_{u,t}, \;\; \rho \geqq 0, -1 < \alpha < 1, \tag{C.26}$$

In the same way as above, rex_t is defined such that an increase in this variable leads to improved competitiveness. This increases exports and reduces imports so that GDP is positively affected, causing a fall in unemployment, hence $\rho \geqq 0$. The error term $\epsilon_{u,t}$ contains all other variables which might affect U_t.

It is worth stressing that even though NAM is an aggregated model, equation (C.26) omits several facors that are modelled in NAM. One key element is the real interest rate effect, which represents a key channel of monetary policy under inflation targeting. Other features that we omit have to do with the medium term effects of changes in labour supply, (e.g., labour immigration), with the degree of friction in the labour market, labour market policies. Despite its simplicity, (C.26) is general enough to serve as a representation when the purpose is to illustrate the qualitative properties of the joint modelling of wage and price setting and the demand side.

To define rex_t in terms of the variables of the wage-price model above, we have:

$$re_t \equiv (1 - \zeta)(pi - q)_t, 0 < \zeta < 1 \tag{C.27}$$

q_t is an endogenous variable by the price setting of domestic producers, while pi_t is represented as a random-walk with drift:

$$pi_t = g_{pi} + pi_{t-1} + \varepsilon_{pit} \tag{C.28}$$

This equation represents a nominal stochastic trend model of the import price.

In the same way as above, we can let pf_t denote the foreign foreign price level in foreign currency, and we let the nominal exchange rate be denoted by e_t. By defining pi_t as $pi_t =: pf_t + e_t$ we see that the random-walk formulation in (C.28) is consistent with assuming that one of, or both of, foreign price pf_t and nominal exchange rate e_t is an integrated series, $I(1)$. It is reasonable to assume that $pf_t \sim I(1)$. If we assume that $e_t \sim I(0)$ in a fixed exchange rate regime, while $e_t \sim I(1)$ in a regime with floating exchange rate, we see that the $pi_t \sim I(1)$ is a formulation that is robust to a regime shift in the the exchange rate policy.

For concreteness, we think of (C.28) as a simple model of a system with fully floating nominal exchange rate. In NAM (C.28) is replaced by a separate module of the nominal exchange rate, and an equation for interest rate setting under inflation targeting. Clearly, if the model is stable in real terms with such a naive model of the nominal trend, it is reasonable to assume that it will also be stable when is replaced by (C.28) the more relevant equations found in NAM.

[15]Kolsrud and Nymoen (2014) contains a relatively complete analysis, using both algebra and simulation, of both the ICM and PCM version

Finally, we include a common real trend, for the log of average labour productivity z_t that we have introduced in the theoretical model above.

$$z_t = g_z + z_{t-1} + \varepsilon_{at} \tag{C.29}$$

ε_{at}, and ε_{pit} are assumed to be innovations with zero expectations.

To illustrate the properties of the model, and of a simple one-off estimation of the equilibrium rate,we generate a data set (T=200) for re_t, ws_t, U_t, pi_t, z_t and p_t using parameter values that give dynamic stationarity, and with a single location shift in period 150. The structural disturbances are Gaussian and independent.

We then FIML estimate the structural equations corresponding to the long-run equations in section C.4 and C.5 on a data set that ends in period 160, and simulate the estimated structural form dynamically over a period that starts in period 160 and ends in period 200. The dynamic simulation is stochastic (1000 replications). The average of the solution paths represents the estimated expectations of the endogenous variables. Since we have estimated the true model, the solution converges to the imputed steady-state values of the endogenous variables.

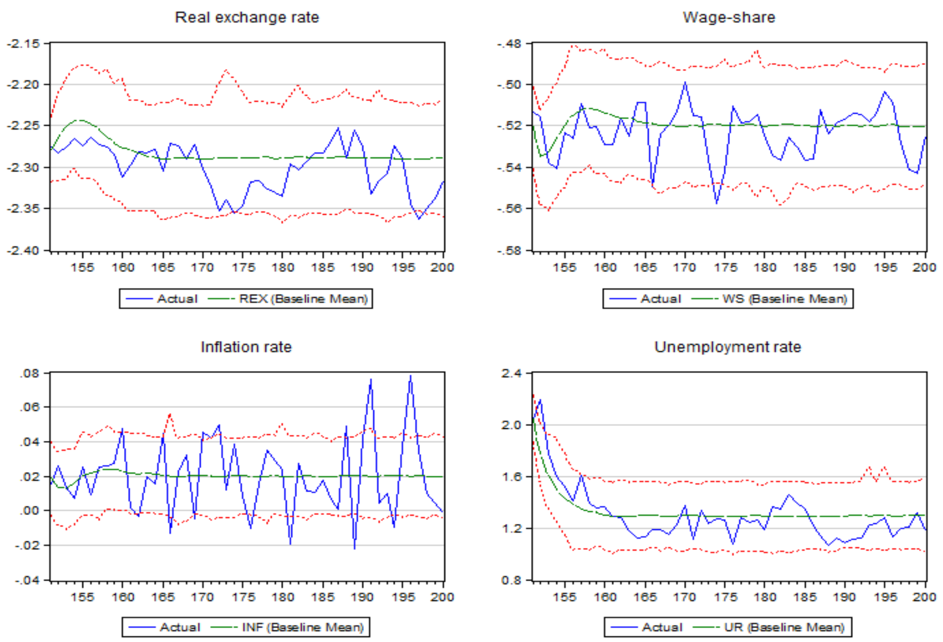


Figure C.4: Dynamic simulation of a wage-price model extended by equation (C.26) for unemployment, using data from a VAR representation and Monte Carlo simulation. Illustrating system stability with respect to a large temporary shock to unemployment in period 151.

The figure contains four panels with blue graphs of the actuals (i.e., the computer generated data) for re_t, ws_t, Δp_t (i.e., inflation) and U_t. The dashed green line is the average of the simulated model solutions. The red dotted lines are upper and lower 95 % prediction intervals around the solution.

The fourth panel shows the solution for the rate of unemployment. The solution starts at a relatively high level, which is a consequence of the imputed shock to unemployment in period 151. The three other graphs shows that there is a reduction of inflation early in the period. Since there is no direct effect of unemployment on prices in the model, the reduction in inflation is due to a reduction in wage growth.

The figure for the wage-share shows a reduction in the beginning of the solution period, hence wage inflation is being more reduced than price inflation.

There is no response in the nominal exchange rate in this model, but the reduction in Δp_t nevertheless less leads to a depreciation of the real exchange rate, which is increased in the first panel in Figure C.4. This is an example of so called internal devaluation.

The stable equilibrium nature of the solutions are evident. The line representing the solution for U_t declines smoothly towards the level stable level of 1.28 % unemployment showing that this is the equilibrium rate U^* for this structure (i.e. for the chosen parameter values). The NAIRU interpretation is also confirmed by the graph for inflation, which show a constant expectation, hence the price level is non-accelerating at the stable rate of unemployment, (NAIRU is 1.28 %). The wage-share graph is interesting since it shows a cyclical approach towards the steady-state level.

There are no structural breaks after period 151, so when two actuals for inflation are significantly outside the prediction interval, they are the result of tail-observations ("black swans"), and are not the result of location shifts.

Figure C.5: Dynamic simulation of a wage-price model extended by equation (C.26) for unemployment, using data from a VAR representation and Monte- Carlo simulation. Illustrating system stability with respect to a permanent shock to unemployment in period 151

While Figure C.4 is illustrating stability after temporary (though large) shock, one can still question the system's ability to stabilize after a "permanent shock" to the rate of unemployment. In Figure C.5 we therefore show the responses to a permanent shock. Again, we let the shock occur in period 151. We start the simulation in period 130 and the graphs therefore shows a tendency of adjustment toward the low equilibrium with $NAIRU = 1.28$ in the period between the start of the simulation and period 150. In period 151 the shock hits, and unemployment starts a gradual increase towards a new NAIRU of 1.62 % unemployment. As the 'Inflation' graph shows, inflation is constant both at the old and new NAURU level.

The same is case to the wage share.

We note that although there is a temporarily reduction in the wage share after period 151, there is no long-run reduction. The explanation is, as noted above, that the long run producer real-wage is consistent with the price-setting curve, not the wage curve. Finally, note that there seems to be a permanent increase in the real exchange rate. Without this internal devaluation, the increase in the NAIRU level would have been larger.

In this way, the simulation with a shock to unemployment also confirms the graphical analysis in Figure C.3 above, namely that the effects of a large shock is counteracted by a real-exchange rate depreciation. However, while a NAIRU-model would "require" that the deprecation is strong enough to completely offset the long-term effects of the initial shock, the more plausible case is that the cancellation of the shock is more partial.

C.8 Concluding remarks

An noted above, there is little danger in assuming that the main conclusions of our theoretical model continue to hold if we model nominal wage and price setting in more detail, with a norm setting sector (wage-leader) and a wage following sector. The theoretical model of wage formation then applies to the wage leader, which in the case of Norway can be taken to be collective agreement in manufacturing. The wage setting in the rest (and much larger in terms of employment) of the economy is then mainly regulated by the wage relativity to manufacturing.

Simulation of such an extended model, which comes closer to NAM specifications, confirms that the wage-price dynamics is stable for a given rate of unemployment, and that the equilibrium rate of unemployment is therefore only set-determined. If anything stability of the dynamics becomes more robust in the extended model. For example the coefficient of the wedge term can be zero in the wage norm equation without system instability as a necessary consequence.

The theoretical discussion above, was based on the assumption that import prices in foreign currency were exogenous and unresponsive to the Norwegian cost and price level. Hence, in theory, kroner denominated import prices increases by one percent if the nominal exchange rate increases by one percent (a nominal depreciation). However, it is widely remarked that import prices have not fully reflected movements in the exchange rate. For example Naug and Nymoen (1996) and Wolden Bache (2002) who investigated import prices on Norwegian manufactures, estimated that the import price index increased by 0.6 percent if the nominal exchange rate is increased by one percent. In NAM, we find a similar empirical relationship for the (total) price index, indicating that so called "pricing to market" or imperfect exchange rate pass through is a characteristic of wage and price setting.

Allowing for less than full pass-through of exchange rate changes on import prices does not affect the basic analysis of the wage and price setting process that we have given above. The main modification is that nominal wages and prices are "sticky" with respect to exchange rate shocks. The same is the case for the *real* exchange rate since the domestic price level does not fully reflect the movements in the nominal exchange rate.

In order to keep the analysis tractable, we have so far assumed that the nominal exchange rate is not influenced by Norwegian wages or prices, or any other domestic variables like for example interest rates. Realistically speaking, the nominal exchange rate is not completely determined from outside. In Chapter 3.7 we account for how the nominal exchange rate has been modelled in NAM, with reference to the portfolio approach to the foreign exchange market. At this point, it is nevertheless worth pointing out that unless expectations formation about future depreciation are seriously de-stabilising the market, allowing for e.g., an effect of interest rate differentials on the nominal exchange rate will not lead to an unstable domestic wage-price setting process. Instead, it is reasonable that it can be stabilizing.

C.9 Implications for modelling

The result that the steady state level of unemployment is generally undetermined by the wage-price sub-model is a strong case for building larger systems of equations. Conversely, in general no inconsistencies, or issues about overdetermination, arise from enlarging the wage/price setting equations with a separate equation for the rate of unemployment, where demand side variables may enter.

For example, Akram and Nymoen (2009) show how the specification of the supply side, either as a Phillips curve model, PCM, or as incomplete competition model, ICM, given by equation (C.18) and (C.19) above, gains economic significance though the implications of the chosen specification for optimal interest rate setting. And how interest rate setting, affects the real economy mainly trough aggregate demand.

Appendix D

Labour market inactivity rate

As noted in the main text, the population in working age is the variable $BEF1574$. In principle, $BEF1574$ can be divided into those who are active in the labour market B_A and those who are inactive, B_{IA}:

$$BEF1574 = B_A + B_{IA}$$

If we let B_A be defined by:

$$B_A = N + AKULED,$$

B_{IA} can be defined implicitly by re-writing the identity that defines the NAM variable SYSSRATE:

$$\begin{aligned}\frac{SYSSRATE}{100} &= \frac{N}{N + AKULED + B_{IA}} = \frac{N + AKULED - AKULED}{N + AKULED + B_{IA}} \\ &= \frac{1 - \frac{AKULED}{N+AKULED}}{1 + \frac{B_{IA}}{N+AKULED}}\end{aligned}$$

We can now define:

$$IAR = \frac{B_{IA}}{N + AKULED}$$

as the labour market inactivity rate. It is the ratio between the inactive population and a "labour force" consisting of employment as measured in National accounts and unemployment in the Labour force survey. With the aid of the above defintions it can be found as:

$$IAR = \frac{(1 - (AKULED/(N + AKULED))}{SYSSRATE/100} - 1. \tag{D.1}$$

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