FI analysis

A model for household debt

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Summary

This FI analysis presents a model for household debt in Sweden. Household debt is closely linked to house prices, and both of these are determined by interest rates and economic outlooks, as well as by one another. The estimated properties of the model are reasonable; the model reacts as expected to shocks and on the whole its historical forecasts agree well with the outcomes. This means that we can use the model as support for FI's analysis of household debt.

The article describes two scenarios showing potential developments in household debt in the coming periods. The base scenario is based on the National Institute of Economic Research's (NIER) assessment of future macroeconomic developments. In this scenario, house prices and household debt rise by 9.5 and 6.4 per cent annually respectively during 2015, and then increase at a somewhat slower pace in the following years. The debt-to-income ratio stabilises around 185 per cent towards the end of 2017. In the second scenario, it is assumed that house prices will grow much faster in 2016. This means that debt will also grow faster and the debt-to-income ratio will then reach almost 190 per cent in 2018.

Finansinspektionen
08-787 80 00
finansinspektionen@fi.se

www.fi.se

Ref.: 15-16378

Introduction

There are several reasons for Finansinspektionen (FI) to follow household indebtedness. Firstly, a rapid increase in indebtedness may be a sign that vulnerabilities are building up in the financial system and thus that the risk of financial instability is increasing, see Finansinspektionen (2015d). FI shall also work to counteract financial imbalances, as they can make the economy more vulnerable, see Finansinspektionen (2014b).

FI already monitors and analyses household debt, for instance in the reports "The Swedish mortgage market" and "Stability in the financial system". Moreover, analysis of indebtedness is included when FI makes decisions each quarter on the so-called countercyclical capital buffer, see Finansinspektionen (2014a). The information available provides FI with a good picture of indebtedness in Sweden, but at present there are no tools for studying how debt may develop in the future.

The debt model developed in this study contributes to FI's analysis in several ways. Firstly, the model can be used to make forecasts for the debts, which contributes to FI's long-term planning for identifying vulnerabilities and taking measures to reduce them. A model systematises the analysis work and gives increased understanding of the driving forces behind the developments in debt. In addition, the model makes it possible to study how debts develop under different economic conditions – for instance, if economic activity strengthens faster than in an intended main scenario.

This study is arranged as follows. We begin by discussing the factors that can be assumed to be the driving forces behind household debt. As household debts are strongly linked to housing prices, we start with the driving forces behind supply and demand in the housing market. In the next stage, we describe and study the estimated model. The study concludes with an account of the model forecasts under two different assumptions (scenarios). In the first scenario, it is assumed that GDP and the repo rate will develop in line with the National Institute of Economic Research's (NIER) assessment in the report Wage Formation in Sweden 2015, see National Institute of Economic Research (2015). At the same time, Swedish house prices have risen much faster recently and there is a risk that the rate of price increase will remain high. In the second scenario we therefore assume that house prices will increase faster.

Household debts are strongly linked to housing prices

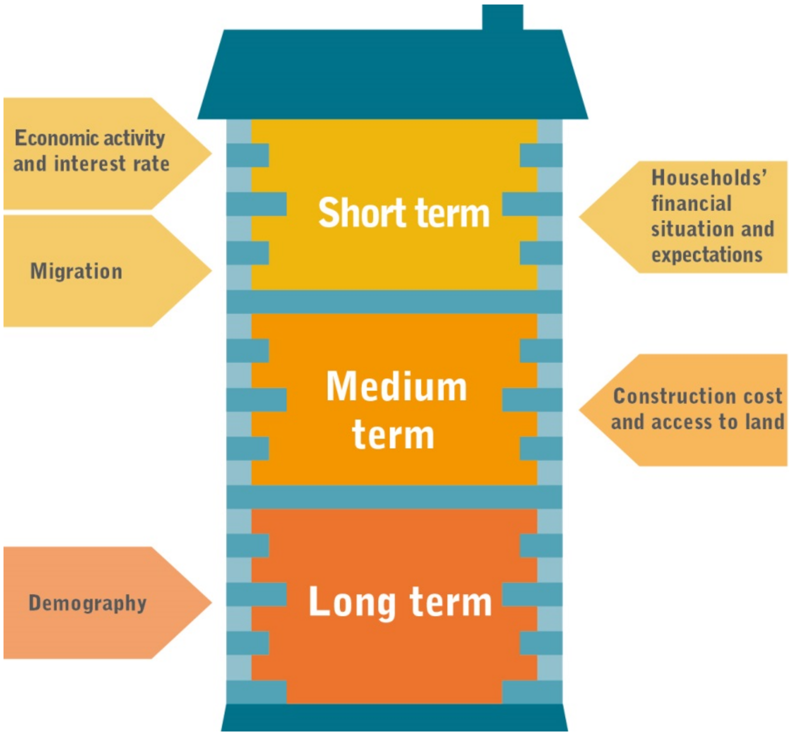
For a debt to arise, there must be someone who is willing to lend, and someone else who wants to borrow. This applies regardless of the purpose of the loan. Willingness to lend is governed, for instance, by the lender's cost for financing the loan. These financing costs are affected by access to (international) capital market and by regulation, see Hansen (2013). During the financial crisis 2008-2010, the supply of credit declined as a result of the banks' access to capital declining and in 2010 a mortgage cap was introduced, limiting the size of a mortgage in relation to the value of the home. The capacity to bear a debt depends on the household's economy and what the cost of the loan is (or rather, the relationship between these factors).

In Sweden, mortgages comprise almost 80 per cent of household debt. This is explained by a large share of households in Sweden owning their home and the majority of the housing purchase being financed through loans. Moreover, the homes are used as collateral for the loans and thus comprise around 50 per cent of the households' total wealth, see Sveriges Riksbank (2013b). To understand the development of debt in Sweden therefore, one must first understand how house price have developed. When house prices are high, the buyer needs to borrow more for the purchase than when prices are low. Moreover, those who already have loans can increase their borrowing when prices rise.

As on any market, prices and quantities here are determined by supply and demand. However, the housing market differs from other markets in some ways. One difference from many markets is that the supply changes slowly – it takes time to demolish and to build – and prices therefore react earlier than quantities. Moreover, a home is both an asset (an investment) and a service one consumes, by renting or owning a house or an apartment.

Figure 1 illustrates the factors that can be expected to affect the housing market and thus housing prices.

Figure 1: Factors that affect the housing market



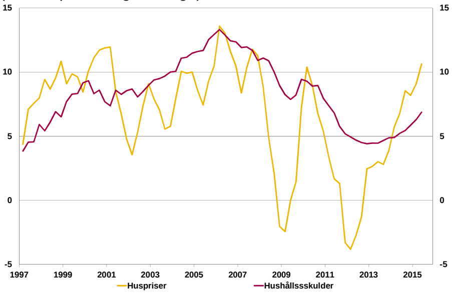
DEMAND FOR HOUSING IMPORTANT IN THE SHORT RUN

In the short run, the supply of housing remains in principle constant. This means that changes in demand primarily affect price developments in the shortest time horizon. The most important component of demand, and a decisive factor in purchasing a home, is the household's financial conditions, that is, their income after tax and their wealth. Hansen (2013) claims that household incomes are affected by both structural factors, such as the age distribution in the country, and by cyclical factors, such as interest rates and changes in allowances or taxation of interest expenditure or housing.

As the purchase of a home is a long-term commitment, expectations play a particularly large role. These expectations concern both the

Chart 1. House prices and debts

(Annual percentage change)



Source: Statistics Sweden

Note. House prices are measured according to the Property price index (FPI).

household's own finances and the country's expected economic development. The expectations typically cover housing prices, unemployment, interest rates, taxes and wages. Over the past 20 years, households' disposable incomes have risen substantially, while real interest rates – that is, interest minus the inflation rate – have clearly fallen. The low interest rates, rising disposable incomes and reduced tax on housing have meant that households' debts have increased by almost 10 per cent a year on average during 2000-2010 (see Chart 1). Finansinspektionen et al. (2015) describes the significance of the development in real interest rates for housing prices and indebtedness in greater detail. At present, the real interest rate in Sweden is lower than 1 per cent, which contributes to the rise in indebtedness.

HOUSING SUPPLY IMPORTANT IN THE LONGER RUN

The supply of housing is more sluggish than the demand, and thus plays an important role in the slightly longer run. Supply is largely dependent on the availability of land and the cost of construction. Construction costs in turn are affected by land prices, construction materials prices, construction worker salaries, taxes and subsidies, as well as regulations in the construction area. Construction has been at a low level in Sweden since the 1990s crisis. It has been held back by high land prices and the regulation of the rental market, among other things.

DEMOGRAPHIC FACTORS

Migration affects the need for housing. In Sweden, immigration has contributed to a population increase in recent decades. Moreover, there has been a rapid urbanisation, which has led to an increased need for housing in metropolitan areas. These are two reasons why prices have increased rapidly, particularly in metropolitan areas. Demographic developments also affect the demand for housing in the longer run. All in all, population growth, age distribution and migratory patterns are important. One can note that construction has not matched the growth in population and migration into the metropolitan areas in Sweden, see Finansinspektionen et al. (2015).

THE CORRELATION BETWEEN HOUSING PRICES AND DEBTS IS NOT PERFECT

The relation between the rate of growth in property prices and household debt is strong, but there are periods when it is weaker (see Chart 1). There are several explanations for this difference. If the supply of tenant-owned apartments and single-family dwellings increases, this will push down property prices. At the same time, it will lead to more people owning their own homes, which in the short run gives increased indebtedness at aggregate level. This leads to a partly negative correlation between housing prices and debts. Moreover, only those who take on new loans are affected by an increase in housing prices. The home-owners who sell an apartment to buy a house "suffer" from the price increase in the new purchase and benefit from the price increase on their sale. If the purchased property is cheaper than the sold one, then that particular property owner will actually be less highly mortgaged than prior to the two transactions, despite the increase in property prices. A third reason why the correlation between housing prices and debts is not perfect is that the number of property deals made has an effect on the development of debt. If a price increase means fewer sales, the increase in housing prices will not have a full impact on debts.

A model for household debts

THE MODEL'S VARIABLES

Household debts are measured by means of statistics for Swedish monetary financial institutions' (MFI) lending to households and housing prices by the property price index (FPI).

The previous section suggests possible explanatory variables for the model. However, to be able to include the variables in the model, there must be data that extends sufficiently far back in time, at least to the early 2000s. If a variable is considered to contribute to explaining the development of debts or house prices and there is a sufficient number of observations in the time series, we have included it in the model estimation and then studied the correlation between the variable in question and the other variables in the model. Those variables that give reasonable estimated correlations have been retained in the model. In a good model, changes in the explanatory variables shall show reasonable changes in debts and housing prices, both in terms of the economy and in terms of size. If the correlation between two variables deviates from the expected, we exclude one of the variables.

The housing supply can be approximated by means of the change in the stock of houses and apartments. However, the statistics on the housing stock have too few observations for a model estimate. Instead we have tried to use information on construction start-ups and building permits. The problem is that these variables do not contribute to explaining the development of debt in the model and moreover they give correlations that are not reasonable, according to economic theory.

It would be useful to include measures of construction costs in Sweden, in accordance with the discussion in the previous section. As we noted there, construction costs are dependent on land prices, construction materials prices, construction worker salaries, as well as taxes and subsidies, and regulations in the construction area. However, all of these variables are difficult to measure, particularly over time. All in all, this means that we do not use a measure of supply in the final model.[1]

Housing demand is due to the household's financial situation: Whether they have a job, the size of their income and their wealth, and the cost of borrowing (interest and taxation). Above all, it is how the household perceives these factors and how they expect them to develop that affects decisions on consumption and borrowing. Developments in traditional macro variables, such as disposable income, wealth, unemployment, employment, GDP and consumption are therefore possible variables that capture important aspects of the demand for housing. On the other hand, these measures do not capture households' expectations for the future as they are backward-looking. The NIER compiles a measure of household confidence that summarises households' views of the Swedish economy and their own finances,

1 It would be useful to include an approximation of supply in the model, as this enables experiments that examine how debts might be affected by an increase in construction. When the model is further developed, a new attempt should be made to identify such a variable.

now and in a year's time.[2] Household confidence is therefore a potential candidate for explaining both house prices and indebtedness.

Household confidence (CCI) gives reasonable correlations with both house prices and indebtedness in the model. It works better than GDP, consumption and labour market variables. When we include confidence together with one of the traditional macroeconomic variables, the model's own properties are deteriorated – the correlation between confidence and debts is undermined. We have also tested adding income and wealth variables to the model, but their contribution to explaining house prices and indebtedness at an aggregate level is minimal.

A further variable that contributes to desirable behaviour by the model is the mortgage rate, which in theory is also of central importance to growth in indebtedness. When interest rates are low, the day-to-day loans cost is low and the scope for bearing the cost of a debt increases.[3] In the model we use a weighted mortgage rate.

It is difficult to measure the demographic composition, but we have nevertheless made an attempt to take it into account by testing population growth in the model. However, the model has no effect on house prices or debts. It is more likely that the population affects growth in debt in an equilibrium state[4] than the short-term correlations we intend to model.

The model that shows the best properties contains household confidence according to the CCI, housing prices according to the FPI, household debt and a weighted mortgage rate. This is the model described and used in the rest of the article.

THE MODEL IS BASED ON HISTORICAL CORRELATIONS IN DATA

We use a model-based approach that combines expert knowledge, in the form of opinions on the long-term growth rates, with correlations in data.[5] The model describes two things:

1. The way the variables are expected to develop in a normal state, that is, when all variables are in equilibrium. Here expert knowledge is important.
2. How the variables are expected to develop from outcome to equilibrium. Here data are important.

Opinions on the long-run growth rates of the variables are given in the form of so-called prior distributions (see Table 1). The prior distributions have been guided by housing prices and debts growing at the same pace as nominal GDP in a normal state. In recent years, debts have increased faster than nominal GDP. However, the difference in growth rates has to a large extent been due to structural factors, such as many rental properties being converted to tenant-owner associations, see Hansen (2013). Other such structural factors include reduced tax on housing services and the downward trend in interest rates

2 Detailed information on the NIER's Economic Tendency Survey (households) is provided on their website: www.konj.se.

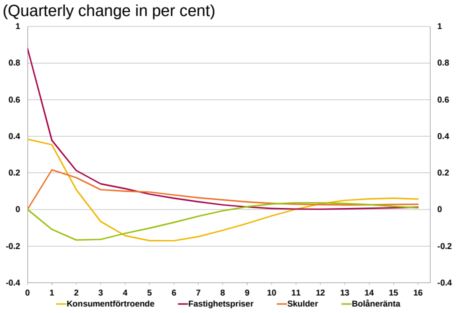
3 All else being equal. However, it may be the case that low interest rates coincide with an economic recession. Then it is not clear how indebtedness will develop.

4 Growth in an equilibrium state (or a normal situation) is the growth rate the variables have in the long run. The equilibrium concept is discussed further later on.

5 The model is a so-called vector auto regression and has proved to work well in forecasting contexts, see Robertson and Tallman (1999) and Adolfson et al. (2007). The model is described in an appendix.

Chart 2. Responses for property prices

(Quarterly change in per cent)

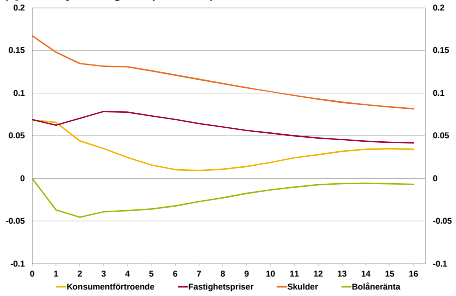


Source: FI

Note: The lines show how property prices react to a shock to the respective variable. The X axis shows the quarter after the shock occurs. A complete review of the impulse responses is provided in appendix 4.

Chart 3. Responses for household debt

(Quarterly change in per cent)



Source: FI

Note: The lines show how household debt reacts to a shock to the respective variable. The X axis shows the quarter after the shock occurs. A complete review of the impulse responses is provided in appendix 4.

in recent decades. Interest rates are included in the model, but not conversions to tenant-owner associations and lower taxes. All of the factors probably affect both dynamics and equilibrium in the model. We have chosen to use these as arguments to set equilibrium to the same as nominal GDP (in the prior distribution) as it is difficult to quantify and thereby model the structural factors.

The views on the model's equilibriums are updated with information in data and gives what is known as posterior distribution (see Table 1). The way the different variables' forecasts move from outcome to equilibrium is described by estimated dynamic parameters where all of the variables affect one another simultaneously. From here on we refer to the posterior distributions as the model's *equilibrium*. The model is estimated from the first quarter of 2002 until the most recent outcome available (second quarter of 2015).

Table 1: The model's equilibrium

	Prior distribution		Posterior distribution	
Variable	Lower limit	Upper limit	Lower limit	Upper limit
CCI	-0.1	0.1	- 0.1	0.1
FPI	3.8	5.3	3.6	5.1
Household debt	3.8	5.3	4.1	5.6
Mortgage rate	3.0	4.0	2.6	3.6

Note: The prior distributions are our subjective views on the equilibrium of the ingoing variables and are stated as normally distributed 95-per cent probability intervals. The posterior distributions are the corresponding intervals after the prior distributions have been updated with the information in the data. The posterior distributions are thus products of subjective views and information in data.

An important property of forecasting and analysis models is that changes in one variable shall give reasonable changes in the others. This characteristic determines whether the model can be used for experiments. Further, it is important that the model's forecasts are accurate. We can examine this with the aid of historical forecasts and outcomes.

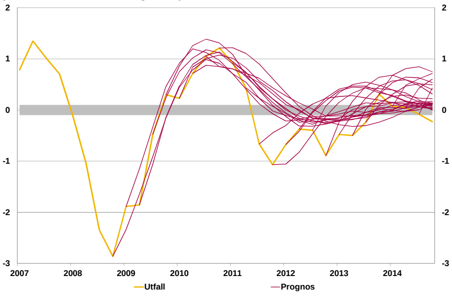
THE MODEL SHALL REACT IN A REASONABLE MANNER TO SHOCKS

The following section studies the model's so-called impulse responses. An impulse response shows how the model reacts (response) to a change (impulse) in one of the variables. A general description of impulse responses is included in Appendix 3. The model's impulse responses are important as they determined the model's properties. A complete review of the impulse responses is provided in Appendix 4. Here we discuss the overall results with a focus on how house prices and debts react to changes in the model's different variables. All shocks are constructed in such a way that we find debts and house prices react reasonably to impulses from the variables in the model. This applies both from the perspective of the economy and of size of the response.

Chart 2 shows how housing prices (FPI) are affected in the model. Housing prices rise initially when consumer confidence changes unexpectedly (the actual impulse to the CCI is not shown). The effect in the FPI then wanes cyclically, which is because the CCI captures the

Chart 4: Consumer confidence (CCI)

(Standardised net figures)

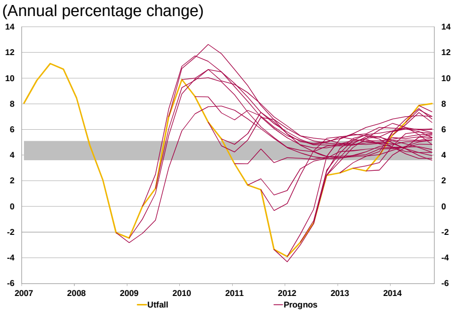


Sources: The NIER and FI

Note. The forecasts were made between the last quarter of 2008 and the first quarter of 2015. The grey field marks the equilibrium distribution.

Chart 5: House prices (FPI)

(Annual percentage change)

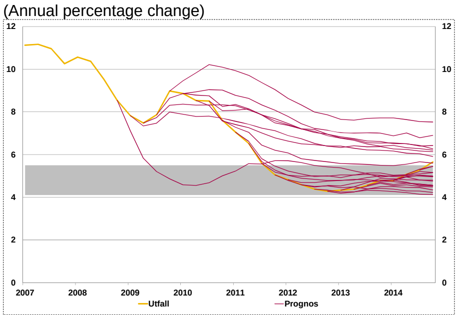


Sources: Statistics Sweden and FI

Note. See the note to Chart 4.

Chart 6: Household debts

(Annual percentage change)

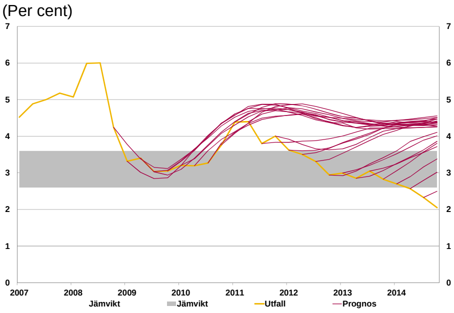


Sources: Statistics Sweden and FI

Note. See the note to Chart 4.

Chart 7: Mortgage rate

(Per cent)



Sources: Datastream and FI

Note. See the note to Chart 4.

typical economic cycle pattern. The FPI reacts positively to an increase in itself and the debt variable, and a higher interest rate gives a slower growth rate in housing prices.

Debts react in a similar manner as house prices with regard to unexpected increases in the model's variables, see Chart 3. The usual difference is that debts are more sluggish – it takes longer before the effects of the impulse wane in the model. In practice, this means that the adjustment of the debts from outcome to equilibrium will move slowly.

FORECASTING PERFORMANCE IS ALSO IMPORTANT

Forecasting performance is another common means of evaluating a model. This is most often done by means of statistical measures based on average forecasting error, that is, the difference between outcome and forecast, and how much the forecasting error varies around the outcomes.[6] Instead of using these statistical measures, we have chosen to report and discuss the actual model forecasts in their entirety and compare them with the historical outcomes. On each forecast occasion we give the model the same information as it would have had if the forecast was made at the historical point in time (so-called real time).[7]

When one evaluates the forecasting performance of a model, it is particularly interesting to study an eventful period. Periods that differ from earlier periods are more difficult to forecast and it is interesting to see how the model manages this. We have therefore chosen to study the period 2009-2014. This period extends over both the dramatic prelude to the financial crisis (2008-2009), the recover in 2010 and the debt crisis in the euro area (2010-2011). Initially, we are in the midst of the financial crisis and economic activity in Sweden has weakened substantially over the past six months.

On the first forecasting occasion (2008, Q4) the CCI and the growth rate in house prices are far below their respective equilibriums (see Chart 4). However, growth in debt is above its equilibrium and the mortgage rate is close to its equilibrium. The weak economic activity in the outcome (CCI and FPI) dampens the forecast for household debt relatively substantially, see Charts 4 and 5. Chart 6 shows that debt forecasts in this stage are lower than the actual outcomes. The economic situation also gives a low interest rate forecast and the forecast is close to the outcomes, see Chart 7. The forecasts for the CCI and FPI gradually adapt upwards towards their respective equilibriums.

Economic activity in Sweden strengthens in 2010 and 2011. The model captures this and forecasts rising CCI. These forecasts are close to the historical outcomes. The interest rate forecasts also continue to be accurate during this period. Given that the forecasting errors are small, the forecasts for these variables are revised very little during 2010-2011. However, the model does not capture the development in the FPI 2010-2012. The CCI and development of debt are relatively strong in 2010 and the mortgage rate situation is relatively low, so there is nothing in the model that can explain the weak development in the FPI.

6 The most common measures are mean error, mean absolute error and mean square error.

7 We use the most recently-published versions of outcomes, which means that data may have been revised since the time of publication and thus the forecasts can differ somewhat from those that would have been made in real time.

A second model for interesting alternative scenarios

The model we found to work is a simple specification. For forecasting purposes it is a practical instrument (see the section "Forecasting performance is also important"). However, one of the model's purposes is to analyse and compare different alternative economic developments. One example of an alternative scenario is that growth is lower than in a main scenario. However, in the current model specification it is not possible to construct such a scenario, as GDP growth is not included in the model. We use a second model for this purpose. This makes it possible to translate an alternative sequence of events for a variable that is not included in the model into a sequence for a variable that is included. For instance, we can link an alternative development in GDP, in Sweden or abroad, to an alternative sequence for consumer confidence (CCI). Given this constructed CCI sequences, we can then make forecasts for debt and housing prices that are consistent with the alternative development in GDP.

The initially weak forecast for debt is revised upwards in later forecasts, which is due to stronger economic activity and rising house prices in 2009.

In autumn 2011 the economic situation changes again. Discussions regarding sovereign debt problems in southern Europe intensify and make their mark on both public confidence and the real economy. Following this, CCI declines at the same time as housing prices begin to fall (and then later show negative growth rates). Moreover, the Riksbank stops raising its policy rate. In this situation, the rate of debt increase in outcomes is slowed down more than in the forecasts made by the model for 2010.

In connection with the economic recession around 2011, the model makes good debt forecasts. After that, the debt forecasts are good up to and including the final forecasting occasion. After 2012, when the growth rate in the FPI gradually began to rise, the model's forecasts for housing prices are also good. On the other hand, the model's forecasts for interest rates are higher than the outcomes throughout 2012-2014. Similar forecasting errors can be found in all Swedish forecasters' assessments of the repo rate during this period (see the Riksbank 2013a, 2014a and 2015a).

Forecasts from the second quarter of 2015

This section presents forecasts based on outcomes up to and including the second quarter of 2015. FI does not forecast economic developments in Sweden and we therefore use the NIER's assessment in its report Wage Formation in Sweden 2015, published in October, to construct a base scenario. We use the NIER's forecasts[8] for nominal growth in GDP, disposable incomes[9] and the repo rate. Given the recent acceleration in house prices, it is conceivable that they will continue to rise at a faster pace. We therefore also make an alternate forecast where we assume that the rate of growth in house prices will be higher than in the base scenario. The construction of these so-called conditional forecasts is described in an appendix,

GPD and the repo rate are not included in the debt model (see the section on "The model's variables"). However, we link these variables together with those included in the debt model in a separate model consisting of nominal GDP, payroll expense[10], consumer confidence, the repo rate and the mortgage rate (see the fact text "A second model for constructing several alternative scenarios").

FORECASTS GIVEN THE NATIONAL INSTITUTE OF ECONOMIC RESEARCH'S ASSESSMENTS

Our model consists of two components: growth in an equilibrium state and adjustment to equilibrium, see the section "The model is based on

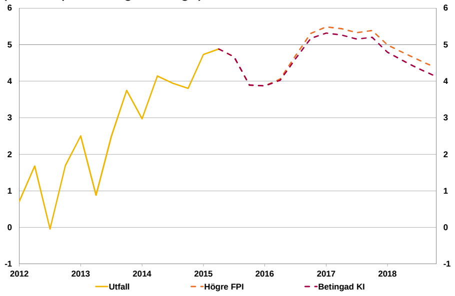
8 Finansinspektionen thanks the National Institute of Economic Research for sharing their unpublished forecasts.

9 As the NIER does not forecast nominal disposable income on a quarterly basis, we ourselves create a series that follows the NIER's assessment of payroll expense and matches the NIER's annual forecasts for nominal disposable income. We do this by means of Chow and Lin's (1971) procedure.

10 It is actually nominal disposable incomes that are interesting here. However, disposable incomes contain a lot of white noise and we therefore use payroll expense instead (the entire economy) in the model. Payroll expense comprises around 80 per cent of disposable income.

Chart 8: GDP growth

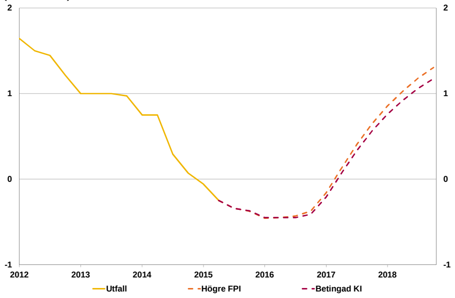
(Annual percentage change)



Sources: The NIER, Statistics Sweden and FI

Chart 9: The repo rate

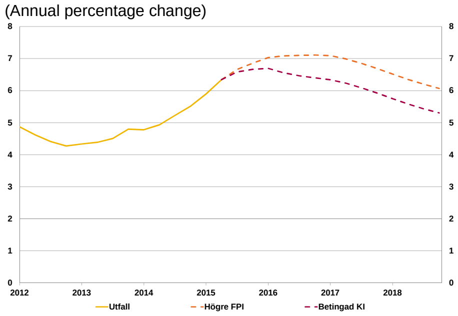
(Per cent)



Sources: The NIER, Statistics Sweden and FI.

Chart 10: Growth in household debt

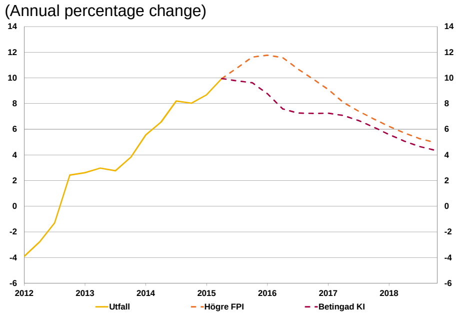
(Annual percentage change)



Sources: Statistics Sweden and FI

Chart 11: Growth in house prices

(Annual percentage change)



Sources: Statistics Sweden and FI

historical correlations in data". Initially, growth in house prices and debt are above their respective equilibrium values. GDP growth is close to its equilibrium and the NER assesses that growth will be close to equilibrium in 2015-2016 (see Chart 8). Moreover, the NIER forecasts that the repo rate will remain negative during these years (see Chart 9). The NIER's assessments show consumer confidence being normal in 2015 and somewhat above normal in 2016, at the same time as the mortgage rate is very low during the forecasting period. All in all, the sequence of events for consumer confidence and the mortgage rate leads to debt slowly adapting towards its equilibrium. Debts are expected to grow by 6.4 and 6.5 per cent respectively on average in 2015 and 2016, which is higher than in 2014 (see Chart 10).[11] The reason for the slow adjustment in debt is the persistence in the debt series and the low repo rate. The effect of the repo rate on debt and house prices is shown in Appendix 1. When the repo rate and thus the mortgage rate increases in the forecast, growth in household debt falls further, to 6.1 per cent in 2017 and 5.5 per cent in 2018.

The forecast for property prices is explained by the same factors as the debt forecast. Growth in property prices is expected to be strong in 2015. They increase by 9.5 per cent compared with 7.1 per cent in 2014 (Chart 11). After that, the growth rate falls somewhat, but is expected to remain strong in 2016 (7.7 per cent as an annual average). When interest rates begin to normalise, the growth rate in housing prices will fall further (to 6.8 per cent in 2017 and 4.9 per cent in 2018).

STRONGER GROWTH RATE FOR HOUSE PRICES

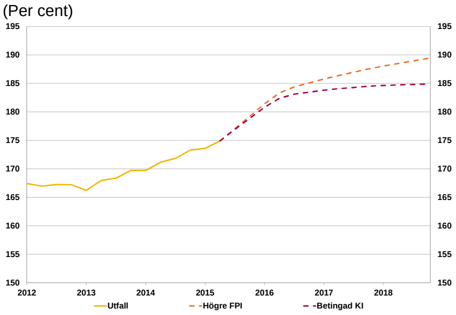
Charts 8-11 also show forecasts in the scenario with higher housing prices. In this scenario we have assumed that housing prices grow by 1 percentage point more per quarter during one year than in the NIER's assessment, which gives a forecast of 10.3 and 11.3 per cent as an annual average for 2015 and 2016 respectively. The higher property prices mean that the forecast for household debt will be 0.1-0.8 per cent higher as an annual average than in the main scenario. All in all, the higher house prices will lead to the level of household debt being in total around 2.5 per cent higher at the end of 2018.

THE DEBT-TO-INCOME RATIO DEPENDS ON DEVELOPMENTS IN HOUSE PRICES

The forecast in the base scenario is that the debt-to-income ratio – household debt in relation to their disposable incomes – will stabilise at around 185 per cent (see Chart 12). Stronger house prices entail marginally stronger developments in economic activity, through household confidence. Disposable incomes also become a few tenths higher in 2015-2018. As debts increase more than incomes in the house price scenario, however, the debt-to-income ratio is expected to increase faster than in the main scenario, and to reach almost 190 per cent at the end of 2018.

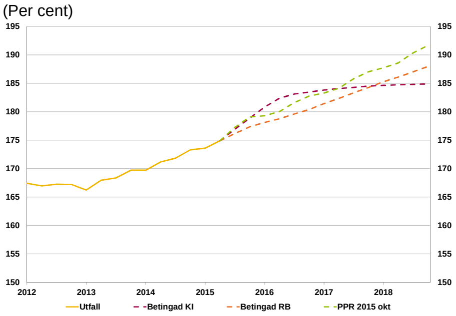
11 The chart shows quarterly observations for changes since the same period in the previous year, so-called annual percentage change. The annual average is the average of annual percentage changes during a specific year.

Chart 12: Households' debt-to-income ratio



Sources: Statistics Sweden and FI

Chart 13: Households' debt-to-income ratio



Sources: The Riksbank, Statistics Sweden and FI

THE SIGNIFICANCE OF MACRO ASSUMPTIONS AND EQUILIBRIUM

The model's forecasts are determined by equilibrium growth rates, the distance between outcome and equilibrium and the dynamic parameters (that is, the impulse responses). In the long run, it is of course the equilibriums that determine the forecasts, but in the shorter run outcomes and possible restrictions (conditions) on the forecasts and the estimated parameters play a role. If the outcomes are close to equilibrium, the adjustment is relatively fast, but if the outcomes deviate substantially from equilibrium, it make take some years before the model's forecasts attain equilibrium.

Chart 13 shows three forecasts for the debt-to-income ratio. The first is the model's forecast when we conditionon the NIER's assessed economic development. The second forecast also comes from the model, but then the model is conditional on the Riksbank's (RB) macro outlook.[12] Finally, Chart 13 also shows the debt-to-income forecast from the RB's October report, see Sveriges Riksbank (2015b). The three forecasts differ from one another and by studying the differences in pairs we can understand how the constituents of the model function.

We begin by comparing the two model forecasts, those that are conditional on the NIER's and the RB's economic assessments respectively (see Chart 13). As the model's equilibrium and parameters are the same in both of these forecasts, the differences come from the conditions in this case.[13] The RB has a higher GDP forecast for 2015 and 2016 than the NIER. The repo rate forecasts are similar in 2015 and 2016 and the RB has lower interest rate forecasts in 2017 and 2018 than the model gives when made conditional on the NIER's forecast. All in all, GDP and the repo rate give debt forecasts that are higher in 2017 and 2018 in the forecast conditional on the RB assessment. A further difference between the two institutions' macroeconomic outlooks is that the NIER assesses that developments in disposable incomes are lower in 2015 and 2016 than in the RB's forecast. For 2017 and 2018 the RB' forecasts are lower than the model's forecasts (conditional on the NIER's assessment). All this gives a debt-to-income ratio that is somewhat higher at the end of 2018 when we make it conditional on the RB's assessment rather than the NIER's.

The Riksbank's published debt-to-income forecast is higher than both of the conditional model forecasts. One possible explanation for the difference between the model's forecast conditional on the RB's macroeconomic outlook and the RB's assessment of the debt-to-income ratio is that the model's and the Riksbank's equilibrium growth rates for household debt differ.

All in all, the difference between the three forecasts for the debt-to-income ratio shows that both the macroeconomic assumptions and the view of the variables' equilibriums plays a role for the forecasts.

Concluding comments

Debts comprise important vulnerabilities in the financial system. Companies and households with large debts are more sensitive when economic conditions change. It is therefore important for FI to follow developments in debt.

12 Finansinspektionen thanks the Riksbank for sharing their unpublished forecasts.

13 Neither the NIER nor the RB publishes forecasts for nominal GDP and nominal disposable incomes on a quarterly basis so we can only discuss the differences in a rough outline.

This FI analysis introduces a model for household debt and property prices. A corresponding model for companies will be developed later. The purpose of the model is to make forecasts that can be conditional on different macroeconomic developments. All in all, the model diagnostics – impulse responses and forecasting performance – shows that the model is applicable. In the article we use the NIER's assessment from the report Wage Formation in Sweden 2015, published in October, to create a base scenario. In this base scenario the growth rate in property prices and household debt remains high, but slows down going forward. Moreover, we make an alternative forecast where property prices increase much more than in the base scenario. The alternative scenario gives higher growth in debt and the debt-to-income ratio.

The model's forecasts shall not be interpreted as FI's official forecasts, but as an aid to supplement the qualitative analysis of household debt already being made.

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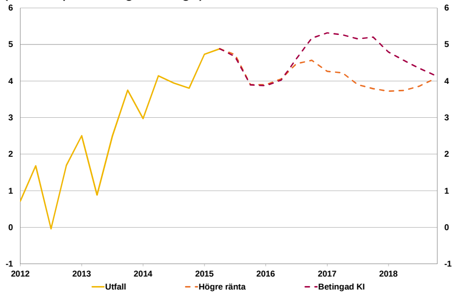
Appendix 1: The significance of the interest rate in the model – a scenario

Chart A1: GDP growth

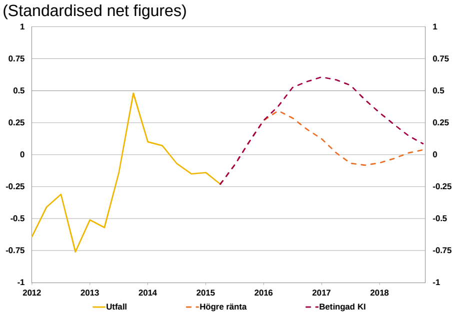
(Annual percentage change)



Sources: The NIER, Statistics Sweden and FI

Chart A2: Consumer confidence (CCI)

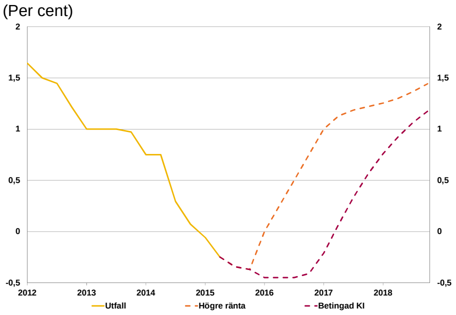
(Standardised net figures)



Sources: The NIER and FI

Chart A3: The repo rate

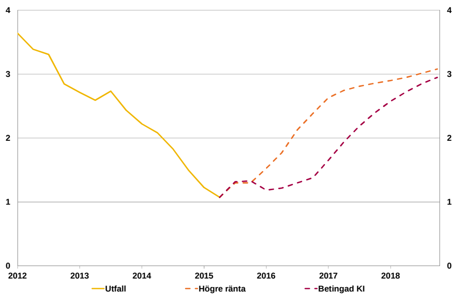
(Per cent)



Sources: The NIER, Statistics Sweden and FI

Chart A4: Mortgage rate

Per cent



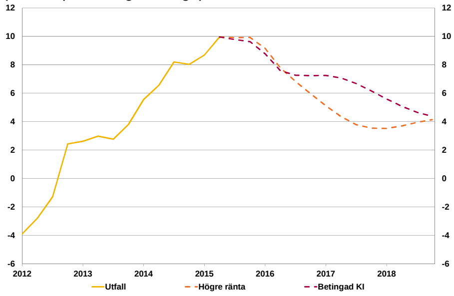
Sources: Datastream and FI

The section "Forecasts from the second quarter of 2015" discusses the model's forecasts and claims that the interest rate has considerable significance for how quickly the model adapts to its equilibrium. To illustrate this, we have made an alternative scenario where we have added a higher interest rate than that of the NIER's assessment.

The interest rate scenario means that the increases in the repo rate will begin in the first quarter of 2016 to reach 1 per cent in the first quarter of 2017, see Chart A3. After that, the two scenarios are no longer conditional on interest rates, but there remains a difference between the two forecast paths throughout the entire period. The higher repo rate has a direct impact on the mortgage rate, see Chart A4. The higher interest rate also leads to weaker economic activity, which is reflected in both GDP and consumer confidence, see Charts A1 and A2. The lower consumer confidence and higher mortgage rate mean that house prices will be around 2 percentage points lower every year (Chart A5). Households' debts are affected less and show growth of up to one percentage point lower (Chart A6).

Chart A5: Growth in house prices

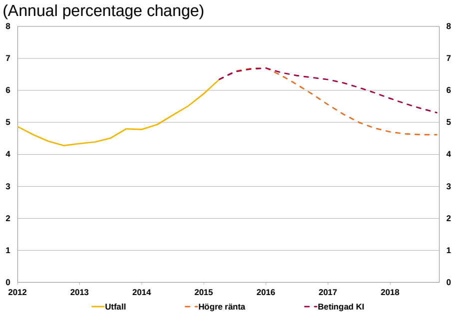
(Annual percentage change)



Sources: The NIER, Statistics Sweden and FI

Chart A6: Growth in households' debt-to-income ratios

(Annual percentage change)



Sources: Statistics Sweden and FI

Appendix 2: Bayesian VAR models

In the autoregressive (AR) model,

(A1) $$x_t = \beta_0 + \beta_1 x_{t-1} + \beta_2 x_{t-2} + \boldsymbol{a}_t,$$

the latest observation in a variable depends on earlier observations of the same variable. In equation (A1) x depends on up to two periods (time lags) back in time. a_t is a randomly distributed error term and contains all of the variation in x that is not captured in the equation (A1). If more than one variable is included in the model it is called a Vector Autoregression model (VAR). A VAR model with two variables and one lag looks like this

(A2) $$\begin{aligned} x_{1t} &= \beta_{10} + \beta_{11} x_{1t-1} + \beta_{12} x_{2t-1} + a_{1t} \\ x_{2t} &= \beta_{20} + \beta_{21} x_{1t-1} + \beta_{22} x_{2t-1} + a_{2t} \end{aligned}.$$

Model (A2) can be written in the form of a matrix as:

(A3) $$\boldsymbol{x}_t = \tilde{C} \boldsymbol{x}_{t-1} + \boldsymbol{a}_t,$$

where

$$\boldsymbol{x}_t = [\mathbf{1} \quad x_{1t} \quad x_{2t}]', \ \boldsymbol{a}_t = [a_{1t} \quad a_{2t}]', \text{ and}$$
$$\tilde{C} = \begin{bmatrix} \beta_{10} & \beta_{11} & \beta_{12} \\ \beta_{20} & \beta_{21} & \beta_{22} \end{bmatrix}.$$

The model's error term $\boldsymbol{a}_t$ is independently normally distributed with mean $\mathbf{0}$ and covariance matrix $\boldsymbol{\Omega}$.
The VAR model can be estimated using the least squares method[14] equation by equation. However, we have chosen to use Bayesian estimation. The Bayesian approach uses the analyst's opinions (priors) regarding the model's parameters, namely $\tilde{C}$ and $\boldsymbol{\Omega}$. One can have an opinion on $\tilde{C}$, but usually it is the model's equilibrium (normal state) that the user has knowledge and opinions on. This equilibrium is a function of all of the elements in $\tilde{C}$ and it is complicated even in small specifications to have an opinion of all of them. We therefore do as Villani (2009) and re-write the model in its mean-adjusted form:

(A4) $$(\boldsymbol{x}_t - \boldsymbol{\mu}) = C(\boldsymbol{x}_{t-1} - \boldsymbol{\mu}) + \boldsymbol{a}_t,$$

where $$\boldsymbol{\mu} = [\mu_1 \quad \mu_2]' \text{ and } C = \begin{bmatrix} \beta_{11} & \beta_{12} \\ \beta_{21} & \beta_{22} \end{bmatrix}.$$

A general VAR model with k variables and P lags can be written in mean-adjusted form as:

(A5) $$(\boldsymbol{x}_t - \boldsymbol{\mu}) = \sum_{p=1}^{P} C_p (\boldsymbol{x}_{t-p} - \boldsymbol{\mu}) + \boldsymbol{a}_t$$

where $\boldsymbol{x}_t$ is a k-dimensional vector $[x_{1t}\ x_{2t} \quad \cdots \quad x_{kt}]'$ of observations at the point in time t[15], $\boldsymbol{\mu}$ is a k-dimensional vector of the corresponding

14 The least squares method minimises the observations' squared deviations from a regression line.

15 That is, the most "recent" observation of the respective series in the model.

equilibrium value $[\mu_1\ \mu_2\ \ \cdots\ \ \mu_k]'$, $C_{\boldsymbol{p}}$ is a $(k \times k)$ matrix with coefficients and $\boldsymbol{a}_t = [a_{1t}\ a_{2t}\ \ \cdots\ \ a_{kt}]$ is independently normally distributed random errors with mean $\mathbf{0}$ and covariance matrix Ω. Now we can use opinions on the equilibriums directly on $\boldsymbol{\mu}$. The equilibrium $\boldsymbol{\mu}$ need not be constant, but can be set as time-dependent.[16]

The equilibriums of the various variables follow normal distributions with the mean value $\mathbf{m_i}$ and variance s_i^2. The dynamic parameters' (C_p) prior distribution is normal with mean value and variance according to:

$$\beta_{ij} \sim N\left(\boldsymbol{b}_{ij}, s_{ij}^2\right),$$

where

$$s_{ij} = \frac{\lambda_1 \lambda_2}{p^{\lambda_3}} \times \frac{\hat{\sigma}_i}{\hat{\sigma}_j} \times \lambda_e.$$

The prior variance for the dynamic parameters is thus determined by some hyperparameters. The hyperparameter λ_1 shows how compressed the prior distribution is in general. A value close to 0 means that the entire mass of the distribution is set very close to the centre $\boldsymbol{b}_{ij}$, which in turn means that the prior distribution becomes very significant in the estimate. When λ_1 is large, more weight will instead be given to data. The size of λ_2 determines how much more (or less) we shrink the cross-variable prior distribution compared with the own dynamics.[17] If $\lambda_2 < 1$, the distribution shrinks relative to the own dynamics. λ_3 determines how much the prior distribution shrinks when the length of the lag increases and λ_e is used to introduce exogeneity restrictions in the model. If a variable is not going to be affected by another variable, then λ_e is set to 0, otherwise it is set at 1.[18] More on hyperparameters and prior distribution for C_p is given by Doan et al. (1984) and Villani (2009).

We have chosen to set $\boldsymbol{b}_{ij}$ to 0.3 for differenced variables and 0.5 for level variables [19], λ_1 to 0.2, and λ_2 to 1. The latter so that we can give the cross-variable dependence in the data the chance to impact on the estimates. The lag hyperparameter λ_3 is set at 1, which means that the prior distributions shrink linear to the lag. The exogeneity hyperparameter is not used as we do not have foreign variables in any of the models. The ratio of the variables' standard deviation $\hat{\sigma}_i / \hat{\sigma}_j$ manages that the scale of the variables may differ. The variance of the random terms follows an inverse Wishart distribution in the prior.

The estimated parameters are given as a whole distribution where the prior distribution has been updated with information in data. This so-called posterior distribution, $p(\phi|x)$, is proportional to the product of the prior distribution, $p(\phi)$, and the likelihood function $p(x|\phi)$:

$$p(\phi|x) \propto p(x|\phi) \times p(\phi). \qquad \text{(A6)}$$

16 By time-dependent, we mean for instance a linear trend or shift in equilibrium. One such typical shift is the slowdown in inflation after the fixed exchange rate was abandoned in 1992.

17 By own dynamics we mean the effect of one variable on itself, and by cross-variable we mean a variable's effect on other variables in the model.

18 A typical exogeneity restriction is that the USA's GDP affects Swedish GDP, while Sweden is too small to affect the USA. Therefore both the mean value and standard deviation for the coefficients that capture the dependence of Sweden in the USA equation are set at (very close to) zero.

19 This means that the variables are weakly persistent in the prior distribution and that the level variables are more persistent than the variables modelled in changes. These parameters are updated in the model with the information in the data.

The posterior distribution in this case does not exist in a closed form and must therefore be simulated. Villani (2009) describes the fully-conditional posterior distribution for $C|\mu,\Omega$, $\mu|C,\Omega$ and $\Omega|C,\mu$ and how one can simulate it with a Gibbs sampler, see Chib (1995).

One can then use the posterior distribution to select the quantities one is interested in – for instance, mean value, median, standard deviation and probability interval. One can also let the model generate forecasts for each extraction from the posterior distribution, which gives the full forecast distribution from the model.

Appendix 3: Impulse responses

One established method of evaluating models is to study how they react to shocks. If, for the sake of clarity, we use a model with one lag, we have the following structural form:

(A7) $$A\boldsymbol{x}_t = B\boldsymbol{x}_{t-1} + e_t,$$

where e_t is a randomly distributed error term with the mean 0 and an identity matrix as covariance matrix. Matrix B describes the dynamics of the system and matrix A shows how the model's variables at time point t react to a shock (a shock to one or more elements in the vector e_t) at point in time t.

Equation (A7) can be written

(A8) $$\boldsymbol{x}_t = A^{-1}B\boldsymbol{x}_{t-1} + A^{-1}e_t = C\boldsymbol{x}_{t-1} + a_t,$$

where a_t has the covariance matrix Ω. Equation (B8) is the form in which the model is presented in appendix 2.

For the model to be exactly identified, there must be as many elements with a zero value as elements over or above the diagonal in A^{-1}.[20] However, the zeros do not all need to be over or below the diagonal. A simple and common method of identifying the model is to set all of the elements above the diagonal in A^{-1} at zero. This means that a shock to one equation (variable) affects all of the equations (variables) that are "below" it in the equation system. On the other hand, none of the equations that is "below" has any effect on the equations above it. For instance, in the household model a shock to the CCI affects all variables for the time period the shock occurs, while a shock to the mortgage rate only affects itself in the shock time period. This is called recursive model identification, or Cholesky identification. The important thing, from an economic perspective, when using a recursive identification strategy is thus the order in which the variables are placed in the model. Normally one chooses to place the variable that moves the "fastest" at the bottom of the equation system.[21] The slower variables are put into the system first so that they can influence the "faster" variables.

The actual impulse responses can be interpreted as follows. Let us assume that the model is in equilibrium. If we let the model generate a forecast starting from this point in time, it will remain at equilibrium for all variables if we feed the model with $e_t = 0$ for all future periods.

Now we make a further forecast, but we let one element (at a time) in e_t be equal to 1. For instance, $e_t = [1\ 0\ 0\ 0]'$ gives a shock to the CCI equation in the household model. Then all variables will be affected through the C- and A^{-1}-matrices. As the model is stationary, the dynamic effects will wane over time. The impulse responses show how the shocked forecast deviates from a forecast without shocks.

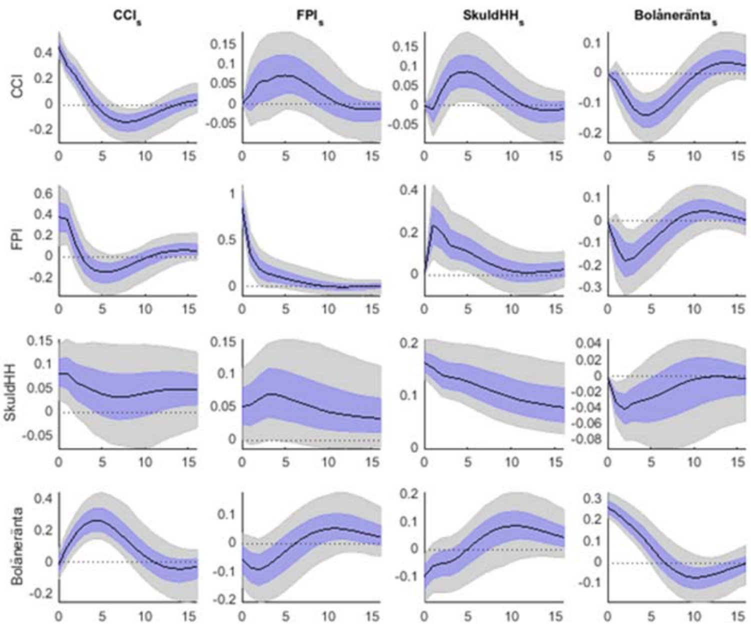
20 One may not have two identical rows in A^{-1}.

21 By fast we mean variables that change often. Interest rates that change every day are examples of such variables. GDP is measured quarterly and is therefore said to move more slowly in this context.

Appendix 4: The model's estimated impulse responses

Chart A7 presents the model's impulse responses, that is, how the model reacts to a shock to one of the ingoing variables. The size of the shock corresponds to one unit in the shock variable's error term. The responses are the models' endogenous responses to these (exogenous) shocks.[22] The figures should be read as follows: The responses are sorted into columns, where the variable that is shocked can be found in the sub-figures that are on the "diagonal" in the matrix. The individual responses are thus given in rows in the column where the shock lies. Hereafter we refer to the sub-figures by stating row and column number in the matrix, for instance, row 3 in column 2 is referred to as (3,2). The effect on the respective variables, such as they are included in the model, is measured on the y axis of the sub-figures (see the section "Explanatory variables" for details as to how the variables are transformed). The x axis shows the number of quarters from the time that the shock occurred.

Chart A7: Impulse responses for the household model



Note. The figure shows the household model's estimated impulse responses, based on 10,000 replicates from the posterior distribution. The black line is the median in the distribution. The purple fields are probability intervals of 50 per cent and the grey and purple fields constitute 95 per cent intervals respectively. The impulse response figures should be read as follows. The sub-figures that are below the "diagonal" show the variable that is exposed to a shock. The shock takes place at 0 point in time and time points 1 to 16 show how the shocked variable itself reacts in the 16 following quarters. The sub-figures that are in the same (vertical) column as the shocked variable (in the diagonal) show how the other variables in the model are affected by the shock concerned. The rows (horizontal) show how one and the same variable is affected when the respective variable in the model is subjected to a shock.

IMPULSE TO CONSUMER CONFIDENCE

The first column shows the model's response to a shock to a CCI shock. The first row in the first column, sub-figure (1,1), shows how household confidence responds to a shock, of around 0,4 to itself at 0 point in time. In sub-figure (1,1) we then see how the shock's own

22 Endogenous means that it is determined within the model and exogenous that it is determined outside of the model.

effect wanes and then ceases after around 15 quarters. Further, we can note that the effect of the shock is positive for around one year and then marginally negative. This probably means that the model has captured a cyclical pattern.

The property price index, FPI, shows a similar pattern as the CCI. The shock in the CCI initiates a comparatively large positive effect, in relation to the size of the impulse, on the FPI for around 2 quarters which then changes to a somewhat negative effect, see sub-figures (2,1). This impulse response shows clearly that house prices depend on household confidence.

What is most noteworthy with regard to the effect on debts is that it is very persistent (sub-figure 3,1). A shock to the CCI at 0 point in time generates a positive effect on debts, which remains for the quarters reported in the figure, even if the size of the effects wanes gradually during the period. This persistence in household debts recurs in all impulses. The development in debts appears to have a clear link to developments in economic activity.

Finally, sub-figure (4,1) shows that a positive shock to the CCI entails a higher interest rates compared to an original scenario around 2.5 years after the shock occurred.

IMPULSE TO PROPERTY PRICES

Column two shows the responses when the FPI is shocked. To begin with, the effect of the shock to the FPI itself is short-lived. Just over one year after the shock has occurred, its entire effect has expired (sub-figure (2,2)). Sub-figure (2,1) shows how the CCI reacts when the FPI is shocked. Here the effect is positive and prolonged. It is likely that rising house prices will increase households' real wealth, which contribute to stronger household confidence.

Sub-figure (3,2) presents the effect of property prices on household debts. It is clear that house prices and household debts are closely interlinked – a positive shock to the FPI means that indebtedness rises faster over the coming 6 years.

The response to the mortgage rate appears less reasonable, however; the shock to the FPI at first initiates a negative interest rate effect that changes sign after around one year and becomes positive. The effect then wanes gradually and ceases completely after around four years (sub-figure (4,2)). However, we consider that this impulse response is not sufficient to disqualify the model as most of the impulse responses look good.

IMPULSE TO THE HOUSEHOLD DEBTS

The next column, the third one, describes the responses of a debt shock of around 0.25 percentage points. In sub-figure (3,3) we see again that the debts are persistent, the effect of the shock remains in the debt process for the entire period.

The debt impulse gives a positive effect on the CCI, see sub-figure (1,3). One explanation could be that increased indebtedness gives more scope for consumption, which could improve household confidence. However, this effect is relatively small and ceases after around two years.

Above we saw that a house price shock leads to increased indebtedness. The reverse also applies. After a debt shock, house prices increase, see sub-figures (3,2). The direct effect is almost 0.2 - that is, the shock in the debts generates almost a "one to one" effect on house prices.

Further, the sub-figure (3,4) shows that an increase in the debts, after just over two quarters, leads to a positive interest rate effect. The fact that the interest rate response is positive could be due to growth in debt normally increasing in connection with an economic boom. A stronger economic situation should lead to a higher interest rate, all else being equal.

IMPULSE TO MORTGAGE RATE

Column four reports the responses for the mortgage rate. When the interest rate rises, we expect somewhat weaker economic development (represented by a lower CCI) and somewhat lower growth in house prices and debts. The shock to the mortgage rate is around 0.3. The restraining effect of the interest rate in the model is dynamically greater than this, however, as it "lives on" for around 6 quarters.

A higher interest rate means among other things higher loan costs, which should reasonably mean that household confidence is negatively affected. This is also what the response in sub-figure (1,4) shows; confidence responds with a negative effect that ceases after around ten quarters and then becomes weakly positive for around four quarters afterwards.

The effect on house prices is also expected. Sub-figure (2,4) shows that the shock to the mortgage rate gives a directly negative effect on house prices that gradually wanes over the 6-7 quarters following on from the shock. A somewhat positive effect follows on from this until the effect has ceased entirely after around 16 quarters.

Debts have a small negative response to the interest rate shock. After 2 years, the effect of the interest rate impulse has passed through the debts.

Appendix 5: Conditional forecasts in the models

CONSISTENTLY CONDITIONAL FORECASTS IN THE MODELS

A conditional forecast means that we put restrictions on the model's forecasts. For instance, if we want to use an external assessment of the FPI, we put the restriction that the model's FPI forecast shall be the same as in the assessment. Let us assume that we use the shock to the FPI equation to introduce the restriction. Then all equations (variables) that "lie below" the FPI equation in the model will be affected in period 0 through the matrix A^{-1} in the equation (A8), see appendix 3. After this, the entire system will be affected through matrix C in the equation (A8). This means that the other variables will be affected by the condition (or rather, by the difference between the restriction placed and the model's own forecast for the conditional variable). The way a condition will affect the model is shown by the impulse responses, see appendix 3. A conditional forecast can be regarded as a number of impulse responses at different points in time.

We present different alternative scenarios in the main article and Appendix 1. These are stronger growth in house prices and a higher repo rate. The repo rate is included in the bridging model and therefore the scenario starts by our putting restrictions on the repo forecasts in this model.[23] In a second stage we run the household model (with the restrictions on the CCI and the mortgage rate given by the bridging model) and then obtain forecasts for debt and property prices.

The order in the house price scenario is the reverse. In the first stage we put the restrictions on the FPI in the household model. We read directly from the model how household debt develops under this alternative. In a second stage, we put the conditional forecasts for the CCI and the mortgage rate from the household model into the bridging model. This may seem a little messy, but the approach means that the forecasts are consistent between the models.

CONDITIONAL FORECASTS AROUND AN EXTERNAL ASSESSMENT

The section “Forecasts given the National Institute of Economic Research’s assessments” show how the model can be forced to follow forecasts made outside of the model for one or two variables. Given that these deviate from the model’s own forecasts, other variables in the model will also be affected. For example, if the model is made conditional on higher growth in house prices (than in the model’s own forecast), we expect that growth in household debt will also increase (compared with the model’s own forecast). Conditional forecasts shall thus be regarded as an alternative to the model’s endogenous forecasts and the difference between these is

$$\boldsymbol{d}_{t+h} = \boldsymbol{x}_{t+h}^{alt} - \boldsymbol{x}_{t+h}^{endo}, h = 1, \dots, H,$$

where $\boldsymbol{d}_{t+h}, \boldsymbol{x}_{t+h}^{alt}$ och $\boldsymbol{x}_{t+h}^{endo}$ is k-dimensional vectors. H is the maximum forecast horizon and k is the number of variables in the model. The alternative scenarios presented in the section “Stronger growth rate for house prices” are constructed as

$$\boldsymbol{x}_{t+h}^{Scen} = \boldsymbol{x}_{t+h}^{assess} + \boldsymbol{d}_{t+h}$$

and shown together with $\boldsymbol{x}_{t+h}^{assess}$ (which is a k-dimensional vector with the forecaster’s assessment of the variables).

23 The restrictions are put on one at a time in our scenarios. One can, of course, construct a scenario with higher growth *and* a higher repo rate. Then one puts restrictions on both variables at the same time.