SEÐLABANKI ÍSLANDS

WORKING PAPER

CENTRAL BANK OF ICELAND

No. 41

QMM
A Quarterly Macroeconomic Model of the Icelandic Economy

By

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February 2009

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Also available on the Central Bank of Iceland World Wide Web site (http://www.sedlabanki.is)

ISSN 1028-9445

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A Quarterly Macroeconomic Model of the Icelandic Economy*

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Version 2.0
February 2009

Abstract

This paper documents and describes Version 2.0 of the Quarterly Macroeconomic Model of the Central Bank of Iceland (QMM). QMM and the underlying quarterly database have been under construction since 2001 at the Research and Forecasting Division of the Economics Department at the Bank and was first implemented in the forecasting round for the *Monetary Bulletin* 2006/1 in March 2006. QMM is used by the Bank for forecasting and various policy simulations and therefore plays a key role as an organisational framework for viewing the medium-term future when formulating monetary policy at the Bank. This paper is mainly focused on the short and medium-term properties of QMM. Steady state properties of the model are documented in a paper by Daníelsson (2009).

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Model Overview

1. Introduction to QMM

This paper documents and describes the Quarterly Macroeconomic Model of the Central Bank of Iceland (QMM). QMM and the underlying quarterly database has been under construction since 2001 at the Research and Forecasting Division of the Economics Department at the Bank and was first implemented in the forecasting round for the *Monetary Bulletin* 2006/1 in March 2006. QMM is used by the Bank for forecasting and various policy simulations and therefore plays a key role as an organisational framework for viewing the medium-term future when formulating monetary policy at the Bank.

Those familiar with the models used by the Bank of England will immediately see the likeness of QMM and the Medium-term Macro Model (MTMM) of the Bank of England (1999, 2000).[1] This is no coincidence as the MTMM was extensively used as a role model when constructing the original version of QMM. We would like to thank the Bank of England for making their work public and for their hospitality during a visit to the Bank in February 2001. The Bank of England is, however, in no way responsible for any part of QMM or this paper.

This paper documents Version 2.0 of QMM. The original version was documented in the *Working Paper* no. 32 from December 2006 by Ásgeir Daníelsson, Lúdvík Elíasson, Magnús F. Gudmundsson, Björn A. Hauksson, Ragnhildur Jónsdóttir, Thorvardur T. Ólafsson and Thórarinn G. Pétursson; all past or present staff at the Research and Forecasting Division of the Economics Department of the Central Bank of Iceland. An updated version, Version 1.1, was published on the Bank's homepage in June 2007 by the same authors.[2]

1.1. The role of QMM

QMM's role is to assist the Central Bank of Iceland with analysing the current economic situation, making economic projections, assessing the effects of alternative policies and shocks, evaluating risks, handling uncertainty and communicating both within and outside the Bank. No single model can, however, fulfil all these roles. All models are imperfect as they are unavoidably a simplification of reality. Forecasts at the Central Bank of Iceland are therefore a result of a thorough procedure which involves a combination of judgement and projections from various models. QMM represents the core model of the Central Bank's forecasting system shown in Figure 1.1, which illustrates the relationship between models, judgement, forecasts and policy advice. The functioning of the system is very dependant on having a well-suited core model which can serve as a primary organisational framework to change mechanical model projections and judgement into forecasts and policy advice. In order

[1] Other macroeconomic models that influenced the construction of QMM include the AQM of the Austrian Nationalbank, the MEP of the Central Bank of Chile, Christopher Murphy's Model (MM) and the Swedish Riksbank's BASMOD.

[2] Version 1.1 is available on the the Bank's website (see Section 2.4, pages 13-14 for an overview of the main revisions from Version 1.0): http://www.sedlabanki.is/lisalib/getfile.aspx?itemid=5234.

to fulfil this role the core model must incorporate the Bank's assessments of the most important relationships in the economy and capture the essence of the transmission mechanism of monetary policy. In this respect, QMM marks a significant improvement from previously models used by the Bank.

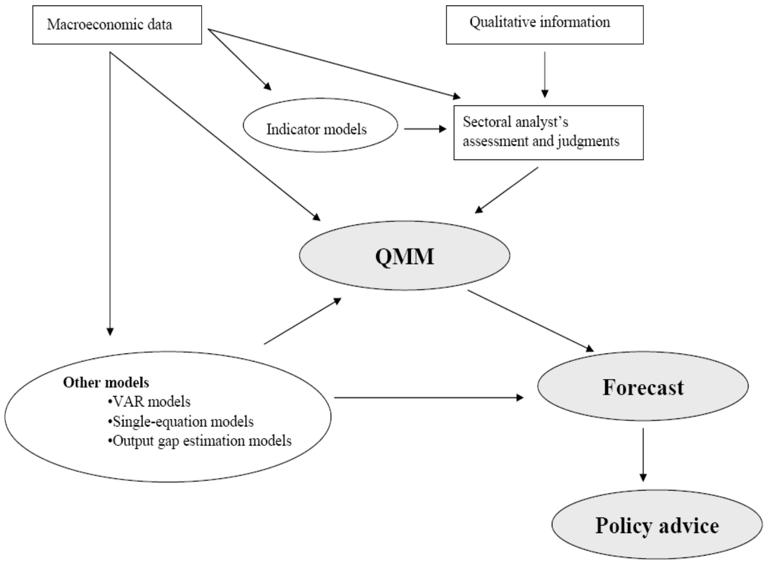


Figure 1.1. Overview of QMM's role in the Central Bank of Iceland's forecasting process

1.2. The structure of the paper

The remainder of this paper is organised as follows. **Chapter 2** gives a short overview of QMM, discussing the demand and supply sides of the model, the nominal and real dichotomy of the model and its dynamic behaviour. Future modelling developments are also discussed. **Chapter 3** discusses the data used in QMM and the general approach to estimation of individual equations of the model.

The second part of the paper describes QMM in detail. **Chapter 4** contains the financial system in the model, describing how interest rates and other asset prices are determined. The demand for money and the definition of household wealth are also described. **Chapter 5** describes the determination of the major demand components, i.e. consumption, investment, stockbuilding and net trade. The chapter concludes with a description of potential output and the output gap. **Chapter 6** describes the labour market in QMM, covering wage determination, labour demand and supply, and unemployment. **Chapter 7** describes price determination and inflation in QMM, covering the implicit price deflators of the national accounts components and other important prices. **Chapter 8** discusses fiscal policy and **Chapter 9** the household income accounts in the model. Finally, **Chapter 10** contains backward looking versions of the forward looking part of the model.

The third part of the paper reports some important model properties. **Chapter 11** discusses how monetary policy works in QMM, highlighting the main transmission channels in the model. The chapter concludes with an illustrative example of the transmission lags and the size of the effects of an unanticipated monetary policy shock. **Chapter 12** continues to analyse the model's properties in terms of a number of other interesting shocks.

The fourth and final part of the paper contains appendices. **Chapter 13** lists all the variables in QMM and cross-references of all variables to each equation they enter. The final chapter, **Chapter 14**, contains a detailed description of the data, its sources and methods used to generate it.

2. Overview of QMM

2.1. The level of aggregation

QMM is a one-sector representation of the Icelandic economy, containing 24 empirically estimated behavioural relations and 83 other equations, such as accounting identities and definitions. Thus, the model contains 107 endogenous variables and adding the 45 exogenous variables, gives a total of 152 variables in the model. This is therefore a medium-sized macroeconomic model with a high level of aggregation, although sufficiently detailed to describe the most important parts of the macrostructure of the Icelandic economy.

This high level of aggregation has many benefits but also some drawbacks. The main benefit is the fact that the model is much easier to manage and understand than older generation macroeconomic models with hundreds or even thousands of variables and equations. This allows concentrating on explaining the interactions of aggregate demand and supply and how that drives inflation, on the one hand, and how monetary policy responds to these developments and affects them, on the other hand. It is therefore no coincidence that the trend in central bank modelling has been to move away from such monstrous models to smaller and better specified ones. The main drawback is, however, the obvious loss of information on the finer details of the economy. However, within the context of doing forecasts and simulations for conducting monetary policy this drawback is generally thought to be small. QMM contains all the key transmission mechanisms of monetary policy and has a standard description of all the main components of aggregate demand and supply and their interactions over the medium and long-run. Thus, information and assumptions on specific prices or sectors of the economy can easily be handled outside the model and fed into QMM in each forecasting round.

2.2. The overall structure of QMM

The model is constructed in such a way as to be consistent with standard macroeconomic theory. This implies, e.g. that the long-run path for the real economy is independent of nominal variables. Hence, QMM displays both nominal neutrality (the long-run real equilibrium is independent of the nominal price level) and inflation neutrality (the long-run real equilibrium is independent of the rate of inflation). The nominal equilibrium is determined by monetary policy which determines the path for nominal prices and the rate of inflation. Finally, QMM displays nominal and real inertia, thus allowing a short-run trade-off between the real economy and inflation.

2.2.1. The supply side

The supply side of QMM is characterised by a constant-returns-to-scale Cobb-Douglas production function with diminishing marginal returns on the factor inputs, labour and capital, plus exogenous technological progress, (5.41).

The constant factor shares property of the Cobb-Douglas production function imposes long-run restrictions on wage developments and capital formation. The marginal product condition with respect to capital gives the capital-output share as a function of the real cost of capital, which imposes a long-run restriction on business investment (5.9). The marginal product condition with respect to labour gives real unit labour costs equal to the constant labour share in value added, which imposes a long-run restriction on wage developments (6.1). Short-run wage developments are given by a Phillips curve relationship, with real unit labour costs determined by deviations of the unemployment rate from its natural rate (NAIRU), deviations of the real exchange rate from its steady state value, a price wedge between output and consumer prices and deviations from the steady state wage share (6.2).

Developments of the unemployment rate in QMM are given by an Okun's type relation between deviations of unemployment from NAIRU and deviations of actual output growth from potential output growth (6.5). Labour supply is determined by an exogenously given population at working age and the participation rate, which is given by a simple dynamic adjustment process with cyclical responses to output growth (6.7). Finally, labour demand is given as a residual series (6.9).

2.2.2. The demand side

The demand side of QMM reflects the open economy nature of the Icelandic economy. Its full detail comes from aggregating the separate expenditure components of GDP:

- In the long-run, private consumption (5.1) is given by real disposable income, real household wealth and the real long-term interest rate, capturing intertemporal substitution effects and interest rate effects on household debt burden. In the short-run (5.2) there are also effects from the unemployment rate, capturing influences of precautionary saving.

- Real government consumption is assumed to be exogenous in QMM. This implies that nominal government consumption is given by real government consumption and the endogenous development of the implicit price deflator for government consumption (5.4).

- Long-run business investment (excluding the aluminium sector and irregular airplane investment), through the standard stock-flow condition (5.8), is consistent with the marginal product condition (5.7) which determines the stock of capital. Short-run fluctuations in business investment (5.10) also display accelerating properties, with output growth affecting investment growth. Total business investment adds the exogenously given aluminium and airplane investment (5.11).

- Residential housing investment (5.14) is given as a function of a Q-type ratio between house prices and the cost of house building, with short-run acceleration-type and real interest rate effects and allowing for asymmetric short-run effects of shocks to house prices and housing investment prices.

- Total fixed investment (5.5) is the sum of business investment, housing investment and exogenous government investment.

- With stockbuilding in the Icelandic national account mainly consisting of marine and aluminium products, inventories (5.21) are given as a simple function of exports of aluminium and marine products.

- Exports of Icelandic goods and services (excluding marine and aluminium products) (5.26) depend on world trade volumes and the real exchange rate. Total exports adds the exogenously given exports of marine and aluminium products (5.27).

- Imports of goods and services (5.30) depend on domestic demand and a measure of the real exchange rate which reflects the price competitiveness of domestic importers. The rising share of imports to domestic demand is modelled as a function of increasing globalisation of trade, proxied as the share of world trade in world GDP.

2.2.3. Nominal variables, inflation and monetary policy

In QMM, the rate of inflation in the long run is tied down by monetary policy. Hence, monetary policy provides the nominal anchor in the model. This again implies that in the long run, inflation is a 'monetary phenomena', i.e. sustained increases in prices cannot occur without excessively loose monetary policy.

In simulations QMM uses a forward-looking Taylor (1993) rule where the short-term interest rate reacts to expected future deviations of inflation from the Central Bank of Iceland inflation target and deviation of actual output from potential output (the output gap), (4.1).[3]

Long-term interest rates are given by the average of the current and expected short-term rates, in line with the expectations hypothesis (4.6), using rational (or model consistent) expectations. Long-term indexed rates (or real rates) are determined by the standard Fisher-relation (4.7).

Since the Central Bank uses the short-term interest rate as its policy instrument, money demand determines the quantity of money in circulation rather than money supply. In QMM, real money holdings (4.28) are given as a function of output, real net

[3] It should be emphasised that this policy rule is not meant to be an exact description of actual policy formulation at the Central Bank of Iceland.

household wealth and the nominal short-term interest rate (the opportunity cost of holding money). It should be noted that this formulation of monetary policy implies that money has no causal role in QMM. However, in the absence of persistent shocks to velocity, the money supply will move in line with nominal output in the long-run nominal equilibrium.

Consumer price inflation is given by a standard expectations-augmented Phillips curve, allowing for temporary real exchange rate and real unit labour cost shocks (7.1). Some price setters are assumed to form their expectations in a forward-looking way using rational (or model consistent) expectations, while the other part of price setters are assumed to model their expectations in a backward-looking manner. The specification imposes dynamic homogeneity to ensure a vertical long-run Phillips curve.

Other prices are determined by mark-up pricing over marginal costs:

- Import prices are given as a function of international prices in domestic currency (non-oil commodity prices, oil prices and world export prices) and a domestic component given by unit labour costs (7.2).
- Export prices (excluding aluminium and marine exports) are given as a function of domestic and international consumer prices (7.3). Aggregate export prices are also influenced by the exogenously given international prices of marine and aluminium goods (7.4).
- The private consumption deflator (7.5) is assumed to grow at the same rate as consumer prices, allowing for different seasonal patterns and different short-run responses to exchange rate shocks due to the slightly different import densities of the two price indices.
- The government consumption deflator (7.6) is assumed to evolve in line with unit labour costs and consumer prices.
- Prices of investment goods are given as a function of building costs and import prices in domestic currency, reflecting the large share of imported capital goods in Iceland (7.7).
- Housing investment costs are assumed to grow in line with general building costs (7.8).
- The government investment deflator evolves in line with general building costs and investment prices (7.9).
- The domestic output deflator is the residual price series and is given as the ratio between nominal and real GDP (7.10).
- Residential house prices are determined by an inverted housing demand function, with real house prices given as a function of the ratio of the housing stock to disposable labour income and the real interest rate (7.12).

- Building costs are given as a function of consumer prices and unit labour costs (7.13).

- The real exchange rate is given by the standard risk-adjusted UIP condition, assuming that some investors form their expectations in a forward-looking way using rational (or model consistent) expectations, while the other part of investors are assumed to model their expectations in a backward-looking manner (4.16). The nominal exchange rate is derived from the standard definition of the real exchange rate (4.10).

2.2.4. Dynamic adjustment

In the long-run, real prices, such as the real exchange rate and the real interest rate, should ensure that in the real long-run equilibrium, aggregate demand grows in line with trend output growth along a balanced growth path, which in turn, is determined by technological progress and available factor supplies. The long-run nominal equilibrium on the other hand is determined by monetary policy.

As discussed above, there is a complete long-run dichotomy between the paths of nominal and real variables. Hence, there is no long-run trade-off between inflation, on the one hand, and unemployment or output, on the other hand. The long-run Phillips curve is vertical and it is impossible to achieve persistently higher output or lower unemployment by tolerating higher inflation.[4]

In the short-to-medium term there is however sluggish adjustment towards the long-run equilibrium. It therefore takes time for the economy to respond to exogenous shocks that move it away from equilibrium.[5] There are two types of inertia:

- Real inertia, where real variables respond sluggishly. This could involve costs of adjusting employment and stock levels. This type of sluggish behaviour is reflected in all the expenditure equations and the labour market in QMM.

- Nominal inertia, where nominal variables respond sluggishly. This could involve prices (price inertia), e.g. due to menu costs, and wages (wage inertia), e.g. due to overlapping wage contracts. The wage-price dynamics in QMM reflect both types of inertia.

The sluggish behaviour of real and nominal variables in QMM implies that aggregate demand can deviate from potential output in the short to medium term. This is captured in QMM by the output gap which measures capacity utilisation in the economy, or the level of goods market pressure (5.43), and the deviations of the unemployment rate from an exogenous NAIRU, for measuring labour market pressures, (6.5).

[4] Although not captured in QMM, empirical evidence suggests that high inflation is more likely to be damaging to the real economy and economic welfare.

[5] There are many reasons possible for this sluggish behaviour, including physical adjustment costs, information costs, learning and institutional factors.

This property of QMM also implies that there is a short-run trade-off between inflation and the real economy: Inflation will generally rise as pressures of demand on capacity build up and fall when these pressures ease. Hence, although the long-run Phillips curve is vertical, the short-run curve is upward sloping (in inflation output gap space), thus offering the possibility that monetary policy can try to reduce fluctuations in the real economy over the business cycle at the same time it attempts to anchor inflation expectations to the inflation target.

2.3. Changes to QMM in the current version

Version 2.0 of QMM marks a significant change from the previous version of the model. The changes fall into two categories: regular re-estimation and revision of individual equations and a fundamental change of the modelling framework to allow for rational (or model consistent) expectations.

The estimation period has been extended to include data up to and including 2006 (instead of 2004 in previous versions). This led to various changes in the modelling relations and revision of various balance sheet weights. The most important changes are:

- Monetary policy (4.1) is now specified in terms of a forward-looking Taylor rule, capturing the fact that the Central Bank sets its policy rate with respect to its expectations of future inflation rather than the current inflation rate as in previous versions of QMM. This forecast-based rule is also shown to lead to much improved trade-offs between inflation variability and output variability than the previous policy rule.

- Long-term interest rates (4.6) now move in line with the expectations hypothesis of the term structure, but also allowing for an overweight on the current short rate reflecting the fact that long rates tend to move more closely with the current short rate over the business cycle than would be suggested by the expectations hypothesis.

- The definition of the real cost of capital (4.8) has been slightly revised.

- The specification of the exchange rate has been changed in QMM. In the current version, the real exchange rate (4.16) is determined by a forward looking risk adjusted real interest rate parity condition while the nominal exchange rate (4.10) is derived from the real exchange rate definition. The real exchange rate specification also allows for some backward-looking behaviour, capturing the observed persistence typically found in real exchange rates.

- The specification for the development of equity prices (4.19) has been revised to be more consistent with the steady state properties of the model as described in Daníelsson (2009).

- Balance sheet weights for household wealth (4.23 and 4.24) and asset revaluation terms (4.25 and 4.26) have been revised in line with recent developments of household balance sheets.

- New data from Statistics Iceland on disposable income has led to an important revision of the consumption equation (5.2). In the revised equation, the long-run wealth effect is somewhat smaller but the interest rate sensitivity stronger.

- The estimated equation for business investment (5.10) now excludes aluminium investment and airplane investment.

- The housing investment equation (5.14) now allows for short-run effects of the real interest rate and asymmetric short-run effects of house price and housing investment price shocks.

- The labour share in the Cobb-Douglas production function (5.42) has been revised from 0.64 to 0.70 in line with the results from the steady-state analysis in Daníelsson (2009).

- In former versions of the consumer price inflation equation (7.1), the forward-looking part of the Phillips-curve reflected a measure of forward looking inflation expectations as measured by break-even inflation expectations derived from the interest rate spread between nominal and indexed government bonds. However, in forecasting exercises this forward-looking part was updated according to a simple adaptive expectations mechanism. In the current versions, inflation expectations are truly forward-looking and are formulated according to rational expectations. The Phillips-curve is also backward looking and allows for temporary real exchange rate and real unit labour cost shocks.

- The short-run developments of the implicit private consumption deflator (7.5) now allows for different responses to exchange rate shocks from the consumer price index, due to slightly different import densities of the two price indices.

- With rational expectations, inflation expectations will be based on QMM as a whole (i.e. model consistent) and therefore no specific modelling of inflation expectations is needed. Break-even inflation expectations (7.18), however, measure expected future inflation over the maturity of the underlying bonds. These break-even inflation expectations are given by the average of the current and expected year-on-year inflation over the next five years.

- The share of grants to households (mainly social security payments) to nominal GDP is now given as a negative function of the output gap (8.16).

- The share of household other non-labour income (mainly net financial income) to nominal GDP is now given as a positive function of the short-term nominal interest rate and a negative function of the long-term real interest rate and inflation (9.4).

These changes improve the fit of the model and its dynamic simulation properties, but the overall behaviour of the model remains similar to those reported in previous versions.

2.4. Future modelling developments

QMM is not derived from fully specified optimisation problems of private agents in the economy but is mainly based on empirically estimated error correction relationships. The degree of empirical coherence is therefore given some precedence over the degree of full theoretical coherence in Pagan's (2003) terms. It therefore follows that the model may not automatically converge to a steady-state solution in the long run. To ensure convergence to steady state three conditions must be fulfilled. First, all nominal variables must grow in line with the Central Bank's inflation target. Second, real variables must converge to a balanced growth path equal to the growth rate of potential output (equal to the sum of the growth rates of population and technology). Finally, the long-run dichotomy between nominal and real variables must be fulfilled. The current version of QMM fulfils the first and last condition but some further restrictions are needed in order to meet the second requirement, see Daníelsson (2009) for further details. The fact that QMM is basically an estimated error correction model makes it also exposed to the Lucas critique which somewhat limits its use for policy and welfare analysis.

Given the lack of fully specified microeconomic foundations for the behavioural relations in QMM, the next logical step in the Bank's modelling work is to build a relatively small DSGE model as many central banks have been working on lately.[6] These models represent an ambitious attempt to combine the latest progress in macroeconomic theory, structural forecasting and practical monetary policy making. Although many issues remain unsolved,[7] work has begun and a small stylised New-Keynesian model based on the work of Hunt (2006) is already being used. That model and the future DSGE model should contribute to improve the forecasting and analytical abilities of the Bank with direct benefits for policy making.

3. Data and estimation approach

3.1. The data

Quarterly national accounts data for Iceland only exists since 1997. Some other data, such as many balance sheet variables, are officially only available annually. This means that quarterly data had to be generated further back in time to allow for meaningful empirical estimation. However, given the substantial structural changes in the Icelandic economy in the last two decades, using long time spans may in some cases not be feasible. This implies that the estimation period usually starts in 1992, when the disinflation process is completed, even though quarterly data was generated back to the beginning of the 1980s in most cases and even further back in some cases.

[6] These include the new Bank of England BEQM, Bank of Canada's TOTEM, Bank of Norway's NEMO, Bank of Finland's AINO, and MAS from the Central Bank of Chile.

[7] These include the microeconomic foundations of imperfections in various markets, price setting, expectations and open-economy issues. Another issue relates to estimation approaches, where some prefer classical or Bayesian estimation approaches, while others favour calibrating methods. Finally, forecast performance of these models needs more testing. For further detail, see Ólafsson (2006).

A substantial effort has been put into generating quarterly data for all the variables entering QMM. This usually involves sampling higher frequency data from different sources to use as auxiliary information for generating disaggregated, quarterly data using the ECOTRIM software. In some cases no such auxiliary information is available and smooth disaggregation of the annual data over the quarterly observations using ECOTRIM is the only available option. A detailed description of the data, its sources and, where applicable, the methods used for generating the quarterly observations is given in Chapter 14 in the Appendix.

3.2. Estimation of long-run relations

A detailed analysis of the long-run properties of each economic relationship in QMM is beyond the scope of this paper. It suffices to say that the long-run solutions reported are estimated using the simple Engle-Granger approach for estimating cointegrating relationships. Although more sophisticated estimation methods are available it should be pointed out that most of the long-run estimation results in QMM are based on well established empirical findings in Iceland, generally using these more sophisticated methods. Table 3.1 reports the most important references.

Table 3.1. Papers analysing long-run properties of economic relations in QMM

Money demand	Pétursson (2000)
Consumption	Baldursson (1993), Central Bank of Iceland (2004)
Investment	Hauksson (2005)
Housing market	Central Bank of Iceland (2004), Elíasson and Pétursson (2009)
Imports	Meacci and Turner (2001)
Wages	Pétursson (2002)

The long-run solutions in QMM typically define the particular quantity variable as a ratio to aggregate output, with this long-run path possibly affected by relative prices. Given these long-run paths, the short-run dynamics are estimated within the standard error correction framework as mentioned above. This reflects the underlying inertia in the economy, where the long-run relationships only assert themselves gradually in the face of shocks to demand or supply. To highlight this interaction between the long-run equilibrium and the short-run dynamics, long-run solutions are given in square-brackets.

It is important to note that equations of the model are developed as a part of the overall structure of QMM. Hence, the particular choice of empirically estimated equations and the variables entering those equations have all been dictated by the overall structure of the model. Furthermore, the selection of a particular equation and the short-run and long-run restrictions imposed in that equation is based not only on statistical inference and economic logic but also on its impact on the overall simulation properties of QMM. Each equation of the model does therefore not necessarily represent the 'best' single-equation estimate of the particular variable, but should rather be interpreted within the context of QMM. This also implies that equations or parts of QMM may regularly be replaced by something that is viewed to better represent the current structure of the Icelandic economy. A macroeconomic model can therefore never be viewed as final, but rather as an ongoing project. Updated versions of QMM will therefore regularly be made available to the public.

3.3. Notational conventions

Several conventions are used in this paper to present the empirical results of QMM. Upper-case letters denote the original variables, while lower-case letters denote natural logarithms of the same variables. The subscript t denotes time, while upper-case T denotes a linear time trend (set equal to zero in 1970:Q1). $Q1$, $Q2$, $Q3$ and $Q4$ denote quarterly centered seasonal dummies (equal to 3/4 in the relevant quarter and -1/4 otherwise), while impulse dummy variables are denoted by D and shift dummy variables by S (see Table 13.3 in the Appendix for a summary of dummy variables in QMM). Year-on-year changes are denoted as Δ_4, i.e. $\Delta_4 x_t = x_t - x_{t-4}$ and quarterly differences as Δ, i.e. $\Delta x_t = x_t - x_{t-1}$. Δ^2 denotes double differences, i.e. $\Delta^2 x_t = \Delta x_t - \Delta x_{t-1}$, or the acceleration of x_t. Finally, tables reporting single-equation analysis of estimated equations give the value O/S when the effects of a shocks to a given explanatory variable overshoot its long-run value.

3.4. Statistical information

T-values for the null hypothesis that a given variable is statistically significant from zero are given in brackets below each parameter estimate. Information on empirical fit (using degrees of freedom adjusted R^2) and equation standard error is given with empirical results on the most important equations. In cases where the estimated equation involves forward-looking variables, the equation is estimated with GMM, with a J-test giving additional information on model fit. Otherwise, standard OLS estimates are used.

Also shown are standard diagnostic tests for first-order residual autocorrelation (the Breusch-Godfrey F-test), residual normality (the Jarque-Bera χ^2-test) and a general form of residual heteroscedasticity (the White F-test). Where relevant, a F-test for the static long-run restriction imposed is also presented. To account for the non-stationarity properties of the data, the dynamic OLS method (DOLS) is used with the long-run test statistics corrected as described in Hamilton (1994). Finally, a F-test for dynamic homogeneity or other types of coefficient restrictions are also presented where relevant. The test statistics values are given with probability values in square brackets.

For the most important equations the empirical fit is also shown graphically, along with single-equation impulse response analysis and the steady-state solution to the equation. In all cases are the variables entering a given equation explicitly documented with cross-references to equations. An overview of all the variables and the cross-references to equations is given in Chapter 13 in the Appendix.

Part II
Model Details

4. Financial markets

This part of QMM describes the financial sector of the economy and the formulation of monetary policy. This includes interest rate setting and asset price determination, the demand for financial assets and definitions of wealth.

4.1. Interest rates and asset prices

4.1.1. Short-term interest rates (RS)

The monetary policy instrument, RS, is assumed to be set such as to minimise deviations of inflation from the inflation target and the deviations of output from its potential. To obtain this goal the following forward-looking version of the standard Taylor (1993) rule is assumed (allowing for some interest rate smoothing, for example reflecting the view that large and frequent interest rate changes can undermine financial stability):

$$RS_t = 0.6RS_{t-1} + 0.4\left[(RRN_t + IT_t) + 1.5(INF_{t+4} - IT_t) + 0.5GAPAV_t\right] \quad (4.1)$$

where:

RS	Short-term interest rate (4.1).
RRN	Real neutral interest rate (exogenous).
IT	Central Bank of Iceland 2.5% inflation target (exogenous).
INF	Four-quarter CPI inflation rate (7.15).
$GAPAV$	Annual average of output gap (5.44).

To arrive at this forecast-base rule specification of monetary policy, a number of different policy rules and parameter values were tried.[8] Model simulations using different rules suggest that (4.1) dominates in terms of standard deviations of inflation and output trade-offs.[9] Most importantly, it strongly dominates the standard Taylor rule using current inflation instead of expected future inflation, used in previous versions of QMM.

4.1.2. Long-term interest rates (RL)

Long-term interest rates (RL) are assumed to to be determined by the average of the current and expected future short rates (RS), in addition to an exogenous term pre-

[8] For example, monetary policy rules suggested by Orphanides et al. (2000) and Husebø et al. (2004). Adding the real exchange rate (either quarterly changes or deviations from the equilibrium real exchange rate) do not seem to improve the policy tradeoffs: fluctuations in the real exchange rate are reduced, but only at the cost of increasing the volatility of inflation, output and interest rates. This is consistent with findings from many other small open economies, cf. West (2003) for New Zealand.

[9] Levin et al. (2003) also find that a rule of this type is robust to model uncertainty. Hunt (2006) uses a same type of policy rule for analysing efficient policy frontiers for Iceland and obtains almost identical parameter values using Bayesian estimation techniques (0.63 for the lagged interest rate, 1.39 for the inflation gap and 0.47 for the output gap).

mium ($TERM$), according to the expectations hypothesis of the term structure. The specification of RL also allows for an overweight on the current short rate reflecting the fact that long rates tend to move more closely with the current short rate over the business cycle than would be suggested by the simple expectations hypothesis (see Black et al., 1997, for a similar idea).

With the long rate proxied by a bond with roughly 5 year maturity, the expectations hypothesis gives the following relationship between RL and RS as:

$$RL_t = \frac{1}{20}\sum_{j=0}^{19} RS^e_{t+j} + TERM_t \tag{4.2}$$

where RS^e denotes rational expectations of RS based on information at time t (i.e. RS^e_{t+j} denotes $E_t RS_{t+j}$). To estimate the relative weights of the current short rate and the long rate consistent with the expectations hypothesis, it is useful to rewrite (4.2) as:

$$RL_t = RL^e_{t+1} + (RS_t - RS^e_{t+20})/20 + (TERM^e_{t+1} - TERM_t) \tag{4.3}$$

The following equation is therefore estimated with GMM with $TERM$ and four lags of RS and RL as instruments, in addition to a dummy variable equal to one in 2001:Q1, the first quarter of the inflation targeting regime:

$$\begin{aligned} RL_t \;=\;& \lambda_{rl}(RS_t + TERM_t) \\ &+(1-\lambda_{rl})\left[RL_{t+1} + (RS_t - RS_{t+20})/20 + (TERM_{t+1} - TERM_t)\right] \end{aligned} \tag{4.4}$$

The resulting estimate is given as:[10]

$$\begin{aligned} RL_t \;=\;& \underset{(2195.5)}{0.189}(RS_t + TERM_t) \\ &+(1-0.189)\left[RL_{t+1} + (RS_t - RS_{t+20})/20 + (TERM_{t+1} - TERM_t)\right] \end{aligned} \tag{4.5}$$

Estimation method	GMM
Adjusted R^2	0.842
Equation standard error	0.58%
Coefficient restrictions (F-test)	0.00 [0.99]
J-test for over-identifying restrictions (χ^2-test)	6.03 [0.74]
Normality test (χ^2-test)	1.02 [0.60]
Sample period	1998:Q1-2003:Q4 (T = 24)

[10] The estimation period ends in 2003:Q4 due to the inclusion of RS_{t+20} as a regressor (data for RS is available up to 2008:Q4). The homogeneity restriction is easily accepted and the J-test does not reject the over-identifying restrictions.

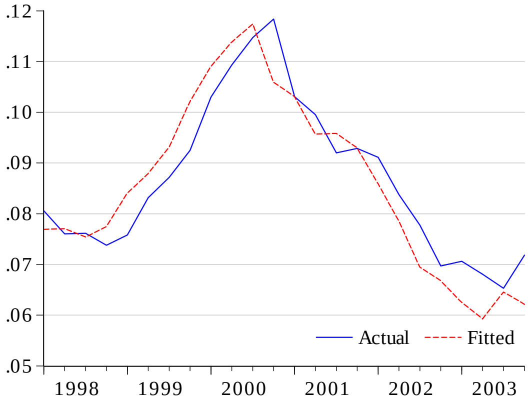


Figure 4.1. Fitted and actual RL_t

The specification of RL used in QMM is therefore given as:

$$RL_t = 0.189RS_t + (1 - 0.189)\sum_{j=0}^{19} RS_{t+j}/20 + TERM_t \tag{4.6}$$

where:

RL	Long-term interest rate (4.6).
RS	Short-term interest rate (4.1).
$TERM$	Term premium (exogenous).

4.1.3. Long-term indexed interest rates (RLV)

Long-run indexed interest rates are given by the Fisher relation and an inflation risk premium:

$$RLV_t = (RL_t - INFE_t) - PRISK_t \tag{4.7}$$

where:

RLV	Long-term indexed interest rate (4.7).
RL	Long-term interest rate (4.6).
$INFE$	Break-even inflation expectations (7.18).
$PRISK$	Inflation risk premium (exogenous).

4.1.4. Real cost of capital (RCC)

Investment is affected by the real cost of capital, RCC, which in turn is given by the long-term real interest rate (RLV), the depreciation rate of capital ($DELTA$) and a corporate risk premium ($PRBUS$):

$$RCC_t = (RLV_t + PRBUS_t)/4 + DELTA_t \tag{4.8}$$

where:

RCC	Real cost of capital (4.8).
RLV	Long-term indexed interest rate (4.7).
$PRBUS$	Business premium on risk-free interest rate (exogenous).
$DELTA$	Depreciation rate for total capital stock (exogenous).

4.1.5. Real interest rate differential (RID)

The quarterly gross risk adjusted real interest rate differential is given as:

$$RID_t = \frac{(1 + RS_t/4)/(1 + INF_t/4)}{[(1 + WRS_t/4)/(1 + WINF_t/4)]\,(1 + RISK/4)} \tag{4.9}$$

where:

RID	Real interest rate differential (4.9).
RS	Short-term interest rate (4.1).
INF	Four-quarter CPI inflation rate (7.15).
WRS	Foreign short-term interest rate (exogenous).
$WINF$	Four-quarter world inflation rate (7.16).
$RISK$	Exchange rate risk premium (exgogenous).

4.1.6. Nominal exchange rate (EER, EUR and EUS)

The nominal effective exchange rate is derived from the real exchange rate expression:

$$EER_t = \frac{CPI_t}{REX_t \times WCPI_t} \tag{4.10}$$

where:

EER	Exchange rate index of foreign currency (4.10).
CPI	Consumer price index (7.1).
$WCPI$	World consumer prices (exogenous).
REX	Real exchange rate (4.16).

Changes in the US dollar and euro exchange rates are simply assumed to follow that of the effective exchange rate index:

$$\Delta eus_t = \Delta eer_t \tag{4.11}$$
$$\Delta eur_t = \Delta eer_t \tag{4.12}$$

where:

EUS	USD exchange rate (4.11).
EUR	Euro exchange rate (4.12).
EER	Exchange rate index of foreign currency (4.10).

4.1.7. Real exchange rate (REX, $REXX$ and $REXM$)

A general measure of the real exchange rate is given by relative consumer prices defined as $REX = CPI/(EER \times WCPI)$. It is assumed that REX is determined by the real interest rate differential and the expected real exchange rate, but allowing for some inertia and a weight on the exogenous equilibrium real exchange rate, $REXEQ$:

$$rex_t = \alpha_{rex} rex_{t-1} + \beta_{rex} rex^e_{t+1} + (1 - \alpha_{rex} - \beta_{rex}) rexeq_t + rid_t \tag{4.13}$$

where RID is the quarterly risk adjusted gross real interest rate differential and REX^e is the expected real exchange rate, which is given as a weighted average of the past and future values of REX and the current $REXEQ$:[11]

$$rex^e_{t+1} = \gamma_{rex} rex_{t-1} + \phi_{rex} rex_{t+1} + (1 - \gamma_{rex} - \phi_{rex}) rexeq_t \tag{4.14}$$

Equations (4.13) and (4.14) can be solved jointly to obtain an estimatable equation for REX as:

$$\begin{aligned}(rex_t - rexeq_t) \quad &= \quad (\alpha_{rex} + \beta_{rex}\gamma_{rex})(rex_{t-1} - rexeq_t) \\ &\quad\quad +\beta_{rex}\phi_{rex}(rex_{t+1} - rexeq_t) + rid_t\end{aligned} \tag{4.15}$$

Equation (4.16) gives the estimation results for (4.15). Due to the forward-looking part in the equation, the GMM method is used with rex_{t-1} and the current and lagged value of rid, in addition to a shift dummy variable equal to one from 2001:Q1, the first quarter of the inflation targeting regime, as instruments. The coefficient restrictions are easily accepted and the J-test does not reject the over-identifying restrictions:[12]

$$(rex_t - rexeq_t) = \underset{(5.7)}{0.552}(rex_{t-1} - rexeq_t) + \underset{(4.8)}{0.435}(rex_{t+1} - rexeq_t) + rid_t \tag{4.16}$$

[11] Thus γ_{rex} denotes the share of investors forming expectations in a backward-looking manners, whereas ϕ_{rex} denotes the share of investors forming expectations rationally. This has become standard in the literature (cf. Berg et al., 2006, and Isard and Laxton, 2000).

[12] The coefficient restrictions is the coefficient restriction on the real interest rate differential. For a similar equation in a general equilibrium setup using Bayesian estimation of Icelandic data, see Hunt (2006).

Estimation method	GMM
Adjusted R^2	0.904
Equation standard error	2.67%
Coefficient restrictions (F-test)	0.05 [0.83]
J-test for over-identifying restrictions (χ^2-test)	1.73 [0.42]
Normality test (χ^2-test)	16.7 [0.00]
Sample period	1997:Q1-2007:Q4 ($T = 44$)

where:

REX	Real exchange rate (4.16).
$REXEQ$	Equilibrium real exchange rate (exogenous).
RID	Real interest rate differential (4.9).

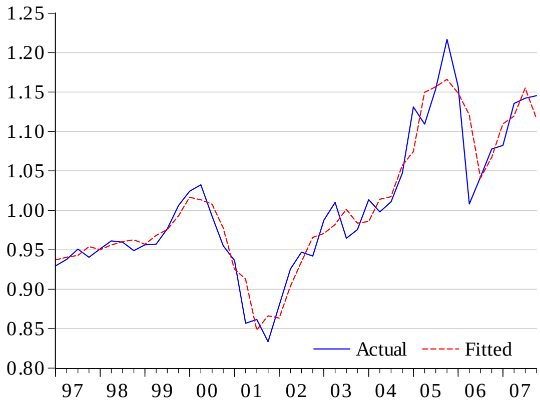


Figure 4.2. Fitted and actual rex_t

The competitive position of the exporting industry is measured by the exporters' real exchange rate:

$$REXX_t = \frac{PX_t}{EER_t \times WPX_t} \tag{4.17}$$

where:

$REXX$	Exporters' real exchange rate (4.17).
PX	Export price deflator (7.4).
EER	Exchange rate index of foreign currency (4.10).
WPX	World export prices (exogenous).

The competitive position of domestic competitive industry is measured by the importers' real exchange rate:

$$REXM_t = \frac{PM_t}{PGDP_t} \tag{4.18}$$

where:

$REXM$	Importers' real exchange rate (4.18).
PM	Import price deflator (7.2).
$PGDP$	GDP price deflator (7.10).

4.1.8. Equity prices (EQP)

Equity prices are simply assumed to grow in line with GDP inflation (with the effects of capital gains from equity holdings on household balance sheets picked up by the $REVA$ term below, 4.25):

$$\Delta eqp_t = \Delta pgdp_t \tag{4.19}$$

where:

EQP	Equity prices (4.19).
$PGDP$	GDP price deflator (7.10).

4.2. Money and wealth

4.2.1. Household sector wealth (WEL, HW, NFW, GFW, DH, $REVA$ and $REVD$)

Household sector wealth (WEL) consists of housing wealth (HW) and net financial wealth (NFW):

$$WEL_t = HW_t + NFW_t \tag{4.20}$$

where:

WEL	Household sector wealth (4.20).
HW	Housing wealth (4.21).
NFW	Net financial wealth (4.22).

Housing wealth is defined as:

$$HW_t = PH_t \times KH_t \tag{4.21}$$

where:

HW	Gross housing wealth (4.21).
PH	House prices (7.12).
KH	Private sector housing stock (5.20).

Net financial wealth is given as the difference between gross financial wealth and household debt:

$$NFW_t = GFW_t - DH_t \tag{4.22}$$

where:

NFW	Net financial wealth (4.22).
GFW	Gross financial wealth (4.23).
DH	Household debt (4.24).

Assuming a stable gross financial wealth-to-debt ratio equal to ω_w, gives gross financial wealth as (this ratio has remained stable around 0.6 in recent years):

$$\begin{aligned} GFW_t \quad = \quad & REVA_t \times GFW_{t-1} + \left(\frac{\omega_w}{\omega_w - 1}\right)[PC_t \times RHPI_t - CN_t \\ & -PH_t \times (IH_t - DELTAH_t \times KH_{t-1})] \end{aligned} \tag{4.23}$$

and household debt as:

$$\begin{aligned} DH_t \quad = \quad & REVD_t \times DH_{t-1} + \left(\frac{1}{\omega_w - 1}\right)[PC_t \times RHPI_t - CN_t \\ & -PH_t \times (IH_t - DELTAH_t \times KH_{t-1})] \end{aligned} \tag{4.24}$$

where:

GFW	Gross financial wealth (4.23).
DH	Household debt (4.24).
PC	Private consumption deflator (7.5).
$RHPI$	Real household post-tax income (9.5).
CN	Nominal private consumption (5.3).
PH	House prices (7.12).
IH	Private sector housing investment (5.14).
KH	Private sector housing stock (5.20).
$DELTAH$	Deprecation rate for housing stock (exogenous).
$REVA$	Household assets revaluation term (4.25).
$REVD$	Household debt revaluation term (4.26).

The revaluation terms are given as:

$$REVA_t = 0.83\left(\frac{CPI_t}{CPI_{t-1}}\right) + 0.17\left(\frac{EQP_t}{EQP_{t-1}}\right) \tag{4.25}$$

and

$$REVD_t = 0.87\left(\frac{CPI_t}{CPI_{t-1}}\right) + 0.13\left(\frac{EER_t}{EER_{t-1}}\right)\left(\frac{WCPI_t}{WCPI_{t-1}}\right) \tag{4.26}$$

where:

$REVA$	Household assets revaluation term (4.25).
$REVD$	Household debt revaluation term (4.26).
CPI	Consumer price index (7.1).
EQP	Equity prices (4.19).
EER	Exchange rate index of foreign currency (4.10).
$WCPI$	World consumer price index (exogenous).

The asset and liabilities weights in $REVA$ and $REVD$ are derived from the household balance sheet and reflect the weight of assets and debt in bonds, interest bearing deposits, stocks and foreign assets.[13]

4.2.2. Broad money demand ($M3$)

Steady state money demand gives real money balances as a function of output, net wealth and the opportunity cost of holding money, given by the short-run interest rate, with money demand homogenous with respect to output and wealth. The long-run relation also allows for a linear time trend, capturing the effects of financial innovations on money holdings in the recent years:[14]

$$(m3 - pgdp) = \alpha_m + \beta_m gdp + (1 - \beta_m)(wel - pgdp) - \phi_m RS \tag{4.27}$$

where $M3/PGDP$ are real money holdings, GDP is the scale variable, $WEL/PGDP$ is real wealth and RS is the short-term interest rate. The short-run dynamics of real money balances are also negatively affected by the acceleration of inflation:

$$\begin{aligned}
\Delta(m3_t - pgdp_t) \;=\; & \underset{(2.6)}{-0.131} - \underset{(1.1)}{0.007}Q1 + \underset{(4.2)}{0.026}Q2 + \underset{(2.4)}{0.017}Q3 \\
& + \underset{(2.5)}{0.026}D0312 + \underset{(2.8)}{0.001}T + \underset{(3.4)}{0.383}\Delta(m3_{t-2} - pgdp_{t-2}) \\
& + \underset{(1.9)}{0.102}\Delta gdp_{t-4} + \underset{(2.4)}{0.120}\Delta(wel_t - pgdp_t) - \underset{(6.9)}{0.667}\Delta^2 pgdp_t \\
& - \underset{(5.4)}{0.576}\Delta^2 pgdp_{t-1} - \underset{(2.4)}{0.109}\,[(m3_{t-1} - pgdp_{t-1}) - 0.421 gdp_{t-1} \\
& - 0.579(wel_{t-1} - pgdp_{t-1}) + 0.117 RS_{t-1}]
\end{aligned} \tag{4.28}$$

[13] The weights in the household assets and debt revaluation terms are based on shares of the different types of financial assets and liabilities of households as of June 2008. The constants reflect the shares of nominal interest rate assets and liabilities. On the asset side, the 83% weight reflects the share of indexed-linked assets, while the 17% weight reflects the share of equities. On the liabilities side, the 87% weight reflects the share of indexed-linked loans, while the 13% share reflects the share of foreign currency denominated loans. Both the revaluation terms ignore, however, the direct capital gains from interest rate changes for two reasons. First, it can be argued that households do not incorporate these effects when making consumption decisions, at least when the effects are expected to be temporary. Second, incorporating these capital gains can lead to large and implausible swings in the revaluation terms when measured from low interest rate levels.

[14] This trend is not included in long-run simulations of QMM.

Estimation method	OLS
Adjusted R^2	0.788
Equation standard error	1.35%
Long-run restrictions (F-test)	0.24 [0.63]
LM test for serial correlation (F-test)	1.37 [0.25]
Normality test (χ^2-test)	5.47 [0.06]
White test for heteroscedasticity (F-test)	1.09 [0.39]
Sample period	1990:Q1-2006:Q4 ($T = 68$)

where:

$M3$	Broad money (4.28).
$PGDP$	GDP price deflator (7.10).
GDP	GDP (5.39).
RS	Short-term interest rate (4.1).
WEL	Household sector wealth (4.20).
T	Linear time trend.
$Q1$-$Q3$	Centered seasonal dummies.
$D0312$	Dummy variable: 1 2003:Q1-2003:Q2 and zero otherwise.

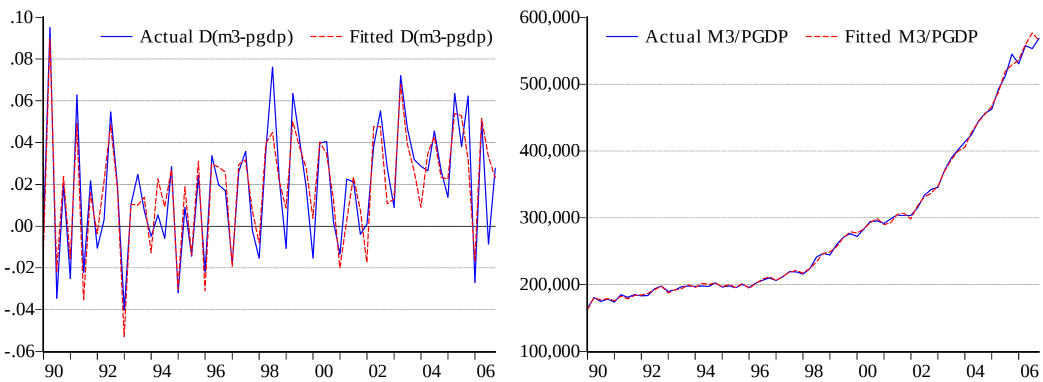


Figure 4.3. Fitted and actual $\Delta(m3 - pgdp)_t$ and $M3_t/PGDP_t$

Single equation dynamic responses of (4.28):

Table 4.2. Responses of $(m3 - pgdp)$ to a 1% increase in RHS variables

Quarters	$pgdp$	gdp	$wel - pgdp$	RS
Simultaneous	−0.67	0.00	0.12	0.00
One quarter ahead	−0.50	0.05	0.17	−0.01
Four quarters ahead	0.10	0.29	0.38	−0.05
Eight quarters ahead	0.15	0.44	0.52	−0.09
Long run	0.00	0.42	0.58	−0.12
50% of long-run effect	-	O/S	3Q	5Q
90% of long-run effect	-	O/S	8Q	11Q

Steady state solution:
$(m3 - pgdp - gdp) = const + 0.579(wel - pgdp - gdp) - 0.117RS + 0.0088T$

5. Demand and output

This part of QMM describes the expenditure and production side of the model. This includes public and private demand, net trade and the evolution of the production possibilities of the economy.

5.1. Private and public consumption

5.1.1. Private consumption (C and CN)

In accordance with the permanent income hypothesis, private consumption expenditure is determined in the long-run by household disposable income, wealth and the real interest rate:

$$c = \alpha_c + \beta_c rhpi + (1 - \beta_c)(wel - pc) - \phi_c RLV \tag{5.1}$$

where C is consumption, $RHPI$ is real disposable income, WEL/PC is real wealth and RLV is the real long-term interest rate. The short-run dynamics also allow for effects from the unemployment rate, reflecting precautionary saving effects:[15]

$$\begin{aligned} \Delta c_t \;=\;& \underset{(3.7)}{0.089} - \underset{(2.8)}{0.038}Q1 + \underset{(1.2)}{0.010}Q2 - \underset{(3.2)}{0.035}Q3 + \underset{(3.7)}{0.384}\Delta c_{t-4} - \underset{(2.4)}{1.616}\Delta UR_t \\ & + \underset{(4.0)}{0.246}\Delta(wel_t - pc_t) - \underset{(3.7)}{0.345}\left[c_{t-1} - 0.969 rhpi_{t-1} - 0.031(wel_{t-1} - pc_{t-1})\right. \\ & \left. + 2.432 RLV_{t-1} - 0.059D031 + 0.077S023\right] \end{aligned} \tag{5.2}$$

[15] The shift dummy $S023$ captures a structural break in the constant in the long-run relation in 2002Q3 suggested by the Andrews and Ploeberger (1994) *ExpF*-test. This structural break captures a downward shift in the consumption-income ratio around that time, probably reflecting the effects of increased household indebtness.

Estimation method	OLS
Adjusted R^2	0.933
Equation standard error	1.68%
Long-run restrictions (F-test)	0.01 [0.93]
LM test for serial correlation (F-test)	1.02 [0.32]
Normality test (χ^2-test)	0.59 [0.74]
White test for heteroscedasticity (F-test)	0.46 [0.86]
Sample period	1994:Q2-2006:Q4 ($T = 51$)

where:

C	Private consumption (5.2).
$RHPI$	Real household post-tax income (9.5).
WEL	Household sector wealth (4.20).
PC	Private consumption deflator (7.5).
RLV	Long-term indexed interest rate (4.7).
UR	Unemployment rate (6.5).
$Q1$-$Q3$	Centered seasonal dummies.
$D031$	Dummy variable: 1 2003:Q1 and zero elsewhere.
$S023$	Shift dummy variable: 1 from 2002:Q3 and zero before.

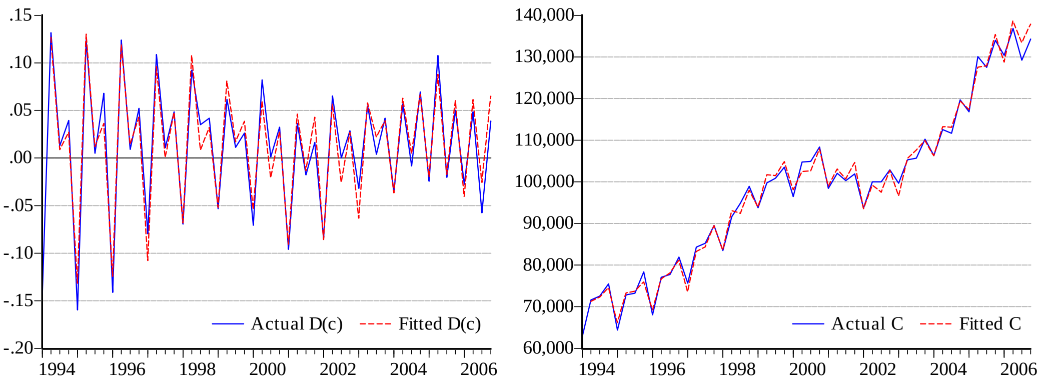


Figure 5.1. Fitted and actual Δc_t and C_t

Single equation dynamic responses of (5.2):[16]

[16]Note that a permanent increase in income will eventually boost wealth. Hence, a permanent 1% increase in income will eventually lead to a 1% rise in consumption.

Table 5.1. Responses of c to a 1% increase in RHS variables

Quarters	$rhpi$	$wel - pc$	UR	RLV
Simultaneous	0.00	0.25	−1.62	0.00
One quarter ahead	0.33	0.17	−1.06	−0.84
Four quarters ahead	0.79	0.17	−0.92	−1.98
Eight quarters ahead	1.08	0.06	−0.17	−2.71
Long run	0.97	0.03	0.00	−2.43
50% of long-run effect	O/S	O/S	-	O/S
90% of long-run effect	O/S	O/S	-	O/S

Steady state solution:
$(c - rhpi) = const + 0.031(wel - pc - rhpi) - 2.432RLV$

Nominal private consumption is given as:

$$CN_t = PC_t \times C_t \tag{5.3}$$

where:

- CN Nominal private consumption (5.3).
- PC Private consumption deflator (7.5).
- C Private consumption (5.2).

5.1.2. Government consumption (GN)

In forecasting with QMM, real government consumption is given exogenously. Nominal government consumption is therefore obtained as:

$$GN_t = PG_t \times G_t \tag{5.4}$$

where:

- GN Nominal government consumption (5.4).
- G Government consumption (exogenous).
- PG Government consumption deflator (7.6).

5.2. Fixed investment and the capital stock

5.2.1. Fixed investment (I and IN)

Fixed investment consists of business investment, housing investment and government investment:

$$I_t = IBUS_t + IH_t + IG_t \tag{5.5}$$

where:

I	Fixed investment (5.5).
$IBUS$	Business investment (5.11).
IH	Private sector housing investment (5.14).
IG	Government investment (exogenous).

Nominal investment is given by:

$$IN_t = PI_t \times I_t \tag{5.6}$$

where:

IN	Nominal fixed investment (5.6).
PI	Investment goods price deflator (7.7).
I	Fixed investment (5.5).

5.2.2. Business investment ($IBREG$, $IBUS$ and $IBUSN$)

Profit maximisation and constant-returns-to-scale imply a long-run relationship between the capital-output ratio and the user cost of capital:

$$(kbus - gdp) = \alpha_{ib} - \sigma_{ib} rcc \tag{5.7}$$

where σ_{ib} is the elasticity of substitution between capital and labour, $KBUS$ is the capital stock, GDP is output and RCC is the real cost of capital. Assuming a Cobb-Douglas production technology (cf. 5.41) implies that $\sigma_{ib} = 1$ and $\alpha_{ib} = \log(1 - \beta_g)$, where β_g is the labour share in the production function. Furthermore from the stock-flow identity (5.19), a long-run stable capital-investment ratio is obtained (where ζ_{ib} is the log of the sum of the constant rate of depreciation and the long-run growth rate of capital):

$$kbus - ibus = -\zeta_{ib} \tag{5.8}$$

where $IBUS$ is investment. Taken together these two long-run relations give a steady state condition for business investment of the form:

$$ibus = (\alpha_{ib} + \zeta_{ib}) + gdp - rcc \tag{5.9}$$

This steady state investment-output relation is applied for regular business investment (business investment excluding the aluminium sector and airplane investment), $IBREG$, with the short-run dynamics given as:[17]

[17] The dummy variable $D9395$ accounts for a potential measurement problem in the capital stock in the national accounts data, see Hauksson (2005). The second dummy variable $D9801$ proxies the effects of a substantial shift in capital gearing (leverage effect) in the late 1990s, which probably reflects a reduction in credit rationing. See Hauksson (2005) for a discussion and a direct estimation of this effect.

$$
\begin{aligned}
\Delta ibreg_t \quad = \quad & \underset{(6.2)}{-2.449} + \underset{(2.4)}{0.063}Q1 + \underset{(2.6)}{0.075}Q2 + \underset{(1.1)}{0.041}Q3 \\
& \underset{(3.5)}{-0.100}D9395 + \underset{(3.5)}{0.092}D9801 - \underset{(4.0)}{0.310}D021 + \underset{(3.4)}{0.255}D053 \\
& \underset{(1.4)}{+0.134}\Delta ibreg_{t-3} + \underset{(1.4)}{0.412}\Delta gdp_{t-2} - \underset{(6.2)}{0.405}[ibreg_{t-1} - gdp_{t-1} + rcc_{t-1}]
\end{aligned}
\tag{5.10}
$$

Estimation method	OLS
Adjusted R^2	0.560
Equation standard error	7.17%
Long-run restrictions (F-test)	1.90 [0.16]
LM test for serial correlation (F-test)	0.06 [0.80]
Normality test (χ^2-test)	0.34 [0.84]
White test for heteroscedasticity (F-test)	0.66 [0.76]
Sample period	1992:Q1-2006:Q4 ($T = 60$)

where:

$IBREG$	Regular business investment (5.10).
GDP	GDP (5.39).
RCC	Real cost of capital (4.8).
$D9395$	Dummy variable: 1 1993:Q1-1995:Q4 and zero elsewhere.
$D9801$	Dummy variable: 1 1998:Q1-2001:Q4 and zero elsewhere.
$D021$	Dummy variable: 1 2002:Q1 and zero elsewhere.
$D053$	Dummy variable: 1 2005:Q3 and zero elsewhere.
$Q1$-$Q3$	Centered seasonal dummies.

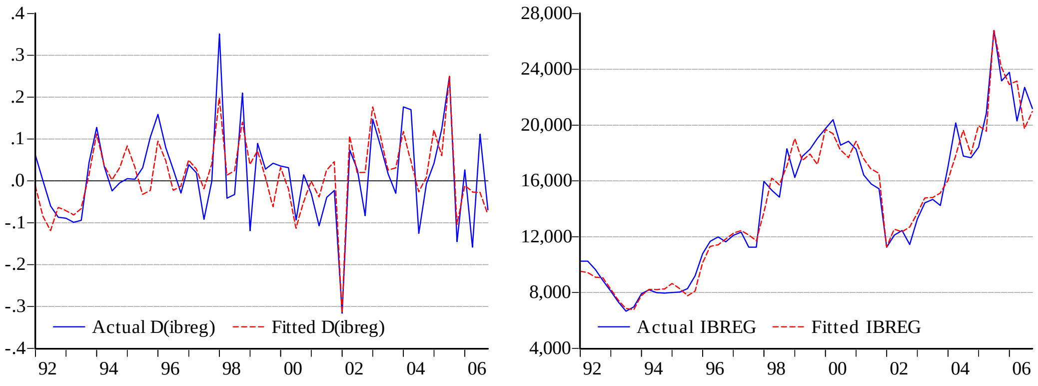


Figure 5.2. Fitted and actual $\Delta ibreg_t$ and $IBREG_t$

Single equation dynamic responses of (5.10):

Table 5.2. Responses of $ibreg$ to a 1% increase in RHS variables

Quarters	gdp	rcc
Simultaneous	0.00	0.00
One quarter ahead	0.41	−0.41
Four quarters ahead	0.97	−0.82
Eight quarters ahead	0.99	−0.96
Long run	1.00	−1.00
50% of long-run effect	O/S	2Q
90% of long-run effect	O/S	6Q
Steady state solution:		
$(ibreg - gdp) = const - rcc$		

Total business sector investment is given by:

$$IBUS_t = IBREG_t + IBALU_t + IBAIR_t \tag{5.11}$$

where:

$IBUS$	Business investment (5.11).
$IBREG$	Regular business investment (5.10).
$IBALU$	Aluminium sector investment (exogenous).
$IBAIR$	Investment in airplanes (exogenous).

Nominal business investment is given by:

$$IBUSN_t = IN_t - IHN_t - IGN_t \tag{5.12}$$

where:

$IBUSN$	Nominal business investment (5.12).
IN	Nominal fixed investment (5.6).
IHN	Nominal housing investment (5.15).
IGN	Nominal government investment (5.16).

5.2.3. Private sector housing investment (IH and IHN)

Using the same argument as for $IBREG$ above, the housing investment-output ratio can be written a function of the opportunity cost of investment, which in this case is given by a Tobin's Q price ratio between house prices (PH) and the cost of housing construction, given by the housing investment deflator (PIH):

$$(ih - gdp) = \alpha_{ih} + \beta_{ih}(ph - pih) \tag{5.13}$$

where IH is housing investment, GDP is output and PH/PIH is the Q ratio. This gives the following dynamic equation for housing investment, allowing for short-run effects of RLV and asymmetric short-run effects of shocks to PH and PIH:[18]

$$\begin{aligned}
\Delta ih_t = & -\underset{(2.4)}{0.195} - \underset{(7.7)}{0.151}Q1 - \underset{(12.5)}{0.095}Q2 - \underset{(4.9)}{0.036}Q3 - \underset{(8.5)}{0.126}D971 \\
& +\underset{(1.7)}{0.225}\Delta gdp_{t-4} + \underset{(2.5)}{0.284}\Delta ph_{t-1} - \underset{(1.8)}{1.445}\Delta RLV_t \\
& -\underset{(2.4)}{0.065}[(ih_{t-1} - gdp_{t-1}) - 0.372(ph_{t-1} - pih_{t-1})]
\end{aligned} \tag{5.14}$$

Estimation method	OLS
Adjusted R^2	0.841
Equation standard error	3.14%
Long-run restrictions (F-test)	8.64 [0.00]
LM test for serial correlation (F-test)	0.57 [0.45]
Normality test (χ^2-test)	13.9 [0.00]
White test for heteroscedasticity (F-test)	7.84 [0.00]
Sample period	1990:Q1-2006:Q4 (T = 68)

where:

IH	Private sector housing investment (5.14).
GDP	GDP (5.39).
PH	House prices (7.12).
PIH	Housing investment deflator (7.8).
RLV	Long-term indexed interest rate (4.7).
$Q1$-$Q3$	Centered seasonal dummies.

[18] Due to the apparent residual heteroscedasticity, the equation reports White heteroscedasticity-consistent t-values in brackets. The long-run restrictions implied by the long-run solution of the investment equation are rejected by the data. The restriction rejected is the homogeneity restriction between IH and GDP, but the restriction on PH and PIH (equal coefficient but with opposite sign) is not rejected.

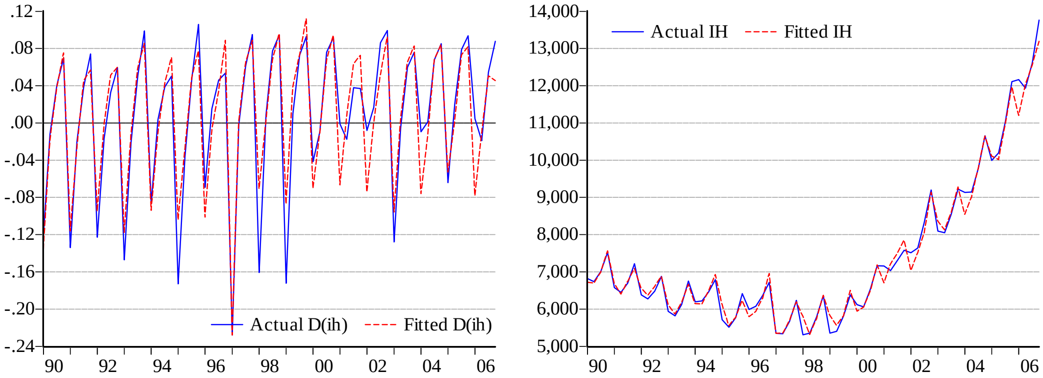


Figure 5.3. Fitted and actual Δih_t and IH_t

Single equation dynamic responses of (5.14):

Table 5.3. Responses of ih to a 1% increase in RHS variables

Quarters	gdp	ph	pih	RLV
Simultaneous	0.00	0.00	0.00	−1.44
One quarter ahead	0.06	0.31	−0.02	−1.35
Four quarters ahead	0.46	0.32	−0.09	−1.11
Eight quarters ahead	0.59	0.33	−0.15	−0.85
Long run	1.00	0.37	−0.37	0.00
50% of long-run effect	5Q	1Q	11Q	-
90% of long-run effect	29Q	6Q	31Q	-

Steady state solution:
$(ih - gdp) = const + 0.372(ph - pih)$

Nominal housing investment is given by:

$$IHN_t = PIH_t \times IH_t \tag{5.15}$$

where:

IHN	Nominal housing investment (5.15).
PIH	Housing investment deflator (7.8).
IH	Private sector housing investment (5.14).

5.2.4. Government investment (IGN and $IGNNET$)

Real government investment in QMM is given exogenously. Nominal government investment is therefore given as:

$$IGN_t = PIG_t \times IG_t \tag{5.16}$$

where:

IGN	Nominal government investment (5.16).
IG	Government investment (exogenous).
PIG	Government investment inflator (7.9).

As expenditure on depreciation is included in government consumption, government investment net of depreciation is needed in the equation on public sector net borrowing (8.18). Hence, nominal net government investment is given as:

$$IGNNET_t = IGN_t - PIG_t \times DELTAG_t(K_{t-1} - KBUS_{t-1} - KH_{t-1}) \tag{5.17}$$

where:

$IGNNET$	Nominal net government investment (5.17).
IGN	Nominal government investment (5.16).
PIG	Government investment deflator (7.9).
$DELTAG$	Depreciation rate for government capital stock (exogenous).
K	Total capital stock (5.18).
$KBUS$	Business capital stock (5.19).
KH	Private sector housing stock (5.20).

5.2.5. Capital stock (K, $KBUS$ and KH)

The capital stock is the previous period's stock, allowing for depreciation, plus the current investment:

$$K_t = (1 - DELTA_t)K_{t-1} + I_t \tag{5.18}$$

$$KBUS_t = (1 - DELTAB_t)KBUS_{t-1} + IBUS_t \tag{5.19}$$

$$KH_t = (1 - DELTAH_t)KH_{t-1} + IH_t \tag{5.20}$$

where:

K	Total capital stock (5.18).
$KBUS$	Business capital stock (5.19).
KH	Private sector housing stock (5.20).
I	Fixed investment (5.5).
$IBUS$	Business investment (5.11).
IH	Private sector housing investment (5.14).
$DELTA$	Depreciation rate for total capital stock (exogenous).
$DELTAB$	Depreciation rate for business capital stock (exogenous).
$DELTAH$	Deprecation rate for housing stock (exogenous).

5.2.6. Stockbuilding (II and IIN)

Measured inventories in the Icelandic national accounts are predominantly from the marine and aluminium export sectors. Assuming a constant ratio between inventories and the exports of marine and aluminium products, and that inventories amount to roughly 2-3 months of sales, implies the following relationship for stockbuilding:[19]

$$II_t = 0.21[\Delta EXMAR_t + \Delta EXALU_t] \tag{5.21}$$

where:

II	Net stockbuilding (5.21).
$EXMAR$	Exports of marine products (exogenous).
$EXALU$	Exports of aluminium products (exogenous).

Nominal stockbuilding is similarly given as:[20]

$$\begin{aligned} IIN_t \;=\;& 0.21[EER_t \times (1.002 \times PXMAR_t) \times \Delta EXMAR_t \\ &+ EUS_t \times (1.011 \times PXALU_t) \times \Delta EXALU_t] \end{aligned} \tag{5.22}$$

where:

IIN	Nominal net stockbuilding (5.22).
EER	Exchange rate index of foreign currency (4.10).
$PXMAR$	Price of marine products in foreign currency (exogenous).
$EXMAR$	Exports of marine products (exogenous).
EUS	USD exchange rate (4.11).
$PXALU$	Price of aluminium products in US dollars (exogenous).
$EXALU$	Exports of aluminium products (exogenous).

[19] Assuming that inventories amount to 2-3 months of sales gives a constant equal to $(2/12 + 3/12)/2 = 0.21$.

[20] The scaling factors in (5.22) are due to the re-normalisation of the $PXREG$, $PXALU$ and $PXMAR$ price indices in the QMM database.

5.3. Domestic demand (DD and DDN)

Domestic demand is determined by an accounting identity, as the sum of private and government consumption, investment and stockbuilding:

$$DD_t = C_t + G_t + I_t + II_t \tag{5.23}$$

where:

DD	Domestic demand (5.23).
C	Private consumption (5.2).
G	Government consumption (exogenous).
I	Fixed investment (5.5).
II	Net stockbuilding (5.21).

Nominal domestic demand is given by a corresponding accounting identity:

$$DDN_t = CN_t + GN_t + IN_t + IIN_t \tag{5.24}$$

where:

DDN	Nominal domestic demand (5.24).
CN	Nominal private consumption (5.3).
GN	Nominal government consumption (5.4).
IN	Nominal fixed investment (5.6).
IIN	Nominal net stockbuilding (5.22).

5.4. Net trade

5.4.1. Export volume of goods and services ($EXREG$, EX and EXN)

In the long-run, exports of goods and services (excluding marine and aluminium products) are determined by international demand (proxied by world trade) and relative prices, with unit income elasticity:

$$exreg = \alpha_{ex} + trade - \beta_{ex} rex \tag{5.25}$$

where $EXREG$ are exports of goods and services excluding marine and aluminium products, $TRADE$ is world trade and REX is the real exchange rate. This gives the following dynamic equation:

$$\begin{aligned} \Delta exreg_t \;=\; & \underset{(5.3)}{5.761} - \underset{(2.0)}{0.099}Q1 + \underset{(1.0)}{0.065}Q2 + \underset{(3.4)}{0.171}Q3 - \underset{(2.8)}{0.334}D981 \\ & + \underset{(4.5)}{0.361}\Delta exreg_{t-4} - \underset{(5.3)}{0.566}[exreg_{t-1} - trade_{t-1} + 0.480 rex_{t-1}] \end{aligned} \tag{5.26}$$

Estimation method	OLS
Adjusted R^2	0.839
Equation standard error	11.66%
Long-run restrictions (F-test)	5.66 [0.02]
LM test for serial correlation (F-test)	0.05 [0.83]
Normality test (χ^2-test)	3.93 [0.14]
White test for heteroscedasticity (F-test)	1.54 [0.18]
Sample period	1990:Q1-2006:Q4 ($T = 68$)

where:

$EXREG$	Exports, excluding aluminium and marine goods (5.26).
$TRADE$	World trade (exogenous).
REX	Real exchange rate (4.16).
$Q1$-$Q3$	Centered seasonal dummies.
$D981$	Dummy variable: 1 1998:Q1 and zero elsewhere.

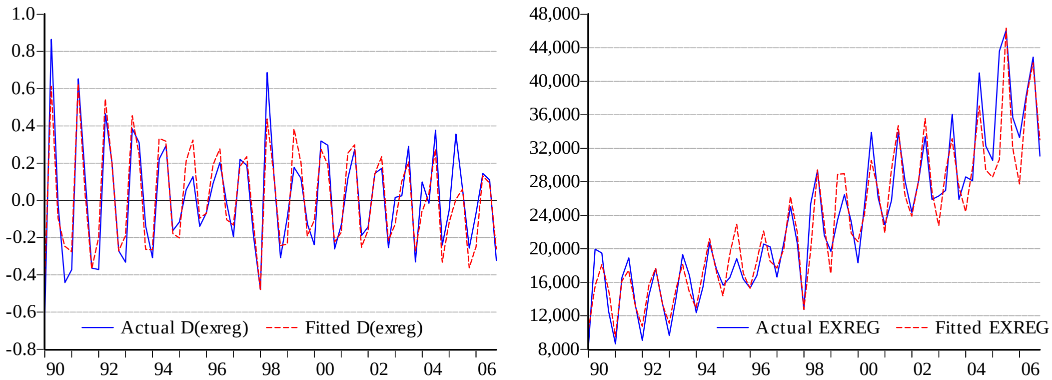


Figure 5.4. Fitted and actual $\Delta exreg_t$ and $EXREG_t$

Single equation dynamic responses of (5.26):

Table 5.4. Responses of $exreg$ to a 1% increase in RHS variables

Quarters	$trade$	rex
Simultaneous	0.00	0.00
One quarter ahead	0.57	−0.27
Four quarters ahead	0.96	−0.46
Eight quarters ahead	1.07	−0.51
Long run	1.00	−0.48
50% of long-run effect	O/S	O/S
90% of long-run effect	O/S	O/S
Steady state solution:		
$(exreg - trade) = const - 0.480rex$		

Total exports are given as:

$$EX_t = EXREG_t + EXALU_t + EXMAR_t \tag{5.27}$$

where:

EX	Exports of goods and services (5.27).
$EXREG$	Exports, excluding aluminium and marine goods (5.26).
$EXALU$	Exports of aluminium products (exogenous).
$EXMAR$	Exports of marine products (exogenous).

Nominal exports of goods and services are given as:[21]

$$\begin{aligned} EXN_t \;\; = \;\; & PXREG_t \times EXREG_t \\ & + EUS_t \times (1.011 \times PXALU_t) \times EXALU_t \\ & + EER_t \times (1.002 \times PXMAR_t) \times EXMAR_t \end{aligned} \tag{5.28}$$

where:

EXN	Nominal exports of goods and services (5.28).
$PXREG$	Export prices excluding aluminium and marine products (7.3).
EUS	USD exchange rate (4.11).
$EXREG$	Exports, excluding aluminium and marine goods (5.26).
$PXALU$	Price of aluminium products in US dollars (exogenous).
EER	Exchange rate index of foreign currency (4.10).
$EXALU$	Exports of aluminium products (exogenous).
$PXMAR$	Price of marine products in foreign currency (exogenous).
$EXMAR$	Exports of marine products (exogenous).

[21] The scaling factors in (5.28) are due to the re-normalisation of the $PXREG$, $PXALU$ and $PXMAR$ price indices in the QMM database.

5.4.2. Import volume of goods and services (IMP, $IMPN$ and $SPEC$)

In the long-run, imports of goods and services are determined by domestic demand and relative prices, with unit income elasticity. The long-run relationship also allows for an upward trend, reflecting increased trade specialisation in international trade (captured by the ratio between world trade and world output):

$$imp = \alpha_{im} + dd - \beta_{im} rexm + \phi_{im} spec \tag{5.29}$$

where IMP are the imports of goods and services, DD is domestic demand, $REXM$ is the importers' real exchange rate, and $SPEC$ is the trade specialisation term. This gives the following dynamic equation:

$$\begin{aligned} \Delta imp_t &= \underset{(6.7)}{-0.769} + \underset{(0.9)}{0.023} Q1 + \underset{(2.6)}{0.061} Q2 + \underset{(2.7)}{0.066} Q3 \\ &\quad + \underset{(1.9)}{0.125} \Delta imp_{t-2} + \underset{(8.0)}{1.465} \Delta dd_t \\ &\quad \underset{(6.7)}{-0.790} [imp_{t-1} - dd_{t-1} + 0.492 rexm_{t-1} - 0.545 spec_{t-1}] \end{aligned} \tag{5.30}$$

Estimation method	OLS
Adjusted R^2	0.886
Equation standard error	4.84%
Long-run restrictions (F-test)	5.87 [0.02]
LM test for serial correlation (F-test)	0.15 [0.70]
Normality test (χ^2-test)	0.14 [0.93]
White test for heteroscedasticity (F-test)	1.88 [0.10]
Sample period	1990:Q1-2006:Q4 (T = 68)

where:

IMP	Imports of goods and services (5.30).
DD	Domestic demand (5.23).
$REXM$	Importers' real exchange rate (4.18).
$SPEC$	Trade specialisation (5.32).
$Q1$-$Q3$	Centered seasonal dummies.

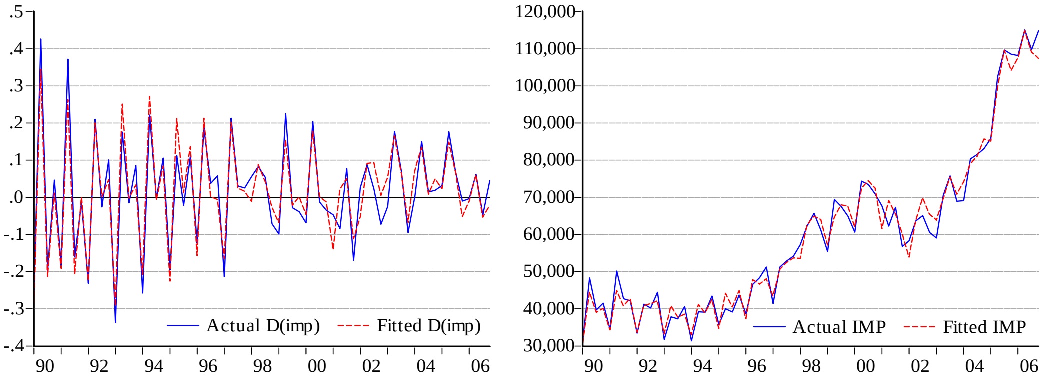


Figure 5.5. Fitted and actual Δimp_t and IMP_t

Single equation dynamic responses of (5.30):

Table 5.5. Responses of imp to a 1% increase in RHS variables

Quarters	dd	$rexm$	$spec$
Simultaneous	1.47	0.00	0.00
One quarter ahead	1.10	−0.39	0.43
Four quarters ahead	1.01	−0.51	0.57
Eight quarters ahead	1.00	−0.49	0.54
Long run	1.00	−0.49	0.55
50% of long-run effect	O/S	1Q	O/S
90% of long-run effect	O/S	2Q	O/S

Steady state solution:
$(imp - dd) = const - 0.492rexm + 0.554spec$

Nominal imports are given as:

$$IMPN_t = PM_t \times IMP_t \tag{5.31}$$

where:

$IMPN$	Nominal imports of goods and services (5.31).
IMP	Imports of goods and services (5.30).
PM	Import price deflator (7.2).

The trade specialisation variable is defined as:

$$SPEC_t = TRADE_t/WGDP_t \tag{5.32}$$

where:

$SPEC$	Trade specialisation (5.32).
$TRADE$	World trade (exogenous).
$WGDP$	World GDP (exogenous).

5.4.3. Balance of payments (BAL, $BALT$ and $BIPD$)

The balance of trade is given as

$$BALT_t = EXN_t - IMPN_t \tag{5.33}$$

where:

$BALT$	Balance of trade (5.33).
EXN	Nominal exports of goods and services (5.28).
$IMPN$	Nominal imports of goods and services (5.31).

The balance of interest payments, dividends and profits ($BIPD$) is proxied as by the product of the sum of an exogenous foreign nominal interest rate (WRS) and a risk premium ($BIPDF$), and the average net foreign assets (NFA) over the current and past quarter:[22]

$$BIPD_t = \left(\frac{WRS_t + BIPDF_t}{4}\right)\left(\frac{NFA_t + NFA_{t-1}}{2}\right) \tag{5.34}$$

where:

$BIPD$	Balance of interest, salaries, dividends and profits (5.34).
WRS	Foreign short-term interest rate (exogenous).
$BIPDF$	Risk premium on world interest rate (exogenous).
NFA	Net foreign assets (5.36).

The current account balance is determined by an accounting identity:

$$BAL_t = BALT_t + BIPD_t + BTRF_t \tag{5.35}$$

where:

BAL	Current account balance (5.35).
$BALT$	Balance of trade (5.33).
$BIPD$	Balance of interest, salaries, dividends and profits (5.34).
$BTRF$	Balance of transfers (exogenous).

[22] The risk premium $BIPDF$ is not a pure interest rate premium since it can be negative when return on equity is low. It is the difference on returns of all net foreign assets (including equity).

5.4.4. Net foreign assets (NFA, ISA and FOH)

Net foreign assets are defined as the difference between gross Icelandic holdings of foreign assets and foreign holdings of Icelandic assets:

$$NFA_t = ISA_t - FOH_t \tag{5.36}$$

where:

NFA	Net foreign assets (5.36).
ISA	Icelandic holdings of foreign assets (5.37).
FOH	Foreign holdings of Icelandic assets (5.38).

Both Icelandic and foreign asset holdings are modelled using a simple stock-flow framework. Domestic holdings of foreign assets is revalued according to changes in world equity prices, with the stock growing at an annual rate of γ_y, which is the steady state growth rate, thus ensuring that the asset holdings grow at a long-run rate consistent with a balance growth rate path:[23]

$$ISA_t = ISA_{t-1}\frac{EER_t}{EER_{t-1}}\left(0.8 + 0.2\frac{WEQP_t}{WEQP_{t-1}}\right)(1+\gamma_y)^{(1/4)} \tag{5.37}$$

Foreign holdings of domestic assets are given as (the revalue term reflects that foreign holdings of domestic assets is in the form of loans in foreign currency):

$$\begin{aligned} FOH_t \;=\; & FOH_{t-1}\left(\frac{EER_t}{EER_{t-1}}\right) - BAL_t + ISA_{t-1} \times \left[(1+\gamma_y)^{(1/4)} - 1\right] \\ & \times \left[0.8\left(\frac{EER_t}{EER_{t-1}}\right) + 0.2\left(\frac{EER_t}{EER_{t-1}} \times \frac{WEQP_t}{WEQP_{t-1}}\right)\right] \end{aligned} \tag{5.38}$$

where:

ISA	Icelandic holdings of foreign assets (5.37).
FOH	Foreign holdings of Icelandic assets (5.38).
EER	Exchange rate index of foreign currency (4.10).
$WEQP$	World equity prices (exogenous).
BAL	Current account balance (5.35).

5.5. Output

5.5.1. Gross domestic production (GDP and $GDPN$)

Expenditure-based GDP is an accounting identity including domestic demand, exports and imports:

$$GDP_t = DD_t + EX_t - IMP_t \tag{5.39}$$

[23] The growth rate γ_y equals 3.2% (5.42), when assuming a population growth of 1%.

where:

GDP	GDP (5.39).
DD	Domestic demand (5.23).
EX	Exports of goods and services (5.27).
IMP	Imports of goods and services (5.30).

Nominal GDP is similarly given as:

$$GDPN_t = DDN_t + EXN_t - IMPN_t \tag{5.40}$$

where:

$GDPN$	Nominal GDP (5.40).
DDN	Nominal domestic demand (5.24).
EXN	Nominal exports of goods and services (5.28).
$IMPN$	Nominal imports of goods and services (5.31).

5.5.2. Potential output and the output gap (*GDPT*, *GAP* and *GAPAV*)

Potential output is described with a constant-returns-to-scale Cobb-Douglas production function and an exogenous labour-augmenting technical progress:

$$gdpt_t = \log \alpha_g + \beta_g(\gamma_g T) + \beta_g empt_t + (1 - \beta_g)k_t \tag{5.41}$$

where $GDPT$ is potential output, $EMPT$ is trend employment, K is the capital stock, β_g is the labour share, and $\gamma_g T$ is the labour-augmenting technical progress, captured with a linear time trend. The capital stock is assumed to be fully employed and trend employment is given by (6.10). By setting the shares of production factors exogenously according to historical income shares and the results from the analysis of the steady state properties of QMM (see Daníelsson, 2009), the estimated equation reduces to (estimated for the period 1981:Q1-2006:Q4):[24]

$$gdpt_t = -\underset{(56.7)}{1.079} + 0.70 \times \underset{(20.3)}{0.0055}T + 0.70 empt_t + 0.30k_t \tag{5.42}$$

where:

$GDPT$	Potential output (5.42).
$EMPT$	Trend employment (6.10).
K	Capital stock (5.18).
T	Linear time trend.

The output gap is defined as the difference between actual and potential output:

[24]The forecasting round often also uses an exogenously given estimate of potential output obtained using a HP-filtered trend of the technological progress based on the same Cobb-Douglas production function.

$$GAP_t = GDP_t/GDPT_t - 1 \tag{5.43}$$

where:

GAP	Output gap (5.43).
GDP	GDP (5.39).
$GDPT$	Potential output (5.42).

An annual average of the output gap is used as a measure of demand pressure in the inflation equation (7.1) and as the measure of future inflation pressures in the monetary policy rule (4.1):

$$GAPAV_t = \left(\frac{GAP_t + GAP_{t-1} + GAP_{t-2} + GAP_{t-3}}{4} \right) \tag{5.44}$$

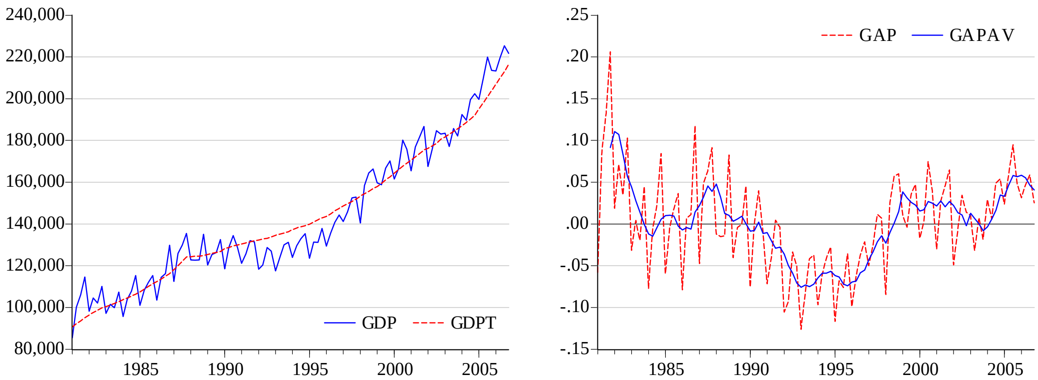


Figure 5.6. Actual and potential output and the output gap

6. Labour market

This section describes the labour market in QMM. Wage setting is assumed to take place in a monopolistic competition setting, with cyclically sensitive labour supply and long-run labour demand derived from the production function of the economy.

6.1. Wages and labour costs

6.1.1. Wages (W)

It follows from profit maximisation and the production function (5.41) that the wage share should be constant in the long run:[25]

[25] The firm's decision problem is given as maximising $GDPT - (W \times REM/PGDP) \times EMPT - RCC \times K$, which gives the first order condition (6.1).

$$(w + rem - prodt - pgdp) = (ulct - pgdp) = \log \beta_g \tag{6.1}$$

where W is the nominal wage rate, REM is the employers' wage related cost, $PRODT$ is trend labour productivity, $PGDP$ is the output price and β_g is the wage share from the production function (5.42).

The wage share (or real unit labour costs, see equation (6.4)) has, however, been trending upwards in Iceland since the middle of the 1990s. A potential explanation for this could be the increasing share of the public sector in this period. If the wage share in the public sector is larger than the share in the private sector, a growing share of the public sector in nominal output will lead to a rise in the economy-wide wage share in (6.1). The trending behaviour of the wage share could also reflect a small-sample problem as the wage share rebounded from a temporary decline in the late 1980s together will cyclical effects reflecting the extremely tight labour market in the last few years, or the effects of missing, unobservable structural variables such as union power and the replacement ratio.[26]

The wage equation is specified in terms of real unit labour costs (or the wage share), $(W \times REM/PRODT)/PGDP = ULCT/PGDP$ (see equation 6.4), with the short run dynamics characterised by a Phillips curve where the wage share is affected by its deviations from its steady state value, deviations of unemployment from a constant $NAIRU$, deviations of the real exchange rate from its equilibrium rate, and the price wedge between output and consumer prices:

$$\begin{aligned}
\Delta(ulct_t - pgdp_t) = & \underset{(5.5)}{-0.254} + \underset{(5.9)}{0.030}Q1 + \underset{(3.0)}{0.011}Q2 + \underset{(0.6)}{0.002}Q3 \\
& \underset{(3.5)}{-0.037}D971 - \underset{(3.6)}{0.041}D062 + \underset{(5.7)}{0.0018}T \\
& \underset{(4.6)}{-0.995}(UR_t - NAIRU_t) + \underset{(2.2)}{0.367}(UR_{t-4} - NAIRU_{t-4}) \\
& \underset{(8.3)}{-0.899}\Delta(pgdp_t - cpi_t) + \underset{(2.0)}{0.053}(rex_{t-1} - rexeq_{t-1}) \\
& \underset{(5.5)}{-0.478}[ulct_{t-1} - pgdp_{t-1}]
\end{aligned} \tag{6.2}$$

Estimation method	OLS
Adjusted R^2	0.668
Equation standard error	1.00%
Long-run restrictions (F-test)	2.56 [0.06]
LM test for serial correlation (F-test)	1.20 [0.28]
Normality test (χ^2-test)	0.21 [0.90]
White test for heteroscedasticity (F-test)	0.96 [0.49]
Sample period	1992:Q1-2006:Q4 ($T = 60$)

where:

[26] Long-run simulations assume that the wage share is constant in line with the underlying supply side of QMM.

W	Wages (6.2).
REM	Employers' wage-related cost (exogenous).
$PRODT$	Trend labour productivity (6.12).
$PGDP$	GDP price deflator (7.10).
CPI	Consumer price index (7.1).
UR	Unemployment rate (6.5).
$NAIRU$	Natural rate of unemployment (exogenous).
REX	Real exchange rate (4.16).
$REXEQ$	Equilibrium real exchange rate (exogenous).
$D971$	Dummy variable: 1 1997:Q1 and zero elsewhere.
$D062$	Dummy variable: 1 2006:Q2 and zero elsewhere.
$Q1$-$Q3$	Centered seasonal dummies.
T	Linear time trend.

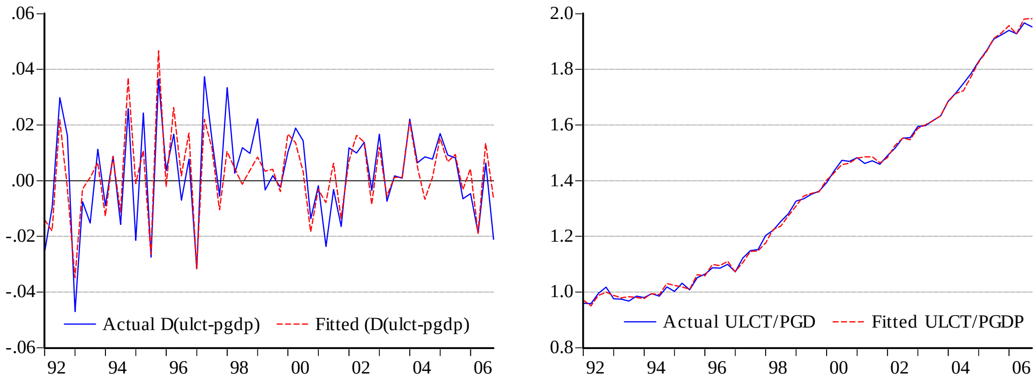


Figure 6.1. Fitted and actual $\Delta(ulct - pgdp)_t$ and $ULCT_t/PGDP_t$

Single equation dynamic responses of (6.2):[27]

[27]Note that the equation is dynamically homogenous as the sum of the $PGDP$ and CPI impacts is always unity. Note also that in a steady state $UR = NAIRU$. Hence, although the table reports 'long-run' effects of $UR - NAIRU$ and $rex - rexeq$, the effects on wages are only temporary.

Table 6.1. Responses of w to a 1% increase in RHS variables

Quarters	rem	$prodt$	$pgdp$	cpi	$UR - NAIRU$	$rex - rexeq$
Simultaneous	-1.00	1.00	0.10	0.90	-1.00	0.00
One quarter ahead	-1.00	1.00	0.53	0.47	-1.51	0.05
Four quarters ahead	-1.00	1.00	0.93	0.07	-1.63	0.10
Eight quarters ahead	-1.00	1.00	1.00	0.00	-1.34	0.11
Long run	-1.00	1.00	1.00	0.00	-1.31	0.11
50% of long-run effect	0Q	0Q	1Q	-	O/S	2Q
90% of long-run effect	0Q	0Q	4Q	-	O/S	3Q

Steady state solution:
$(w + rem - prodt - pgdp) = const + 0.0037T$

6.1.2. Unit labour costs (ULC and $ULCT$)

Overall unit labour costs are given by the following identity:

$$ULC_t = \frac{W_t \times REM_t}{PROD_t} \tag{6.3}$$

where:

ULC	Unit labour costs (6.3).
W	Wages (6.2).
REM	Employers' wage-related cost (exogenous).
$PROD$	Labour productivity (6.11).

Unit labour costs in the business sector are given by the following identity:

$$ULCT_t = \frac{W_t \times REM_t}{PRODT_t} \tag{6.4}$$

where:

$ULCT$	Trend unit labour costs (6.4).
W	Wages (6.2).
REM	Employers' wage-related cost (exogenous).
$PRODT$	Trend labour productivity (6.12).

6.2. Unemployment and labour participation

6.2.1. Unemployment (UN and UR)

The unemployment rate is modelled as an Okun-type relation with output growth:[28]

[28] To ensure that UR equals $NAIRU$ in the long-run, the constant is constrained to equal $-\phi_{ur}\gamma_y$, where ϕ_{ur} is the coefficient on output growth and γ_y is the steady state output growth rate, equal

$$
\begin{aligned}
\Delta UR_t \quad = \quad & \underset{(1.5)}{0.003}Q1 - \underset{(1.4)}{0.003}Q2 + \underset{(1.6)}{0.003}Q3 \\
& + \underset{(4.1)}{0.515}\Delta UR_{t-1} - \underset{(3.8)}{0.541}\Delta UR_{t-2} + \underset{(2.3)}{0.322}\Delta UR_{t-3} + \underset{(2.3)}{0.310}\Delta UR_{t-4} \\
& - \underset{(1.9)}{0.023}(\Delta_4 gdp_{t-1} - \gamma_y) - \underset{(2.4)}{0.077}[UR_{t-1} - NAIRU_{t-1}]
\end{aligned}
\tag{6.5}
$$

Estimation method	OLS
Adjusted R^2	0.865
Equation standard error	0.29%
Long-run restrictions	0.00 [0.95]
LM test for serial correlation (F-test)	0.51 [0.48]
Normality test (χ^2-test)	1.18 [0.55]
White test for heteroscedasticity (F-test)	0.54 [0.84]
Sample period	1992:Q1-2006:Q4 ($T = 60$)

where:

UR	Unemployment rate (6.5).
$NAIRU$	Natural rate of unemployment (exogenous).
GDP	GDP (5.39).
$Q1$-$Q3$	Centered seasonal dummies.

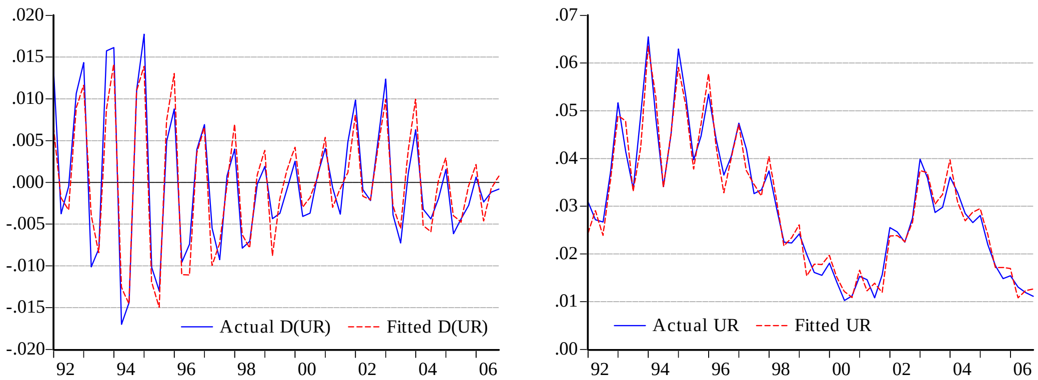


Figure 6.2. Fitted and actual ΔUR_t and UR_t

Single equation dynamic responses of (6.5):[29]

to 3.2% from (5.42), when assuming a population growth of 1%. This restriction is easily accepted by the data.

[29] Although the table reports the 'long-run' effects of an output growth shock, UR equals $NAIRU$ in steady state.

Table 6.2. Responses of UR to a 1% increase in RHS variables

Quarters	$NAIRU$	$\Delta_4 gdp$
Simultaneous	0.00	0.00
One quarter ahead	0.08	−0.02
Four quarters ahead	0.33	−0.10
Eight quarters ahead	0.69	−0.21
Long run	1.00	−0.30
50% of long-run effect	O/S	O/S
90% of long-run effect	O/S	O/S
Steady state solution:		
$UR = NAIRU$		

The level of unemployment is defined as:

$$UN_t = PA_t \times POWA_t - EMP_t \tag{6.6}$$

where:

UN	Level of unemployment (6.6).
PA	Participation rate (6.7).
$POWA$	Population at working age (16-64 years old) (exogenous).
EMP	Level of employment in man-years (6.9).

6.2.2. Participation rate (PA and PAT)

The labour participation rate is assumed to respond to cyclical fluctuations as follows:

$$\begin{aligned} PA_t \;=\; & \underset{(2.7)}{0.218} + \underset{(0.4)}{0.002}Q1 + \underset{(3.8)}{0.023}Q2 + \underset{(5.1)}{0.024}Q3 \\ & + \underset{(2.7)}{0.257}PA_{t-1} + \underset{(5.5)}{0.463}PA_{t-4} + \underset{(1.5)}{0.030}\Delta_4 gdp_{t-1} \end{aligned} \tag{6.7}$$

Estimation method	OLS
Adjusted R^2	0.910
Equation standard error	0.65%
LM test for serial correlation (F-test)	2.59 [0.11]
Normality test (χ^2-test)	3.79 [0.15]
White test for heteroscedasticity (F-test)	1.87 [0.52]
Sample period	1990:Q1-2006:Q4 ($T = 68$)

where:

PA	Participation rate (6.7).
GDP	GDP (5.39).
$Q1$-$Q3$	Centered seasonal dummies.

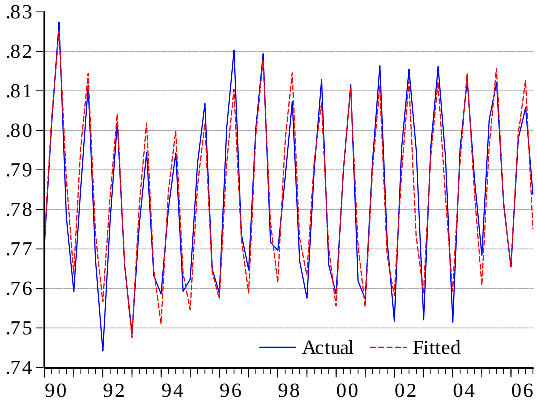


Figure 6.3. Fitted and actual PA_t

Single equation dynamic responses of (6.7):

Table 6.3. Responses of PA to a 1% increase in RHS variables

Quarters	$\Delta_4 gdp$
Simultaneous	0.00
One quarter ahead	0.03
Four quarters ahead	0.04
Eight quarters ahead	0.07
Long run	0.11
50% of long-run effect	5Q
90% of long-run effect	18Q
Steady state solution:	
$PA = const + 0.109\Delta gdp$	

Trend participation rate smoothes out the seasonal fluctuations in PA and serves as an input in trend employment (6.10). It is given as a four-quarter moving average of PA:

$$PAT_t = \left(\frac{PA_t + PA_{t-1} + PA_{t-2} + PA_{t-3}}{4} \right) \tag{6.8}$$

where:

PAT	Trend participation rate (6.8).
PA	Participation rate (6.7).

6.3. Employment and labour productivity

6.3.1. Employment in man-years (EMP and $EMPT$)

Employment in man-years is defined as:

$$EMP_t = PA_t \times POWA_t \times (1 - UR_t) \tag{6.9}$$

where:

EMP	Level of employment in man-years (6.9).
PA	Participation rate (6.7).
$POWA$	Population at working age (16-64 years old) (exogenous).
UR	Unemployment rate (6.5).

Trend employment is given as:

$$EMPT_t = PAT_t \times POWA_t \times (1 - NAIRU_t) \tag{6.10}$$

where:

$EMPT$	Trend employment (6.10).
PAT	Trend participation rate (6.8).
$POWA$	Population at working age (16-64 years old) (exogenous).
$NAIRU$	Natural rate of unemployment (exogenous).

6.3.2. Labour productivity ($PROD$ and $PRODT$)

Labour productivity is given by the following identity:

$$PROD_t = \frac{GDP_t}{EMP_t} \tag{6.11}$$

where:

$PROD$	Labour productivity (6.11).
GDP	GDP (5.39).
EMP	Level of employment in man-years (6.9).

Trend productivity is used to approximate business sector productivity and is similarly defined from the production function (5.41) as:

$$PRODT_t = \frac{GDPT_t}{EMPT_t} \tag{6.12}$$

where:

$PRODT$	Trend labour productivity (6.12).
$GDPT$	Potential output (5.42).
$EMPT$	Trend employment (6.10).

7. Price setting and inflation

This section describes price setting in QMM. Overall consumer price inflation is modelled as an expectations-augmented Phillips curve and other prices as a mark-up over marginal costs, with marginal costs in each case reflecting the inputs relevant for each sector.

7.1. Different price indices

7.1.1. Consumer price index (CPI)

Consumer price inflation is given by an expectations-augmented Phillips curve, also allowing for a temporary real exchange rate and real unit labour costs shocks. The equation imposes dynamic homogeneity on the coefficients (which is not rejected by the data) to ensure a vertical long-run Phillips curve and, hence, that no long-run trade-off between inflation and output exists. Due to the forward-looking part in the equation, the GMM method is used with two lags of $\Delta_4 cpi_t$ and a single lag of $\Delta_4 rexm_t$, $(\Delta_4 ulct_t - \Delta_4 cpi_t)$ and $GAPAV_{t-1}$ as instruments. The J-test does not reject the over-identifying restrictions. The equation is estimated using data until 2008:Q3:

$$\begin{aligned}\Delta_4 cpi_t &= \underset{(13.8)}{0.625}\Delta_4 cpi_{t-1} + \underset{(3.8)}{0.178}\Delta_4 cpi_{t+8} \\ &\quad +(1-0.625-0.178)\log(1+IT_t) + \underset{(3.8)}{0.111}\Delta_4 rexm_{t-1} \\ &\quad +\underset{(2.4)}{0.077}\Delta_4(ulct_{t-4} - cpi_{t-4}) + \underset{(2.6)}{0.083}GAPAV_{t-1}\end{aligned} \tag{7.1}$$

Estimation method	GMM
Adjusted R^2	0.883
Equation standard error	0.69%
Dynamic homogeneity (F-test)	1.17 [0.29]
J-test for over-identifying restrictions (χ^2-test)	1.26 [0.26]
Normality test (χ^2-test)	0.18 [0.91]
Sample period	1994:Q1-2006:Q3 ($T = 51$)

where:

CPI	Consumer price index (7.1).
IT	Central Bank of Iceland 2.5% inflation target (exogenous).
$GAPAV$	Annual average of output gap (5.44).
$REXM$	Importers' real exchange rate (4.18).
$ULCT$	Trend unit labour costs (6.4).

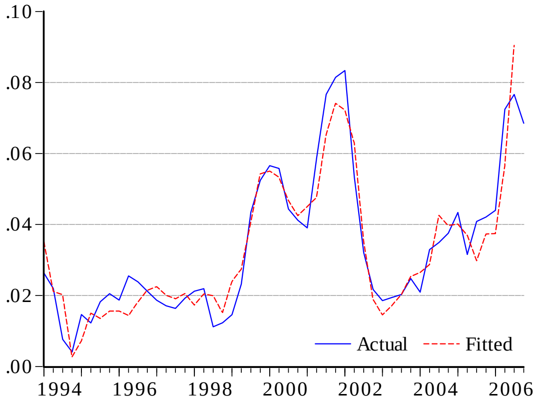


Figure 7.1. Fitted and actual $\Delta_4 cpi_t$

Single equation dynamic responses of (7.1):[30]

Table 7.1. Responses of $\Delta_4 cpi$ to a 1% increase in RHS variables

Quarters	$\log(1+IT)$	$\Delta_4 rexm$	$\Delta_4(ulct - cpi)$	$GAPAV$
Simultaneous	0.37	0.10	0.07	0.07
One quarter ahead	0.61	0.27	0.11	0.20
Four quarters ahead	0.90	0.49	0.24	0.37
Eight quarters ahead	0.98	0.55	0.37	0.41
Long run	1.00	0.56	0.39	0.42
50% of long-run effect	1Q	1Q	2Q	1Q
90% of long-run effect	4Q	2Q	4Q	2Q
Steady state solution:				
$\Delta_4 cpi = \log(1+IT)$				

7.1.2. Import price deflator (PM)

Import prices are determined by the main components of imports, i.e. general goods and services, oil and non-oil commodities. There are also affects of domestic labour costs, reflecting effects of domestic price pressures on importers' mark-ups:

[30] Note that the steady state solutions for $GAPAV$, $\Delta_4 rexm$ and $\Delta_4(ulct - cpi)$ are zero. Hence, although the table reports 'long-run' effects of these variables, their effects on inflation are only temporary. The steady state solution for $\Delta_4 cpi$ is therefore $\Delta_4 cpi = \log(1 + IT)$, which implies that $INF = IT$ in steady state, where INF is year-on-year percentage changes in the CPI level.

$$\begin{aligned}\Delta pm_t &= -\underset{(1.7)}{0.183}\Delta pm_{t-1} + \underset{(12.2)}{0.753}\Delta(wpx_t + eer_t) \qquad (7.2)\\ &+\underset{(2.6)}{0.272}\Delta(wpx_{t-1} + eer_{t-1}) + \underset{(1.7)}{0.070}\Delta(pcom_t + eus_t) + \underset{(1.3)}{0.071}\Delta ulct_{t-2}\\ &+(1 + 0.183 - 0.753 - 0.272 - 0.070 - 0.071)\Delta(poil_{t-1} + eus_{t-1})\end{aligned}$$

Estimation method	OLS
Adjusted R^2	0.874
Equation standard error	1.25%
Dynamic homogeneity (F-test)	2.21 [0.14]
LM test for serial correlation (F-test)	0.07 [0.80]
Normality test (χ^2-test)	0.34 [0.84]
White test for heteroscedasticity (F-test)	1.60 [0.17]
Sample period	1992:Q1-2006:Q4 ($T = 60$)

where:

PM	Import price deflator (7.2).
WPX	World export prices (exogenous).
$POIL$	Oil prices in USD (exogenous).
$PCOM$	Non-oil commodity prices in USD (exogenous).
$ULCT$	Trend unit labour costs (6.4).
EUS	USD exchange rate (4.11).
EER	Exchange rate index of foreign currencies (4.10).

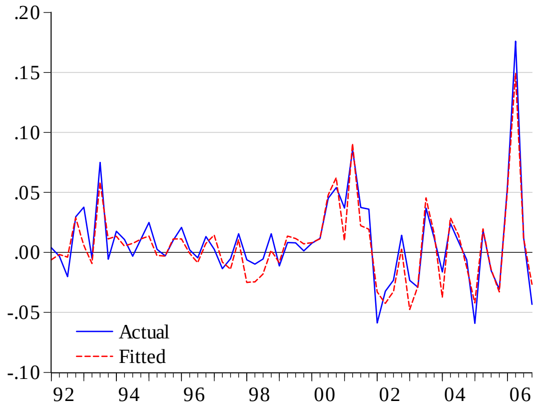


Figure 7.2. Fitted and actual Δpm_t

Single equation dynamic responses of (7.2):

Table 7.2. Responses of Δpm to a 1% increase in RHS variables

Quarters	$\Delta ulct$	Δwpx	$\Delta poil$	$\Delta pcom$	Δeer	Δeus
Simultaneous	0.00	0.75	0.00	0.07	0.75	0.07
One quarter ahead	0.00	0.89	0.02	0.06	0.89	0.07
Four quarters ahead	0.06	0.87	0.02	0.06	0.87	0.07
Eight quarters ahead	0.06	0.87	0.02	0.06	0.87	0.07
Long run	0.06	0.87	0.02	0.06	0.87	0.07
50% of long-run effect	O/S	O/S	O/S	O/S	O/S	O/S
90% of long-run effect	O/S	O/S	O/S	O/S	O/S	O/S

Steady state solution:
$\Delta pm = 0.059\Delta ulct + 0.867\Delta(wpx + eer) + 0.015\Delta(poil + eus) + 0.059\Delta(pcom + eus)$

7.1.3. Export price deflators ($PXREG$ and PX)

The export series $EXREG$ excludes aluminium and marine products. The largest remaining component is exports of services, which price is assumed to be determined by domestic and foreign consumer prices:

$$\begin{aligned}\Delta pxreg_t &= \underset{(2.4)}{0.022}D971 + \underset{(2.5)}{0.140}\Delta cpi_{t-2} + \underset{(23.9)}{0.803}\Delta(wcpi_t + eer_t) \\ &\quad +(1 - 0.140 - 0.803)\Delta(wcpi_{t-2} + eer_{t-2})\end{aligned} \tag{7.3}$$

Estimation method	OLS
Adjusted R^2	0.940
Equation standard error	0.90%
Dynamic homogeneity (F-test)	0.76 [0.39]
LM test for serial correlation (F-test)	3.83 [0.06]
Normality test (χ^2-test)	1.03 [0.60]
White test for heteroscedasticity (F-test)	0.13 [0.94]
Sample period	1997:Q1-2006:Q4 ($T = 40$)

where:

$PXREG$	Export prices excluding aluminium and marine products (7.3).
CPI	Consumer price index (7.1).
$WCPI$	World consumer prices (exogenous).
EER	Exchange rate index of foreign currencies (4.10).
$D971$	Dummy variable: 1 1997:Q1 and zero elsewhere.

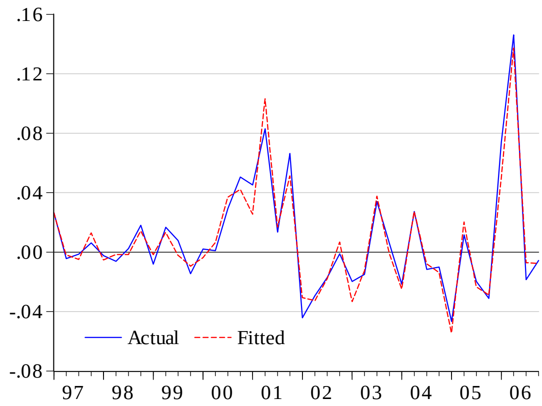


Figure 7.3. Fitted and actual $\Delta pxreg_t$

Single equation dynamic responses of (7.3):

Table 7.3. Responses of $\Delta pxreg$ to a 1% increase in RHS variables

Quarters	Δcpi	$\Delta(wcpi + eer)$
Simultaneous	0.00	0.80
One quarter ahead	0.00	0.80
Four quarters ahead	0.14	0.86
Eight quarters ahead	0.14	0.86
Long run	0.14	0.86
50% of long-run effect	2Q	0Q
90% of long-run effect	2Q	2Q

Steady state solution:
$\Delta pxreg = 0.140\Delta cpi + 0.860\Delta(wcpi + eer)$

Export prices for goods and services are given as

$$PX_t = \frac{EXN_t}{EX_t} \tag{7.4}$$

PX Export price deflator (7.4).
EXN Nominal exports of goods and services (5.28).
EX Exports of goods and services (5.27).

7.1.4. Private consumption deflator (PC)

The growth rate of the private consumption deflator depends on CPI inflation, but allowing for different seasonal patterns and different short-run responses of PC and

CPI inflation rates to exchange rate shocks, due to slightly different import densities of these indices:

$$\begin{aligned}\Delta pc_t &= \underset{(3.3)}{0.326}\Delta pc_{t-1} + (1-0.326)\Delta cpi_t + \underset{(3.3)}{0.050}\Delta^2 eer_t \\ &\quad + \underset{(3.5)}{0.0067}Q1 + \underset{(1.5)}{0.0031}Q2 - \underset{(1.0)}{0.0022}Q3\end{aligned} \tag{7.5}$$

Estimation method	OLS
Adjusted R^2	0.816
Equation standard error	0.43%
Dynamic homogeneity (F-test)	0.20 [0.66]
LM test for serial correlation (F-test)	0.76 [0.39]
Normality test (χ^2-test)	2.26 [0.32]
White test for heteroscedasticity (F-test)	1.38 [0.25]
Sample period	1997:Q1-2006:Q4 (T = 40)

where:

PC	Private consumption deflator (7.5).
CPI	Consumer price index (7.1).
EER	Exchange rate index of foreign currencies (4.10).
$Q1$-$Q3$	Centered seasonal dummies.

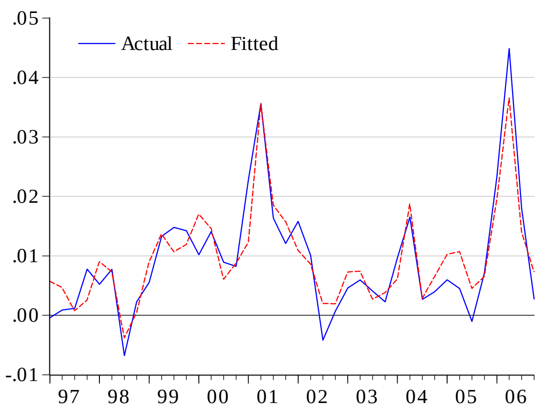


Figure 7.4. Fitted and actual Δpc_t

Single equation dynamic responses of (7.5):

Table 7.4. Responses of Δpc to a 1% increase in RHS variables

Quarters	Δcpi	Δeer
Simultaneous	0.67	0.050
One quarter ahead	0.89	0.016
Four quarters ahead	1.00	0.001
Eight quarters ahead	1.00	0.000
Long run	1.00	0.000
50% of long-run effect	0Q	-
90% of long-run effect	0Q	-
Steady state solution:		
$\Delta pc = \Delta cpi$		

7.1.5. Government consumption deflator (PG)

The government consumption deflator is determined by unit labour costs and consumer prices:

$$\begin{aligned}\Delta pg_t &= \underset{(4.1)}{0.025}Q1 - \underset{(0.7)}{0.003}Q2 - \underset{(0.3)}{0.002}Q3 \\ &\quad + \underset{(5.4)}{0.668}\Delta ulct_t + (1-0.668)\Delta cpi_t\end{aligned} \tag{7.6}$$

Estimation method	OLS
Adjusted R^2	0.756
Equation standard error	1.10%
Dynamic homogeneity (F-test)	1.69 [0.20]
LM test for serial correlation (F-test)	3.19 [0.08]
Normality test (χ^2-test)	3.75 [0.15]
White test for heteroscedasticity (F-test)	0.49 [0.74]
Sample period	1997:Q1-2006:Q4 (T = 40)

where:

PG	Government consumption deflator (7.6).
$ULCT$	Trend unit labour costs (6.4).
CPI	Consumer price index (7.1).
$Q1$-$Q4$	Centered seasonal dummies.

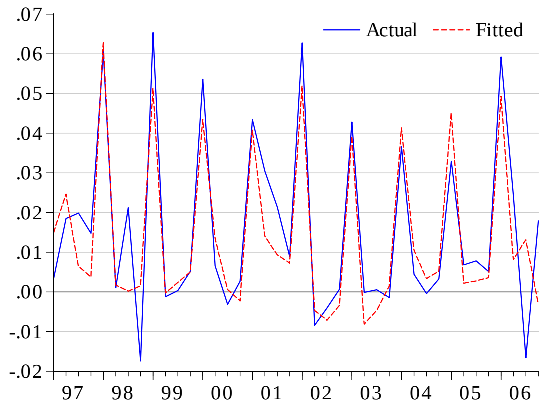


Figure 7.5. Fitted and actual Δpg_t

Single equation dynamic responses of (7.6):

Table 7.5. Responses of Δpg to a 1% increase in RHS variables

Quarters	$\Delta ulct$	Δcpi
Simultaneous	0.67	0.33
One quarter ahead	0.67	0.33
Four quarters ahead	0.67	0.33
Eight quarters ahead	0.67	0.33
Long run	0.67	0.33
50% of long-run effect	0Q	0Q
90% of long-run effect	0Q	0Q
Steady state solution:		
$\Delta pg = 0.668\Delta ulct + 0.332\Delta cpi$		

7.1.6. Investment goods price deflator (PI)

The price of investment goods is determined by building costs and import prices, the latter reflecting the large share of imported capital goods:

$$\Delta pi_t = \underset{(0.8)}{0.003}Q1 - \underset{(3.3)}{0.011}Q2 - \underset{(4.4)}{0.015}Q3 + \underset{(17.6)}{0.594}\Delta bc_t + (1 - 0.594)\Delta pm_t \tag{7.7}$$

Estimation method	OLS
Adjusted R^2	0.744
Equation standard error	0.94%
Dynamic homogeneity (F-test)	0.52 [0.47]
LM test for serial correlation (F-test)	1.45 [0.23]
Normality test (χ^2-test)	3.55 [0.17]
White test for heteroscedasticity (F-test)	0.78 [0.55]
Sample period	1992:Q1-2006:Q4 (T = 60)

where:

PI	Investment goods price deflator (7.7).
BC	Building costs (7.13).
PM	Import price deflator (7.2).
$Q1$-$Q3$	Centered seasonal dummies.

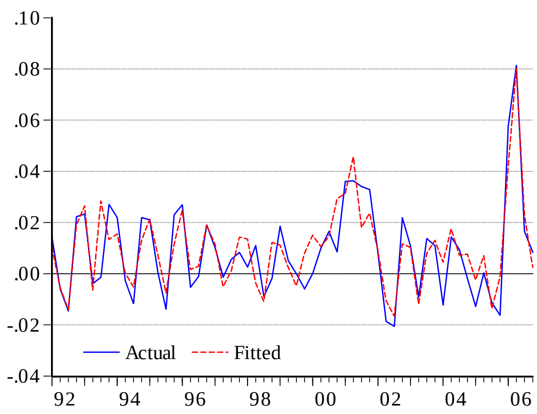


Figure 7.6. Fitted and actual Δpi_t

Single equation dynamic responses of (7.7):

Table 7.6. Responses of Δpi to a 1% increase in RHS variables

Quarters	Δbc	Δpm
Simultaneous	0.59	0.41
One quarter ahead	0.59	0.41
Four quarters ahead	0.59	0.41
Eight quarters ahead	0.59	0.41
Long run	0.59	0.41
50% of long-run effect	0Q	0Q
90% of long-run effect	0Q	0Q
Steady state solution:		
$\Delta pi = 0.594\Delta bc + 0.406\Delta pm$		

7.1.7. Housing investment deflator (PIH)

The housing investment deflator is simply given as:

$$\Delta pih_t = \Delta bc_t \tag{7.8}$$

where:

PIH	Housing investment deflator (7.8).
BC	Building costs (7.13).

7.1.8. Government investment deflator (PIG)

The price of government investment is determined by building costs and the general price of investment goods:[31]

$$\begin{aligned} \Delta pig_t &= \underset{(1.0)}{0.001}Q1 - \underset{(2.4)}{0.005}Q2 - \underset{(0.9)}{0.002}Q3 \\ &\quad -\underset{(3.0)}{0.155}\Delta pig_{t-1} + \underset{(10.4)}{0.641}\Delta bc_t + (1 + 0.155 - 0.641)\Delta pi_t \end{aligned} \tag{7.9}$$

Estimation method	OLS
Adjusted R^2	0.860
Equation standard error	0.50%
Dynamic homogeneity (F-test)	0.04 [0.84]
LM test for serial correlation (F-test)	1.30 [0.26]
Normality test (χ^2-test)	0.60 [0.74]
White test for heteroscedasticity (F-test)	3.91 [0.00]
Sample period	1992:Q1-2006:Q4 (T = 60)

[31] The t-values reported are based on the White heteroscedasticity consistent standard errors.

where:

PIG	Government investment deflator (7.9).
BC	Building costs (7.13).
PI	Investment goods price deflator (7.7).
$Q1$-$Q3$	Centered seasonal dummies.

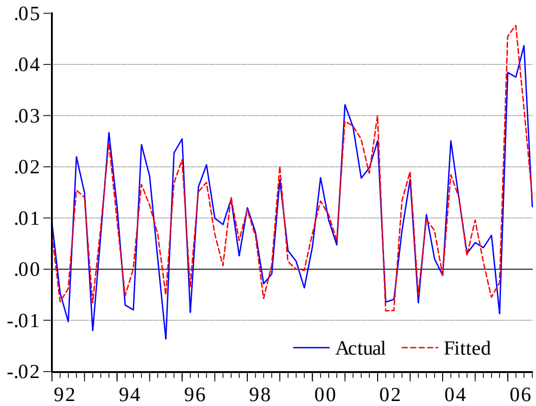


Figure 7.7. Fitted and actual Δpig_t

Single equation dynamic responses of (7.9):

Table 7.7. Responses of Δpig to a 1% increase in RHS variables

Quarters	Δbc	Δpi
Simultaneous	0.64	0.51
One quarter ahead	0.54	0.43
Four quarters ahead	0.56	0.44
Eight quarters ahead	0.56	0.44
Long run	0.56	0.44
50% of long-run effect	O/S	O/S
90% of long-run effect	O/S	O/S
Steady state solution:		
$\Delta pig = 0.555\Delta bc + 0.445\Delta pi$		

7.1.9. GDP price deflator ($PGDP$)

The GDP price deflator is the residual price level from the income accounting identity and is given as:

$$PGDP_t = \frac{GDPN_t}{GDP_t} \tag{7.10}$$

where:

$PGDP$	GDP price deflator (7.10).
$GDPN$	Nominal GDP (5.40).
GDP	GDP (5.39).

7.1.10. House prices (PH)

The demand for housing can be written as a positive function of household income and a negative function of real house prices and interest rates. By inverting the demand function a long-run solution for real house prices can be written as:

$$(ph - cpi) = \alpha_{ph} - \beta_{ph}(kh - ly) - \phi_{ph} RLV \tag{7.11}$$

where PH are house prices, CPI is the general price level, KH is the housing stock, LY is real household disposable labour income and RLV is the real long-term interest rate:[32]

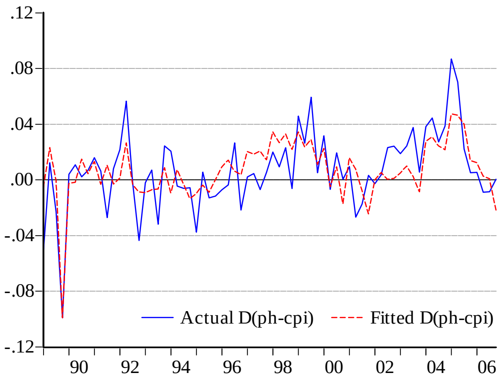
$$\begin{aligned}
\Delta(ph_t - cpi_t) \quad = \quad & \underset{(5.0)}{0.284} - \underset{(5.1)}{0.103} D894 + \underset{(3.6)}{0.303} \Delta(ph_{t-2} - cpi_{t-2}) \\
& + \underset{(2.4)}{0.139} \Delta ly_t - \underset{(2.7)}{1.400} \Delta RLV_t \\
& - \underset{(4.9)}{0.191} \left[(ph_{t-2} - cpi_{t-2}) + 0.642(kh_{t-2} - ly_{t-2}) \right. \\
& \left. + 0.883 RLV_{t-2} - 0.350 S04 + 0.173 D04 \right]
\end{aligned} \tag{7.12}$$

Estimation method	OLS
Adjusted R^2	0.496
Equation standard error	1.96%
Long-run restrictions (F-test)	1.54 [0.22]
LM test for serial correlation (F-test)	2.63 [0.11]
Normality test (χ^2-test)	1.27 [0.53]
White test for heteroscedasticity (F-test)	0.25 [0.94]
Sample period	1989:Q1-2006:Q4 ($T = 72$)

where:

[32] The shift dummy $S04$ captures the structural break in the constant in the long-run relation in 2004Q1 suggested by the Andrews and Ploeberger (1994) *ExpF*-test. This probably reflects the structural change in the domestic housing market on housing prices, analysed in Elíasson and Pétursson (2009). The impulse dummy $D04$ captures the large outlier in 2004 when $S04$ is introduced, suggesting that the structural change in the housing market occurred in two steps from the beginning of 2004, with the full shift occurring in the beginning of 2005.

PH	House prices (7.12).
CPI	Consumer price index (7.1).
KH	Private sector housing stock (5.20).
LY	Real post-tax labour income (9.6)
RLV	Long-term indexed interest rate (4.7).
$D894$	Dummy variable: 1 1989:Q4 and zero elsewhere.
$S04$	Shift dummy variable: 1 from 2004:Q1 and zero before.
$D04$	Dummy variable: 1 2004:Q1-2004:Q4 and zero elsewhere.



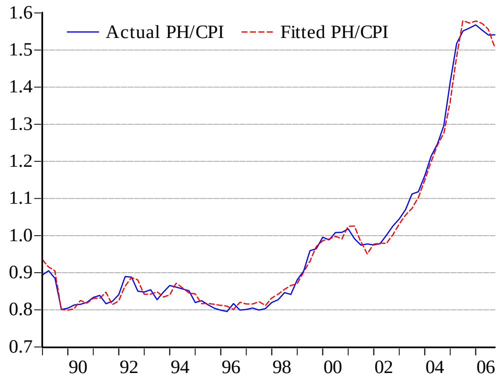


Figure 7.8. Fitted and actual $\Delta(ph_t - cpi_t)$ and PH_t/CPI_t

Single equation dynamic responses of (7.12):

Table 7.8. Responses of $ph - cpi$ to a 1% increase in RHS variables

Quarters	kh	ly	RLV
Simultaneous	0.00	0.14	−1.40
One quarter ahead	0.00	0.14	−1.40
Four quarters ahead	−0.38	0.48	−1.57
Eight quarters ahead	−0.69	0.69	−0.98
Long run	−0.64	0.64	−0.88
50% of long-run effect	O/S	O/S	O/S
90% of long-run effect	O/S	O/S	O/S

Steady state solution:
$(ph - cpi) = const - 0.642(kh - ly) - 0.883RLV$

7.1.11. Building costs (BC)

Building costs are determined by consumer prices and unit labour costs:

$$\Delta bc_t = \underset{(3.8)}{0.381}\Delta bc_{t-1} + \underset{(3.7)}{0.415}\Delta cpi_t + \underset{(2.2)}{0.298}\Delta cpi_{t-1} - \underset{(2.6)}{0.318}\Delta cpi_{t-2} \tag{7.13}$$
$$+(1 - 0.381 - 0.415 - 0.298 + 0.318)\Delta ulct_t + \underset{(4.1)}{0.028}D021$$

Estimation method	OLS
Adjusted R^2	0.573
Equation standard error	0.64%
Dynamic homogeneity (F-test)	0.19 [0.66]
LM test for serial correlation (F-test)	1.49 [0.23]
Normality test (χ^2-test)	4.49 [0.11]
White test for heteroscedasticity (F-test)	0.61 [0.69]
Sample period	1992:Q1-2006:Q4 ($T = 60$)

where:

BC	Building costs (7.13).
CPI	Consumer price index (7.1).
$ULCT$	Trend unit labour costs (6.4).
$D021$	Dummy variable: 1 2002:Q1 and zero elsewhere.

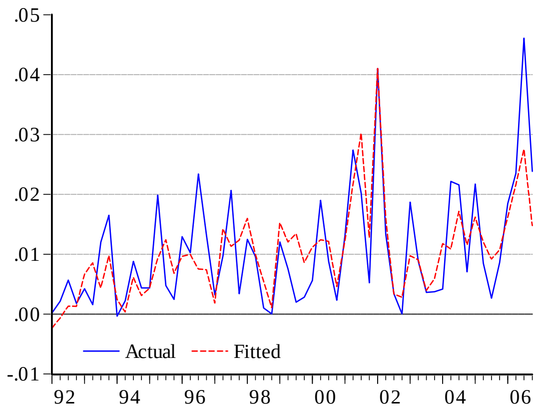


Figure 7.9. Fitted and actual Δbc_t

Single equation dynamic responses of (7.13):

Table 7.9. Responses of Δbc to a 1% increase in RHS variables

Quarters	Δcpi	$\Delta ulct$
Simultaneous	0.41	0.22
One quarter ahead	0.87	0.31
Four quarters ahead	0.65	0.36
Eight quarters ahead	0.64	0.36
Long run	0.64	0.36
50% of long-run effect	O/S	0Q
90% of long-run effect	O/S	2Q
Steady state solution:		
$\Delta bc = 0.637\Delta cpi + 0.363\Delta ulct$		

7.2. Inflation

7.2.1. Quarterly and annual inflation rates ($INFQ$, INF and $WINF$)

Quarterly inflation is calculated as:

$$INFQ_t = CPI_t/CPI_{t-1} - 1 \tag{7.14}$$

and year-on-year inflation as:

$$INF_t = CPI_t/CPI_{t-4} - 1 \tag{7.15}$$

where:

$INFQ$	Quarterly CPI inflation rate (7.14).
INF	Four-quarter CPI inflation rate (7.15).
CPI	Consumer price index (7.1).

Similarly, year-on-year world inflation is given as:

$$WINF_t = WCPI_t/WCPI_{t-4} - 1 \tag{7.16}$$

where:

$WINF$	Four-quarter world inflation rate (7.16).
$WCPI$	World consumer prices (exogenous).

7.3. Inflation expectations

Inflation expectations in QMM are assumed to be rational, i.e. consistent with the QMM model structure (model consistent expectations). They are therefore derived in a forward-looking manner from (7.1) using the Fair-Taylor algorithm.

7.3.1. Break-even inflation expectations ($INFE$)

Historical data on break-even inflation expectations in QMM are obtained from the interest rate spread between nominal and indexed bonds, taking account of an inflation risk premium, cf. equation (4.7):

$$INFE_t = (RL_t - RLV_t) - PRISK_t \tag{7.17}$$

For forecasting, break-even inflation expectations are given as the five year average of the model-consistent expected inflation rate:

$$INFE_t = \frac{1}{20}\sum_{j=0}^{19} INF_{t+j} \tag{7.18}$$

where:

$INFE$	Break-even inflation expectations (7.17).
RL	Long-term interest rate (4.6).
RLV	Long-term indexed interest rate (4.7).
$PRISK$	Inflation risk premium (exogenous).
INF	Four-quarter CPI inflation rate (7.15).

8. Fiscal policy

The fiscal part mainly comprises accounting identities and adding-up constraints using exogenous tax rates.

8.1. Government income

8.1.1. Taxation receipts (TAX)

Total taxation receipts are an accounting identity:

$$TAX_t = TJ_t + TC_t + TE_t \tag{8.1}$$

where:

TAX	Total tax receipts (8.1).
TJ	Household tax payments (8.2).
TC	Corporate tax payments (8.6).
TE	Total taxes on production and imports (8.11).

8.1.2. Household tax payments (TJ, TJY, TI and TJO)

Household tax payments are given by the sum of receipts from taxes on household income, financial income and other taxes paid by households:

$$TJ_t = TJY_t + TI_t + TJO_t \tag{8.2}$$

where:

TJ	Household tax payments (8.2).
TJY	Household income tax (8.3).
TI	Household financial income tax (8.4)
TJO	Other household tax payments (8.5).

Household income tax payments are given as:

$$TJY_t = RJY_t \times (YE_t + CJ_t) - ALLOW_t \times POWA_t \tag{8.3}$$

where:

TJY	Household income tax (8.3).
RJY	Household income tax rate (exogenous).
YE	Wages, salaries and self-employed income (9.2).
CJ	Current grants to the household sector (8.16).
$ALLOW$	Personal allowances (exogenous).
$POWA$	Population at working age (16-64 years old) (exogenous).

Tax payments on financial income as a ratio to nominal GDP are given as a function of real equity prices and long-term nominal interest rates:

$$\begin{aligned} TI_t/GDPN_t \;=\; & \underset{(2.3)}{0.001} - \underset{(1.0)}{0.0002}Q1 - \underset{(1.6)}{0.0003}Q2 - \underset{(1.7)}{0.0004}Q3 \\ & + \underset{(7.1)}{1.304} TI_{t-1}/GDPN_{t-1} - \underset{(2.2)}{0.416} TI_{t-2}/GDPN_{t-2} \\ & + \underset{(2.6)}{0.002}(eqp_{t-4} - pgdp_{t-4}) - \underset{(2.5)}{0.018}\Delta_4 RL_{t-4} \end{aligned} \tag{8.4}$$

Estimation method	OLS
Adjusted R^2	0.985
Equation standard error	0.04%
LM test for serial correlation (F-test)	0.57 [0.46]
Normality test (χ^2-test)	1.92 [0.38]
White test for heteroscedasticity (F-test)	2.96 [0.02]
Sample period	1998:Q3-2006:Q4 (T = 34)

where:

TI	Household financial income tax (8.4)
$GDPN$	Nominal GDP (5.40).
EQP	Equity prices (4.19).
$PGDP$	GDP price deflator (7.10).
RL	Long-term interest rate (4.6).
$Q1$-$Q3$	Centered seasonal dummies.

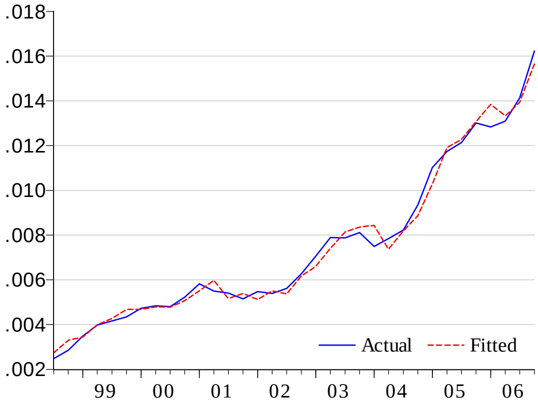


Figure 8.1. Fitted and actual $TI_t/GDPN_t$

Single equation dynamic responses of (8.4):

Table 8.1. Responses of $TI/GDPN$ to a 1% increase in RHS variables

Quarters	$(eqp - pgdp)$	RL
Simultaneous	0.000	0.00
One quarter ahead	0.000	0.00
Four quarters ahead	0.002	−0.018
Eight quarters ahead	0.009	−0.086
Long run	0.014	0.000
50% of long-run effect	7Q	-
90% of long-run effect	13Q	-
Steady state solution:		
$TI/GDPN = const - 0.014(eqp - pgdp)$		

Other household direct taxes are given as:

$$TJO_t = RJO_t \times GDPN_t \tag{8.5}$$

where:

TJO	Other household tax payments (8.5).
RJO	Household other tax rate (exogenous).
$GDPN$	Nominal GDP (5.40).

8.1.3. Corporate tax payments (TC, TCI, TCP, TIC and TWC)

Corporate tax payments are given by the sum of receipts from corporate income and property taxes:

$$TC_t = TCI_t + TCP_t + TIC_t + TWC_t \tag{8.6}$$

where:

TC	Corporate tax payments (8.6).
TCI	Corporate income tax payments (8.7).
TCP	Corporate property tax payments (8.8).
TIC	Other tax payments (8.9).
TWC	Corporate wage cost tax payments (8.10).

Corporate income tax receipts are given as:

$$TCI_t = RCI_t \times GDPN_{t-4} \tag{8.7}$$

where:

TCI	Corporate income tax payments (8.7).
RCI	Corporate income tax rate (exogenous).
$GDPN$	Nominal GDP (5.40).

Corporate property tax receipts are given as:

$$TCP_t = RCP_t \times GDPN_t \tag{8.8}$$

where:

TCP	Corporate property tax payments (8.8).
RCP	Corporate property tax rate (exogenous).
$GDPN$	Nominal GDP (5.40).

Other tax payments are given as:

$$TIC_t = RFIC_t \times GDPN_t \tag{8.9}$$

where:

TIC	Other tax payments (8.9).
$RFIC$	Tax rate for other payments (exogenous).
$GDPN$	Nominal GDP (5.40).

Corporate wage costs tax payments are given as:

$$TWC_t = RWC_t \times YE_t \tag{8.10}$$

where:

TWC	Corporate wage cost tax payments (8.10).
RWC	Corporate wage cost tax rate (exogenous).
YE	Wages, salaries and self-employed income (9.2).

8.1.4. Taxes on expenditure (TE, $TVAT$, TSD and $TIMP$)

Total taxes on production and imports are given as the sum of value-added taxation receipts, tarriffs and other import taxes, and other expenditure taxation receipts:

$$TE_t = TVAT_t + TIMP_t + TSD_t \tag{8.11}$$

where:

TE	Total taxes on production and imports (8.11).
$TVAT$	Value-added taxation receipts (8.12).
$TIMP$	Tariffs and other taxes on imports (8.13).
TSD	Other expenditure taxation receipts (8.14).

Value-added taxation receipts are given as:

$$TVAT_t = RVAT_t \times CN_t \tag{8.12}$$

where:

$TVAT$	Value-added taxation receipts (8.12).
$RVAT$	Value-added tax rate (exogenous).
CN	Nominal private consumption (5.3).

Tariffs and other taxes on imports are given as:

$$TIMP_t = RIMP_t \times IMPN_t \tag{8.13}$$

where:

$TIMP$	Tariffs and other taxes on imports (8.13).
$RIMP$	Tax rate on imports (exogenous).
$IMPN$	Nominal imports of goods and services (5.31).

Other expenditure tax receipts are given as:

$$TSD_t = RSD_t \times CN_t \tag{8.14}$$

where:

TSD	Other expenditure taxation receipts (8.14).
RSD	Other expenditure tax rate (exogenous).
CN	Nominal private consumption (5.3).

8.2. Government expenditure and net borrowing

8.2.1. Subsidies ($SUBS$)

Government subsidies on production are given as:

$$SUBS_t = RTS_t \times GDPN_t \tag{8.15}$$

where:

$SUBS$	Government subsidies (8.15).
RTS	Effective subsidies rate (exogenous).
$GDPN$	Nominal GDP (5.40).

8.2.2. Other public sector expenditure (CJ and DI)

Besides government consumption and investment, government expenditure includes current grants to the household sector and interest rate payments on general government debt.

The ratio of grants to households (predominantly social security payments) to nominal GDP is assumed to be negatively related to the output gap:

$$CJ_t/GDPN_t = \underset{(3.9)}{0.029} + \underset{(2.8)}{0.421} CJ_{t-1}/GDPN_{t-1} - \underset{(2.6)}{0.036} GAPAV_t \tag{8.16}$$

Estimation method	OLS
Adjusted R^2	0.438
Equation standard error	0.18%
LM test for serial correlation (F-test)	1.23 [0.27]
Normality test (χ^2-test)	0.00 [0.98]
White test for heteroscedasticity (F-test)	1.06 [0.36]
Sample period	1997:Q1-2006:Q4 (T = 40)

where:

CJ	Current grants to the household sector (8.16).
$GDPN$	Nominal GDP (5.40).
$GAPAV$	Annual average of output gap (5.44).

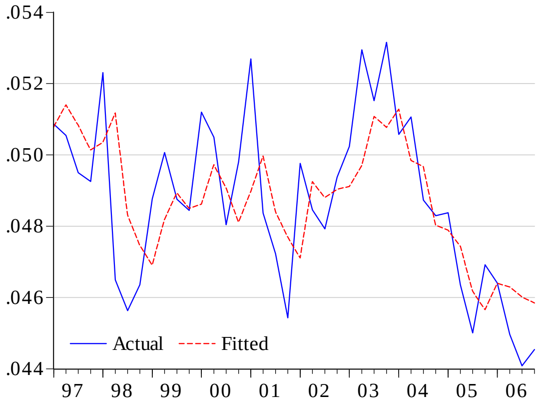


Figure 8.2. Fitted and actual $CJ_t/GDPN_t$

Single equation dynamic responses of (8.16):[33]

Table 8.2. Responses of $CJ/GDPN$ to a 1% increase in RHS variables

Quarters	$GAPAV$
Simultaneous	-0.03
One quarter ahead	-0.04
Four quarters ahead	-0.06
Eight quarters ahead	-0.06
Long run	-0.06
50% of long-run effect	0Q
90% of long-run effect	2Q
Steady state solution:	
$CJ/GDPN = const - 0.060GAPAV$	

Interest payments on government domestic nominal and indexed debt and foreign debt grow according to, with the first 4% term approximating the fixed pension fund liabilities of the government:[34]

$$\Delta DI_t = \left[0.48\left(\frac{0.04}{4}\right) + 0.21\left(\frac{RL_t}{4}\right) + 0.31\left(\left(\frac{EER_t}{EER_{t-1}}\right)\left(1+\frac{WRS_t}{4}\right) - 1\right)\right] PSNB_t \tag{8.17}$$

[33] Note that the steady state solutions for $GAPAV$ is zero. Hence, although the table reports 'long-run' effects, its effects on $CJ/GDPN$ is only temporary.

[34] The weights are for 2007 and are obtained from Statistics Iceland.

where:

DI	General government debt interest payments (8.17).
RL	Long-term interest rate (4.6).
EER	Exchange rate index of foreign currency (4.10).
WRS	Foreign short-term interest rate (exogenous).
$PSNB$	Public sector net borrowing (8.18).

8.2.3. Public sector net borrowing ($PSNB$)

Public sector net borrowing is the sum of expenditure items less taxation receipts:

$$PSNB_t = (GN_t + IGNNET_t + CJ_t + DI_t + SUBS_t) - TAX_t \tag{8.18}$$

where:

$PSNB$	Public sector net borrowing (8.18).
GN	Nominal government consumption (exogenous).
$IGNNET$	Nominal net government investment (5.17).
CJ	Current grants to the household sector (8.16).
DI	General government debt interest payments (8.17).
$SUBS$	Government subsidies (8.15).
TAX	Total tax receipts (8.1).

9. Household income accounting

This final section closes QMM by defining the household income accounting identities.

9.1. Total household pre-tax income (YJ, YE, YIC and $YDIJ$)

Total household sector pre-tax income is given by the identity:

$$YJ_t = YE_t + CJ_t + YIC_t + YDIJ_t \tag{9.1}$$

where:

YJ	Total household pre-tax income (9.1).
YE	Wages, salaries and self-employed income (9.2).
CJ	Current grants to the household sector (8.16).
YIC	Households' other income (9.3).
$YDIJ$	Other household non-labour income (9.4).

Total wages, salaries and self-employed income is assumed to grow in line with nominal wages and employment:

$$\Delta ye_t = \Delta w_t + \Delta emp_t \tag{9.2}$$

where:

YE	Wages, salaries and self-employed income (9.2).
W	Wages (6.2).
EMP	Level of employment in man-years (6.9).

Households' other income is given as a constant ratio to wage income:

$$YIC_t = RIC_t \times YE_t \tag{9.3}$$

where:

YIC	Households' other income (9.3).
RIC	Ratio of households' other income to YE (exogenous).
YE	Wages, salaries and self-employed income (9.2).

Households' (nominal) net financial income is given as a positive function of the short-term interest rate (reflecting the positive interest rate effect on short-term deposits) and a negative function of the long-term indexed interest rate and inflation (reflecting the domination of indexed long-term debt):

$$\begin{aligned} YDIJ_t/GDPN_t \;=\; & \underset{(2.1)}{0.003} - \underset{(0.6)}{0.0002}Q1 + \underset{(2.0)}{0.001}Q2 + \underset{(1.7)}{0.001}Q3 \\ & +\underset{(12.4)}{1.424}YDIJ_{t-1}/GDPN_{t-1} - \underset{(3.6)}{0.460}YDIJ_{t-2}/GDPN_{t-2} \\ & +\underset{(1.9)}{0.028}RS_{t-1} - \underset{(2.8)}{0.086}RLV_t - \underset{(2.2)}{0.065}\Delta cpi_{t-1} + \underset{(3.7)}{0.0032}D05461 \end{aligned} \tag{9.4}$$

Estimation method	OLS
Adjusted R^2	0.991
Equation standard error	0.10%
LM test for serial correlation (F-test)	1.87 [0.18]
Normality test (χ^2-test)	0.85 [0.65]
White test for heteroscedasticity (F-test)	2.82 [0.01]
Sample period	1994:Q3-2006:Q4 (T = 50)

where:

$YDIJ$	Other household non-labour income (9.4).
$GDPN$	Nominal GDP (5.40).
RS	Short-term interest rate (4.1).
RLV	Long-term indexed interest rate (4.7).
CPI	Consumer price index (7.1).
$D05461$	Dummy variable: 1 2005Q4-2006Q1 and zero elsewhere.
$Q1$-$Q3$	Centered seasonal dummies.

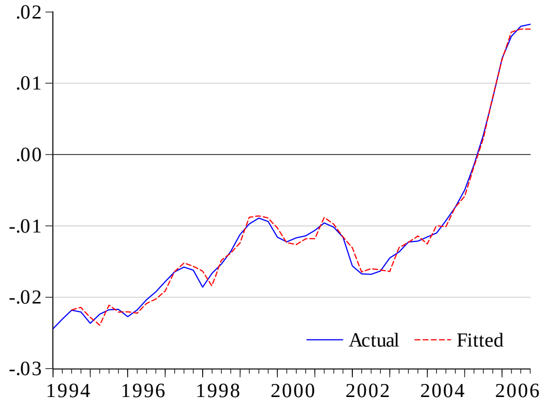


Figure 9.1. Fitted and actual $YDIJ_t/GDPN_t$

Single equation dynamic responses of (9.4):

Table 9.1. Responses of $YDIJ/GDPN$ to a 1% increase in RHS variables

Quarters	RS	RLV	Δcpi
Simultaneous	0.00	−0.09	0.00
One quarter ahead	0.03	−0.21	−0.06
Four quarters ahead	0.16	−0.61	−0.36
Eight quarters ahead	0.31	−1.06	−0.73
Long run	0.79	−2.42	−1.83
50% of long-run effect	11Q	10Q	11Q
90% of long-run effect	32Q	32Q	33Q

Steady state solution:
$YDIJ/GDPN = const + 0.790RS - 2.420RLV - 1.830\Delta cpi$

9.2. Real household post-tax income ($RHPI$ and LY)

Real household post-tax income is defined as total household sector pre-tax income less tax deductions from household income, all deflated with the private consumption price deflator:

$$RHPI_t = \left(\frac{YJ_t - TJ_t}{PC_t}\right) \tag{9.5}$$

where:

$RHPI$	Real household post-tax income (9.5)
YJ	Total household pre-tax income (9.1).
TJ	Household tax payments (8.2).
PC	Private consumption deflator (7.5).

Real post-tax labour income is defined as:

$$LY_t = \frac{(YJ_t - YDIJ_t) - (TJ_t - TI_t)}{PC_t} \tag{9.6}$$

where:

LY	Real post-tax labour income (9.6)
YJ	Total household pre-tax income (9.1).
$YDIJ$	Other household non-labour income (9.4).
TJ	Household tax payments (8.2).
TI	Household financial income tax (8.4)
PC	Private consumption deflator (7.5).

10. Backward-looking version of QMM

Although the forward-looking version of QMM is generally used, a backward-looking version is also available. These are equations for the monetary policy rule (4.1), nominal long-term interest rates (4.6), the real exchange rate (4.16), and inflation and inflation expectations (7.1).

10.1. Short-term interest rates (RS)

The backward-looking version of the policy rule is given as:

$$RS_t = 0.6RS_{t-1} + 0.4\left[(RRN_t + IT_t) + 1.5(INF_t - IT_t) + 0.5GAPAV_t\right] \tag{10.1}$$

10.2. Long-term interest rates (RL)

The backward-looking version of the nominal long-term interest rate is given as:

$$\begin{aligned} \Delta RL_t \;=\; & -\underset{(3.6)}{0.015}D011 - \underset{(5.3)}{0.025}D063 + \underset{(2.1)}{0.252}\Delta RL_{t-1} + \underset{(3.5)}{0.653}\Delta RS_t \\ & -\underset{(1.3)}{0.253}\Delta RS_{t-1} - \underset{(3.3)}{0.143}[RL_{t-1} - TERM_{t-1} - RS_{t-1}] \end{aligned} \tag{10.2}$$

Estimation method	OLS
Adjusted R^2	0.570
Equation standard error	0.42%
LM test for serial correlation (F-test)	0.49 [0.49]
Normality test (χ^2-test)	0.04 [0.98]
White test for heteroscedasticity (F-test)	0.50 [0.80]
Sample period	1996:Q1-2006:Q4 ($T = 44$)

where:

RL	Long-term interest rate (4.6).
RS	Short-term interest rate (4.1).
$TERM$	Term premium (exogenous).
$D011$	Dummy variable: 1 2001:Q1 and zero elsewhere.
$D063$	Dummy variable: 1 2006:Q3 and zero elsewhere.

10.3. Real exchange rate (REX)

The backward-looking version of the real exchange rate equation is given as:

$$(rex_t - rexeq_t) = \underset{(21.0)}{0.948}(rex_{t-1} - rexeq_{t-1}) + rid_t \tag{10.3}$$

Estimation method	OLS
Adjusted R^2	0.800
Equation standard error	3.87%
LM test for serial correlation (F-test)	1.26 [0.27]
Normality test (χ^2-test)	23.18 [0.00]
White test for heteroscedasticity (F-test)	5.14 [0.03]
Sample period	1997:Q1-2007:Q4 ($T = 44$)

where:

REX	Real exchange rate (4.16).
$REXEQ$	Equilibrium real exchange rate (exogenous).
RID	Real interest rate differential (4.9).

10.4. Inflation and inflation expectations (CPI and $INFE$)

The backward-looking version of the inflation equation is given as:

$$\begin{aligned} \Delta_4 cpi_t = {} & \underset{(11.7)}{0.650}\Delta_4 cpi_{t-1} + (1 - 0.650)\log(1 + INFE_t) \\ & + \underset{(4.4)}{0.075}\Delta_4 rexm_{t-1} + \underset{(3.4)}{0.092}\Delta_4(ulct_{t-4} - cpi_{t-4}) + \underset{(3.9)}{0.104}GAPAV_{t-1} \end{aligned} \tag{10.4}$$

Estimation method	OLS
Adjusted R^2	0.887
Equation standard error	0.69%
LM test for serial correlation (F-test)	2.07 [0.16]
Normality test (χ^2-test)	0.25 [0.88]
White test for heteroscedasticity (F-test)	0.40 [0.81]
Sample period	1994:Q1-2006:Q4 ($T = 52$)

In the backward-looking version inflation expectations are assumed to be given as a weighted average of an adaptive expectations term and the inflation target, with the standard value of the weight on the adaptive expectations term, ω_{pe}, equal to 0.6 and the error correction in the adaptive expectations term, η_{pe}, given as 0.5:[35]

$$INFE_t = \omega_{pe} \left\{ INFE_{t-1} + \eta_{pe}(INF_{t-1} - INFE_{t-1}) \right\} + (1 - \omega_{pe}) IT_t \qquad (10.5)$$

where:

CPI	Consumer price index (7.1).
$INFE$	Break-even inflation expectations (7.17).
$GAPAV$	Annual average of output gap (5.44).
$REXM$	Importers' real exchange rate (4.18).
$ULCT$	Trend unit labour costs (6.4).
INF	Four-quarter CPI inflation rate (7.15).
IT	Central Bank of Iceland 2.5% inflation target (exogenous).

[35] This implies that current inflation expectations are given by past expectations with a weight of 0.3, past inflation with a weight of 0.3 and the inflation target with a weight of 0.4.

Part III
Model Properties

11. Monetary policy transmission mechanism in QMM

The propagation of monetary policy shocks throughout the economy is fairly standard in QMM. The model incorporates all the main channels of monetary policy, i.e. an interest rate channel, an asset price channel, an exchange rate channel, and an expectations channel. Through these channels the monetary policy shock propagates to aggregate demand, and from there to inflation. Figure 11.1 gives a simplified overview over these main transmission channels.[36]

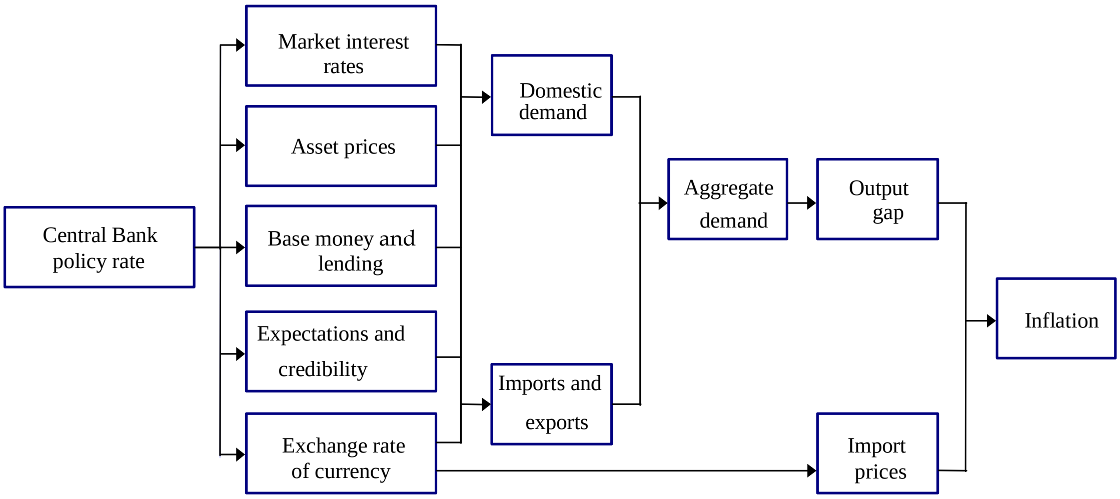


Figure 11.1. The transmission mechanism of monetary policy (Pétursson, 2001b)

11.1. Interest rate channel

In QMM, monetary policy actions are conducted through changes in the short-term interest rate (4.1). A rise in the policy rate affects the slope of the yield curve through long-term interest rates (4.6). If inflation expectations are sufficiently anchored, this will also raise the long-term real interest rates (4.7) and the real cost of capital (4.8). This has a first round effect on various expenditure items, such as consumption (5.2) and business investment (5.10), thus dampening domestic demand and easing capacity pressures as measured by the output gap (5.43). This further dampens demand for imported goods and services (5.30), increases unemployment (6.5), and reduces the demand for housing (7.12). Easing demand pressures reduces pressure on prices of domestic (7.1) and imported goods (7.2), and nominal assets, such as housing (7.12), and labour (6.2).

The second round effects are equally important (if not more so). For example, as demand in goods and labour markets falls, household labour income also declines (9.6), leading to a fall in total household disposable income (9.5). This further reduces private consumption and aggregate demand in the economy.

[36] From Pétursson (2001b), which gives a detailed discussion of these channels, with some structural VAR estimation results for Iceland. The credit channel, shown in Figure 11.1, does not really play a prominent role in QMM.

11.2. Asset price channel

Through its effect on asset prices, the monetary policy shock will also affect household net wealth and private sector balance sheets. A rise in the short-term interest rate will dampen the demand for money (4.28) and the subsequent rise in long-term interest rates and fall in nominal income will lead to a fall in equity prices (4.19) and rise in household debt (4.24). The rising debt and the fall in equity prices and in the market value of long-term bonds will reduce the net financial wealth of households (4.22) and the market value of firms. In addition, the fall in house prices will reduce housing investment (5.14), and both will reduce the housing wealth of households (4.21). Total household wealth (4.20) will therefore fall, reducing private consumption and aggregate demand further.

11.3. Exchange rate channel

An important channel for monetary policy in small open economies like Iceland is the working of monetary policy through changes in the exchange rate. The rise in short-term interest rates will usually lead to a currency appreciation (4.10), which will lead to a temporary real exchange rate appreciation (4.16) as domestic nominal prices adjust slowly. The competitive position of the export industry (4.17) will therefore weaken temporarily with export volumes (5.26) and export prices in domestic currency (7.4) declining. The competitive position of sectors competing with imported goods will also weaken as import prices in domestic currency (7.2) fall, thus pushing relative import prices (4.18) down and import volumes (5.30) up, hence shifting demand out of the economy. This increase in demand for imported goods will somewhat counteract the fall in imports stemming from falling domestic demand discussed above and may even lead to a worsening of the trade balance (5.33). The worsening of the competitive position of the export and domestic competitive sectors and the shift of demand out of the country will reduce overall output and dampen inflationary pressures. The ability of the business sector to pay wages and offer jobs will also be hurt, dampening wage pressures with identical second round effects through falling private sector incomes and demand as discussed above.

There is also a direct, supply effect of exchange rate changes to domestic prices through import prices. As import prices fall, imported goods become cheaper, leading directly to a fall in consumer prices (7.1) and output prices for goods using imported intermediate goods for production (7.7). This further dampens wage pressures with a further second round effect on prices through falling unit labour costs (6.4).

11.4. Expectations channel

Finally, the effects of monetary policy are strengthened further through its effects on private sector expectations. Long-term nominal interest rates (4.6) depend directly on expectations of future policy rate developments. The real exchange rate (4.16) and inflation (7.1) depend on expectations about its own future development and, hence, also on the expectations of future monetary policy. Expectations of a sustained tight monetary policy can therefore affect demand and inflation over and above the direct effect of the current policy stance described above.

11.5. An illustration: A temporary 1 percentage point rise in the policy interest rate

To illustrate how monetary policy works in QMM, this section shows how an unanticipated 1 percentage point rise in the policy rate affects the economy over a ten year period. The shock is assumed to last for one quarter but beyond that the short-term interest rate is assumed to follow the forward-looking Taylor rule (4.1).[37] As can be seen in Figure 11.2, the policy rate remains above baseline for one year, moving temporarily below the baseline in the fifth quarter as inflation falls below target, before returning to its pre-shock level four years after the shock.

11.5.1. The effects on output and inflation

As shown in Figures 11.2, the immediate effects of the interest rate hike on inflation and output are rather small. However, output starts to fall markedly from baseline from the second quarter, with the peak effect occurring in the fifth quarter with output 0.41% below the baseline scenario. The inflationary effect takes a bit longer to emerge, with year-on-year inflation basically unchanged for the first two quarters. The peak effect occurs in the fifth quarter, at the same time as the output effect peaks, with inflation 0.24 percentage points lower than in the baseline scenario. Both output and inflation are close to their baseline values after five to six years.

11.5.2. The transmission of the policy shock through the economy

Figure 11.2 also shows how the policy shock is transmitted through the economy to the final effects on output and inflation described above. The nominal long-term interest rate immediately rises by 24 basis points. This is consistent with the analysis of the transmission of policy shocks to other interest rates in Pétursson (2001a), using a structural VAR analysis, and results from a similar analysis using other macroeconomic models, such as the Federal Reserve's FRB/US model reported in Brayton and Tinsley (1996). Since the nominal long-term rate rises by less than the policy rate, the typical inverted yield curve is obtained. As nominal prices are sticky, this leads to a similar rise in real long-term interest rates. Furthermore, as the interest rate differential vis-à-vis abroad rises, the nominal exchange rate immediately appreciates by 0.67% (or 2.7% in annual terms). Due to nominal price stickiness, this also leads to an appreciation of the real exchange rate with the real exchange rate peaking in the fourth quarter, before gradually returning to baseline. The exchange

[37] It is also assumed that the inflation target remains unchanged as do private agents' expectations of the target. The shock can therefore be thought of as a 'modest' intervention (cf. Leeper and Zha, 2003). Note also that the simulation results reported here only provide an illustration of the properties of QMM and cannot be used mechanically to predict how the economy reacts to monetary policy in reality, as all simulation exercises are highly stylised and are based on a number of simplifying assumptions.

rate impulse response is not consistent with the simple uncovered interest rate parity, where the exchange rate should immediately appreciate by the full amount and then gradually depreciate to ensure that expected returns on foreign and domestic assets are equal. The QMM profile is however consistent with international evidence from structural VAR analysis, cf. Eichenbaum and Evans (1995) and similar structural VAR results from Pétursson (2001b). The exchange rate response is also similar to what is found in similar experiments using the other country models, such as the TOTEM model of Bank of Canada (Murchison and Rennison, 2006), the NEMO model of Norges Bank (Brubakk et al., 2006) and the macroeconomic model of Bank of Israel (Argov et al., 2007).

Asset prices also fall immediately after the policy shock, with household net wealth immediately declining by 0.45 percentages points below the baseline (year-on-year) before fading out over the next six years.

Higher real interest rates and the real appreciation of the currency lead to a rise in the real cost of borrowing for investment and worsening of the competitive position of the export industry, leading to declining demand for labour. Thus, unemployment gradually starts to rise with the peak effect of roughly 0.04 percentages points occurring after two years. The effects are quite small although similar to what is found in other models, such as the BEQM model (Harrison et al., 2005). With falling demand for labour, nominal wages start to decline below baseline, with year-on-year wage inflation falling 0.20 percentages points below the baseline scenario in the fifth quarter. The reduction in wage inflation is smaller than the reduction in overall inflation, suggesting that nominal wages are stickier than nominal prices in QMM. The effects on real wages are therefore much smaller, with real wages remaining slightly above baseline from the third quarter after an initial contraction. The real wage effect is, however, small throughout.

The rise in the real interest rates and exchange rate, together with declining private sector net wealth, lead to a fall in domestic demand. Consumption falls 0.25% below baseline in the third quarter and remains below baseline for six quarters before moving above the baseline scenario, as real disposable income rises slightly and the real exchange rate appreciates, until they fade out in ten years. The effects on business investment are, however, much stronger than on private consumption. Business investment falls by over 1% below baseline in the third quarter before gradually returning to its pre-shock level. The effects on total investment are much more mooted as overall investment includes government and aluminium investment, both of which are exogenous in QMM. The relative contribution of private consumption and investment to the contraction in domestic demand after a monetary policy shock in QMM is similar to what is found in other macroeconomic models, such as the Norges Bank, NEMO model (cf. Brubakk et al., 2006).

Finally, exports of goods and services start to contract as the real exchange rate appreciates, which increases the foreign currency export price and reduces export demand, with peak effect in the seventh quarter with exports 0.28% below baseline. Imports of goods and services also start to move above baseline from the third quarter, after an initial contraction. Thus, the income effect from lower domestic demand is initially stronger than the relative price effect before the effect of lower import prices starts to dominate. Thus, QMM initially generates a small improvement in the trade balance before a trade deficit emerges that peaks at 1% of baseline GDP after one year.

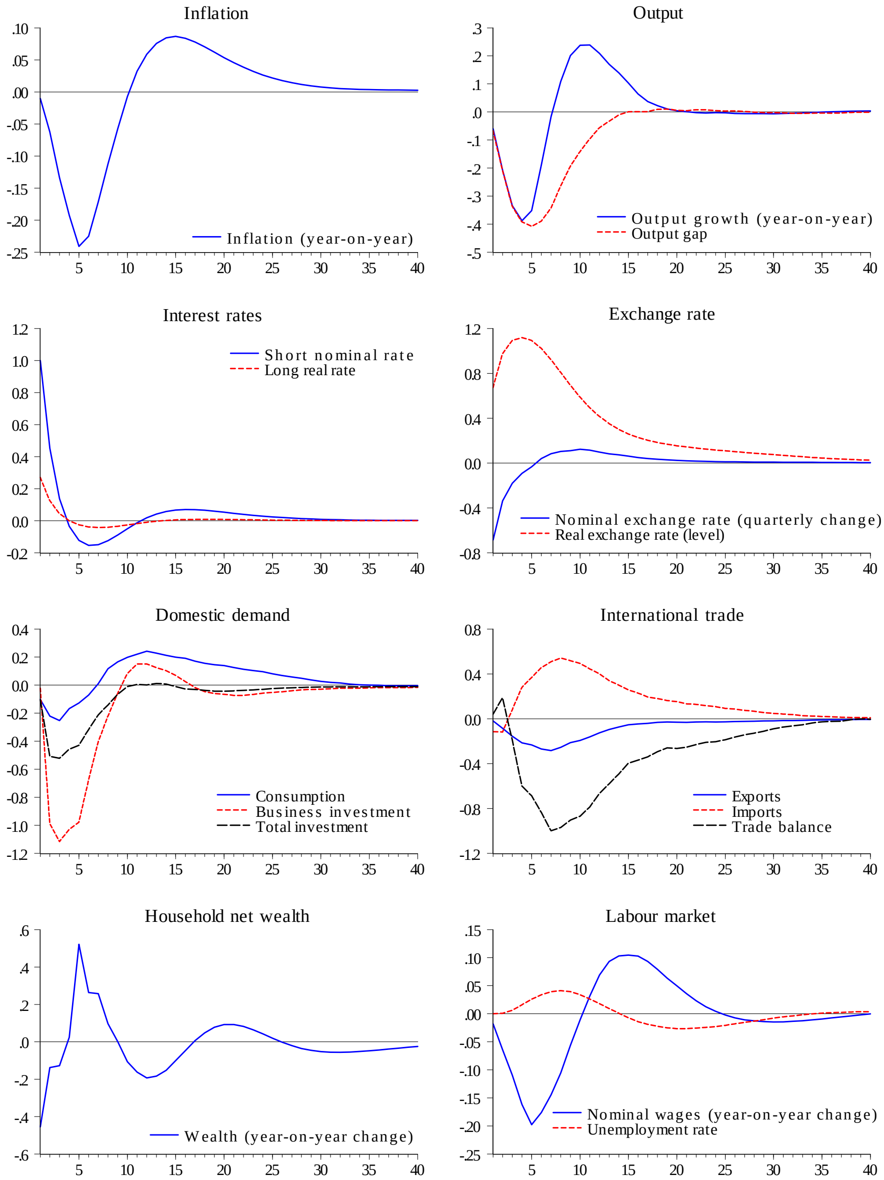


Figure 11.2. A monetary policy shock (deviations from baseline)

11.5.3. Comparison with international evidence

As Figure 11.2 illustrates, QMM generates the persistent and hump shaped impulse responses typically found in the empirical literature (cf. Christiano et al., 1999). The time lags and size of the monetary policy impulses are also quite similar to what is typically found in other macroeconomic models used at other central banks, such as the BEQM model of Bank of England (Harrison et al, 2005), Federal Reserve's FRB/US model (Brayton and Tinsley, 1996), the TOTEM model of Bank of Canada (Murchison and Rennison, 2006), the NEMO model of Norges Bank (Brubakk et al., 2006) and the macroeconomic model of Bank of Israel (Argov et al., 2007). The results are also in line with the survey results of various country models. For example, in a sample of twelve inflation targeting countries, Schmidt-Hebbel and Tapia (2002) find a peak decline in output for the median country to be 0.27% compared to the 0.41% decline in QMM, with 50% of the peak output effect attained in two quarters in both cases. They also find a peak decline in year-on-year inflation of 0.12 percentage points in the median country which is somewhat smaller than the 0.24 percentage points decline found in QMM. The 50% of the peak effect is also attained slightly faster in QMM: in three quarters instead of four in the median inflation-targeting country. The results in QMM are also similar to those found in Fagan and Morgan (2005) in a survey of euro area models. The results are also broadly similar to those found in Pétursson (2001b) using a structural VAR model.

11.5.4. Comparison with previous version of QMM

Compared to the previous version of QMM (Figure 11.3), the output effect is stronger and more persistent in the new version. The real exchange rate and inflation effects are also much faster and stronger, reflecting the forward-looking nature of the new version of QMM.

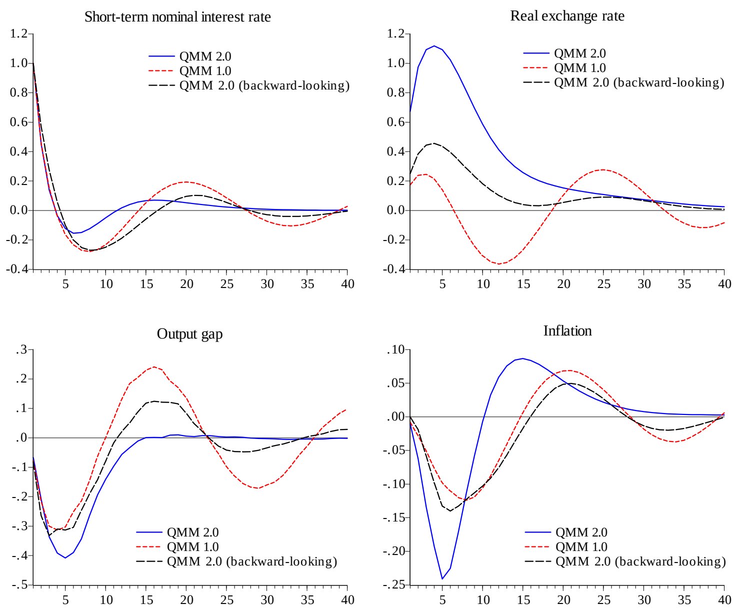


Figure 11.3. Monetary policy shocks in different versions of QMM

As the figure also shows, the dynamic properties of the model have greatly improved from Version 1.0, with a substantial decrease in the inherent oscillating behaviour found in the previous version. Although some of this improvement can be contributed to the general revision of the model, the largest part of the improvement comes from introducing forward-looking behaviour in the new version of QMM.

12. Other types of shocks

Whereas the previous section served to illustrate how a monetary policy shock propagates through the model economy, the shocks discussed in this section are designed to highlight different aspects of QMM and explain some important properties of the model.

Before proceeding, it is however worth noting several points concerning the interpretation of these shocks and their effects. First, the shocks analysed are assumed to be unanticipated by economic agents, but once they hit they are immediately recognised and acted upon according to the model structure. This also applies to the monetary policy authority, who uses the simple monetary policy rule assumed in QMM to counteract the initial shock to ensure that inflation expectations are anchored to the inflation target.[38] Second, the simulations assume that the economy is hit by a single isolated shock at a time. This is clearly a simplification as in reality the economy is typically hit simultaneously by multiple, and possibly interacting, shocks. For the purpose of exploring the properties of QMM, however, it is useful to keep things as simple as possible and look at different shocks individually.

We start by analysing two fiscal policy shocks that serve to highlight how fiscal policy can influence aggregate demand directly and through consumption decisions. They are also of importance as they give an idea of the size of the automatic fiscal stabilisers in QMM.[39] The third shock analysed is an exchange rate shock (e.g. stemming from a shock to the exogenous exchange rate risk premium). One interesting aspect of this shock is that it gives an idea of the level of the exchange rate pass-through in QMM. The fourth shock is a terms of trade shock which is obviously of interest in a small, open, and resource based economy such as Iceland. For similar reasons, the fifth shock – a world demand shock – is obviously of interest. The final shock is a domestic productivity shock, which serves to highlight how demand and policy respond to a supply shock in QMM.

The results from the simulation exercises below are consistent with typical find-

[38]Note that the monetary policy shock in the previous section is somewhat different in nature to the shocks in this section as the policy rate is an endogenous variable. The policy shock therefore reflects a temporary deviation from normal policy behaviour, while the shocks in this section represent shocks to exogenous variables.

[39]Note, however, that the analysis of these two fiscal shocks ignores the future fiscal implications of the shocks, i.e. how the current increase in expenditure or cut in taxes needs to be financed in the future. In a Ricardian setup the expectations of future financing fully crowds out the expansionary effects of the fiscal shock as private agents increase their savings to meet the future increases in taxes. Most research suggests, however, that this Ricardian equivalence effect is less than perfect (see, for example, Masson et al., 1995).

ings from the literature and are broadly in line with findings from other macroeconomic models, such as the BEQM model of Bank of England (Harrison et al, 2005), Federal Reserve's FRB/US model (Brayton and Tinsley, 1996), the TOTEM model of Bank of Canada (Murchison and Rennison, 2006), the NEMO model of Norges Bank (Brubakk et al., 2006) and the macroeconomic model of Bank of Israel (Argov et al., 2007).

12.1. A government expenditure shock

Figure 12.1 illustrates the effect of a shock to the exogenously given government expenditure (G), amounting to a rise in nominal government expenditure equivalent to 1% of nominal GDP for four quarters. This rise in government expenditure directly raises domestic demand with output rising immediately by just under 0.5% and peaking at close to 0.6% above baseline in the fourth quarter, before fading out after five years. The increased demand for domestic goods and services leads to lower unemployment and higher wages, thus raising real disposable income. Asset prices also rise, and therefore net wealth as well, all contributing to a small but persistent rise in private consumption. There is also an increase in investment reflecting the acceleration properties of business investment in QMM.

The rise in domestic demand leads to building up of inflationary pressures that monetary policy must counteract. It is assumed that the monetary policy authority immediately identifies the shock and responds to it by raising the short-term interest rate according to the monetary policy rule in the model. The following rise in real interest rates contributes to some crowding-out of the initial government spending shock. The higher real interest rate also leads to a real exchange rate appreciation which leads to further crowding-out as exports decline compared to the baseline scenario. The biggest impact of the appreciation, however, is to direct a part of the increased expenditure towards imported goods and services, leading to a significant trade deficit.

The rise in real interest rates and the real exchange appreciation causes a small negative output gap to open up. This, together with the fact that private agents have perfect foresight about the temporary nature of the shock, also serves to limit the inflationary impact of the spending shock, with inflation straying only mildly from target.

The effects of a government expenditure shock in QMM are similar to those found in the literature, cf. Hemming et al. (2002) who find that the short-run expenditure multipliers are usually between 0.6 and 1.4 compared to 0.6 in QMM. The fact that the effect in QMM is in the lower part of the range reported in Hemming et al. (2002) probably reflects the crowding-out effect of the real exchange rate appreciation and the 'leakage' effect through demand for imports, which are likely to be more important in small, open economies. Thus, the short-run expenditure multiplier is similar to what has been found in other small, open economies such as New Zealand (Dunstan et al., 2007) and Denmark (Danmarks Nationalbank, 2003), but smaller than what is typically found in larger economies such as the United States (Reifschneider et al., 1999), the United Kingdom (Church et al., 2000) and the euro area (Fagan and Morgan, 2005).

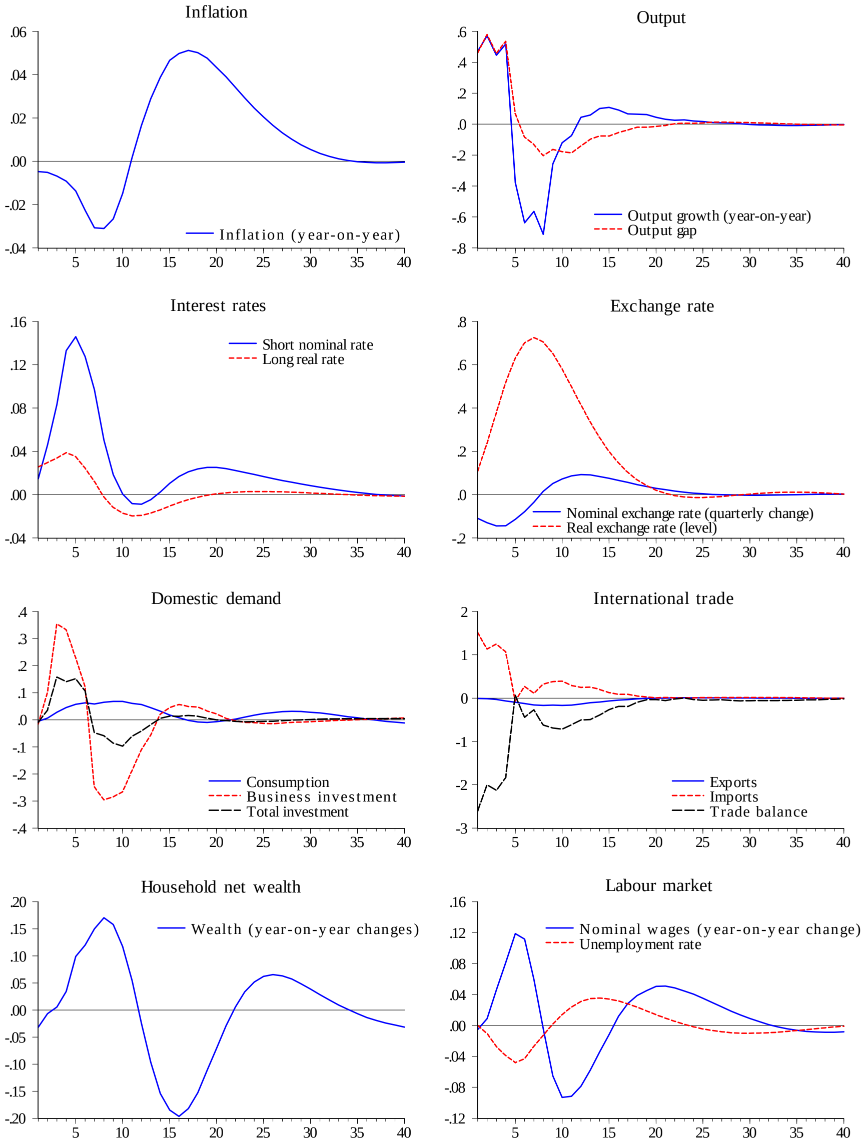


Figure 12.1. A government expenditure shock (deviations from baseline)

12.2. An income tax shock

Figure 12.2 shows the effects of a temporary cut in the income tax rate (RJY), corresponding to 1% of nominal GDP for four quarters. This is equivalent to a $1\frac{2}{3}$ percentage point cut in the tax rate. The tax cut leads to increased supply of labour as labour income increases. This increase in labour income raises consumption and overall demand. However, the output effect of this shock takes a longer time to emerge compared to the government expenditure shock in the previous section as the tax cut only affects output indirectly through private sector spending decisions and is not a direct part of aggregate demand, as public consumption is. Thus, output rises only gradually and peaks at close to 0.5% above baseline in the fifth quarter, mainly through rising private consumption, before fading out after five years.

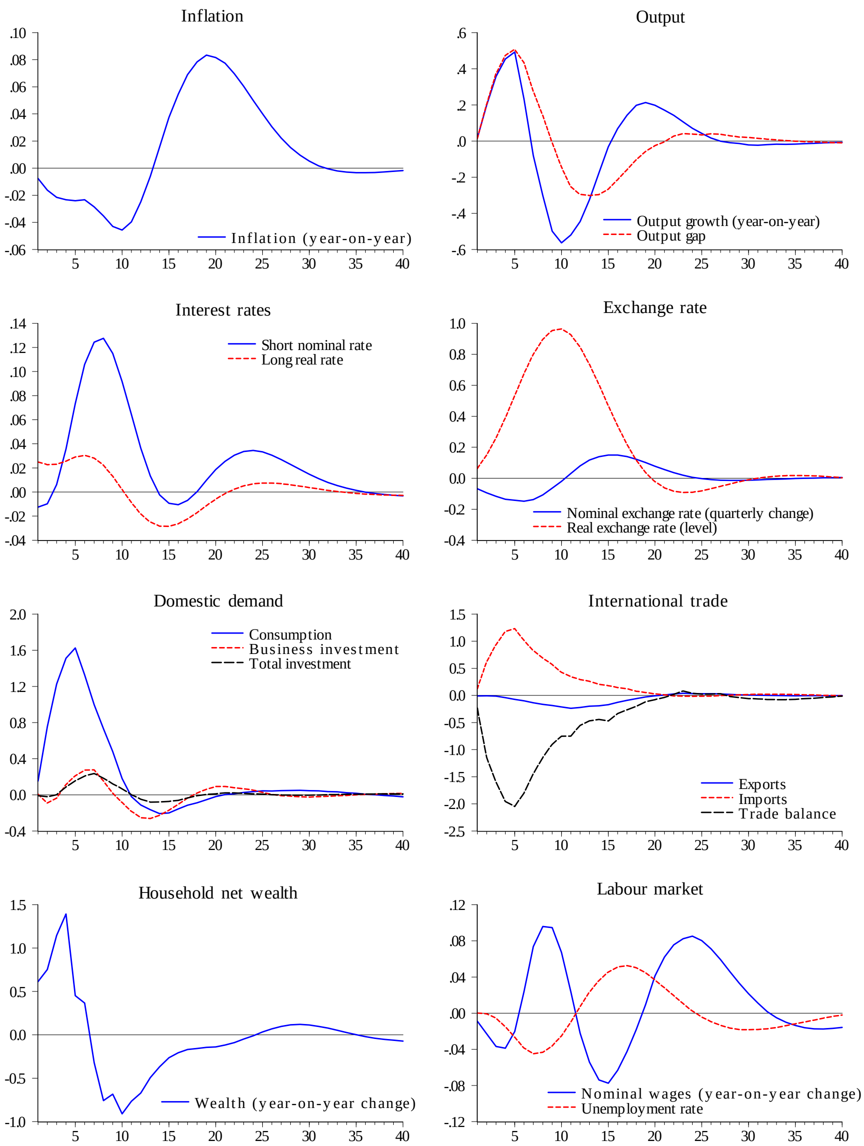


Figure 12.2. An income tax shock (deviations from baseline)

The effect of the tax cut on inflation, the real exchange rate and interest rates is comparable to the effect of the government expenditure shock, again leading to crowding-out and leakage effects, thus offsetting the output stimulation. The short-run tax multiplier is similar to those reported in Hemming et al. (2002), who report tax multipliers ranging from 0.3 to 0.8, compared to 0.5 found in QMM. They are also similar to the findings for the United States (Reifschneider et al., 1999) and the United Kingdom (Church et al., 2000), but somewhat larger than Dunstan et al. (2007) find for New Zealand.

12.3. An exchange rate shock

Figure 12.3 illustrates the effects of a 1% temporary exchange rate shock that may be thought of as being driven by an increase in the exogenous currency risk premium ($RISK$) or, equivalently, by a rise in the exogenous foreign interest rate (WRS). This negative portfolio shock is assumed to last for four quarters before returning to baseline. The nominal exchange rate immediately depreciates by 1% as the relative return on foreign assets rises in comparison with returns on domestic assets. The exchange rate continues to depreciate for a year with a peak effect on the real exchange rate in the sixth quarter, where the real exchange rate is roughly 0.4% below the baseline scenario.

The depreciation puts upward pressure on inflation, both directly through rising import prices and indirectly through the opening up of a positive output gap. The central bank therefore raises the policy rate but the effects on real long-term rates are rather small due to the temporary nature of the shock. Rising interest rates lead to a contraction in consumption and investment but, as mentioned above, a positive output gap emerges due to a strong increase in net exports, which mainly comes from a contraction in demand for imported goods and services following the contraction in domestic demand and the depreciation of the currency. Finally, with inflation rising, other nominal prices, such as asset prices and wages follow.

This shock can also be analysed in terms of the rate of exchange rate pass-through, an issue of great importance in a small, open economy like Iceland. Thus, based on the above analyses, a 1% depreciation of the exchange rate gives a peak impact on inflation of roughly 0.25 percentages points, indicating a level of pass-through equal to 0.25. This is somewhat smaller than previous studies of exchange rate pass-through in Iceland have found (see *Monetary Bulletin* 2008/2, pp. 44-46). This is probably due to the temporary nature of the shock and the fact that monetary policy is allowed to respond by raising interest rates, thus mitigating the inflationary effect of the shock. The fact that expectations are rational also serves to dampen the effect as economic agents are assumed to understand the temporary nature of the shock and fully expect that monetary policy responds to return inflation to target. The size of the pass-through effect remains, however, somewhat larger than usually found in other countries when analysing a similar shock (cf. Pétursson, 2008).

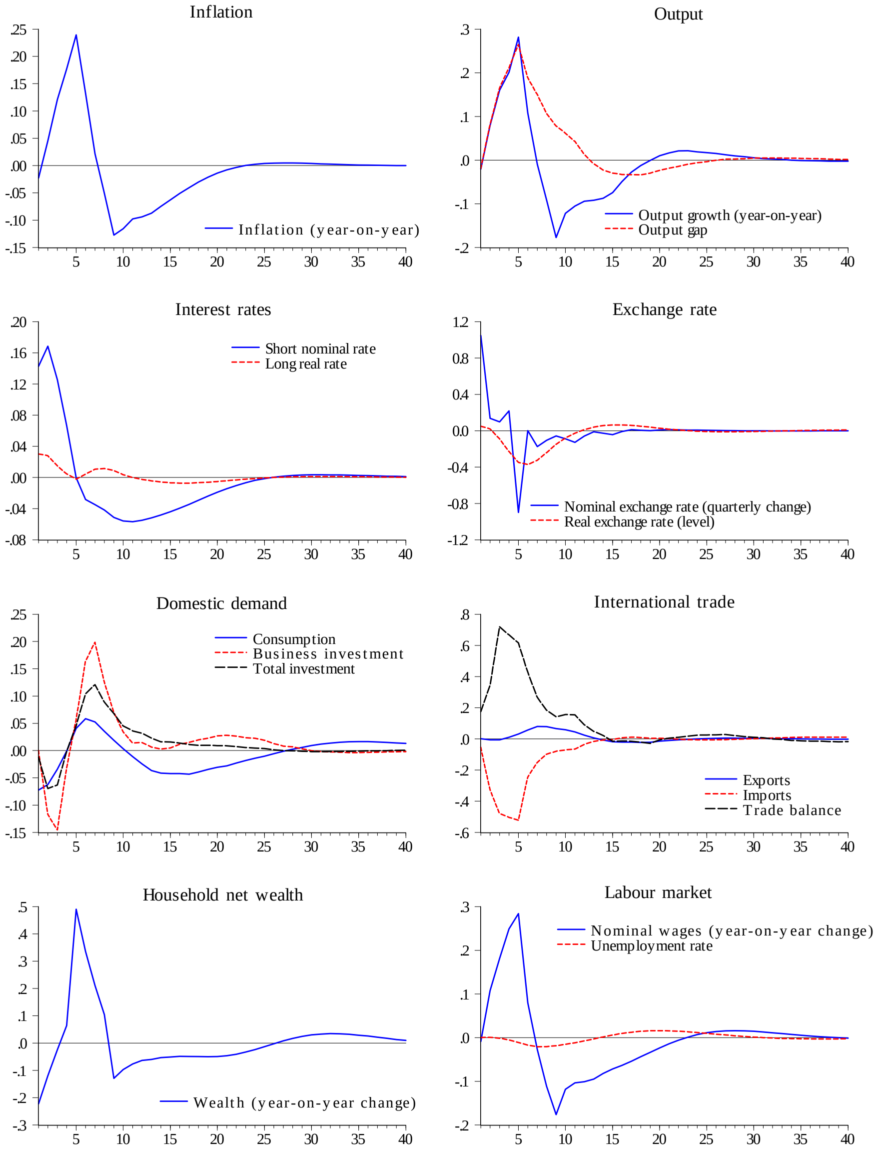


Figure 12.3. An exchange rate shock (deviations from baseline)

12.4. A terms of trade shock

Figure 12.4 illustrates the effects of a 1% positive terms of trade shock driven by an exogenous increase in export prices for aluminium ($PXALU$) and marine products ($PXMAR$). The shock is assumed to last for four quarters before returning to baseline.

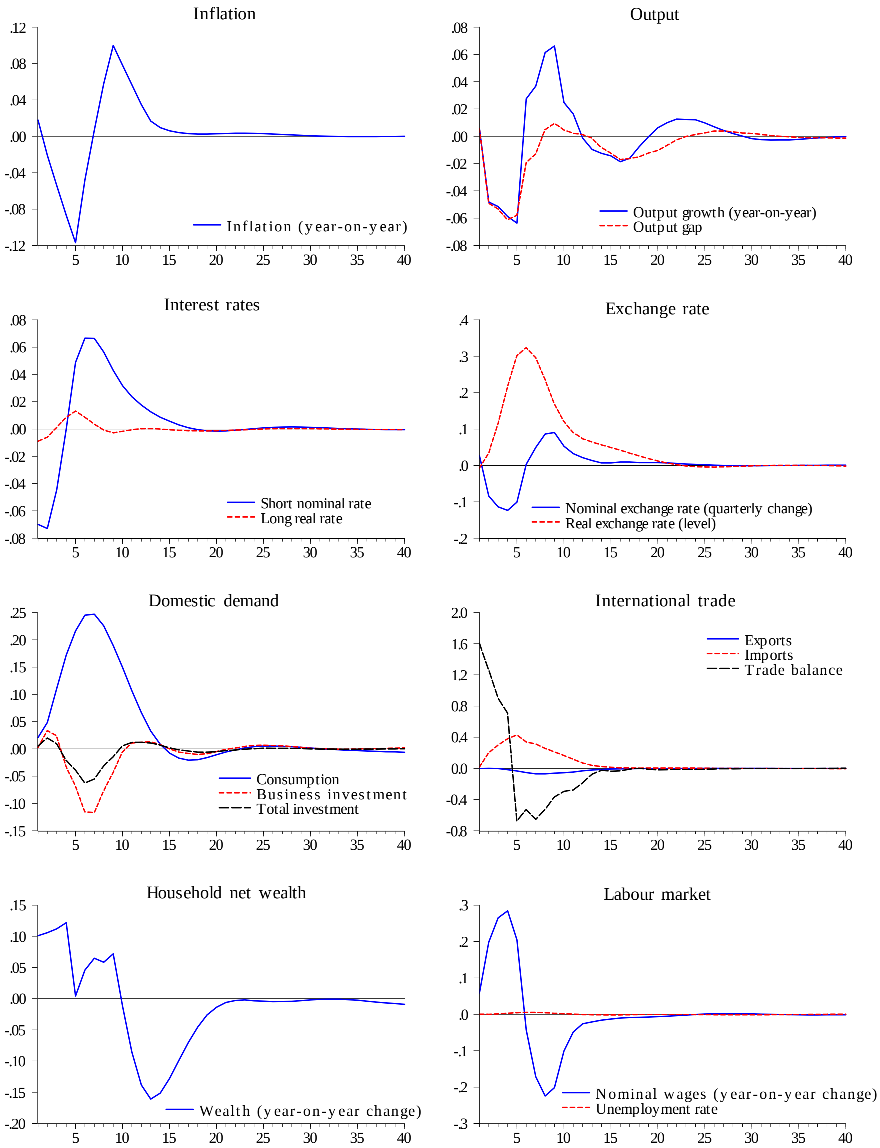


Figure 12.4. A terms of trade shock (deviations from baseline)

The improvement in terms of trade implies that domestic output is more valuable relative to world production. Domestic wealth and labour income therefore rise, which induces an increase in consumption. A large share of the increased consumption expenditure is however directed towards imported goods and services that are now relatively cheaper as the real exchange rate appreciates. Although the improvements in the terms of trade increase overall domestic demand, investment contracts due to the rise in the real interest rate and appreciation of the exchange rate which reduces the competitive position of industries excluding the aluminium and marine sectors.[40] The real exchange appreciation also leads to a small contraction in exports and the negative contribution of net exports is enough to lead to a small reduction in output even though domestic demand increases following the terms of trade shock. Thus, a small negative output gap opens up. This shock therefore again illustrated the importance of the dynamics of imports in QMM, reflecting the fact that most durable goods consumed by Icelandic households are imported.

The negative output gap and the appreciation of the domestic currency reduce inflation in the short run, which the central bank responds to by reducing interest rates. Rates are however tightened again later as higher wages ultimately lead to increased inflation.

12.5. A world demand shock

The next experiment shows how a shock to world demand for Icelandic exports propagates through the economy. The shock is given by a 1% exogenous increase in world output ($WGDP$) and world trade ($TRADE$) and is assumed to last for four quarters before returning to baseline. The shock is therefore structured such as to increase the scale variable in exports for goods and services excluding marine and aluminium products ($EXREG$) without directly affecting imports, which includes the variable trade specification, defined as $SPEC = TRADE/WGDP$.

As Figure 12.5 illustrates, an increase in the demand for Icelandic exports leads to rising exports, with a peak effect in the fourth quarter when exports are 0.43% above baseline.[41] The increase in demand for exports leads to an appreciation of the domestic currency, as a positive output gap creates expectations of future interest rate hikes, and increased demand for domestic factors of production, which puts upward pressures on employment and wages. As domestic incomes start rising, asset prices move up, boosting household wealth and consumption expenditure. Furthermore, as domestic demand rises, so does investment expenditure due to the acceleration properties of investment behaviour in the model.

The increase in domestic demand and net exports lead to a positive output gap. Although inflation initially falls due to the exchange rate appreciation, inflation starts rising as inflationary pressures gradually emerge. This is met with tightening of monetary policy that ensures that a negative output gap eventually opens up which is sufficient to return inflation to target. In addition, a temporary trade deficit emerges to bring the external side back to balance.

[40] Note that aluminium and marine exports are treated as exogenous in QMM. The positive terms of trade shock does therefore not induce an increase in production of these products in this exercise.

[41] Note that total exports of goods and services also include aluminium and marine exports, both of which are treated as exogenous in QMM. The increase in exports following the world demand shock roughly reflect the share of $EXREG$ in total exports which has gradually risen for the last few decades and has been about 45% on average for the last ten years.

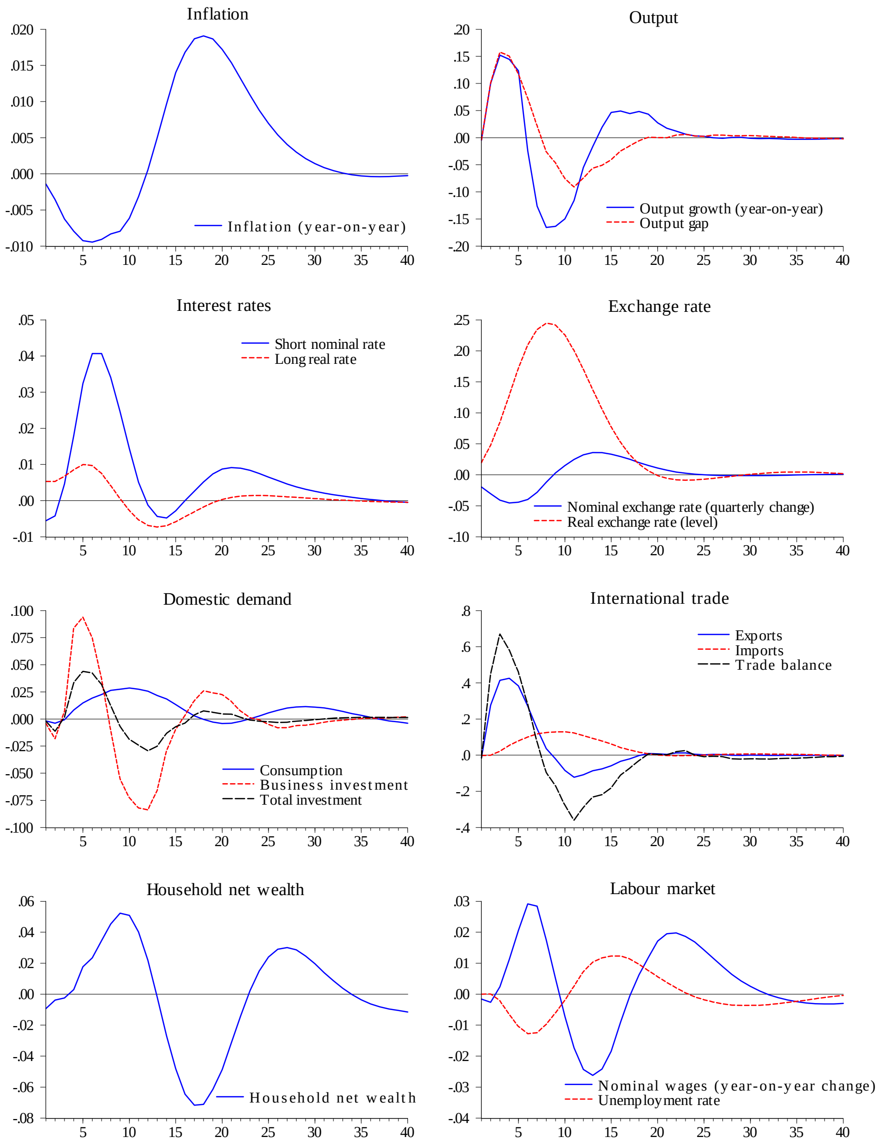


Figure 12.5. A world demand shock (deviations from baseline)

12.6. A productivity shock

The last shock analysed is an exogenous 1% increase in labour productivity ($PRODT$), lasting for one year before returning to baseline (shown in Figure 12.6). This positive productivity shock implies that firms can increase production levels for given levels of inputs. Thus, the level of potential output increases and the output gap immediately becomes negative by 1%.

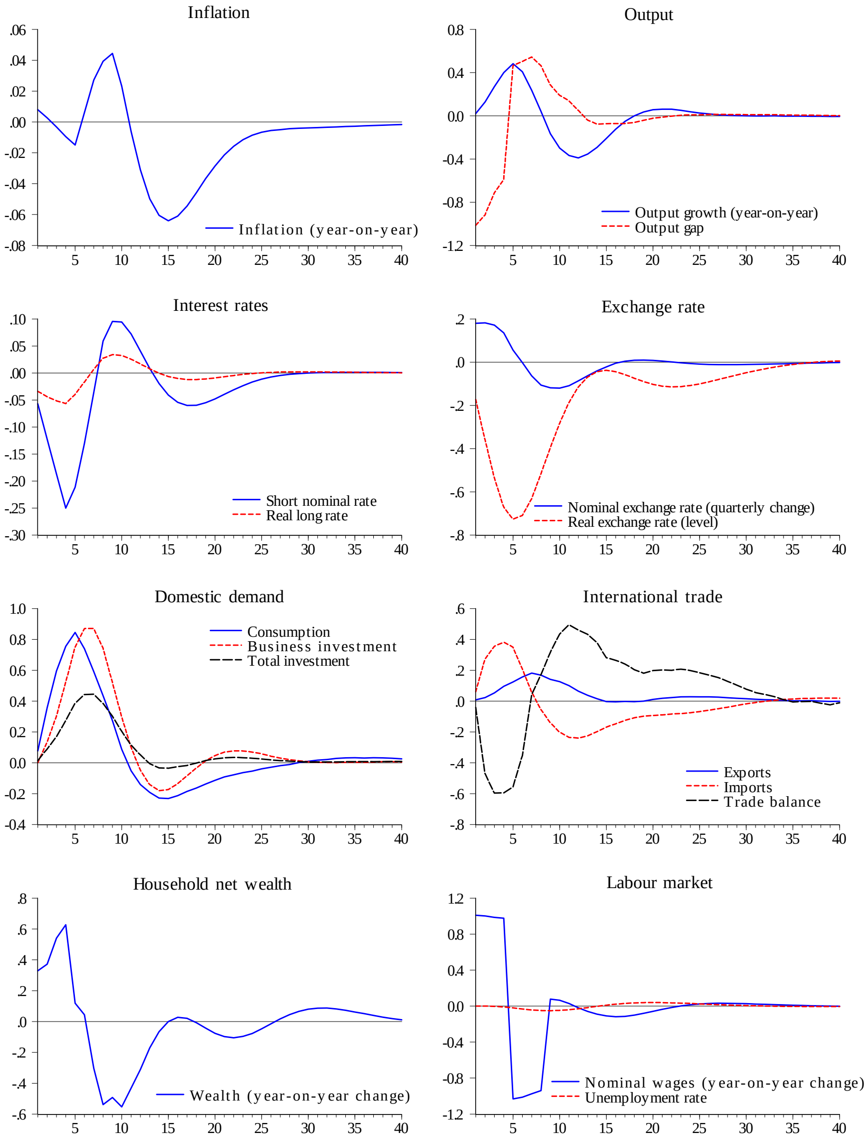


Figure 12.6. A productivity shock (deviations from baseline)

This positive supply shock puts downward pressure on inflation which the central bank responds to by lowering interest rates. The fall in real interest rates leads to a depreciation of the currency which outweighs the disinflationary effect of the productivity shock in the short run. Increased labour productivity raises nominal wages and incomes, thus leading to increases in private consumption. Furthermore, as real interest rates fall, investment starts to increase. The depreciation of the currency also boosts exports and imports rise despite the falling exchange rate as the positive income effect outweighs the negative substitution effect. A trade deficit therefore emerges in the short run, which has to be countered with a real exchange rate depreciation and a prolonged period of surpluses to restore external balance.

Finally, as domestic demand increases, output starts to rise which ensures that the negative output gap is closed and a positive gap emerges so that the disinflation effect of the productivity shock is reversed.

Part IV
Appendices

13. Variables listing

Table 13.1. List of variables

Name	Description	Type	Equations
ALLOW	Personal allowances	X	(8.3)
BAL	Current account balance	I	(**5.35**), (5.38)
BALT	Balance of trade	I	(**5.33**), (5.35)
BC	Building costs	E	(7.7), (7.8), (7.9) (**7.13**)
BIPD	Balance of interest, salaries, dividends and profits	T	(**5.34**), (5.35)
BIPDF	Risk premium on world interest rate	X	(5.34)
BTRF	Balance of transfers	X	(5.35)
C	Private consumption	E	(**5.2**), (5.3), (5.23)
CJ	Current grants to the household sector	E	(8.3), (**8.16**), (8.18) (9.1)
CN	Nominal private consumption	D	(4.23), (4.24), (**5.3**) (5.24), (8.12), (8.14)
CPI	Consumer price index	E	(4.25), (4.26), (6.2) (**7.1**), (7.3), (7.5) (7.6), (7.12), (7.13) (7.14), (7.15), (9.4)
DD	Domestic demand	I	(**5.23**), (5.30), (5.39)
DDN	Nominal domestic demand	I	(**5.24**), (5.40)
DELTA	Depreciation rate for total capital stock	X	(4.8), (5.18)
DELTAB	Depreciation rate for business capital stock	X	(5.19)
DELTAG	Depreciation rate for government capital stock	X	(5.17)
DELTAH	Depreciation rate for housing stock	X	(4.23), (4.24), (5.20)
DH	Financial debt of households	T	(4.22), (**4.24**)
DI	General government debt interest payments	T	(**8.17**), (8.18)
EER	Exchange rate index of foreign currency	D	(**4.10**), (4.11), (4.17) (4.25), (5.22), (5.28) (5.37), (5.38), (7.2) (7.3), (7.5), (8.17)
EMP	Level of employment in man-years	I	(6.6), (**6.9**), (6.11), (9.2)
EMPT	Trend employment	D	(5.42), (**6.10**), (6.12)
EQP	Equity prices	E	(**4.19**), (4.25), (8.4)

Table 13.1. List of variables (continued)

Name	Description	Type	Equations
EUR	Euro exchange rate	E	(**4.12**)
EUS	US dollar exchange rate	E	(**4.11**), (5.22), (5.28) (7.2)
EX	Exports of goods and services	I	(**5.27**), (5.39), (7.4)
EXALU	Exports of aluminium products	X	(5.21), (5.22), (5.27) (5.28)
EXMAR	Exports of marine products	X	(5.21), (5.22), (5.27) (5.28)
EXN	Nominal exports of goods and services	I	(**5.28**), (5.33), (5.40) (7.4)
EXREG	Exports, excluding aluminium and marine goods	E	(**5.26**), (5.27), (5.28)
FOH	Foreign holdings of Icelandic assets	T	(5.36), (**5.38**)
G	Government consumption	X	(5.4), (5.23)
GAP	Output gap	D	(**5.43**), (5.44), (7.2)
GAPAV	Annual average of output gap	D	(4.1), (**5.44**), (7.1) (8.16)
GDP	GDP	I	(4.28), (5.10), (5.14) (**5.39**), (5.43), (6.5) (6.7), (6.11), (7.10)
GDPN	Nominal GDP	I	(**5.40**), (7.10), (8.4) (8.5), (8.7), (8.8), (8.15), (8.16), (9.4)
GDPT	Potential output	E	(**5.42**), (5.43), (6.12)
GFW	Gross financial wealth	T	(4.22), (**4.23**)
GN	Nominal government consumption	D	(**5.4**), (5.24), (8.18)
HW	Housing wealth	D	(4.20), (**4.21**)
I	Fixed investment	I	(**5.5**), (5.6), (5.18) (5.23)
IBAIR	Investment in airplanes	X	(5.11)
IBALU	Aluminium sector investment	X	(5.11)
IBREG	Regular business investment	E	(**5.10**), (5.11)
IBUS	Business investment	I	(5.5), (**5.11**), (5.19)
IBUSN	Nominal business investment	I	(**5.12**)
IG	Government investment	X	(5.5), (5.16)
IGN	Nominal government investment	D	(5.12), (**5.16**), (5.17)

Table 13.1. List of variables (continued)

Name	Description	Type	Equations
IGNNET	Nominal net government investment	T	(**5.17**), (8.18)
IH	Private sector housing investment	E	(4.23), (4.24), (5.5) (**5.14**), (5.15), (5.20)
IHN	Nominal housing investment	D	(5.12)
II	Net stockbuilding	E	(**5.21**), (5.23)
IIN	Nominal net stockbuilding	D	(**5.22**), (5.24)
IMP	Imports of goods and services	E	(**5.30**), (5.31), (5.39)
IMPN	Nominal imports of goods and services	D	(**5.31**), (5.33), (5.40) (8.13)
IN	Nominal fixed investment	D	(**5.6**), (5.12), (5.24)
INF	Four-quarter CPI inflation rate	D	(4.1), (4.9), (**7.15**) (7.18)
INFE	Break-even inflation expectations	E	(4.7), (**7.18**)
INFQ	Quarterly CPI inflation rate	D	(**7.14**)
ISA	Icelandic holdings of foreign assets	T	(5.36), (**5.37**), (5.38)
IT	Central Bank of Iceland inflation target	X	(4.1), (7.1)
K	Total capital stock	I	(5.17), (**5.18**), (5.42)
KBUS	Business capital stock	I	(5.17), (**5.19**)
KH	Private sector housing stock	I	(4.21), (4.23), (4.24) (5.17), (**5.20**), (7.12)
LY	Real post-tax labour income	D	(**9.6**), (7.12)
M3	Broad money	E	(**4.28**)
NAIRU	Natural rate of unemployment	X	(6.2), (6.5), (6.10)
NFA	Net foreign assets	I	(5.34), (**5.36**)
NFW	Net financial wealth	I	(4.20), (**4.22**)
PA	Participation rate	E	(6.6), (**6.7**), (6.8) (6.9)
PAT	Trend participation rate	D	(**6.8**), (6.10)
PC	Private consumption deflator	E	(4.23), (4.24), (5.2) (5.3), (**7.5**), (9.5) (9.6)
PCOM	Non-oil commodity prices in USD	X	(7.2)
PG	Government consumption deflator	E	(5.4), (**7.6**)
PGDP	GDP price deflator	D	(4.18), (4.19), (4.28) (5.40), (6.2), (**7.10**) (8.4)
PH	House prices	E	(4.21), (4.23), (4.24) (5.14), (**7.12**)

Table 13.1. List of variables (continued)

Name	Description	Type	Equations
PI	Investment goods price deflator	E	(5.6), (**7.7**), (7.9)
PIG	Government investment deflator	E	(5.16), (5.17), (**7.9**)
PIH	Housing investment deflator	E	(5.14), (5.15), (**7.8**)
PM	Import price deflator	E	(4.18), (5.31), (**7.2**) (7.7)
POIL	Oil prices in USD	X	(7.2)
POWA	Population at working age (16-64)	X	(6.6), (6.9), (6.10) (8.3)
PRBUS	Business premium on risk-free interest rate	X	(4.8)
PRISK	Inflation risk premium	X	(4.7)
PROD	Labour productivity	D	(6.3), (**6.11**)
PRODT	Trend labour productivity	D	(6.2), (6.4), (**6.12**)
PSNB	Public sector net borrowing	I	(8.17), (**8.18**)
PX	Export price deflator	I	(4.17), (**7.4**)
PXALU	Price of aluminium products in US dollars	X	(5.22), (5.28)
PXMAR	Price of marine products in foreign currency	X	(5.22), (5.28)
PXREG	Export prices excluding aluminium and marine products	E	(5.28), (**7.3**)
RCC	Real cost of capital	D	(**4.8**), (5.10)
RCI	Corporate income tax rate	X	(8.7)
RCP	Corporate property tax rate	X	(8.8)
REM	Employers' wage-related cost	X	(6.2), (6.3), (6.4)
REVA	Household assets revaluation term	T	(4.23), (**4.25**)
REVD	Household debt revaluation term	T	(4.24), (**4.26**)
REX	Real exchange rate	E	(4.10), (**4.16**), (5.26) (6.2)
REXEQ	Equilibrium real exchange rate	X	(4.16), (6.2)
REXM	Importers' real exchange rate	D	(**4.18**), (5.30), (7.1)
REXX	Exporters' real exchange rate	D	(**4.17**)
RFIC	Tax rate for other payments	X	(8.9)
RHPI	Real household post-tax income	D	(4.23), (4.24), (5.2) (**9.5**)
RI	Interest rate income tax rate	X	
RIC	Ratio of other households' income to YE	X	(9.3)
RID	Real interest rate differential	D	(4.16)
RIMP	Tax rate on imports	X	(8.13)
RISK	Exchange rate risk premium	X	(4.9)
RJO	Household other tax rate	X	(8.5)
RJY	Household income tax rate	X	(8.3)

Table 13.1. List of variables (continued)

Name	Description	Type	Equations
RL	Long-term interest rate	E	(**4.6**), (4.7), (8.4) (8.17)
RLV	Long-term indexed interest rate	T	(**4.7**), (4.8), (5.2) (7.12), (9.4)
RRN	Real neutral interest rate	X	(4.1)
RS	Short-term interest rate	E	(**4.1**), (4.6), (4.9) (4.28), (9.4)
RSD	Other expenditure tax rate	X	(8.14)
RTS	Effective subsidies rate	X	(8.15)
RVAT	Value-added tax rate	X	(8.12)
RWC	Corporate wage cost tax rate	X	(8.10)
SPEC	Trade specialisation	D	(5.30), (**5.32**)
SUBS	Government subsidies	T	(**8.15**), (8.18)
TAX	Total tax receipts	I	(**8.1**), (8.18)
TC	Corporate tax payments	I	(8.1), (**8.6**)
TCI	Corporate income tax payments	T	(8.6), (**8.7**)
TCP	Corporate property tax payments	T	(8.6), (**8.8**)
TE	Total taxes on production and imports	I	(8.1), (**8.11**)
TERM	Term premium	X	(4.6)
TI	Household financial income tax	T	(8.2), (**8.4**), (9.6)
TIC	Other tax payments	T	(8.6), (**8.9**)
TIMP	Tarriffs and other taxes on imports	T	(8.11), (**8.13**)
TJ	Household tax payments	I	(8.1), (**8.2**), (9.5) (9.6)
TJO	Other household tax payments	T	(8.2), (**8.5**)
TJY	Household income tax	T	(8.2), (**8.3**)
TRADE	World trade	X	(5.26), (5.32)
TSD	Other expenditure taxation receipts	T	(8.11), (**8.14**)
TVAT	Value-added taxation receipts	T	(8.11), (**8.12**)
TWC	Corporate wage cost tax payments	T	(8.6), (**8.10**)
ULC	Unit labour costs	D	(**6.3**)
ULCT	Trend unit labour costs	D	(**6.4**), (7.1), (7.2) (7.6), (7.13)
UN	Level of unemployment	D	(**6.6**)
UR	Unemployment rate	E	(5.2), (6.2), (**6.5**) (6.9)
W	Wages	E	(**6.2**), (6.3), (6.4) (9.2)

Table 13.1. List of variables (continued)

Name	Description	Type	Equations
WCPI	World consumer prices	X	(4.26), (7.3), (7.16)
WEL	Household sector wealth	I	(**4.20**), (4.28), (5.2)
WEQP	World equity prices	X	(5.37), (5.38)
WGDP	World GDP	X	(5.32)
WINF	Four-quarter world inflation rate	D	(4.9)
WPX	World export prices	X	(4.17), (7.2)
WRS	Foreign short-term interest rate	X	(4.9), (5.34), (8.17)
YDIJ	Other household non-labour income	E	(9.1), (**9.4**), (9.6)
YE	Wages, salaries and self-employed income	I	(8.3), (8.10), (9.1) (**9.2**), (9.3)
YIC	Households' other income	T	(9.1), (**9.3**)
YJ	Total household pre-tax income	I	(**9.1**), (9.5), (9.6)
Summary			
	Total number of variables		152
	Number of endogenous variables	(E)	30
	Number of technical variables	(T)	22
	Number of definitions	(D)	29
	Number of identities	(I)	26
	Number of exogenous variables	(X)	45

Equations where variables are defined are in bold. D denotes definitions, E denotes endogenous variables, I denotes identities, T denotes technical definitions and X denotes exogenous variables.

Table 13.2. List of empirically estimated equations

Number of estimated equations		24	
Variable	Mnemonic	Equation number	Page number
Long-term interest rates	RL	4.6	21
Real exchange rate	REX	4.16	24
Broad money demand	M3	4.28	28
Private consumption	C	5.2	30
Regular business investment	IBREG	5.10	34
Private sector housing investment	IH	5.14	36
Exports of goods and services (excluding marine and aluminium)	EXREG	5.26	40
Imports of goods and services	IMP	5.30	43
Potential output	GDPT	5.42	47
Wages	W	6.2	49
Unemployment rate	UR	6.5	52
Participation rate	PA	6.7	53
Consumer price index	CPI	7.1	56
Import price deflator	PM	7.2	58
Export prices excluding aluminium and marine products	PXREG	7.3	59
Private consumption deflator	PC	7.5	61
Government consumption deflator	PG	7.6	62
Investment goods price deflator	PI	7.7	63
Government investment deflator	PIG	7.9	65
House prices	PH	7.12	67
Building costs	BC	7.13	69
Household financial income tax	TI	8.4	72
Current grants to the household sector	CJ	8.16	76
Other household non-labour income	YDIJ	9.4	79

Table 13.3. Dummy variables in QMM

Dummy variable	Period equal to one	Equation that dummy variable enters
D0312	2003:Q1-2003:Q2	M3 (4.28)
D031	2003:Q1	C (5.2)
S023	From 2002:Q3	C (5.2)
D9395	1993:Q1-1995:Q4	IBREG (5.10)
D9801	1998:Q1-2001:Q4	IBREG (5.10)
D021	2002:Q1	IBREG (5.10), BC (7.13)
D053	2005:Q3	IBREG (5.10)
D971	1997:Q1	IH (5.14),W (6.2),PXREG (7.3)
D981	1998:Q1	EXREG (5.26)
D062	2006:Q2	W (6.2)
D894	1994:Q4	PH (7.12)
D04	2004:Q1-2004:Q4	PH (7.12)
S04	From 2004:Q1	PH (7.12)
D05461	2004Q4-2006Q1	YDIJ (9.4)

14. Data description

In this section is a detailed description of the data used in QMM. The information includes the beginning of the series, the data source and unit, the FAME code of the variable in the Central Bank of Iceland centralised database, and any explanation of the data necessary. This might include how higher frequency observations are averaged to quarterly observations, how quarterly data was calculated in cases where only annual observations are available and how data from different sources was linked together.

The main data sources are the following:

Mnemonic	Institution	Icelandic
CBI	Central Bank of Iceland	Seðlabanki Íslands
DOL	Directorate of Labour	Vinnumálastofnun
EcoWin	Reuters (EcoWin)	-
FIN	Ministry of Finance	Fjármálaráðuneytið
ICEX	Iceland Stock Exchange	Kauphöll Íslands
ILMS	Institute of Labour Market Research	Kjararannsóknarnefnd
IMF	IMF	-
ISD	Icelandic Securities Depository	Verðbréfaskráning Íslands
LRI	Land Registry of Iceland	Fasteignamat ríkisins
NEI	National Economic Institute	Þjóðhagsstofnun
OECD	OECD	-
STATICE	Statistics Iceland	Hagstofa Íslands
DIR	Director of Internal Revenue	Ríkisskattstjóri

Name: $ALLOW$. **Short description:** Personal allowances. **Beginning of series:** 1988Q1. **Source:** STATICE/CBI. **Unit:** Millions of kronas at current prices. **FAME code:** QMM.EXO.ALLOWZ.Q. **Comment:** Defined as $(RJY \times (YE + CJ) - TJY)/POWA$.

Name: BAL. **Short description:** Current account balance. **Beginning of series:** 1978Q1. **Source:** CBI. **Unit:** Millions of kronas at current prices. **FAME code:** QMM.DEM.BALZZZ.Q. **Comment:** An accounting identity defined as $BAL = BALT + BIPD + BTRF$.

Name: $BALT$. **Short description:** Balance of trade. **Beginning of series:** 1970Q1. **Source:** CBI. **Unit:** Millions of kronas at current prices. **FAME code:** QMM.DEM.BALTZZ.Q. **Comment:** Defined as $EXN - IMPN$.

Name: BC. **Short description:** Building costs. **Beginning of series:** 1970Q1. **Source:** STATICE/CBI. **Unit:** Index, $2000 = 1$. **FAME code:** QMM.PRI.-BCZZZZ.Q. **Comment:** Measures changes in building costs of a specified block of flats. The index is normalised so that the average index of the quarters of year 2000 equals 1. **Detailed description:** Simple average of official monthly observations from 1976. Estimated series from CBI prior to 1976.

Name: $BIPD$. **Short description:** Balance of interest, salaries, dividends and profits. **Beginning of series:** 1978Q1. **Source:** CBI. **Unit:** Millions of kronas at current prices. **FAME code:** QMM.DEM.BIPDZZ.Q. **Comment:** Quarterly data available since 1978.

Name: $BIPDF$. **Short description:** Risk premium on world interest rate. **Beginning of series:** 1970Q2. **Source:** CBI. **Unit:** Fraction. **FAME code:** QMM.DEM.BIPDFZ.Q. **Detailed description:** This is a factor that makes $BIPD$ consistent with equation (5.34) in historical data. If net foreign assets would only consist of bonds it could be viewed as a pure interest rate premium. However, since $BIPD$ also includes equity holdings it is not a pure interest rate premium but rather a more general risk premium. It is obtained as $8BIPD_t/(NFA_t + NFA_{t-1}) - WRS_t$ in historical data but is generally treated as exogenous from the last observed value in forecasts and simulations.

Name: $BTRF$. **Short description:** Balance of transfers. **Beginning of series:** 1978Q1. **Source:** CBI. **Unit:** Millions of kronas at current prices. **FAME code:** QMM.EXO.BTRFZZ.Q. **Comment:** Quarterly data available from 1978.

Name: C. **Short description:** Private consumption. **Beginning of series:** 1970Q1. **Source:** STATICE/CBI. **Unit:** Millions of kronas at constant 2000 prices. **FAME code:** QMM.DEM.CZZZZZ.Q. **ECOTRIM:** Flow AR(1) Max Log Par : -.99 to .99. **Comment:** Quarterly data available since 1997Q1 from STATICE. **Detailed description:** *Period from 1970 to 1979:* The annual value is divided between the quarters such that the growth rate in each quarter is the same and the growth over the year fits with the annual values. Seasonal variation derived from the period 1997 to 2003 is added. The difference between the annual value and the sum of the quarters is then distributed evenly between the quarters. *Period from 1979 to 1990:* 40% of annual values is split between the quarters using a simple disaggregation algorithm (minimizing the sum of squared residuals). The rest of the annual values is disaggregated using an auxiliary series for the quarterly variation. This series shows quarterly sales for consumption goods and private cars. *Period from 1990 to 1996:* This is disaggregated in the same way as the previous period, except the additional (quarterly) series for the 60% of consumption uses VAT reports as an indication of sales volume. These reports are bi-monthly. Quarterly values were constructed simply by dividing every other period in half, thus splitting it evenly between the previous and the following period.

Name: CJ. **Short description:** Current grants to the household sector. **Beginning of series:** 1979Q1. **Source:** STATICE. **Unit:** Millions of kronas at current prices. **FAME code:** QMM.GOV.CJZZZZ.Q. **ECOTRIM:** Flow Boot, Feibes and Lisman – FD. **Comment:** The main items are social security payments, child benefits and interest rate subsidies (the last two items are linked to income so they are in a way a negative part of the income tax). **Detailed description:** Annual data obtained from the sector accounts (*Disposable income from the household sector*) from STATICE. Quarterly data obtained with ECOTRIM using no reference series.

Name: CN. **Short description:** Nominal private consumption. **Beginning of series:** 1970Q1. **Source:** STATICE/CBI. **Unit:** Millions of kronas at current prices. **FAME code:** QMM.DEM.CNZZZZ.Q. **ECOTRIM:** Flow AR(1) Max Log Par : -.99 to .99. **Comment:** Quarterly data available since 1997Q1 from STATICE. **Detailed description:** *Period from 1970 to 1996:* Annual data on nominal private consumption from STATICE was disaggregated using ECOTRIM, using quarterly data on $CPI \times C$ as a related series.

Name: CPI. **Short description:** Consumer price index. **Beginning of series:** 1970Q1. **Source:** STATICE/CBI. **Unit:** Index, 2000 = 1. **FAME code:** QMM.PRI.CPIZZZ.Q. **Comment:** Prior to 2008 CPI measurements were conducted by STATICE during the first two working days of each month. Quarterly data was obtained by using centralised quarterly averages using monthly observations of the headline CPI. For example, the fourth-quarter value was calculated as $[0.5CPI_{OCT} + CPI_{NOV} + CPI_{DEC} + 0.5CPI_{JAN}]/3$. Since January 2008, CPI measurements are conducted for a one-week period during the middle of each month. Therefore, since 2008Q1 quarterly data is obtained as simple quarterly averages of monthly observations of headline CPI. The index is normalised so that the average index of the quarters of the year 2000 equals 1.

Name: DD. **Short description:** Domestic demand. **Beginning of series:** 1971Q1. **Source:** STATICE/CBI. **Unit:** Millions of kronas at constant 2000 prices. **FAME code:** QMM.DEM.DDZZZZ.Q. **ECOTRIM:** Flow AR(1) Max Log Par : -.99 to .99. **Comment:** Quarterly data available since 1997Q1 from STATICE. **Detailed description:** *Period from 1970 to 1996:* Annual data on domestic demand from STATICE was disaggregated using ECOTRIM, using quarterly data on domestic demand from the income identity $DD = C + G + I + II$ at constant 1990 prices as a related series.

Name: DDN. **Short description:** Nominal domestic demand. **Beginning of series:** 1971Q1. **Source:** STATICE/CBI. **Unit:** Millions of kronas at current prices. **FAME code:** QMM.DEM.DDNZZZ.Q. **Comment:** Defined from the income identity $DDN = CN + GN + IN + IIN$.

Name: $DELTA$. **Short description:** Depreciation rate for total capital stock. **Beginning of series:** 1970Q1. **Source:** STATICE/CBI. **Unit:** Fraction. **FAME**

code: QMM.EXO.DELTAZ.Q. **ECOTRIM:** Flow AR(1) MaxLogPar: -.99 to .99. **Comment:** The historical values of the depreciation rate are calculated using the STATICE annual data on depreciation which are disaggregated using ECOTRIM with quarterly data on K, constructed using the dynamic equation for the capital stock and lagged one period, as a reference series.

Name: $DELTAB$. **Short description:** Depreciation rate for business capital stock. **Beginning of series:** 1970Q1. **Source:** STATICE/CBI. **Unit:** Fraction. **FAME code:** QMM.EXO.DELTAB.Q. **ECOTRIM:** Flow AR(1) MaxLogPar: -.99 to .99. **Comment:** The historical values of the depreciation rate are calculated using the STATICE annual data on depreciation which are disaggregated using ECOTRIM with quarterly data on $KBUS$, constructed using the dynamic equation for the capital stock and lagged one period, as a reference series.

Name: $DELTAG$. **Short description:** Depreciation rate of government capital stock. **Beginning of series:** 1970Q1. **Source:** STATICE/CBI. **Unit:** Fraction. **FAME code:** QMM.EXO.DELTAG.Q. **ECOTRIM:** Flow AR(1) MaxLogPar: -.99 to .99. **Comment:** The historical values of the depreciation rate are calculated using the STATICE annual data on depreciation which are disaggregated using ECOTRIM with quarterly data on $K - KBUS - KH$, constructed using the dynamic equation for the capital stock and lagged one period, as a reference series.

Name: $DELTAH$. **Short description:** Depreciation rate of housing stock. **Beginning of series:** 1970Q1. **Source:** STATICE/CBI. **Unit:** Fraction. **FAME code:** QMM.EXO.DELTAH.Q. **ECOTRIM:** Flow AR(1) Max Log Par : -.99 to .99. **Comment:** The historical values of the depreciation rate are calculated using the STATICE annual data on depreciations which are disaggregated using ECOTRIM using quarterly data on KH, constructed using the dynamic equation for the capital stock and lagged one period, as a reference series.

Name: DH. **Short description:** Financial debt of households. **Beginning of series:** 1986Q1. **Source:** CBI. **Unit:** Millions of kronas at current prices (average prices during the period). **FAME code:** QMM.FIN.DHZZZZ.Q. **ECOTRIM:** StockL Boot, Feibes and Lisman - FD. **Detailed description:** Financial debt of households is obtained from quarterly data produced by the CBI (FAME series LAK.SAM.EUM$$$.EIN.SX.XXX.ISK.IS.N.F (credit system, assets, loans and domestic securities holdings, individuals)) from 1991Q4. Quarterly data for earlier periods have been estimated with ECOTRIM. The CPI is used to transform end-of-year data at end-of-year prices to average price during the period.

Name: DI. **Short description:** General government debt interest payments. **Beginning of series:** 1980Q1. **Source:** STATICE/CBI. **Unit:** Millions of kronas at current prices. **FAME code:** QMM.GOV.DIZZZZ.Q. **ECOTRIM:** Flow Boot, Feibes and Lisman - FD. **Detailed description:** Quarterly data on net general government debt interest rate payments obtained with ECOTRIM.

Name: EER. **Short description:** Exchange rate index of foreign currency. **Beginning of series:** 1972Q1. **Source:** CBI. **Unit:** Index, 2000 = 1. **FAME code:** QMM.FIN.EERZZZ.Q. **Comment:** Quarterly average of monthly average observations (FAME series VIS.ISK.OVVG.S.D). The index is normalised so that the average index of the quarters of year 2000 equals 1. **Detailed description:** *Period from January 1993*: Official trade-weighted exchange rate index, using trade and services weights from previous year bilateral trade (adjusted for third-country effects). The index includes the United States, Great Britain, Canada, Denmark, Norway, Sweden, Switzerland, Euro area and Japan, with the weights updated each year. *Period from 1980 to 1992:* From 1980 to 1992 the previous year bilateral trade and services weights are used. *Period from 1972 to 1979:* Up to 1980 the trade weights for 1980 are used.

Name: EMP. **Short description:** Level of employment in man-years. **Beginning of series:** 1980Q1. **Source:** CBI. **Unit:** Heads measured in man-years. **FAME code:** QMM.LAB.EMPZZZ.Q. **Comment:** Calculated using official data on UR and UN as $EMP = ((1 - UR)/UR)UN$.

Name: $EMPT$. **Short description:** Trend employment. **Beginning of series:** 1980Q4. **Source:** CBI. **Unit:** Heads measured in man-years. **FAME code:** QMM.LAB.EMPTZZ.Q. **Comment:** Defined as $EMPT = PAT \times POWA \times (1 - NAIRU)$.

Name: EQP. **Short description:** Equity prices. **Beginning of series:** 1987Q1. **Source:** ICEX/CBI. **Unit:** Index, 2000 = 1. **FAME code:** QMM.FIN.-EQPZZZ.Q. **Comment:** Quarterly averages of end-of-month data from 1987 to 1993 and quarterly averages of daily data from 1993 onwards. **Detailed description:** From 1987Q1 to 1992Q4 the HMARK index published by VÍB was used as no official stock index data existed. From 1993Q1 to 2003Q4 ICEX-MAIN stock index was used. From 2004Q1 the OMXIPI index published by ISD is used. The index is normalised so that the average index of the quarters of year 2000 equals 1.

Name: EUR. **Short description:** Euro exchange rate. **Beginning of series:** 1999Q1. **Source:** CBI. **Unit:** Index, 2000 = 1. **FAME code:** QMM.FIN.-EURZZZ.Q. **Comment:** Icelandic kronas per 1 Euro. Quarterly average of monthly average observations.

Name: EUS. **Short description:** US dollar exchange rate. **Beginning of series:** 1972Q3. **Source:** CBI. **Unit:** Index, 2000 = 1. **FAME code:** QMM.FIN.-EUSZZZ.Q. **Comment:** Icelandic kronas per 1 US dollar (adjusted for krona redenomination in 1980). Quarterly average of monthly average observations.

Name: EX. **Short description:** Exports of goods and services. **Beginning of series:** 1970Q1. **Source:** STATICE/CBI. **Unit:** Millions of kronas at constant 2000 prices. **FAME code:** QMM.DEM.EXZZZZ.Q. **ECOTRIM:** Flow AR(1) Max Log Par : -.99 to .99. **Comment:** Quarterly data available since 1997Q1 from STATICE. **Detailed description:** *Period from 1970 to 1996:* Quarterly data obtained with ECOTRIM by disaggregating annual values using EXN/PX at constant 1990 prices as a related series. Annual data for the period 1970 to 1979 are calculated from the volume index.

Name: $EXALU$. **Short description:** Exports of aluminium products. **Beginning of series:** 1988Q1. **Source:** STATICE/CBI. **Unit:** Millions of kronas at constant 2000 prices. **FAME code:** QMM.EXO.EXALUZ.Q. **ECOTRIM:** Flow AR(1) MaxLogPar: -.99 to .99. **Detailed description:** The annual exports of power intensive industry products is estimated from the annual price index and FOB value of exports. Quarterly data are obtained with ECOTRIM using the quarterly values of exports with average prices of year 2000 as a related series. The quarterly data on average prices of year 2000 is calculated from exports of each quarter on the average price of that quarter divided by $PXALU$.

Name: $EXMAR$. **Short description:** Exports of marine products. **Beginning of series:** 1988Q1. **Source:** STATICE/CBI. **Unit:** Millions of kronas at constant 2000 prices. **FAME code:** QMM.EXO.EXMARZ.Q. **ECOTRIM:** Flow AR(1) MaxLogPar: -.99 to .99. **Detailed description:** The annual exports of marine products is estimated from the annual price index and FOB value of exports. Quarterly data are obtained with ECOTRIM using the quarterly values of exports with average prices of year 2000 as a related series. The quarterly data on average prices of year 2000 is calculated from exports of each quarter on the average price of that quarter divided by $PXMAR$.

Name: EXN. **Short description:** Nominal exports of goods and services. **Beginning of series:** 1970Q1. **Source:** STATICE/CBI. **Unit:** Millions of kronas at current prices. **FAME code:** QMM.DEM.EXNZZZ.Q. **ECOTRIM:** Flow AR(1) Max Log Par : -.99 to .99. **Comment:** Quarterly data available since 1997Q1 from STATICE. **Detailed description:** *Period from 1970 to 1977:* Exported goods are obtained from STATICE. Exported services were disaggregated using exported services as recorded by an older definition by STATICE as an indicator series. *Period from 1978 to 1996:* Exported goods and services are obtained from the CBI.

Name: $EXREG$. **Short description:** Exports, excluding aluminium and marine products. **Beginning of series:** 1988Q1. **Source:** STATICE/CBI. **Unit:** Millions of kronas at constant 2000 prices. **FAME code:** QMM.DEM.EXREGZ.Q. **Comment:** Defined as $EXREG = EX - EXALU - EXMAR$.

Name: FOH. **Short description:** Foreign holdings of Icelandic assets. **Beginning of series:** 1989Q4. **Source:** CBI. **Unit:** Millions of kronas at current prices. **FAME code:** QMM.DEM.FOHZZZ.Q. **Comment:** Foreign holdings of Icelandic assets are from the balance of payments and external positions statistics (in the International investment positions table). **Detailed description:** FOH equals Direct investment in Iceland + Portfolio investment liabilities + Financial derivatives liabilities + Other capital liabilities.

Name: G. **Short description:** Government consumption. **Beginning of series:** 1970Q1. **Source:** STATICE/CBI. **Unit:** Millions of kronas at constant 2000 prices. **FAME code:** QMM.EXO.GZZZZZ.Q. **Comment:** Quarterly data available since 1997Q1 from STATICE. **Detailed description:** *Period from 1970 to 1996:* Quarterly data obtained with ECOTRIM by disaggregating annual values using GN/PG at constant 1990 prices as a related series. Annual data for the period 1970 to 1979 are calculated from the volume index.

Name: GAP. **Short description:** Output gap. **Beginning of series:** 1980Q4. **Source:** CBI. **Unit:** Fraction. **FAME code:** QMM.DEM.GAPZZZ.Q. **Comment:** Obtained as the Solow residual from the Cobb-Douglas production function (5.42) using trend employment and capital.

Name: $GAPAV$. **Short description:** Annual average of output gap. **Beginning of series:** 1981Q3. **Source:** CBI. **Unit:** Fraction. **FAME code:** QMM.DEM.-GAPAVZ.Q. **Comment:** Annual average of GAP defined in equation (5.44).

Name: GDP. **Short description:** GDP. **Beginning of series:** 1971Q1. **Source:** STATICE/CBI. **Unit:** Millions of kronas at constant 2000 prices. **FAME code:** QMM.DEM.GDPZZZ.Q. **ECOTRIM:** Flow AR(1) Max Log Par : -.99 to .99. **Comment:** Quarterly data available since 1997Q1 from STATICE. **Detailed description:** *Period from 1970 to 1996:* Quarterly data obtained with ECOTRIM by disaggregating annual values using $DD + EX - IMP$ at constant 1990 prices as a related series. Annual data for the period 1970 to 1979 are calculated from the volume index.

Name: $GDPN$. **Short description:** Nominal GDP. **Beginning of series:** 1971Q1. **Source:** STATICE/CBI. **Unit:** Millions of kronas at current prices. **FAME code:** QMM.DEM.GDPNZZ.Q. **Comment:** Quarterly data available since 1997Q1 from STATICE. **Detailed description:** Defined from the income identity $GDPN = DDN + EXN - IMPN$.

Name: $GDPT$. **Short description:** Potential output. **Beginning of series:** 1980Q4. **Source:** CBI. **Unit:** Millions of kronas at constant 2000 prices. **FAME code:** QMM.DEM.GDPTZZ.Q. **Comment:** Potential (trend) output calculated from a Cobb-Douglas production function in equation (5.42).

Name: GFW. **Short description:** Gross financial wealth. **Beginning of series:** 1987Q1. **Source:** DIR/CBI/ISD. **Unit:** Millions of kronas at current prices (average prices during the period). **FAME code:** QMM.FIN.GFWZZZ.Q. ECOTRIM: StockL Fernandez Par : -.99 to .99 and StockL Boot, Feibes and Lisman – SD. **Comment:** Total household holding of bonds, bank deposits and equities. **Detailed description:** GFW consists of deposits with banks, bonds and equities. The CBI provides direct observations on deposits owned by households since 2003Q4. These data exist at a quarterly frequency. Data on the households ownership of bonds are annual data on bonds declared to the DIR. ECOTRIM is used to create quarterly data (StockL Fernandez Par : -.99 to .99) using data from CBI on changes in aggregate deposits as a related series. The CPI is used to transform end-of-quarter data at end-of-quarter prices to average prices during the period. Data on equity-ownerships by households are obtained from ISD. These are daily data and the quarterly value is obtained as the end-of-quarter value. EQP is used to transform end-of-quarter data at end-of-quarter prices to average prices during the period.

Before 2003Q4 quarterly data for the sum of deposits, bonds and equities were estimated from the sum of deposits and bonds as declared by the households to DIR using ECOTRIM to disaggregate the annual data (StockL Boot, Feibes and Lisman – SD) and from estimates from ISD of the end-of month value of registered shares owned by households. Estimates of equity owned by households was not available from ISD prior to 1999, therefore these earlier quarters were estimated from share prices and nominal share holdings of households as declared to the DIR. ECOTRIM (StockL Boot, Feibes and Lisman – SD) was used to estimate quarterly data on nominal share holdings of households. The two series (before 2003Q4 and after 2003Q4) for the sum of deposits, bonds and equities are linked so that the values before 2003Q4 are increased by the factor between the two estimates of the sum for 2003Q4.

Name: GN. **Short description:** Nominal government consumption. **Beginning of series:** 1970Q1. **Source:** STATICE/FIN/CBI. **Unit:** Millions of kronas at current prices. **FAME code:** QMM.DEM.GNZZZZ.Q. **ECOTRIM:** Flow AR(1) Max Log Par: -.99 to .99. **Comment:** Quarterly data available since 1997Q1 from STATICE. **Detailed description:** *Period from 1970 to 1996:* Monthly information on a part of government consumption for 1970 to 1996 is from FIN. To generate quarterly data for 1970-1996, information on wages were distributed evenly over the year, and changes within the year assumed to follow changes in the STATICE wage index. Wages were estimated at 2/3 of total government consumption. Government consumption, other than wages from above, was assumed to fluctuate within the year according to the monthly data. This constituted on average about 53% of total government consumption (varying between 47% and 60% in individual years). Other government consumption was disaggregated without the use of additional data.

Name: HW. **Short description:** Housing wealth. **Beginning of series:** 1970Q1. **Source:** STATICE/LRI/CBI. **Unit:** Millions of kronas at current prices. **FAME code:** QMM.FIN.HWZZZZ.Q. **Comment:** Before 1998 the annual estimates of HW do not agree with STATICE data as they used BC to estimate price changes prior to 1998 instead of PH. **Detailed description:** Defined as $HW = PH \times KH$.

Name: I. **Short description:** Fixed investment. **Beginning of series:**

1970Q1. **Source:** STATICE/CBI. **Unit:** Millions of kronas at constant 2000 prices. **FAME code:** QMM.DEM.IZZZZZ.Q. **ECOTRIM:** Flow Boot, Feibes and Lisman - FD and Flow AR(1) Max Log Par : -.99 to .99. **Comment:** Quarterly data available since 1997Q1 from STATICE. **Detailed description:** Quarterly data for the period before 1997Q1 is obtained by: (1) Estimating quarterly data from annual data with ECOTRIM (Flow Boot, Feibes and Lisman - FD) using no reference series; (2) Estimate the seasonality factors in the quarterly series from 1997Q1 using STAMP and then adding these seasonality factors to the series constructed in (1); and (3) Using ECOTRIM (Flow AR(1) Max Log Par : -.99 to .99) to estimate quarterly data from annual data before 1997Q1 using the reference series constructed in (2).

Name: $IBAIR$. **Short description:** Investment in airplanes. **Beginning of series:** 1970Q1. **Source:** STATICE/CBI. **Unit:** Millions of kronas at constant 2000 prices. **FAME code:** QMM.EXO.IBAIRZ.Q. **ECOTRIM:** Flow Boot, Feibes and Lisman – FD and Flow AR(1) MaxLogPar: -.99 to .99. **Comment:** Annual data obtained from STATICE. Quarterly data obtained with ECOTRIM. **Detailed description:** Prior to 2006 annual data was disaggregated in ECOTRIM (Flow Boot, Feibes and Lisman – FD) without using a reference series. As of 2006 quarterly data was estimated from annual data with ECOTRIM (Flow AR(1) MaxLogPar: -.99 to .99) using data for net airplane imports (obtained from STATICE) as a reference series to account for recent volatility in airplane investment.

Name: $IBALU$. **Short description:** Aluminium sector investment. **Beginning of series:** 1970Q1. **Source:** STATICE/CBI. **Unit:** Millions of kronas at constant 2000 prices. **FAME code:** QMM.EXO.IBALUZ.Q. **ECOTRIM:** Flow Boot, Feibes and Lisman - FD. **Comment:** Fixed investment in energy-intensive industries; i.e. investment in the production of metals (mostly aluminium) and in the production and distribution of electricity and (hot and cold) water. Only annual data available from STATICE. **Detailed description:** Quarterly data obtained with ECOTRIM using no reference series.

Name: $IBREG$. **Short description:** Regular business investment. **Beginning of series:** 1970Q1. **Source:** STATICE/CBI. **Unit:** Millions of kronas at constant 2000 prices. **FAME code:** QMM.DEM.IBREGZ.Q. **Detailed description:** Obtained as a residual series according to $IBREG = IBUS - IBALU - IBAIR$.

Name: $IBUS$. **Short description:** Business investment. **Beginning of series:** 1970Q1. **Source:** STATICE/CBI. **Unit:** Millions of kronas at constant 2000 prices. **FAME code:** QMM.DEM.IBUSZZ.Q. **ECOTRIM:** Flow Boot, Feibes and Lisman - FD and Flow AR(1) Max Log Par : -.99 to .99. **Comment:** Quarterly data available since 1997Q1 from STATICE. **Detailed description:** Quarterly data for the period before 1997Q1 is obtained by: (1) Estimating quarterly data from annual data with ECOTRIM (Flow Boot, Feibes and Lisman - FD) using no reference series.; (2) Estimate the seasonality factors in the quarterly series from 1997Q1 using STAMP and then adding these seasonality factors to the series constructed in (1);

and (3) Using ECOTRIM (Flow AR(1) Max Log Par : -.99 to .99) to estimate quarterly data from annual data before 1997Q1 using the reference series constructed in (2).

Name: $IBUSN$. **Short description:** Nominal business investment. **Beginning of series:** 1970Q1. **Source:** STATICE/CBI. **Unit:** Millions of kronas at current prices. **FAME code:** QMM.DEM.IBUSNZ.Q. **Detailed description:** Obtained as a residual series according to $IBUSN = IN - IGN - IHN$.

Name: IG. **Short description:** Government investment. **Beginning of series:** 1970Q1. **Source:** STATICE/CBI. **Unit:** Millions of kronas at constant 2000 prices. **FAME code:** QMM.EXO.IGZZZZ.Q. **ECOTRIM:** Flow Boot, Feibes and Lisman - FD and Flow AR(1) MaxLog Par : -.99 to .99. **Comment:** Quarterly data available since 1997Q1 from STATICE. **Detailed description:** Quarterly data for the period before 1997Q1 is obtained by: (1) Estimating quarterly data from annual data with ECOTRIM (Flow Boot, Feibes and Lisman - FD) using no reference series, (2) Estimate the seasonality factors in the quarterly series from 1997Q1 using STAMP and then adding these seasonality factors to the series constructed in (1); and (3) Using ECOTRIM (Flow AR(1) MaxLog Par : -.99 to .99) to estimate quarterly data from annual data before 1997Q1 using the reference series constructed in (2).

Name: IGN. **Short description:** Nominal government investment. **Beginning of series:** 1970Q1. **Source:** STATICE/CBI. **Unit:** Millions of kronas at current prices. **FAME code:** QMM.DEM.IGNZZZ.Q. **ECOTRIM:** Flow Fernandez Par : -.99 to .99. **Comment:** Quarterly data available since 1997Q1 from STATICE. **Detailed description:** Before 1997 the annual values from STATICE are disaggregated in ECOTRIM (Flow Fernandez Par : -.99 to .99) with quarterly data $BC \times IG$ as a reference series.

Name: $IGNNET$. **Short description:** Nominal net government investment. **Beginning of series:** 1990Q1. **Source:** STATICE/CBI. **Unit:** Millions of kronas at current prices. **FAME code:** QMM.DEM.IGNNET.Q. **ECOTRIM:** Flow AR(1) Max Log Par : -.99 to .99. **Comment:** Obtained as IGN minus depreciation of public capital at current prices, which was obtained from annual data using ECOTRIM, with $PIG \times DELTAG \times (K - KH - KBUS)$) as a reference series.

Name: IH. **Short description:** Private sector housing investment. **Beginning of series:** 1970Q1. **Source:** STATICE/CBI. **Unit:** Millions of kronas at constant 2000 prices. **FAME code:** QMM.DEM.IHZZZZ.Q. **ECOTRIM:** Flow Boot, Feibes and Lisman - FD and Flow AR(1) Max Log Par : -.99 to .99. **Comment:** Quarterly data available since 1997Q1 from STATICE. **Detailed description:** Quarterly data for the period before 1997Q1 is obtained by: (1) Estimating quarterly data from annual data with ECOTRIM (Flow Boot, Feibes and Lisman - FD) using no reference series; (2) Estimate the seasonality factors in the quarterly series from 1997Q1 using STAMP and then adding these seasonality factors to the series constructed in (1); and (3) Using ECOTRIM (Flow AR(1) Max Log Par : -.99 to .99) to estimate quarterly data from annual data before 1997Q1 using the reference series constructed in (2).

Name: IHN. **Short description:** Nominal housing investment. **Beginning of series:** 1970Q1. **Source:** STATICE/CBI. **Unit:** Millions of kronas at current prices. **FAME code:** QMM.DEM.IHNZZZ.Q. **ECOTRIM:** Flow AR(1) Max Log Par : -.99 to .99. **Comment:** Quarterly data available since 1997Q1 from STATICE. **Detailed description:** Before 1997 the annual values from STATICE are disaggregated in ECOTRIM (Flow AR(1) Max Log Par : -.99 to .99) with quarterly data $BC \times IH$ as a reference series.

Name: II. **Short description:** Net stockbuilding. **Beginning of series:** 1980Q1. **Source:** STATICE/CBI. **Unit:** Millions of kronas at constant 2000 prices. **FAME code:** QMM.DEM.IIZZZZ.Q. **ECOTRIM:** Flow AR(1) Max Log Par : -.99 to .99. **Comment:** Quarterly data available since 1997Q1 from STATICE. **Detailed description:** Prior to 1997 annual net stockbuilding data was disaggregated in ECOTRIM with changes in EX as a related series.

Name: IIN. **Short description:** Nominal net stockbuilding. **Beginning of series:** 1971Q1. **Source:** STATICE/CBI. **Unit:** Millions of kronas at current prices. **FAME code:** QMM.DEM.IINZZZ.Q. **ECOTRIM:** Flow AR(1) (minimum sum of squared residuals). **Comment:** Quarterly data available since 1997. **Detailed description:** Prior to 1997 annual net stockbuilding data was disaggregated in ECOTRIM with changes in EXN as a related series.

Name: IMP. **Short description:** Import volume of goods and services. **Beginning of series:** 1970Q1. **Source:** STATICE/CBI. **Unit:** Millions of kronas at constant 2000 prices. **FAME code:** QMM.DEM.IMPZZZ.Q. **ECOTRIM:** Flow AR(1) Max Log Par : -.99 to .99. **Comment:** Quarterly data available since 1997Q1 from STATICE. **Detailed description:** *Period from 1970 to 1996:* Quarterly data obtained with ECOTRIM by disaggregating annual values using $IMPN/PM$ at constant 1990 prices as a related series. Annual data for the period 1970 to 1979 are calculated from the volume index.

Name: $IMPN$. **Short description:** Nominal imports of goods and services. **Beginning of series:** 1970Q1. **Source:** STATICE/CBI. **Unit:** Millions of kronas at current prices. **FAME code:** QMM.DEM.IMPNZZ.Q. **ECOTRIM:** Flow AR(1) Max Log Par : -.99 to .99. **Comment:** Quarterly data available since 1997Q1 from STATICE. **Detailed description:** Imported goods and services from 1978 to 1996 are taken from the CBI, statistics department. Imported goods from 1970 to 1977 from STATICE. Imported services from 1970 to 1977 were disaggregated using imported services as recorded by an older definition by STATICE as an indicator series.

Name: IN. **Short description:** Nominal fixed investment. **Beginning of series:** 1970Q1. **Source:** STATICE/CBI. **Unit:** Millions of kronas at current prices. **FAME code:** QMM.DEM.INZZZZ.Q. **ECOTRIM:** Flow Fernandez Par : -.99 to .99. **Comment:** Quarterly data available since 1997Q1 from STATICE. **Detailed description:** Before 1997 the annual values from STATICE are disaggregated in ECOTRIM with quarterly data on $BC \times I$ as a reference series.

Name: INF. **Short description:** Four-quarter CPI inflation rate. **Beginning of series:** 1971Q1. **Source:** CBI. **Unit:** Fraction. **FAME code:** QMM.PRI.INFZZZ-.Q. **Comment:** Variable defined in equation (7.15).

Name: $INFE$. **Short description:** Break-even inflation expectations. **Beginning of series:** 1994Q1. **Source:** CBI. **Unit:** Fraction. **FAME code:** QMM.PRI.-INFEZZ.Q. **Detailed description:** Historical data obtained as $RL - RLV - PRISK$. Forecasted data obtained using model consistent expectations, cf. (7.18).

Name: $INFQ$. **Short description:** Quarterly CPI inflation rate. **Beginning of series:** 1970Q2. **Source:** CBI. **Unit:** Fraction. **FAME code:** QMM.PRI.INFQZZ-.Q. **Comment:** Variable defined in equation (7.14).

Name: ISA. **Short description:** Icelandic holdings of foreign assets. **Beginning of series:** 1989Q4. **Source:** CBI. **Unit:** Millions of kronas at current prices. **FAME code:** QMM.DEM.ISAZZZ.Q. **Comment:** Icelandic holdings of foreign assets are from the balance of payments and external positions statistics (in the International investment positions table). **Detailed description:** ISA equals Direct investment abroad + Portfolio investment assets + Financial derivatives assets + Other capital assets + Central Bank's reserve of foreign currencies.

Name: IT. **Short description:** Central Bank of Iceland inflation target. **Source:** CBI. **Unit:** Fraction. **FAME code:** QMM.EXO.ITZZZZ.Q. **Comment:** Inflation target currently defined in terms of annual CPI inflation and is equal to 2.5%.

Name: K. **Short description:** Total capital stock. **Beginning of series:** 1970Q1. **Source:** STATICE/CBI. **Unit:** Millions of kronas at constant 2000 prices. **FAME code:** QMM.DEM.KZZZZZ.Q. **ECOTRIM:** StockL Fernandez Par : -.99 to .99. **Comment:** Only annual data available from STATICE. **Detailed description:** Quarterly data obtained using ECOTRIM with a quarterly series constructed using the stock-flow identity as a reference series.

Name: $KBUS$. **Short description:** Business capital stock. **Beginning of series:** 1970Q1. **Source:** STATICE/CBI. **Unit:** Millions of kronas at constant 2000 prices. **FAME code:** QMM.DEM.KBUSZZ.Q. **ECOTRIM:** StockL Fernandez Par : -.99 to .99. **Comment:** Only annual data available from STATICE. **Detailed**

description: Quarterly data obtained from ECOTRIM with a quarterly series constructed using the stock-flow identity as a reference series.

Name: KH. **Short description:** Private sector housing stock. **Beginning of series:** 1970Q1. **Source:** STATICE/CBI. **Unit:** Millions of kronas at constant 2000 prices. **FAME code:** QMM.DEM.KHZZZZ.Q. **ECOTRIM:** StockL Fernandez Par : -.99 to .99. **Comment:** Only annual data available from STATICE. **Detailed description:** Quarterly data is estimated with ECOTRIM using a series estimated from quarterly data on investment in apartments and the stock-flow identity as a reference series. The upward revision of the estimate of the housing stock at the end of 2001 of 2.4% is set at the last quarter of 2001.

Name: LY. **Short description:** Real post-tax labour income. **Beginning of series:** 1987Q4. **Source:** CBI. **Unit:** Millions of kronas at 2000 prices. **FAME code:** QMM.INC.LYZZZZ.Q. **Comment:** Calculated as $LY = [(YJ - YDIJ) - (TJ - TI)]/PC$.

Name: $M3$. **Short description:** Broad money. **Beginning of series:** 1970Q1. **Source:** CBI. **Unit:** Millions of kronas at current prices. **FAME code:** QMM.FIN.-M3ZZZZ.Q. **Comment:** Quarterly average of monthly values. **Detailed description:** Contains notes and coins in circulation and deposit money banks demand deposits, demand savings deposits and time savings deposits.

Name: $NAIRU$. **Short description:** Natural rate of unemployment. **Source:** CBI. **Unit:** Fraction. **FAME code:** QMM.EXO.-NAIRUZ.Q. **Comment:** Currently fixed and equal to 3%.

Name: NFA. **Short description:** Net foreign assets. **Beginning of series:** 1989Q4. **Source:** CBI. **Unit:** Millions of kronas at current prices. **FAME code:** QMM.DEM.NFAZZZ.Q. **Comment:** The difference between Icelandic holdings of foreign assets and foreign holdings of Icelandic assets, defined as $NFA = ISA - FOH$.

Name: NFW. **Short description:** Net financial wealth. **Beginning of series:** 1987Q1. **Source:** DIR and CBI. **Unit:** Millions of kronas at current prices. **FAME code:** QMM.FIN.NFWZZZ.Q. **Comment:** Data derived from GFW and DH as $NFW = GFW - DH$.

Name: PA. **Short description:** Participation rate. **Beginning of series:** 1980Q1. **Source:** CBI. **Unit:** Fraction. **FAME code:** QMM.LAB.PAZZZZ.Q. **Comment:** Calculated as $(UN + EMP)/POWA$.

Name: PAT. **Short description:** Trend participation rate. **Beginning of series:** 1980Q4. **Source:** CBI. **Unit:** Fraction. **FAME code:** QMM.LAB.PATZZZ.Q. **Comment:** Calculated as a four-quarter moving average of PA, (6.8).

Name: PC. **Short description:** Private consumption deflator. **Beginning of series:** 1970Q1. **Source:** STATICE/CBI. **Unit:** Index, 2000 = 1. **FAME code:** QMM.PRI.PCZZZZ.Q. **Detailed description:** Defined as $PC = CN/C$.

Name: $PCOM$. **Short description:** Non-oil commodity prices in USD. **Beginning of series:** 1980Q2. **Source:** IMF. **Unit:** Index, 2000 = 1. **FAME code:** QMM.EXO.PCOMZZ.Q. **Comments**: Obtained from IMF (code: Q.00176NFDZF...). **Detailed description:** Index of market prices of non-fuel commodities. The index is normalised so that the average index of the quarters of year 2000 equals 1.

Name: PG. **Short description:** Government consumption deflator. **Beginning of series:** 1970Q1. **Source:** STATICE/CBI. **Unit:** Index, 2000 = 1. **FAME code:** QMM.PRI.PGZZZZ.Q. **Detailed description:** Defined as $PG = GN/G$.

Name: $PGDP$. **Short description:** GDP price deflator. **Beginning of series:** 1971Q1. **Source:** STATICE/CBI. **Unit:** Index, 2000 =1. **FAME code:** QMM.PRI.PGDPZZ.Q. **Detailed description:** Defined as $PGDP = GDPN/GDP$.

Name: PH. **Short description:** House prices. **Beginning of series:** 1970Q1. **Source:** LRI/STATICE. **Unit:** Index, 2000 = 1. **FAME code:** QMM.PRI.PHZZZZ.Q. **ECOTRIM:** Index Fernandez Par : -.99 to .99. **Comment:** Annual values obtained implicitly from STATICE series on the housing stock at fixed and current prices. **Detailed description:** Implicit annual prices for apartments are calculated from the STATICE data. Quarterly values are estimated with ECOTRIM. Following the practice at the STATICE a series composed of the building cost index (BC) before 1997 and the LRI series on prices of apartments after that was used as a reference series in the estimation of the quarterly data.

Name: PI. **Short description:** Investment goods price deflator. **Beginning of series:** 1970Q1. **Source:** STATICE/CBI. **Unit:** Index, 2000 = 1. **FAME code:** QMM.PRI.PIZZZZ.Q. **Detailed description:** Defined as $PI = IN/I$.

Name: PIG. **Short description:** Government investment deflator. **Beginning of series:** 1970Q1. **Source:** STATICE/CBI. **Unit:** Index, 2000 = 1. **FAME code:** QMM.PRI.PIGZZZ.Q. **Detailed description:** Defined as $PIG = IGN/IG$.

Name: PIH. **Short description:** Housing investment deflator. **Beginning of series:** 1970Q1. **Source:** STATICE/CBI. **Unit:** Index, 2000 = 1. **FAME code:** QMM.PRI.PIHZZZ.Q. **Detailed description:** Defined as $PIH = IHN/IH$.

Name: PM. **Short description:** Import price deflator. **Beginning of series:** 1970Q1. **Source:** STATICE/CBI. **Unit:** Index, 2000 =1. **FAME code:** QMM.PRI.PMZZZZ.Q. **Detailed description:** Defined as $PM = IMPN/IMP$.

Name: $POIL$. **Short description:** Oil prices in USD. **Beginning of series:** 1970Q4. **Source:** IMF. **Unit:** Index, 2000 = 1. **FAME code:** QMM.EXO.POILZZ.Q. **Comment:** Petroleum (spot prices), US$ per barrel, obtained from IMF (code: Q.00176AAZZF...). The index is normalised so that the average index of the quarters of year 2000 equals 1.

Name: $POWA$. **Short description:** Population of working age. **Beginning of series:** 1970Q1. **Source:** STATICE/CBI. **Unit:** Heads. **FAME code:** QMM.EXO.POWAZZ.Q. **ECOTRIM:** StockL Boot, Feibes and Lisman – SD. **Comment:** Working age defined as 16-64 years old. **Detailed description:** Annual data are disaggregated to quarters with ECOTRIM.

Name: $PRBUS$. **Short description:** Business premium on risk-free interest rate. **Source:** CBI. **Unit:** Fraction. **FAME code:** QMM.EXO.PRBUSZ.Q. **Comment:** Currently assumed fixed at 2%.

Name: $PRISK$. **Short description:** Inflation risk premium. **Source:** CBI. **Unit:** Fraction. **FAME code:** QMM.EXO.PRISKZ.Q. **Comment:** Currently fixed and set equal to 0.5%.

Name: $PROD$. **Short description:** Labour productivity. **Beginning of series:** 1980Q1. **Source:** CBI. **Unit:** Fraction. **FAME code:** QMM.LAB.PRODZZ.Q. **Comment:** Average labour productivity defined as $PROD = GDP/EMP$.

Name: $PRODT$. **Short description:** Trend labour productivity. **Beginning of series:** 1981Q1. **Source:** CBI. **Unit:** Fraction. **FAME code:** QMM.LAB.-PRODTZ.Q. **Comment:** Average trend labour productivity from the production function (5.42) defined as $PRODT = GDPT/EMPT$.

Name: $PSNB$. **Short description:** Public sector net borrowing. **Beginning of series:** 1990Q1. **Source:** CBI. **Unit:** Millions of kronas at current prices. **FAME code:** QMM.GOV.PSNBZZ.Q. **Comment:** Accounting identity defined as $PSNB = (GN + IGN + CJ + DI + SUBS) - TAX$.

Name: PX. **Short description:** Export price deflator. **Beginning of series:** 1970Q1. **Source:** STATICE/CBI. **Unit:** Index, 2000 =1. **FAME code:** QMM.PRI.PXZZZZ.Q. **Detailed description:** Defined as $PX = EXN/EX$.

Name: $PXALU$. **Short description:** Price of aluminium products in US dollars. **Beginning of series:** 1988Q1. **Source:** STATICE/CBI. **Unit:** Index, 2000 =1. **FAME code:** QMM.EXO.PXALUZ.Q. **ECOTRIM:** Index Litterman Min SSR : -.99 to .99. **Comment:** The price index used is for the power intensive industry in whole. **Detailed description:** *Period from 1988 to 1996:* The annual price index is estimated from changes in Laspayers' index for power intensive industry until 1993 and the Fisher index from 1994 to 1996. The annual values are disaggregated using quarterly average of monthly FOB values of exported power intensive industry products divided by the volume of the export as a related series. *Period from 1997 onwards:* The index is found by using the change in quarterly Fisher index which is available from STATICE since 1997Q1. The index is normalised so that the average index of the quarters of year 2000 equals 1.

Name: $PXMAR$. **Short description:** Price of marine products in foreign currency. **Beginning of series:** 1986Q1. **Source:** STATICE/CBI. **Unit:** Index, 2000 =1. **FAME code:** QMM.EXO.PXMARZ.Q. **ECOTRIM:** Index Fernandez : -.99 to .99. **Detailed description:** *Period from 1988 to 1996:* The annual price index is estimated from changes in Laspayers' index for marine exports until 1993 and the Fisher index from 1994 to 1996. The annual values are disaggregated using quarterly average of monthly FOB values of exported marine products divided by the volume of the export as a related series. *Period from 1997 onwards:* The index is found by using the change in quarterly Fisher index which is available from STATICE since 1997Q1 . The index is normalised so that the average index of the quarters of year 2000 equals 1.

Name: $PXREG$. **Short description:** Export prices excluding aluminium and marine products. **Beginning of series:** 1988Q1. **Source:** STATICE/CBI. **Unit:** Index, 2000 =1. **FAME code:** QMM.PRI.PXREGZ.Q. **Detailed description:** Defined as $PXREG = (PX \times EX - EUS \times 1.011 \times PXALU - EER \times 1.002 \times PXMAR \times EXMAR)/EXREG$.

Name: RCC. **Short description:** Real cost of capital. **Beginning of series:** 1980Q1. **Source:** CBI. **Unit:** Fraction. **FAME code:** QMM.FIN.RCCZZZ.Q. **Comment:** Real user cost of capital is calculated with a Hall-Jorgenson type formula on a quarterly basis using equation (4.8).

Name: RCI. **Short description:** Corporate income tax rate. **Beginning of series:** 1990Q1. **Source:** CBI. **Unit:** Fraction. **FAME code:** QMM.EXO.RCIZZZ.-Q. **Detailed description:** Obtained as $TCI/GDPN_{-4}$ in historical data but treated exogenous from last observed value in forecasts and simulations.

Name: RCP. **Short description:** Corporate property tax rate. **Beginning of series:** 1990Q1. **Source:** CBI. **Unit:** Fraction. **FAME code:** QMM.EXO.RCPZZZ.-Q. **Detailed description:** Obtained as $TCP/GDPN$ in historical data but treated exogenous from last observed value in forecasts and simulations.

Name: REM. **Short description:** Employers' wage-related cost. **Beginning of series:** 1980Q1. **Source:** ILMS/CBI. **Unit:** Fraction. **FAME code:** QMM.EXO.REMZZZ.Q. **ECOTRIM:** Boot, Feibes and Lisman - FD. **Comment:** ILMS estimates various taxes that are linked to wages once a year, usually for the month of July. For convenience the employees' contribution to the pension funds is included. This contribution is compulsory. The entitlements that household have in the pension funds are treated as a part of the household's decision problem. **Detailed description:** The tax rate is a simple average calculated for different types of manual labourers covered in the ILMS surveys. Quarterly data obtained with ECOTRIM by disaggregating annual values.

Name: $REVA$. **Short description:** Household assets revaluation term. **Beginning of series:** 1987Q2. **Source:** CBI. **Unit:** Fraction. **FAME code:** QMM.FIN.-REVAZZ.Q. **Comment:** Defined in equation (4.25).

Name: $REVD$. **Short description:** Household debt revaluation term. **Beginning of series:** 1980Q2. **Source:** CBI. **Unit:** Fraction. **FAME code:** QMM.FIN.-REVDZZ.Q. **Comment:** Defined in equation (4.26).

Name: REX. **Short description:** Real exchange rate. **Beginning of series:** 1972Q1. **Source:** CBI. **Unit:** Fraction. **FAME code:** QMM.FIN.REXZZZ.Q. **Comment:** Historical data defined as $REX = CPI/(EER \times WCPI)$ and forecasted data obtained from equation (4.16).

Name: $REXEQ$. **Short description:** Equilibrium real exchange rate. **Source:** CBI. **Unit:** Fraction. **FAME code:** QMM.FIN.REXEQZ.Q. **Comment:** Currently fixed and equal to 0.9.

Name: $REXM$. **Short description:** Importers' real exchange rate. **Beginning of series:** 1971Q1. **Source:** CBI. **Unit:** Fraction. **FAME code:** QMM.FIN.-REXMZZ.Q. **Comment:** Defined as $REXM = PM/PGDP$.

Name: $REXX$. **Short description:** Exporters' real exchange rate. **Beginning of series:** 1972Q1. **Source:** CBI. **Unit:** Fraction. **FAME code:** QMM.FIN.-REXXZZ.Q. **Comment:** Defined as $REXX = PX/(EER \times WPX)$.

Name: $RFIC$. **Short description:** Tax rate on other payments. **Beginning of series:** 1998Q1. **Source:** CBI. **Unit:** Fraction. **FAME code:** QMM.EXO.RFICZZ.-Q. **Detailed description:** Obtained as $TIC/GDPN$ in historical data but treated as exogenous from last observed value in forecasts and simulations.

Name: $RHPI$. **Short description:** Real household post-tax income. **Beginning of series:** 1994Q1. **Source:** CBI. **Unit:** Millions of kronas at constant 2000 prices. **FAME code:** QMM.INC.RHPIZZ.Q. **Comment:** Quarterly data on nominal disposable income deflated by the private consumption deflator, (9.5).

Name: RI. **Short description:** Interest rate income tax rate. **Beginning of series:** 1997Q1. **Source:** CBI. **Unit:** Fraction. **FAME code:** QMM.EXO.RIZZZZ.Q. **Comment:** Given as the current 10% flat rate from 1997Q1.

Name: RIC. **Short description:** Ratio of households' other income to YE. **Beginning of series:** 1980Q1. **Source:** CBI. **Unit:** Fraction. **FAME code:** QMM.EXO.RICZZZ.Q. **Comment:** Obtained as YIC/YE in historical data but treated as exogenous from last observed value in forecasts and simulations.

Name: RID. **Short description:** Real interest rate differential. **Beginning of series:** 1987Q4. **Source:** CBI. **Unit:** Fraction. **FAME code:** QMM.FIN.WRIDZZ.Q. **Comment:** Defined as (4.9).

Name: $RIMP$. **Short description:** Tax rate on imports. **Beginning of series:** 1990Q1. **Source:** CBI. **Unit:** Fraction. **FAME code:** QMM.EXO.RIMPZZ.Q. **Comment:** Obtained as $TIMP/IMPN$ in historical data but treated as exogenous from last observed value in forecasts and simulations.

Name: $RISK$. **Short description:** Exchange rate risk premium. **Source:** CBI. **Unit:** Fraction. **FAME code:** QMM.EXO.RISKZZ.Q. **Comment:** Currently fixed and set equal to 1.5%.

Name: RJO. **Short description:** Household other tax rate. **Beginning of series:** 1987Q1. **Source:** CBI. **Unit:** Fraction. **FAME code:** QMM.EXO.RJOZZZ.Q. **Detailed description:** Obtained as $TJO/GDPN$ in historical data but treated as exogenous from last observed value in forecasts and simulations.

Name: RJY. **Short description:** Household income tax rate. **Beginning of series:** 1988Q1. **Source:** CBI. **Unit:** Fraction. **FAME code:** QMM.EXO.RJYZZZ.-Q. **Detailed description:** Obtained as $(TJY + ALLOW \times POWA)/(YE + CJ)$ in historical data but treated as exogenous from last observed value in forecasts and simulations.

Name: RL. **Short description:** Long-term interest rate. **Beginning of series:** 1994Q1. **Source:** CBI/ICEX. **Unit:** Fraction. **FAME code:** QMM.FIN.RLZZZZ.Q. **Comment:** Monthly averages of FAME series RIBR.05A.A.VBM.VTI.ISK.IS.O.D until 2004Q2 and RIKB 10 0317 from 2004Q3 onwards. **Detailed description:** Average of end-of-month Treasury notes yields. Before 1996Q2 Treasury notes where quoted by the Central Bank, but from 1996Q1 and onwards the yields are quotes from ICEX.

Name: RLV. **Short description:** Long-term indexed interest rate. **Beginning of series:** 1980Q1. **Source:** CBI. **Unit:** Fraction. **FAME code:** QMM.FIN.RLVZZZ-.Q. **Comment:** Quarterly averages of end-of-month values. **Detailed description:** Long-term yield on indexed bonds. Data for 1980-1987 are chain linked with data from Economic Statistics published by the CBI. A data break in 1984Q4 is interpolated. Data until 2002Q2 are five year government indexed bond. From 2002Q2 to 2004Q3 the RIKS15 government index bond was used as the five year bond was no longer active in 2003. From 2004Q4 onwards the HFF14 indexed housing loan fund bond (which has a government guarantee) is used as the government intends to buy back the RIKS15 bond.

Name: RRN. **Short description:** Real neutral interest rate. **Source:** CBI. **Unit:** Fraction. **FAME code:** QMM.EXO.RRNZZZ.Q. **Comment:** Currently fixed and equal to 4.5%.

Name: RS. **Short description:** Short-term interest rate. **Beginning of series:** 1987Q4. **Source:** CBI. **Unit:** Fraction. **FAME code:** QMM.FIN.RSZZZZ.Q. **Comment:** Quarterly averages of end-of-month values. **Detailed description:** Central Bank of Iceland monetary policy rate measured in annual yields. From March 1998 this is the interest rate on 14-day repurchase agreements (7-day from June 2004) between the Central Bank and domestic financial institutions. Before March 1998 this is the interest rate on tap sales.

Name: RSD. **Short description:** Other expenditure tax rate. **Beginning of series:** 1990Q1. **Source:** CBI. **Unit:** Fraction. **FAME code:** QMM.EXO.RSDZZZ.-Q. **Detailed description:** Obtained as TSD/CN in historical data but treated as exogenous from last observed value in forecasts and simulations.

Name: RTS. **Short description:** Effective subsidies rate. **Beginning of series:** 1980Q1. **Source:** CBI. **Unit:** Fraction. **FAME code:** QMM.EXO.RTSZZZ.Q. **Detailed description:** Obtained as $SUBS/GDPN$ in historical data but treated as exogenous from last observed value in forecasts and simulations.

Name: $RVAT$. **Short description:** Value-added tax rate. **Beginning of series:** 1990Q1. **Source:** CBI. **Unit:** Fraction. **FAME code:** QMM.EXO.RVATZZ.Q. **Detailed description:** Obtained as $TVAT/CN$ in historical data but treated as exogenous from last observed value in forecasts and simulations.

Name: RWC. **Short description:** Corporate wage cost tax rate. **Beginning of series:** 1990Q1. **Source:** CBI. **Unit:** Fraction. **FAME code:** QMM.EXO.-RWCZZZ.Q. **Detailed description:** Obtained as TWC/YE in historical data but treated as exogenous from last observed value in forecasts and simulations.

Name: $SPEC$. **Short description:** Trade specialisation. **Beginning of series:** 1970Q1. **Source:** CBI. **Unit:** Fraction. **FAME code:** QMM.DEM.SPECZZ.Q. **Comment:** Defined as $SPEC = TRADE/WGDP$.

Name: $SUBS$. **Short description:** Government subsidies. **Beginning of series:** 1980Q1. **Source:** STATICE/CBI. **Unit:** Millions of kronas at current prices. **FAME code:** QMM.GOV.SUBSZZ.Q. **ECOTRIM:** Flow Boot, Feibes and Lisman - FD. **Comment:** Net production subsidies, i.e. production subsidies and financial transfers net of government income from assets, dividends and rent. **Detailed description:** Quarterly data obtained from ECOTRIM.

Name: TAX. **Short description:** Total tax receipts. **Beginning of series:** 1990Q1. **Source:** CBI. **Unit:** Millions of kronas at current prices. **FAME code:** QMM.GOV.TAXZZZ.Q. **Comment:** Accounting identity given as $TAX = TJ + TC + TE$.

Name: TC. **Short description:** Corporate tax payments. **Beginning of series:** 1990Q1. **Source:** CBI. **Unit:** Millions of kronas at current prices. **FAME code:** QMM.GOV.TCZZZZ.Q. **Comment:** Accounting identity given as $TC = TCI + TCP + TWC$.

Name: TCI. **Short description:** Corporate income tax payments. **Beginning of series:** 1990Q1. **Source:** STATICE/CBI. **Unit:** Millions of kronas at current prices. **FAME code:** QMM.GOV.TCIZZZ.Q. **ECOTRIM:** Flow Boot, Feibes and Lisman - FD. **Detailed description:** Quarterly data obtained with ECOTRIM.

Name: TCP. **Short description:** Corporate property tax payments. **Beginning of series:** 1990Q1. **Source:** STATICE/CBI. **Unit:** Millions of kronas at current prices. **FAME code:** QMM.GOV.TCPZZZ.Q. **ECOTRIM:** Flow Boot, Feibes and Lisman - FD. **Detailed description:** Quarterly data obtained with ECOTRIM.

Name: TE. **Short description:** Total taxes on production and imports. **Beginning of series:** 1990Q1. **Source:** CBI. **Unit:** Millions of kronas at current prices. **FAME code:** QMM.GOV.TEZZZZ.Q. **Comment:** Accounting identity given as $TE = TVAT + TIMP + TSD$.

Name: $TERM$. **Short description:** Term premium. **Source:** CBI. **Unit:** Fraction. **FAME code:** QMM.EXO.TERMZZ.Q. **Comment:** Currently fixed and set equal to 0.5%.

Name: TI. **Short description:** Household financial income tax. **Beginning of series:** 1987Q1. **Source:** STATICE. **Unit:** Millions of kronas at current prices. **FAME code:** QMM.GOV.TIZZZZ.Q. **ECOTRIM:** Flow Boot, Feibes and Lisman - FD. **Comment:** Quarterly data obtained from annual data using ECOTRIM.

Name: TIC. **Short description:** Other tax payments. **Beginning of series:** 1998Q1. **Source:** STATICE/CBI. **Unit:** Millions of kronas at current prices. **FAME code:** QMM.GOV.TICZZZ.Q. **ECOTRIM:** Flow Boot, Feibes and Lisman - FD. **Detailed description:** There is discrepancy in the data for household tax payments from STATICE depending on whether the data is obtained from the sectoral accounts or public finance accounts. The household taxpayments in QMM are obtained from the sectoral accounts, that is *Disposable income of the household sector*. Therefore in order for total tax receipts in QMM to add up to the government's total tax revenues from the public finance accounts the discrepancy between the sector accounts and the public finance accounts is captured by the variable TIC.

Name: $TIMP$. **Short description:** Tariffs and other taxes on imports. **Beginning of series:** 1990Q1. **Source:** STATICE/CBI. **Unit:** Millions of kronas at current prices. **FAME code:** QMM.GOV.TIMPZZ.Q. **ECOTRIM:** Flow AR(1)Max Log Par : -.99 to .99. **Detailed description:** Quarterly data obtained with ECOTRIM using $IMPN$ as auxiliary information.

Name: TJ. **Short description:** Household tax payments. **Beginning of series:** 1987Q1. **Source:** CBI. **Unit:** Millions of kronas at current prices. **FAME code:** QMM.GOV.TJZZZZ.Q. **Comment:** Accounting identity given as $TJ = TJY + TI + TJO$.

Name: TJO. **Short description:** Other household tax payments. **Beginning of series:** 1987Q1. **Source:** STATICE/CBI. **Unit:** Millions of kronas at current prices. **FAME code:** QMM.GOV.TJOZZZ.Q. **Detailed description:** Total household tax payments are obtained from the sectoral accounts (*Disposable income from the household sector*) from STATICE. The variable TJO is in fact a residual and is derived as: Total household tax payments – Household income tax – Household financial income tax. Quarterly data is obtained by dividing the annual data equally into four.

Name: TJY. **Short description:** Household income tax. **Beginning of series:** 1979Q1. **Source:** STATICE/CBI. **Unit:** Millions of kronas at current prices. **FAME code:** QMM.GOV.TJYZZZ.Q. **ECOTRIM:** Flow AR(1)Max Log Par : -.99 to .99. **Detailed description:** Quarterly data obtained with ECOTRIM using YE as auxiliary information.

Name: $TRADE$. **Short description:** World trade. **Beginning of series:** 1970Q1. **Source:** IMF/CBI. **Unit:** Index, 2000 = 1. **FAME code:** QMM.EXO.-TRADEZ.Q. **Comment:** The index is normalised so that the average of the quarters of year 2000 equals 1. **Detailed description:** Trade weighted import volumes in Iceland's main trading partners (Canada, Denmark, Euro area, Japan, Norway, Sweden, Switzerland, UK and US). The weights are revised annually on the basis of the previous year trade in goods and services, using the same weights as in the official exchange rate index (EER).

Name: TSD. **Short description:** Other expenditure taxation receipts. **Beginning of series:** 1990Q1. **Source:** FIN/ STATICE/CBI. **Unit:** Millions of kronas at current prices. **FAME code:** QMM.GOV.TSDZZZ.Q. **ECOTRIM:** Flow AR(1) Max Log Par :-.99 to .99. **Detailed description:** Quarterly data obtained with ECOTRIM using CN as auxiliary information.

Name: $TVAT$. **Short description:** Value added taxation receipts. **Beginning**

of series: 1990Q1. **Source:** STATICE/CBI. **Unit:** Millions of kronas at current prices. **FAME code:** QMM.GOV.TVATZZ.Q. **ECOTRIM:** Flow AR(1) Max Log : -.99 to .99. **Detailed description:** Quarterly data obtained with ECOTRIM using CN as auxiliary information.

Name: TWC. **Short description:** Corporate wage cost tax payments. **Beginning of series:** 1990Q1. **Source:** STATICE/CBI. **Unit:** Millions of kronas at current prices. **FAME code:** QMM.GOV.TWCZZZ.Q. **ECOTRIM:** Flow AR(1) Max Log : -.99 to .99. **Detailed description:** Quarterly data obtained with ECOTRIM using $W \times EMP$ as auxiliary information.

Name: ULC. **Short description:** Unit labour costs. **Beginning of series:** 1980Q1. **Source:** CBI. **Unit:** Fraction. **FAME code:** QMM.LAB.ULCZZZ.Q. **Comment:** Defined as $ULC = W \times REM/PROD$.

Name: $ULCT$. **Short description:** Trend unit labour costs. **Beginning of series:** 1981Q1. **Source:** CBI. **Unit:** Fraction. **FAME code:** QMM.LAB.ULCTZZ.Q. **Comment:** Defined as $ULCT = W \times REM/PRODT$.

Name: UN. **Short description:** Level of unemployment. **Beginning of series:** 1980Q1. **Source:** DOL. **Unit:** Number of heads. **FAME code:** QMM.LAB.-UNZZZZ.Q. **Comment:** Quarterly averages of monthly unemployment data from DOL.

Name: UR. **Short description:** Unemployment rate. **Beginning of series:** 1970Q1. **Source:** DOL. **Unit:** Fraction. **FAME code:** QMM.LAB.URZZZZ.Q. **Comment:** Quarterly averages of monthly unemployment rate data from DOL.

Name: W. **Short description:** Wages. **Beginning of series:** 1980Q1. **Source:** STATICE. **Unit:** Index, 2000 = 1. **FAME code:** QMM.LAB.WZZZZZ.Q. **ECOTRIM:** AR(1) Max Log Par : -.99 to .99. **Comment:** The index is normalised so that the average index of the quarters of year 2000 equals 1. **Detailed description:** Annual data on wage cost is given in the national accounts. REM is used to estimate the indirect wage cost and EMP and the share of self-employed in the data on man-years (collected until 1997 by NEI) to calculate the wage cost per unit of labour (excluding self-employed). The wage index produced by STATICE is used as a reference series when annual data is disaggregated using ECOTRIM.

Name: $WCPI$. **Short description:** World consumer prices. **Beginning of series:** 1970Q1. **Source:** IMF/CBI. **Unit:** Index, 2000 = 1. **FAME code:** QMM.EXO.WCPIZZ.Q. **Comment:** The index is normalised so that the average index of the quarters of year 2000 equals 1. **Detailed description:** Trade weighted average of consumer prices in Canada, Denmark, Euro area, Japan, Norway, Sweden, Switzerland, UK and US. The weights are revised annually on the basis of the previous year trade in goods and services, using the same weights as in the official exchange rate index (EER).

Name: WEL. **Short description:** Household sector wealth. **Beginning of series:** 1987Q1. **Source:** CBI. **Unit:** Millions of kronas at current prices. **FAME code:** QMM.FIN.WELZZZ.Q. **Comment:** Defined as $WEL = HW + NFW$.

Name: $WEQP$. **Short description:** World equity prices. **Beginning of series:** 1970Q1. **Source:** EcoWin. **Unit:** Index, 2000 = 1. **FAME code:** QMM.EXO.-WEQPZZ.Q. **Comment:** Morgan Stanley Capital International (MSCI) Index from EcoWin (code: ew:wld15420). The index is normalised so that the average of the quarters of year 2000 equals 1.

Name: $WGDP$. **Short description:** World GDP. **Beginning of series:** 1970Q1. **Source:** OECD/CBI. **Unit:** Index, 2000 = 1. **FAME code:** QMM.EXO.-WGDPZZ.Q. **Comment:** The index is normalised so that the average index of the quarters of year 2000 equals 1. **Detailed description:** Trade weighted real GDP levels in Iceland's main trading partners (Canada, Denmark, Euro area, Japan, Norway, Sweden, Switzerland, UK and US). The weights are revised annually on the basis of the previous year trade in goods and services, using the same weights as in the official exchange rate index (EER).

Name: $WINF$. **Short description:** Four-quarter world inflation rate. **Beginning of series:** 1971Q1. **Source:** CBI. **Unit:** Fraction. **FAME code:** QMM.PRI.-WINFZZ.Q. **Comment:** Variable defined in equation (7.16).

Name: WPX. **Short description:** World export prices. **Beginning of series:** 1970Q1. **Source:** OECD/CBI. **Unit:** Index, 2000 = 1. **FAME code:** QMM.EXO.-WPXZZZ.Q. **Comment:** The index is normalised so that the average index of the quarters of year 2000 equals 1. **Detailed description:** Trade weighted foreign currency export price deflators (obtained as the ratio of nominal and real exports of goods and services data) of Iceland's main trading partners (Canada, Denmark, Euro area, Japan, Norway, Sweden, Switzerland, UK and US). The weights are revised annually on the basis of the previous year trade in goods and services, using the same weights as in the official exchange rate index (EER).

Name: WRS. **Short description:** Foreign short-term interest rate. **Beginning of series:** 1970Q1. **Source:** OECD/CBI. **Unit:** Fraction. **FAME code:** QMM.EXO.WRSZZZ.Q. **Comment:** Trade weighted foreign 3 month Treasury Bill interest rates of Iceland's main trading partners (Canada, Denmark, Euro area, Japan, Norway, Sweden, Switzerland, UK and US). The weights are revised annually on the basis of the previous year trade in goods and services, using the same weights as in the official exchange rate index (EER).

Name: $YDIJ$. **Short description:** Other household non-labour income. **Beginning of series:** 1994Q1. **Source:** STATICE. **Unit:** Millions of kronas at current prices. **FAME code:** QMM.INC.YDIJZZ.Q. **Comment:** The variable contains nominal interest incomes, including dividends and nominal interest rate outlays. For the indexed loans the indexation cost is included. For the foreign exchange denominated loans the interest cost in Icelandic kronas is included.

Name: YE. **Short description:** Wages, salaries and self-employed income. **Beginning of series:** 1979Q1. **Source:** STATICE. **Unit:** Millions of kronas at current prices. **FAME code:** QMM.INC.YEZZZZ.Q. **ECOTRIM:** Flow AR(1) Max Log Par : -.99 to .99. **Detailed description:** Annual data on income from wages and salaries are obtained from STATICE from the sectoral accounts (*Disposable income from the household sector*). Quarterly data obtained with ECOTRIM using $W \times EMP$ as a reference series.

Name: YIC. **Short description:** Households' other income. **Beginning of series:** 1979Q1. **Source:** STATICE. **Unit:** Millions of kronas at current prices. **FAME code:** QMM.INC.YICZZZ.Q. **ECOTRIM:** Flow AR(1) Max Log Par : -.99 to .99. **Detailed description:** Includes income from pension funds, unemployment benefits, payment for parental leave and accident-compensation. Annual data available from STATICE from the sector accounts. Quarterly data obtained with ECOTRIM using $W \times EMP$ as a reference series.

Name: YJ. **Short description:** Total household pre-tax income. **Beginning of series:** 1994Q1. **Source:** DIR. **Unit:** Millions of kronas at current prices. **FAME code:** QMM.INC.YJZZZZ.Q. **Detailed description:** Calculated as $YJ = YE + CJ + YIC + YDIJ$.

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