Household Expectations and the Credit Cycle

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Abstract

The paper investigates the role of expectations in the household credit cycle. First, I provide empirical evidence that survey data on expectations have strong predictive power for the dynamics of household debt. Optimism on future income predicts an increase in credit, in line with the permanent income hypothesis. Second, I show that beliefs depart from rationality at the aggregate level in a way coherent with the hypothesis of natural expectations (Fuster et al. 2010). Then, I provide a tractable model that accounts for these two pieces of evidence and investigate the implications of non-rational expectations on credit. I study a consumption-savings model in which a representative agent has natural expectations. In this economy, a positive shock to income generates a boom-bust cycle in debt as observed in the data. The consumer fails to forecast long-run income and gets over-indebted; eventually, expectations adjust and debt declines. Overall, the model's predictions match well the positive correlation between debt and income which cannot be captured with rational expectations nor with alternative beliefs hypotheses.

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1 Introduction

The financial crisis has revealed the need to rethink the role of household debt in macroeconomic models, which is especially important given the dramatic expansion in the household credit to GDP ratio over the last 50 years in advanced economies Recent studies provide empirical evidence on the relationship between credit and economic activity. Mian, Sufi, and Verner (2017) show that a rise in the household debt to GDP ratio predicts lower output growth over the medium term, and Jordá, Schularick and Taylor (2013) document that intensive credit expansions tend to be followed by deep recessions and slow recoveries. These results inform that policy-makers should look at household credit and incorporate it into a broader policy framework; but what drives credit boom-bust episodes?

The existing literature focuses intensely on the role of credit supply shocks and the effects of macroeconomic frictions. In particular, researchers in macro-finance rely on rational expectations and exogenous credit supply shocks so that expansions in credit supply lead to an increase in debt and consumption, whereas credit tightening to a reduction in output growth. Quantitative analysis, however, indicates that under rational expectations credit supply and housing preferences shocks cannot account for the boom-bust in credit observed during the financial crisis (Justiniano, Primiceri, and Tambolotti, 2015). These findings suggest the presence of alternative explanations. In this paper, I study the role of households' expectations in the demand side and propose a complementary channel. As documented in the existing literature, credit supply shocks are relevant factors for understanding the household credit cycle, but non-rational expectations in the demand side are additional elements not investigated yet. Building on the principle that expectations influence decisions, optimism may generate an expansion in credit and consumption and lead to a crisis when such confidence declines. Plotting the Consumer Sentiment Index and the Personal Saving Rate for the period 1978-2016, we observe that the saving rate tend to decrease when the Consumer Sentiment Index is high and increase when the index drops (Figure 1). On the contrary, the Consumer Sentiment Index and the Total Consumer Credit flow appear to follow the same pattern suggesting that households expectations data may be useful to understand the credit cycle.[1] How expectations are formed and how they affect macroeconomic dynamics remain open questions that I address in this paper.

The novelty of the paper is to investigate the role of expectations in the household credit cycle regardless of credit frictions, heterogeneity, house prices, or credit supply. Although there are

[1]There is a negative and significant correlation between the Personal saving rate and the Consumer confidence index (-0.5) and a positive one between the Total consumer credit flow and the Consumer confidence index (0.45).

few studies analyzing the relationship between households' expectations and consumption, no papers focus on the link between households expectations and debt, using survey data.[2] The study focuses on beliefs on future income and consumer credit, defined as the total credit extended to individuals, excluding loans secured by real estate; the aim is indeed to explain the reasons behind the sharp increase in consumer credit in the last 50 years and to understand why during booms consumers increase debt in the first place. My contribution to the literature is threefold. First, I provide some empirical evidence that expectations data on future economic activity are strong predictors of household debt. Survey data on expectations are useful to understand the dynamics of consumer credit and are not meaningless noise. The predictions are in line with the permanent income hypothesis so that optimism on future economic growth predicts an increase in household debt. Second, using survey data, I investigate how beliefs are formed and show that expectations depart from the rational benchmark displaying rigidity at the aggregate level in a way coherent with the theory of natural expectations, as proposed by Fuster et al. (2010). Natural expectations imply that agents have wrong beliefs about the real process of the fundamental and over-estimate the persistence of the process so that they are excessively optimistic in good times and pessimistic in bad times. Finally, I develop a theoretical model that accounts for both pieces of the empirical evidence that allows investigating the implications of non-rational expectations on the debt dynamics. In this economy, shocks to income affect expectations which in turn drive household debt. A positive shock to income generates a boom-bust cycle in debt as observed in the data. The representative consumer fails to forecast long-run income, gets over-optimistic and over-indebted; eventually, expectations adjust and debt declines. Overall, the model's predictions match well the positive correlation between debt and income and a negative correlation between current debt to real GDP and future income growth that cannot be captured with rational expectations nor with alternative beliefs hypotheses.

I begin by documenting that survey forecasts on future growth have substantial predictive power for household debt, savings, and consumption, using data from the Survey of Professional Forecasters (SPF) over the period 1968:Q4-2016:Q1. The predictability is considerable in magnitude: a one standard deviation increase in expected real GDP (RGDP) growth is associated with an increase in credit growth of 2.44 percentage points over the next year; this result is significant considering that, over the spanned period, the annual credit growth is on average 7.7%. These results are coherent with the predictions of the permanent income hypothesis (PIH), according to which household debt is driven by expected future income growth and the willingness to smooth consumption over time. The findings are consistent using consumers' expectations on future economic conditions from the Survey of Consumers by the University of Michigan. Further, the relation is robust across time,

[2]Other papers instead focus on mortgages, the role of collateral and extrapolative expectations on house prices (i.e. Gleaser and Nathanson, 2015).

countries and specifications. Therefore, the 2000s' boom in household debt and the Great Recession in the USA are not the unique reasons driving the described results. I conclude that survey data on expectations are a relevant tool to understand the household debt dynamics and are not pure noise.

Since household credit is closely linked to agents' expectations, it becomes crucial to identify possible models of beliefs formation and subsequently develop a theoretical model to investigate the implications of miss-specified beliefs on the credit cycle. Do expectations depart from rationality? How? Exploiting survey data from the SPF, I show that expectations depart from the rational benchmark in a way coherent with the natural expectations hypothesis. Specifically, I show that the US RGDP exhibits (partial) mean reversion, as assumed from the model, and agents use a simple autoregressive rule to predict future growth. Further, following the work by Coibion and Gorodinchenko (2012), I test the full information rational expectations hypothesis (FIRE) studying the forecast errors and forecast revisions predictability and find evidence that expectations depart from the rational benchmark in favour of models with non-rational extrapolative beliefs and aggregate rigidity at the aggregate level.

In the last section, I introduce natural expectations in a consumption-saving model and compare the predictions of the model with those obtained assuming rationality. The model accounts for the described empirical factors. First, according to the PIH, the model predicts a positive relationship between expectations on future income and household debt. Second, natural expectations are coherent with the results of non-rational extrapolative expectations at the aggregate level. Except for the beliefs, the model is a standard open economy with a representative borrower with no financial or any other friction. Every period the agent updates his forecasts on the future income given the realised income and these beliefs influence his borrowing decisions. In this economy, the agent is rational in the sense that he optimises under the given constraints, but he considers his biased beliefs as correct. Following Fuster et al. (2010), the income process has hump-shaped dynamics, and the agent overestimates the persistence of good (or bad) news. This over-estimation happens because the agent applies a simple autoregressive forecasting rule that does not capture the hump-shaped dynamics of the true process. Positive news on current income induces the agent to over-estimate the long-run income and subsequently to increase the demand for credit leading to over-borrowing relative to the rational case. Eventually, beliefs are disappointed and converge to the rational benchmark and debt decreases, generating a boom-bust cycle in debt. The predictions of the model match well the empirical impulse responses to a shock to RGDP growth, obtained from a VAR in 5 variables, which show that following a positive shock to the RGDP growth, debt jumps on impact and exhibits a hump-shaped path. The model captures the partial mean reversion in debt observed in the empirical impulses; rational expectations, instead, generate a negative correlation between income and debt as an increase in income is associated to an increase in savings. Overall, natural expectations match well some features of the data, such as the positive contemporaneous correlation between income and debt, and the negative correlation between current debt to real GDP and future income growth three years ahead. These features instead cannot be accounted with rational expectations, nor alternative hypothesis expectations, such as noisy signals (Sims, 2003), sticky information (Mankin and Reis, 2002), and adaptive expectations.[3]

Overall, the paper aims at filling the gap on the role of households' expectations in the credit cycles. The paper provides new insights that the theoretical literature on household credit and business cycles should take into account. Exploiting survey data, I document that expectations on future income are non-rational and have significant implications for the credit dynamics. These findings highlight the importance to consider households' non-rational beliefs when studying credit and business cycles. Models that omit the demand side and focus exclusively on credit supply may neglect a relevant component and produce inaccurate predictions.

The remainder of the paper is organised as follows. In Session 2 I briefly discuss the related literature. In Section 3 I describe the expectations data and the consumer credit and macroeconomic data. Section 4 presents the empirical evidence on the link between beliefs on future output and household debt; it shows that survey data are good predictors of household debt and the predictions are in line with the permanent income hypothesis. Section 5 describes the natural expectations hypothesis and provide empirical evidence in favour of this hypothesis. Section 6 presents the theoretical model of natural expectations and household debt. Finally, the last sections summarise the main conclusions.

2 Related literature

The paper is related to several strands of research. First of all, to the natural expectation theory as proposed by Fuster et al. (2010). That paper introduces a parsimonious quasi-rational model named natural expectations, and study the consequences on excess returns in a Lucas tree model. The model is extended by Fuster et al. (2012) which investigates the effects of natural expectations on asset prices showing that they generate empirically observed patterns in macroeconomic series. My work adopts their theory but looks at implications of non-rational beliefs on consumer credit.

[3]In the Appendix, I compare the model to alternative hypotheses on expectations, such as noisy signals, sticky information, and adaptive expectations. These hypotheses on beliefs' formation have substantially different implications on long-term expectations and hence on credit responses. Overall, the predictions obtained natural expectations match better the patterns observed in the data.

Hence, I contribute to their work by providing a new application for the natural expectations hypothesis and novel empirical evidence in favour of this theory exploiting survey data.[4]

Second, the paper is linked to the empirical literature on survey expectations data. In macroeconomics, most of the works focus on inflation forecasts (Coibon and Gorodnichenko, 2015; Malmendier and Nagel, 2015; Piazzesi and Schneider, 2012), and only a few extend the analysis to other macroeconomic variables (Souleles, 2004; Kuchler and Zafar, 2016). Using the Survey of Professional Forecasters (SPF), Coibon and Gorodnichenko (2012) document the rejection of full-information rational expectations in the direction of sticky information, as proposed by Mankin and Reis (2002), and noisy information, as Woodford (2003). Agents in these models are perfectly rational but subject to information frictions. Relative to their work, my contribution is to provide a detailed analysis of a different set of macroeconomic variables to understand how beliefs evolve and to map the empirical evidence to the natural expectations hypothesis.

This study is then partially related to the literature that explores the link between financial markets and the real economy through the debt-driven consumption channel. This strand focuses mainly on the role of credit supply shocks with nominal rigidities (Eggertsson and Krugman, 2012; Guerrieri and Lorenzoni, 2015), demand externalities (Bianchi, 2011; Bianchi and Mendoza, 2015) or preference shocks. However, the quantitative analyses suggest that credit supply and preference shocks are not able to account for the boom and bust in private credit observed during the financial crisis (Justiniano, Primiceri, and Tambolotti, 2015); therefore, other mechanisms may be behind the dynamics of credit. Further, those models fail to account for predictable forecast errors and rely on rational expectations and exogenous financial or preference shocks.

On the other hand, researchers in finance revived the old argument (e.g. Minsky, 1977) that investors sentiment drives credit supply. The literature on behavioural credit cycle (Greenwood, Hanson, and Jin, 2016; Bordalo et al., 2016; López-Salido et al., 2016) discards the rational expectation hypothesis to explain the dynamics of credit supply. Similarly to these works, I discard the rational expectation hypothesis; but I look at the demand side and focus on households' biased beliefs rather than investors'. I introduce a risk adverse household who makes consumption-savings choices, as opposed to a risk-neutral investor who needs to finance risky projects. The aim of this paper is indeed to explain how biased beliefs on the future income affect demand for credit, without looking at the supply of funds to firms.

Finally, this paper is related to the macroeconomic literature on expectations shocks. This

[4]Further, I focus on beliefs on future income rather than on future house prices as in Pancrazi and Pietrunti (2014).

literature maintains the assumption of rational expectations and introduce exogenous shocks to justify shifts in optimistic or pessimistic beliefs. These papers add either a confidence shock, as in Angeletos et al. (2015), noise shocks (Lorenzoni, 2009) or both noise and news shocks (i.e. Barsky and Sims, 2012).[5] Here, instead, I look at shifts in beliefs driven by changes in the fundamentals rather than exogenous sentiment shocks. For this reason, the paper is closely linked to the literature on behavioural biases and, in particular, to the natural expectations theory.

3 Data

The empirical analysis focuses on two categories of data: (1) expectations data (consumers' and professional forecasters'), and (2) data on macroeconomic variables, households debt, and savings. Data are available at quarterly frequencies.

3.1 Expectations data

3.1.1 Professional forecasters expectations (SPF)

Data on professional forecasters expectations come from the quarterly U.S. Survey of Professional Forecasters (SPF) provided by the Federal Reserve Bank of Philadelphia. The survey began in 1968: Q4; some variables have been in the study since the beginning of the survey, while others were added in 1981: Q3. The forecasters provide projections for five quarters for several macroeconomic variables, including Real GDP growth rate (RGDP), Civilian Unemployment Rate (UNEMP), 3 Months Treasury Bill Rate (3MTBill), Price Index for the GDP (PGDP), and 10 years Treasury Bond (10YTBond). Specifically, respondents are asked to indicate their forecast for the current quarter - the quarter in which the survey is conducted - and the following four quarters. Expectations are aggregated by the average across forecasters' responses. Further, I average forecasts over 4 quarters ahead to obtain 4-quarters forecasts; this procedure allows to reduce the noise and make them comparable to the Survey of Consumers data and the literature.[6] In the Appendix, I also use the data on the forecasts for the annual average rate of growth in real chain-weighted GDP over the

[5]Recently, Boz and Mendoza (2012) considered the role of expectations on the ability to borrow, while Kaplan et al. (2016) studied the role of beliefs about future house price growth in the credit cycle. In this paper, I investigate the link between expectations and household debt, without relying on the role of the collateral or house prices.

[6]To get expectations on the RGDP growth rate over the next year, I use the SPF data on the RGDP Annualized Percent Change of Mean Responses which reports the forecast for quarter-over-quarter growth in period t over several horizons. Then, I compute the geometric mean of the expected forecast for the next 4 quarters (as in Coibion and Gorodnichenko, 2015).

next 10 years. The analysis focuses on the expected RGDP growth rate and unemployment rate; Table 1 reports the descriptive statistics for these two measures.

3.1.2 Household expectations by the Survey of Consumers

Data on household expectations come from the Survey of Consumers by the University of Michigan. The survey asks respondents about the predicted direction of future changes in the unemployment rate, the interest rate, and the business conditions over the next 12 months and collects qualitative answers.[7] At the aggregate level, I use quarterly time series, reporting the relative share of agents who give a particular answer; i.e.for the Expected Change in Business condition in 1 year,the index is computed as the fraction of agents that expects the Business condition to be better over the next year minus fraction of agents that the expects the Business condition to be worst over the next year plus 100. Concerning the expectations on future unemployment, instead, I look at the fraction of agents who expect the unemployment to increase. Aggregate data are available at the quarterly frequency from 1968:Q4 to 2016:Q2.

3.1.3 Professionals' and households' expectations: correlation

The empirical analysis focuses mainly on data by the SPF for two reasons. First, this data allows making quantitative predictions, which cannot be obtained using the Survey of Consumers by the University of Michigan given the qualitative nature of the data.[8] Second, professional forecasters are some of the most informed economic agents, so they can provide a conservative benchmark for assessing potential deviations from full-information rational expectations.

Households' and professional forecasters' expectations are highly positively correlated with each other. Table 2 reports partial correlations between the different measures of expectations for the variables of interest. Most relationships are positive and significantly different from zero. For instance, the average correlation between Michigan "Expected Change in Business Conditions in 1

[7]For instance, respondents are asked: *Now turning to business conditions in the country as a whole – do you think that during the next 12 months we will have good times financially or bad times or what?* Answer: *Good times, Uncertain, Bad times.*

[8]The first best for the analysis is to test the rational expectation hypothesis on households' expectations; however, to my knowledge, no quantitative data on consumers' expectations is available for a sufficiently long series. Further, the quantitative feature of the data is particularly important when testing rationality.

Year" and the SPF RGDP growth rate over the next year is 63%.[9]

The high degree of correlation between the time series suggests that survey data contain shared beliefs on the aggregate state of the economy; this evidence goes against a common criticism on survey data on expectations that are believed to be noisy and meaningless, as described by Greenwood and Shleifer (2014). Figure 2 plots the Michigan "Expected Change in Business Conditions in 1 Year" and the SPF RGDP growth rate over the next year and documents that the two series follow the same pattern. To confirm that professional forecasters expectations are a good proxy for households expectations, I regress the Michigan consumers expectations on the SPF data, controlling for the business cycle (Table 3). Specifically, I use as controls (i) the US Business Cycle Expansions and Contractions[10] and (ii) the Real GDP growth rate. The positive relationship between the professional forecasters and consumers expectations is not driven by the trend but survives within the business cycle. These results suggest that it is reasonable to extend the results obtained with the SPF data to consumers' expectations.

3.2 Consumer credit and macroeconomic data

Survey data are merged with a database containing the historical values of the variables object of the forecast and additional macroeconomic variables. I use data from different sources. The Federal Reserve Bank of Philadelphia itself provides third release data for the variables object of the forecast. Data on additional macroeconomic variables at quarterly frequency are from the Federal Reserve Economic Data (FRED) by the Federal Reserve Bank of St. Louis. I collect aggregate data on consumer credit from the Consumer Credit (G.19) database provided by the Federal Reserve Board. Data on Total Consumer Credit Outstanding (hereafter Household credit) in levels are available at a monthly frequency and span the period 1943:Q1-2016:Q2.[11] For the empirical analysis, I reconstruct quarterly data in levels and percentage changes quarter-over-quarter and year-over-year. Total Consumer Credit Outstanding which covers most credit extended to individuals, excluding loans secured by real estate. Data on Personal consumption expenditures and Personal saving rates instead are from the Federal Reserve Bank of St. Louis. The former measures

[9]The correlation is lower for the expected interest rate and the unemployment rate. The former fact may be because Survey of Consumers asks respondents about the Prime rate, while the SPF asks about the 3 Months Treasury Bill Rate (or 10YTBond). Similarly the latter may be because the SPF measures the expected unemployment rate, while the latter measures the expected change in unemployment; in this case indeed the correlation is not significant.

[10]The time series indicates the US Business Cycle Expansions and Contractions as defined by the National Bureau of Economic Research (NBER). This is a dummy variable that is equal to 1 during recessions and 0 during expansions.

[11]I use the series: Total consumer credit owned and securitized, seasonally adjusted level. Further, I collect data on Mortgages from the same source.

goods and services purchased by U.S. residents. The latter is the personal saving as a percentage of disposable personal income (DPI). To calibrate the US RGDP process, I use the FRED series Real Gross Domestic Product in Billions of Chained 2009 Dollars, Quarterly, Seasonally Adjusted (GDPC96). Finally, the other macroeconomic variables are provided by the FRED; these are the unemployment rate (UNRATE), the 3MTBill (TB3MS), the 10YTBond (GS10) and the consumer price index (CPIAUCSL).

4 Expectations data and household debt

In this section, I show that survey data on expectations are good predictors of household debt. Optimism on future RGDP growth anticipates future consumer credit growth as predicted by the permanent income hypothesis.

4.1 Do beliefs on future output help predict changes in household debt?

I begin by testing the link between expectations and consumers' credit. I use a forecasting framework to answer the question: do beliefs on future output help predict changes in household debt in the short run? Formally, I estimate variants of the following regression using quarterly U.S. data:

$$D_{t,t+4} = \alpha + \beta E_t(RGDPgr_{t,t+4}) + \delta(L)Z_t + \gamma(L)D_{t,t+4} + u_{t,t+4} \qquad (1)$$

Where $E_t(RGDPgr_{t,t+4}) = E_t(RGDPgr_{t,t+4}|I_t)$ denotes the SPF average forecast, made at time t, of Real GDP growth rate (RGDP gr) over the next four quarters. $D_{t,t+4}$ is the percentage change between time t and t+4 of the dependent variable, which can be Household debt, personal savings rate, and personal consumption expenditures. In the baseline specification, Z_t includes contemporaneous macroeconomic variables known at time t (in the information set: $Z_t \in I_t$) that may affect both expectations and households credit, like unemployment, GDP, Consumer Price Index, long and short-term interest rate.[12] All specifications include two lags of the dependent variable:

[12]Results are very similar when controlling for lagged variables assuming that agents have information only on the previous quarter when forming their forecasts ($Z_t \notin I_t$).

these lags ensure that mean reversion of the dependent variable is not driving our results.[13] β is the primary object of study to test whether expectations are informative. According to the permanent income hypothesis (PIH), there is a positive relationship between the expected future growth and household debt growth. Further, expectations on future RGDP growth have opposite effects on savings and credit; agents increase debt when they expect the permanent income to grow and otherwise expand savings when they expect it to decrease. These predictions hold regardless of how expectations are formed.

Expectations on future real GDP growth have substantial forecasting power for realised household credit growth. Table 4 (Panel A) reports the baseline results from OLS regressions.[14] In Columns (1) and (4) the dependent variable is Household credit; this measure covers most credit extended to individuals, excluding loans secured by real estate; Column (2) refers to the Personal savings rate, and Column (3) to Personal consumption expenditures. The coefficient β_{debt} is positive and always significantly different from zero; while the estimated coefficient $\beta_{savings}$ has a negative sign, as predicted by the theory. Changes in expected future growth have substantial forecasting power for household debt: a one standard deviation increase in expected RGDP is associated with an increase in credit growth of 2.44 percentage points. This result is significant considering that, over the spanned period, the annual credit growth is on average 7.7%; hence, the increase corresponds to 32% of the average credit growth. The effect is greater on credit than consumption; a one standard deviation increase in expected output growth raises consumption growth by 0.7 percentage points, and the average personal consumption expenditure growth rate is 6.89%. Overall, individuals' forecasts on future economic growth have substantial predictive power for household debt and savings, in the direction predicted by the PIH. SPF expectations alone explain the 27% of the variability of household debt. Further, when controlling for the macroeconomic variables, the increment to the adjusted R^2 that results from augmenting the baseline regression with the SPF expectations is higher than 17 percent. On the contrary, household credit decreases when agents' expect higher unemployment rate (Table 4, Column (7)); a one standard deviation increase in the expected unemployment rate is associated with a reduction in household credit growth of 5.68 percentage points.

Robusteness check. These results are open to a variety of interpretations. One possibility is

[13]The lag structure has been defined to keep it reasonable and according to the information criteria for Household credit, which is the primary variable of interest. In the baseline specification, I consider current expectations to keep the model parsimonious, given the limited number of observations. Formal lag selection criteria (AIC/BIC) suggest including lagged expectations; however, when I include up to 5 lags results do not change significantly, β remains significant, and none of the lagged expectation is significant.

[14]Standard errors in parenthesis are clustered at quarter level.

that expectations reflect pieces of information available at time t, omitted in the regression, that drive household debt. A large number of predictors may be added in the forecasting regression to solve this issue. To address this high-dimensional problem, I adopt a two steps procedure as suggested by Stock and Watson (2002). First, I estimate a time series of the factors from the potential predictors using principal components and 257 macroeconomic variables.[15] Second, I estimate a linear regression including as regressors the estimated factors. Let $D_{t,t+4}$ be the time series of household debt growth rate to be predicted and X_t be an N-dimensional time series of candidate predictors. Let ($D_{t,t+4}$, X_t) admit a factor model representation with r common latent factors F_t,

$$X_t = \lambda F_t + e_t$$
$$D_{t,t+4} = \gamma_t F_t + \delta w_t + \epsilon_{t,t+4}$$

Where e_t is a $nx1$ vector of idiosyncratic disturbances and w_t a $mx1$ vector of observed predictors, including $E_t(RGDPgr_{t,t+4})$. I fix $r = 8$ according to McCracken and Ng (2015) that find eight common latent factors using the same data. Table 4 (Panel A) reports the results of the baseline regression (1) augmented with the estimated common factors.[16] The coefficient of interest β is always positive and significant, suggesting that expectations on future RGDP growth do not exclusively reflect omitted information (Columns (5) and (6)). The same is true for expectations on the future unemployment rate (Column (8)). The 257 macroeconomic variables include forward-looking measures such as stock-market indices; therefore, these results confirm that survey data on expectations are fundamentally different from other forward-looking variables and are helpful to trace household debt.

Expectations or realisations? So far, we have seen that expectations contain meaningful information that helps to predict household debt. This result might be because debt fluctuates in response to other factors, and forward-looking beliefs naturally precede their changes. In particular, expectations may anticipate future realised growth, which in turn drives household debt. To alleviate any concern that the correlation between expected and future growth might be driving the results, I include the future realised RGDP growth rate as control and estimate the following regression:

$$D_{t,t+4} = \alpha + \beta_1 E_t(RGDPgr_{t,t+4}) + \beta_2 RGDPgr_{t,t+4} + \delta(L)Z_t + \gamma(L)D_{t,t+4} + u_{t,t+4} \quad (2)$$

[15]For a detailed description of the data, see the FRED-QD quarterly large macroeconomic databases.

[16]The estimated regressions include all the factors.

The coefficient of interest β_1 remains positive and significant (Table 4, Columns (1) and (2), Panel B). The effect is reduced but remains large in magnitude: one standard deviation increase in SFP expectations increases debt by 2.16 percentage points. Overall, for a given realised state of the economy, preceding optimism over future growth is associated with an increase in household debt growth. Expectations appear to be important determinants of household debt and overtake the realised RGDP growth. As a robustness check, I add as controls the factors recovered as shown in the previous section, over the current (t) and future ($t+4$) quarter.[17] This specification allows controlling for the events that arise at time $t+4$, affect household debt and may be anticipated by the forward-looking beliefs.[18] Indeed, it ensures that fluctuations in expectations are orthogonal to fluctuations in household debt, assuming that: $E_t[u_{t,t+4}|E_t(RGDPgr_{t,t+4}), RGDPgr_{t,t+4}, F_t, F_{t+4}] = 0$. Table 4 (Panel B) confirms the previous results: given the realised growth, an improvement in SPF expectations on future growth leads to an increase of household debt (Columns (3) and (4)). Results are consistent also for the expected unemployment rate (Columns (7) and (8)).

Hints on the theory. These results go in favour of the PIH according to which household debt is driven by expected future income growth and the willingness to smooth consumption over time. At the same time, I can reject alternative models in which household borrow to get liquidity anticipating bad times. If this was the case, in fact, the relation between expectations over future income growth and household debt should have the opposite sign. Further, expectations on future income growth are a key driver of the demand for debt as opposed to realised income, which is not relevant as predicted by the permanent income theory. Given the realised income, optimism leads to an increase in household debt and pessimism to a reduction in debt. These results can be coherent both with models of rational and non-rational expectations in which beliefs drive choices.

Short or long-term expectations? In the analysis, I consider short-term forecasts, while the PIH defines a relation between the forecasts of the long-run income growth and credit. SPF data do not allow to explore this relation since it provides forecasts on RGDP over the next 10 years only at the annual frequency and from 1992. Although only a short time series is available, the correlation between long and short-term expectations is positive and significant (0.5) (see Appendix C). Further, short-term expectations are strongly autocorrelated (0.85); therefore, it is reasonable to approximate the PIH relation using the short-term beliefs.

Additional robustness. Results are consistent with consumers' expectations by the Survey of Consumers. Further, results are consistent across countries, using a panel of 11 countries, and across

[17]Adding as controls the macroeconomic indicators for t and $t+4$, results do not change.
[18]Given the short sample, I don't control for the factors for all quarters from t to $t+4$.

time, on a sub-sample excluding post-2000 data. This evidence suggests that the Great Recession is not driving the previous results (see Appendix B for details). Further, I run a similar exercise using SPF several variables, including 3 Months Treasury Bill Rate, PGDP, and 10 years Treasury Bond. Expectations on this set of variables are not good predictors of household debt when controlling for lagged macroeconomic variables, suggesting that the expected growth and unemployment are the most relevant factors that agents consider when choosing debt. Finally, so far I assumed that a single agent with non-rational expectations represents the economy and hence heterogeneity in beliefs is not key to understand the household credit cycle. In Appendix B, using SPF data, I provide evidence in support of this assumption showing that a small fraction of agents does not drive the positive relationship between household debt and expected income growth observed in Table 4. The results, in fact, are robust when we exclude the most optimistic (or pessimistic) agents.

5 The natural expectations hypothesis

We have seen that expectations on future growth are strong predictors of consumer credit in the short-term, and this result is robust to several specifications. In the light of these findings, it becomes relevant to understand how consumers form beliefs and subsequently develop a theoretical model coherent with the empirical evidence to investigate their impacts on the household credit cycle. In this section, I present the natural expectations hypothesis, as proposed by Fuster et al. (2010) and provide evidence that this hypothesis is coherent with the survey data on expectations.

5.1 Definition

The natural expectations theory is based on two main assumptions. First, the time series of interest y_t, in level or logs, has long-horizon hump-shaped dynamics so that it exhibits (partial) mean reversion in the long run. Second, the representative agent forecasts future changes in y_t by estimating an autoregressive process on Δy_t with few lags of historical changes (and/or a small number of moving average terms) and fails to estimate the medium- long-run properties of y_t. Expectations are not consistent with the true model, but they are empirically disciplined since the agent estimates the parameter using historical data. Let the true data generating process (DGP) for y_t be:

$$y_{t+1} = \phi(L)y_t + \beta(L)\epsilon_t \tag{3}$$

The parameter $\phi(L)$ and $\beta(L)$ are such that the process exhibits (partial) mean reversion in the long run. The agent does not know the true DGP and bases his beliefs on the following forecasting rule:

$$\widetilde{E_t}(\Delta y_{t+1}) = \rho(L)\Delta y_t + \eta_t \tag{4}$$

Here the $\widetilde{E_t}(.)$ is the natural expectations operator. The rule is such that the agent does not capture the hump-shaped dynamics of the true process in equation (3) and the parameters in $\rho(L)$ are estimated using historical data. The agent extrapolates historical data into the future; he is assumed to know the true parameter ρ of the AR(1) model and no uncertainty nor learning on the parameter is in place.[19] Expectations deviate from rationality since they fail to forecast the mean reversion, and over-predict the long-run persistence of positive and negative shocks. Overall predictions are accurate at short horizons but poor at long horizons. Each period, given the realized Δy_t, short and long-term beliefs adjust according to the forecasting rule in (4).

5.2 Why natural expectations? Match with the empirical evidence from survey data

Overall natural expectations are described by few characteristics: (i) expectations are non-rational and extrapolative at the aggregate level, (ii) the true process has an hump-shaped dynamics, (iii) households use simple forecasting rules, (iv) beliefs overestimate the persistence of the true process, and (v) there is a positive relationship between long and short term expectations. In this section, I document that these features are coherent with the empirical evidence.

5.2.1 Testing rationality: forecast error predictability

Natural expectations imply that expectations depart from rationality as they are extrapolative and characterised by frequent updating. The agent extrapolates historical data into the future and assign excessive weights to recent observations. Further, each period expectations adjust according to the observed realisations of Δy_t. Following Coibion and Gorodnichenko (2015), I investigate whether beliefs are systematically biased in a way coherent with the natural expectations hypothesis, testing the predictability of ex-post forecast errors and revisions. Rational expectations imply that agents have full knowledge of the economy and exploit the information optimally; therefore,

[19]Fuster et al. (2010) introduce an additional parameter λ that I assume to be equal to zero, so that intuitive and natural expectations coincide. Further, in their seminal paper, Fuster et al. (2010) provide an example in which y_{t+1} is an AR(2) and the agent estimates an AR(1) on Δy_{t+1} such that: $y_{t+1} = \phi_1 y_t + \phi_2 y_{t-1} + \epsilon_t$, $\Delta y_{t+1} = \rho\Delta y_t + \eta_t$ with $(\phi_1 + \phi_2) < 1$ and $\rho > 0$.

errors and revisions are unpredictable and orthogonal to the information set available to agents at the time the prediction is made.

Let $\Delta y_{t,t+4}$ be the real GDP growth rate between time t and $t+4$ (or the unemployment rate) and consider the following definitions relative to time t:

- Realized value of $\Delta y_{t,t+4}$: $\Delta y_{t,t+4}$
- Average expectations of $\Delta y_{t,t+4}$: $\widetilde{E_t}(\Delta y_{t,t+4})$
- Forecast error on $\Delta y_{t,t+4}$: $\varepsilon_{t,t+4} = Fe_{t,t+4} = \Delta y_{t,t+4} - \widetilde{E_t}(\Delta y_{t,t+4})$
- Forecast revision on $\Delta y_{t,t+4}$: $Fr_{t,t+4} = \widetilde{E_t}(\Delta y_{t,t+4}) - \widetilde{E_{t-1}}(\Delta y_{t,t+4})$
- Forecast revision on $\Delta y_{t-1,t+3}$: $Fr_{t-1,t+3} = \widetilde{E_t}(\Delta y_{t-1,t+3}) - \widetilde{E_{t-1}}(\Delta y_{t-1,t+3})$
- Lagged forecast revision on $\Delta y_{t-1,t+3}$: $Fr_{lag,t-1,t+3} = \widetilde{E_{t-1}}(\Delta y_{t-1,t+3}) - \widetilde{E_{t-2}}(\Delta y_{t-1,t+3})$

Using survey data from the SPF, I construct these measures. Forecast errors are constructed using the third release data, provided by the SPF; this is the best comparison measure since final data may be affected by re-classifications or re-definitions; while first release data are less accurate and are subject to measurement errors. Given these definitions, I run three different tests to check if expectations depart from the full information rational expectations hypothesis (FIRE) and if the natural expectations theory is consistent with the empirical evidence from survey data. Results are reported in Table 5. Specifically, I study the following properties:

1. The agent extrapolates past growth into the future: recent observations are predictors of future forecast errors. To test this assumption I run the following test:

$$\varepsilon_{t,t+4} = \alpha_1 + \beta_1 \Delta y_{t-4,t} + u_{t,t+4} \tag{5}$$

   Under rational expectations, the coefficients α_1 and β_1 are zero. This test is informative of whether expectations are rational or extrapolative. Expectational errors are systematically biased and predictable at the aggregate level, as shown in Column (1). The null of FIRE is rejected at 1% level of statistical significance. The rejection of the null goes in the direction predicted by models with extrapolative expectations, the negative coefficient β_1 shows that agents extrapolate recent observations into the future, so that past observations predict lower future forecast errors.

2. Forecast revisions predict ex-post forecast errors. To test this assumption, I estimate the following regression:

$$\varepsilon_{t,t+4} = \alpha_2 + \beta_2 Fr_{t,t+4} + u_{t,t+4} \tag{6}$$

Under rational expectations, the coefficients α_2 and β_2 are zero since the Fr_t is in the information set at time t. The null hypothesis of rational expectations is rejected, as shown in Column (2), and forecast revisions predict future forecast errors. The positive coefficient β_2, lower than one, implies sluggish forecasts and slow reaction to macroeconomic shocks; positive revisions indeed are associated with a rise in the forecast error meaning that expectations adjust but not enough. The positive coefficient is consistent with the natural expectations hypothesis under some assumptions on the parameters. For instance, let $\Delta y_{t+1} = \beta(L)\epsilon_t$ and $\widetilde{E_t}(\Delta y_{t+1}) = \rho\Delta y_t + \eta_{t+1}$. Then $\beta_1 > \rho$ implies a positive relationship between the forecast errors and the forecast revisions as the one observed in the data. Table 6 shows the estimates for the ARIMA(1,1,0), ARIMA(0,1,11) and ARIMA(0,1,18) for the quarterly US RGDP; the estimated coefficients are such that $\beta_1 > \rho$.

3. Current forecast revisions predict future forecast revisions. Finally, I run the following test:

$$Fr_{t-1,t+3} = \alpha_3 + \beta_3 Fr_{lag,t-1,t+3} + u_{t-1,t+3} \tag{7}$$

Rationality implies α_3 and β_3 equal to zero since the forecast revision should be unpredictable given the information set at time t; while a positive β_3 implies persistent and smooth adjustment. Column (3) shows that forecast revisions are predictable. Further, it provides evidence in favour of sluggish expectations, as an upward revision at time $t-1$ predicts a positive update at time t. The positive sign of the coefficient is coherent with the natural expectations hypothesis under some assumptions on the parameters. These conditions are satisfied when considering an ARIMA(1,1,0) and an ARIMA(0,1,18) (or an ARIMA(0,1,11)) for the expected and realized quarterly US RGDP, as reported in Table 6.[20]

[20] Let $\Delta y_{t+1} = \beta(L)\epsilon_t$ and $\widetilde{E_t}(\Delta y_{t+1}) = \rho\Delta y_t + \eta_{t+1}$. Assume $\Delta y_0 = \widetilde{E_0}(\Delta y_t) = 0$ for any $t > 0$ and $\Delta y_1 = e_1 > 0$. At time t=1, the agent observes Δy_1 and $Fe_1 = \Delta y_1 - \widetilde{E_0}(\Delta y_1) = \Delta y_1 = e_1 > 0$ and slowly adjust his forecasts upward such that $Fr_2 = \widetilde{E_1}(\Delta y_2) - \widetilde{E_0}(\Delta y_2) = \rho e_1 > 0$. At time t=2, under the assumption that $\beta_1 > \rho$, $Fe_2 = \Delta y_2 - \widetilde{E_1}(\Delta y_2) = (\beta_1 - \rho)e_1 > 0$ and $Fr_3 = \widetilde{E_2}(\Delta y_3) - \widetilde{E_1}(\Delta y_3) = e_1\rho(\beta_1 - \rho) > 0$. Hence, there is a positive link between the forecast error and the forecast revision, as well as between current and future revisions. At t=3, the agent observes $\Delta y_3 = \beta_2 e_1$ and revises upward such that $Fe_3 = \Delta y_3 - \widetilde{E_2}(\Delta y_3) = (\beta_2 - \rho\beta_1)e_1$ and

In conclusion, we find evidence in favour of non-rational expectations and rigidity at the aggregate level. Forecast error predictability reflects extrapolative expectations and slow updating to macroeconomic shocks; results are consistent with the natural expectations hypothesis.[21]

5.2.2 The true process: the hump-shaped dynamics

Second, the natural expectations hypothesis assumes that the true process of y_t exhibits partial mean reversion in the long run. Fuster et al. (2010) show that many macroeconomic series, including the US RGDP and the unemployment rate, have an hump-shaped dynamics with (partial) mean reversion. Further, they document that to capture the short-term properties of macroeconomic time series it is necessary to estimate a highly flexible statistical model as low-order models have difficulty in detecting hump-shaped dynamics.[22] To provide further evidence in favour of this hypothesis, I estimate several ARIMA(0,1,q) for the US RGDP in log, with large q. When q is sufficiently large, this flexible representation implies a hump-shaped pattern and partial mean reversion (Table 6 and Figure 3).[23]

5.2.3 The estimated process: a simple autoregressive rule

The model assumes a representative household who uses a simple autoregressive model to forecast future changes in y_t. To provide evidence in support of this assumption, I exploit survey data on expectations and run an out-of-sample forecasting exercise to choose the best order of the following process $\widetilde{E_t}(\Delta y_{t,t+4}) = \rho(L)\Delta y_{t-4,t} + \epsilon_{t,t+4}$. In this exercise, I estimate each model on a sub sample and then predict the future values of $\widetilde{E_t}(y_{t,t+4})$ beyond the estimation sample using the realized values of the change in the forecasted variable; specifically to predict $\widetilde{E_t}(\Delta y_{t,t+4})$ I

$Fr_4 = \widetilde{E_3}(\Delta y_4) - \widetilde{E_2}(\Delta y_4) = \rho e_1(\beta_2 - \beta_1)$. Under the chosen calibration, $(\beta_2 - \rho\beta_1) > 0$ and both the forecast error and the forecast revision are positive. A similar reasoning applies for the following quarters.

[21]This beliefs' formation process is not limited to few variables. These findings indeed are consistent with an extensive set of variables, including 3 Months Treasury Bill Rate, PGDP, and 10 years Treasury Bond. Further, using data on Consensus Economics, results for the second test are similar, although the time series is short. The null hypothesis of rational expectations is rejected, and the coefficient β_2 is positive and significant. The coefficient remains positive when running country-by-country regressions.

[22]Fuster et al. (2010) provide a Monte Carlo analysis to show that ARIMA(0,1,q), with large q, is better to capture empirically relevant low-frequency mean reversion compared to a lower order ARIMA(p,1,q) with p and q ≥ 3. They show that ARIMA(0,1,q) processes are not subject to bias in the estimated persistence when the true data generating process is not an ARIMA(0,1,q).

[23]For this aim the AIC/BIC criteria are not appropriate since these measures tend to prefer models with few parameters that may not fully capture complex dynamics.

use $\Delta y_{t-4,t}, \Delta y_{t-5,t-1}, \Delta y_{t-6,t-2}$ and so on, which are in the information set at time t. Table 18 reports the Mean-Square Forecast Error (MSFE) and the Mean Absolute Error (MAE) from this exercise.[24] The MSFE and MAE are two measures of predictions' accuracy such that the fit of the model increases when these measures decrease. The smallest forecast error is associated with one lag such that the best forecasting rule is $\widetilde{E_t}(\Delta y_{t,t+4}) = \rho \Delta y_{t-4,t} + \epsilon_{t,t+4}$. Results are consistent when changing the out-of-sample window (different columns). This evidence goes in favour of the idea that the representative agent estimates an auto-regressive model AR(1) and extrapolates from the past, giving excessive weight to recent changes.[25] In Appendix C, I show that this is the best process, in terms of out-of-sample performance, also when we allow for moving average components. The forecasting rule with only one recent observation is the one that approximates better the survey data in terms of out-sample performance, hence the hypothesis of simple models associated with natural beliefs seems justifiable.

5.2.4 Over-estimates of the long-run persistence

Low order models imply that shocks are expected to be more persistent than they are, so that good (or bad) times are expected to persist over time; indeed, the order of the model determines the estimated long-run persistence which is equal to (1+ma(L))/(1-ar(L)).[26] The long run persistence is defined as the ultimate impact of the shock on the level of y_t. Table 6 shows how the persistence for the US RGDP varies with the estimated model. For instance, an ARIMA(0,1,18) exhibits mean reversion and the associated persistence is equal to (1+ma(L))=0.299, while an ARIMA(1,1,0) implies a persistence equal to $1/(1-\rho)$=1.476 with the estimated ρ equal to 0.3227.[27] This feature characterises natural expectations; the household estimates low order models and overestimate the persistence of the process. This fact implies that beliefs do not capture the long-run mean reversion of the series so that they are over-optimistic during booms, and over-pessimistic during busts.

[24] I use the out-of-sample forecast to reduce the risk of over-fitting.

[25] Otherwise, under alternative hypothesis on the beliefs, the forecast should depend on all, or more than one, past lags of the dependent variable. For instance, adaptive expectations use all historical data and down-weight old data exponentially.

[26] Here ma(L) is equal to the sum of the moving average components and ar(L) is the sum of the autoregressive parameters such that ma(L)=$\beta_1 + \beta_2 + \beta_3 + ...$ and ar(L)=$\phi_1 + \phi_2 + \phi_3 + ...$

[27] An estimated persistence equal to 0.3 means that a one unit shock as an ultimate impact on the level of y_t of 0.3. Further, using survey data on the expected RGDP growth over the next year the estimated persistence is about 1.17 with $\hat{\rho} = 0.1459$.

5.2.5 Short and long term expectations

Natural expectations imply that short and long term forecasts are positively correlated. Let the agent estimates an AR(1) model with $\rho > 0$ such that $\widetilde{E}_t(\Delta y_{t+1}) = \rho \Delta y_t$, and $\widetilde{E}_t(\Delta y_{t+j}) = \rho^j \Delta y_t$ for any $j \geq 0$. Short and long term predictions move in the same direction and their relationship is described by the parameter ρ. Accordingly, Appendix C shows that there is a positive correlations between the expected real GDP growth rate at 1 year (4 quarters ahead) and at 10 years (40 quarters ahead). Rational expectations instead should imply no relation between the expected growth rate at 1 and 10 years. Further, coherently with the hypothesis of natural expectations, during booms short term expectations are greater than long term expectations; while the opposite is true during busts.

5.2.6 Additional evidence

The hypothesis of natural expectations is coherent with the extensive experimental evidence on extrapolation where recent observations are those that matter the most and, in particular, with Beshears et al. (2013) who show that agents fail to forecast long-term mean-reversion, while agents capture well short-run momentum. Besides, the model relies on the additional assumption that no learning on the true process is in place. The experimental evidence by Landier et al. (2017) supports the hypothesis of no learning in the short-medium run, showing that extrapolation is the primary driver of expectations, and no learning occurs. Finally, the natural expectations hypothesis does not allow for model uncertainty; the agent indeed does not take into account model and parameter uncertainty when forming his predictions. This assumption is coherent with the idea of overconfidence on predictions (over-precision), according to which agents assigns overly narrow confidence intervals to their predictions. This effect can be explained by anchoring (Tversky and Kahneman, 1974) to the initial estimate which in this case is the natural forecast.

6 A model of natural expectations and household debt

In the previous section, we have seen two facts. First, expectations data are not pure noise and help to predict household debt in line with the permanent income hypothesis (PIH) (Section 4). Second, expectations are non-rational and display aggregate rigidities in a way coherent with natural expectations (Section 5). Given this empirical evidence, now I test if non-rational expectations can account for the household credit cycle. Can non-rational expectations explain boom and bust in household debt? To address this question, I propose a model in which consumers form natural expectations, and these beliefs influence their borrowing decisions. The model reflects the cited empirical factors. It predicts a positive relationship between expectations on future income and household debt growth according to the PIH. Further, it accounts for the evidence on non-rational extrapolative expectations with slow adjustment at the aggregate level.

Except for the expectation process, the model is a standard small open economy with a representative borrower, without heterogeneity, financial or other frictions. The representative agent chooses consumption and credit and optimises given the budget constraint and his biased expectations. Beliefs indeed represent the sole source of distortion and non-rationality. I study this tractable model as it reflects the PIH and allows to highlight the effects of non-rational beliefs on the dynamics of credit without the need of additional confounding factors.[28] Following Fuster et al. (2010), the fundamental has an hump-shaped dynamics, and the agent has natural expectations; hence he has wrong beliefs about the dynamics of the fundamental process and underestimates the degree of mean-reversion of the income process. This fact happens because the agent applies a simple AR(1) forecasting rule, over-weights recent observations and fails to forecast long-run income. Under this assumption, beliefs on the long-run income are excessively optimistic during booms and pessimist during busts. In this economy, a shock to income translates into a shift in the expected future income and in turn into a change in debt; every period, the agent observes the realised income, updates his beliefs and his choices for debt. The model implies that the agent separates the forecasting and the choice problem; expectations drive choices, so that believes do not depend on the context or on their potential consequences.[29] A positive shock to current income, hence, induces agents to over-estimate long-run income and subsequently to increase the demand for credit, over-borrowing compared to the full-information rational equilibrium. This phase is followed by a period of disappointed expectations and gradual adjustment. Overall, natural expectations generate a boom-bust cycle in household credit without relying on heterogeneous beliefs, collateral constraints or supply shocks.

6.1 Theoretical model

Consider a representative agent with an infinite life horizon and preferences described by the following utility function for $t = 0, 1, .., \infty$:

[28] Although the US economy is not a small open economy; this model is reasonable for our purposes since in recent years the United States has been borrowing heavily on foreign capital markets at low-interest rates according to the "saving glut" hypothesis by Bernanke, (2005).

[29] Further, the agent ignores potential model or parameter uncertainty; his rationality is bounded so that he is not able to deal with complicated frameworks but prefer to adopt simple rules. This assumption relies on the wide experimental evidence on cognitive biases.

$$\widetilde{E_t}\Sigma_{j=0}^{\infty}\beta^t U(c_{t+j}) \tag{8}$$

$\widetilde{E_t(.)}$ denotes the biased expectation operator at date t (given the information set available at time t) and β the discount factor. Each period, the household receives an exogenous and stochastic endowment y_t and can borrow or lend in a one-period bond that pays a constant interest rate. The endowment process represents the unique source of uncertainty. Given y_0, the evolution of the income is given by a ARIMA(0,1,q) process:

$$\Delta y_{t+1} = \beta(L)\epsilon_t \tag{9}$$

with:

$$\epsilon_t \sim N(0, \sigma^2) \tag{10}$$

The income y_t follows a stochastic process I(1), Δy_t is a stationary process and ϵ_t is a zero mean stochastic variable. For any $t = 0, 1, .., \infty$, the period-by-period budget constraint faced by the agent is:

$$c_t + (1 + r)d_t = y_t + d_{t+1} \tag{11}$$

Where d_{t+1} denotes the debt position assumed (chosen) in period t and r is the risk-free interest rate. The model can be considered as a small open economy so that r is the world interest rate, or as a partial equilibrium model of households in a closed economy, where r is the exogenous risk-free rate.

Every period t (for $t = 0, 1, .., \infty$), given his beliefs, the consumer optimizes rationally choosing the processes $\{c_{t+j}, d_{t+j+1}\}_{j=0}^{\infty}$, given d_t and subject to equations (9)-(11) and the no-Ponzi constraint of the form:

$$\lim_{j \to \infty} \frac{d_{t+j+1}}{(1 + r)^j} \leq 0 \tag{12}$$

The following Euler condition is obtained by combining the first-order conditions of the agent's optimisation problem:

$$U'(c_t) = \beta(1+r)\widetilde{E_t}U'(c_{t+1}) \tag{13}$$

With rational expectation, the Euler equation is defined in the same way, except for the expectations operator. To achieve a greater tractability, I set $\beta(1+r) = 1$ and a quadratic utility function such that $U(c_t) = c_t - \frac{\gamma}{2}c_t^2$. Under these assumptions, equation (13) becomes $c_t = \widetilde{E_t}(c_{t+1})$; using the inter-temporal budget constraints, the transversely condition and the law of iterated expectations[30]:

$$c_t = \frac{r}{1+r}\Sigma_{j=0}^{\infty}(\frac{1}{1+r})^j\widetilde{E_t}(y_{t+j}) - rd_t \tag{14}$$

and

$$\Delta d_{t+1} = \Sigma_{j=1}^{\infty}(\frac{1}{1+r})^j\widetilde{E_t}(\Delta y_{t+j}) \tag{15}$$

According to equations (14)-(15), changes in consumption depend on the revision in the expected permanent income, while changes in debt on expected future variations in income. Coherently with the empirical evidence, the model predicts a positive correlation between expected income growth and changes in debt: the demand for debt increases when the representative agent expects his permanent income to increase in the future.

6.2 The income process

Following Fuster et al. (2010), the income process exhibits partial mean reversion in the long run. Considering an hump-shaped process is relevant for two reasons. First, it is the best process to describe the medium-term dynamics which is at the core of this study; the US RGDP indeed displays a mean-reverting pattern around the trend (Appendix C). Second, it allows us to focus on cases in which the agent slowly learns about the income reversion, and recent observations are key drivers of the expected long-run income. To calibrate the true data generating process (DGP), I estimate several ARIMA(0,1,q) for the US RGDP, with large q. When q is sufficiently large, this flexible representation implies a hump-shaped pattern and partial mean reversion.[31] The baseline model is calibrated on an ARIMA(0,1,18) (Table 6). Although it may not be the best process to describe the US RGDP, it is a plausible sufficiently flexible model with an hump-shaped dynamics.

[30]To solve the problem we can apply the law of iterated expectations since the agent takes as correct his beliefs, and cannot predict systematic changes in the forecasts. Further, the transversality condition imposes that the no-Ponzi constraint is satisfied with strict equality. Finally, I assume that consumption is always positive.

[31]For this aim the AIC/BIC criteria are not appropriate since these measures tend to prefer models with few parameters that may not fully capture complex dynamics.

Further, results do not depend on the chosen order of the process, but the theoretical impulse responses are very similar when considering alternative orders that exhibit partial mean reversion (i.e. ARIMA(0,1,11)).

6.3 Natural expectations

Natural expectations imply that the perceived income process differs from the true one. Given the true DGP for Δy_t, the agent estimates an AR(1), such that for any $j \geq 1$:

$$\widetilde{E_t}(\Delta y_{t+1}) = \rho \Delta y_t \tag{16}$$

$$\widetilde{E_t}(\Delta y_{t+j}) = \rho^j \Delta y_t \tag{17}$$

Each period, the agent observes the realized Δy_t and updates his short and long-term beliefs using the rules in equations (16) - (17). Overall, the agent infers a mistaken sequence of income shocks and attributes his forecasts errors entirely to the predicted shocks. Otherwise, under rational expectations, if no shocks arise, the agent has no reason to update his forecasts since he has complete knowledge of the true DGP. The order of the model determines the estimated persistence and low order models imply that shocks are expected to be more persistent than they are. To choose the correct order of the process I exploit the out-of-sample forecasting exercise, presented in Table 18. I assume that the agent estimates an auto-regressive model AR(1) and extrapolates from the past, giving excessive weight to recent changes.

6.4 Calibration

An equilibrium is a set of processes $\{c_t, d_{t+1}, \Delta y_t, \widetilde{E_t}(\Delta y_{t+j}), \widetilde{E_t}(y_{t+j})\}_{j=1}^{\infty}$ that for any t satisfies equations (14) e (15), given (9)-(12), (16)-(17) and d_0. I calibrate the model at quarterly frequencies aiming at replicating some facts of the US credit cycles. I calibrate Δy_t on an ARIMA(0,1,q) with q=18, estimated on the US RGDP (Table 6). The discount factor is calibrated on the average Effective Federal Funds Rate (Percent, Quarterly) over the period 1968:Q4- 2016:Q1 such that $\beta = 0.95$. The standard deviation of the income growth rate shock σ equal to 0.008 is chosen to replicate as well as possible the impulse responses from a VAR in 5 variables (Figure 6).[32] The process for the expectations is calibrated on an AR(1) using quarterly data for the US RGDP

[32]Results are very similar with $\sigma = 0.006$, the estimated standard deviation of the residuals from an ARIMA (0,1,18).

(Table 6), such that ρ is equal to 0.3227.[33] Finally, I set the initial debt to income ratio equal to $d_0 = .10$ to match the average Household credit to real GDP ratio over the period 1968:Q4:2016:Q1.

6.5 Impulse responses

Figure 4 displays the term structure for the expectations on y_{t+j} and Δy_{t+j} to a shock to Δy_t. The term structure reports the long term expectations $\widetilde{E_1}(\Delta y_{t+j})$ computed at time t=1 for any $j \geq 1$. After a positive shock to income, the agent overstates the persistence of the shock since the AR(1) process implies a perceived persistence equal to 1.479, while the true one is 0.299. The agent does not capture the hump-shaped dynamics of y_{t+j}, under-predicts the income over the short term and over-predicts the long run income (Panel A). This is the case because he estimates an AR(1) and forecasts positive (decreasing) values of Δy_{t+j} until convergence to zero (Panel B). Every quarter, given the realized Δy_{t+j}, the agent updates his short and long term expectations revising upward if $\Delta y_{t+j} > \widetilde{E_t}(\Delta y_{t+j})$ and downward if $\Delta y_{t+j} < \widetilde{E_t}(\Delta y_{t+j})$. Eventually, natural beliefs converge to the rational ones when $\Delta y_{t+j} = \widetilde{E_t}(\Delta y_{t+j}) = 0$.

Figure 5 reports the impulse response functions to a one standard deviation shock to Δy_t. Under rational expectations, consumption permanently increases on impact and then remains constant. Debt initially raises, because the consumer envisages an increase in the permanent income. When the current income gets larger than the future permanent income (at t=3), debt starts decreasing: the rational agent foresees the hump-shaped dynamics and saves the exceeding income to finance future consumption. Finally, when the income reaches its new steady state, debt stabilises at a new level.With natural expectations, credit and consumption rise on impact as the consumer forecast a permanent increase in income (Figure 4).[34] Each quarter, the agent revises his expectations on Δy_{t+j} and y_{t+j} for any $j \geq 1$. At t=2, expectations adjust upward, and consumption and debt rise accordingly. The same occurs at t=3. As long as the Δy_t is positive, the consumer expects a positive permanent growth in income and increases debt and consumption; in this phase, in fact, both debt and income increase and finance consumption. When Δy_t gets negative, the expectations immediately adjust downward anticipating a reduction in income; thus both debt and consumption reduce. Eventually, when natural beliefs converge to the rational benchmark, consumption and debt reach the new steady-state level. Over the long run, a positive shock leads to a permanent increase in debt and to a consumption level inferior to the rational benchmark since the agent has

[33] I do not calibrate the ρ parameter using the survey data because they are related to expected RGDP gr over the next year, while in the model $\widetilde{E_t}(\Delta y_{t+1})$ is the expected growth for the next quarter.

[34] The initial increase in consumption and debt is lower than with rational expectations, because of slow adjustment.

to pay back the initial extra consumption. After good news, the model generates a credit boom that does not occur with rational expectations. Further, the model implies an endogenous partial reversion for the debt due to forecast revisions. These dynamics arises because miss-specified beliefs drive the demand for debt.

6.6 Model evaluation

6.6.1 Conditional correlations

In this section, I explore the qualitative implications of natural expectations on the household credit path. The theoretical framework is too stylized for full quantitative analysis, but it can help answer the question: can biased expectations generate cyclical changes in debt? To address this question, I compare the impulse responses obtained from the model, with those generated by a VAR(1) in 5 variables[35]:

$$[RGDPgr_t, log(Household\_credit_t), Unrate_t, 10YTBond_t, E_t(RGDP_{t,t+4})] \tag{18}$$

Figure 6 reports the impulse responses to a shock to the real GDP growth rate ($RGDPgr_t$), from the VAR. The shaded areas represent one-standard-error bias-corrected bootstrap confidence bands of Kilian (1998). The shock is identified using a Cholesky identification scheme so that shocks to fundamentals affect expectations contemporaneously, while shocks to expectations do not affect macro variables on impact. This assumption ensures consistency with the theory, in which shocks to the fundamentals affect beliefs and endogenous variables contemporaneously. The VAR includes two additional variables to reduce the risk of miss-specification: the unemployment rate and the 10-years Treasury Bond rate as a proxy for the long-term interest rate. Otherwise, if relevant variables are omitted, their presence in the VAR residuals may determine our result. Impulses are consistent when using as an alternative measure of expectations the Michigan Consumer Confidence Index, as well as alternative orders (Appendix C).

Following a positive shock to the RGDP growth rate, expectations on income growth jump on impact and then decrease gradually (Figure 6). The impulse response of Household credit to innovations in the RGDP gr is significant, fast-building, and declines after few periods showing an hump-shaped pattern. The model captures well the partial mean reversion in debt observed in the empirical impulses. The empirical impulse response functions are smoother compared to those predicted from the theory. Indeed, the VAR(1) implies a smoother process for Δy_t compared to the ARIMA(0,1,18) chosen for the calibration; in turn, also the responses for debt and Δy_t are smoother.

[35]The order of the VAR is chosen according to the information criteria.

In Appendix A, I compare natural expectations to alternative hypotheses on beliefs, such as adaptive expectations, sticky information and noisy signals. These hypotheses have substantially different implications on long-term expectations and hence on credit responses. Among the alternative models, the adaptive theory is the only one that matches the empirical impulses from a qualitative point of view; although its predictions are quantitatively too large. The other models, including rational expectations, instead, predict an increase in savings (decrease in debt) after a positive shock to income growth since rational agents know the true DGP and foresee the income path.

6.6.2 Unconditional correlations

Finally, I evaluate the model in terms of unconditional correlations. Table 8 reports the statistical moments from the US data and the simulated models. Data are quarterly to match the frequency of the calibration. The models are simulated for 190 periods of quarterly data, to match the length of the series. I run 1000 simulations with $\sigma = 0.008$, compute the moments for each simulation and average the moments over these 1000 independent simulations.

First of all, the natural expectation model matches well the positive correlation between household credit and income. Under natural expectations, indeed, an increase in RGDP is associated to a rise in household debt; rational expectations, with an hump-shaped fundamental, instead generate a negative relationship between current income and debt as an increase in income is associated to a rise in savings. Then the model matches well the negative relationship between current household credit to RGDP and future RGDP growth rate, at t+4, t+8 and t+12. The observed correlation between current debt to RGDP and future RGDP growth rate at t+12 is -0.147 and the simulated one -0.171; rational expectations instead imply a positive correlation of about 0.1. Natural expectations capture better these moments compared to the other models except for adaptive expectations which match well the sign of the correlations. These results show a predictable reduction in RGDP growth, coherent to the empirical evidence: a rise in debt to RGDP ratio predicts a decrease of the RGDP growth three years ahead (as in Mian et al. 2017). The natural and the adaptive expectations models get the true sign of these moments because debt increases during the boom phase, while alternative hypotheses imply an increase in savings. Further, the model captures the mean reversion in debt, getting the negative correlation between current and future debt at t+8 and t+12. In the data, the correlation of current and future debt growth rate at t+12 is -0.241, while the simulated one is -0.15; rational expectations instead generate a correlation close to zero (-0.07). Overall, the model represents an improvement in matching the moments and the empirical impulse responses relative to the rational case and the alternative hypotheses on the beliefs' process.

7 Conclusions

The paper examines the effect of non-rational expectations on the household credit dynamics. Introducing biased beliefs in the demand side is a novel way of thinking about the credit cycle and allows to explain why during good times consumers increase debt in the first place, regardless of credit frictions, house prices or supply shocks. First, I show that expectations on future income growth have strong predictive power for the path of household debt. Second, exploiting survey data, I demonstrate that beliefs depart from rationality in a way coherent with the natural expectations hypothesis. Then, I study the demand side by introducing natural expectations in a consumption-saving model and show that they have strong implications on debt. The ability to generate sizeable credit cycles rests crucially on the assumption made about the beliefs' process. Qualitatively natural expectations represent a significant improvement compared to the rational case; indeed, following a positive shock to income growth, they generate an initial increase in debt and a subsequent reduction, as observed in the data. Rational expectations, instead, cannot explain a similar boom-bust cycle in household debt.

In conclusion, the paper shows that households' biased expectations play a large role in the debt dynamics and alternative assumptions on the beliefs have substantially different macroeconomic implications. The presence of natural expectations alone can generate sizable fluctuations in debt in a simple model with no frictions, heterogeneity nor supply side. A richer model with the supply side and financial frictions may help in getting a better empirical fit. Natural expectations indeed can amplify the effects of expansionary credit supply shocks. For instance, consider a supply shock that generates an increase in income, such as a reduction in the interest rate or a change in the credit constraint. If such shock arises, it generates a boom during which natural consumers over-estimate the long run level of income over-borrowing relative to the rational benchmark. Hence this demand-side bias exacerbates the boom in debt and represent a strong complementary channel to the supply side hypothesis.

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9 Figures and Tables

Table 1: Summary statistics

Variables	Mean	Std. Dev.	Min.	Max.	N
$E_t(RGDPgr_{t,t+4})$ (SPF)	2.727	1.364	-1.614	6.191	191
Forecast error on RGDP	-0.145	1.764	-7.103	4.311	183
Forecast revision on RGDP	-0.121	0.895	-3.397	2.694	186
$E_t(Unrate_{t,t+4})$ (SPF)	6.475	1.591	3.759	10.697	191
Forecast error on Unrate	0.023	0.321	-0.696	1.307	185
Forecast revision on Unrate	-0.021	0.431	-0.882	1.803	188
Exp Change in Business Conditions in 1 Year (Michigan)	108.105	12.67	73	146	191
Exp increase in Unemployment during the Next Year (Michigan)	34.66	11.491	14	70	191
Household credit $\text{gr}_{t.t+4}$	7.671	4.939	-3.8	19.2	191
Savings rate $\text{gr}_{t,t+4}$	7.396	22.367	-49.7	122.7	191
Personal consumption $\text{gr}_{t,t+4}$	6.896	2.928	-3.2	12.7	191
Consumer Price Index	137.171	63.541	35.433	239.409	191
Unrate	6.284	1.582	3.4	10.7	191
10YTBond	6.618	2.914	1.64	14.85	191
3MTBill	4.926	3.349	0.01	15.05	191
GDP	10486.094	3998.852	4844.779	17622.486	191
RGDP $\text{gr}_{t,t+1}$	2.545	3.346	-9.890	11.4	186

Note: Survey data are from the U.S. Survey of Professional Forecasters (SPF) provided by the Federal Reserve Bank of Philadelphia. Aggregate expectations are the average across forecasters'. Data on household expectations come from the Survey of Consumers by the University of Michigan. Data on Consumer Credit Outstanding and macroeconomic variables are from the FRED. The RGDP $\text{gr}_{t,t+1}$ is the third revision used to compute the forecast errors. Data are quarterly, 1968:Q4-2016:Q2. See Section 3 for details.

Table 2: Professionals' and households' beliefs: correlations

Variables	(1) $E_t(RGDPgr_{t,t+4})$	(2) $E_t(PGDP_{t,t+4})$	(3) $E_t(3MTBill_{t,t+4})$	(4) $E_t(Unrate_{t,t+4})$
Exp Change in Business Conditions	0.635			
in 1 Year (n.obs 191)	(0.000)			
Business Conditions Exp	0.558			
during the Next Year (n.obs 191)	(0.000)			
Business Conditions Exp	0.418			
during the Next 5 Years (n.obs 186)	(0.002)			
Exp Change in Prices		0.866		
in the Next Year (n.obs 191)		(0.000)		
Exp Change in Interest Rates			0.2604	
during the Next Year (n.obs 140)			(0.019)	
Exp increase in Unemployment				-0.005
during the Next Year (n.obs 191)				(0.949)
Probability of Losing a Job				0.505
during the Next 5 Years (n.obs 65)				(0.000)

Note: SPF forecasts in columns and Michigan data in rows. All data are quarterly. P-values in parenthesis. See Section 3 for details. In the Michigan Survey of Consumers, some variables are available for a shorter period.

Table 3: Professionals' and households' beliefs: SPF and Michigan data

	(1)	(2)	(3)	(4)
Variables	Exp Change in Business Conditions in 1 Year			
$E_t(RGDPgr_{t,t+4})$	5.901***	6.029***	5.782***	
	(0.522)	(0.609)	(0.648)	
US Business cycle		-3.894*		
		0.973		
		(2.377)		
RGDP gr_t			0.342	
			(1.089)	
$E_{t-1}(RGDPgr_{t-1,t+3})$				3.851***
				(0.617)
Constant	92.01***	91.53***	92.10***	97.59***
	(1.590)	(1.986)	(1.628)	(1.881)
Observations	191	191	190	190
R^2	0.404	0.404	0.404	0.172

Note: Table reports results from estimating $Exp_t(Business_{t,t+4}) = \alpha + \beta E_t(RGDPgr_{t,t+4}) + u_{t,t+4}$. $Exp_t(Business_{t,t+4})$ is the Michigan Expected Change in Business condition in 1 year, this is the relative share of agents who expects the Business condition to be better over the next year. $E_t(RGDPgr_{t,t+4})$ is the SPF expected Real GDP growth rate (RGDP gr) over the next four quarters. US Business cycle is a dummy equal to 1 during recessions, 0 otherwise. P-values in parenthesis. *** p<0.01, ** p<0.05, * p<0.1. For details see Section 3.

Table 4: SPF Expectations and Household Credit

Panel A: Expected RGDP gr and unemployment rate

Variables	(1) H. Credit	(2) Savings	(3) Consumption	(4) H. Credit	(5) H. Credit	(6) H. Credit	(7) H. Credit	(8) H. Credit
Exp RGDP $gr_{t,t+4}$	1.813***	-2.863**	0.592***	1.399***	1.770***	1.143***		
	(0.253)	(1.351)	(0.217)	(0.218)	(0.253)	(0.177)		
Exp $Unrate_{t,t+4}$							-3.586***	-3.051***
							(1.297)	(1.128)
Constant	-0.982	18.01***	0.0394	1.032	-0.456	-12.51	1.658	-22.77**
	(0.885)	(4.824)	(0.895)	(4.559)	(4.957)	(9.555)	(5.232)	(9.887)
Baseline $controls_t$	NO	NO	NO	NO	YES	YES	YES	YES
$Factors_t$	NO	NO	NO	YES	NO	YES	NO	YES
Observation	186	186	186	185	186	185	186	185
R^2	0.675	0.108	0.625	0.794	0.727	0.816	0.622	0.795

Panel B: Expected and realized RGDP gr and unemployment rate

Variables	(1) H. Credit	(2) H. Credit	(3) H. Credit	(4) H. Credit	(5) H. Credit	(6) H. Credit	(7) H. Credit	(8) H. Credit
Exp RGDP $gr_{t,t+4}$	1.541***	1.488***	1.463***	1.652***				
	(0.216)	(0.249)	(0.216)	(0.196)				
RGDP $gr_{t,t+4}$	0.147*	0.172**	-0.0606	-0.0958				
	(0.0856)	(0.0855)	(0.0736)	(0.0731)				
RGDP $gr_{t-4,t}$	0.110	0.0335	0.0532	0.0896				
	(0.0904)	(0.0818)	(0.0705)	(0.0604)				
Exp $Unrate_{t,t+4}$					-2.146	-1.372	-2.720**	-3.188**
					(1.314)	(1.166)	(1.310)	(1.414)
$Unrate_{t,t+4}$					-1.877***	-2.256***	-0.960*	-0.946*
					(0.242)	(0.246)	(0.505)	(0.479)
$Unrate_{t-4,t}$					4.186***	3.520***	3.989***	4.693***
					(1.290)	(1.196)	(1.333)	(1.403)
Constant	-0.898	-0.277	1.278	9.040	2.845	1.327	-3.441	-7.908
	(0.895)	(4.930)	(4.690)	(5.875)	(1.798)	(4.326)	(10.32)	(12.27)
Baseline $controls_t$	NO	YES	NO	NO	NO	YES	NO	NO
$Factors_t$	NO	NO	YES	YES	NO	NO	YES	YES
$Factors_{t+4}$	NO	NO	NO	YES	NO	NO	NO	YES
Observations	181	181	181	181	186	186	185	181
R^2	0.686	0.735	0.796	0.829	0.704	0.775	0.779	0.811

Note: Table reports results from estimating $D_{t,t+4} = \alpha + \beta E_t(RGDPgr_{t,t+4}) + \delta(L)Z_t + \gamma(L)D_{t,t+4} + u_{t,t+4}$ and $D_{t,t+4} = \alpha + \beta E_t(Unrate_{t,t+4}) + \delta(L)Z_t + \gamma(L)D_{t,t+4} + u_{t,t+4}$. $E_t(RGDPgr_{t,t+4})$ is the SPF average forecast of Real GDP growth rate (RGDP gr) over the next four quarters. $E_t(Unrate_{t,t+4})$ is the SPF average forecast of the unemployment rate over the next year. $D_{t,t+4}$ is the percentage change between time t and t+4 of the dependent variable, which can be Household credit, Personal savings, and Personal consumption expenditures. All regressions include two lags of the dependent variable. Baseline controls are: Consumer Price Index, 10YTBond, 3MTBill, GDP, and unemployment rate. Newey-west standard errors are reported in parentheses with 4 lags. P-values in parenthesis. *** p<0.01, ** p<0.05, * p<0.1. Few observations are missing in the SPF data. For details see section 4.

Table 5: Testing ex-post forecast error predictability at aggregate level

Panel A: Expected Real GDP growth (RGDP gr)

Variables	(1) Forecast errors	(2) Forecast errors	(3) Forecast revisions
Lag Rgdp gr	-0.0999		
	(0.0612)		
Forecast revision		0.779**	
		(0.307)	
Lag forecast revision			0.459***
			(0.141)
Constant	0.139	0.0163	-0.0204
	(0.279)	(0.195)	(0.0627)
Observations	179	177	180
R^2	0.019	0.068	0.093

Panel B: Expected unemployment rate (unrate)

Variables	(1) Forecast errors	(2) Forecast errors	(3) Forecast revisions
Lag unrate	-0.0824***		
	(0.0302)		
Forecast revision		0.457***	
		(0.151)	
Lag forecast revision			0.358***
			(0.0757)
Constant	0.517**	-0.0431	-0.00832
	(0.216)	(0.0418)	(0.0166)
Observations	184	182	184
R^2	0.0243	0.0677	0.0932

Note: In Panel A, Column (1): $Fe_{t,t+4} = \alpha_1+\beta_1 RGDP_{t-4,t}+u_{t,t+4}$; Column (2): $Fe_{t,t+4} = \alpha_2+\beta_2 Fr_{t,t+4}+u_{t,t+4}$; Column (3): $Fr_{t-1,t+2} = \alpha_3+\beta_3 Fr_{lag,t-1,t+3}+u_{t-1,t+3}$. The Forecast error is defined as $Fe_{t,t+4} = RGDP_{t,t+4} - E_t(RGDP_{t,t+4})$, the Forecast revision on $RGDP_{t,t+4}$ as $Fr_{t,t+4} = E_t(RGDP_{t,t+4}) - E_{t-1}(RGDP_{t,t+4})$, the Forecast revision on $RGDP_{t-1,t+3}$ as $Fr_{t-1,t+3} = E_t(RGDP_{t-1,t+3}) - E_{t-1}(RGDP_{t-1,t+3})$, the Lagged forecast revision on $RGDP_{t-1,t+3}$ as $Fr_{lag,t-1,t+3} = E_{t-1}(RGDP_{t-1,t+3}) - E_{t-2}(RGDP_{t-1,t+3})$. The same definitions apply for the expected unemployment rate (Panel B). In Panel A, there are few missing observations for the Forecast error due to the SPF missing data. Newey-west standard errors are reported in parentheses with 4 lags. P-values in parenthesis. *** p<0.01, ** p<0.05, * p<0.1.

Table 6: The RGDP process ARIMA(p,1,q)

Variables	(1) $RGDP_t$ ARIMA(1,1,0)	(2) $RGDP_t$ ARIMA(0,1,11)	(3) $RGDP_t$ ARIMA(0,1,18)
$RGDP_{t-1}$	0.3227***	-	-
	(0.598)	-	-
Ma_1	-	0.323***	0.339***
	-	(0.0783)	(0.103)
Ma_2	-	0.227***	0.288***
		(0.0738)	(0.0768)
Ma_3	-	0.156*	0.117
	-	(0.0903)	(0.1)
Ma_4	-	0.153**	0.162
	-	(0.0626)	(0.000)
Ma_5	-	-0.0615	-0.0497
	-	(0.0799)	(-0.131)
Ma_6	-	0.047	0.0807
	-	(0.0818)	(0.0803)
Ma_7	-	-0.0829	-0.0429
	-	(0.0954)	(0.0995)
Ma_8	-	-0.197**	-0.245**
	-	(0.093)	(0.0955)
Ma_9	-	0.0261	0.0851
	-	(0.0943)	(0.106)
Ma_{10}	-	-0.0222	-0.00211
	-	(0.0855)	(0.0847)
Ma_{11}	-	0.168*	0.0755
	-	(0.0935)	(0.105)
Ma_{12}	-	-	-0.172**
	-	-	(0.0837)
Ma_{13}	-	-	-0.0157
	-	-	(0.101)
Ma_{14}	-	-	-0.00953
	-	-	(0.0901)
Ma_{15}	-	-	-0.221**
	-	-	(0.0998)
Ma_{16}	-	-	0.0596
	-	-	(0.0841)
Ma_{17}	-	-	0.00705
	-	-	(0.0866)
Ma_{18}	-	-	-0.157*
	-	-	(0.0881)
Constant	0.0067***	0.00725***	0.00685***
	(0.0008)	(0.0003)	(0.0045)
Observations	190	190	190
Persistence	1.476	0.736	0.299

Note: Quarterly data from 1968:Q4 to 2016:Q2. The dependent variable is ln($RGDP_t$). P-values in parenthesis. *** p<0.01, ** p<0.05, * p<0.1.

Table 7: Out of sample performance - AR process

Model	MSFE (obs 122)	MAE (obs 122)	MSFE (obs 142)	MAE (obs 142)	MSFE (obs 162)	MAE (obs 162)
L(0)	.1144	.1469	.0902	.1018	.0315	.0407
L(0/1)	.1319	.1671	.0953	.1139	.0342	.0472
L(0/2)	.1392	.1740	.1020	.1213	.0402	.0537
L(0/3)	.1420	.1767	.1077	.1243	.0431	.0555
L(0/4)	.1465	.1790	.1107	.1266	.0432	.0560
L(0/5)	.1496	.1817	.1110	.1285	.0385	.0552
L(0/6)	.1537	.1815	.1169	.1314	.0369	.0543
L(0/7)	.1665	.1868	.1262	.1353	.0357	.0529
L(0/8)	.1765	.1931	.1327	.1404	.0401	.0571
L(0/9)	.1990	.2091	.1409	.1440	.1409	.0622
L(0/10)	.2293	.2272	.1556	.1530	.0646	.0681

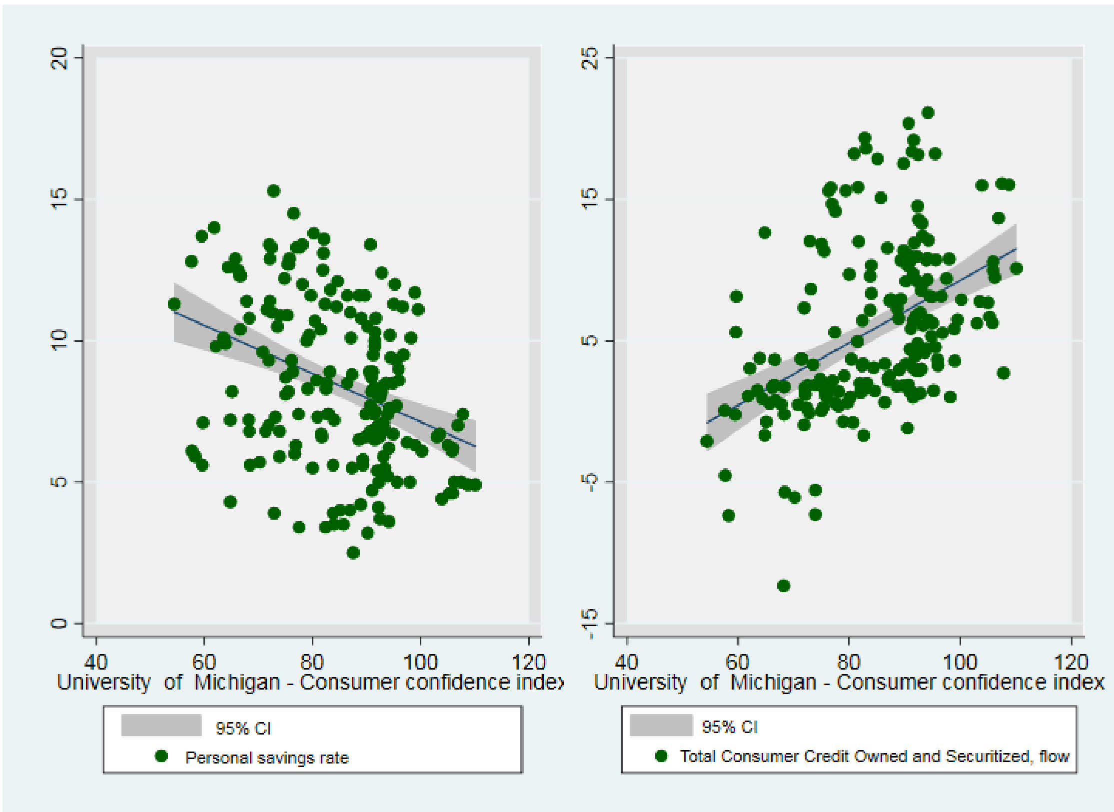
Note: Mean Square Forecast error (MSFE) and Mean Absolute Error (MAE) from an out of sample forecasting exercises used to choose the correct order of the following process: $\widetilde{E_t}(\Delta y_{t,t+4}) = \rho(L)\Delta y_{t-4,t} + \epsilon_{t,t+4}$. For instance, L(0) uses only $\Delta y_{t-4,t}$, while L(0/1) both $\Delta y_{t-4,t}$ and $\Delta y_{t-5,t-1}$ and so on. Different columns indicate different out-of-sample windows. I use SPF survey data on expectations and US ln(RGDP) data at quarterly frequency.

Table 8: Unconditional correlations - model evaluation

Correlations	US Data	Rational $\sigma = 0.008$	Natural $\rho = 0.3227$	Sticky info $\lambda = 0.438$	Adaptive $\phi = 0.33$	Noisy signals $\sigma_\eta^2 = 0.00623^2$
$\rho(debt_t,\, rgdp_t)$	0.997***	-0.6794	1.000	-0.6547	0.9646	-0.6960
	(0.996 - 0.997)					
$\rho(\frac{debt_t}{rgdp_t},\, rgdp\_gr_t)$	-0.115	0.2280	0.841	0.2106	-0.0724	0.2173
	(-0.271 - 0.042)					
$\rho(\frac{debt_t}{rgdp_t},\, rgdp\_gr_{t+4})$	-0.109	0.1485	-0.2008	0.1395	-0.212	0.1509
	(-0.265 - 0.047)					
$\rho(\frac{debt_t}{rgdp_t},\, rgdp\_gr_{t+8})$	-0.144*	0.1082	-0.2000	0.1030	-0.1848	0.1117
	(-0.317 - 0.029)					
$\rho(\frac{debt_t}{rgdp_t},\, rgdp\_gr_{t+12})$	-0.147*	0.0747	-0.1711	0.0733	-0.1468	0.0789
	(-0.318 - 0.025)					
$\rho(debt\_gr_t,\, debt\_gr_{t+1})$	0.803***	0.7979	0.2999	0.9128	0.3847	0.8983
	(0.732 - 0.874)					
$\rho(debt\_gr_t,\, debt\_gr_{t+4})$	0.426***	0.3947	0.0847	0.5164	0.15	0.5179
	(0.300 - 0.552)					
$\rho(debt\_gr_t,\, debt\_gr_{t+8})$	-0.046	0.1828	-0.1719	0.1915	-0.0352	0.1945
	(-0.194 - 0.103)					
$\rho(debt\_gr_t,\, debt\_gr_{t+12})$	-0.241***	-0.0682	-0.1494	-0.0740	-0.0761	-0.0810
	(-0.194 - 0.103)					

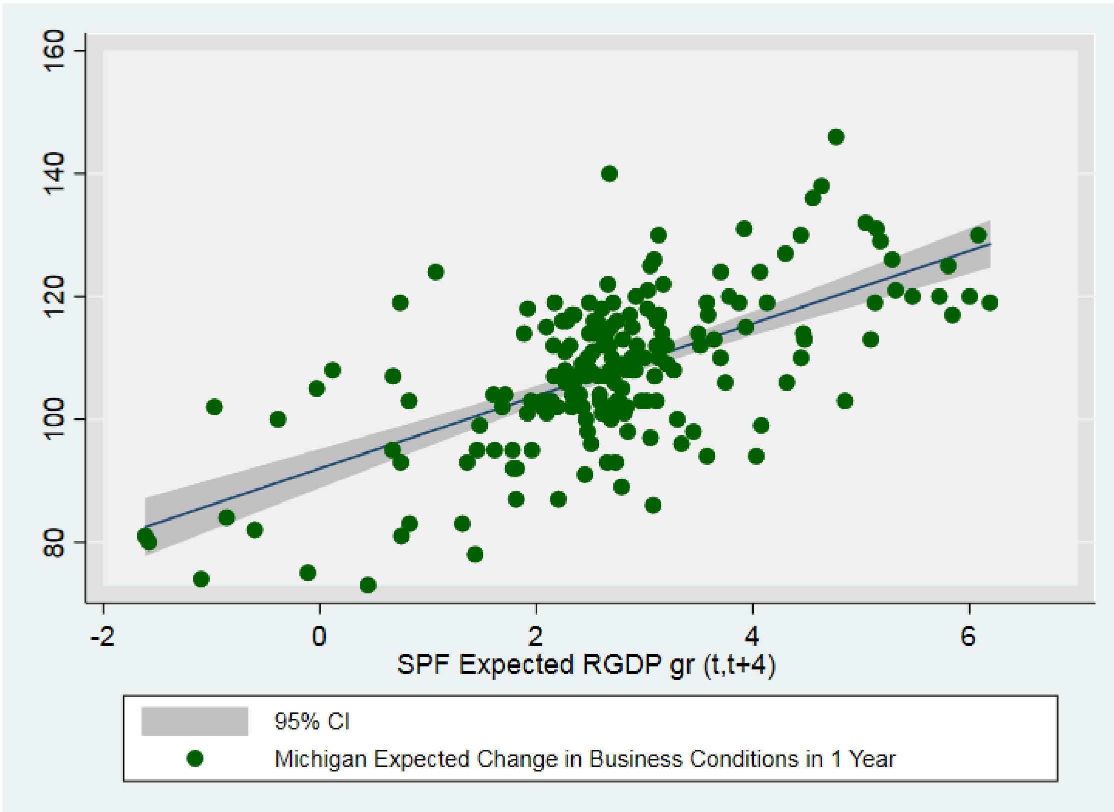
Note: The table compares the correlations computed on the US data in log, at quarterly frequency from 1968:Q4 to 2016:Q2, and the moments from the simulations with alternative assumptions: rational expectations, natural expectations, sticky information, adaptive expectations, and noisy signals. I run 1000 simulations, compute the moments for each simulation and average the moments over the 1000 independent simulations. I set $\sigma = 0.008$ to match the impulse of the VAR in 5 variables and calibrate the model on US quarterly data in log (see section 6.4). Confidence intervals in parenthesis are obtained bootstrapping the statistics by re-sampling observations (with replacement). *** p<0.01, ** p<0.05, * p<0.1.

Figure 1: Consumer Confidence Index - Michigan Survey



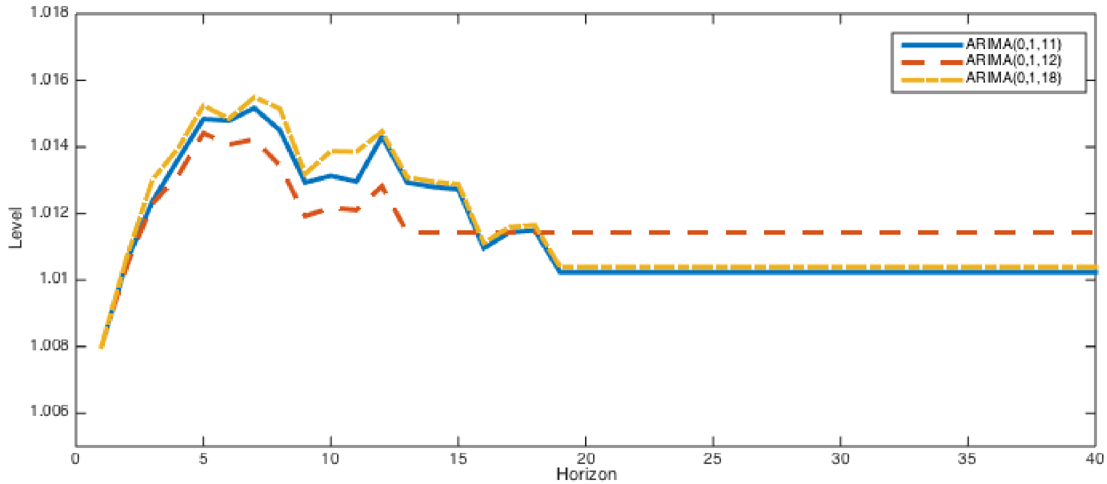
Note: In the left hand side panel, the Personal savings rate is reported on the y axis, this is the personal saving as a percentage of disposable personal income (PSAVERT); the University of Michigan Consumer confidence index is on the x axis. The two series are negatively correlated, and the correlation is negative also when considering Personal savings in level rather than the personal savings rate. In the right hand side panel, the Total Consumer Credit Owned and Securitized, in flow, is reported on the y axis, the flow data represent changes in the level of credit due to economic and financial activity, and exclude breaks in the data series due to changes in methodology, source data, and other technical aspects of the estimation that could affect the level of credit (FLTOTALSL); the University of Michigan Consumer confidence index on the x axis. All data are quarterly, from 1968:Q4 to 2016:Q2.

Figure 2: Professionals' and households' expectations: SPF and Michigan



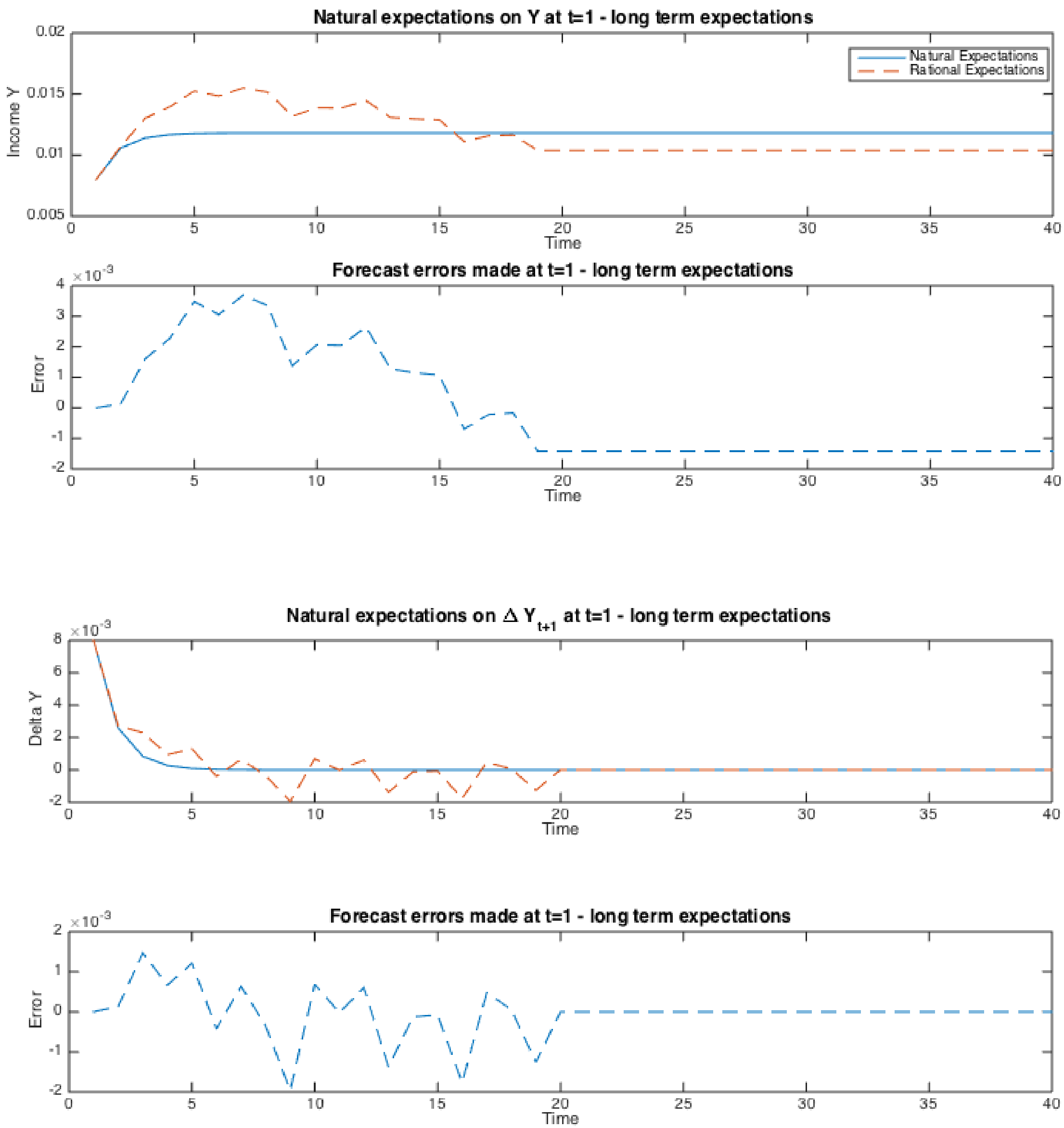
Note: The Expected Change in Business condition in 1 year, on the y axis, is the relative share of agents who expects the Business condition to be better over the next year; this is computed as the fraction of agents that expects the Business condition to be better over the next year minus fraction of agents that the expects the Business condition to be worst over the next year plus 100. The SPF Expected RGDP $gr_{t,t+4}$, on the x axis, is the SPF expected Real GDP growth rate (RGDP gr) over the next 4 quarters. All data are quarterly, from 1968:Q4 to 2016:Q2.

Figure 3: Hump-shaped dynamics under flexible ARIMA(p,1,q) models



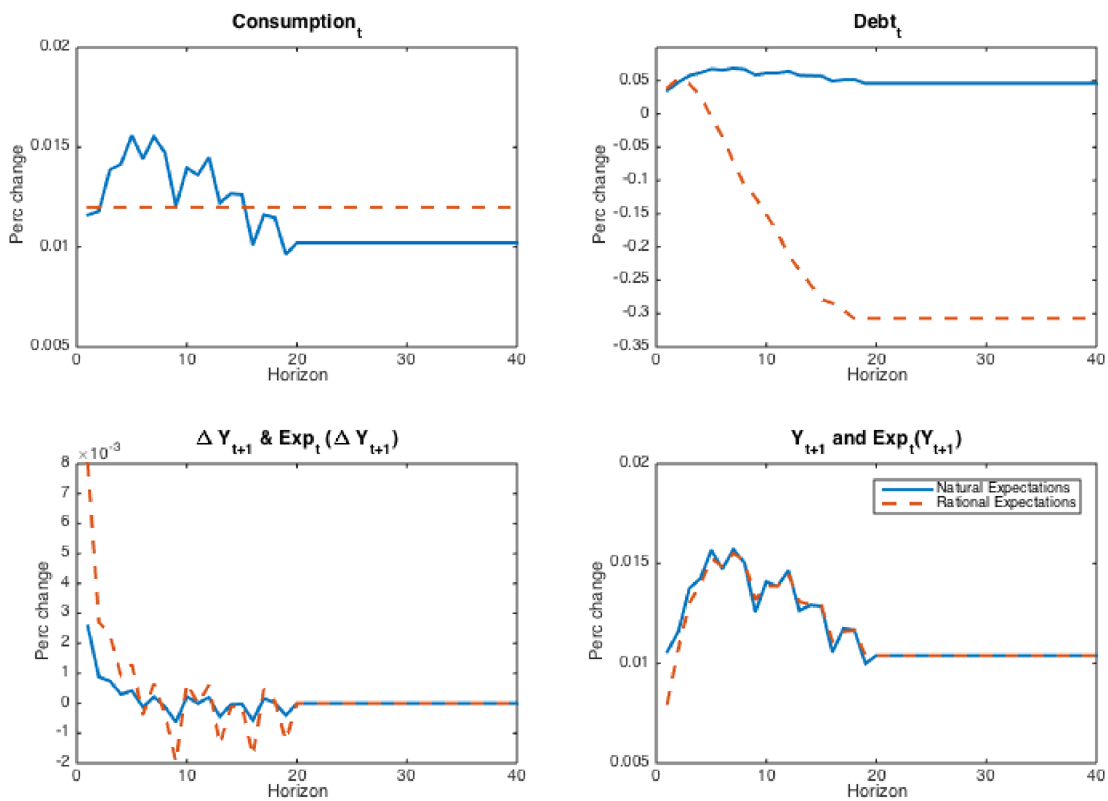
Note: Impulse responses of y_t to a one standard deviation shock to Δy_t, under alternative calibrations. The process for Δy_t is estimated using quarterly data from 1968:Q4 to 2016:Q2 for the US $\ln(\text{RGDP}_t)$.

Figure 4: Beliefs term structure following one positive shock



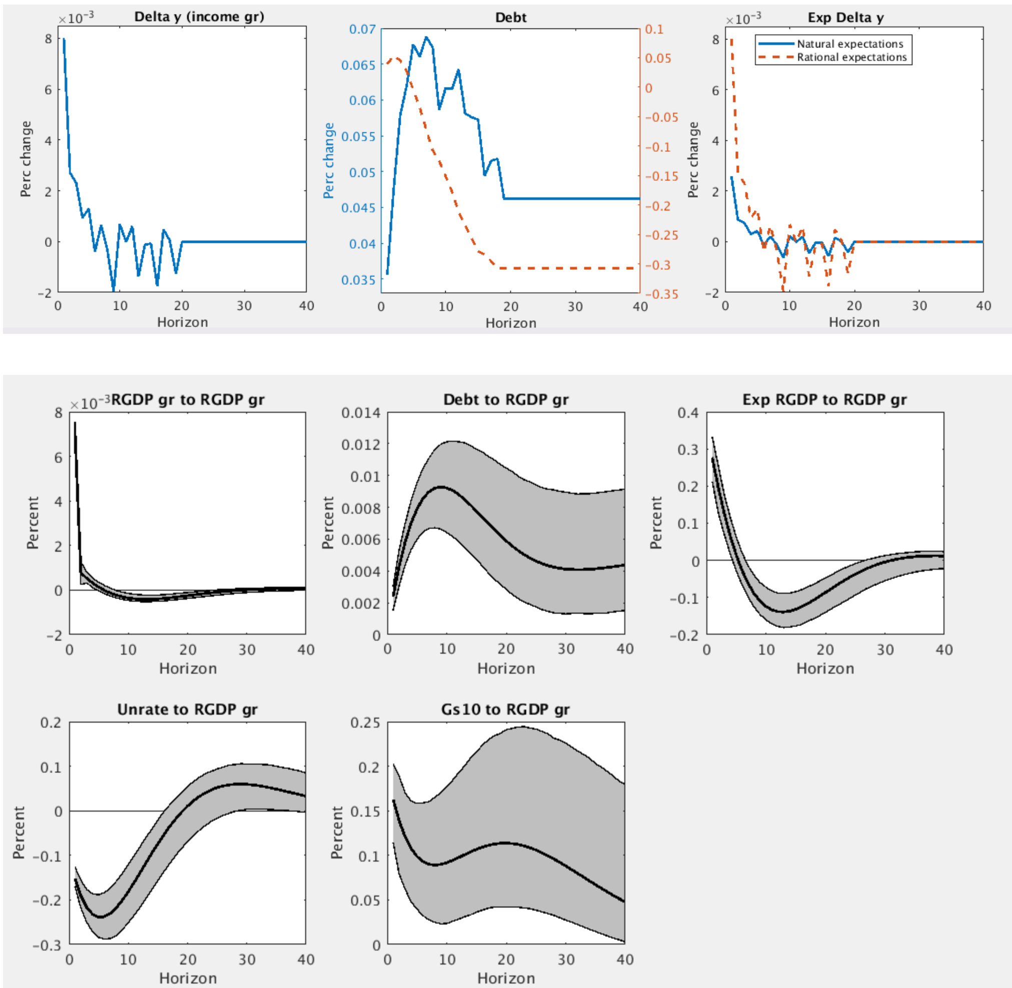
Note: Beliefs term structure (in percentage change) following one standard deviation shock to Δy_t. Dashed orange lines are the rational expectations case. Solid blue lines the natural expectations, with $\rho = 0.3227$. The upper panel displays $\widetilde{E_{t=1}}(y_{t+j})$ and the relative forecast error $(y_{t+j} - \widetilde{E_{t=1}}(y_{t+j}))$ for $j \geq 1$. The lower panel displays $\widetilde{E_{t=1}}(\Delta y_{t+j})$ and the relative forecast error $(\Delta y_{t+j} - \widetilde{E_{t=1}}(\Delta y_{t+j}))$ for $j \geq 1$. Time on the horizontal axis is the forecast horizon in quarters.

Figure 5: Impulse responses following one positive shock



Note: Impulse responses following one standard deviation shock to Δy_t. Dashed orange lines are the rational expectations case. Solid blue lines the natural expectations, with $\rho = 0.3227$. In the lower panels, the solid blue lines are $\widetilde{E_t}(\Delta y_{t+1})$ and $\widetilde{E_t}(y_{t+1})$ for $t \geq 1$, respectively; the dashed orange lines instead are the realized values at time t, Δy_t and y_t, respectively.

Figure 6: Empirical and theoretical responses to a shock to the fundamental



Note: The upper graph displays the theoretical impulses to a one standard deviation shock to Δy_t for the variables of interest. The lower one reports the IRFs to a one standard deviation innovation to the Real GDP growth rate ($RGDPgr_t$), from a VAR in 5 variables. Shocks are identified with a Cholesky scheme and $RGDPgr_t$ is ordered first. Shaded areas are the confidence bands. Debt is $ln(Household\_credit)$, Gs10 is the 10 Year Treasury Bond rate (10YTBond), Unrate is the unemployment rate and Exp RGDP is the expected RGDP growth rate over next year ($E_t(RGDPgr_{t,t+4})$). US quarterly data: 1968:Q4-2016:Q2.

A Appendix: Alternative beliefs' models

A.1 Adaptive expectations

Adaptive expectations are obtained by weighting past observations exponentially. They derive from the following model:

$$\widetilde{E_t^A}(\Delta y_{t+1}) = \phi \Sigma_{j=0}^{\infty} (1-\phi)^j \Delta y_{t-j} \tag{19}$$

With $0 \leq \phi \leq 1$. This is equivalent to:

$$\widetilde{E_t^A}(\Delta y_{t+1}) = \widetilde{E_{t-1}^A}(\Delta y_t) + \phi(\Delta y_t - \widetilde{E_{t-1}^A}(\Delta y_t)) \tag{20}$$

The agent adjusts his prior expectations according to the last observed error by a factor ϕ. This one is a parsimonious model with only one free-parameter. In this economy, the agent optimises knowing his preferences, constraints, beliefs, and the exogenous realised income. Differently, he does not know the true income process. Each quarter, the agent forms adaptive expectations on Δy_{t+j} for any $j \geq 1$, and in turn for the income process y_{t+j}, according to the equation (19). He expects the growth rate to be constant forever and consequently the income to grow over time such that for any $j \geq 1$:

$$\widetilde{E_t^A}(\Delta y_{t+1}) = \widetilde{E_t^A}(\Delta y_{t+j}) \tag{21}$$

Each period, based on the observables, the agent updates his short and long-term beliefs using these rules.

Match with the empirical evidence. Adaptive expectations are a particular case of extrapolative expectations coherently to Table 5 (Column (1)). Then, let Δy_t be an ARIMA(0,1,q) such that $\Delta y_{t+1} = \beta(L)\epsilon_t$; $\phi < \beta_1$ implies slow reaction to shocks as predicted by the empirical evidence in Table 5 (Column (2)). After a shock, expectations adjust gradually and forecast revision at time t predicts the revision at time t+1 as in Table 5 (Column (3)). Given the time series for the US RGDP growth rate, I compute the adaptive expectations for several values of the parameter ϕ. I set the parameter ϕ equal to 0.33, to minimize the absolute difference between the computed adaptive expectations and the SPF data. The parameter ϕ defines how far the agent extrapolates into the past; a low value for ϕ implies that the agent assigns a smaller weight to new information relative to past expectations.

Impulse responses. Figure 7 shows the term structure for the expectations on y_{t+j} and Δy_{t+j} to a shock to Δy_{t+j}. The term structure reports the long term expectations $\widetilde{E_1^A}(\Delta y_{t+j})$ and $\widetilde{E_1^A}(y_{t+j})$ computed at time t=1 for any $j \geq 1$. Rational expectations coincide with the true data generating process. Following a positive shock, the adaptive agent expects y_t to grow at a positive constant rate, although small; the forecast error, is negative and gets larger (in absolute value) with the forecasting horizon j. Any quarter, given the realized Δy_{t+j}, expectations are updated and eventually converge to the rational ones. Until reaching convergence, the agent substantially fails to forecast long-run income and these over-optimistic beliefs drive his debt choices.

Figure 10 displays the impulse responses following a one standard deviation shock to Δy_t. A positive shock to the fundamentals implies an immediate jump in consumption and debt since the consumer expects his income to growth permanently at a positive growth rate and strongly over-predict the long run income. Each period, the agent gets disappointed and revises his forecasts towards rational ones; accordingly, consumption declines over time. Debt increases as long as the consumer expects a positive increase in income; when expectations get pessimistic with $\widetilde{E_t^A}(\Delta y_{t+j}) < 0$, debt starts decreasing. The level of debt remains high as it is needed to finance consumption and to pay back the previous debt. Over the long run, a positive shock leads to a permanent increase in debt and to a consumption level inferior to the rational benchmark since the agent needs to pay back the initial extra consumption. Further, the model generates a credit boom disconnected from the true dynamics of the fundamentals.

A.2 Sticky information

In this section, I consider a model of inattentive agents as proposed by Mankiw and Reis (2002). Let the economy be populated by a continuum of identical agents. The agents update their information sets each period with probability $(1-\lambda)$ and acquire no new information with probability λ. Agents indeed may rationally choose not to revise every period when they face a fixed cost to updating their information (Reis, 2006). $1/(1-\lambda)$ is the average duration of information updates, and it is a measure of information rigidity. When agents update their information sets, they acquire full-information and have rational expectations. At time t, the average expectations across agents is a weighted average of current and past full-information rational expectations:

$$\widetilde{E_t^S}(\Delta y_{t+k}) = (1-\lambda)\Sigma_{j=0}^{\infty}\lambda^j E_{t-j}(\Delta y_{t+k}) \tag{22}$$

This is equivalent to:

$$\widetilde{E_t^S}(\Delta y_{t+k}) = (1-\lambda)E_t(\Delta y_{t+k}) + \lambda\widetilde{E_{t-1}^S}(\Delta y_{t+k}) \tag{23}$$

Where E(.) is the rational expectations operator. As in Reis (2006), I consider agents to be "consumption planners". This means that they fix their level of consumption and let their savings adjust one to one with their income when they don't update. After a positive shock, a fraction $(1-\lambda)$ of agents updates the beliefs rationally and chooses consumption and savings coherently. A fraction λ instead doesn't update, nor change the consumption plan; this portion of agents receives a larger income and therefore let savings increase. Every quarter, a fraction $(1-\lambda)$ of consumers updates and chooses consumption rationally. Overall, consumption is a weighted average of current and past rational consumption plans and debt changes accordingly.[36]

Match with the empirical evidence. As proved by Coibion and Gorodnichenko (2015), there is a perfect map between the coefficient β_2 obtained from regressing the forecast error on the forecast revision (Column (2), Table 5) and the parameter λ. A positive value of β_2 is coherent with the hypothesis of sticky information and $\beta_2 = \frac{\lambda}{(1-\lambda)}$. Therefore, I set $\lambda = 0.438$.

[36]Aggregate consumption is given by $c_t^S = (1-\lambda)c_t^{rat} + \lambda c_{t-1}^S$; while debt can be derived from the budget constraint.

Impulse responses. Figure 8 shows the term structure for the expectations on y_{t+j} and Δy_{t+j} to a shock to Δy_{t+j}. The term structure reports the long term expectations $\widetilde{E_1^S}(\Delta y_{t+j})$ and $\widetilde{E_1^S}(y_{t+j})$ computed at time t=1 for any $j \geq 1$. Rational expectations coincide with the true data generating process. Following a positive shock to Δy_t, only a fraction of agents immediately updates rationally. Hence, the average forecast made at t=1 on the long run captures the correct path but is below the realized value; while the average forecast error is positive for all horizons (Panel A). Every quarter, a positive fraction of agents updates the beliefs, so the average forecast increases and gets closer to the rational one. Eventually expectations convergence, but in the medium run, biased expectations drive the demand for debt.

Figure 11 displays the impulse responses following a one standard deviation shock to Δy_t. After a positive shock, consumption and savings gradually increase. A portion $(1-\lambda)$ of consumers correctly anticipate the income dynamics and rationally increases savings and consumption soon after the shock. Savings increases more than rationally because some agents do not revise the consumption plan immediately and over-save the extra-income. Each quarter, more agents revise their beliefs and consumption plans, the average forecast slowly moves upward and consumption gradually increases. Overall, the model yields to a level of consumption and savings larger than under rational expectations, because consumers over-save in the first few quarters and exploit their savings to finance the extra consumption afterwards.

A.3 Noisy signals

In this section, I consider a model with noisy signals as in Sims (2003). The representative agent continuously receives information on Δy_t, but observes only a noisy signal s_t such that:[37]

$$\Delta y_t = \beta(L)\epsilon_t, \epsilon_t \sim N(0, \sigma_\epsilon^2) \tag{24}$$

[37] The representative agent observes a change in income equal to s_t but doesn't know whether this is equal to the true Δy_t, or not.

and:

$$s_t = \Delta y_t + \eta_t, \eta_t \sim N(0, \sigma_\eta^2) \tag{25}$$

The noise term η_t generates an independent source of variation in the expectations and prevents from correctly identifying the permanent component ϵ_t. After observing an increase of s_t, the agent needs time to learn about the nature of the change. Both shocks indeed imply an immediate increase in s_t: however, the noise shock generates only a one-period change in the signal, while ϵ_t has a permanent effect on the income in level.
Since the agent does not fully observe the true state (Δy_t), he needs to solve a signal extraction problem via Kalman filtering. Thus the forecasts are a weighted average of agent's prior beliefs and an error correction term:

$$\widetilde{E_t^N}(\Delta y_t) = \widetilde{E_{t-1}^N}(\Delta y_t) + G(s_t - \widetilde{E_{t-1}^N}(\Delta y_t)) \tag{26}$$

Where G is the Kalman gain and depends on the signal to noise ratio. Except for the information frictions, the agent is fully rational and computes $E_t^N(\Delta y_{t+j})$ for any $j > 1$ according to the true DGP. [38] The presence of noisy signals generates expectational errors, both when ϵ and η arrive. The consumer has only limited information regarding the long-term income and these expectations drive the demand for debt.

Match with the empirical evidence. As shown by Coibion and Gorodnichenko (2015), there is a perfect map between the coefficient β_2 obtained from regressing the forecast error on the forecast revision, and the Kalman gain G (Column (2), Table 5). A positive value for the parameter β_2 is coherent to the hypothesis of noisy signals and $\beta_2 = \frac{1-G}{G}$. The Kalman gain depends on the signal to noise ratio s.t. $G = \frac{\sigma_{\Delta_y}}{\sigma_{\Delta_y}+\sigma_\eta}$. Without information frictions G is equal to 1; $G \leq 1$ instead implies information frictions and $(1-G)$ can be interpreted as the degree of information rigidity. I calibrate the model using

[38] I solve the signal extraction problem, considering a state space representation: (1) $\alpha_t = T\alpha_{t-1} + e_t$ (state equation), and (2) $y_t = Z\alpha_t + \zeta_t$ (measurement equation). α_t is a vector of unobservable state variable and y_t a vector of observables. The error terms have zero mean, are jointly normally distributed and uncorrelated s.t: e_t iid N(0,H) and ζ_t iid N(0,S).

the estimated coefficient and the estimated variance for Δy_t. Given these two values, I recover the variance of the noise shock and set $\sigma^2_\eta = 0.00623^2$ (and $\sigma^2_{\Delta y} = 0.008^2$).

Impulse responses. Figure 9 shows the term structure for the expectations on y_{t+j} and Δy_{t+j} to a shock to Δy_{t+j}. The term structure reports the long-term expectations $\widetilde{E^N_1}(\Delta y_{t+j})$ and $\widetilde{E^N_1}(y_{t+j})$ computed at time t=1 for any $j \geq 1$. Rational expectations coincide with the true data generating process. Following a positive shock to the fundamental, the representative agent updates his beliefs filtering out the noise and knowing the true DGP. The forecasts rationally capture the hump-shaped pattern but fail to match the long run income in level and generate a positive forecast error on long-term expectations both for y_{t+j} (Panel A) and Δy_{t+j} (Panel B) for any $j \geq 1$. Every quarter, the forecasts move in the direction of the detected error; slow adjustment implies that the forecasts are too low after a positive change, while they are too high after a negative change. Expectations get very close to the rational ones, but convergence occurs after more than 40 quarters. The speed of convergence depends on the signal to noise ratio $\frac{\sigma_{\Delta y}}{\sigma_\eta}$; convergence is achieved faster when the ratio reduces as the forecasts are less sensitive to the observed forecast error. With a sufficiently low ratio, the forecasts instead converge once Δy_{t+j} reaches zero. Overall, in the short run, the agent fails to predict the long-term income, and these biased beliefs affect his consumption/savings choices.

Figure 12 displays the impulse responses following a one standard deviation shock to Δy_t. After a positive shock to the fundamentals, consumption and savings gradually increase. Initially, the agent foresees a permanent increase in income and hence raises consumption. Consumption grows less than rationally because the agent underestimates the long run income; further, he anticipates the hump-shaped dynamics and rationally increases savings.[39] Each quarter, expectations are revised in the direction of the observed error. Consumption gradually increases towards the rational level as the forecasts move towards the rational benchmark and savings rationally increase. Since expectations are very sensitive to the detected errors, consumption frequently changes over time. After a positive Δy_t, the agent revises his forecast upward on future income and increases consumption;

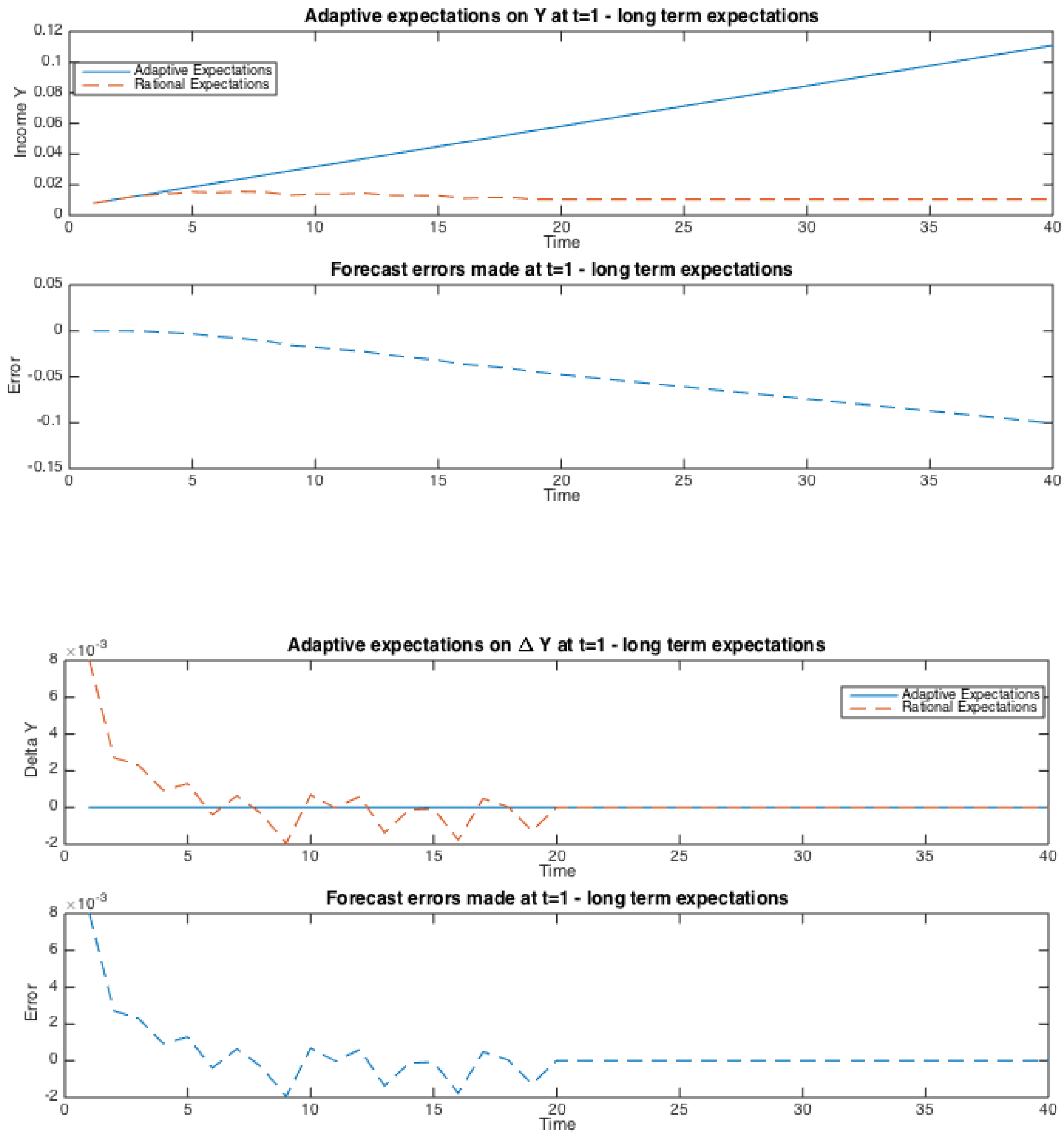
[39] In the first few quarters, debt increases but less than rationally. From t=3, debt starts decreasing and follows a path similar to the rational case.

on the contrary, after a negative Δy_t consumption decreases.[40] The learning process and the impulse for consumption depend strongly on the signal to noise ratio $\frac{\sigma_{\Delta y}}{\sigma_\eta}$.[41] However, following a positive shock to the income growth rate, the model always predicts an increase in savings, and never a growth in debt.

[40]The impulse response for consumption is not smooth because expectations frequently adjust in response to the detected error. The calibrate Kalman Gain is equal to 0.56 which means that considerable weight is assigned to the ex-post forecast error.

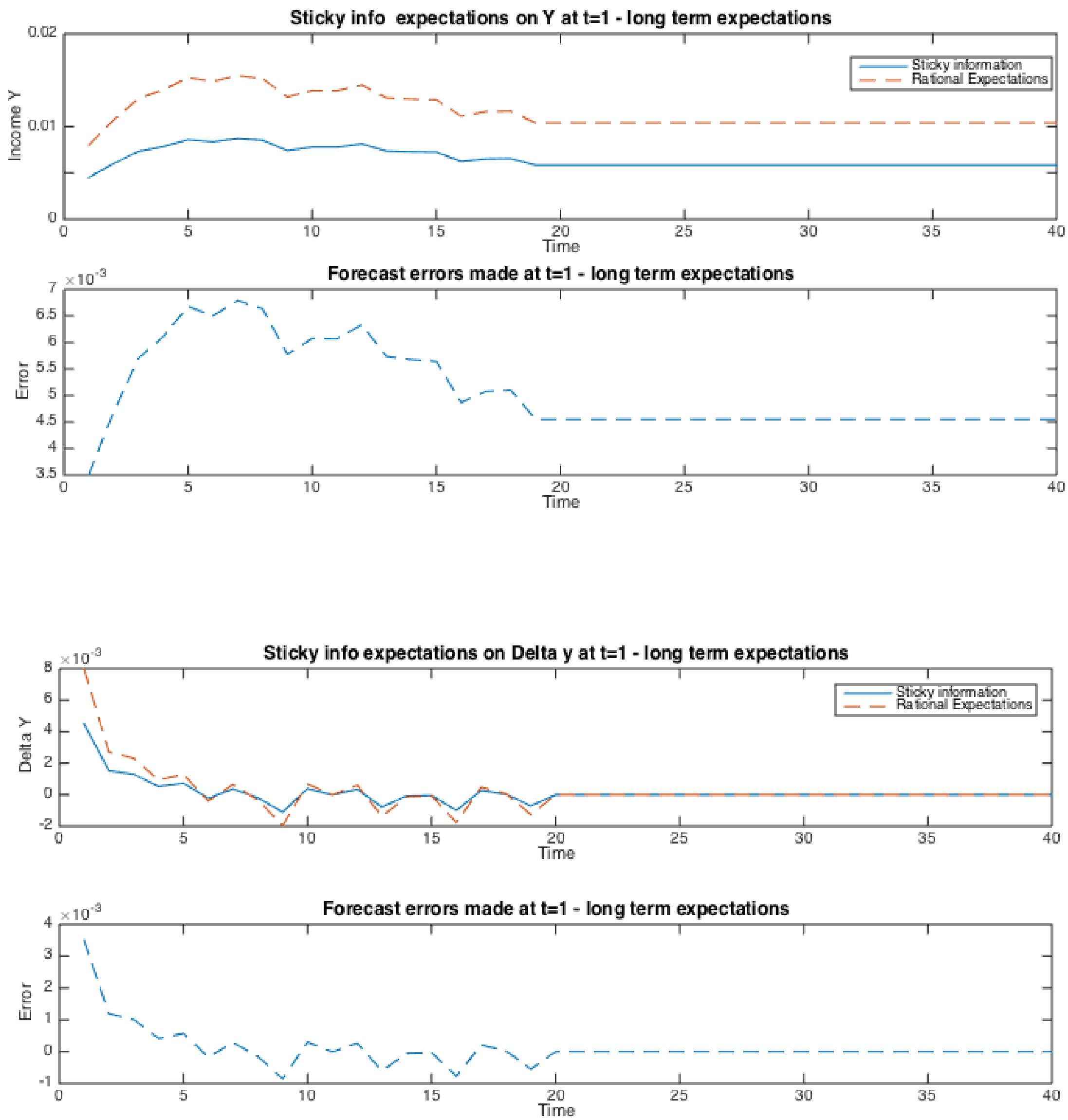
[41]When the ratio is high enough, the weight associated with the signal is high, and expectations and consumption are very sensitive to the observed errors. Shifts in consumption are frequent, and consumption remains below the rational level for longer; savings increase more in the first few quarters and finance the extra consumption afterwards. Otherwise, when the ratio is sufficiently low, the weight assigned to the prior is high, and expectations slowly adjust. At t=1, the forecasts adjust upward very little, the expected future growth is low, and hence savings only slightly change. As income increase, consumption rise and expectations adjust.

Figure 7: Beliefs term structure - Adaptive expectations



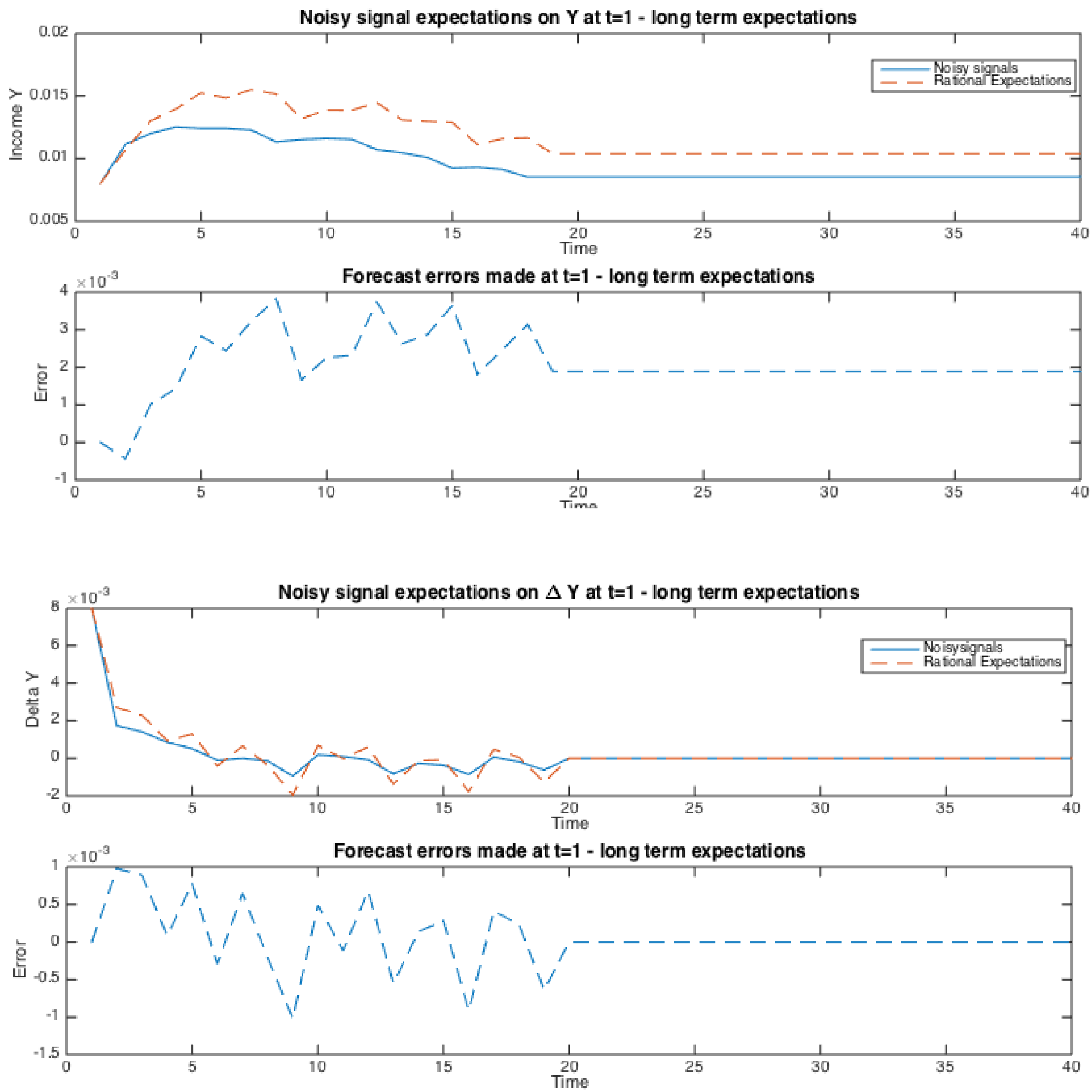
Note: Beliefs term structure (in percentage change) following one standard deviation shock to Δy_t. Dashed orange lines are the rational expectations case. Solid blue lines the adaptive expectations, with $\phi = 0.33$. The upper panel displays $\widetilde{E^A_{t=1}}(y_{t+j})$ and the relative forecast error $(y_{t+j} - \widetilde{E^A_{t=1}}(y_{t+j}))$ for $j \geq 1$. The lower panel displays $\widetilde{E^A_{t=1}}(\Delta y_{t+j})$ and the relative forecast error $(\Delta y_{t+j} - \widetilde{E^A_{t=1}}(\Delta y_{t+j}))$ for $j \geq 1$. Time on the horizontal axis is the forecast horizon in quarters.

Figure 8: Beliefs term structure - Sticky information



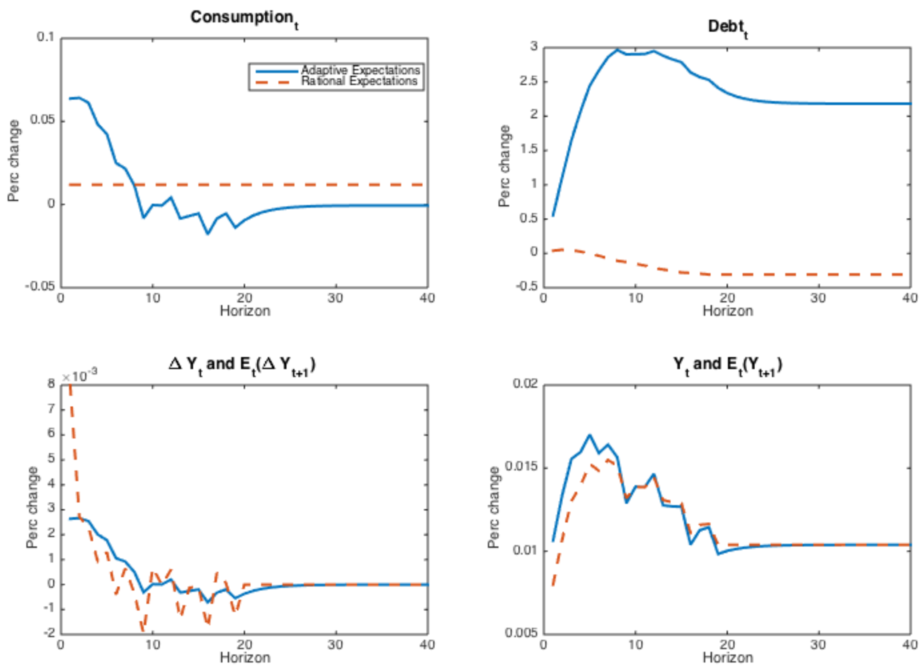
Note: Beliefs term structure (in percentage change) following one standard deviation shock to Δy_t. Dashed orange lines are the rational expectations case. Solid blue lines the sticky information case, with $\lambda = 0.438$. The upper panel displays $\widetilde{E^S_{t=1}}(y_{t+j})$ and the relative forecast error $(y_{t+j} - \widetilde{E^S_{t=1}}(y_{t+j}))$ for $j \geq 1$. The lower panel displays $\widetilde{E^S_{t=1}}(\Delta y_{t+j})$ and the relative forecast error $(\Delta y_{t+j} - \widetilde{E^S_{t=1}}(\Delta y_{t+j}))$ for $j \geq 1$. Time on the horizontal axis is the forecast horizon in quarters.

Figure 9: Beliefs term structure - Noisy signals



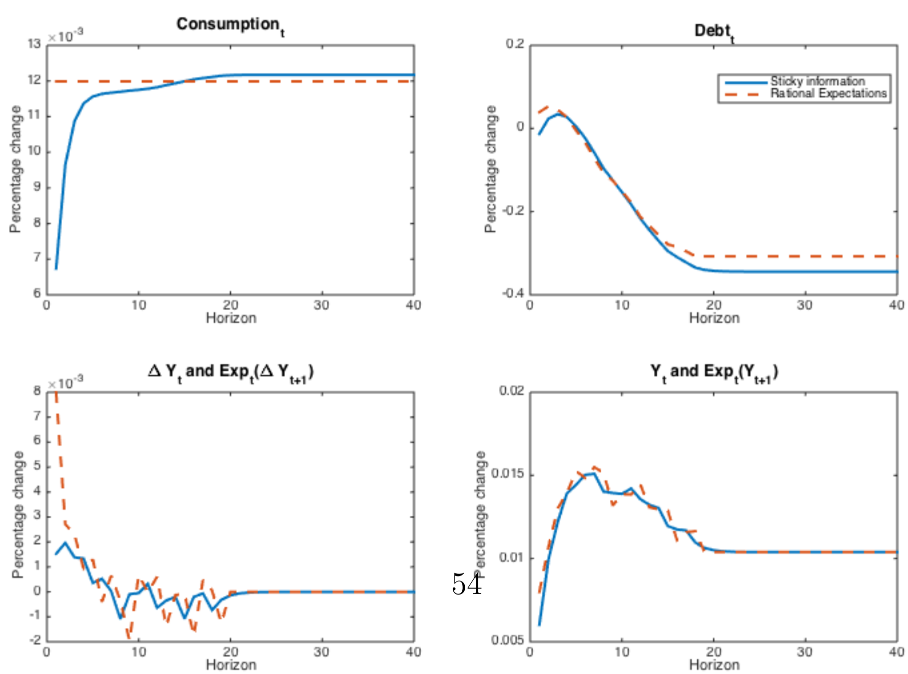
Note: Beliefs term structure (in percentage change) following one standard deviation shock to Δy_t. Dashed orange lines are the rational expectations case. Solid blue lines the noisy signal case with $\sigma_\eta = 0.00623$. The upper panel displays $\widetilde{E^N_{t=1}}(y_{t+j})$ and the relative forecast error $(y_{t+j} - \widetilde{E^N_{t=1}}(y_{t+j}))$ for $j \geq 1$. The lower panel displays $\widetilde{E^N_{t=1}}(\Delta y_{t+j})$ and the relative forecast error $(\Delta y_{t+j} - \widetilde{E^N_{t=1}}(\Delta y_{t+j}))$ for $j \geq 1$. Time on the horizontal axis is the forecast horizon in quarters.

Figure 10: Impulse responses - Adaptive expectations



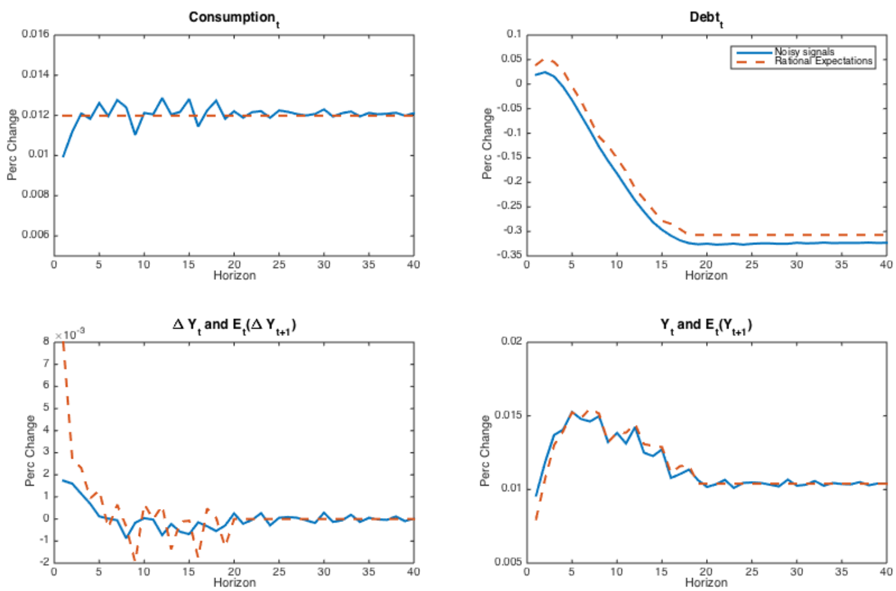
Note: Impulse responses following one standard deviation shock to Δy_t. Dashed lines are the rational expectations case. Solid blue lines the adaptive expectations, with $\phi = 0.33$. In the lower panels, expectations are $\widetilde{E_t^A}(\Delta y_{t+1})$ and $\widetilde{E_t^A}(y_{t+1})$ for $t \geq 1$, respectively.

Figure 11: Impulse responses - Sticky information



Note: Impulse responses following one standard deviation shock to Δy_t. Dashed orange lines are the rational expectations case. Solid blue lines the sticky information case, with $\lambda = 0.438$. In the lower panels, expectations are $\widetilde{E_t^S}(\Delta y_{t+1})$ and $\widetilde{E_t^S}(y_{t+1})$ for $t \geq 1$, respectively.

Figure 12: Impulse responses - Noisy signals



Note: Impulse responses following one standard deviation shock to Δy_t. Dashed orange lines are the rational expectations case. Solid blue lines the noisy signal case with $\sigma_\eta = 0.00623$. In the lower panels, expectations are $\widetilde{E_t^N}(\Delta y_{t+1})$ and $\widetilde{E_t^N}(y_{t+1})$ for $t \geq 1$, respectively.

B Appendix: Robustness checks

Do beliefs on future output help predict changes in household debt in the short run and is it robust to different specifications, countries, and measures of expectations? Do few optimistic agents drive this relationship?

B.1 Is this relationship driven by few optimistic agents? Testing the role of heterogeneity

In this section, I test if a small fraction of optimistic agents drives the relationship observed in Table 4. If this is the case, heterogeneity in expectations may be a relevant factor to take into account when studying the household credit cycle. To test this, hypothesis, I use micro-data on forecasters' expectations and check if the most optimistic agents (in the top 5/10/20.. percentiles) are driving the positive relationship observed in Table 4. Table 9 shows that this is not the case. Panel B reports the results of the forecasting regression estimated considering the average expectations of the most 5% pessimistic agents (Column 1), the 10% (Column 2) and so on. The relationship is positive and significant also when considering only the most pessimistic agents; thus, the positive correlation is not exclusively due to a small fraction of optimistic agents.

B.2 SPF and Michigan expectations

Expectations on future real GDP growth have substantial forecasting power for realised household credit growth, mortgages, savings and consumption. Table 10 reports the baseline results from OLS regressions. In Columns (1) and (5) the dependent variable is Household credit; this covers most credit extended to individuals, excluding loans secured by real estate, Columns (2) and (6) refer to mortgages, Columns (3) and (7) to the Personal savings rate, and Columns (4) and (8) to Personal consumption expenditures. Changes in expected future growth have substantial forecasting power for mortgages. When controlling for the realised RGDP growth rate, the effect is reduced but remains large in magnitude (Table 12).

The empirical findings are robust when using consumers' expectations by the Michigan Survey (Table 11). In Columns (1) and (4), the explanatory variable is the average percentage

Table 9: Household Credit and expected RGDP growth by percentiles

Panel A: Household Credit and expected RGDP growth by optimism

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Variables	H. Credit	H. Credit	H. Credit	H. Credit	H. Credit	H. Credit	H. Credit	H. Credit	H. Credit
$E_t(RGDPgr_{t,t+4})$_p5_opt	1.781***								
	(0.252)								
$E_t(RGDPgr_{t,t+4})$_p10_opt		1.780***							
		(0.254)							
$E_t(RGDPgr_{t,t+4})$_p20_opt			1.796***						
			(0.256)						
$E_t(RGDPgr_{t,t+4})$_p25_opt				1.792***					
				(0.257)					
$E_t(RGDPgr_{t,t+4})$_p50_opt					1.803***				
					(0.270)				
$E_t(RGDPgr_{t,t+4})$_p75_opt						1.819***			
						(0.294)			
$E_t(RGDPgr_{t,t+4})$_p80_opt							1.756***		
							(0.307)		
$E_t(RGDPgr_{t,t+4})$_p90_opt								1.559***	
								(0.333)	
$E_t(RGDPgr_{t,t+4})$_p95_opt									1.966***
									(0.326)
Constant	-0.218	-0.278	-0.293	-0.303	-0.568	-0.759	-0.795	-0.570	1.624
	(4.961)	(4.969)	(4.953)	(4.960)	(5.006)	(5.059)	(5.055)	(4.998)	(4.800)
Baseline controls	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	186	186	186	186	186	186	186	185	163
R^2	0.725	0.724	0.724	0.723	0.718	0.710	0.704	0.684	0.726

Panel B: Household Credit and expected RGDP growth by pessimism

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Variables	H. Credit	H. Credit	H. Credit	H. Credit	H. Credit	H. Credit	H. Credit	H. Credit	H. Credit
$E_t(RGDPgr_{t,t+4})$_p5	1.288***								
	(0.241)								
$E_t(RGDPgr_{t,t+4})$_p10		1.305***							
		(0.229)							
$E_t(RGDPgr_{t,t+4})$_p20			1.485***						
			(0.237)						
$E_t(RGDPgr_{t,t+4})$_p25				1.529***					
				(0.238)					
$E_t(RGDPgr_{t,t+4})$_p50					1.641***				
					(0.238)				
$E_t(RGDPgr_{t,t+4})$_p75						1.691***			
						(0.243)			
$E_t(RGDPgr_{t,t+4})$_p80							1.693***		
							(0.243)		
$E_t(RGDPgr_{t,t+4})$_p90								1.714***	
								(0.247)	
$E_t(RGDPgr_{t,t+4})$_p95									1.722***
									(0.248)
Constant	0.681	0.300	0.145	0.000870	0.120	-0.0199	-0.0375	-0.0845	-0.155
	(5.460)	(5.067)	(5.016)	(5.017)	(4.952)	(4.943)	(4.952)	(4.957)	(4.970)
Baseline controls	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	163	185	186	186	186	186	186	186	186
R^2	0.703	0.703	0.718	0.719	0.725	0.726	0.726	0.725	0.724

Note: Results from estimating $D_{t,t+4} = \alpha + \beta E_t(RGDP_{t,t+4}) + \delta(L)Z_t + \gamma(L)D_{t,t+4} + u_{t,t+4}$. In the upper panel, $E_t(RGDPgr_{t.t+4})$_p5_opt indicates the average expectations in the top 5% of optimist agents and so on for the other percentiles. Otherwise, in the lower panel $E_t(RGDPgr_{t.t+4})$_p5 indicates the average expectations in the top 5% of pessimist agents and so on for the other percentiles. The percentiles are computed for each quarter. $D_{t,t+4}$ is the percentage change between time t and t+4 of the Household credit. All regressions include two lags of the dependent variable. Baseline controls are: inflation, 10YTBond, 3MTBill, GDP, and unemployment rate. Newey-west standard errors are reported in parentheses with 4 lags. P-values in parenthesis. *** p<0.01, ** p<0.05, * p<0.1.

of respondents who, in a given quarter, believe that there will be better times in the next year. Similarly, I estimate the equation considering the average percentage of respondents who, in a given quarter, believe that there will be higher unemployment (Columns (5) and (8)) and interest rates (Columns (9) and (12)) over the next year. Results are in line with previous findings. Households expectations are relevant predictors of credit growth rate: debt increases when agents foresee good times, and it decreases when consumers expect higher unemployment rate. On the contrary, savings contract when consumers are optimistic and rise otherwise. Consumers' expectations on future business conditions alone explain 25% of the variability of debt and the increase obtained from augmenting the baseline regression with the Michigan expectations is greater 12% of the variation in next year debt. Further, when controlling for the common factors (Table 11, Panel B), the coefficient of interest β_1 remains positive and significant. Finally, adding the realised RGDP, the coefficients remains correct in sign but loses significance (Table 13, Panel B); while expectations on future unemployment remain significant (Table 14, Panel B).

Table 10: Household Credit and expected RGDP growth over the next year

Variables	(1) H. Credit	(2) Mortgages	(3) Savings	(4) Cons. exp	(5) H. Credit	(6) Mortgages	(7) Savings	(8) Cons. exp
$E_t(RGDPgr_{t,t+4})$	1.813***	0.786***	-2.863**	0.592***	1.770***	0.708***	-2.784*	0.509**
	(0.219)	(0.134)	(1.351)	(0.217)	(0.253)	(0.146)	(1.512)	(0.252)
Constant	-0.982	-1.197**	18.01***	0.0394	-0.456	4.200	-15.16	2.175
	(0.885)	(0.475)	(4.824)	(0.895)	(4.957)	(2.800)	(29.06)	(2.401)
Baseline controls	NO	NO	NO	NO	YES	YES	YES	YES
Observations	186	181	186	186	186	181	186	186
R^2	0.675	0.866	0.108	0.625	0.727	0.886	0.179	0.755

VARIABLES	(1) H. Credit	(2) Mortgages	(3) Savings	(4) Cons. exp	(5) H. Credit	(6) Mortgages	(7) Savings	(8) Cons. exp
$E_t(RGDPgr_{t.t+4})$	1.399***	0.463***	-1.051	0.364*	1.143***	0.290**	0.0858	0.142
	(0.218)	(0.148)	(1.291)	(0.198)	(0.177)	(0.132)	(1.423)	(0.182)
Constant	1.032	-6.214*	35.32	4.156	-12.51	-10.04*	51.36	-8.482**
	(4.559)	(3.730)	(34.14)	(4.116)	(9.555)	(5.825)	(61.22)	(4.283)
Baseline controls	NO	NO	NO	NO	YES	YES	YES	YES
$Factors_t$	YES	YES	YES	YES	YES	YES	YES	YES
Observations	185	181	185	185	185	181	185	185
R^2	0.794	0.926	0.377	0.749	0.816	0.944	0.438	0.858

Note: Table reports results from estimating $D_{t,t+4} = \alpha + \beta E_t(RGDPgr_{t,t+4}) + \delta(L)Z_t + \gamma(L)D_{t,t+4} + u_{t,t+4}$. $E_t(RGDPgr_{t,t+4})$ is the SPF average forecast of Real GDP growth rate (RGDP gr) over the next four quarters. $D_{t,t+4}$ is the percentage change between time t and t+4 of the dependent variable, which can be Household credit, Mortgages, Personal savings, and Personal consumption expenditures. All regressions include two lags of the dependent variable. Baseline controls are: Consumer Price Index, 10YTBond, 3MTBill, GDP, and unemployment rate. Newey-west standard errors are reported in parentheses with 4 lags. P-values in parenthesis. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Few observations are missing in the SPF data.

Table 11: Household Credit and Michigan Survey of Consumers' expectations

Variables	(1) H. Credit	(2) Mortgages	(3) Savings	(4) Cons. exp	(5) H. Credit	(6) Mortgages	(7) Savings	(8) Cons. exp
Exp Change in Business	0.124***	0.0929***	-0.458*	0.0297				
Conditions in 1 Year	(0.0319)	(0.0159)	(0.268)	(0.0201)				
Exp increase in Unempl.					-0.165***	-0.0779***	0.508**	-0.0744***
during the Next Year					(0.0323)	(0.0207)	(0.224)	(0.0243)
Constant	-9.486	-2.968	23.20	-0.0561	10.67**	9.192***	-43.50	6.717**
	(6.722)	(2.456)	(31.79)	(2.835)	(5.106)	(3.245)	(36.29)	(2.868)
Baseline controls	YES	YES	YES	YES	YES	YES	YES	YES
Observations	186	181	186	186	186	181	186	186
R^2	0.670	0.899	0.208	0.726	0.708	0.888	0.213	0.788

Variables	(1) H. Credit	(2) Mortgages	(3) Savings	(4) Cons. exp	(5) H. Credit	(6) Mortgages	(7) Savings	(8) Cons. exp
Exp Change in Business	0.0828***	0.0472***	-0.218	0.0167				
Conditions in 1 Year	(0.0290)	(0.0148)	(0.207)	(0.0129)				
Exp increase in Unempl.					-0.0975***	-0.0602***	0.239	-0.0331*
during the Next Year					(0.0308)	(0.0176)	(0.179)	(0.0195)
Constant	-16.71***	-12.50***	52.01	-1.514	-2.266	-4.218	18.40	3.269
	(4.952)	(3.022)	(36.35)	(3.806)	(4.760)	(3.905)	(34.02)	(4.040)
Factors_t	YES	YES	YES	YES	YES	YES	YES	YES
Observations	185	181	185	185	185	181	185	185
R^2	0.789	0.946	0.445	0.592	0.789	0.944	0.439	0.858

Note: Table reports results from estimating $D_{t,t+4} = \alpha + \beta Exp_t + \delta(L)Z_t + \gamma(L)D_{t,t+4} + u_{t,t+4}$. Exp_t is the Exp Change in Business in 1 Year or the Exp increase in Unemployment during the next year. The former is the relative share of agents that expect good times in 1 year, the latter the fraction of respondents who expect an increase in unemployment during the next year, in a given quarter, in the Michigan Survey of Consumers survey. $D_{t,t+4}$ is the percentage change between time t and t+4 of the dependent variable, which can be Household credit, Mortgages, Personal savings, and Personal consumption expenditures. All regressions include two lags of the dependent variable. Baseline controls are: Consumer Price Index, 10YTBond, 3MTBill, GDP, and unemployment rate. Newey-west standard errors are reported in parentheses with 4 lags. P-values in parenthesis.*** p<0.01, ** p<0.05, * p<0.1.

Table 12: Household Credit, expected and realized RGDP growth

Variables	(1) H. Credit	(2) Mortgages	(3) Saving	(4) Cons. exp.	(5) H. Credit	(6) Mortgages	(7) Saving	(8) Cons. exp.
$E_t(RGDPgr_{t,t+4})$	1.541***	0.708***	-2.049	0.341*	1.488***	0.687***	-2.624**	0.226
	(0.216)	(0.127)	(1.623)	(0.178)	(0.249)	(0.165)	(1.280)	(0.219)
RGDP_gr$_{t-4,t}$	0.147*	-0.000703	0.0392	0.145*	0.172**	0.00811	0.104	0.167***
	(0.0856)	(0.0515)	(0.561)	(0.0825)	(0.0855)	(0.0532)	(0.529)	(0.0587)
RGDP_gr$_{t,t+4}$	0.110	0.239***	-1.842**	0.0666	0.0335	0.188**	-1.495**	0.0136
	(0.0904)	(0.0823)	(0.825)	(0.0518)	(0.0818)	(0.0731)	(0.756)	(0.0326)
Constant	-0.898	-1.781***	20.28***	0.159	-0.277	3.055	-6.367	2.292
	(0.895)	(0.517)	(5.168)	(0.895)	(4.930)	(2.509)	(27.16)	(2.136)
Baseline controls	NO	NO	NO	NO	YES	YES	YES	YES
Observations	181	177	181	181	181	177	181	181
R^2	0.686	0.885	0.181	0.641	0.735	0.897	0.223	0.770

Variables	(1) H. Credit	(2) Mortgages	(3) Saving	(4) Cons. exp.	(5) H. Credit	(6) Mortgages	(7) Saving	(8) Cons. exp.
Exp Change in Business	0.119***	0.0892***	-0.460**	0.0195	0.0888***	0.0841***	-0.418	0.00269
Conditions in 1 Year	(0.0348)	(0.0160)	(0.223)	(0.0143)	(0.0319)	(0.0158)	(0.258)	(0.0148)
RGDP_gr$_{t-4,t}$	0.287***	0.0276	0.321	0.199**	0.315***	0.0378	0.177	0.213***
	(0.0917)	(0.0529)	(0.448)	(0.0899)	(0.0887)	(0.0525)	(0.528)	(0.0718)
RGDP_gr$_{t,t+4}$	0.0896	0.207***	-1.472**	0.0695	0.0328	0.152**	-1.327*	0.0196
	(0.0921)	(0.0747)	(0.697)	(0.0516)	(0.0970)	(0.0692)	(0.675)	(0.0341)
Constant	-10.42***	-10.29***	62.70**	-1.286	-6.582	-3.067	27.72	2.190
	(3.615)	(1.810)	(24.49)	(1.775)	(6.463)	(2.290)	(32.86)	(2.453)
Baseline controls	NO	NO	NO	NO	YES	YES	YES	YES
Observations	181	177	181	181	181	177	181	181
R^2	0.660	0.903	0.221	0.631	0.701	0.907	0.243	0.765

Note: Table reports results from estimating $D_{t,t+4} = \alpha + \beta E_t(RGDPgr_{t,t+4}) + \delta(L)Z_t + \gamma(L)D_{t,t+4} + u_{t,t+4}$ and $D_{t,t+4} = \alpha + \beta Exp_t(Business) + \delta(L)Z_t + \gamma(L)D_{t,t+4} + u_{t,t+4}$. $E_t(RGDPgr_{t,t+4})$ is the SPF average forecast of Real GDP growth rate (RGDP gr) over the next four quarters. $Exp_t(Business)$ is the relative share of agents that expect good times in 1 year, in a given quarter, in the Michigan Survey of Consumers survey. $D_{t,t+4}$ is the percentage change between time t and t+4 of the dependent variable, which can be Household credit, Mortgages, Personal savings rate, and Personal consumption expenditures. Baseline controls are: Consumer Price Index, 10YTBond, 3MTbill, GDP, and unemployment rate. Newey-west standard errors are reported in parentheses with 4 lags. All regressions include two lags of the dependent variable. *** p<0.01, ** p<0.05, * p<0.1.

Table 13: Household Credit, expected and realized RGDP growth

Variables	(1) H. Credit	(2) Mortgages	(3) Saving	(4) Cons. exp.	(5) H. Credit	(6) Mortgages	(7) Saving	(8) Cons. exp.
$E_t(RGDPgr_{t,t+4})$	1.463***	0.503***	-1.785	0.269	1.652***	0.549***	-0.797	0.243
	(0.216)	(0.160)	(1.390)	(0.198)	(0.196)	(0.146)	(1.394)	(0.217)
RGDP_gr$_{t-4,t}$	-0.0606	-0.0544	0.663	0.0578	-0.0958	-0.0753*	0.391	0.0607
	(0.0736)	(0.0385)	(0.458)	(0.0557)	(0.0731)	(0.0412)	(0.449)	(0.0511)
RGDP_gr$_{t,t+4}$	0.0532	0.154***	-0.969**	0.0885*	0.0896	0.131***	-0.239	0.0779*
	(0.0705)	(0.0414)	(0.423)	(0.0489)	(0.0604)	(0.0482)	(0.587)	(0.0406)
Constant	1.278	-7.725**	50.84	5.011	9.040	-6.517**	86.59*	10.16*
	(4.690)	(3.259)	(33.66)	(3.968)	(5.875)	(3.251)	(50.06)	(5.645)
Factors$_t$	YES	YES	YES	YES	YES	YES	YES	YES
Factors$_{t+4}$	NO	NO	NO	NO	YES	YES	YES	YES
Observations	181	177	181	181	181	177	181	181
R^2	0.796	0.933	0.410	0.758	0.829	0.936	0.490	0.775

Variables	(1) H. Credit	(2) Mortgages	(3) Saving	(4) Cons. exp.	(5) H. Credit	(6) Mortgages	(7) Saving	(8) Cons. exp.
Exp Change in Business	0.0765**	0.0567***	-0.282	0.00726	0.0790***	0.0531***	-0.279	0.0143
in 1 Year	(0.0307)	(0.0124)	(0.220)	(0.0125)	(0.0293)	(0.0140)	(0.195)	(0.0126)
RGDP_gr$_{t-4,t}$	0.0809	-0.0322	0.718	0.100	0.0701	-0.0487	0.644	0.0875
	(0.0904)	(30.0489)	(0.530)	(0.0657)	(0.0961)	(0.0507)	(0.520)	(0.0619)
RGDP_gr$_{t,t+4}$	0.0798	0.158***	-0.992**	0.0935*	0.0339	0.103**	-0.193	0.0684
	(0.0870)	(0.0425)	(0.425)	(0.0500)	(0.0711)	(0.0470)	(0.573)	(0.0423)
Constant	-14.16**	-15.17***	76.98*	1.940	-9.252	-13.48***	107.5*	6.694
	(5.878)	(2.835)	(40.19)	(3.285)	(7.632)	(3.502)	(55.43)	(5.156)
Factors$_t$	YES	YES	YES	YES	YES	YES	YES	YES
Factors$_{t+4}$	NO	NO	NO	NO	YES	YES	YES	YES
Observations	181	177	181	181	181	177	181	181
R^2	0.761	0.936	0.416	0.752	0.789	0.936	0.500	0.772

Note: Table reports results from estimating $D_{t,t+4} = \alpha + \beta E_t(RGDPgr_{t,t+4}) + \delta(L)Z_t + \gamma(L)D_{t,t+4} + u_{t,t+4}$ and $D_{t,t+4} = \alpha + \beta Exp_t)Business) + \delta(L)Z_t + \gamma(L)D_{t,t+4} + u_{t,t+4}$. $E_t(RGDPgr_{t,t+4})$ is the SPF average forecast of Real GDP growth rate (RGDP gr) over the next four quarters. $Exp_t(Business)$ is the relative share of agents that expect good times in 1 year, in a given quarter, in the Michigan Survey of Consumers survey. $D_{t,t+4}$ is the percentage change between time t and t+4 of the dependent variable, which can be Household credit, Mortgages, Personal savings rate, and Personal consumption expenditures. Baseline controls are: Consumer Price Index, 10YTBond, 3MTbill, GDP, and unemployment rate. Newey-west standard errors are reported in parentheses with 4 lags. All regressions include two lags of the dependent variable. *** p<0.01, ** p<0.05, * p<0.1.

Table 14: Household Credit, expected and realized Unemployment rate - Michigan

Variables	(1) H. Credit	(2) Mortgages	(3) Saving	(4) Cons. exp.	(5) H. Credit	(6) Mortgages	(7) Saving	(8) Cons. exp.
Exp increase in Unempl.	-0.0388	-0.00190	0.0932	0.00400	-0.0565	-0.0150	0.138	-0.0192
during the Next Year	(0.0436)	(0.0220)	(0.155)	(0.0199)	(0.0348)	(0.0243)	(0.140)	(0.0143)
unrate_t	1.939***	1.348***	-8.153**	0.995***	1.817***	1.045***	-6.146*	1.167***
	(0.332)	(0.312)	(3.384)	(0.239)	(0.351)	(0.345)	(3.649)	(0.177)
unrate_{t+4}	-1.787***	-1.318***	8.659**	-0.926***	-1.930***	-1.248***	8.024**	-1.021***
	(0.333)	(0.234)	(3.644)	(0.317)	(0.278)	(0.265)	(3.750)	(0.217)
Constant	4.043**	0.131	4.725	0.507	4.579	4.479	-21.58	3.328*
	(1.946)	(1.624)	(11.93)	(0.930)	(4.295)	(3.295)	(29.08)	(1.971)
Baseline controls	NO	NO	NO	NO	YES	YES	YES	YES
Observations	186	181	186	186	186	181	186	186
R^2	0.723	0.898	0.288	0.643	0.761	0.915	0.348	0.858

Variables	(1) H. Credit	(2) Mortgages	(3) Saving	(4) Cons. exp.	(5) H. Credit	(6) Mortgages	(7) Saving	(8) Cons. exp.
Exp increase in Unempl.	-0.0619*	-0.0372**	0.115	-0.0140	-0.0658**	-0.0390**	0.202	-0.0230
during the Next Year	(0.0339)	(0.0161)	(0.172)	(0.0197)	(0.0330)	(0.0165)	(0.150)	(0.0208)
unrate_t	1.205**	0.894***	-3.402	0.653***	1.353***	0.811**	-1.977	0.613**
	(0.480)	(0.289)	(2.734)	(0.246)	(0.399)	(0.349)	(3.360)	(0.295)
unrate_{t+4}	-1.051*	-0.902***	1.527	-0.597*	-1.029*	-0.767**	-1.359	-0.473
	(0.618)	(0.291)	(3.481)	(0.313)	(0.602)	(0.317)	(3.548)	(0.344)
Constant	1.651	0.0160	40.20	5.811	-1.617	-4.028	144.8**	7.632
	(10.51)	(5.065)	(62.29)	(6.357)	(12.37)	(6.199)	(71.04)	(7.036)
Factors_t	YES	YES	YES	YES	YES	YES	YES	YES
Factors_{t+4}	NO	NO	NO	NO	YES	YES	YES	YES
Observations	185	181	185	185	181	177	181	181
R^2	0.778	0.939	0.398	0.762	0.808	0.939	0.512	0.783

Note: Table reports results from estimating $D_{t,t+4} = \alpha + \beta Exp_t(unrate) + \delta(L)Z_t + \gamma(L)D_{t,t+4} + u_{t,t+4}$. $Exp_t(unrate)$ the fraction of respondents who expect an increase in unemployment during the next year in a given quarter in the Michigan Survey of Consumers survey. $D_{t,t+4}$ is the percentage change between time t and t+4 of the dependent variable, which can be Household credit, Mortgages, Personal savings rate, and Personal consumption expenditures. Baseline controls are: Consumer Price Index, 10YTBond, 3MTbill, GDP, and unemployment rate. Newey-west standard errors are reported in parentheses with 4 lags. All regressions include two lags of the dependent variable. *** p<0.01, ** p<0.05, * p<0.1.

B.3 Cross-country analysis

The work takes a broader view to show that private credit has a similar dynamics across all of the advanced countries. To test whether results are robust across countries, I use an international survey of professional forecasters by the Consensus Economics for the period from 2001: Q1 to 2016: Q1. This database reports forecast of the real GDP (RGDP) growth rate over the next year for 11 countries: USA, UK, Italy, Germany, Norway, Netherlands, Swiss, Spain, France, Japan, Sweden and Canada. Aggregate expectations are the average across forecasters' responses. Using the panel, I study the link between expectations on future real GDP growth and changes in debt. I only have a short time series of these data; however, it is still relevant to look at it since world-wide most of the variation in the growth rate of household debt took place in the last 20 years. I use data on household debt provided by the BIS. These are quarterly break-adjusted series and capture the outstanding amount of credit to households and non-profit institutions serving households at the end of reference quarter; credit is provided by domestic banks, other institutions and non-residents; it covers the core debt, defined as loans, debt securities and currency and deposits.

Results are robust across countries: the coefficient of interest is always positive and significant, even when adding time and country fixed effect and additional controls (Table 15, Panel A). To avoid Nickell bias, I do not include lags of the dependent variables.[42] Time fixed effects are highly significant suggesting that there is a common time component driving the credit cycle across countries. This result is consistent with the recent empirical evidence on household debt and business cycles word-wide (Mian, Sufi, and Verner, 2017). A one standard deviation increase in expectations leads to a 0.48 standard deviation increase in household debt (2.56 percentage points), with the other variables held constant and without fixed effect; results are very similar with time fixed effect. Adding country fixed effect, debt increases by 0.31 standard deviation (1.67 percentage points) and results are very similar including both time and fixed effect. [43] Controlling for the realized RGDP growth rate the effect is reduced, but it is still positive and significant: a one standard deviation increase in expectations leads to a 0.28 standard deviation increase in household debt (1.38 percentage points), with the other variables held constant and without fixed effect (Panel B); results are similar with time fixed effect. With country fixed effect, debt increases by 0.19 standard deviations (0.93 percentage points) and results are very similar including both time and country fixed effect.

[42] An alternative/complementary approach would be to use Arellano Bond GMM estimator.

[43] The growth rate of household debt follows a similar pattern for most of the advanced economies over this 8 years in terms of household growth rate (and as % of GDP); Japan, Swiss and Germany instead follow a different path. When I estimate the same predictive regression country by country, I observe a positive coefficient, although not always significant; this should not surprise given the very short time series.

Table 15: Household Credit and Consensus Economics

Variables	(1) H. Credit	(2) H. Credit	(3) H. Credit	(4) H.Credit
$E_t(RGDPgr_{t,t+4})$	3.019***	1.967***	3.248***	1.903***
	(0.268)	(0.234)	(0.222)	(0.191)
inflation$_t$	0.304	-0.552***	0.788***	0.0468
	(0.221)	(0.152)	(0.196)	(0.121)
rgdp$_t$	-0.0350	0.0874	0.0549	0.00272
	(0.0718)	(0.0680)	(0.0790)	(0.0785)
3M interbank rate$_t$	-0.0841	-0.199	0.586***	0.593***
	(0.228)	(0.213)	(0.165)	(0.174)
10Y Gov bond$_t$	1.249***	0.835***	0.701***	-0.627**
	(0.253)	(0.225)	(0.190)	(0.245)
unrate$_t$	-0.228***	-1.110***	-0.157***	-0.828***
	(0.030)	(0.059)	(0.026)	(0.054)
Time fixed effect	NO	NO	YES	YES
Country fixed effect	NO	YES	NO	YES
Observations	658	658	658	658
R^2	0.486	0.732	0.645	0.854

Variables	(1) H. Credit	(2) H. Credit	(3) H. Credit	(4) H.Credit
$E_t(RGDP_{t,t+4})$	2.132***	1.267***	2.952***	1.708***
	(0.249)	(0.209)	(0.217)	(0.205)
RGDP_gr$_{t,t+4}$	0.593***	0.609***	0.239***	0.236***
	(0.0666)	(0.0704)	(0.0599)	(0.0478)
inflation$_t$	0.742***	0.00246	0.881***	0.120
	(0.220)	(0.128)	(0.214)	(0.127)
rgdp$_t$	-0.0108	0.0305	0.0628	-0.0437
	(0.0629)	(0.0544)	(0.0832)	(0.0799)
3M interbank rate$_t$	0.308*	0.378**	0.558***	0.736***
	(0.179)	(0.185)	(0.154)	(0.169)
10Y Gov bond$_t$	0.789***	0.299	0.633***	-0.640***
	(0.192)	(0.184)	(0.177)	(0.228)
unrate$_t$	-0.169***	-1.006***	-0.139***	-0.833***
	(0.0349)	(0.0579)	(0.0310)	(0.0572)
Time fixed effect	NO	NO	YES	YES
Country fixed effect	NO	YES	NO	YES
Observations	641	641	641	641
R^2	0.552	0.784	0.652	0.859

Note: Table reports results from estimating $D_{i,t,t+4} = \alpha + \beta E_{i,t}(RGDPgr_{i,t,t+4}) + \delta(L)Z_{i,t} + u_{i,t,t+4}$. $E_{i,t}(RGDPgr_{i,t,t+4})$ is the SPF average forecast of Real GDP growth rate (RGDP gr) over the next four quarters in the given country i. $D_{i,t,t+4}$ is the percentage change between time t and t+4 of the Household credit. Standard errors in parenthesis are country level. *** p<0.01, ** p<0.05, * p<0.1. Few observations are missing in the SPF data.

B.4 Is it robust across time?

I run the same set of regressions on a sub-sample, excluding post-2000 data. Results are consistent, the coefficient of interest is reduced but remains positive and significant suggesting that the Great Recession is not driving the previous result (Table 16).

Table 16: Household credit and expected RGDP, excluding post- 2000 data

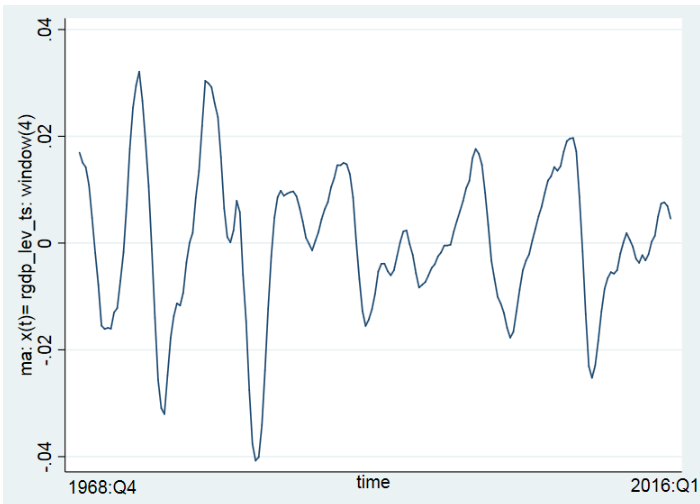
Variables	(1) H. Credit.	(2) Mortgages	(3) Saving	(4) Cons. exp.	(5) H. Credit.	(6) Mortgages	(7) Saving	(8) Cons. exp.
$E_t(RGDPgr_{t,t+4})$	1.708***	0.875***	-1.444	0.416***	1.157***	0.625***	-0.143	0.0601
	(0.210)	(0.136)	(1.264)	(0.154)	(0.230)	(0.157)	(1.073)	(0.120)
Constant	0.412	-0.438	11.84***	1.301	-14.73**	-9.888**	105.1***	-10.17***
	(1.149)	(0.947)	(4.177)	(0.863)	(6.738)	(4.912)	(24.41)	(2.374)
Controls	NO	NO	NO	NO	YES	YES	YES	YES
Observations	124	120	124	124	124	120	124	124
R^2	0.714	0.783	0.100	0.537	0.780	0.841	0.455	0.765

Variables	(1) H. Credit	(2) Mortgages	(3) Saving	(4) Cons. exp.	(5) H. Credit	(6) Mortgages	(7) Saving	(8) Cons. exp.
$E_t(RGDPgr_{t,t+4})$	1.550***	0.792***	-1.663	0.258*	0.985***	0.633***	-2.039**	-0.148
	(0.219)	(0.132)	(1.746)	(0.140)	(0.243)	(0.169)	(1.021)	(0.146)
$RGDP\_gr_{t-4,t}$	0.0795	0.0154	0.455	0.0831	0.112	0.0112	1.112***	0.118**
	(0.0798)	(0.0465)	(0.540)	(0.0736)	(0.0933)	(0.0452)	(0.297)	(0.0492)
$RGDP\_gr_{t,t+4}$	0.0833	0.163**	-0.929**	0.0681	-0.0388	0.109*	-0.288	-0.0572**
	(0.0945)	(0.0644)	(0.404)	(0.0461)	(0.0986)	(0.0615)	(0.318)	(0.0257)
Constant	0.334	-1.055	13.84***	1.007	-13.46**	-9.378**	118.3***	-9.089***
	(1.171)	(0.849)	(4.279)	(0.870)	(6.649)	(4.695)	(24.72)	(2.345)
Baseline controls	NO	NO	NO	NO	YES	YES	YES	YES
Observations	124	120	124	124	124	120	124	124
R^2	0.719	0.809	0.157	0.556	0.784	0.851	0.495	0.791

Note: Table reports results from estimating $D_{t,t+4} = \alpha + \beta E_t(RGDPgr_{t,t+4}) + \delta(L)Z_t + \gamma(L)D_{t,t+4} + u_{t,t+4}$. $E_t(RGDPgr_{t,t+4})$. is the SPF average forecast of Real GDP growth rate (RGDP gr) over the next four quarters. $D_{t,t+4}$ is the percentage change between time t and t+4 of the dependent variable, which can be Household credit, Mortgages, Personal savings rate, and Personal consumption expenditures. Baseline controls are: Consumer Price Index, 10YTBond, 3MTbill, GDP, and unemployment rate. Newey-west standard errors are reported in parentheses with 4 lags. All regressions include two lags of the dependent variable. *** p<0.01, ** p<0.05, * p<0.1.

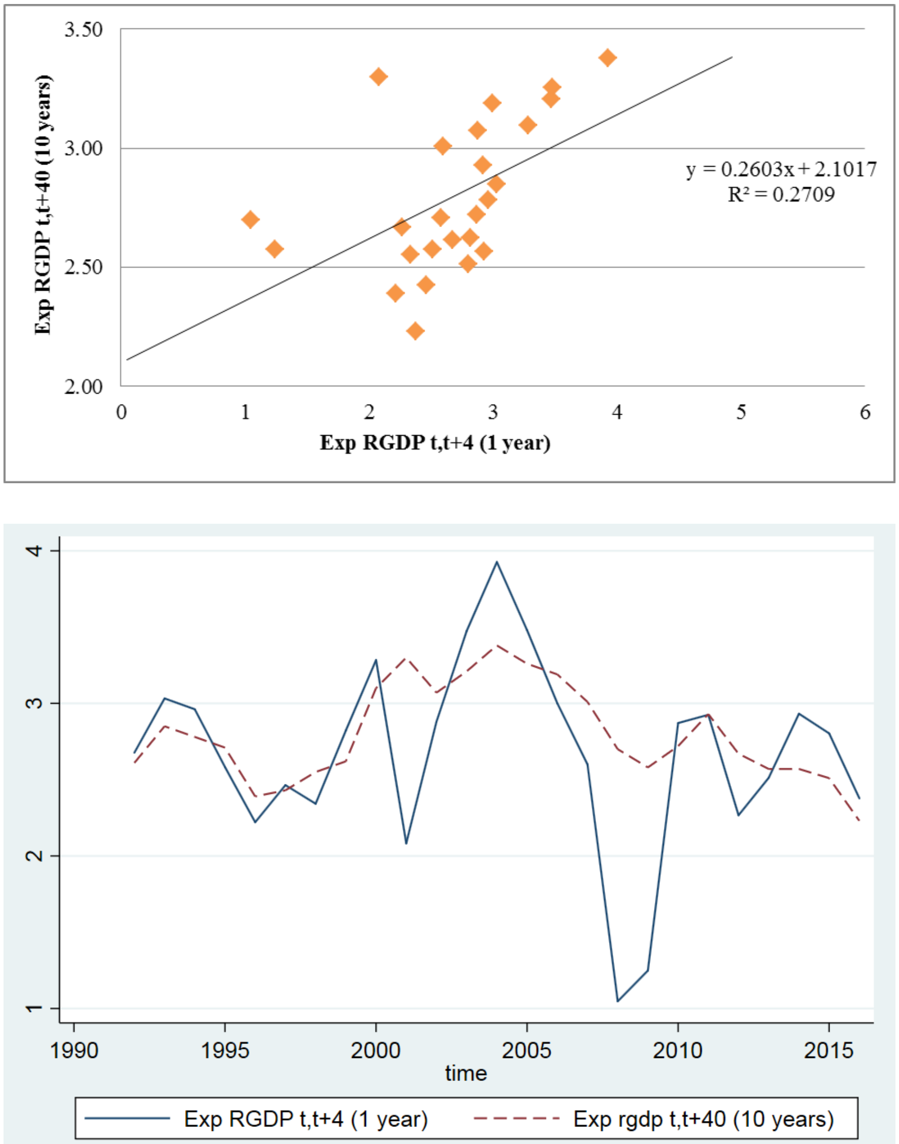
C Appendix: Natural expectations

Figure 13: RGDP cycle component



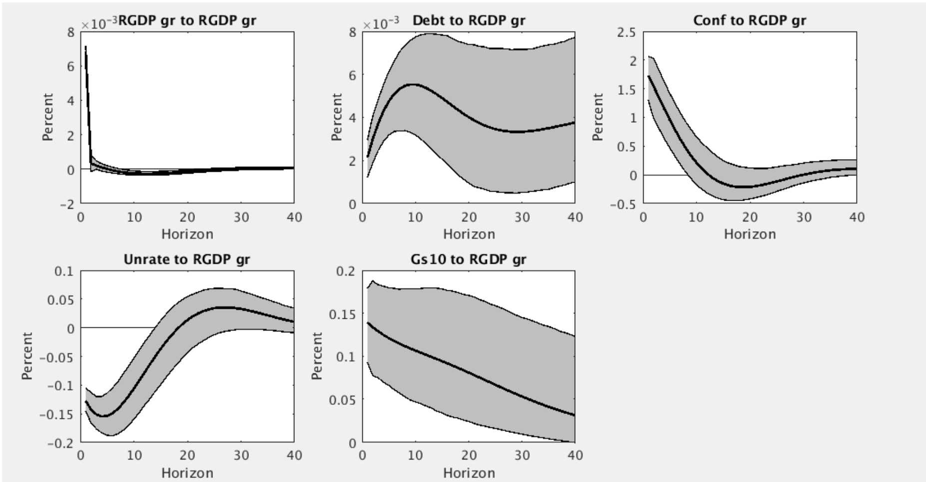
Note: RGDP cyclical component extracted applying the HodrickPrescott high-pass filter and smoothing the series with moving average with a window of 4 quarters. US data for the ln(RGDP), 1968:Q4-2016:Q1.

Figure 14: Short and long term expected RGDP growth rate



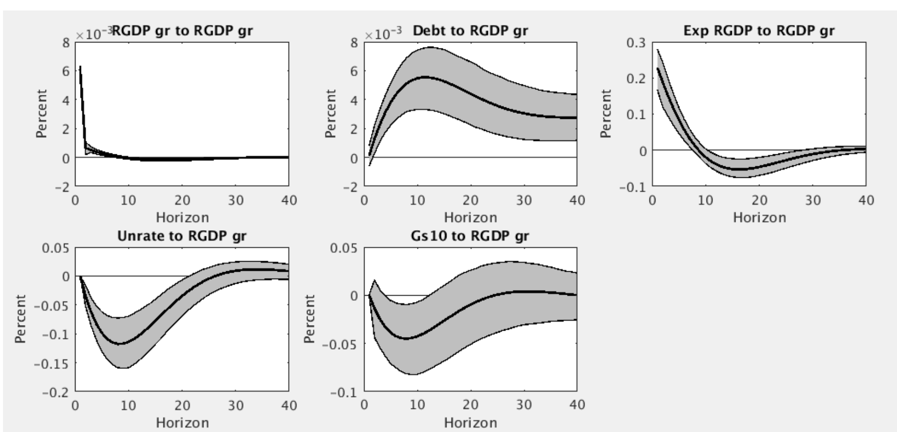
Note: The upper panel reports the correlation between $E_t(RGDPgr_{t,t+4})$ and $E_t(RGDPgr_{t,t+40})$ in percentage, using SPF data. The lower panel reports the time series for these two, where the blu solid line is the expected growth rate at 1 year ($E_t(RGDPgr_{t,t+4})$) and the red dashed line is the expected growth rate at 10 years ($E_t(RGDPgr_{t,t+40})$).

Figure 15: Empirical impulses with Consumer Confidence



Note: IRFs to a one standard deviation innovation to the Real GDP growth rate ($RGDPgr_t$), from a VAR in 5 variables. Shocks are identified with a Cholesky scheme and $RGDPgr_t$ is ordered first. Shaded areas are the confidence bands. Debt is $ln(Household\_credit)$, Gs10 is the 10 Year Treasury Bond rate (10YTBond), unrate is the unemployment rate and Confidence is the Michigan Consumer Confidence index.

Figure 16: Empirical impulses with alternative order



Note: IRFs to a one standard deviation innovation to the Real GDP growth rate ($RGDPgr_t$), from a VAR in 5 variables. Shocks are identified with a Cholesky scheme with the following order: $[Unrate_t, 10YTBond_t, RGDPgr_t, log(Household\_credit_t), E_t(RGDP_{t,t+4})]$. A shock to the $RGDPgr_t$ affects expectations and debt on impact as predicted in the model. Shaded areas are the confidence bands. Debt is $ln(Household\_credit)$, Gs10 is the 10 Year Treasury Bond rate (10YTBond), unrate is the unemployment rate and Exp RGDP is the SPF expected real GDP growth rate $E_t(RGDP_{t,t+4})$.

Table 17: Out of sample performance - ARIMA process

Model	MSFE (obs 122)	MAE (obs 122)	MSFE (obs 142)	MAE (obs 142)	MSFE (obs 162)	MAE (obs 162)
ARIMA(1,1)	2902.171	417.6714	2043.036	287.2562	1043.925	147.7166
ARIMA(1,2)	2903.328	417.6452	2044.118	287.2793	1040.463	147.441
ARIMA(1,3)	2904.568	417.6935	2044.622	287.3007	1042.035	147.5429
ARIMA(1,4)	-	-	2044.944	287.3149	1042.013	147.5437
ARIMA(1,5)	2904.146	417.5428	2044.943	287.3158	1040.727	147.4306
ARIMA(2,1)	2894.203	417.1162	2033.29	286.5477	1014.593	145.5601
ARIMA(2,2)	2904.306	417.6803	-	-	1018.745	145.8748
ARIMA(2,3)	2898.011	417.3764	2032.49	286.5116	1019.326	145.9108
ARIMA(2,4)	2893.419	416.9449	2036.39	286.7803	1025.05	146.2391
ARIMA(2,5)	2892.866	416.9112	2035.603	286.7203	1022.503	146.0669
ARIMA(3,1)	2899.632	417.4858	2034.866	286.6559	1018.949	145.8878
ARIMA(3,2)	2898.971	417.4414	2033.399	286.5583	1018.98	145.8898
ARIMA(3,3)	2892.681	417.0205	2036.266	286.8452	1024.384	146.2286
ARIMA(3,4)	2893.13	416.9283	2035.961	286.749	1017.904	145.8041
ARIMA(3,5)	2916.659	418.5683	2045.846	287.4236	1019.649	145.8959
ARIMA(4,1)	2894.532	417.1412	2032.761	286.5308	1019.018	145.8922
ARIMA(4,2)	2890.647	416.8591	2036.519	286.8562	1021.477	146.0233
ARIMA(4,3)	2894.906	417.1389	2038.286	286.8747	-	-
ARIMA(4,4)	2899.079	417.3546	2040.338	287.0716	-	-
ARIMA(4,5)	2906.384	417.8774	2040.859	287.0692	-	-
ARIMA(5,1)	2892.297	416.8589	2034.206	286.5971	1020.098	145.9021
ARIMA(5,2)	2892.515	416.8685	2035.212	286.6559	1021.071	145.9716
ARIMA(5,3)	2892.549	416.8703	2043.345	287.2954	1020.73	145.9471
ARIMA(5,4)	2892.489	416.8643	2053.379	287.9034	1014.706	145.5558
ARIMA(5,5)	2920.165	418.7772	2045.887	287.4002	1014.706	145.5558

Note: Mean Square Forecast error (MSFE) and Mean Absolute Error (MAE) from an out of sample forecasting exercises used to choose the correct order of the following process: $\widetilde{E_t}(\Delta y_{t+1}) = \rho(L)\Delta y_t + \delta(L)\epsilon_{t+1}$. For instance, ARIMA(1,1) means that the agent estimates an ARIMA(1,1) on Δy_{t+1} such that the estimates model is $\widetilde{E_t}(\Delta y_{t+1}) = \rho\Delta y_t + \delta\epsilon_t + \epsilon_{t+1}$. Different columns indicate different out-of-sample windows. I use SPF survey data for expectations. Data are missing when no convergence is achieved.

Table 18: Out of sample performance - MA process

Model	MSFE (obs 122)	MAE (obs 122)	MSFE (obs 142)	MAE (obs 142)	MSFE (obs 162)	MAE (obs 162)
MA(1)	2857.218	416.433	1010.351	145.52	1974.884	283.919
MA(2)	2883.115	417.113	1024.418	146.3314	2011.156	285.7181
MA(3)	2891.454	417.262	1028.069	146.5439	2024.328	286.283
MA(4)	2894.259	417.403	1030.656	146.7556	2029.874	286.6186
MA(5)	2896.748	417.4474	1033.006	146.9121	2033.367	286.7679
MA(6)	2898.358	417.3814	1035.401	147.0763	2036.295	286.8211
MA(7)	2900.837	417.4269	1036.854	147.1714	2042.124	287.1114
MA(8)	2904.807	417.5564	1038.253	147.2594	2048.135	287.4251
MA(9)	2905.21	417.5674	2048.697	147.2934	2048.697	287.4514
MA(10)	2904.516	417.58	1038.802	147.2928	2047.637	287.4113

Note: Mean Square Forecast error (MSFE) and Mean Absolute Error (MAE) from an out of sample forecasting exercises used to choose the correct order of the following process: $\widetilde{E_t}(\Delta y_{t+1}) = \delta(L)\epsilon_{t+1}$. For instance, MA(1) means that the agent estimates an MA(1) on Δy_{t+1} such that the estimated model is $\widetilde{E_t}(\Delta y_{t+1}) = \delta\epsilon_t + \epsilon_{t+1}$. Different columns indicate different out-of-sample windows. I use SPF survey data for expectations. Data are missing when no convergence is achieved.