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When's the holiday over?

Assessing the sustainability of local government debt in Sweden

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Swedish local governments are emerging from an era of low indebtness after the Swedish financial crisis in the 1990s preceded the creation of a comparatively robust, rules-based macro-prudential framework. Yet, the persistently low interest rates observed since 2008 have allowed an accelerating debt accumulation under those frameworks, pre-empting questions of debt sustainability should interest rates reverse. The present thesis develops a forecasting methodology based on vector auto-regression models and contingent sustainability conditions in order to answer the research question *"are Swedish municipalities on a sustainable debt path?"*. In so doing, it attempts three contributions. Firstly, it extends a methodology previously used for Greece (Zettelmeyer et al., 2017) to fit the panel dimension of local governments, in general, and the institutional setting in Sweden, in particular. Secondly, it produces results that chime into the empirical literature and wider debate around local government debt in Europe. Thirdly, it makes cautious observations surrounding the significant devolution of power in Sweden and the structural factors underlying differences in debt accumulation between different types of municipalities. Results suggest that all but a handful of municipalities are on sustainable debt paths. However, the structural break in 2008 and general robustness issues require that results are interpreted with care.

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Introduction

The road to ruin started with an ambition to renovate the large stock of social housing built during the 1960s in the coastal municipality of Haninge, just south of Stockholm. Over the year 1985 – 1993, the costs of the project grew and the municipality extended additional credits and guarantees. It became evident to civil servants in the municipality that the finances were becoming untenable, but worker turnover and contradictive decisions taken at the political level thwarted a consolidation (Berg et al., 1998). The episode ended after non-payment of a loan on the part of the municipal property development company. The finances of the municipality were much too weak to uphold the guarantees necessary and the central government had to step in, partly because of the social welfare at risk and partly because Swedish municipalities lacked, and still lack, a legal bankruptcy procedure. The total cost of the ensuing settlement; SEK 800m state emergency transfer to the municipality of Haninge, an emergency loan to the property development company of SEK 650m and a 25% cut to annual welfare expenses in the municipality over a period of three years.

The episode demonstrates the importance of sustainable local government finances from two perspectives. Firstly, the livelihoods and human welfare at risk when welfare spending needs to be cut or development projects need to be suspended. Secondly, the financial stability issues relating to scenarios in which the central government is not able to shoulder the large contingent liabilities. Consequently, there is a need to analyse local government debt sustainability before unsustainability is evident. Given the long planning horizons of local governments, this translates to *years* before the fact.

For this purpose, the present thesis develops a forecasting methodology and tailored sustainability conditions to answer the research question *"are Swedish municipalities on a sustainable debt path?"*. The methodology draws on Zettelmeyer et al. (2017), but extends the methodology to fit the institutional setting and large panel dimension of Sweden's 290 municipalities. The thesis contributes to recent empirical scholarship concerned with local government indebtness in Europe (Kluza, 2016; Prior et al., 2016) and the methodological debate surrounding debt sustainability (Navarro-Galera et al., 2016; Neck & Strum, 2008), by applying an extended form of a model previously used for sovereign debt.

Swedish local governments, particularly the municipalities (*primärkommuner*), are emerging from an era of low indebtness. The fiscal reforms and consolidation after the Swedish financial crisis in the 1990s created comparatively robust, rules-based frameworks that local governments must follow, most notably a budget balancing requirement (BBR). In the context of persistently low interest rates since the financial crisis, such regulation has limited sway over debt accumulation, which the present thesis will demonstrate. The total stock of local government debt has increased by 70% since 2003 (SCB, 2017). It is of primary policy importance to know if the debt accumulated is sustainable should interest rates reverse in the near future, as many expect them to do (Riksbanken, 2017; ECB, 2017). A second policy motivation stems from Sweden's relatively unique level of devolution (OECD, 2017). While the results of the present thesis are not explicitly comparable with many previous investigations, the results are put in their international context, noting that devolution and decentralisation is a wider, international trend amongst developed and developing countries alike (Liu & Waibel, 2010).

The results of the present thesis are threefold. Firstly, there seems to be a structural shift in the way Swedish local governments accumulate debt in and around the financial crisis of 2008. Interesting in its own right, this result reduces the base of the forecasts to 2008 – 2015, which still produces internally valid results for the methodology used, but increases the uncertainty of the forecasts. Secondly, the analysis suggests that the 290 municipalities are on a sustainable debt path overall, with the exception of 10-20 from the groups of sparsely populated municipalities near larger cities and countryside municipalities with a tourism industry. Thirdly, the analysis suggests that devolution does not necessitate short-sighted debt-accumulation in the presence of robust, macro-prudential regulation, but the effectiveness of such regulation need to be monitored when essential variables in the macroeconomy change structurally, such as interest rates.

The methodology of the thesis hinges on a separation of structural variables and macroeconomic variables by grouping municipalities with similar characteristics into 9 established groups (SKL, 2017), two of which were outlined above. A vector auto-regression (VAR) model is estimated for each group, allowing forecasts with dynamic uncertainty and coefficient heterogeneity across groups. The estimates are cross-checked against a panel-VAR for the full sample estimated with a general method of moments (GMM) technique, following Abrigo & Love (2010), and a number of robustness tests are performed. The forecasts allow me to determine whether each municipality satisfies two sustainability conditions[1] over the forecast horizon.

Within the context of forecasting long-term, economic equilibria, Keynes famously said – *"in the long-run, we are all dead"* (Keynes, 1923). Indeed, in the long-run, we are all dead. And the crudeness involved in stipulating economic equilibria for the distant future often seems to be a game in which one faces an overhanging risk of being completely wrong. There are known unknowns, like what kind of interest rates Swedish municipalities will be facing in 5 years, and unknown unknowns, of which it seems contrived to give an example, but e.g. a new payments technology that widely changes the nature of financial debt. Such uncertainty notwithstanding, we need to ask ourselves *"what is a sustainable level of indebtness for our local governments?"* because the planning horizon of local governments is inevitably long-term and the number of people whose lives depend on local government welfare services is typically huge. Especially in a devolved country like Sweden.

The present thesis proceeds as follows. Section I motivates the investigation with respect to the literature and the policy environment, respectively. Section II presents the methodology and derives the most critical robustness tests and features of the model. Section III gives a detailed exposition of the data

[1] Breaking the sustainability condition, in short, entails exhibiting welfare expenses and interest rate expenses that exceed total income for periods longer than 2-3 years. This condition is also qualified by looking at the debt-to-income ratio of the municipality.

and the institutional setting facing Sweden's 290 municipalities. Section IV presents the results and associated robustness tests. Section V analyses the results and suggests policy implications and future avenues of research. Section VI concludes.

Motivation

The main contributions of the present thesis chime into a Swedish debate around public debt, public management and financial sustainability. But the methodology and a few, select inferences are interesting from a general and international perspective. Particularly those pertaining to devolution of power to the local government level, since Sweden is comparably extreme in this respect, and the tentative inferences regarding structural breaks to the efficiency of balanced-budget regulation. With this in mind, the current section has been divided into a literature review and a policy motivation. The former highlights the methodological and empirical shoulders I stand on, and what research I come into conversation with. The latter motivates the present investigation given current circumstances in Sweden and Europe.

Literature review

Local governments typically lack the bankruptcy procedure of private companies, but they do not have the non-enforceable debt of sovereign nations (Gelpern, 2012). They cannot print money to pay off debt, but neither do they have the hard budget constraints of private companies, as was evident in the case presented in the introduction (Qian & Roland, 1998; Janos, 1986). This division has led some researchers to employ methodologies typically associated with corporate finance (Kluza, 2012; Johansson, 2016) in the analysis of local government debt sustainability. Others rely on frameworks developed in the field of fiscal federalism (Greer & Denison, 2016; Grant & Woods, 2016) and yet others conduct case-study analysis (Liu & Waibel, 2010). The present thesis actually draws most of its methodological insights from the literature on sovereign debt (Zettelmeyer et al., 2017), and amends the methodologies developed herein to the institutional conditions faced by Swedish local governments.

The literature on sovereign debt is a vast field, catalysed by seminal papers like Barro (1979) on the determinants of public debt. The present thesis is primarily interested in sovereign debt *sustainability* literature, of which Neck & Strum (2008, chapter 1) provides a comprehensive survey. A hot topic in Europe ever since the onset of the 2010 Euro crisis, the relevant literature for the purposes of this investigation is framed by the ambition to determine whether a country will be able to meet the payments on its outstanding and future debt *ex ante* – before those payments are made/cancelled. There are historical investigations as well, but these are methodologically quite different from what I set out to do (Bohn, 2008; Galli, 2008). International institutions, particularly the IMF and the OECD, have lead the *ex-ante* literature since the early 1990s, and they have progressed through advancing two classes of models. The first, used extensively by the IMF in its Article IV Consultations since the 1990s, is the baseline scenario approach (IMF, 2003). Here, a deterministic model is built for the evolution of sovereign debt by compounding interest payments and making assumptions about economic growth, interest rates, demographics and other variables. This gives a baseline evolution of sovereign debt, which is then stressed using different adverse scenarios, defined by the experts. The adverse scenarios give an upper bound to the evolution of sovereign debt. While intuitive, this class of model fails to account for interdependencies and dynamic uncertainty in the forecasts.

The second class of models, to which this essay belongs, is characterised by the design of a stochastic model, which incorporates the forecast uncertainty. This forecast uncertainty becomes larger every additional year into the future. Ostry et al. (2006) provides an illustrative example, where a vector auto regression (VAR) model is estimated using data on the primary surplus, growth, exchange rates and interest rates of 3 emerging market economies. This study emphasises the role of the fiscal policy response to shocks for the avoidance of unsustainable debt accumulation. A few other scholars have used VAR models in the national setting, including Tanner & Samake (2006) and Zettelmeyer et al. (2017). The present investigation draws the basis of its empirical methodology from the latter, expanding it to fit the panel dimension and richness of a dataset on Swedish local governments. Zettelmeyer et al. (2017) asks if Greece needs more debt relief, and “if so, how much?”. In order to answer the two questions[2], they construct an empirical investigation in two parts. Firstly, they calculate the probability of observing long-lived primary surpluses in Greece, using a panel of 48 advanced and emerging economies from 1955 – 2015. This is used to show how the assumptions of the IMF and the Eurogroup on Greece’s future primary balances are not plausible. The country therefore needs more debt relief.

Secondly, Zettelmeyer et al. (2017) estimates a VAR model for a sample of 17 advanced economies, enabling long-term forecasts of Greece’s debt levels and primary surpluses. They estimate the model using ordinary least squares (OLS) without fixed effects, by stacking the data appropriately. In addition to the VAR model, Zettelmeyer et al. (2017) uses a complete dataset on Greece’s official credit to incorporate amortizations. Forecasting Greece’s debt levels and primary surpluses, *conditional* on different interest rate paths, supports the conclusion that the debt relief suggested by the Eurogroup in May 2016 could address Greece’s sustainability problem, *if* the Eurogroup and other institutions are willing to accept very long maturity extensions. What the present thesis draws from Zettelmeyer et al. (2017) is the VAR methodology that can produce forecasts of debt levels conditional on interest rate paths. The methodology is expanded to cover the panel of 290 Swedish municipalities and the sustainability analysis becomes quite different, given that the conditions and capacities of Swedish local governments are very separate from those of Greece. The gap in the literature that this thesis attempts to bridge is the use of VAR and panel-VAR methodology in studies of local government debt sustainability. I suggest a way in which such models can be applied to local governments, which have previously been analysed with methods of corporate finance

[2] And, seemingly as a matter of tradition within applied economics and academia, all the endless questions encountered in the process of answering the first two.

or fiscal federalism, primarily[3]. The present thesis then attempts to square and critically evaluate the results produced by the methodology by relating them to insights from adjacent fields of literature.

Such an adjacent field of literature is the study of how institutional mechanisms and regulations influence local government economic behaviour. Persson (2015) shows that the BBR imposed on Swedish municipalities in 1995 increased their income elasticity of consumption, primarily through the non-replacement of retiring workers in times of economic stress. Monacelli (2016) analyses the impact of EU budgeting rules on Spanish municipalities, and Grembi (2016) conducts a natural experiment to determine the impact of fiscal rules introduced in Italy in 1999. The former finds that fiscal discipline was improved but investment severely restricted, while the latter found that the effects were much stronger if the mayor of the municipality could be re-elected. Centrally imposed regulations are critical to the current investigation and the results vary according to their efficacy.

A second strand of adjacent literature consists of cross-country comparisons, which the present thesis uses in order to put the Swedish results in an international context and assess their external validity. The OECD (2014) have conducted surveys of municipal governments in times of financial stress. The evidence points towards an association between decentralisation and indebtedness; that indebtedness tends to increase if the same party is in power at the local and national levels; and if there is an expectation that the local government will be bailed-out by the sovereign. Liu & Waibel (2010) provide another instructive cross-country analysis of bankruptcy procedures and the general institutional developments relating to subnational debt.

Policy motivation

Swedish local governments, both *kommuner* (municipalities) and *landsting* (regions), are emerging from an era of low indebtness. The fiscal reforms and consolidation after the Swedish financial crisis in the 1990s created comparatively robust, rules-based frameworks and stringent financial regulations that local governments have had to follow, most notably a balanced-budget requirement (BBR) requirement. However, with mounting demographic pressure, through immigration and an ageing population, local governments are forecasting both higher future current expenditures and higher investment needs (Kommuninvest, 2017). This will undoubtedly require more external financing, which has already increased by 70% since 2003 (SCB, 2017). At the European level, local government debt-to-income ratios grew from 2008 to 2013, while their share of total investment spending dropped from 10.2% to 8.6% (Kluza, 2016). Persistent low interest rates have meant that Swedish local governments can accumulate more debt and still cover interest rate expenses within the scope of the BBR.

[3] A recent contribution to the branch using methods of corporate finance is Kluza (2016), who analyses free cash flow of Polish local governments and construct forecasts of these using Monte Carlo simulations. For moderate interest rate increases of 1.5%, the study concludes that 2.5% of Polish local governments will exhibit alarmingly low space for debt servicing. Navarro-Galera et al. (2016) enriches the corporate finance perspective by analysing how different accounts on local government income statements are associated with a definition of sustainability suggested by the International Federation of Accountants (IFAC).

The reliance of thousands and thousands of people on the welfare services provided Swedish local governments constitutes the primary motivation for the study and monitoring of local government finances, as to ensure their continuous operation. Sweden's municipalities have legal power to levy the majority of taxes and they are legally responsible for schooling, transport, water and sewers, social services etc. The list can be made long. Devolution, or at least decentralisation, is an international trend in advanced and emerging market economies alike (Ianchovichina, Liu & Nagarajan, 2006). But Sweden stands out for its exceptional devolution to the local level and is therefore an interesting case internationally, for countries in the process of devolving. What institutions and regulations are necessary to contain principal-agent dilemmas and what processes are needed to ensure long-term provision of welfare services?

A secondary policy motivation stems from macroeconomic financial stability. The fact is that local government debt has received unwarrantedly little attention as compared to its larger cousin of sovereign debt, notwithstanding the *subnational* origin of several sovereign debt crises in the last 25 years.[4] In 2001, for example, Argentina defaulted on its outstanding stock of bonds partially because it had been saddled with runaway debt from the provinces of Mendoza and Buenos Aires. The ensuing financial instability, essentially Argentina's lack of access to international capital markets, lasted for 14 years. Argentina settled with the last creditors in February of 2016 (Gelpern, 2016). The debts of local governments can easily become contingent liabilities of the central government. And if the aggregate debts are not *monitored*, such liabilities can cause unbearable financial stress for the central government. Ominously, Sweden has no provision for local government bankruptcy[5]. This is not necessarily a bad thing. But it does signal central government involvement *ex ante*, should a local government fall into distress.

The present thesis develops a forecasting methodology based on a panel-VAR model to analyse local government debt sustainability in Sweden. The forecasting procedure is motivated by the *long* planning horizons of Swedish municipalities and need for monitoring debt sustainability *ex ante*, as to ensure continuous welfare service delivery. The VAR methodology is selected primarily for three reasons. Firstly, it allows a long-term perspective because forecasts can be extended to cover 10-15 years without restrictive computational requirements and without having to arbitrarily assume specific paths for some of the macro variables. The long forecast horizon is required if results are to be useful for local governments, because of their long planning horizons discussed above. The VAR-methodology is selected in favour of corporate finance methods, which typically focus on a short term horizon of 3-5 years. Secondly, VARs allow dynamic uncertainty in the sense that confidence intervals for the forecasts can be computed within the model. These allow the production of "fan charts" and, most importantly, the analysis of unsustainability even though it is a low-probability event. Since insolvency and unsustainability is such critical events, I am interested in rather low probabilities of local governments ending up there. Thirdly, the model addresses the most

[4] Examples include Brazil in 1991, Russia in 1998-2001 and Argentina in 2001 (Liu & Waibel, 2008).

[5] There has long been a divide between European and American local government bankruptcy regulation. In 1975, no cities or local governments in Europe had the legal possibility to go bankrupt. The overwhelming expectation was that the central government would step in, which it did on numerous occasions, not least for the City of Rome in 1973 (Farnsworth, 1975).

important endogeneity concerns in the sense that the dependent variables are *all* allowed to influence each other. More on this in the **Model** section.

The implications of methodology are that forecasts will be based on the interaction of debt, income, interest rates and welfare expenses of Swedish municipalities over the sample period 1998 – 2015. There are a number of statistical requirements that need to be fulfilled in order for the methodology to be valid, amongst others the absence of structural breaks and unit root variables. I return to this in the **Data-** and **Results** sections. Swedish municipalities are clearly entering unchartered waters, particularly if interest rates should reverse sharply in the near future. The present thesis aims to contribute with empirics relevant for the policy discussion of such unchartered waters, and to bridge the gap identified above in the academic literature.

Model

"Essentially, all models are wrong, but some are useful", George Box (1987)

The present thesis is interested in the evolution of local government debt in Sweden and whether or not the bearer municipalities are able to shoulder associated costs. There are 290 municipalities in Sweden; each with its own capital structure, financial strategy and economic fundamentals. This cross-sectional richness is what substantiates the model and the results of this thesis. The overall approach to the modelling of local government debt consists of a separation between structural variables, which are confined to vary *between* municipalities or groups of municipalities, and macro variables, which jointly determine the evolution of debt *given* the specific structural circumstances of each municipality. In short, a time-series panel data approach.

The joint *determination* of the evolution of debt warrants further qualification. The macro variables included in my model are costs of capital (r), welfare expenses (c), income growth (g) and the change in the stock of debt (d). I do not posit that costs of capital and welfare expenses *cause* accumulation of debt in the same way that the decision to build a new hospital does. The joint determination of the accumulation of debt is more related to the concept of Granger causality in that costs of capital, welfare expenses and income growth contain useful information if we want to forecast what debt accumulation will be the following year. And vice versa. Debt accumulation typically affects the credit worthiness of the debtor, which in turn influences its cost of capital, for example. This information is useful if we want to forecast the cost of capital.

The way in which the macro variables are related to each other is then allowed to vary from municipality to municipality. For a concrete example, the welfare expenses of big city municipalities with their own capital markets programmes tend to be more interest rate sensitive than those of countryside municipalities that primarily rely on loans from public institutions. The structural variables, like economic fundamentals, geography and present stock of debt, are what cause differences in the evolution of debt between individual (and groups of) municipalities. Therefore, this investigation estimates a benchmark model with panels of individual municipalities and a final model with panels of groups of municipalities. While other scholars restrict the relationships between the macro variables to be identical across panels (Zettelmeyer et al., 2017; Tanner & Samanke, 2006), I let mine vary between different groups of municipalities.

The overall approach to answering the research question *"are Swedish municipalities on a sustainable debt path?"* requires that I forecast the evolution of debt for an adequate time period, judging whether each municipality satisfy a sustainability condition or not. I construct a panel vector auto-regression (VAR) model, in line with the qualities described above, for this purpose. Using a stable grouping of municipalities, I then estimate and forecast the model. I construct one unconditional forecast and one forecast that is conditional on an a continuous rise in interest rates up until 2022. This is important for two reasons. Firstly, because debt accumulation during the current period of low interest rates has been significant and whether municipalities can shoulder higher (probable) interest rate expenses is critical to the investigation. Secondly, because interest rates (excluding the spread for each individual municipality) is beyond the control of the subnational entities. Though their cost of capital is determined, amongst other things, by their financial strategy, municipalities essentially just need to *react* to exogenous factors like the repo rate of the central bank. The section about Granger causality (**Results**) demonstrates that conditional forecasts are justified from an empirical perspective. This overall methodology allows me to analyse which municipalities run into debt issues for different interest rate scenarios, and make cautious inferences as to why that might be. The equation below represents a baseline model.

$$BY_{it} = \Gamma_1 Y_{it-1} + \Gamma_2 Y_{it-2} + \cdots + \Gamma_p Y_{it-p} + u_i + \varepsilon_{it} \quad (1)$$

Where the subscripts *i* and *t* denote panel *i* and time *t*, respectively; Y_{it} is a *1xk* vector of dependent variables:

$$Y_{it} = \begin{bmatrix} r_{it} \\ g_{it} \\ c_{it} \\ d_{it} \end{bmatrix}$$

Consisting of the macro variables cost of capital r in percent, income growth rate g in percent, welfare expenses c as a fraction of total income and net percentage change to the debt stock d (*k=4*); u_i is a *1xk* vector of fixed effects specific to each dependent variable; e_{it} is a *1xk* vector of idiosyncratic errors. $\Gamma_1,\ldots,\Gamma_p$ are *kxk* matrices with parameters to be estimated, that describe the relationships between the dependent variables. The *kxk* matrix B is an upper-diagonal matrix with assumptions about the simultaneous variation of the dependent variables that allows the system of equations to be fully identified. The error terms e_{it} ideally need to satisfy three conditions:

1. $E[\varepsilon_{it}] = 0$
2. $E[\varepsilon'_{it}\varepsilon_{it}] = \xi$
3. $E[\varepsilon'_{it}\varepsilon_{is}] = 0$ for all $t > s$.

These ensure that the parameters can be efficiently estimated using different techniques, given a suitable dataset. Results from tests of these assumptions are presented in the **Results** section. The *structural* variation is caught in the fixed effects term, u_i, which would account for things such as metropolitan – rural divides, different levels of auxiliary income etc. Since these structural factors remain *fixed* for each local government, the estimated coefficients $\Gamma_1,\ldots,\Gamma_p$ can be used to forecast values of the dependent (*macro*) variables. This is trivial, since only lagged values, error terms that equal zero in expectation and estimated parameters figure on the right-hand side of equation (1). I use a general method of moments (GMM) procedure developed by Abrigo & Love (2016) to estimate equation (1) as a *benchmark* model. The benefits of GMM is that the procedure is generally more robust to endogeneity like reverse causality than OLS. The programs developed by Abrigo & Love (2016) also allow the estimation of u_i for the full sample. However, the main drawback is that the coefficients are not allowed to vary between panels. The exposition below will show that the coefficients are critical in determining the long-term forecasts. The method is also quite weak for panels with short time-dimensions and complicates the forecasting procedure significantly.

To be able to adequately forecast the evolution of debt, I thus need to change my specification as to allow the estimated parameters $\Gamma_1,\ldots,\Gamma_p$ to change across panels, as well as to face the short time-dimension for which data is available. Instead of running a panel-VAR for the nation, I group municipalities according to structural variables and run separate, normal VARs for each of the groups, stacking the data adequately and allowing both heterogenous parameters and fixed effects across groups. The model is represented by equation (2).

$$BY_{it} = \Gamma_{1i}Y_{it-1} + \Gamma_{2i}Y_{it-2} + \cdots + \Gamma_{pi}Y_{it-p} + u_i + \varepsilon_{it} \tag{2}$$

Where *i=[1,…,9]* now denotes each of 9 groups of municipalities. There are several important differences between equations (1) and (2). Firstly, the coefficients $\Gamma_{1i},\ldots,\Gamma_{pi}$ now depend on what panel we are looking at. Secondly, although u_i looks the same, the interpretation of this terms has changed because we have changed what each panel consists of. Previously, the fixed effects were allowed to vary for each municipality. But in the new model they are only allowed to vary across groups. Because I now estimate the model as a VAR for each group there are restrictions put on the parameters *within* groups – the coefficients $\Gamma_1,\ldots,\Gamma_p$ and the fixed effects u_i are restricted to be identical for municipalities in the same group, but the can vary between groups. Peseran et. Al (1999) have previously suggested one way of dealing with bias arising from heterogenous coefficients in panel-VAR estimations by allowing for homogeneity within pre-specified groups. And while there is no parametric way to test whether the within-group restrictions imposed are valid in the context of my model, I use my *benchmark* model to test the adequacy of the restrictions.

Benchmarking aside, the grouping of the 290 municipalities nevertheless becomes extremely important. Municipalities in the same group ideally need to be similar in respects relevant for the accumulation of debt, *except* the values of the macro variables. The cost of capital is allowed to vary freely between municipalities in the same group, and such variation can send signals of numerous differences. But the impact of a 5% hike in the cost capital on debt accumulation needs to be similar in municipalities in the same group, assuming that they have identical values for the remaining macro variables. The bottom line model that allows for significant short-term variation *within* groups, but in which the long-run equilibrium, e.g. the forecasted value of indebtness in 2030, is predominantly determined by the parameters estimated for the group as a whole, *and* the starting value of the macro variables for the municipality in question. Hence the importance of selecting an adequate and stable grouping. The present thesis uses an established and stable grouping by *Sveriges Kommuner och Landsting,* based on economic fundamentals, described in further detail in the **Data** section.

I transition to a grouped VAR model for four reasons. 1. It will enable me to pinpoint the structural variation and what differs between panels. The potential issue of geographic interdependency is mitigated by the fact that municipalities are grouped according to economic fundamentals. 2. It will enable heterogenous coefficients across panels. 3. The nature of Swedish municipalities is such that many of the 290 face similar economic challenges and are relatively similar in economic respects from a high-level perspective. Aggregation, of course, obscures many finer details. But similar types of datasets and groupings are available in other countries than Sweden, which is why my methodology might be interesting to develop and apply to other countries for an international perspective. 4. It allows me present results in a comprehensible and informative way.

I developed my model to suit the panel data obtained from local government balance sheets and income statements, which rightly infers an element of "fitting the model to the data". The question is, when do we not? In the spirit of the above quote from American statistician George Box, I strive to make my model *useful.* What follows is a mathematical exposition of my grouped VAR model and associated robustness tests, for which results are reported in the **Results** section.

Mathematics

"Hired an odd-job man to do 8 jobs for me. When I got back he had only done jobs 1,3,5 and 7."

Consider a rearrangement of equation (2) for group *i* where both sides have been pre-multiplied with the inverse of B:

$$Y_t = Y_{t-1}A_1 + Y_{t-2}A_2 + \cdots + Y_{t-p}A_p + \gamma + e_t$$

Where $A_1 = B^{-1}\Gamma_1$, $\gamma = B^{-1}u$ and

$$e_t = \begin{bmatrix} e_{1t} \\ e_{2t} \\ e_{3t} \\ e_{4t} \end{bmatrix} = B^{-1}\varepsilon_t$$

Standard OLS estimation methods can be used to obtain consistent estimates of the parameters and the residuals, because it can be shown that, for an adequately-restricted B matrix (Lütkepohl, 2005, page 358), that the new error terms, e_t, satisfy:

1. $E[e_t] = E[B^{-1}\varepsilon_t] = B^{-1}E[\varepsilon_t] = 0$
2. $E[e'_t e_t] = \Sigma$

With

$$\Sigma = \begin{bmatrix} \sigma_1^2 & \sigma_{12} & \sigma_{13} & \sigma_{14} \\ \sigma_{12} & \sigma_2^2 & \sigma_{23} & \sigma_{24} \\ \sigma_{13} & \sigma_{23} & \sigma_3^2 & \sigma_{34} \\ \sigma_{14} & \sigma_{24} & \sigma_{34} & \sigma_4^2 \end{bmatrix}$$

Where $\sigma_1^2 = var(e_{1t})$ and $\sigma_{12} = cov(e_{1t}, e_{2t})$. In order for the system to be fully identified we need to place $k(k+1)/2$ restrictions, which is typically done through a Wold causal ordering. In my model, this translates to restricting the elements of the B matrix as follows:

$$B = \begin{bmatrix} 1 & 0 & 0 & 0 \\ b_{21} & 1 & 0 & 0 \\ b_{31} & b_{32} & 1 & 0 \\ b_{41} & b_{42} & b_{43} & 1 \end{bmatrix}$$

I.e. the diagonal elements are restricted to unity and the elements above the main diagonal are restricted to zero (a total of 4(4+1)/2=10 restrictions). While the restrictions are crucial for the identification of the model, they also need to be deeply rooted in economic theory because there is no robust way to test what restrictions should be placed parametrically (Enders, 2015, page 313). As noted by Enders, two of the foremost advantages of adopting a Wold causal ordering are improved precision of the estimates and decreased forecast-error variance, as compared to the over-parameterised unrestricted VAR model. Since the present thesis is primarily interested in forecasting, these advantages weight in heavily on the choice of model.

The restrictions on the B matrix imply that some, but not all, of the variables can have simultaneous effects on the others. Specifically, the cost of capital r is allowed to simultaneously affect all other variables; the local government income growth rate g is allowed to affect the debt accumulation d and welfare expenses c, welfare expenses is only allowed to affect debt accumulation simultaneously, and debt accumulation is only allowed to affect the other variables in future periods, since $Y_t = [r_t \ g_t \ c_t \ d_t]'$. I will attempt to justify these restrictions by arguing why the relevant variable *cannot* affect the others simultaneously:

1. d_t. Debt accumulation measures the percentage change in the end-of-year debt stock (per capita) compared to the previous year. Hence, d_t should intuitively have no simultaneous effect on g_t, the income growth rate observed during the same year, because legally Swedish municipalities are not allowed to finance current expenditure with debt. Typically, the investment projects undertaken using debt finance will yield additional income in future periods. Neither should d_t affect r_t simultaneously, because interest rate expenses and additional costs of capital are typically realised in the periods subsequent to when the debt was incurred. Lastly, d_t should not affect c_t simultaneously because c_t includes only current spending on welfare services, which should only be affected by investment projects (new schools, hospitals etc.) with a lag.
2. c_t measures the current spending on welfare services as a fraction of total income. This normalisation allows informative comparison across municipalities and facilitates the controlling or demographics, on which more is said below. c_t should not affect the income growth rate g_t simultaneously because spending decisions are typically taken on the basis of municipal income from last year, signifying that expenses follow income and not the other way around. The strict budget balancing requirement imposed on Swedish municipalities put extra weight on this type of income-based budgeting. It is possible to think of examples where higher welfare spending in a given year leads to additional income if the welfare spending e.g. draws attention and tourism from outside the municipality, but I nonetheless assume that such factors can be neglected. Neither should c_t affect r_t simultaneously since the cost of capital is primarily determined by interest rates and the capital structure of the municipality in previous periods.
3. g_t is posited not to have simultaneous effects on the cost of capital r_t because risk premiums and the interest rates that local governments pay on their debt only react to higher/lower income with a lag. Looking at the municipalities that issue their own bonds, we see that the average maturity is around 2 years and most bonds have fixed coupons. For such financial instruments, income growth would only affect the cost of capital in future periods. Furthermore, the interest rates municipalities pay on the long-term (typically 5-10 years) loans obtained from commercial banks and public agencies would not react to current income growth.

A critical thing to note is that the covariances of the error terms in e_t are not restricted to zero, meaning that e.g. a general *shock* to income growth in Sweden can be associated with an immediate *shock* to interest rates. But the variation goes through the error term. Higher income growth, all other things equal, does not influence the cost of capital in the current period. Zettelmeyer et al. (2017) uses a similar causal ordering.

The estimation of equation (2), which is rewritten below in concise matrix notation, is conducted with OLS and the conditions imposed on the error terms e_t ensure consistent, unbiased estimates of $A_1,\ldots, A_p$ (Lütkepohl, 2005, page 72).

$$Y_t = AZ_{t-1} + e_t \qquad (3)$$

Where $A = [\gamma \;\; A_1 \;\; A_2 \;\; \ldots \;\; A_k]$, a *4x(4k+1)* matrix, and

$$Z_{t-1} = \begin{bmatrix} 1 \\ Y_{t-1} \\ \vdots \\ Y_{t-p} \end{bmatrix}$$

Which is a *(4k+1)x1* column vector. Post-multiplying equation 3 with $Z_{t-1}{'}$ and taking expectations gives

$$E[Y_t Z_{t-1}{'}] = AE[Z_{t-1}Z_{t-1}{'}]$$

Which we estimate with

$$\frac{1}{p}\sum_{t=1}^{p} Y_t Z_{t-1}{'} = \frac{1}{p}YZ'$$

$$\frac{1}{p}\sum_{t=1}^{p} Z_{t-1} Z_{t-1}{'} = \frac{1}{p}ZZ'$$

Where Z is the *(4k+1)xp* matrix $Z = [Z_0 \;\; Z_1 \;\; \ldots \;\; Z_{p-1}]$ and Y is the *4xp* matrix $Y = [Y_1 \;\; Y_2 \;\; \ldots \;\; Y_p]$. Through estimation of A by $\hat{A}$ we obtain:

$$\frac{1}{p}YZ' = \hat{A}\frac{1}{p}ZZ'$$

And, hence, the estimator is $\hat{A} = YZ'(ZZ')^{-1}$.

However, the VAR model needs to be stable if the estimation is to yield consistent estimates. The stability conditions are derived below. Consider a variant of equation (3) in which the constant has been broken out of the A and Z matrices:

$$Y_t = \gamma + \acute{A}\acute{Z}_{t-1} + e_t$$

Where $\acute{A}$ and $\acute{Z}_{t-1}$ are now *4x4k* matrices. Writing out the variable Y_t for each period in the sequence we obtain:

$$Y_1 = \gamma + \acute{A}\acute{Z}_0 + e_1$$

$$Y_2 = \gamma + \acute{A}\acute{Z}_1 + e_1 = \gamma + \acute{A}\left(\gamma + \acute{A}\acute{Z}_0 + e_1\right) + e_2$$

$$\therefore \qquad Y_2 = (I_4 + \acute{A})\gamma + \acute{A}^2 \acute{Z}_0 + \acute{A} e_1 + e_2$$

$$\dots$$

$$Y_t = (I_4 + \acute{A} + \dots + \acute{A}^{t-1})\gamma + \acute{A}^t \acute{Z}_0 + \sum_{i=0}^{t-1} \acute{A}^i \, e_{t-i}$$

Since we are interested in forecasted values of Y_t which in theory can extend beyond an infinite time horizon, we need to convince ourselves that the above expression is summable. Otherwise the sequence can be explosive and estimation would not yield consistent estimates. This is guaranteed if all the eigenvalues of $\acute{A}$ have modulus less than 1 (Lütkepohl, 2005, Appendix A, Section A.9.1). If these conditions are satisfied, $\acute{A}^{\,t}$ converges to zero rapidly as $t \to \infty$. Tests of the stability condition will be reported for each version of the model in the **Results** section. If assuming an infinite starting period, this allows us to write the VAR in vector moving average form:

$$Y_t = \mu + \sum_{i=0}^{\infty} \acute{A}^i \, e_{t-i}$$

This representation is interesting because it signifies that the dependent variables approach some equilibrium given by $\acute{A}$, γ and $\acute{Z}_0$ in the absence of shocks. While this is clearly an idealistic scenario, it does have significance for the present thesis since the primary objective is to forecast Y_t and shocks are zero in expectation. In fact, we can ignore the term $\acute{A}^t \acute{Z}_0$ in the limit and it is possible to show, for $t \to \infty$, that $\mu = (I_4 - \acute{A})^{-1}\gamma$. The long-term and forecasting equilibria are given by the estimated coefficients and the estimated fixed effect, which is why the importance of allowing different coefficients for different groups of municipalities was noted above.

We can use the vector moving average representation of the VAR to get the forecast errors. This is also of primary interest to the present thesis, since it seeks to evaluate long-term, forecasted debt sustainability. Suppose that we are interested in forecasting Y_t starting in period h.

$$E_h[Y_t] = E\left[(I_4 + \acute{A} + \dots + \acute{A}^{t-h})\gamma + \acute{A}^h \acute{Z}_h\right] + E\left[\sum_{i=h}^{\infty} \acute{A}^i \, e_{t-i}\right]$$

Or, to simplify matters a bit

$$E_h[Y_t] = E[\mu] + E\left[\sum_{i=h}^{\infty} \acute{A}^i \, e_{t-i}\right] = \mu$$

The forecast error is consequently

$$Y_t - E_{t-1}[Y_t] = \sum_{i=h}^{\infty} \acute{A}^i \, e_{t-i}$$

If we are able to assume, and qualify, that the error terms e_t are normally distributed, then the forecast errors will also be multivariate normal since they are a linear transformation of a normally distributed sequence. This is what allows the present thesis to construct confidence intervals around the point forecasts, which is important for two reasons. Firstly, I want to be able to demonstrate at least the *known* uncertainty around the forecast within the context of my model. Secondly, the question asked is about the sustainability of local government finances. Because unsustainability, or even insolvency, is a cataclysmic event with serious repercussions for the provision of welfare services, I am interested in relatively low probabilities that such an adverse scenario will occur. The seriousness of the situation warrants looking at unsustainable debt pats, even if they only occur with a probability of e.g. 0.2.

Implicit assumptions, robustness tests and potential sources of endogeneity

A number of robustness tests are performed and reported in the **Results** section. While I refer to other authors for their derivations, I will outline the significance of the tests for the model described above. Firstly, all variables included in the model are tested for unit roots, using augmented Dickey-Fuller tests (Enders, 2015, page 206) and the Harris-Tzavalis test for the *benchmark* panel-VAR (Harris & Tzavalis, 1999). In the presence of unit roots, a VAR risks becoming unstable. There is some disagreement around whether variables that *do* contain unit roots should be differenced in order to appear stationary (Enders, 2015, page 291). Sims et al. (1990) argues *against* differencing because it obscures variation in the data. A stable VAR implies that the system as a whole is stationary, but individual variables may still contain unit roots. For the purposes of this investigation, I will go with the majority view and require the dependent variables to be stationary. I suspect this to be of importance since the investigation is geared towards forecasting and conditional forecasting, which should necessitate a stationary system even though the future realisations of one of the variables (r) are stipulated outside of the model. Having stationary variables also significantly simplifies testing for Granger causality, which is a critical stepping stone in the context of making my model *useful.*

Granger causality is analysed by conducting a F-tests on the coefficients $A_1,\ldots, A_p$. The aim is to discover whether lagged values of one variable contains information that is useful for the forecasting of other variables. As such, the null hypothesis posits that

$$a_{21}^1 = a_{21}^2 = \cdots = a_{21}^p = 0$$

Where a_{21}^p is the first element in the second row of the matrix A_p. This particular null hypothesis stipulates that r *does not* Granger cause g in the context of my model, and, ideally, it should be rejected. The same test is then run iteratively for all variables in the model.

Another critical stepping stone in making the forecasts reliable is that we should ideally have no structural breaks in the sequences. The methodology developed in this thesis hinges on a separation of structural variables and macro variables, the former being confined to the cross-sectional dimension – to vary across municipalities. The grouped VAR model would become less useful if it turned out that there is a structural break in one group but not the others, e.g. big cities completely change their financing strategy or income patterns after the financial crisis of 2008. While singular events can be discussed and analysed, unobserved and unexplained structural breaks are negative for at least two reasons. Firstly, they diminish the time horizon for which we have useful information to conduct the forecast. Secondly, if unobserved, they bias the estimates towards the old state of affairs. Another complication arises from the fact that I need to stack my data in order to estimate a VAR for 20 – 60 municipalities, depending on the group. Therefore, I cannot use a standard test for a structural breakpoint, such as the Chow (1960) test (for discrete breaks with known t). I again need to rely on non-parametric tests to assert that the VARs are stable and valid. Further attention to this fact is given in the **Results** section.

The model developed does entail a few hidden assumptions, primarily about demographics, inflation and amortisation. Demographics are abstracted from in the sense that all macro variables are normalised with respect to municipality income per capita (except the cost of capital which is in percentage points). By this design, there is no direct, causal effect of a population increase/decrease on any of the macro variables in the model. However, the variables could be correlated with one or multiple lags. Insofar as demographic changes occur *within* groups of municipalities this could create issues in the sense that my model is blind to such variation. However, the grouping mitigates such issues since it is partly based on the population of each municipality. Furthermore, the grouping is based on a more holistic measure of demographics than the crude size of the population. At an aggregate level, I would thus argue that the abstraction is adequate so long as we keep demographics in mind in the interpretation of the results.

All variables included in the model are in real terms, with underlying variables having been deflated with respect to the base year of 1998. This achieves a similar abstraction from inflation. For a model forecasting the debt of a sovereign state it would be an unsuitable abstraction, because many central governments have some degree of influence over monetary policy and could thus use expansionary monetary policy to "inflate away" debt. Such a strategy is not available to local governments. It is very unlikely, unless a major, structural crisis occurs (which the present model would miss, anyway), that the central government of Sweden embarked on a strategy to inflate away local government debt, especially since the Riksbank has independent control over monetary policy. This implies that the conditions faced by local governments in the context of my model are *real*, including the cost of capital.

The amortisations schedule is endogenised by the fact that the model uses the *net* percentage change in the debt stock, i.e. the new debt minus debt paid off as a fraction of total debt outstanding. By this method, the model forecasts future debt levels based on the historical amortisations schedule. The amortisations schedule could drastically change in the future in response to some new centrally imposed regulation, but so could the way in which municipalities finance their investments. Such uncertainty is related to structural breakpoints, discussed above. The objective of the current thesis is to assess debt sustainability *given* that the current institutional framework stands. Should debt accumulation prove to be unsustainable under the current framework, that would give reason to change it. Conversely, atypical local government behaviour should be monitored and the results of this thesis should be disregarded if there is overwhelming belief that a structural break is about to occur.

Omitted variables are a major concern for the type of investigation conducted in this thesis. Even though some parametric tests are indicative of a complete specification, like testing if the estimated residuals are white noise, omitted variables could theoretically still hide in the error term. Hypothesising variables that are correlated with the two or more of the dependent variables is possible. Examples include the number of inhabitants, if welfare expenses per capita can be expected to decrease with the size of the population while economic growth is increased. My model hinges on that this variation is picked up by the grouping of the 290 municipalities into 9 groups. Other omitted variables could potentially include levels of education and whether public transport expenses are picked up by the central government with different geographic weights. As with other macro-level VAR models (McCarty & Schmidt, 1997; Shan, 2005), I refrain from any direct causal inferences and focus instead on correlation and whether the dependent variables can help predict each other. For this purpose, the error terms need to be well-behaved as to exclude any major biases resulting from omitted variables. But the investigation is *not* able to conclude that any such variables do not exist.

The present thesis aims to analyse the sustainability of local government debt levels *ex ante* using a grouped VAR methodology and associated forecasts. This model was selected on the basis of its promise to fulfil the requirements of long-term, dynamic forecasting ability and separation between structural variation across groups of municipalities. The model imposes two, main restriction that are evaluated in the **Results** section, pertaining to structural breaks and coefficient homogeneity *within* groups. It also puts a number of requirements on the data and estimated residuals, like variable stationarity. In order to ascertain internal validity, these requirements are analysed below. External validity and policy implications are discussed at the end of the **Results** section.

Data[6]

Swedish institutions and context

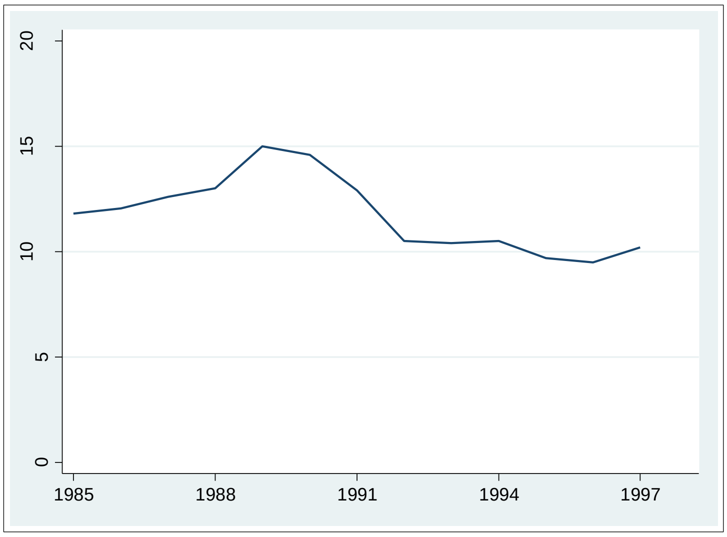
A Swede was asked if she had lived in Stockholm all her life. "Not yet," she answered.

The financial crisis of 1991/1992 precipitated a wholesale reform and significant new regulation that governs public finances, both local and national, to this day. Before 1995, municipalities suffered worse financial positions and constituted a drain on national fiscal resources (Heikensten, 1998). There were instances local

[6] All data in this thesis is from Statistics Sweden, unless otherwise noted.

government politicians and leaders of government agencies even requested more funding in national media. These requests were, because of their political nature, difficult for the central government to ignore. It was recognised that the opportunistic budgeting behaviour needed to be combated and new guidelines were necessary to consolidate local government finances (SOU, 2011). Figure 1 shows the fraction of total public sector debt held by municipalities over time. Part of the hike observed between the years 1988 and 1991 would be explained by sharply increased central government debt, but the absolute value of central government debt started to decrease in 1994. The sequence hints at a structural change in local government debt accumulation vis-à-vis the level of total public sector debt around 1990 – 1991.

FIGURE 1: LOCAL GOVERNMENT DEBT (% of public sector debt)



Source: Author's rendition of Statistics Sweden (2017).

Among the most significant pieces of regulation introduced was a budget balancing requirement (BBR) for Sweden's 290 municipalities. The BBR constitutes one of three institutional features of high significance for the present thesis, together with a central income equalisation system and the high degree of devolution. The high degree of municipal autonomy was outlined in the **Motivation** section. Through devolution, municipalities have become responsible for the provision of welfare services including schooling, public transport, water and sewers, social services, some health care and emergency services. Some of these services are required by law and others are voluntary (SFS, 1991). Municipalities have legal authority to levy taxes and set marginal income tax rates, which vary from 35.15% (Dorotea municipality) to 29.20% (Solna municipality). The high degree of autonomy is what justifies the inclusion of welfare expenses, income and debt accumulation as *dependent* variables.

Devolution to local levels can create principal-agent issues if local government *expects* the central government to intervene in times of financial need (Ianchovichina et Al., 2006). Oftentimes, this is not an irrational expectation, which implies that the central government needs to set up governing mechanisms such that municipalities do not budget with the expectation of getting bailed out. This is where the BBR enters the institutional framework. More explicitly, it functions through requiring municipalities to budget higher income than expenditures in every given year. Exceptions are granted for extraordinary circumstances after a change to the municipal law in 2012 (SFS 1991). Moreover, if the *realised* budget incurs a deficit, it needs to be recovered during the three years immediately following the deficit. The BBR contributes to the present investigation in two ways. Firstly, it hints at a suitable condition for sustainability. Local governments are free to incur whatever debt they like as long as interest rate expenses can be covered under the BBR. Given that they are mandated to provide a certain level of welfare services, an *unsustainable* debt burden would imply that welfare- and interest rate expenses exceed annual income. Secondly, it makes the grouped VAR analysis more robust since no municipalities within the same group run sustained, unfinanced deficits (the model would be sensitive to such structural variation *within* groups).

The third important institutional feature is the income equalisation system[7]. This municipal transfer system effectively ensures that all 290 municipalities have roughly the same level of *tax income* per inhabitant. It is operated by the central government that requires municipalities with a tax base for income taxes significantly stronger the national average[8] to pay transfers to the central system. These resources are then augmented with large, central government transfers to be distributed among the municipalities according to their tax base for income taxes. The result is a situation in which all municipalities have a tax base for income taxes of 115% of the national average (SKL, 2008). The municipalities are then allowed to set their own marginal tax rates, which results in total income varying from roughly 50 000 – 70 000 SEK per inhabitant in 2015. A first idea for this investigation was to use exogenous variation in central government transfers to draw inferences for indebtness. However, the absence of such a case, the equalisation system at least mitigates a confounding factor within the groups of municipalities.

Grouping

The conflicting demands for an adequate grouping becomes a challenge. We need something that confines structural variation, like demography and income levels after subsidies, to the cross-sectional dimension – to vary across groups and not within. We need a grouping in which municipalities with similar investment needs are placed in the same group. For example, the three big cities of Stockholm, Gothenburg and Malmö may want to invest in an underground rail system, which would make their investment need higher vis-à-vis countryside municipalities. Furthermore, we need a grouping that has been stable over the sample period and is likely to remain stable over the forecast horizon. This last fact limits the set of available candidates and gives extra credibility to groupings constructed by public agencies, since changes to those groupings are *well-documented*.[9] The Swedish Association of Local Authorities and Regions (SKL) produces the most established grouping of the 290 municipalities. It is based on 9 categories, listed below. The selection criteria

[7] Commonly referred to as the "Robin Hood" tax; the strong are supposed to cater for the weak. Although, the present system seems a little less thrilling than the original myth. I have never met a local government politician with superhuman skills at the bow and arrows.
[8] Translating to municipalities with many high-income earners. Stockholm and some commuter municipalities in the vicinity are good examples, where the tax base is around 115% of the national average.
[9] The investigative effort required to design a tailored grouping, documenting all the changes over 18 years of data for 290 municipalities, is beyond the scope of this investigation. Particularly because I suspect the result of such an investigative effort to be similar to SKL's already established grouping.

are given in the sub-points to each group. The parenthesis after the group names gives how many municipalities are in that group.

1. A1 – Big city municipalities (3)
    a. At least 200 000 inhabitants in the main urban centre
2. A2 – Commuter municipalities near big cities (43)
    a. At least 40% of the inhabitants commute to A1
3. B3 – City municipalities (21)
    a. At least 40 000 and at most 200 000 inhabitants in the main urban centre
4. B4 – Commuter municipalities near cities (52)
    a. At least 40% of the inhabitants commute to B3
5. B5 – Low-commuting municipalities near cities (35)
    a. Less than 40% of the inhabitants commute to B3
6. C6 – Smaller city municipalities (29)
    a. At least 15 000 and at most 40 000 inhabitants in the main urban centre
7. C7 – Commuter municipalities near smaller cities (52)
    a. At least 30% of the inhabitants commute to a smaller C6
8. C8 – Countryside municipalities (40)
    a. Less than 15 000 inhabitants in the main urban centre, limited commuting
9. C9 – Countryside municipalities with a tourism industry (15)
    a. Countryside municipalities with a certain level of guest nights at hotels and revenue in hotels/restaurants/retail per inhabitant.

Clearly, the grouping is based on variables relevant for this investigation – demographics and primary economic activity. Several other variables, like investment needs, income levels, the cost of welfare service provision per capita and levels of higher education are correlated with those that define the selection criteria, which should eliminate *some* of their structural variation within groups. Figures 2, 3 4 and 5 show the average cost of capital, debt per capita, income per capita and welfare expenses of each group of municipalities, respectively. Structural differences between the groups of municipalities are evident from these graphs. Second-tier cities (B3) have a significantly higher debt per capita compared to most other groups. They also have amongst the highest income per capita. Commuter municipalities near big cities have amongst the lowest income per capita, but also the lowest debt level. The costs of capital are higher in city municipalities (A1 & B3), who often have their own capital markets programs, in the beginning of the sample period but they converge to 2% towards the end of the sample period. Commuter municipalities (A2, B5, C7) and countryside municipalities (C8, C9) need to devote larger fractions of their income to welfare expenses, as compared to city municipalities. A list of the complete grouping can be found in Appendix A6.

Furthermore, SKL's grouping has been stable over the sample period in the sense that most municipalities would fall into the same categories in 1997 as in 2015, allowing for an aggregate increase in the Swedish population (SKL, 2017). Even so, there was a significant revision of SKL's grouping in 2011, when the category "industrial municipalities" was taken away. This category had been losing members since the 1990s and the overwhelming majority of the municipalities were incorporated into groups B5 – C7. The removal of the category is not a problem in itself, so long as the municipalities that were distributed to groups B5 – C7 would have been assigned to the same groups in the absence of "industrial municipalities" in 1998, at the start of my sample. An argument could be made to say that the category "industrial municipalities" contains useful information for the grouped VAR model in this thesis. And I agree, it is probable that it would. However, given that the group has diminished so quickly in size it is unsuitable to include in a long-term forecast.

There is one other grouping that can contend with SKL's in terms of stability, created by the Swedish Agency for Growth Analysis. This grouping, FA15, is based on geographic employment areas. Stability is an explicit purpose of the grouping since it is used to forecast regional growth patterns. However, what makes the grouping incompatible with the kind of analysis conducted here is the fact that it is primarily based on geography. Thus, commuter municipalities would be grouped together with cities and big cities, even though they have different economic fundamentals, just because they are adjacent. This is undesirable, since I suspect debt accumulation, growth, costs of capital and welfare expenses to be more influenced by economic fundamentals such as primary economic activity and demography. SKL's grouping is therefore favoured over FA15.

Overall, SKL's grouping is selected on the basis that it is the best, established alternative. It is not perfect – in theory it is impossible to find a perfect grouping, since no two municipalities are identical in terms of the structural variables that I want to control for. This unsatisfying fact is consequence of my model, which needs to be mitigated as much as possible, with the aim to make the model useful.

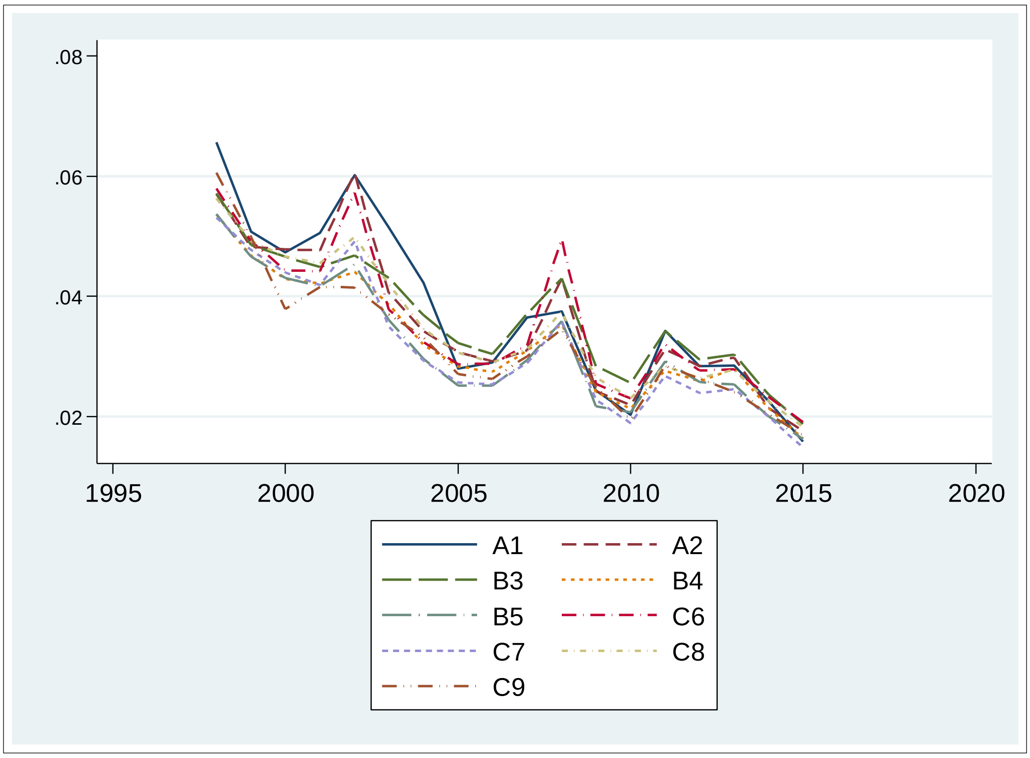
Variables and stationarity tests

"Why didn't the pen float across the paper? Because it was stationary"

The data used to estimate the model in thesis pertain to Sweden's 290 municipalities **and their wholly-owned companies**. The reason for including wholly-owned companies is simple – these companies often hold significant debts that are guaranteed, explicitly or implicitly, by the municipalities. A typical example was exposed in the introduction, where debts of the wholly-owned housing company ended up in the lap of the municipality. Other types of companies include local government companies include waste disposal, housing, transport etc. The ultimate sources of the data are the annual accounts (both profit & loss and balance sheets) of the municipalities, gathered and cross checked by Statistics Sweden (*Räkenskapssammandragen 1998-2015*) (Statistics Sweden, 2017). The data runs from 1998 through 2015 and concerns the end-of-year, nominal stocks and flows. I deflate the data using the CPI of Statistics Sweden.

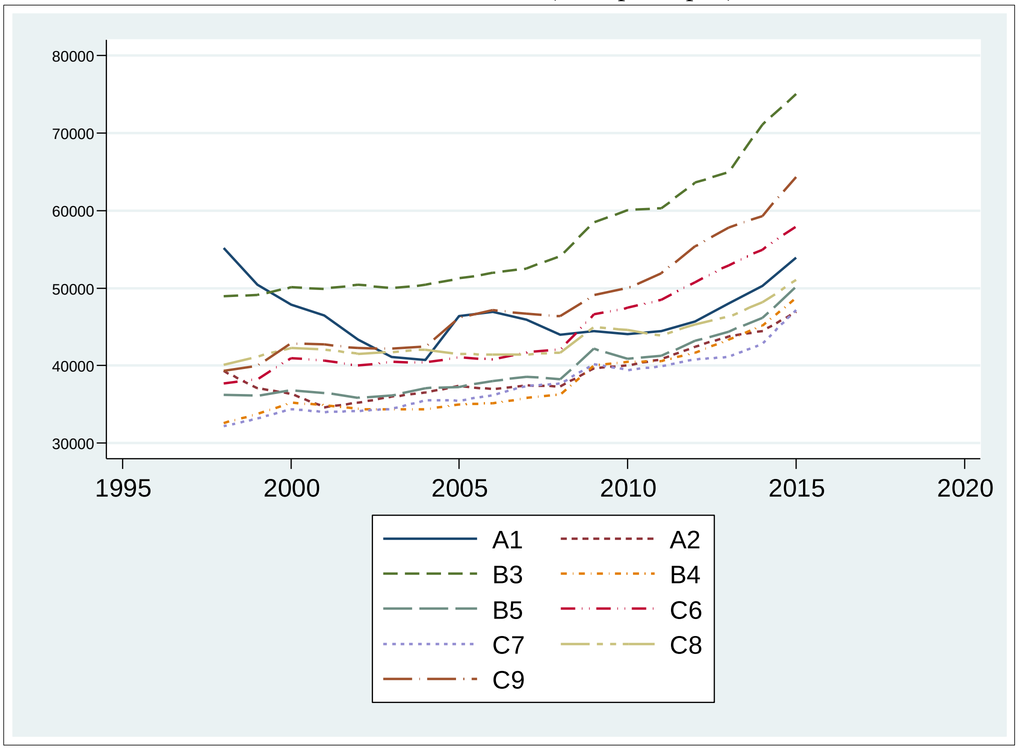
The following three figures display the raw data underlying the variables included in the models, averaged for each group of municipalities. I apologise for the low readability due to the fact that the figures include 9 different series. My intention is to give an intuition for how the series evolve and if any groups of municipalities stand out. It is quite remarkable how well the series follow each other. Costs of capital have fallen overall and the spread between the cost of capital of different groups has diminished over the sample period. The debt per capita is highest in city municipalities (B3), but these also have the highest income per capita, bar countryside municipalities, whose income per capita has increased partly because of urbanisation. Both debt and income per capita decreased sharply in the three big cities of Stockholm, Gothenburg and Malmö after high levels observed in the 1990s and subsequently with urbanisation. The welfare expenses as a fraction of income are also more variable in the three big cities.

FIGURE 2: AVERAGE COST OF CAPITAL (Fraction of outstanding debt)



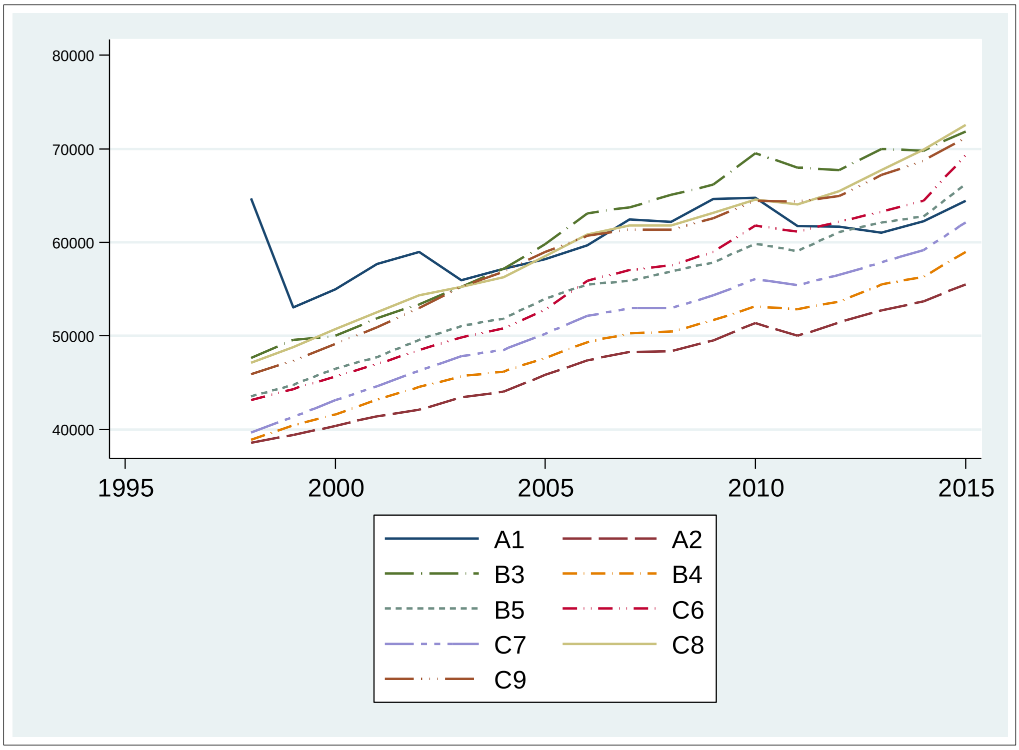
Source: Author's rendition of Statistics Sweden (2017) and own calculations

FIGURE 3: AVERAGE DEBT PER CAPITA (SEK per capita)



Source: Author's rendition of Statistics Sweden (2017) and own calculations

FIGURE 4: AVERAGE INCOME PER CAPITA (SEK per capita)



Source: Author's rendition of Statistics Sweden (2017) and own calculations

FIGURE 5: WELFARE EXPENSES (Fraction of income)

Source: Author's rendition of Statistics Sweden (2017) and own calculations

Measurement error is confined to limitations of data quality, given that I use no proxy variables. The quality of the data is generally high and few changes are made to how the data is gathered over the sample period (SKL, 2012). A few accounts are added and taken away from welfare expenses, but they are all comparatively minor. Below follows a more detailed list of the variables considered in this thesis.

1. Debt accumulation (d) – net change in the debt stock as a fraction of total end-of-year debt. The net change as a fraction of debt outstanding, and not the stock of debt, is considered for two reasons. Firstly, because the stock of debt only changes slowly over time and the municipalities are thus conditioned by their initial stock of debt in the estimation of the model. The present thesis is more interested in how debt has evolved over the sample period. Secondly, debt accumulation is stationery, as shown below. Instruments in foreign currencies are converted using the end-of-year exchange rate. Please note that the debt variable does not include certain forms of debt because of data limitations; specifically, pension liabilities and delayed maintenance costs. This is a limitation of the current scope of the investigation. It is suggested as a feasible extension and an area of further research. d is calculated on the basis of the following accounts.
    a. Financial instruments
    b. Loans from commercial banks
    c. Loans from public institutions
2. Cost of capital (r) – total annual financial costs as a fraction of end-of-year outstanding stock of debt. Note this is a more holistic and realistic variable than e.g. using interest rates on loans.

Financial costs include the items listed below. r has been cross-checked using a large sample of local government bonds from municipalities with open market programmes. The two datasets are coherent and costs of capital, with the exception of a few outliers, generally follows the repo rate set by the Riksbank $+ 1 - 4\%$. This spread is discussed in greated detail in the **Results** section.

a. Interest paid on short- and long-term debt
b. Coupons and issuance costs for international bonds

3. Welfare expenses (c) – annual costs for the provision of welfare services as a fraction of total income. Includes:
   a. Transfers paid to inhabitants
   b. Pensions and salaries (total workforce, including teachers, constructors, bus drivers etc.)
   c. Materials and rents for property
   d. Welfare services bought from external parties (private schools, IT infrastructure etc.)
   e. Realised losses at the sale of financial assets
4. Municipal income growth rate (g) – the annual growth rate of total municipal real income in percent. The growth, and not level of income, is considered for the same two reasons debt accumulation, and not stock of debt, is considered. Total income includes the following accounts. Since the purpose is to analyse long-term debt sustainability, extraordinary state aid/transfers are not included.
   a. Tax income
   b. Income from the equalisation system and other *regular* state and EU transfers
   c. Income from financial instruments and other financial assets
   d. Income relating to the sale of assets and services
   e. Rent for commercial property and housing
5. Total debt to income ratio ($d2y$) – total end-of-year debt divided by annual income, as defined above.
6. Primary balance of the municipality ($pbal$) – the end-of-year annual surplus/deficit of the municipality. This variable is used to cross-check the sustainability condition.

As discussed above, the model requires that the dependent variables are stationary. All are therefore tested for unit roots, using the augmented Dickey-Fuller test for the stacked data (grouped VAR model) – a set of tests for each group. The Ljung-Box test is used to ensure that the estimated residuals from the Dickey-Fuller are white noise. Full results can be found in Appendix A1. For every variable except the cost of capital in the group of big city municipalities (A1), the Dickey-Fuller test allows us to reject the null hypothesis of a unit root. Hence, the estimates and forecasts for the three big cities of Malmö, Stockholm and Gothenburg should be considered unreliable. These three cities account dor a significant fraction of aggregate local government debt in Sweden, but the unit root is of no consequence for the estimation of the VARs of the other groups.

The panel data fort the benchmark model is tested for unit roots using the Harris-Tzavalis (1999) test, since the time-dimension is rather short. The null hypothesis of a unit root can be rejected for all variables in the GMM benchmark model.

Lastly, the municipalities of Gotland, Nykvarn and Knivsta are dropped from the sample because of missing data. Being rather small municipalities in large groups, this should only have limited implications for internal validity.

Results

This section introduces the results produced by the model estimated for the full sample period as the baseline. It compares these results to the *benchmark* GMM model and goes on to analyse the general robustness of the model, using the tests outlined above. In the presence of a structural break, the sample is split and 3 groups are dropped because of unsatisfactory robustness. The model is estimated for the remaining 6 groups over the relevant time period, compared to the *benchmark* GMM model, and thus produces the bottom line results. Analysis and policy recommendations follow.

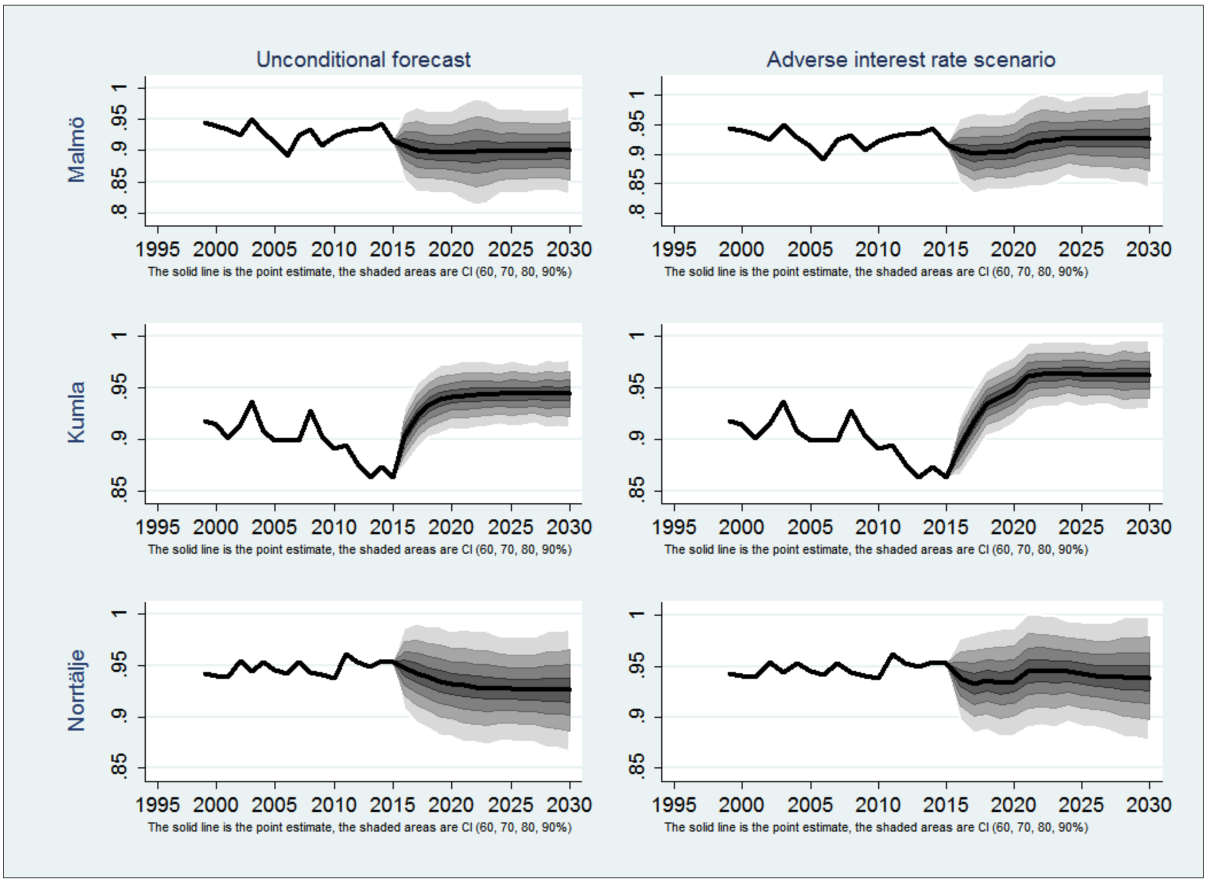
The Baseline

Figure 1 gives a flare of the results for the municipalities of Malmö, Kumla and Norrtälje[10]. The graphs show the sum of interest rate expenses and welfare expenses as a fraction of total income. Hence, a value exceeding one means that the municipality makes a deficit in that year, excluding extraordinary expenses. The area shaded in light grey, medium grey, grey and dark grey represent the confidence intervals 90%, 80%, 70% and 60%, respectively. The left-hand side graphs are the results of the unconditional forecast, where the cost of capital is determined endogenously. The right-hand side graphs are for an adverse interest rate scenario, where the cost of capital increases from 2% to 5.5% over the years 2016-2022.

The forecasts show higher expenses for all municipalities under the adverse interest rate scenario, amounting to 2 – 3 percentage points of total income (point forecast). This seems entirely according to intuition, if anything a little reassuring; the three municipalities are able to weather the relatively sharp increase in interest rates. The only municipality that runs a 5% chance of having a structural deficit towards the end of the forecast horizon is Malmö.

[10] These graphs have been generated for all 290 municipalities, by estimating the grouped VAR model for the relevant group of municipalities (Malmö – A1, Kumla – B4, Norrtälje – C6), and then fitting the forecast to the values of Malmö's, Kumla's and Norrtälje's macro variables in 2015.

FIGURE 6: INTEREST RATE AND WELFARE EXPENSES (Fraction of income)



Note: The panels show welfare and interest expenses as a fraction of income for the municipalities of Malmö, Kumla and Norrtälje, respectively.

Figure 6 illustrates one of two conditions used to analyse sustainability in this thesis. Because municipalities are very different from companies, and also very different from sovereign states, a tailored definition of sustainability is needed to truthfully assess the ability of the local governments to make good on their dues. The two observations that suggest the first sustainability condition is the BBR and the fact that municipalities in a devolved country like Sweden provide critical welfare services. This leads to a situation in which municipalities cannot sustain consecutive deficits (much like private companies) *but* neither can they cut the (welfare) expenses per capita too harshly (much unlike private companies). Hence, I stipulate that a debt accumulation that leads to the sum of interest rate expenses and welfare expenses *exceeding* total income is unsustainable, if the welfare expenses are roughly the same as in 2015. There are three aspects of this sustainability condition worth discussing in greater detail.

Firstly, the supposition that welfare expenses are supposed to be roughly similar to those in 2015 is purely hypothetical. Studying various projections for local government expenditures, which are often only available for the short term, it seems relatively clear that there is no consensus (ESV, 2016; SKL, 2016). However, in some areas like education and schooling, expenses are going to rise per capita over the next 5 – 10 years because of the large inflow of migrants up until the end of 2015. It is uncertain whether labour intensive services, which constitute the lion share of welfare expenses, will become cheaper or more expensive. Given a stagnant or stable productivity growth, there seems to be at least some risk of Baumol's disease. With this in mind, stipulating that welfare expenses should be kept at their 2015 levels, as a lower threshold, seems like a conservative threshold.

The second aspect worthy of deeper discussion is the fact that the condition sets a *low* bar for sustainability if one accepts the proposition made about future welfare expenses. The fact is that a host of municipalities have declared annual deficits during 1998-2015, *without* interest expenses and welfare expenses exceeding income, i.e. without breaking the sustainability condition. There are other expenses in the municipal budget which cause deficits and are more or less regular. Hence, breaking the stipulated sustainability condition signals something *bad*. Over the sample period, only 6 municipalities[11] broke the sustainability condition for two consecutive years, even though many municipalities had *substantial* debt burdens 1998-2001. The number of municipalities that were considered in compliance with the BBR grew from 30% to 60% over the same period (SCB, 2014, chapter 10).

Thirdly, since interest and welfare expenses only provide a snapshot of budget flows, they are best combined with a second condition for sustainability that incorporates stocks. Debt-to-income ratios are used for both private sector and public sector studies as they aptly capture the stock of debt in relation to the annual flow of income. In later forecasts, we will actually see that a non-insignificant[12] fraction of the groups of municipalities show explosive debt-to-income paths.

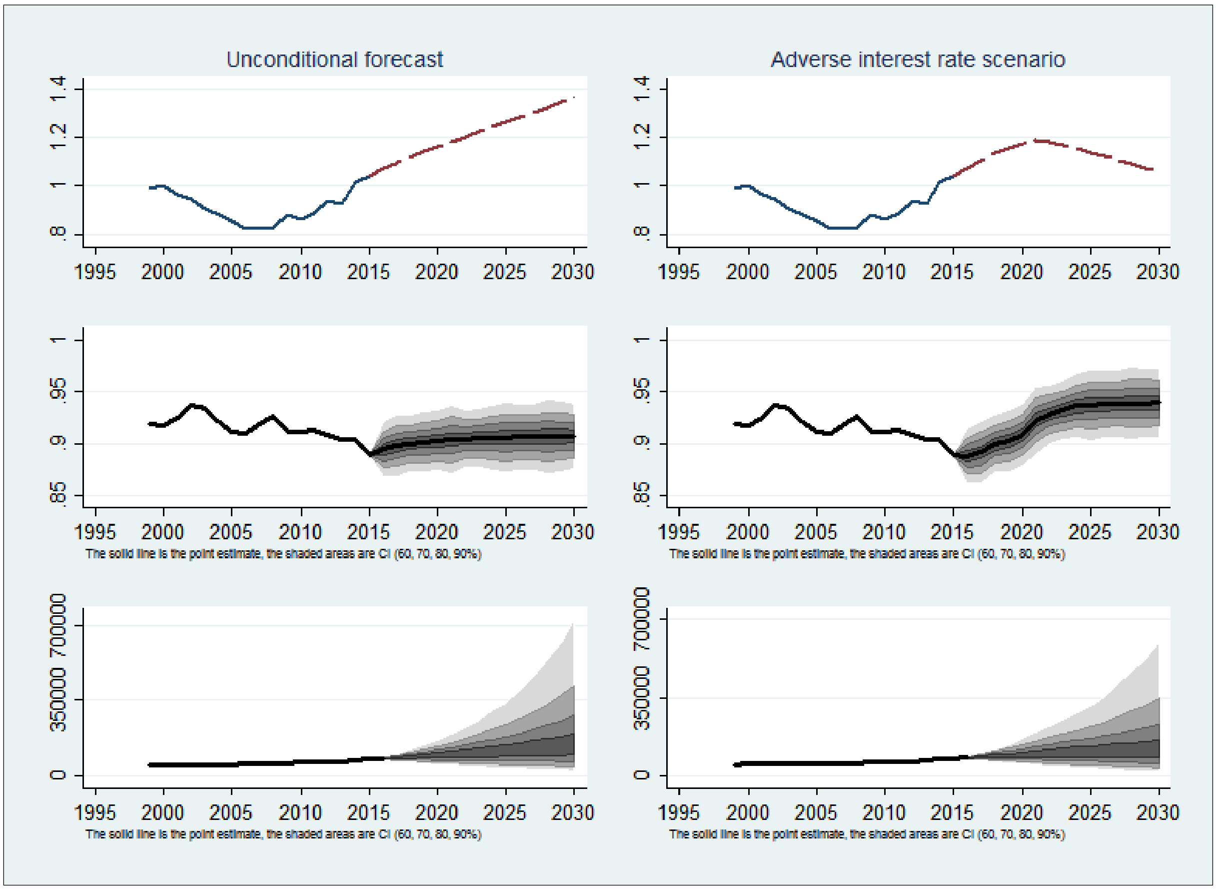
For now, consider Figure 7, which shows the two sustainability conditions plus the total stock of debt (per capita) for the 21 city municipalities (B3) of Sweden. The panels show the forecast for the *average* municipality, meaning that the forecast is based on the average value of the macro variables across the group in 2015. The debt-to-income ratio is just shown as a point forecast, for ease of reference. The striking fact is that city municipalities, on average, would react to significantly higher interest rates by diminishing the accumulation of debt in relation to income. If interest rates stay low, as predicted endogenously by the model, city municipalities would take advantage of this fact and embark on increased debt-financing. Even so, interest and welfare expenses are higher in the adverse interest rate scenario.

Overall, the average city municipality is on a sustainable debt path. This is evident in the adverse interest rate scenario, since both sustainability conditions are fulfilled. Recall that city municipalities have amongst the highest debt per capita (Figure 3) but also have amongst the highest incomes (Figure 4). In the unconditional forecast, the conclusion I draw is one of sustainability, since interest and welfare expenses actually decrease as a fraction of income. A debt-to-income ratio of 1.4 is slightly worrying, but perfectly feasible in a world with low, long-term interest rates.

[11] Täby, Torsby, Hagfors, Nordanstig, Sollefteå, Bjurholm and Vindeln municipalities. These also had significant debt burdens in 1998-2001.

[12] This is a master's thesis. I felt obliged to use at least one double negation.

FIGURE 7: FORECAST FOR CITY MUNICIPALITIES (B3) – FULL SAMPLE



Notes: The top two panels show the evolution of the debt-to-income ratio under the unconditional and the adverse interest rate scenario, respectively. The middle two panels show welfare and interest expenses as a fraction of income and the lower two panels show the aggregate stock of debt in SEK per capita.

In fact, all municipalities clear the first sustainability condition until 2030 if interest rates are forecasted endogenously. Even at the 90% confidence level, all have income that exceeds interest and welfare expenses. The rosy picture does not hold for the adverse interest rate scenario, however. If costs of capital increase to 5.5% through 2022, 36 municipalities show *structural* deficits with probability 0.1 towards the end of the forecast period. The gravity of municipal default warrants low-probability assessments. The vast majority come from group B5 – low-commuting municipalities near cities. The average debt-to-income ratio is explosive for this group under the adverse interest rate scenario. It may seem relatively unintuitive since B5 municipalities have amongst the lowest debt-to-income ratios over the sample period, 1998-2015. But this is a result of the B5 municipalities being comparatively interest rate sensitive and operating on low margins. This exemplifies how, in the model, the long-run forecast is primarily determined by the estimated coefficients – how costs of capital and debt accumulation and the other macro variables interact with each other – rather than the starting values.

Stability of the method and robustness

A number of robustness tests, outlined in the **Model** section, have to be performed to assert the validity of the forecasts. Firstly, an adequate number of lags p need to be selected for the VAR estimation. The technique used in the present thesis tests for the adequate number of lags and then stacks the data appropriately for each group of municipalities, so that a single VAR can be estimated on the stacked data for each group. I also test for the number of lags using a GMM technique, which ends up giving the same results. Based on the Akaike information criterion (AIC), a VAR with one lag is selected, i.e. VAR(1). The fact that the best model includes only one lag speeds up the convergence and makes the coefficients even more important in determining the long-term forecast relative to the initial values of the macro variables.

The second aspect is to test whether the macro variables actually Granger cause each other. The forecasting approach used in this thesis hinges on lagged values of the macro variables containing useful information for the forecasting of the others. If they do not, the VAR model will not be able to produce an assessment of the sustainability of the debt path. Table 1 shows the results of Granger causality tests for the VARs of the 9 groups. The bottom row of the table also shows whether the model is stable of not – whether the eigenvalues of $\acute{A}$ have modulus less than 1.

TABLE 1: GRANGER CAUSALITY TESTS

Dependent ariable	Excluded variable	A1	A2	B3	B4	B5	C6	C7	C8	C9
Cost of capital (r)	g	0.30	0.02**	0.01**	0.07*	0.07*	0.30	0.19	0.22	0.05*
	costs	0.09*	0.53	0.61	0.14	0.18	0.12	0.28	0.08*	0.12
	debt	0.37	0.04**	0.21	0.73	0.78	0.96	0.78	0.40	0.73
	ALL	0.11	0.03**	0.04**	0.08*	0.16	0.42	0.34	0.12	0.05**
Income growth rate (g)	r	0.35	0.09*	0.01**	0.01**	0.05*	0.28	0.00**	0.02**	0.04**
	costs	0.04**	0.00**	0.51	0.09*	0.31	0.01**	0.04**	0.10*	0.92
	debt	0.32	0.03**	0.00**	0.00**	0.05**	0.06	0.02**	0.04**	0.11
	ALL	0.02**	0.00**	0.00**	0.00**	0.05**	0.01**	0.00**	0.01**	0.13
Expenses as a fraction of incomce (c)	r	0.97	0.56	0.72	0.00**	0.82	0.01**	0.00**	0.00**	0.04**
	g	0.58	0.00**	0.00**	0.02**	0.34	0.16	0.02**	0.02**	0.10*
	debt	0.99	0.04**	0.06*	0.00**	0.34	0.00**	0.48	0.23	0.73**
	ALL	0.95	0.00**	0.00**	0.00**	0.61	0.00**	0.00**	0.00**	0.09*
Debt accumulation (d)	r	0.13	0.62	0.08*	0.43	0.00**	0.75	0.43	0.51	0.77
	g	0.45	0.54	0.67	0.03**	0.15	0.10	0.22	0.63	0.51
	costs	0.38	0.00**	0.79	0.13	0.47	0.04**	0.00**	0.02**	0.01**
	ALL	0.16	0.00**	0.29	0.02**	0.00**	0.02**	0.00**	0.15	0.04**
Stability		**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**

Note: ** = 5% significance level, *=10% significance level. The table shows the p-values of the Granger causality tests. Each row shows the p-value associated with the test that the "Excluded variable" Granger-causes the "Dependent variable". A p-value lower than 0.05 enables the conclusion that the excluded variable Granger-causes the dependent variable. For the rows labelled "ALL", the test evaluates whether all but the dependent variable in the model contain useful information for the forecasting of the dependent variable. The last row shows whether the model satisfies the stability condition or not (all eigenvalues of B inside the unit circle).

The Granger causality test give us further reason to exclude group A1 – the three big cities of Malmö, Gothenburg and Stockholm – from the analysis. This VAR contains a unit root and very few variables Granger cause each other. Even block-exogeneity cannot be rejected. Each of the numbers in Table 1 is a p-value of the probability with which we can reject the null hypothesis that the *excluded variable does not* Granger cause the *dependent variable*. Orange (*) a p-value in between 0.05 and 0.1, and green (**) a p-value of less than 0.05.

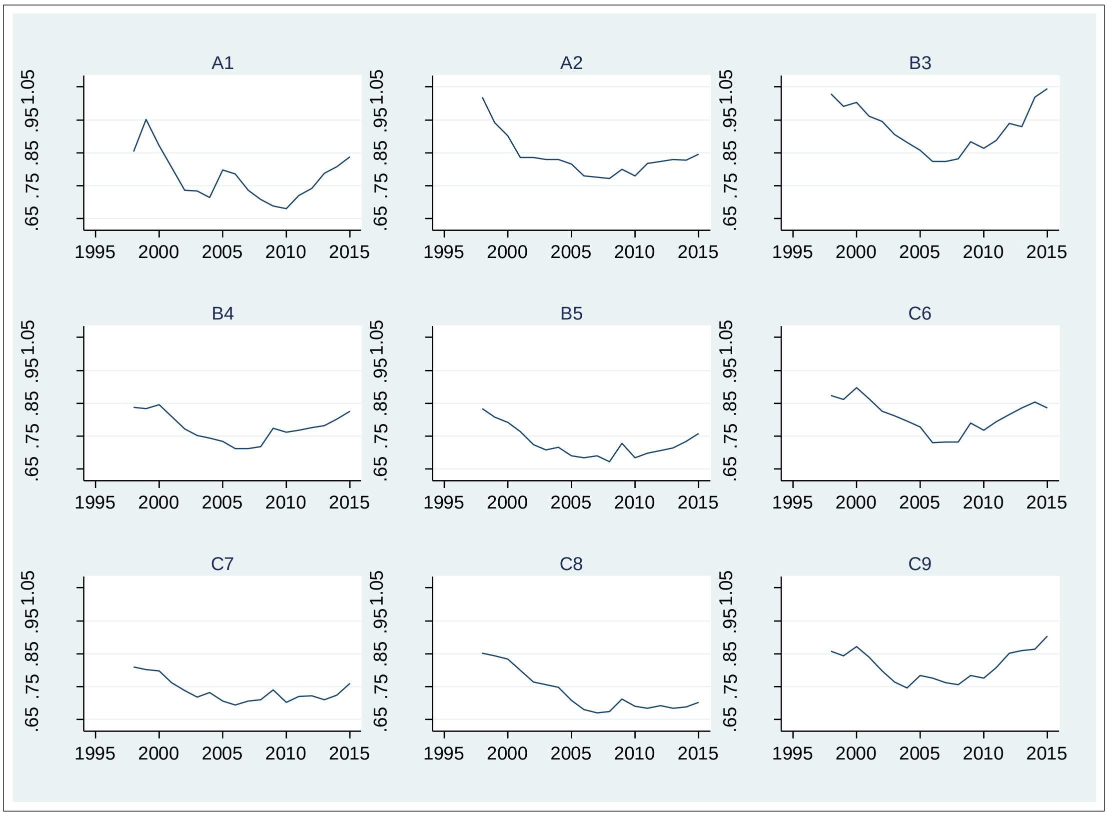
One of the most interesting things to note is that many of the other variables do *not* seem to Granger cause the cost of capital, r. Attention was drawn to this fact earlier in the thesis, in saying that the estimated model is perhaps more suitable for conditional forecasts – in which the cost of capital is *exogenously* determined – than unconditional forecasts. The observation translates relatively well to economic theory. A small municipality should have limited influence to affect general interest rates. This effect seems to outweigh the effect of the risk premium, which each municipality can control itself. Debt growth during periods of low income, for example, should increase the risk premium and therefore the cost of capital of the municipality. So the model does not square perfectly with intuition but the data indicates that conditional forecasts based r would be suitable.

Excluding r, the VAR models do relatively well. For the three other dependent variables, only a few null hypothesis of Granger causality are rejected when **ALL** variables are excluded. The **ALL** row in fact shows a block-Granger causality test – whether the whole system of other variables contains useful information for the forecasting of the dependent variable. The fact that most of these are confirmed gives some validity to the methodology. Furthermore, the VARs are stable across all the 9 groups of municipalities.

A second wave of important robustness tests concern the distribution and features of the estimated error terms. It was discussed how residuals need to be mean-zero, white noise processes, preferably with approximately normal distributions, to make the forecasts valid. One of the most important things are that residuals should not be autocorrelated. It is possible to get consistent estimates as long as all the other conditions on the error terms are fulfilled. However, it would significantly bias he estimates and make the forecasts invalid if any of the other conditions are breached and errors are autocorrelated. The Ljung-Box test is used in order to determine if the residuals are autocorrelated. Unfortunately, we reject the null hypothesis of no serial correlation for all 9 models, using various lag lengths. The tests are shown in the first table of Appendix A2. This means that the residuals are auto-correlated and consequently that the forecasts are biased.

Exploring why the estimated residuals are auto-correlated leads onto the critical issue of breakpoints. Inspecting the estimated residuals, I noted that they had discreetly different signs before 2008 vis-à-vis 2008 and after. Figure 4 gives an idea as to why. The financial crisis seems to have altered the way municipalities accumulate debt and how the macro variables interact with each other for all groups of municipalities, whether countryside or metropolitan. We observe a turning point in and around 2008, in the sense that debt levels had been sinking before but went on a persistent rise after. This is enough motivation to suspect a structural breakpoint in 2008, which leads me to divide the sample period and construct separate estimates for the period after 2008. The inability to test for structural breakpoints parametrically is a limitation of the methodology used in this thesis. I would even posit that structural breakpoints limit the use of VAR models for the purpose of forecasting in general, especially for something as complex as debt accumulation. Further research and alternative methods such as Bayesian estimation is discussed briefly at the end of this section.

FIGURE 8: BREAKPOINT IN DEBT-TO-INCOME RATIOS (Fraction of income)

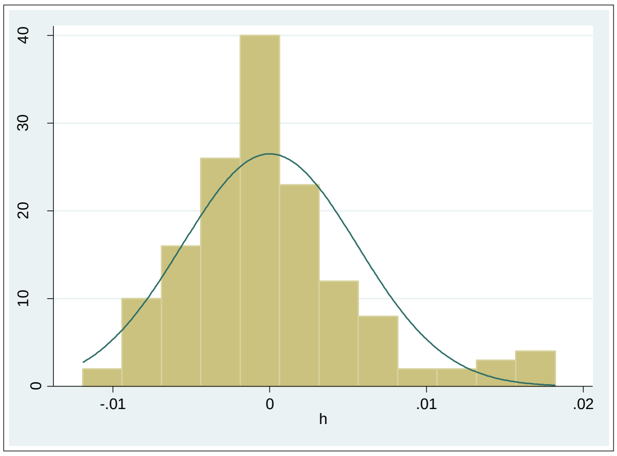


Note: The figure shows the debt-to-income ratios of all groups of municipalities.

Splitting the sample generates much better estimated residuals. The Ljung-Box tests are shown in the second table of Appendix A2 and below, Figure 5 demonstrates the proximity of the estimated residuals to a normal distribution for group B3. However, not all VARs pass the test. There is still significant residual autocorrelation in groups B4 (commuter municipalities near cities), C7 (commuter municipalities near smaller cities) and C8 (countryside municipalities). These groups will have to be disregarded, because the estimates produced by the model are not reliable. While this reduces the richness of the dataset, dropping 3 groups of municipalities has *no* implications for the robustness of the models estimated on the remaining groups, since those models are estimated separately. However, it does have implications for the robustness of the policy implications and the conclusions drawn by the present thesis. I am not able to assert whether the debt paths of 4 out of 9 groups of municipalities are sustainable. Additional research, suggested in the **Results** section of the thesis, is required to analyse these 4 groups.

The estimated residuals of the remaining groups are tested for normality using the Shapiro-Wilks test, which, overall, they pass. This means that the confidence intervals produced for the forecasts are informative, given one has the correct interpretation of the model – the confidence intervals hedge for *known* unknowns and relate to the macro variables included in the model. They do not hedge for systemic shifts or other unknown unknowns.

FIGURE 9: NORMALITY OF ESTIMATED RESIDUALS FOR GROUP B3



Note: The figure shows the frequency distribution of the residuals for the VAR estimated on group B3. A curve has been added to simulate proximity to a normal distribution.

The main drawback stemming from the split sample is a loss of observations. This drawback is what needs to be balanced by the gains in validity. Fewer observations leads to wider confidence intervals. And, perhaps more importantly, disregarding the period 1998-2007 will simply lead to a loss of valuable information. Even though the structural circumstances were different before 2008, there are arguably still things to be learnt from the data. The valuable information that we lose from splitting the sample could help answer questions such as "how do municipalities react to persistently increasing interest rates?". Since interest rates have been falling since 2008, on average, the split-sample model estimates local government reactions to higher interest rates by the relatively short interest rate hikes in 2010-2012. Perhaps we would get a richer picture of such local government reactions if the full sample were included. The problem is that the full dataset cannot be analysed by the type of model employed in this thesis. There is a trade-off between validity and the time period used in the estimation. Even so, the relevant question remains "*are Swedish municipalities on a sustainable debt path*?". Since the debt path seems to have changed after 2008, it might be more suitable *just* to include that very period up until present. I argue that it is, being well-aware of the data loss incurred by splitting the sample.

As a last, non-parametric robustness check, I compare the estimated coefficients on the lagged variables for all groups with estimates obtained from the benchmark GMM panel-VAR. The coefficients can be found in Appendix 4. Overall, the estimates compare relatively well, meaning that they have the same sign and rarely differ more than 0.5 units. However, there are two persistent differences; the coefficient on lagged welfare expenses in the interest rate equation and the coefficient on welfare expenses in the debt accumulation equation. I suspect that this is result from the lack of fixed effects in my grouped VAR models. Since c is not a differenced variable, as opposed to g and d, some of its structural variation across municipalities *within* the same group is probably picked up by the fixed effects in the GMM model. Since such structural variation is not allowed in the grouped-VAR setting, it biases the coefficient on c towards zero. On the other hand, the GMM panel is not stable for 4 out of 6 specifications. Consequently, the benchmark model should not be seen as a gold standard, but rather a coin of similar colour that we can use to roughly determine the value of ours. Overall, my conclusion is that the benchmark model lends some credibility to the grouped VAR approach, but that it does not change anything drastically.

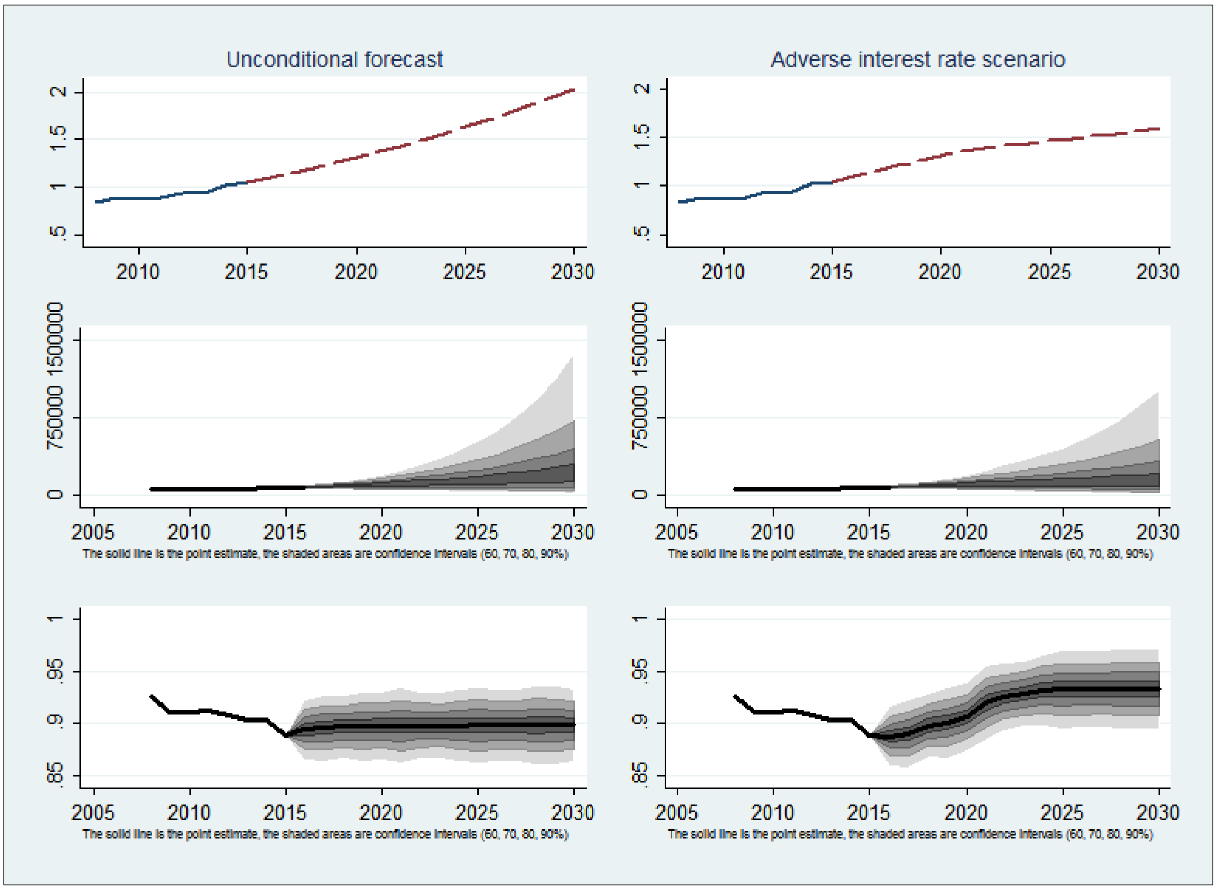
Analysis

"The Devil's in the detail." (You're clear of the quantitative robustness-tests section)

Splitting the sample sheds new light on the likely debt accumulation in the local government sector. Since 2008, municipalities all across Sweden have faced larger investment needs, more challenging circumstances to turn positive annual results and shown an increased appetite for debt-finance. In order to facilitate comparison, consider Figure 10 below, showing the forecasts for group B3 (city municipalities). Figure 6 can be compared to Figure 3, which shows the forecasts for group B3 using the full sample period. The forecasts for groups A1[13], A2, B5, C6 and C9 are included in Appendix A4.

[13] The reader will recall that group A1 did not pass the stationarity tests. However, for the split sample period, I could not resist the temptation of producing forecasts for the three big cities, as well (even though these should be taken with a *large* pinch of salt). Since the model satisfies the stability condition, which is what unit roots usually messes with, it might be interesting to see what the model predicts for the very long run. But, again, the results for group A1 are *not* as robust as the others.

FIGURE 10: FORECAST FOR CITY MUNICIPALITIES (B3) – SPLIT SAMPLE



Notes: The top two panels show the evolution of the debt-to-income ratio under the unconditional and the adverse interest rate scenario, respectively. The middle two panels show the aggregate stock of debt in SEK per capita and the lower two panels show welfare and interest expenses as a fraction of income.

Noticeable is that the debt-to-income ratio now increases further, compared to when the model was estimated over the full sample period. This reflects the structural shift we observe in and around 2008, when debt accumulation started to accelerate after years of deceleration. However, the average B5 municipality still shows more restraint in the adverse interest rate scenario. The debt-to-income ratio increases more modestly under this scenario and not because of higher income growth, but because the municipality takes on less debt.

The fact is that the predicted cost of capital (point forecast) is very difficult to square with the debt-to-income ratio towards the end of the forecast period under the unconditional interest rate scenario. Granted that the government of Japan is able to borrow at rates below 2.5% even though it owes more than 200% of annual income. But a Swedish municipality is unlikely to have the same kind of financial sway. I interpret this unrealistic result as a consequence of two things. For one, the low interest rates and steady debt accumulation observed throughout 2008-2015 gears the forecast towards debt-heavy outcomes. Secondly, the Granger causality tests shown above drew attention to the fact that c, g and d contain little information that is useful for the forecasting of r. Consequently, the right-hand side panel is of higher interest, because it is based on a more realistic path for the cost of capital (and it is based on a better interest rate path for the sake of determining sustainability).

Under the adverse interest rate scenario, the average B3 municipality ends up with a debt-to-income ratio of 1.52 (point forecast[14]) and a cost of capital of 5.5%. 1.52 is quite high, but given that the other sustainability condition is not violated even at the 5% confidence interval, *and* the fact that B3 is a group of larger cities with comparatively large financial resources, I tentatively conclude that the average B3 municipality is on a sustainable debt path. The debt-per-capita forecast (second from the top) is slightly more explosive under the split-sample estimation compared to the path forecasted using the full sample period (Figure 6). One should not, however, devote too much attention to the scales of this graph. They are primarily affected by the large confidence intervals, whereas the median forecast (and 60% confidence interval) remains below 100 000 SEK per capita. The B3 municipalities maintain constructive financial strategies, *decreasing* their accumulation of debt under higher-interest rate conditions. The model produces this result because debt tended to decrease when costs of capital rose during the sample period, albeit with a lag. Given that local government officers adopt the same, sound financial strategies going forward, higher interest rates may well be associated with lower debt accumulation.

The assumed interest rate path warrants deeper analysis before assessing structural differences across the groups of municipalities. Figure 2 showed the municipalities' average costs of capital over the sample period. The takeaway was that the spread between different groups of municipalities has remained quite stable over the whole sample period – if anything, the spread has decreased. It is also possible to discern that one or two groups, like C6 and A1, have slightly more variable costs of capital. For ease of reference, Table 2 shows the mean and standard deviation of the cost of capital for the full sample period. It also shows the average spread between the repo rate of the Riksbank and the municipalities' cost of capital.

TABLE 2: COSTS OF CAPITAL AND SPREADS

	Raw data		**Spread against the repo rate**	
Local government group	Mean	Standard deviation	Mean	Standard deviation
A1	0.037	0.014	1.44	0.72
A2	0.036	0.012	1.28	0.65
B3	0.037	0.010	1.35	0.66
B4	0.033	0.010	0.96	0.74
B5	0.032	0.010	0.87	0.72
C6	0.036	0.012	1.26	0.65
C7	0.032	0.011	0.85	0.70
C8	0.035	0.011	1.18	0.72
C9	0.032	0.011	0.92	0.84

Note: The Table shows the mean of the cost of capital for each group of municipalities and the associated standard deviation, for the raw data and the spread against the repo rate, respectively.

[14] Just as an unnecessary reminder, there is significant uncertainty not captured by the point forecast.

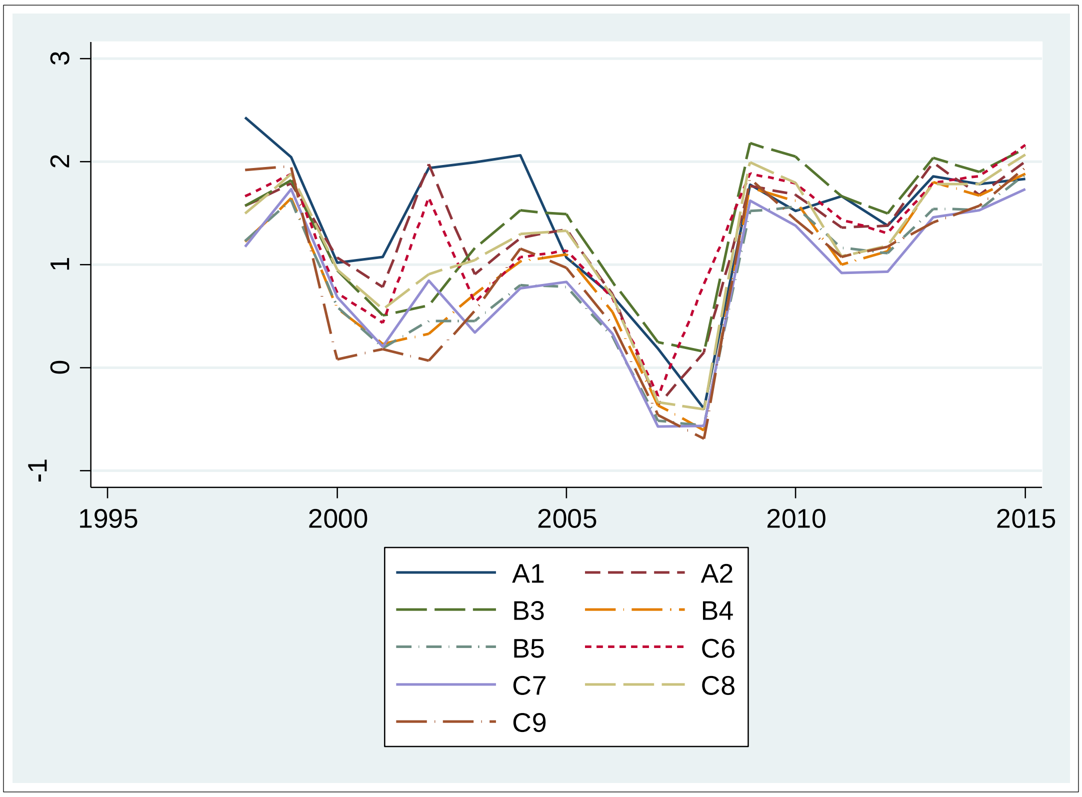
Clearly, the municipalities have very similar costs of capital over the sample period, in terms of both averages and standard deviations. The mid-tier municipalities (groups B4 – B5) have the lowest costs of capital. The spread against the repo rate of the Riksbank, however, is more variable. Interesting to note is that larger, metropolitan local governments had higher spreads against the repo rate, on average. The standard deviations are very similar, bar countryside municipalities with a tourism industry (C9), whose costs of capital seem a little less synchronised with the repo rate[15]. That larger metropolitan municipalities have higher spreads on average is surprising, given that they typically have higher net wealth and a larger annual income. On the other hand, regularity of payments and good financial planning should perhaps make such advantages immaterial in the presence of well-functioning capital markets. I tentatively interpret the result as a consequence of institutions – groups B4 – C7 were quicker to join *Kommuninvest*, a central credit agency owned by local governments. The agency offers long-term, low-interest loans to members and obtain capital from the markets by issuing bonds that have virtually the same risk-weighting as Swedish sovereign bonds (Kommuninvest, 2017). Many larger metropolitan municipalities maintain their own capital markets programs, which *may* result in higher spreads towards the repo rate, be it for the sake of higher issuing expenses (included in r) or actually through a higher risk-weighting.

The important insights for the purposes of this thesis are twofold. Firstly, the spread against the repo rate actually seems to converge to 2% towards the end of the sample period. This is shown in Figure 11 below. Such a long period of convergence is not observed before 2008. Coupled with the fact that the costs of capital for different groups follow each other over the sample period, this lends support to the approach of stipulating interest rate scenarios exogenously. It seems reasonable to analyse debt paths going forward using pre-supposed costs of capital if local governments maintain a 2% spread against the repo rate. This allows me to use the official interest rate forecasts produced by the Riksbank (2017) and other institutions. The path of the cost of capital under the adverse interest rate scenario follows the repo rate forecast of the Riksbank (+2%) until 2019 (end of the forecast of the Riksbank), when it continues increasing and levels off at 5.5% in 2024. Perhaps the word "adverse" is unsuitable, given that the average costs of capital for Sweden's municipalities were around 4.5% at the turn of the century. But compared to the present, the terminology is warranted.

The second insight is that the stipulated interest rate paths ignore important endogenous effects, such as negative debt spirals of higher interest rates, higher debt, higher interest rates etc. because of individual risk-weightings. The trade-off between setting the interest rate endogenously and setting it exogenously should be kept in mind. The model becomes more apt to capture *structural* unsustainability than unsustainability resulting from a particular event. Yet, the conclusion I draw from the data presented and the estimated models is that it is more adequate to assume an interest rate path.

[15] Exactly why would be interesting to analyse on a micro-level, but is outside the scope of this investigation. Could it be that the investment needs of countryside municipalities with a tourism industry are more pro-cyclical and hence they commit to investment projects when rates are very high or very low?

FIGURE 11: SPREADS AGAINST THE REPO RATE OF THE RIKSBANK (%)



Countryside municipalities, large metropolitan areas, commuter municipalities. Each face their own investment needs, their own capital market access, their own cost-structures for the provision of welfare services, and their own strategic goals for the growth of the municipality going forward. The bottom line results of the analysis in this thesis suggest that the debt sustainability of low-commuting municipalities near cities (B5) and countryside municipalities with a tourism industry (C9) should be monitored. The forecasts show that these groups, on average, have rising debt-to-income ratios *and* run at least a 5% risk of sustained, structural deficits. B5 is in the most precarious state, with a 10% risk of structural deficits over 2023 – 2030. Some *individual* municipalities in groups B5 and C9 face even worse circumstances because of high debt levels at present. The answer to the research question *"are Swedish municipalities on a sustainable debt path?"* becomes *"most, but not all. Well-functioning institutions like good economic housekeeping through the BBR have been stressed since 2008, perhaps because of low interest rates. Given how municipalities have handled their financing needs since the financial crisis, and the debt levels observed at present for some individual municipalities, there are at least a handful municipalities that the present thesis suspects are not on a long-term, sustainable debt path"*.

Discussion

The bottom line outcomes present an intimation of debt sustainability for the sector, however, keeping in mind the trade-offs in terms of sample size and statistical properties required to make the forecasts internally valid. What is it, then, that creates the structural differences across groups of municipalities? What are the driving factors behind the differences in debt accumulation between groups? Appendix A5 shows the bottom line coefficients for a closer look at such differences. The striking thing is their similarity in terms of signs[16]. All but one of the instantaneous coefficients are of the same sign and comparable magnitudes. It is the differences in magnitude that generate the divergence between groups in the long-run. The big cities (A1), for instance, are characterised by very strong, simultaneous reactions to interest rates in terms of debt accumulation. The coefficient on the cost of capital in the debt accumulation equation is 3.20. However, this is balanced by a strongly negative coefficient on the lagged costs of capital in the same equation (-1.99). This is what creates the "hump" shape in the forecasted debt accumulation for big cities – once the cost of capital stabilizes at 5.5%, the debt accumulation levels out and decelerates before it settles. In fact, we observe the same effect for the next tier of cities (B3), just with slightly smaller magnitudes. This category includes rather large cities like Uppsala and Örebro with their own capital markets programs.

Why do the big cities *seem* more interest-rate sensitive? Answering this question would require an investigation that goes far beyond the scope of the present thesis. But it is interesting to note that the municipalities with their own capital markets programs are more interest rate sensitive on average. It becomes rather easy to square this with intuition, given that the average municipal bond has a maturity of 2 years (a complete dataset of municipal bonds was assembled in the Bloomberg terminal during the investigation). It is not too surprising that this kind of financial strategy would be more interest rate sensitive, for better or worse, than the long-term loans typically obtained by other municipalities. But does this mean that the investment spending of the metropolitan municipalities is more interest rate sensitive than the others? Or do they simply substitute for other forms of capital? These questions constitute the perhaps most straightforward extension of the current investigation.

Debt accumulation is also more responsive to welfare expenses in the densely populated municipalities A1-B3. It seems that higher welfare expenses are associated with lower debt accumulation in the same year, perhaps because the budgeting process recognises the small fiscal space. This is interesting in relation to Hort (2015), who found that the introduction of the BBR caused an increase in local government consumption elasticity. Expenses are more variable, because if an unforeseen outlay occurs then other consumption needs to be cut back. Why do we not see this pattern, or why is this pattern very weak, in terms of debt accumulation in non-metropolitan municipalities B5 and C9[17]? It could be that the planning horizon for these municipalities is longer than the cities. But this is highly speculative – interviews with budgeting officers at local governments would be helpful in falsifying such speculations. Due to the high-level perspective, data limitations and the implicit assumptions embedded in this thesis, I can only very cautiously point to the structural drivers of debt accumulations between groups of municipalities. But the differences do exist. And they shape how municipalities shoulder higher interest rates over the forecast horizon.

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[16] I have highlighted one of the only outliers and it pertains to group C6, which has a large, positive lagged coefficient on interest rates in the debt accumulation equation.

[17] Recall that A1 and A2 are clustereda round Stockholm, Gothenburg and Malmö, B3 are (large) cities like Uppsala and C6 are smaller cities like Kristianstad.

One additional structural difference is worthy of brief mention. Low-tax municipalities[18] stand to be found primarily in group A2, followed by B4. This fact reflects the commuting patterns to the larger cities. There was no meaningful statistical difference in the debt stock per capita between low-tax municipalities and municipalities with higher tax rates in the same groups in 2015. Neither are the low-tax municipalities forecasted to have very different debt paths going forward, compared to their peers. Then again, the tax income per capita is higher in low-tax municipalities, because many high-income individuals reside there. There is consequently no clear argument for a correlation between tax rates and debt finance.

The dearth of articles in the space of long-term, subnational, debt sustainability complicates an international outlook. To the best of my knowledge, the type of model used in the present thesis has not been employed in previous studies of European local government debt, nor elsewhere. Most articles limit their attention to a historical exposition (Navarro-Galera et al., 2016; Prior et al. 2013) or a short forecasts (Kluza, 2016). Navarro-Galera et al. (2016) found that the income statement, specifically the entries for debt, welfare expenses and annual income, is useful for the analysis of the driving factors behind financial sustainability. Their finding is confirmed by the Granger causality tests conducted in the present thesis. The financial crisis seems to have hit Spanish local governments much worse than Swedish, due to their heavy involvement in property and subsequent property bubble. Swedish local governments are also vulnerable to property bubbles, through wholly-owned property companies. The Swedish market has been more stable than that of Spain, however.

Kluza (2016), who approaches sustainability from a corporate finance perspective, finds that 2-2.5% of Polish local governments will exhibit alarmingly low space for debt servicing if interest rates reverse by 1.5-2%. Kluza uses Monte Carlo simulations to arrive at this conclusion and does not create an explicit econometric model. The results are important because they demonstrate that the debts of local governments can easily become contingent liabilities of the state in times of interest rate reversal. This is what the present thesis set out to show, as well. The fraction of local governments in distress cannot be compared over the long-term, but Polish and Swedish municipalities have an absence of bankruptcy procedure in common.

Borge & Tovmo (2009) studies intertemporal spending behaviour in Sweden, Norway and Denmark before the introduction of the BBR in Sweden and concludes that Danish municipalities were more forward-looking precisely because of such regulation. Taking it one step further would be to say that *unregulated* devolution can lead to myopic behaviour, since Swedish, Danish and Norwegian municipalities are otherwise similarly devolved. The question is whether Swedish municipalities have become less forward-looking *again*, after the financial crisis. The present thesis concludes that there has at least been a(nother) structural break around 2008 that affects debt accumulation in Swedish local governments. And higher levels of debt accumulation are forecasted by if the forecasts are based on the period after 2008. Ashworth et al. (2005) tests the Weak Government Hypothesis but finds no long-run effect of weak governments on debt

[18] Translating to municipalities with average marginal tax rates of 29-30%, of which there were 22 in 2017. Remaining municipalities have average tax rates between 31-34.04%.

accumulation and deficits. There are short-run effects, however, that seem to suggest that coalition governments in Flemish municipalities accumulate more short-term debt. Looking at the political composition of local government authorities would be a natural extension of the present thesis.

There are mainly three other avenues of future research identified in the present thesis. Firstly, the inclusion of other types of debt into the model would create a more holistic assessment of the actual debt sustainability of local governments. Deferred maintenance can be a particularly costly form of debt (Wessel & Olson, 2017) and some pensions obligations are extremely sensitive to interest rate fluctuations (Authers, 2015). The scope of such obligations varies drastically between European countries (CSES, 2010) and much could be learnt from international comparisons. Secondly, a more robust technique could potentially be developed for the estimation of the model. Bayesian estimation techniques may be able to analyse the problem and mitigate the concerns for internal validity stemming from structural breaks and potential sources of endogeneity. The technicalities of such an approach are beyond the capacity of the current thesis. Thirdly, it would be interesting to see a broader research project into the decisions governing financial strategies at municipalities. A survey approach similar to Gelpern & Gulati (2013), who investigate the motives for issuing certain types of government bonds, would be instructive. Dietrichson & Ellegård (2015) provide another example, compiling a survey dataset which suggests that municipalities in Sweden with at least partially centralised budgeting processes have higher annual surpluses. Combined with the macro-modelling conducted here, such an approach could effectively marry the micro- and macro perspectives, which in turn may enable us to answer questions encountered in the present thesis, e.g. why is the debt accumulation of metropolitan municipalities more interest rate sensitive.

A separate avenue of research, *and* a relevant policy research project, would be to ask why some municipalities, typically the big cities, have higher costs of capital than other municipalities. *If* expenses associated with running their own capital markets programs, like credit rating costs and issuance costs, outweigh the benefits, why do they still do it? Would it be beneficial for them to join the central municipal credit agency, Kommuninvest? Given that taxpayer money is on the table, this appears to be a relevant policy investigation.

The main policy implications of the current thesis are twofold. Firstly, *regulated* devolution does not imply debt unsustainability. Sweden's local government are extremely devolved in an international context. Yet, during the period from 1998 – 2008 they largely decreased debt-to-income ratios. Most of them show sustainable debt paths going forward, even though there seems to have been a structural shift in and around the financial crisis of 2008. The importance and granularity of centrally imposed regulation stands out. The BBR seems to have had an effect on debt accumulation and other spending (Hort, 2016) up until 2008. But low interest rates subsequently have diminished the sway of the BBR in containing debt accumulation, because local governments can fit the low costs of capital into their annual budgets. The risk is that there will be a day of reckoning much too soon, if interest rates start reversing. The present thesis finds that for a group of municipalities, this is an issue that requires monitoring. In any event, regulated devolution does not imply unsustainable debt accumulation, but under low-interest rate conditions, extra monitoring may be required.

The second policy implication is the need of increased monitoring in general. Due to political cycles or other structures, local governments may fail to consider the long-term effects of their own financial strategies themselves (Bastida, 2013; Geys, 2007). Particularly during in times of low interest rates. On the other side of the fence, capital markets may not consider the long-term sustainability of local government finances either, because the average maturity of a Swedish local government bond is around 2 years. Furthermore, capital markets have no duty to analyse if the local government meets its other obligations of welfare expenses, as is required for sustainability according to the definition by IFAC (2013). Hence, regular, long-term monitoring in the area of local government debt is needed. *Kommuninvest* (2017) produces the most detailed reports about municipal debt at present, but it naturally focuses on the members of the credit agency, and does not go into much detail about welfare service delivery, nor long-term sustainability.

Conclusions

The last 20 years have offered some fascinating changes to the way in which Sweden's local governments operate, the conditions they face and the services they are required to provide. Between 1998 – 2007, debt-to-income ratios were generally falling. The low interest rates observed ever since have created more room within the scope of the centrally imposed budget balancing requirement, precipitating a sustained increase in debt-to-income ratios. The present thesis has shown that the debt accumulation of Swedish municipalities in relation to income growth, interest rates and welfare expenses seems to have changed after 2007.

A forecasting methodology based on VAR models was developed and estimated on a large panel dataset covering the years 1998 – 2015. The methodology relies on a separation between structural factors and macroeconomic variables by grouping municipalities with similar economic fundamentals together. Given that similar types of groupings exist and can be developed for other countries, the methodology is internationally tenable. What needs to be tailored to suit each country's institutional preconditions is the sustainability condition. The present thesis used the centrally imposed budget balancing requirement and an assumption that welfare services stay at their current per-capita levels to define a sustainability condition. This condition was additionally qualified by the debt-to-income ratio of each individual municipality.

Results suggest that most, but not all, of Sweden's municipalities seem to be on a sustainable debt path. Countryside municipalities with tourism industries and sparsely populated municipalities with low commuting patterns are identified as particular risk groups. A handful of municipalities in these two groups with high current levels of debts per capita should be could analysing in greater detail. Due to the structural shift identified in 2008 and robustness issues, the forecasts should be interpreted with care and deeper analysis is required to ascertain the debt (un)sustainability of particular municipalities. Furthermore, due to robustness issues, the present thesis is only able to produce conclusive results for 5 out of 9 groups of municipalities.

Apart from the structural break in 2008 and the empirical results, the present thesis also infers that devolution does not necessarily precipitate a myopic or unsustainable debt accumulation in the presence of strong, macro-prudential frameworks. But the effectiveness of such frameworks needs to be monitored in the face of overwhelming changes, such as sustained low interest rates. Even so, Swedish municipalities have not embarked on unsustainable debt paths at large. And the access to adequate debt-finance is naturally crucial for the local governments in the fulfilment of their investment needs and the provision of mandated welfare services. The forecasting methodology employed in this thesis was motivated by the long planning horizon of local governments, the dependence of inhabitants on the welfare services provided and the importance of local government debt sustainability for wider financial stability.

Going forward, Sweden's municipalities face higher investment needs stemming from new demands on welfare provision, an ageing incumbent population and a significant inflow of immigrants up until the end of 2015. The time period considered herein just misses the largest inflow of immigrants (2015) and the future will have to show what financing strategies, and broader strategies, municipalities employ to handle associated demands. The need of longer-term monitoring, as demonstrated by the present thesis, seems evident in the face of future challenges.

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Appendices

Appendix A1 – Stationarity tests

Variable	Lags (AIC)	Ljung-Box White Noise Tests of Residuals				ADF Test for Unit Root		
A1		LB(1)	LB(2)	LB(4)	LB(8)	Test statistic	Critical Value	Conclusion
Income growth rate (g)	1 (-152.65)	0.35	0.38	0.05	0.08	-5.58	-3.58	Stationary
Cost of capital (r)	1 (-302.04)	0.35	0.06	0.03	0.07	-2.17	-3.63	Unit root
Primary balance (pbal)	2 (-171.80)	0.35	0.38	0.05	0.08	-5.58	-3.58	Stationary
Debt accumulation (d)	1 (-46.71)	0.73	0.61	0.21	0.35	-4.49	-3.63	Stationary
Expenses as a fraction of income (c)	1 (-186.56)	0.81	0.94	0.03	0.09	-3.95	-3.58	Stationary
Debt over total income (d2y)	1 (-85.81)	0.15	0.29	0.61	0.55	-1.48	-3.58	Unit root
A2								
Income growth rate (g)	0 (-2425.89)	0.28	0.03	0.05	0.18	-36.45	-3.43	Stationary
Cost of capital (r)	1 (-3681.66)	0.28	0.05	0.10	0.00	-10.02	-3.43	Stationary
Primary balance (pbal)	1 (-2847.49)	0.85	0.77	0.61	0.44	-14.83	-3.43	Stationary
Debt accumulation (d)	1 (-879.08)	0.96	0.32	0.68	0.92	-15.30	-3.43	Stationary
Expenses as a fraction of income (c)	2 (-3180.77)	0.01	0.01	0.00	0.00	-10.03	-3.43	Inconclusive
Debt over total income (d2y)	1 (-556.57)	0.17	0.30	0.36	0.42	-6.01	-3.43	Stationary
B3								
Income growth rate (g)	0 (-1208.86)	0.19	0.09	0.01	0.00	-21.98	-3.45	Stationary
Cost of capital (r)	1 (-2316.74)	0.42	0.00	0.00	0.00	-5.38	-3.46	Stationary
Primary balance (pbal)	1 (-1576.72)	0.79	0.35	0.40	0.18	-12.45	-3.45	Stationary
Debt accumulation (d)	0 (-683.23)	0.94	0.90	0.11	0.02	-16.05	-3.45	Stationary
Expenses as a fraction of income (c)	1 (-1816.06)	0.13	0.30	0.02	0.03	-7.12	-3.45	Stationary
Debt over total income (d2y)	2 (646.81)	0.05	0.14	0.21	0.24	-5.06	-3.45	Stationary
B4								
Income growth rate (g)	0 (-3301.16)	0.73	0.01	0.01	0.01	-35.35	-3.43	Stationary
Cost of capital (r)	1 (-5462.48)	0.14	0.00	0.00	0.00	-10.52	-3.43	Stationary
Primary balance (pbal)	1 (-3504.45)	0.91	0.58	0.58	0.72	-20.17	-3.43	Stationary
Debt accumulation (d)	1 (1342.50)	0.09	0.22	0.45	0.26	-18.30	-3.43	Stationary
Expenses as a fraction of income (c)	4 (-4380.63)	0.03	0.08	0.00	0.00	-7.28	-3.43	Stationary
Debt over total income (d2y)	2 (-1446.60)	0.04	0.07	0.24	0.11	-7.55	-3.43	Stationary
B5								
Income growth rate (g)	0 (-2149.12)	0.04	0.00	0.00	0.00	-34.42	-3.43	Inconclusive
Cost of capital (r)	1 (-3620.60)	0.00	0.00	0.01	0.00	-10.30	-3.43	Inconclusive
Primary balance (pbal)	1 (-2505.56)	0.77	0.37	0.29	0.42	-15.06	-3.43	Stationary
Debt accumulation (d)	5 (-674.39)	0.98	0.95	0.96	0.89	-13.81	-3.45	Stationary
Expenses as a fraction of income (c)	1 (-2196.32)	0.79	0.28	0.23	0.01	-15.27	-3.43	Stationary
Debt over total income (d2y)	1 (-1091.23)	0.31	0.45	0.75	0.91	-6.85	-3.43	Stationary
C6								
Income growth rate (g)	0 (-1499.29)	0.97	0.98	0.95	0.99	-15.38	-3.44	Stationary

Cost of capital (r)	0 (-2263.55)	0.22	0.37	0.49	0.00	-14.41	-3.44	Stationary
Primary balance (pbal)	2 (-1527.11)	0.97	0.00	0.00	0.00	-9.95	-3.43	Stationary
Debt accumulation (d)	0 (-988.22)	0.34	0.64	0.21	0.14	-19.02	-3.44	Stationary
Expenses as a fraction of income (c)	1 (-2074.09)	0.58	0.49	0.28	0.54	-5.81	-3.43	Stationary
Debt over total income (d2y)	1 (-850.42)	0.26	0.39	0.56	0.58	-5.28	-3.43	Stationary
C7								
Income growth rate (g)	0 (-3405.45)	0.30	0.01	0.00	0.00	-34.46	-3.43	Stationary
Cost of capital (r)	1 (-4941.14)	0.25	0.00	0.00	0.00	-14.48	-3.43	Stationary
Primary balance (pbal)	1 (-4128.90)	0.75	0.91	0.76	0.22	-17.40	-3.43	Stationary
Debt accumulation (d)	1 (-558.30)	0.27	0.43	0.63	0.95	-23.25	-3.43	Stationary
Expenses as a fraction of income (c)	3 (-4458.89)	0.03	0.08	0.00	0.00	-8.72	-3.43	Stationary
Debt over total income (d2y)	1 (-1432.15)	0.10	0.25	0.29	0.21	-6.01	-3.43	Stationary
C8								
Income growth rate (g)	0 (-2619.09)	0.75	0.01	0.03	0.03	-26.16	-3.43	Stationary
Cost of capital (r)	1 (-4193.03)	0.00	0.00	0.00	0.00	-8.96	-3.43	Inconclusive
Primary balance (pbal)	1 (2890.95)	0.93	0.88	0.62	0.04	-16.34	-3.43	Stationary
Debt accumulation (d)	0 (1374.99)	0.87	0.87	0.98	0.96	-24.43	-3.43	Stationary
Expenses as a fraction of income (c)	3 (-3253.19)	0.23	0.45	0.00	0.00	-8.60	-3.43	Stationary
Debt over total income (d2y)	1 (1409.16)	0.16	0.21	0.40	0.79	-7.43	-3.43	Stationary
C9								
Income growth rate (g)	0 (-989.62)	0.86	0.90	0.91	0.10	-19.41	-3.47	Stationary
Cost of capital (r)	1 (-1539.28)	0.10	0.24	0.56	0.47	-10.30	-3.47	Stationary
Primary balance (pbal)	1 (-1278.77)	0.81	0.91	0.99	0.88	-9.68	-3.46	Stationary
Debt accumulation (d)	0 (439.23)	0.92	0.53	0.37	0.64	-16.66	-3.47	Stationary
Expenses as a fraction of income (c)	2 (-1318.32)	0.04	0.04	0.00	0.00	-6.23	-3.36	Stationary
Debt over total income (d2y)	1 (-396.21)	0.92	0.99	0.95	0.77	-3.73	-3.46	Stationary

Note: The table shows the lags selected by the AIC criterion and associated test statistic. In the four following columns, the table shows the p-value obtained from running the Ljung-Box tests with 2, 3, 4 and 8 lags respectively. A p-value lower than 0.05 rejects the null hypothesis of no serial correlation in the residuals. The last three columns shows the outcome of the Augmented Dickey-Fuller test and the conclusion I draw.

Harris-Tzavalis test for unit root in GMM panel (benchmark)				
	Without trend		With trend	
Variable	Test statistic	p-value	Test statistic	p-value
Total income (Y)	11.42	1.00	-8.41	0.00
Total expenses (c)	7.59	1.00	-18.77	0.00
Stock of debt (d)	8.89	1.00	3.28	0.99
Debt growth rate (debt)	-32.95	0.00	-46.05	0.00
Primary balance (s)	-67.77	0.00	-45.58	0.00
Primary balance (pbal)	-75.79	0.00	-49.33	0.00
Cost of capital (r)	-34.11	0.00	-33.57	0.00
Debt over total income (D2Y)	-4.86	0.00	-2.35	0.009
Expenses as a fraction of income (costs)	-65.72	0.00	-40.52	0.00
Income growth rate (g)	-100.02	0.00	-55.64	0.00

Note: A p-value lower than 0.05 rejects the null hypothesis of a unit root (series is stationary)

Appendix A2

Ljung-Box White Noise tests of residuals: **Full sample**				
Grouped VAR	LB(1)	LB(2)	LB(4)	LB(8)
A1	0.00	0.00	0..00	0.00
A2	0.01	0.02	0.00	0.00
B3	0.03	0.02	0.01	0.02
B4	0.00	0.00	0.00	0.00
B5	0.05	0.03	0.02	0.00
C6	0.01	0.00	0.00	0.00
C7	0.00	0.01	0.00	0.01
C8	0.01	0.00	0.02	0.00
C9	0..01	0.01	0.01	0.00

Note: The columns LB(1), LB(2), LB(4) and LB(8) contain the p-values for which we reject/cannot reject the null hypothesis of no serial correlation. A value lower than 0.05 signals serial-correlation issues.

Ljung-Box White Noise tests of residuals: **Split sample**				
Grouped VAR	LB(1)	LB(2)	LB(4)	LB(8)
A1	0.06	0.15	0.21	0.59
A2	0.01	0.05	0.04	0.06
B3	0.07	0.10	0.13	0.44
B4	0.00	0.01	0.02	0.07
B5	0.10	0.26	0.41	0.57
C6	0.01	0.01	0.06	0.24
C7	0.00	0.01	0.00	0.00
C8	0.01	0.00	0.02	0.00
C9	0..91	0.94	0.99	1.00

Note: The columns LB(1), LB(2), LB(4) and LB(8) contain the p-values for which we reject/cannot reject the null hypothesis of no serial correlation. A value lower than 0.05 signals serial-correlation issues.

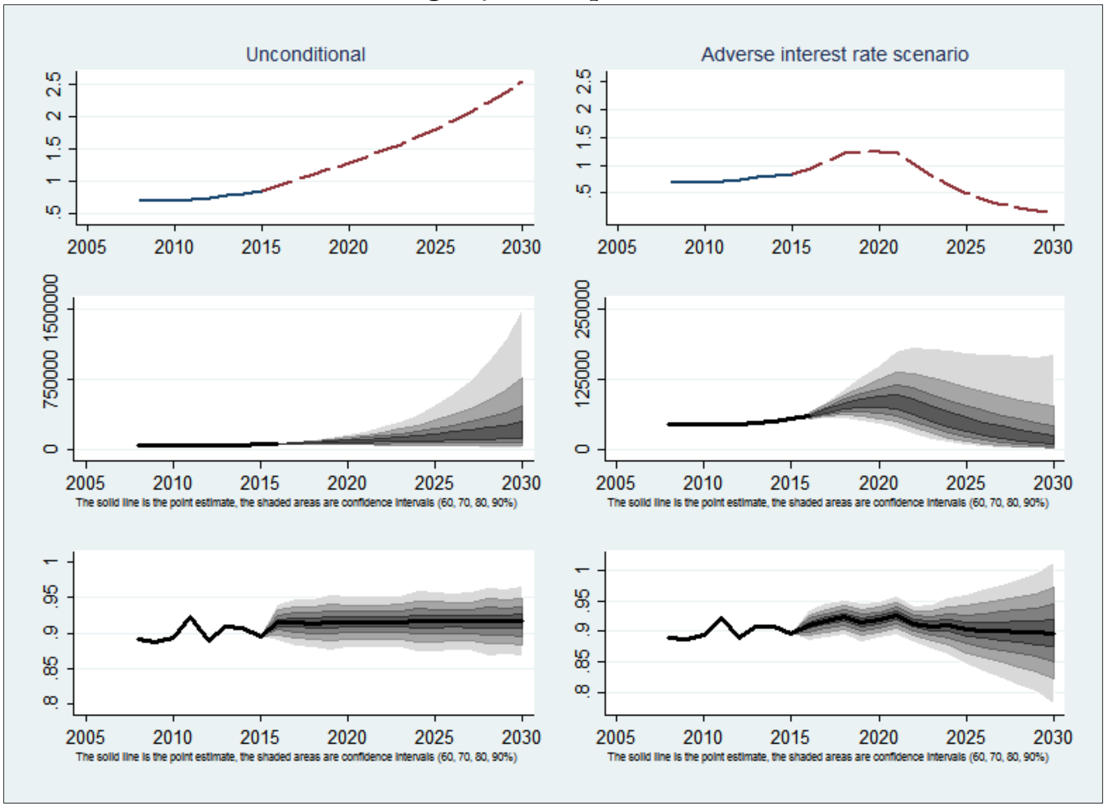
Appendix A3 – Comparison with GMM estimation

Dependent variable	Lagged variable	A1		A2		B3		B5		C6		C9	
		p-VAR	**VAR**	**p-VAR**	**VAR**	**p-VAR**	**VAR**	**p-VAR**	**VAR**	**p-VAR**	**VAR**	**p-VAR**	**VAR**
Cost of capital (r)	r	1.29	0.81	0.53	0.61	0.85	0.74	0.58	0.54	0.30	0.36	-3.01	0.43
	g	0.25	0.02	0.21	0.03	0.09	0.03	0.05	0.02	0.12	-0.03	-1.85	0.03
	c	1.03	-0.6	1.12	0.01	0.53	0.01	0.51	-0.01	0.99	-0.05	-17.32	-0.04
	d	-0.16	0.01	-0.09	-0.01	-0.01	-0.01	0.00	0.00	-0.07	0.00	0.23	0.00
Income growth rate (g)	r	0.58	0.39	0.21	0.12	1.34	0.49	0.43	0.27	0.31	0.11	2.23	0.41
	g	0.03	0.00	-0.30	-0.25	0.00	-0.17	-0.36	-0.37	-0.32	0.04	0.63	-0.25
	c	0.39	0.36	-0.16	0.39	1.37	0.05	-0.37	0.04	-0.79	-0.22	7.84	0.01
	d	0.04	0.06	0.06	0.03	0.20	0.19	0.01	0.01	0.09	0.05	-0.07	0.04
Expenses as a fraction of income (c)	r	-0.45	-0.01	0.01	-0.03	0.21	0.03	0.26	0.04	-0.21	-0.15	-0.02	-0.21
	g	-0.35	0.05	0.03	0.11	0.09	0.07	-0.06	-0.04	0.19	-0.054	0.10	0.06
	c	-1.38	0.56	0.49	0.65	0.72	0.67	0.34	0.13	1.42	0.69	1.09	0.62
	d	0.35	0.00	-0.01	-0.02	-0.01	-0.02	0.01	0.01	-0.09	-0.04	-0.01	0.00
Debt growth rate (d)	r	-4.4	-1.99	0.07	-0.11	-0.87	-0.81	7.94	8.61	0.04	-0.06	14.62	0.17
	g	-1.13	-0.23	-0.60	0.06	-0.93	-0.05	-0.91	-0.40	-0.54	-0.17	7.69	-0.13
	c	-3.83	0.47	-2.83	0.72	-5.92	0.05	-10.63	0.18	-2.13	0.24	72.19	0.72
	d	0.82	0.13	0.39	0.10	0.20	0.07	-0.07	-0.07	0.25	0.08	-1.02	-0.09
Stability		No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	No	Yes

Note: The Table shows the coefficient on the "Lagged Variable" in the equation of the "Dependent Variable" for the VARs on groups A1, A2, B3, B5, C6 and C9. The column "p-VAR" show the value of the coefficient obtained by GMM estimation. The column "VAR" shows the value of the coefficient obtained by the grouped-VAR model used to produce the results of the thesis.

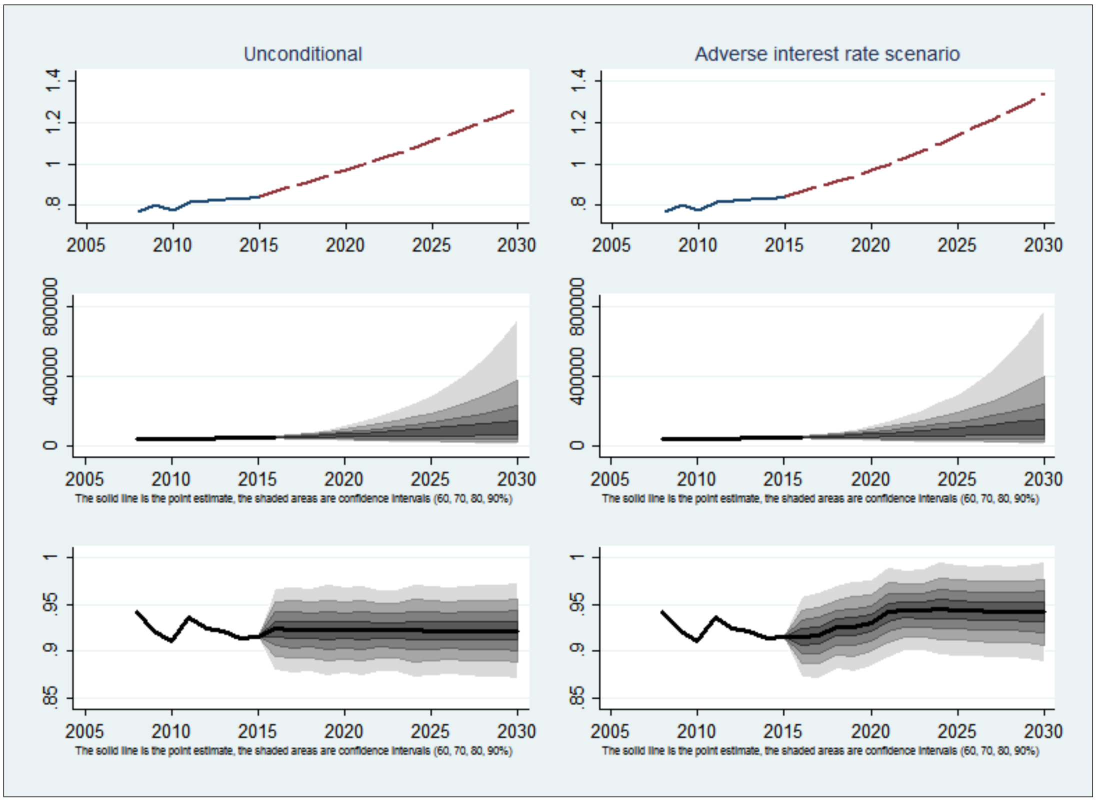
Appendix A4 – Forecasts for the split sample

A1 – Big city municipalities

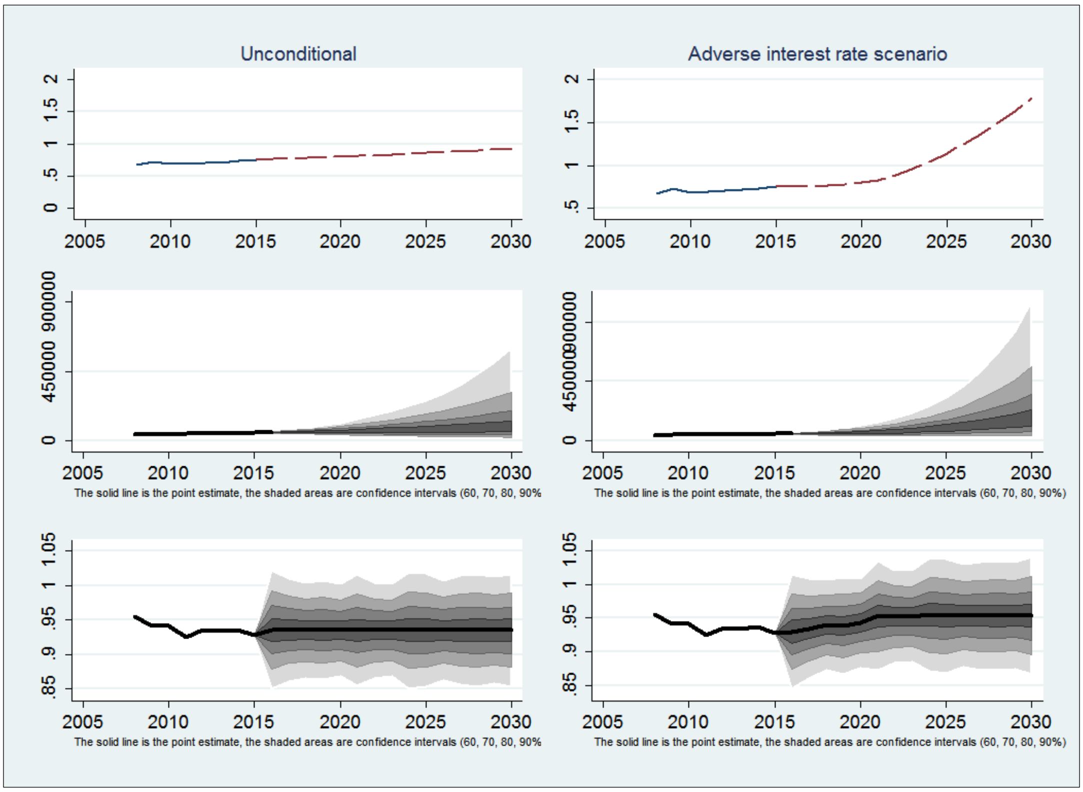


Notes: The top two panels show the evolution of the debt-to-income ratio under the unconditional and the adverse interest rate scenario, respectively. The middle two panels show the aggregate stock of debt in SEK per capita and the lower two panels show welfare and interest expenses as a fraction of income.

A2 – Commuter municipalities near big cities

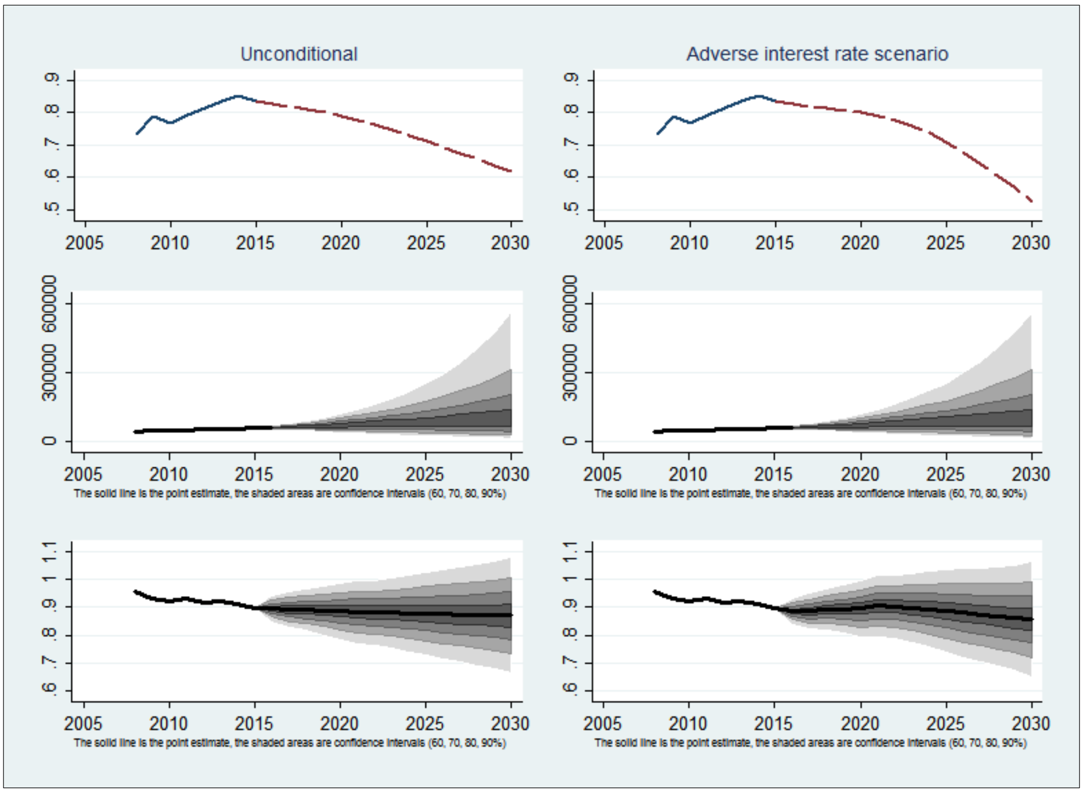


B5 – Low-commuting municipalities near cities

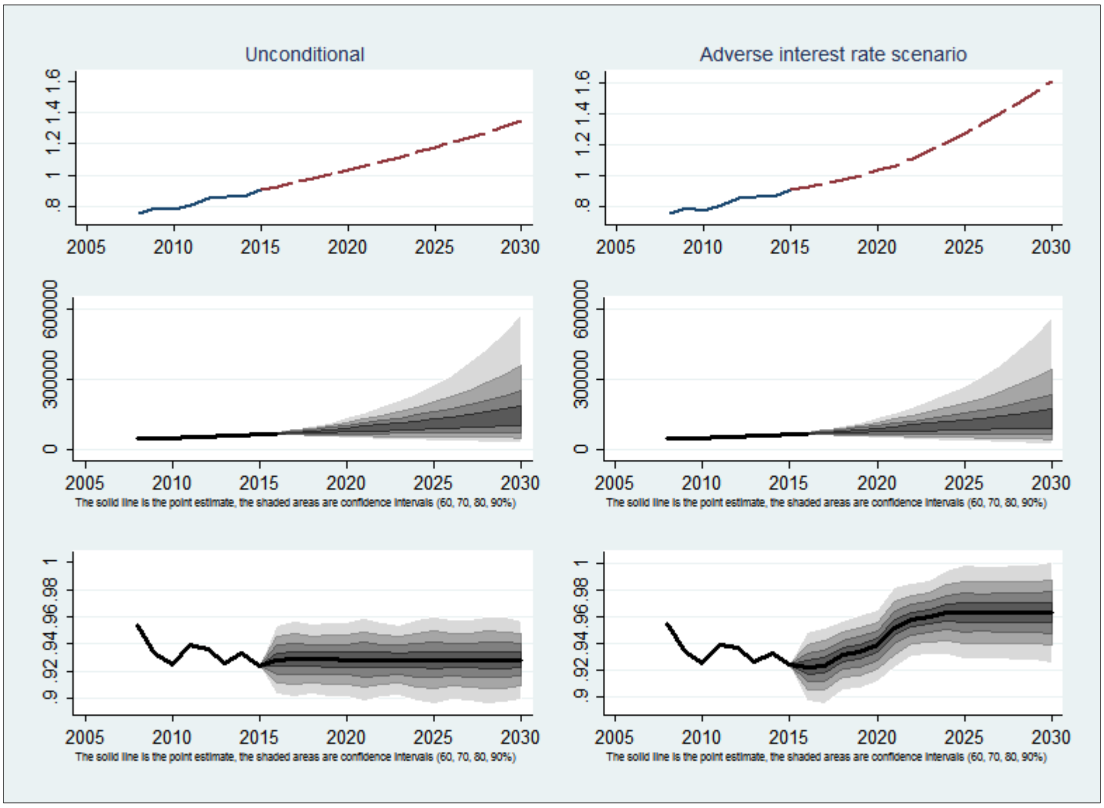


Notes: The top two panels show the evolution of the debt-to-income ratio under the unconditional and the adverse interest rate scenario, respectively. The middle two panels show the aggregate stock of debt in SEK per capita and the lower two panels show welfare and interest expenses as a fraction of income.

C6 – Smaller city municipalities



C9 – Countryside municipalities with a tourism industry



Notes: The top two panels show the evolution of the debt-to-income ratio under the unconditional and the adverse interest rate scenario, respectively. The middle two panels show the aggregate stock of debt in SEK per capita and the lower two panels show welfare and interest expenses as a fraction of income.

Appendix A5 – Bottom line coefficients for the internally valid models + A1

Dependent variable	Variable	A1		A2		B3		B5		C6		C9	
		Inst.	**L(1)**	**Inst.**	**L(1)**	**Inst.**	**L(1)**	**Inst.**	**L(1)**	**Inst.**	**L(1)**	**Inst.**	**L(1)**
Cost of capital (r)	r	1	0.81	1	0.61	1	0.74	1	0.54	1	0.36	1	0.43
	g	..	0.02	..	0.03	..	0.03	..	0.02	..	-0.03	..	0.03
	c	..	-0.6	..	0.01	..	0.01	..	-0.01	..	-0.05	..	-0.04
	d	..	0.01	..	-0.01	..	-0.01	..	0.00	..	0.00	..	0.00
Income growth rate (g)	r	-1.04	0.39	-0.03	0.12	-0.50	0.49	-0.03	0.27	0.14	0.11	-0.09	0.41
	g	1	0.00	1	-0.25	1	-0.17	1	-0.37	1	0.04	1	-0.25
	c	..	0.36	..	0.39	..	0.05	..	0.04	..	-0.22	..	0.01
	d	..	0.06	..	0.03	..	0.19	..	0.01	..	0.05	..	0.04
Expenses as a fraction of income (c)	r	1.19	-0.01	0.00	-0.03	0.25	0.03	0.06	0.04	-0.04	-0.15	0.13	-0.21
	g	0.65	0.05	0.45	0.11	0.13	0.07	0.06	-0.04	0.34	-0.054	0.10	0.06
	c	1	0.56	1	0.65	1	0.67	1	0.13	1	0.69	1	0.62
	d	..	0.00	..	-0.02	..	-0.02	..	0.01	..	-0.04	..	0.00
Debt growth rate (d)	r	3.20	-1.99	0.90	-0.11	2.99	-0.81	12.95	8.61	0.52	-0.06	3.15	0.17
	g	-0.70	-0.23	-0.20	0.06	-0.04	-0.05	0.01	-0.40	-0.18	-0.17	-0.50	-0.13
	c	-1.96	0.47	-1.44	0.72	-0.35	0.05	-0.13	0.18	-0.47	0.24	-0.01	0.72
	d	1	0.13	1	0.10	1	0.07	1	-0.07	1	0.08	1	-0.09

Notes: The entries show the coefficient on the "Variable" in the equation of the "Dependent variable", for VARs on groups A1, A2, B3, B5, C6 and C9. The "Inst." column shows the value of the instantaneous coefficient and the L(1) shows the coefficient of the variable with one lag.

Appendix A6 – Grouping

A1	**(200 000 inhabitants in the main urban centre)**	
Stockholm	Gothenburg	Malmö
A2	**(At least 40% of the inhabitants commute to A1)**	
Upplands Väsby	Sundbyberg	Staffanstorp
Vallentuna	Solna	Burlöv
Österåker	Lidingö	Vellinge
Värmdö	Vaxholm	Kävlinge
Järfälla	Sigtuna	Lomma
Ekerö	Nynäshamn	Svedala
Huddinge	Håbo	Skurup
Botkyrka	Bollebygd	Trelleborg
Salem	Lilla Edet	Kungsbacka
Haninge	Mölndal	Härryda
Tyresö	Kungälv	Partille
Upplands-Bro	Alingsås	Äckerö
Täby	Nacka	Stenungsund
Danderyd	Lerum	Ale
B3	**(At least 40 000 and at most 200 000 inhabitants in the main urban centre)**	
Södertälje	Växjö	Borlänge
Uppsala	Lund	Gävle
Eskilstuna	Helsingborg	Sundsvall
Linköping	Halmstad	Östersund
Norrköping	Trollhättan	Umeå
Jönköping	Borås	Luleå
Örebro	Karlstad	Västerås

B4	**(At least 40% of the inhabitants commute to B3)**	
Nykvarn	Lessebo	Eslöv
Älvkarleby	Alvesta	Ängelholm
Knivsta	Svalöv	Laholm
Heby	Örkelljunga	Färgelanda
Tierp	Bjuv	Grästorp
Gnesta	Sjöbo	Mark
Strängnäs	Hörby	Svenljunga
Trosa	Höör	Kil
Åtvidaberg	Perstorp	Hammarö
Söderköping	Klippan	Forshaga
Mjölby	Åstorp	Grums
Aneby	Landskrona	Lekeberg
Mullsjö	Höganäs	Hallsberg
Habo	Timrå	Kumla
Vännäs	Krokom	Nora
Gagnef	Nordmaling	Surahammar
Säter	Bjurholm	Hallsthammar
B5	**(Less than 40% of inhabitants commute to B3)**	
Enköping	Hylte	Säffle
Östhammar	Tranemo	Laxå
Flen	Herrljunga	Askersund
Kinda	Lysekil	Lindesberg
Finspång	Uddevalla	Sala
Valdemarsvik	Ulricehamn	Köping
Motala	Munkfors	Ockelbo
Vaggeryd	Kristinehamn	Hofors
Nässjö	Robertsfors	Sandviken

Tranås	Älvsbyn	Bräcke
Uppvidinge	Boden	Berg
Tingsryd	Vindeln	
C6	**(At least 15 000 and at most 40 000 inhabitants in the main urban centre)**	
Norrtälje	Ystad	Skövde
Nyköping	Kristianstad	Falköping
Katrineholm	Hässleholm	Karlskoga
Värnamo	Falkenberg	Falun
Ljungby	Varberg	Avesta
Kalmar	Mariestad	Hudiksvall
Oskarshamn	Lidköping	Härnösand
Västervik	Karlshamn	Örnsköldsvik
Gotland	Piteå	Skellefteå
Karlskrona	Kiruna	
C7	**(At least 30% of the inhabitants commute to C6)**	
Vingåker	Olofström	Vara
Oxelösund	Ronneby	Götene
Ödeshög	Sölvesborg	Tibro
Ydre	Östra Göinge	Töreboda
Boxholm	Tomelilla	Skara
Vadstena	Bromölla	Hjo
Gnosjö	Osby	Tidaholm
Sävsjö	Simrishamn	Storfors
Eksjö	Tjörn	Degerfors
Älmhult	Orust	Ljusnarsberg
Markaryd	Munkedal	Skinnskatteberg
Högsby	Vårgårda	Kungsör
Torsås	Essunga	Norberg
Mörbylånga	Karlsborg	Fagersta

Hultsfred	Gullspång	Arboga
Mönsterås	Mellerud	Smedjebacken
Emmaboda	Nybro	Hedemora
Nordanstig		
C8	**(Less than 15 000 inhabitants in the main urban centre and limited commuting)**	
Gislaved	Mora	Strömsund
Vetlanda	Ludvika	Norsjö
Vimmerby	Ovanåkker	Malå
Dals-Ed	Ljusdal	Sorsele
Bengtsfors	Söderhamn	Dorotea
Åmål	Bollnäs	Vilhelmina
Torsby	Ånge	Åsele
Årjäng	Kramfors	Lycksele
Sunne	Sollefteå	Arvidsjaur
Filipstad	Ragunda	Jokkmokk
Hagfors	Pajala	Överkalix
Arvika	Gälivare	Kalix
Hällefors	Haparanda	Övertorneå
Vansbro		
C9	**(Countryside municipalities with a certain level of guest nights at hotels per inhabitant)**	
Borgholm	Leksand	Åre
Båstad	Rättvik	Härjedalen
Sotenäs	Orsa	Storuman
Tanum	Älvdalen	Arjeplog
Strömstad	Eda	Malung-Sälen