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Credit Conditions Indices: Controlling for Regime Shifts in the Norwegian Credit Market

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Abstract The interaction between financial markets and the macroeconomy can be strongly affected by changes in credit market regulations. In order to take account of these effects the authors control explicitly for regime shifts in a system of debt equations for Norway using a common, flexible trend. The estimated shape of the trend matches the qualitative development in the regulations, and the authors argue that it can be viewed as a measure of relative credit availability, or credit conditions, for the period 1975–2008—a credit conditions index (CCI). This entails years of strict credit market regulations in the 1970s, its gradual deregulation in the 1980s, followed by a full-blown banking crisis in the years around 1990 and the development thereafter up to the advent of the current financial crisis. Our study is inspired by Fernandez-Corugedo and Muellbauer (2006), which introduced the methodology and provided estimates of a CCI for the UK. The trend conditions on a priori knowledge about changes in the Norwegian regulatory system, as documented in Krogh (2010b), and it shows robustness when estimated recursively.

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1 Introduction

The financial crisis, which took off after the collapse of Lehman Brothers September 15th 2008, reminded the world that financial markets are fragile and that financial instability can create severe problems in the real economy. It has also spurred an interest in analysing what causes financial instability as well as its consequences for the macro economy at large.[1] In that context it is relevant also to investigate how financial markets have developed over time and in particular to look into the effects of the extensive financial deregulation that has taken place in many European countries – including Norway in the 1980s. While Norway has been relatively shielded from the current crisis, the experiences from a deregulation leading to a full-blown banking crisis are still fresh in memory.

According to Debelle (2004) the process of deregulation (which commonly reduces the incidence of credit constraints) has been one of the main driving forces behind the increase in household borrowing in Western countries the last decades. Furthermore, it has been argued by Goodhart, Hofmann, and Segoviano (2004) that the process of deregulation and also the implementation of inherently procyclical capital requirements have changed how the business cycle works and have led to more prominent boom-bust cycles. Both of these papers indicate that the credit market is plagued with *regime shifts* that have strong and possibly long-term effects. If true, it is important to find a measure which both captures when the most important institutional changes have taken place and works as an indicator for the effects of those changes on credit conditions. Ideally, it should reflect credit availability, that is how easy it is for a household to obtain a loan.[2] It is *a priori misleading* to estimate *e.g.* a model of household borrowing that does not take this into account.[3]

One motivation for finding such a measure is the possibility to control for regime shifts when the regime-neutral part of a given model is estimated. It would contribute in two distinct ways: First, we obviously want models that do not suffer from regime shift problems. Second, the dating and the measure of the quantitative effects of regime shifts might be interesting on its own. This "structural trend" in the credit market could be thought of as summarizing important evidence on the tightness of the credit markets that would only be known qualitatively in its absence. Hence we should seek to interpret the measure in light of our qualitative knowledge to see if it can be interpreted as an estimate of more general concepts, and look for ways to apply this estimate in other settings.

An implementation of most of these ideas is found in the literature on credit conditions indices (CCIs), with Fernandez-Corugedo and Muellbauer (2006) as the main contribution. They estimate a system of 10 equations with various credit-indicators on the left-hand side and a rich set of economic controls on the right. It is argued that a variable measuring relative credit availability (the CCI) should enter in all equations. However, since this variable is unobserved they assume it can be represented by a flexible trend, which facilitates estimation. Qualitative knowledge regarding the UK credit

[1] See Goodhart, Sunrirad, and Tsomocos (2004) for an example of a work that acknowledged the challenge already prior to the crisis, and Blanchard, Dell'Ariccia, and Mauro (2010) for an example of how the "mainstream" has intentions of following.

[2] In the Norwegian case it is evident that significant changes have occurred – confer Krogh (2010b) for a description of how credit market regulations have developed in Norway in the period 1970-2008.

[3] This is of course a critique that applies to more or less any empirical study that excludes regime shift considerations, but it seems that it is particulary important in a credit market setting.

market is presented, and the estimated CCI does fit into the picture, strengthening the argument of their setup. The index can then be interpreted as a measure of supply-side shifts such as those stemming from financial liberalization and also partly as shifts we would expect in the midst of periods with financial turbulence.[4]

In this paper we draw inspiration from the work of Fernandez-Corugedo and Muellbauer (2006) and set out to estimate a system of debt equations where we explicitly control for regime-shifts in the credit market. Our exact methodology differs slightly from that of Fernandez-Corugedo and Muellbauer, but the differences are not essential for practical implementation. Still, we would like to stress that in our preferred vocabulary what we estimate is a flexible, common trend, not a measure of credit conditions. However, if the joint trend of our variables seems to match historical accounts well, it can possibly be interpreted as measuring credit availability. To keep in line with the previous literature, we will therefore claim to have a measure of a Norwegian CCI if we can forcefully argue that the trend matches the "facts" as we see them.

The structure of the paper is as follows. In Section 2 we survey the literature of quantifying credit conditions. We explain our simple theoretical framework for modeling household debt in Section 3, which also presents the econometric specification of our model. We make it clear that the regime-shifts are controlled for by including a common, flexible trend (a spline function) in the two debt-equations. Section 4 sketches in short how the Norwegian credit markets were deregulated during the 1980s and also what other qualitative facts we are aware of. This forms the fundament for what a "reasonable" trend should look like, and its implications in terms of *a priori* assumptions underlying our model are spelt out as well. Section 5 reports our empirical results, and we argue that it seems evident that the structural trend does represent important information and can be interpreted as a credit conditions index. In Section 6 we make some final remarks and give suggestions for future research.

2 Previous studies

Muellbauer and Murphy (1993) is an early attempt to estimate an index measuring the extent of financial liberalization through the use of a flexible trend. Based on an assumption that lenders (or borrowers) aim for a constant debt-service to income ratio, they regress the loan to value ratio for first-time buyers on the log of the tax adjusted mortgage interest rate, the log of the house price to income, and step dummies for all the years in the data set, using annual UK data for the period 1967-90. The dummy

[4] The purpose of this enterprise is mainly to obtain an instrument that allows us to control for the historical development and hence improve our ability to explain events *ex post*. An alternative approach has been explored by the developers of various financial condition indices (FCIs). Hatzius, Hooper, Mishkin, Schoenholtz, and Watson (2010) describe seven FCIs that have been constructed by different institutions, among others Goldman Sachs, the Federal Reserve and the OECD. They also construct a new FCI based on an unbalanced panel of 45 different financial indicators. FCIs vary with respect to how they are constructed, but their common objective is to summarize the information about the *future* development of the economy contained in various financial variables, like various stock indices, interest rates and yield curves. This makes the FCIs a broader type of indices than the CCIs. As we interpret them, the value of an FCI at any point in time reflects how current financial shocks should affect future economic activity *ex ante*. This approach is therefore related, but clearly distinct from the CCI strategy. Future work should consider to clarify the connection between CCIs and FCIs.

coefficients are set to zero in those years the degree of financial liberalization can be assumed to have remained constant, and the estimated flexible trend (plus some other control variables) is given the interpretation as a financial liberalization index. This is then used to allow for a time-varying wealth effect in a consumption model.

The method from Muellbauer and Murphy is developed further in Fernandez-Corugedo and Muellbauer (2006). Using a dataset for the UK economy they construct 10 different credit indicators on the basis of both micro and macro variables. Two of the indicators are the stocks of secured and unsecured debt held by households, while the remaining 8 are based on loan-to-value ratios (LVRs) and loan-to-income ratios (LIRs) for first-time buyers.[5] A measure of the credit conditions index (CCI) is then extracted by formulating a system of equations for all the 10 indicators where the CCI enters as a common, unobserved component alongside a wide range of economic and demographic controls. By assuming that the CCI can be represented by a piecewise linear spline function (plus some policy variables) estimation is made possible. The authors include prior assumptions regarding the slope of the spline function in some of the years (based on qualitative information regarding the liberalization process in the UK) and also on the signs of other variables (based on theoretical considerations). The system is estimated as a nonlinear Seemingly Unrelated Regression (SUR) model and the priors are imposed sequentially.[6]

Their CCI is illustrated in Figure 1 [Chart 13 in Fernandez-Corugedo and Muellbauer (2006)], and the authors argue that it matches the historical development described in the paper quite well. As Fernandez-Corugedo and Muellbauer point out, they attempt to construct the CCI such that it is as independent of the economic environment as possible. Hence, what this index measures is more narrow than what an economist usually would think of when hearing the sentence "credit conditions have tightened/eased". For instance, if CCI takes the same value in 1986 and 1992 (as is approximately the case for the Fernandez-Corugedo and Muellbauer CCI) this means that the *underlying* credit conditions were the same in the two years, but if you take differences in e.g. interest rates and income into account the total picture might look very different – the CCI measures only *relative* credit availability. This distinction is important to remember both when we evaluate the results later in this paper and also when we consider how the CCI can be applied in other settings.

A second work that contributes the CCI literature is Blake and Muellbauer (2009), see also Oxford Economics (2009). This report investigates a system of house price and mortgage stock equations for several countries, among them the UK, Germany, Spain, and Italy. In the spirit of Fernandez-Corugedo and Muellbauer (2006), they include a CCI in the system for each country. In their model for the UK they entertain two alternatives: One is to use the CCI estimated by Fernandez-Corugedo and Muellbauer and extend it to 2008 using a four quarter moving average of a piecewise linear spline. The other is to estimate a new CCI, mentioned above, for the entire sample, which is directly

[5]These are based on more than a million observations of mortgages for first-time buyers. They separate the data by age (less than 27 and 27 plus) and region (North and South) giving them a total of 8 groups. To get the indicators, Fernandez-Corugedo and Muellbauer assume that both the LIR and LVR of each group are logistically distributed such that log-odds ratios for LIRs larger than 2.5 and LVRs larger than 0.9 can be constructed.

[6]The system is first estimated without restrictions and then coefficients violating the priors are set to zero. If several violations occur simultaneously, the parameter violating its restriction most severely is chosen to be set to zero. Then the system is re-estimated.

comparable with their results for other countries. Reassuringly, the two alternatives give very similar CCIs. This is a very interesting finding and it indicates that the "structural trend" detected by the framework of Fernandez-Corugedo and Muellbauer (2006) is quite robust.

In his study of house prices in Australia, Williams (2009) uses the same methodology as Fernandez-Corugedo and Muellbauer (2006) to extract a variable for credit conditions, but here CCI is extracted from a single equation for housing prices. The index is constructed as a trend permitted to have break-points at 3 places. The positions of these are guided by his estimates of a stochastic, unobserved trend from the STAMP software (Koopman, Harvey, Doornik, and Shephard, 2000). Using only three break-points, his CCI has a "simpler" shape than the UK index of Fernandez-Corugedo and Muellbauer (2006) but it fits well with the institutional background for Australia described in the paper.

An application that illustrates the usefulness of a CCI is Aron, Muellbauer, and Murphy (2008), where a UK consumption function is augmented with the CCI of Fernandez-Corugedo and Muellbauer. An easing of credit conditions is argued to affect consumption in several ways – it makes illiquid wealth more "spendable", it eases access to the credit market for first-time buyers (allowing them to save less) and it might also change the interest rate response. CCI is therefore allowed to enter independently and through interaction with other variables and this clearly improves the performance of their model. The separate CCI effect is positive, and it reduces the "pure" effects of housing wealth and expected income growth – but their interaction terms compensate for this. The interaction with the cash-flow effect of changes in nominal interest rates is positive, reducing the otherwise negative impact of this variable. The CCI therefore helps us identify the effects due to changes in the underlying "credit regime" which otherwise would have been attributed to other explanatory variables.

3 Modeling debt

Motivated by the results reviewed in the previous section, we will now formulate a system of equations explaining the stocks of total and secured household debt, where we explicitly allow for regime shifts by means of a flexible trend.

Starting out very basic; how should debt be modeled? Suppose we study a rational agent's consumption vs. savings decision in a general setting. Standard models would normally deliver the result that individual savings will be reduced if future income or initial wealth increases, they will increase if current income increases, while the net effect of a higher real interest rate is ambiguous for net creditors and unambiguously negative for debtors.

Thus we should expect a relationship between savings, income, net wealth, and interest rates. Since savings translate into future wealth, then net wealth should be a function of income, net wealth in the previous period, and the real interest rate. Further, it should also be expected that similar effects are important in the aggregate for a small open economy, making aggregate income and interest rates important determinants for the long run level of aggregate net wealth.

One obvious problem with the simplest framework is that it treats all assets as homogeneous, making it irrelevant whether aggregate net wealth is reduced because of an increase in debt or a decrease in wealth. A more realistic model should take into account the distinct differences between debt and wealth, and also the various forms of debt and wealth that are available, varying with respect to risk, rates of return, and degree of liquidity, to mention some aspects. It is therefore important to investigate the various *subcomponents* of aggregate net wealth. It is probably not unrealistic to assume that there are well-defined functions for both aggregate debt and wealth, not just for net wealth. The function for one subcomponent will depend on income and interest rates, as well as the level of the other subcomponents.

The credit market involves several other frictions that complicate matters. For instance, it is rarely the case that financial institutions supply credit to anyone who is willing to pay the going interest rate. The main reasons for this are different incentive issues, usually due to the fact that an agent possesses some non-verifiable *private information*. This gives rise to the well-known problems of adverse selection and moral hazard. Attempting to mitigate such problems, banks normally screen their debtors quite extensively by checking their income, credit history and how much collateral they have available. The main effect of these screening procedures is to increase the importance of income and wealth in explaining the stock of debt. The interest rate level might also have an effect if institutions relax their requirements in "low interest rate climates".

In this setting we will consider aggregate wealth as an exogenous variable, and try to model aggregate debt as a function of income, wealth and the interest rate.[7] For now, this amounts to the assumption that the stock of debt is given as a function

$$\frac{D}{P} = a(\frac{Y}{P}, \frac{W}{P}, R), \tag{1}$$

where D is the stock of debt, Y is aggregate income, W is aggregate wealth, P is the price level and R is the real interest rate.

The existence of durable goods is likely to affect the shape of (1). Durables will increase many households' need for debt since one derives utility from it over several periods but pays for it today (and most durable goods are quite expensive). This might strengthen the income and wealth effects on the stock of debt.[8]

[7] If we had taken into account the life-cycle perspective due to the work of Franco Modigliani (see e.g. Modigliani and Brumberg (1954) and Ando and Modigliani (1963)), it is clear that a potentially more correct specification would include some demographic variable in order to control for that young people usually borrow, middle-aged save, while old people run down their assets. Erlandsen and Nymoen (2008) have shown that a variable measuring the fraction of "prime-age" individuals has a significant explanatory power in a Norwegian consumption function, and there are good reasons to believe that some demographic shifts have an effect on the aggregate stock of debt as well. However, we had some problems including demographic effects, making this an area of possible progress for future research. Still, even though we have not accounted explicitly for demographic changes, the fact that some cohorts are borrowing while others are saving is a good explanation for why we observe large amount of both debt and wealth, and not just a small component of one of them equal to net wealth. This strengthens the argument for the existence of some well-defined function for the stock of debt on its own.

[8] Some durable goods are traded between households, such as existing houses, and this will reduce the net effect on the stock of debt of such purchases, but it is still likely to be positive as long as the debt of the out-going owner is smaller than that of the new owner.

3.1 Including secured debt

Debt comes in different forms. In our dataset we have the possibility of looking at both the total stock of debt and the stock of secured debt, defined as the stock of housing debt plus total loans from insurance companies. Would it make sense to include a separate equation for secured debt?

Consider an economy where there are two kinds of debt, secured (SD) and unsecured (UD). The interest rate on unsecured debt is assumed to be higher than that on secured. Further, we assume that the availability of secured debt is limited for each agent, with the ceiling for secured debt given as a function

$$\tilde{SD}_i = b(Y_i, W_i, R) \tag{2}$$

for agent i, where subscript i denotes the individual holdings of the various variables.

If unsecured debt is available in unlimited amounts with no screening or other controls, it follows that the optimal allocation of an agent's debt (D_i) is given as:

$$SD_i = \min(D_i, \tilde{SD}_i),$$
$$UD_i = \max(0, D_i - \tilde{SD}_i).$$

What implications do this have for our modeling of secured debt in the aggregate? Given that both types of debt actually exist, it seems reasonable to assume that the ceiling for secured debt is approximately binding, in the sense that most agents get as much secured debt as possible. The remaining gap between SD_i and D_i is filled by unsecured debt. How large the stock of secured debt can become is therefore in large part determined by the *supply side*, producing an aggregate ceiling for SD. We will assume that an aggregate version of (2) can represent this. This is of course grossly simplified, and we do not believe that SD is purely supply determined. However, this does provide, in our opinion, a useful starting point for the empirical analysis.

3.2 Regime shifts

As described below in Section 4, the Norwegian credit market has undergone several important regime shifts. We expect many of them to have had direct effects on the amount of debt held by households.[9] The most obvious example is the financial deregulation that took place in Norway during the 1980s. We cannot see how a model that ignores institutional changes is able to provide a sensible explanation for the development in the stock of debt in this period. However, regime shifts need not be induced only by regulatory changes: increased competition in the banking sector, introduction of new financial instruments and a change in supply side behavior due to certain events are also possible sources of regime shifts.

We try to capture regime shifts through the introduction of a structural trend, ST, in the system of debt equations. Following Fernandez-Corugedo and Muellbauer (2006),

[9] It is also possible to imagine shifts that change the importance of other variables, but as a simplification this idea will not be pursued in the empirical analysis (even though some of the instability in the recursive estimates point in this direction, see Section 5).

we define ST as a piecewise linear spline function plus a function of other variables:

$$ST_t = \sum_{i=1}^{t} \delta_i qd_{it} + \boldsymbol{\xi}'\mathbf{cr_t} \tag{3}$$

for $t = 1, 2, ..., T$, where qd_{it} is a step dummy for quarter i taking the value 0.25 for $t \geq i$ and zero otherwise. The spline-function is completed by assuming $\delta_i = \delta_j$ for all pairs (i, j) belonging to the same year (i.e. the spline function has constant slope within each year). With this, if $t = 1$ is a first quarter and $t = T$ is a fourth, there are $T/4$ unknown δ-coefficients. $\boldsymbol{\xi}$ is a vector of coefficients and in $\mathbf{cr}$ we add two credit policy variables. These enter the trend because it seems reasonable that they also capture regime shifts. The two included variables are the primary reserve requirement that was given to commercial banks (in the south of Norway) and a dummy variable that signals whether additional reserve requirements were active or not. Let these variables be denoted $PRIMC$ and $ADDR$, respectively, and let $\mathbf{cr_t} = (PRIMC_t, ADDR_t)'$.[10]

Gather all δ_i's in a column vector $\boldsymbol{\delta}$ (with the within-year restriction imposed) and all quarter shift-dummies in a column vector $\mathbf{qd_t}$. Let $(\boldsymbol{\delta}', \boldsymbol{\xi}')' = \boldsymbol{\eta}$ and $(\mathbf{qd_t'}, \mathbf{cr_t'})' = \mathbf{c_t}$. The final definition of the structural trend becomes:

$$ST_t = \boldsymbol{\eta}'\mathbf{c_t}. \tag{4}$$

3.3 Model and econometric specification

Based on the preceding discussion we will assume that the stocks of total and secured debt can be represented by versions of (1) and an aggregate version of (2), both adjusted to control for regime shifts through the use of ST. We also add the unemployment rate (U) as a possible explanatory variable. Then we obtain

$$D = f(Y, W, R, U, ST) \tag{5}$$

$$SD = g(Y, W, R, U, ST), \tag{6}$$

where f and g are assumed to have semi log-linear forms.

It may seem peculiar for some that we choose this setup rather than a model for secured and *unsecured debt* – as done in Fernandez-Corugedo and Muellbauer (2006). The main reason for this strategy is the argument in Section 3.1. If we are correct in our presumption that SD is to a large degree supply determined then unsecured debt follows residually as $D_t - SD_t$. This will make it problematic to model the two sub-components together (especially in logs) if secured debt (in levels) should be an explanatory variable in the equation for unsecured debt. To circumvent this problem we have chosen to model total and secured debt together.[11]

[10] $PRIMC$ is a quarterly average based on monthly observations. $ADDR$ takes the value 1 if additional reserve requirements were active through the entire quarter, 2/3 if they were active in two thirds of the quarter and 1/3 if they were active in one month. Both instruments were removed in 1987. See Krogh (2010b) for more details.

[11] This problem was first encountered in Krogh (2010a), where a system for secured and unsecured debt was estimated. In those results we did not capture appropriately a shift from unsecured to secured debt in the 2000s, whereas this shift is picked up by the strategy chosen here.

Define the following vectors of variables:

$$\mathbf{y_t} = \begin{pmatrix} d_t \\ sd_t \end{pmatrix}, \qquad \mathbf{x_t} = \begin{pmatrix} y_t \\ hw_t \\ lw_t \\ mw_t \\ R_t \\ U_t \end{pmatrix}.$$

A complete description of the variables and sources is given in Table 3. Small letters denote the variable deflated with the CPI and in logs. D_t and SD_t are the stocks of households' total debt and secured debt, respectively. We only consider domestic debt, *i.e.* the relatively small foreign debt is excluded. Secured debt consists of households' mortgage debt plus debt to life and non-life insurance companies.[12] Y_t is households' total income, net of dividends.[13] HW_t is housing wealth. LW_t and MW_t are households' stock of liquid (notes, coins and deposits) and moderately liquid wealth (defined as bonds, stocks, loans and other claims).[14] R is the real interest rate net of taxes whereas U is the unemployment rate. Note also that our income definition includes net interests paid, such that the effect of R_t will only capture the substitution effect.

Most of the variables in $\mathbf{y}$ and $\mathbf{x}$ are assumed to be integrated of order one.[15] We assume that the pairs $(d_t, \mathbf{x_t}\prime, ST_t)$ and $(sd_t, \mathbf{x_t}\prime, ST_t)$ form two cointegrated relationships. In addition we assume that $\mathbf{x_t}$ and ST_t are weakly exogenous with respect to the system we define below, and also that sd_t (d_t) is weakly exogenous with respect to the cointegrating vector of d_t (sd_t). These assumptions entail major simplifications relative to a state of the art Johansen analysis, cf. *e.g.* Johansen (2006). The primary reason for this is the inclusion of the structural trend (common to both equations), which to our knowledge is a case where a rank test is not available.

Based on the assumption of cointegration, *Granger's representation theorem* (Engle and Granger, 1987) validates that a vector error correction model (VECM) can be used to model $\mathbf{y}$, $\mathbf{x}$ and ST. Furthermore, given the exogeneity assumptions, the VECM reduces to a system of 2 equations – one for each of the debt variables. This reduced system takes the following form (under a VAR(1) assumption):

$$\Delta \mathbf{y_t} = \boldsymbol{\zeta} + \mathbf{A}'\Delta \mathbf{x_t} - \boldsymbol{\alpha}\left(\mathbf{y_{t-1}} - \boldsymbol{\beta}'\mathbf{x_{t-1}} - \begin{pmatrix} \gamma_1 \\ \gamma_2 \end{pmatrix} ST_{t-1}\right) + \mathbf{e_t} \tag{7}$$

for $t = 1, 2, ..., T$. $\mathbf{A}$, $\boldsymbol{\zeta}$, $\boldsymbol{\alpha}$ and $\boldsymbol{\beta}$ are coefficient matrices and $\mathbf{e_t}$ is a vector of random disturbances with distribution given by:

$$\mathbf{e_t} \sim N(0, \boldsymbol{\Omega}),$$

[12] To get complete series for these two variables starting in 1975Q4 we had to "copy" the seasonal pattern from D to create quarterly series for SD as well. For a full documentation of the data construction, see Appendix A in Krogh (2010a).

[13] Dividends are left out as it only adds noise to our system due to a tax-change that caused a surge in dividends paid out in the years prior to 2006, followed by dramatic drop.

[14] Illiquid wealth (defined as insurance claims) is left out mainly due to its somewhat diffuse economic interpretation.

[15] ADF-tests confirm the I(1) status of all variables except for R, which is I(0), and d and sd, which both appear to be I(2) or possibly I(1) with breaks. We have chosen to treat the debt variables as I(1), with some support from visual inspection of the series.

where $\mathbf{\Omega}$ is a 2 x 2 covariance matrix with elements σ_{ij}. Note that (7) already incorporates the assumption that total and secured debt are excluded from each other's cointegrated relationships. That these variables are weakly exogenous with respect to the long run equation of the other is captured by assuming that $\boldsymbol{\alpha}$ is a diagonal matrix. We also recognize that the long run implications of this system are consistent with the relationships (5) and (6).

It must be admitted that the specification (7) involves too little dynamics. The reason for this simplification is that the number of parameters is quite large already since we have one shift-dummy for every year. This is also the reason why ΔST does not enter contemporaneously in (7).

3.3.1 Identification and estimation

We can now use the definition from (4) to substitute for ST_t in (7). In order to achieve identification we choose units for ST such that the long run effect of a unit increase in ST results in a unit increase in the long run value of d. The normalized and thus identified version of (7) then becomes:

$$\Delta \mathbf{y_t} = \boldsymbol{\zeta} + \mathbf{A}'\Delta \mathbf{x_t} - \boldsymbol{\alpha}\left(\mathbf{y_{t-1}} - \boldsymbol{\beta}'\mathbf{x_{t-1}} - \begin{pmatrix} 1 \\ \gamma^* \end{pmatrix} \boldsymbol{\eta}'\mathbf{c_{t-1}}\right) + \mathbf{e_t}, \tag{8}$$

where

$$\gamma^* = \gamma_2/\gamma_1.$$

We are estimating

$$\Delta \mathbf{y_t} = \boldsymbol{\zeta} + \mathbf{A}'\Delta \mathbf{x_t} + \mathbf{B_0}'\mathbf{y_{t-1}} + \mathbf{B_1'}\mathbf{x_{t-1}} + \begin{pmatrix} 1 \\ \gamma \end{pmatrix} \mathbf{B_2'}\mathbf{c_{t-1}} + \mathbf{e_t} \tag{9}$$

for $t = 1, ..., T$. Estimates of the long run coefficients in (8) are identified through the equations:

$$\hat{\boldsymbol{\alpha}} = -\hat{\mathbf{B}}_\mathbf{0}' \tag{10}$$

$$\hat{\boldsymbol{\beta}}' = \hat{\boldsymbol{\alpha}}^{-1}\hat{\mathbf{B}}_\mathbf{1}' \tag{11}$$

$$\hat{\boldsymbol{\eta}}' = \frac{1}{\hat{\alpha}_{11}}\hat{\mathbf{B}}_\mathbf{2}' \tag{12}$$

$$\hat{\gamma}^* = \frac{\hat{\alpha}_{11}}{\hat{\alpha}_{22}}\hat{\gamma}. \tag{13}$$

4 Qualitative development and deregulation

To assess how reasonable the estimated structural trend is, we need to look at what history can tell us. A detailed account of the Norwegian credit market regulations in the period 1970-2008 is given in Krogh (2010b). This time span entails a period with strict credit market regulations in the 1970s, a gradual deregulation of these markets in the 1980s, followed by the banking crisis in the years around 1990 and the subsequent development up to the advent of the current financial crisis.

Most interesting is the period when the credit market was transformed from a regime of indirect *credit rationing* into a nearly fully liberalized one, *i.e.* the years up to 1987/88. In the 1970s the authorities applied a wide range of instruments in order to keep the growth of credit under control. A target credit growth rate was declared in a credit budget for the coming year each fall and primary reserve requirements, additional reserve requirements, placement requirements and other quantitative requirements were adjusted frequently to ensure that the budget was met. Most interest rates were at outset under direct regulations by interest rate norms set by the government for various forms of bank loans to the public. These norms were given a less strict formulation as interest rate declarations from September 1980, which prevailed for five years until it was abandoned in September 1985, when interest rates were allowed to float freely.

The credit policy was relatively successful in the late 1960s and the beginning of the 1970s, but later on the effectiveness declined steadily. Figure 2 illustrates how the operative difficulties of credit planning became larger over time. This figure shows the percentage deviation between credit actually supplied during a year relative to the target stated in the credit budget. It suggests that the authorities' grip with the credit market became looser through the period, both due to a removal of regulations, softer practice of regulations, and credit institutions doing their best to sidestep regulations (through financial innovations).

Table 1 of the Appendix, taken from Krogh (2010b), is a calendar of the major regulatory changes related to credit markets in Norway over the past 40 years. A first move towards deregulation was taken already in 1977 when interest rate norms were removed – albeit only temporarily as a price freeze (which included interest rates) was introduced shortly afterwards. Then followed a removal of the lion's share of banks' foreign exchange controls in 1978, a very important step in the deregulation with an immense long-term effect, as it made it possible for domestic banks to finance themselves more heavily abroad. Most quantitative regulations were gone by the mid-1980s and the credit market was fully deregulated around 1987/88.

Structural changes have continued to take place after the deregulation, much of this caused by events in the economy at large, reflecting the business cycle or as a result of international shocks, but also induced by new important regulatory changes. In the early 1990s Norway was struck by a severe banking crisis which probably led to a substantial tightening of credit conditions. From the middle of the decade and well into the new millennium the development was relatively smooth, apart from some turbulence related to the Asian crisis, the dot-com bubble and bust and an increase in the risk weight for mortgages with a large loan-to-value (LTV) ratio in 1998 (which tightened credit conditions somewhat). In the late 1990s and in the 2000s we identify in the mortgage survey of Finanstilsynet (Finanstilsynet, 1999-2009) a positive trend in LTV ratios and also in the average time to maturity of mortgages. Factors that can have contributed to such a development are regulatory changes (the introduction of Basel I in 1991 and Basel II in 2007), increased competition in the banking sector and continued integration of international capital flows. Our period of interest ends dramatically with the current international crisis, but the effects in Norway have so far been moderate.

How can we make these qualitative "facts" useful in the empirical analysis? As already noted, a solid notion of the institutional development is vital in order to judge how reasonable the structural trend we estimate is. Let us therefore define a set of **regime**

shift assumptions. These are meant to put bounds on the structural trend, and allow us to incorporate some of the qualitative information just presented.

Regime shift assumptions: Assume, given the values of $PRIMC$ and $ADDR$, that there are no positive shifts in the ST prior to 1980. In 1980 we assume that it does not shift downwards. In 1984-87 we assume that there are no negative shifts. We also assume that ST is non-decreasing in the period 2004-07. In 2008Q4 it is assumed that it does not increase. These assumptions translate into sign-restrictions for the dummy-coefficients. Finally we also assume that the primary reserve requirements and the dummy for additional reserve requirements have negative coefficients.

The assumption regarding 1980 is more an assumption of convenience rather than based on regime shifts: When the price and wage freeze ended in late 1979 it was a sudden increase in inflation the first quarters of 1980 leading to a negative growth in real debt. This assumption makes sure we avoid a negative shift in 1980 because of this.

5 Empirical results

We fit the model in (9) as a nonlinear SUR model with the use of Stata (StataCorp, 2007)[16] adding a constant and seasonal dummies in both equations. Our dataset covers the period 1975Q4-2009Q1 for all variables in levels such that estimation begins in 1976Q1. The spline function is included as a sum of smooth step dummies for the years 1977-2008 (*i.e.* each year dummy, *d*xxxx where xxxx is the year, is the sum of its quarterly dummies). In 2008 we split the dummy in two; the dummy for 2008 takes the value 0.75 from the third quarter and onwards, while an extra dummy called *d*2008q4 takes the value 1 from 2008q4 and onwards. This is done to see if we can detect signs of the financial crisis at the end of the sample. The step dummy for 1976 is dropped as it would be almost like a constant term. We also make an additional modification compared to the setup in (9) by using the change in the nominal interest rate (ΔI_t) instead of that in the real rate (ΔR_t) – this captures the short run effect more precisely.

When estimating the system, the regime shift assumptions from Section 4 were imposed sequentially. First we estimated the full system unrestrictedly. Then all the assumptions were checked and among the coefficients that violated their sign-restriction, we excluded that with the largest p-value (from a likelihood ratio test). Next we estimated the system once more and checked the remaining assumptions. If none of the estimated coefficients had the wrong sign we moved on to remove insignificant variables (judged at a 5 % level). For every insignificant variable dropped we returned to the regime shift assumptions and checked if they were still satisfied. All this was repeated until we found no violations *and* the remaining coefficients to be significant.[17]

[16] We have used our own tailor-made ML command which was based on the raw codes of Gould, Pitblado, and Sribney (2003). This code is documented in Krogh (2010a) and is available upon request.

[17] For a variable to be deemed as insignificant it had to be insignificant both in a partial and in a joint likelihood ratio test. As unrestricted model for the joint tests we used the log-likelihood value from *the first step after the last time a regime shift assumption was violated.*

5.1 Estimates

In the first round of reductions the coefficients for $d1980$, $d1977$, $d1978$, $d2006$, $addr$ and $d2008q4$ were all set to zero due to violation of their regime shift assumptions, but only the coefficient of $d1980$ was significant. After this we removed, step-by-step, 20 insignificant variables. Some insignificant variables were not taken out – these are commented on below. The estimates are given in Table 2.

While a thorough evaluation of the structural trend is saved for Section 5.2, we note immediately that regime shifts seem to play an important role as 22 year-dummies are kept in the model. Looking at the "regime-neutral" part of the model we see that both equations have reasonable coefficient estimates with expected signs. In the short-run dynamics, total debt responds more negatively than secured debt to both a change in the interest rate and a change in the unemployment rate. A change in income only affects total debt, potentially because the availability of secured debt depends relatively more on other factors. A change in the housing wealth affects both variables positively, but secured debt responds more strongly, which seems plausible.

The implied long run model is given as

$$d = \underset{(0.1603)}{0.3169}y + \underset{(0.1083)}{0.2192}hw + \underset{(0.2049)}{0.5916}lw - \underset{(0.3266)}{0.9623}U + ST \tag{14}$$

$$sd = \underset{(0.3938)}{0.6106}y + \underset{(0.3393)}{0.7079}hw + \underset{(-)}{0.7890}ST \tag{15}$$

where the numbers in parenthesis are standard errors.[18]

For secured debt, the sum of the income and housing wealth elasticities exceeds unity and a one percentage increase in both variables increases the total stock of debt by about 1.3 percent. Add to this a unity increase in ST and you get an increase of about 2 percent. Overall, changes in long-run secured debt are for a large part explained by changes in housing wealth and the structural trend, while income growth contributes to a steady increase in debt. This is evident from Figure 3, which shows the 4-quarter growth in long-run secured debt decomposed into the contributions from housing wealth and structural trend changes. As expected, secured debt follows housing wealth quite closely, but especially in the 1980s ST contributes a great deal, too.

Moving to total debt, both the income and housing wealth elasticities are smaller. That the latter is smaller seems reasonable: The collateral effect should be relatively stronger for secured debt alone. Liquid wealth enters with a larger elasticity than housing, and the unemployment rate is shown to have long-run effects. Is it possible that liquid wealth "steals" some effect from housing wealth and also income? That said, the sum of the elasticities seems reasonable. Decomposing the 4-quarter change in long-run debt in the same way as for secured debt gives us Figure 4 – here we add the effects of housing and liquid wealth together as these are of similar size. The graph shows a similar pattern as Figure 3, although ST has a more dominant role than for secured debt.

We are not able to find any significant long run effects from the real interest rate in any of the equations. Note that the income effect of the interest rate is already included

[18]For the derivation of standard errors, see Bårdsen (1989). In the calculations we have used the estimates in Table 2 and their variance-covariance matrix. The implied variance of γ^* is not reported, as it is a function of both error-correction coefficients.

in y, so it is the substitution effect we are not able to detect. For moderately liquid wealth we find no short run nor any long run effects.

The error correction coefficient of total debt is larger than that of secured debt. This fits well with the fact that unsecured debt is more short-term than secured debt, making it harder for secured debt to adjust from disequilibria. The fact that these are highly significant is an indication of cointegration, even though ADF-tests of the error correction terms fail to detect stationarity.

As SD is a subcomponent of D, it is interesting to investigate the implied (time-varying) elasticities for *unsecured debt*, $\epsilon_x ud_t$. These are defined as:

$$\epsilon_x ud_t = \frac{1}{1 - K_t} \left(\epsilon_x d_t - K_t \epsilon_x sd_t\right) \tag{16}$$

for $x = \{y, hw, lw, U, ST\}$. K_t is defined as SD_t/D_t and varies in our sample between 0.67 and 0.81 with an average of 0.74. The implied "average" elasticities will therefore be -0.5190, -1.1717, 2.2754, -3.7012, and 1.6005 with respect to income, housing wealth, liquid wealth, the unemployment rate, and the structural trend, respectively. Most of these estimates seem plausible, but it is a bit odd that unsecured debt increases in liquid wealth.

Diagnostic tests are reported at the bottom of Table 2. Looking at the system in total, absence of autocorrelation in the system is only rejected at the 4th lag, but normality is rejected, and it is the kurtosis of the secured debt equation that causes trouble. Still, Figure 5 illustrates the residuals' univariate-distribution, and they provide some reassurance.

To check if our estimates are robust, we have estimated the final model recursively, ending the sample first in 1994Q1, and sequentially added 2 years of additional data up until 2008Q1, and finally 2009q1. Figure 6 gives the recursive estimates of the long run coefficients in the debt equation, while Figure 7 gives those of the secured debt equation. In the former figure we see the estimates are relatively stable, while there are clear signs of instability in Figure 7. What we observe is that around 2004/05, the implied estimate of the long run coefficient of housing wealth increases from around 0.52 in 2002 to 0.70 in 2006, while that of income decreases, more gradually, from around 0.65 to its final estimate of 0.61. We believe that this instability is a sign of an *additional regime shift* in the equation for secured debt caused by the introduction of home equity credit lines. As will be discussed in Section 5.2, this did cause some shifts in the structural trend, but it is likely that this regime shift hit the market for secured debt harder than that of total debt. It is somewhat difficult to know how to handle this instability – intuitively one would want ST to capture all regime shift effects. It is possible that the lack of interaction between ST and other variables prevents the model from doing so.

Figure 8 shows the results for the final specification of the structural trend, starting with a sample ending in 1988Q1. Since the final model involves 12 constraints on the structural trend (6 due to violation of assumptions, 6 due to insignificance), we repeat this exercise for the specification without the 6 exclusion restrictions. This gives Figure 9. Both figures strongly indicate that we have detected a robust trend[19]

[19] Furthermore, since the trend-estimates in Figures 8-9 have been *rescaled* to make them all equal the final estimate in 1987q4, we have graphed the factors that were used to do so in Figure 11. The factors

5.2 Interpreting the structural trend

Let us inspect the structural trend more closely. Recall the qualitative information summarized in Section 4 while looking at the trend drawn in Figure 10. Early on we see that all the movements are caused by changes in the primary reserve requirement, which has the expected negative impact. We interpret the negative shift in 1979 as caused by the contractionary credit policy initiated in 1978, while that in 1981 as a result of the reregulation of the bond market. The trend increases every year from 1982-87, something which clearly can be seen as the effects of deregulation. It stays constant through 1988 (potentially the first signs of the banking crisis), continues to grow in 1989, and shifts down in 1990, continuing to decline until 1996 – a contraction that we interpret as caused by the banking crisis. The normalization begins in 1997, but a new dip comes in 1998, corresponding to the temporary decrease in the LTV-limit for "low-risk mortgages" under Basel I. It grows steadily from 2000-05 which is probably due to a return to "business as usual" after the crisis. It also grows in 2007, although this is not a significant shift – we have kept this coefficient in any case since we believe that the introduction of home equity credit lines (flexible mortgages) around 2005/06 should have had a positive effect in the last part of the sample. We are not able to detect a negative shift in late 2008.

In total, we judge this to be a very reasonable structural trend. It captures most of the underlying regime shifts described in Section 4 and has only a few defects. In addition, as just shown, it is very robust to sample extensions. Furthermore, as this is a trend inducing changes in the stock of debt for given levels of income and wealth, it seems natural to seek a broader interpretation of it. It says something about relative credit availability, or – as in the terminology of Fernandez-Corugedo and Muellbauer (2006) – credit conditions. Hence ST should also be interpreted as a measure of a Norwegian CCI, since it is able to reflect a combination of regulatory and other supply-side shocks.

5.3 Estimation vs. extraction

Throughout this paper we have interpreted the structural trend as capturing changes in access to credit for given values of income, wealth, etc., *i.e.* the other explanatory variables in the system). This is of course a valid interpretation given the definition of ST in (4). Still, since the main motivation for this study is to provide some measure of the vaguely defined *credit conditions*, our interpretation and understanding of the procedure can be further refined by discussing the differences between estimation and extraction.

We *estimate* the system given by (9). In particular, this gives us estimates of η, denoted $\hat{\eta}$. Given the underlying assumptions, and in particular our definition of ST in (4), we use the estimates to *extract* what we later interpret as a credit conditions index since it seems to match the historical development quite well.

This distinction matters because it highlights that, in some sense, there is no unique structural trend. It all boils down to a choice of how to interpret and use the estimates. We could for instance replace (4) by a definition of a more general structural trend,

can be interpreted as "recursive estimates" of the coefficient of the rescaled trend in the equation for *total* debt. A factor close to one implies that only a small adjustment of ST was necessary, and hence that ST was estimated to cause about as large change in total debt as in the final estimates. Clearly this figure shows that not only the shape, but also the "importance" of the trend is recursively robust.

denoted ST^*, given as

$$ST_t^* = \boldsymbol{\eta}'\mathbf{c_t} + \boldsymbol{\phi}'\mathbf{x_t}. \tag{17}$$

The reader will immediately observe that replacing (4) by (17) will have no impact on the system we are able to estimate. The only difference is that we cannot separate $\boldsymbol{\phi}$ and $\boldsymbol{\beta}$ – we will only be able to estimate the net effect:

$$\boldsymbol{\mu} = \boldsymbol{\beta} + \boldsymbol{\phi}. \tag{18}$$

Hence for estimation it is not possible to discriminate between systems with (4) or (17) as the assumed structural trend. But for extraction it will be a difference. Under the latter assumption it is not obvious how to extract any measure of structural changes, but two candidates look obvious. Let M_t denote the measure extracted under (17) as the assumed trend. Restricting ourselves to linear combinations with x, it is defined as:

$$M_t(\boldsymbol{\theta}) = \hat{\boldsymbol{\eta}}\mathbf{c_t} + (\boldsymbol{\phi} - \boldsymbol{\theta})\mathbf{x_t}. \tag{19}$$

M_t is of course not identified for any $\boldsymbol{\theta}$, but appropriate choices will work. For instance, $\boldsymbol{\theta} = \boldsymbol{\phi}$ will give $M_t = CCI_t$. Hence the way we originally extract the structural trend in this paper can be viewed as applying (17) as our assumed structural trend, but letting CCI be the effect *given* $\mathbf{x_t}$. Another alternative is to try to make M uncorrelated with $\mathbf{x}$. Since $\boldsymbol{\eta}$ is estimated, it is clear that a measure such as CCI_t will have the risk of being closely correlated with $\mathbf{x}$, and you might worry that it picks up some of the effects of $\mathbf{x}$. Choose therefore $\boldsymbol{\theta} = \boldsymbol{\theta}^u$ where the latter is defined by the criterion:

$$\boldsymbol{\theta}^u : \ cov(M_t(\boldsymbol{\theta}^u), \mathbf{x_t}) = 0. \tag{20}$$

$M_t(\boldsymbol{\theta}^u)$ can be labeled the "Uncorrelated Credit Conditions Index", $UCCI$. It will, under a few extra assumptions regarding $\hat{\boldsymbol{\eta}}$ involve regressing ST_t on the explanatory variables $\mathbf{x_t}$, and keep the residual as your structural trend.

We believe that a measure such as CCI_t, which takes $\hat{\boldsymbol{\eta}}\mathbf{c_t}$ as the relevant measure of structural shifts in the credit market, is the most informative choice and can possibly have wide applicability. However, there might be circumstances where a measure such as $UCCI$ would be preferred.

6 Concluding remarks

This paper has provided an estimate of the common structural trend in total and secured stocks of household debt in Norway. We argue that the trend can be interpreted as a credit conditions index, measuring relative credit availability. Our work follows the main principles of Fernandez-Corugedo and Muellbauer (2006) in controlling explicitly for regime shifts in the credit market. Since the trend can be interpreted as a CCI, it will permit researchers to control for structural supply side shifts in the credit market in empirical analyses. We argue that any empirical study in which interest rates, debt or other financial variables are relevant should face the tough question of how to control for the fundamental institutional development that has taken place.

The model underlying our estimates is plausible, even though some statistical properties leave something to be desired as we have maintained a simple lag structure in order to avoid a too large model. Recursive estimates of the model support robustness and in particular the shape of the structural trend is invariant with respect to the sample size. The estimated trend seems to fit nicely with the qualitative development observed in Norway the last 35 years.

There are several ways future research can lead to improved estimates of this trend. Including additional credit indicators would be helpful, but there might be severe data limitations. If new indicators are made available from a period *after* 1975, one could potentially use our estimates in the early parts, and update the index with the new and larger model. Also, the CCI offers an opportunity to improve on existing empirical models for *e.g.* consumption or house prices. A successful outcome of those efforts will entail that the CCI will need to be updated in the future either by "adding new years", keeping the index fixed for the period estimated here, or a more complete revision based on the extended information set.

On the theoretical and methodological side, further work should link the use of a common, structural trend to other methods for detecting regime shifts. Spline functions are not heavily applied in econometrics, see Poirier (1974) for a contribution to this literature. It seems natural to clarify links to e.g. the method for detecting structural changes due to Bai and Perron (1998), and also the use of impulse indicator saturation (see Hendry, Johansen, and Santos (2008)). How to do this is not obvious – among several things this would require an extension of the methods mentioned to allow for common regime shifts in systems of equations.

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A Appendix A – Tables

Table 1: Calendar of the major regulatory events

December 1977:	Most of the interest rate norms removed – interest rates allowed to float freely.
September 1978:	Wage and price freeze introduced (including interest rates).
November 1978:	Quantitative exchange controls for the banks removed. Zero total position (net spot and forward claims) the only requirement.
December 1979:	Wage and price freeze ended. Interest rates were kept under informal regulation.
September 1980:	Interest rate declarations were introduced as a formal way to dictate interest rates. Less strict than interest rate norms.
October 1980:	Bond issuing fully liberalised.
October 1981:	Bond issuing partly re-regulated – direct regulation of loan associations introduced.
January 1983:	Introduction of direct regulation of guarantees issued by financial institutions for loans in the grey market.
January 1984:	Additional reserve requirements removed. Intended to be a permanent removal.
January 1985:	Banks' placement requirement revoked. Revoked for life insurance companies in July 1985.
September 1985:	Interest rate declarations abandoned. Interest rates allowed to float freely.
September 1985:	License requirement for residents' borrowing abroad removed.
January 1986:	Additional reserve requirements re-introduced.
June 1987:	Banks' primary reserve requirements revoked.
October 1987:	Additional reserve requirements removed permanently.
July 1988:	Last part of the direct regulation of loan associations removed. The regulation of guarantees for loans in the grey market was also removed, as well as the direct regulation of private finance companies and non-life insurance companies.
May 1989:	Limits on foreign investment in Norwegian bonds lifted.
June 1990:	New set of foreign exchange regulations introduced.
April 1991:	Basel Accord introduced (Basel I).
December 1996:	The Capital Adequacy Directive (CAD) introduced. An update (CAD-II) came in June 2000.
January 2007	Basel II implemented.

Source: Krogh (2010b).

Table 2: Maximum likelihood estimates of the model in (9)

		Δd_t			Δsd_t	
Variable	Coef.	Std.Err	p-value[a]	Coef.	Std.Err	p-value[a]
Constant	−.3951	.3955	.3192	−.3619	.1425	.0082
Dummy for Q3	(dropped)			.0050	.0017	.0040
Dummy for Q4	.0040	.0019	.0412	.0087	.0028	.0025
$PSTOP$	(dropped)					
ΔI_t	−.3665	.0683	.0000	−.2549	.1025	.0137
ΔU_t	−.6518	.1706	.0001	−.5752	.2100	.0067
Δy_t	.0671	.0225	.0034	(dropped)		
Δhw_t	.1309	.0301	.0000	.2110	.0391	.0000
Δlw_t	.1749	.0348	.0000	.0842	.0435	.0555
d_{t-1}	−.3673	.0499	.0000	(dropped)		
sd_{t-1}	(dropped)			−.0945	.0219	.0000
U_{t-1}	−.3534	.1299	.0074	(dropped)		
y_{t-1}	.1164	.0405	.0055	.0577	.0249	.0199
hw_{t-1}	.0805	.0193	.0001	.0669	.0104	.0000
lw_{t-1}	.2173	.0430	.0000	(dropped)		
$\mathbf{\hat{B}_2' c_{t-1}}$	1			.2030	.0513	.0000
$d1979_{t-1}$	−.0085	.0042	.0436	*		
$d1981_{t-1}$	−.0173	.0054	.0021	*		
$d1982_{t-1}$	.0288	.0052	.0000	*		
$d1983_{t-1}$	.0102	.0061	.0991	*		
$d1984_{t-1}$	.0197	.0066	.0036	*		
$d1985_{t-1}$	.0276	.0069	.0002	*		
$d1986_{t-1}$	.0352	.0074	.0000	*		
$d1987_{t-1}$	.0214	.0078	.0085	*		
$d1989_{t-1}$	.0181	.0054	.0012	*		
$d1990_{t-1}$	−.0054	.0043	.2088	*		
$d1992_{t-1}$	−.0186	.0052	.0006	*		
$d1993_{t-1}$	−.0185	.0053	.0008	*		
$d1994_{t-1}$	−.0118	.0044	.0081	*		
$d1996_{t-1}$	−.0083	.0042	.0507	*		
$d1997_{t-1}$	.0094	.0050	.0637	*		
$d1998_{t-1}$	−.0107	.0042	.0122	*		
$d2000_{t-1}$	.0126	.0040	.0020	*		
$d2001_{t-1}$	.0101	.0050	.0462	*		
$d2003_{t-1}$	.0230	.0054	.0001	*		
$d2004_{t-1}$	.0161	.0048	.0013	*		
$d2005_{t-1}$	.0129	.0060	.0359	*		
$d2007_{t-1}$	.0028	.0051	.5859	*		
$PRIMC_{t-1}$	−.0007	.0003	.0484	*		
σ_{11}	.0000392	5.59e-06	.0000			
σ_{12}	.0000461	7.38e-06	.0000			
σ_{22}	.0000936	.0000116	.0000			
R^2	.9021			.7851		
Log likelihood	971.89829					
No. of obs.	133					
Jarque-Bera	Joint: 34.822 [0.00000]. Eq.1: 2.911 [0.23324]. Eq.2: 31.911 [0.00000]					
Skewness	Joint: 2.446 [0.29427]. Eq.1: 1.292 [0.25568]. Eq.2: 1.155 [0.28260]					
Kurtosis	Joint: 32.376 [0.00000]. Eq.1: 1.619 [0.20318]. Eq.2: 30.756 [0.00000]					
VAR LM-test	AC of order 1: 9.3299 [0.05336]. Order 2: 6.6175 [0.15753] Order 3: 7.7207 [0.10236]. Order 4: 19.2577 [0.00070]. Order 5: 1.6716 [0.79587].					

[a] p-values are based on LR-tests, except for those of the σ's and the CCI coefficient of Δsd which are based on Wald tests.

Table 3: Overview of variables and sources

Variable	Name	Source
D	Gross household stock of debt to domestic institutions	Statistics Norway/Norges Bank[a]
SD	Gross household stock of housing debt to domestic institutions plus all loans to insurance companies	Statistics Norway/Norges Bank[a]
Y	Gross household income except dividends (RD300 - RAM300)	Statistics Norway
I	Average nominal interest rate (4*RENPF300)	Statistics Norway
P	Consumer Price Index (KPI)	Statistics Norway
τ	Capital tax rate (TRTMNW)	Statistics Norway
R	Real interest rate ($I * (1 - \tau) - \Delta_4 \log(P)$)	
HK	Households housing stock (K83)	Statistics Norway
HP	House prices (PBOL)	Statistics Norway
HW	Housing wealth ($HK * HP$)	
U	Unemployment rate (URKORR)	Statistics Norway
LW	Gross household stock of liquid assets (notes, coins and deposits)	Statistics Norway/Norges Bank[b]
MW	Gross household stock of moderately liquid assets (all financial assets except liquid assets and insurance claims)	Statistics Norway/Norges Bank[b]
$PRIMC$	Primary reserve requirement for commercial banks	Krogh (2010b)
$ADDR$	Indicator for additional reserve requirements	Krogh (2010b)

[a] The series from Statistics Norway are only annual prior to 1988 for some series (debt to banks) and prior to some time in the 1990s for others (debt to state banks). To make the series on total debt complete we have utilized the information from equivalent series found in the database FINDATR, previously maintained by Norges Bank (which has quarterly data for 1975-2003 – it is no longer updated). The series for housing debt is completed by imposing the quarterly pattern of the total debt series. See Krogh (2010a) for a more detailed description.

[b] These variables are only available from Statistics Norway from 1995. For the period 1975-2003 we can use data from FINDATR. The series from Statistics Norway are made "complete" by copying the growth rates of the FINDATR series.

B Appendix B – Figures

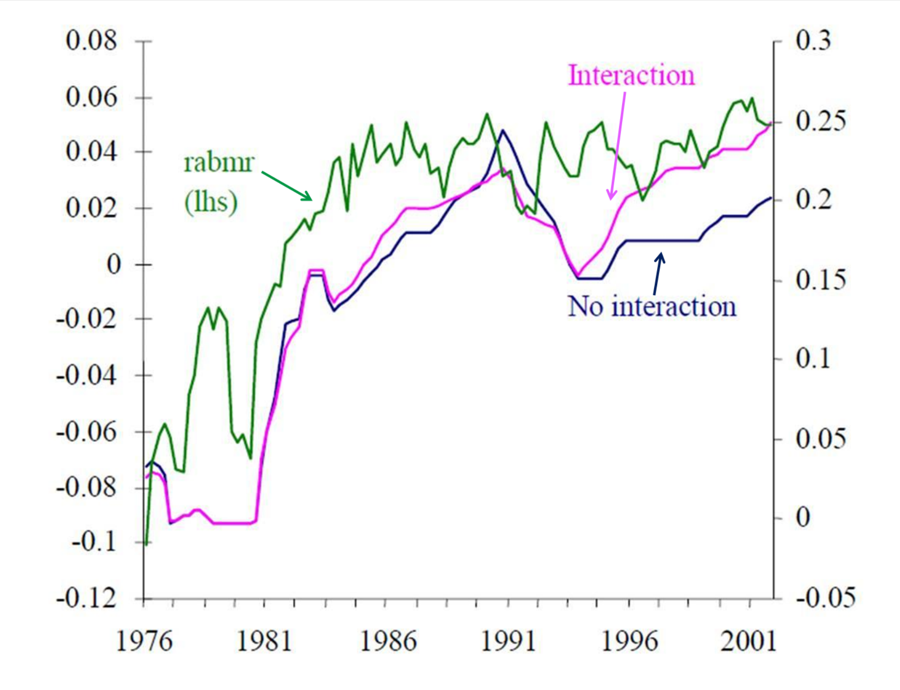

Figure 1: Chart 13 from Fernandez-Corugedo and Muellbauer (2006), illustrating their estimated CCI.

The line labelled "No interaction" is the standard CCI, that labelled "Interaction" is the result when the CCI is interacted with a risk measure. "rabmr" is the real mortgage interest rate.

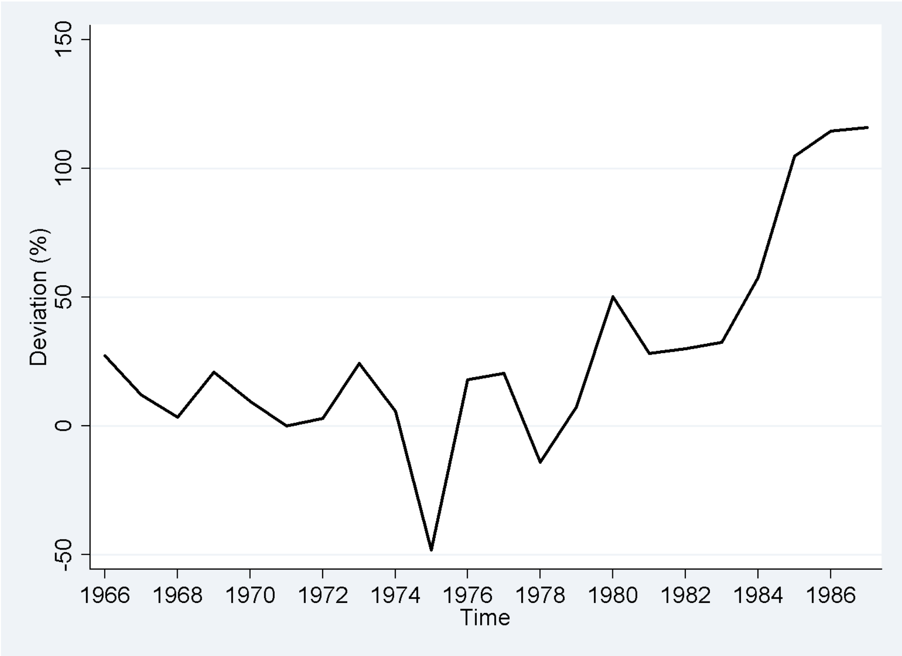

Figure 2: Deviation from the credit budget, 1966-1987. Percentage deviation between the actual credit supplied and the bounds of the credit budget, 1966-1987 (source: Norwegian Official Reports (1989))

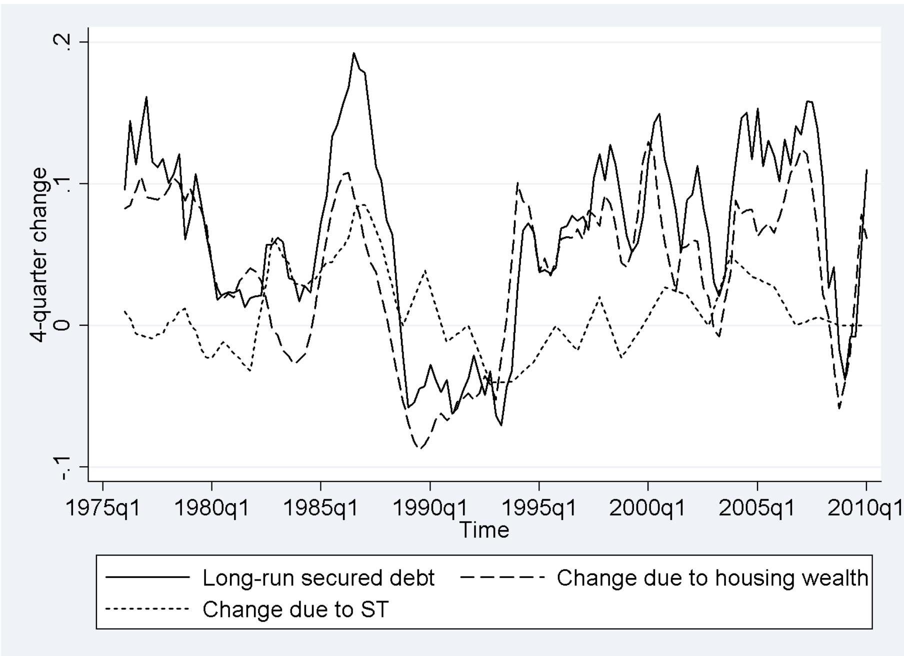

Figure 3: Contributions from housing wealth and ST to changes in long-run secured debt

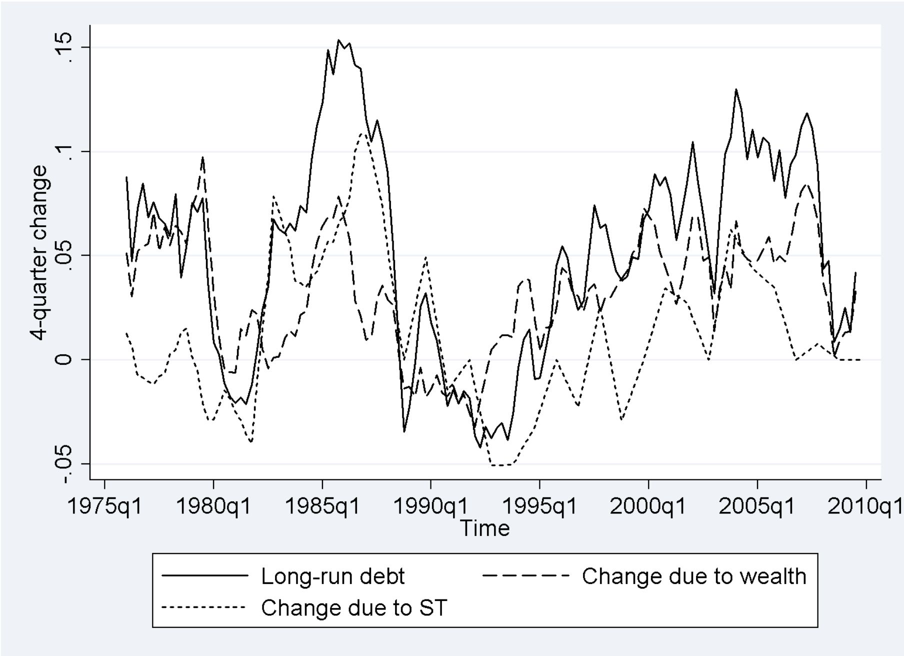

Figure 4: Contributions from wealth and ST to changes in long-run debt

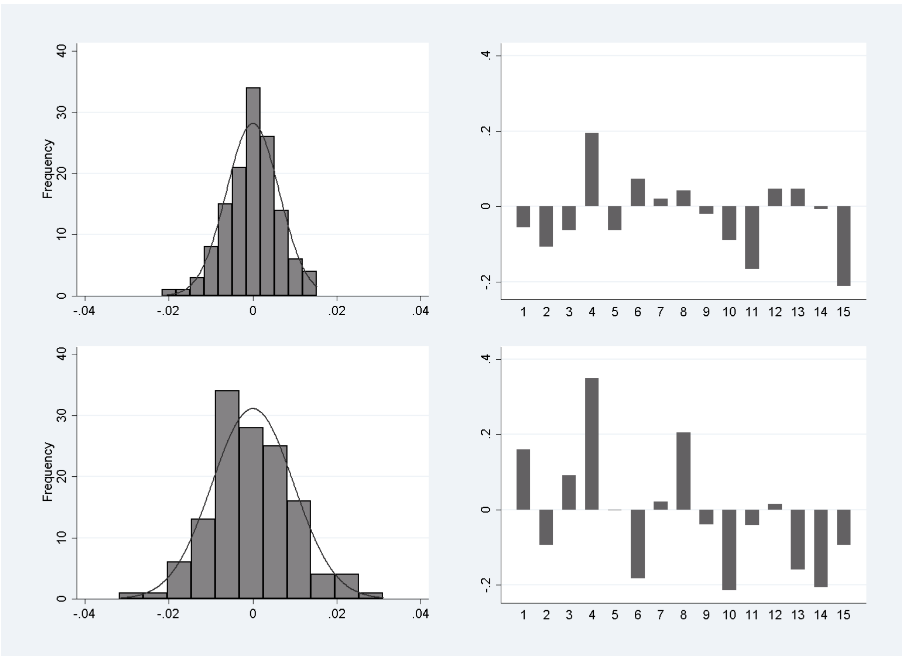

Figure 5: Visual diagnostics for residuals (top panels are for the residuals from the debt equation, bottom for the secured debt equation). Their frequency (left panels) and autocorrelograms (right panels).

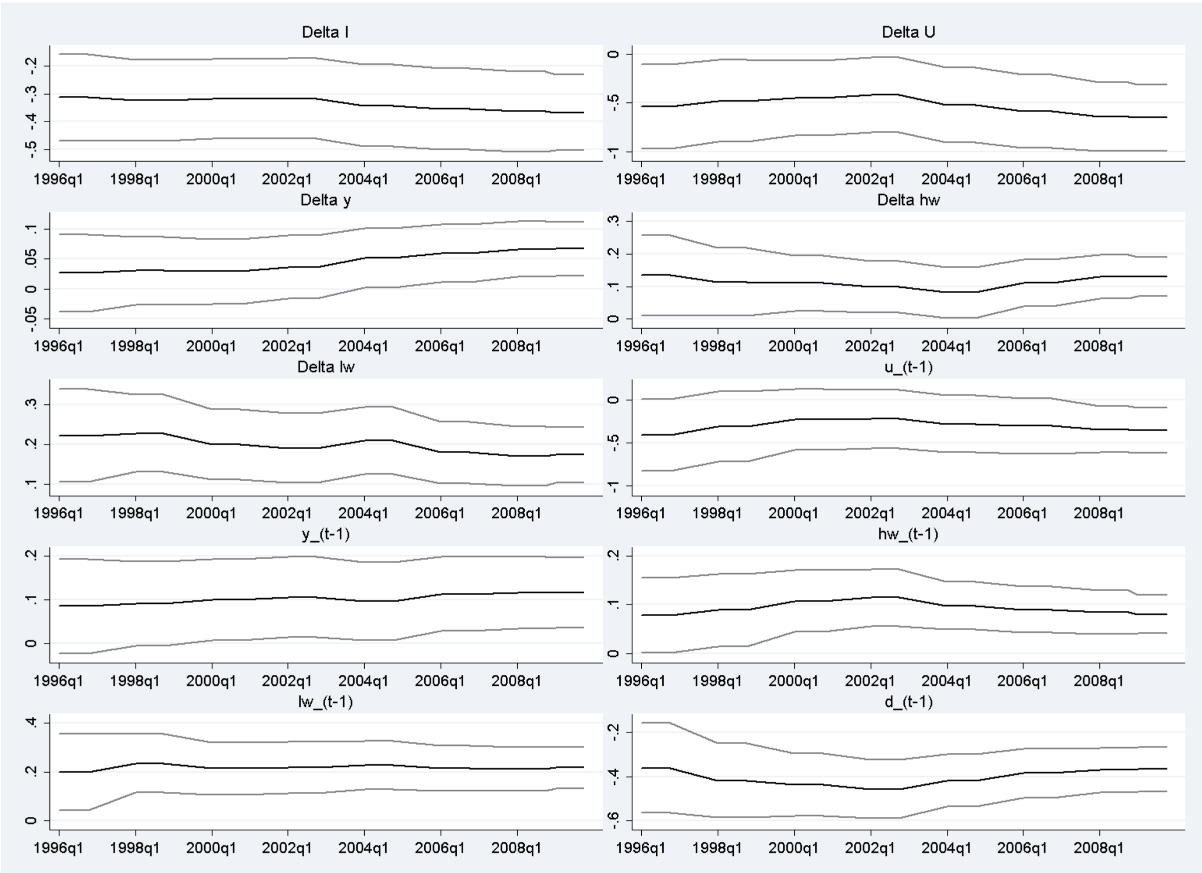

Figure 6: Recursive estimates of the debt equation

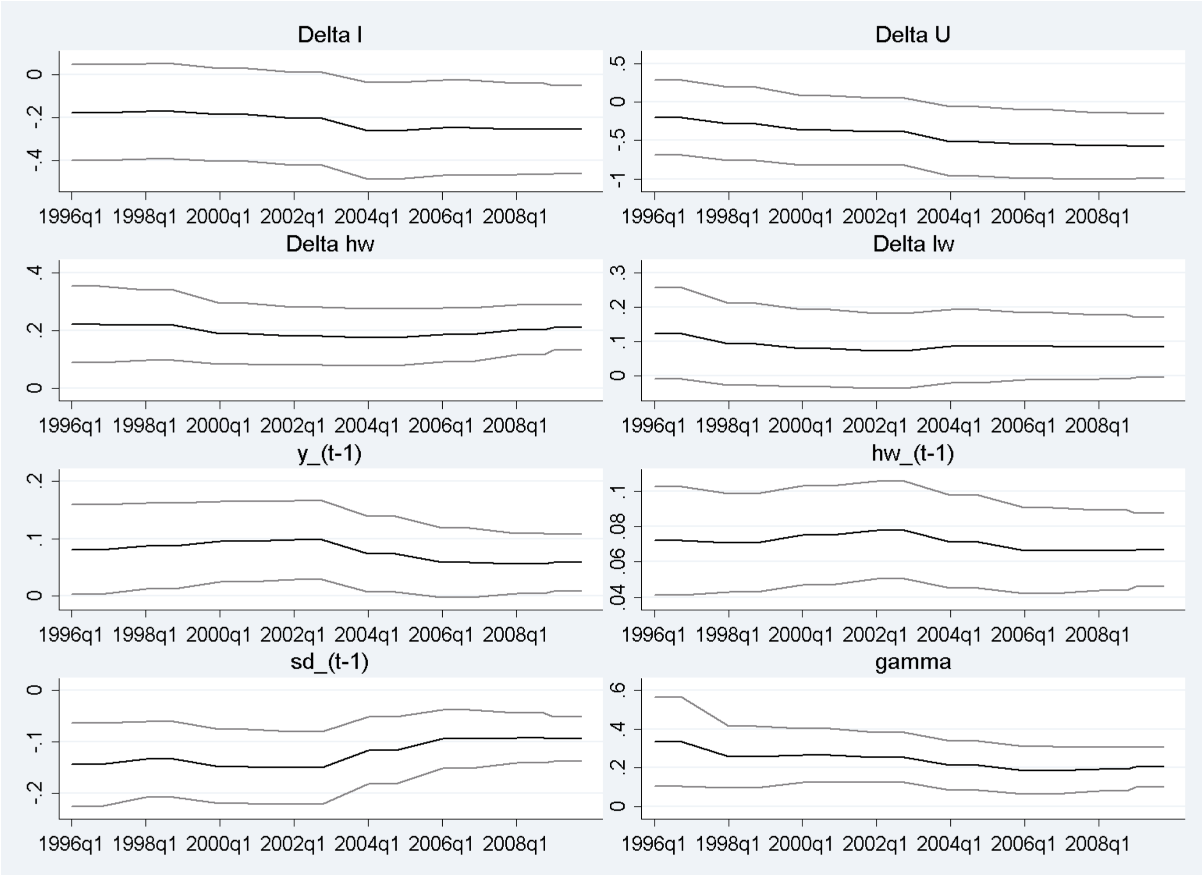

Figure 7: Recursive estimates of the secured debt equation

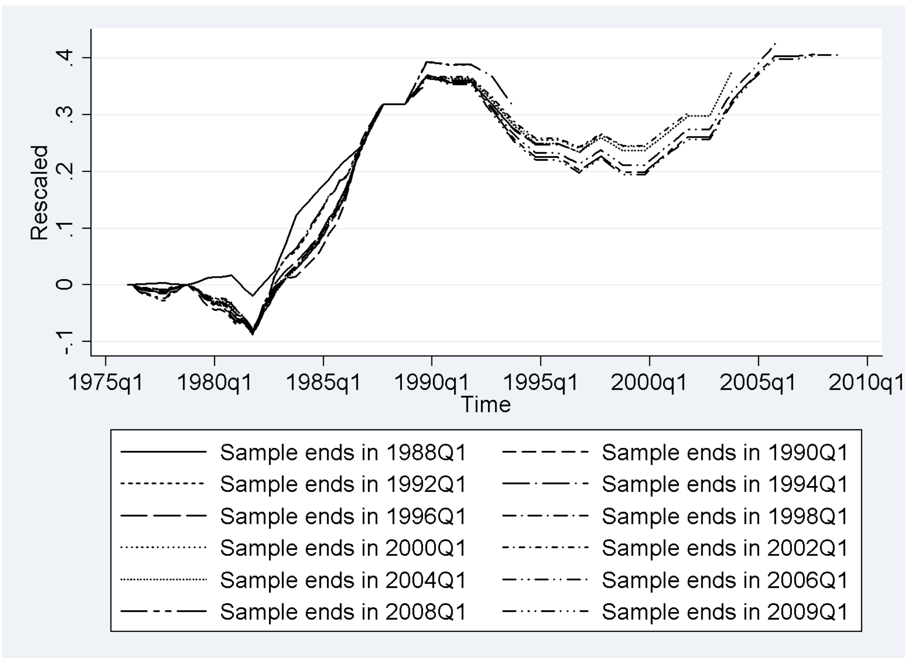

Figure 8: Recursive estimates of the structural trend in the final model, all indices to equal the final ST in 1987Q4.

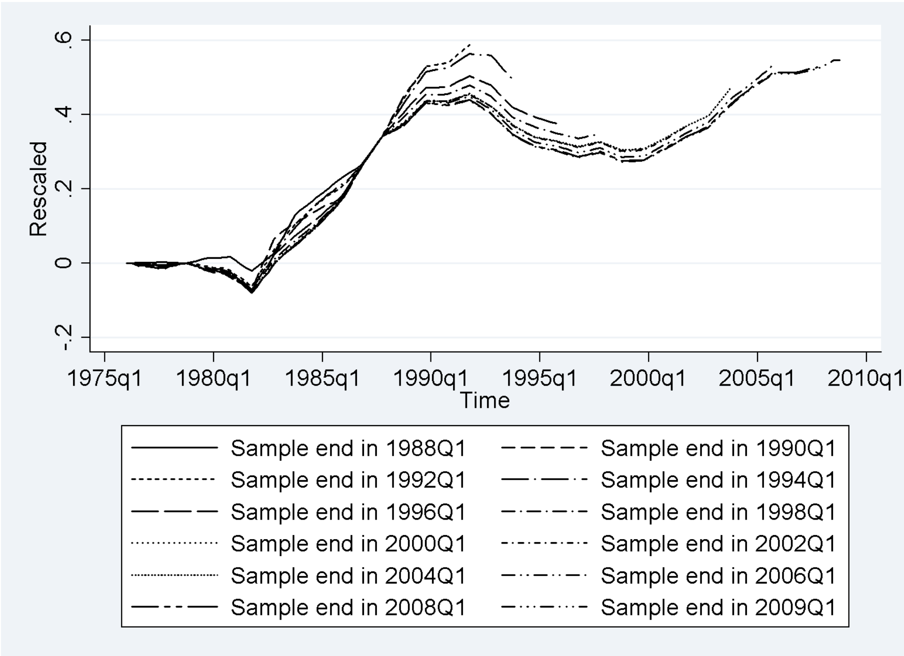

Figure 9: Recursive estimates of the structural trend in the model without exclusion restrictions imposed, all indices to equal the final ST in 1987Q4

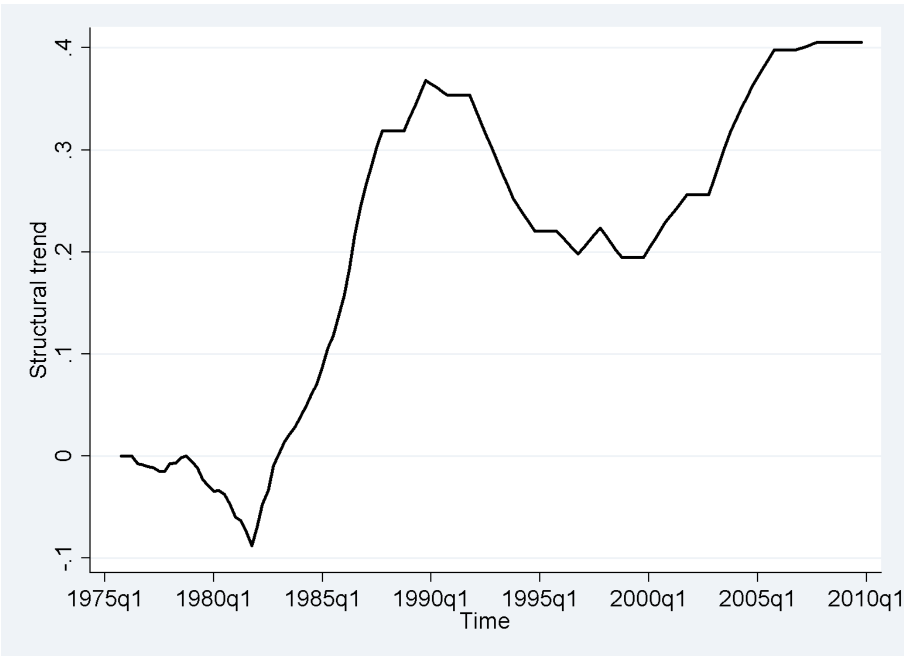

Figure 10: The estimated structural trend, 1975Q4-2008Q4

Figure 11: Factors used to rescale the recursive estimates of ST in Figures 8-9

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