Consumption, household portfolios and the housing market in France

Valérie Chauvin* and John Muellbauer**

Abstract – Consumption and wealth may co-move because of shifts in credit conditions, interest rates, income expectations or demographics whose impact should be identified to disentangle wealth effects. The findings for France from a 6-equation model for consumption and the main elements of household portfolios are that marginal propensities to consume financial wealth are comparable to those in the US or the UK, but housing wealth effects are far weaker, and aggregate consumption falls with higher house prices relative to income. This is interpreted as the need for households in France then to save more if they wish to become homeowners or can expect rents to increase in the future. The estimates suggest that during the French house price boom between 1996 and 2008, offsets from the negative effect of higher house prices and higher debt neutralized the positive effects of higher housing wealth and easier credit on consumption, evading the amplifying feedbacks, via consumption, of the US boom.

Codes JEL / JEL Classification: E21, E27, E44, E51, E58
Keywords: consumption, credit conditions, household debt, housing collateral, monetary transmission

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The US sub-prime crisis, which triggered the global financial crisis, began with a major over-valuation of asset prices, especially of housing. The consequence of overvaluation, eventually, is falling house prices, triggering the down-phase of a financial accelerator. Falling house prices reduce residential investment and lower consumer spending in countries where housing collateral is an important driver of consumption, such as the US and the UK. Falling house prices increase bad loans and lower the capital of financial firms. This impairs the ability of banks to extend credit. The credit-crunch feeds back further on residential investment and household spending, increasing unemployment and reducing GDP, which further reduces the demand for housing and the capital of financial firms.

Macro-evidence has accumulated for the role of leverage and of real estate connected financial instability (Cerutti *et al.*, 2017 and Mian *et al.*, 2017). Mian and Sufi (2014, 2018) have provided extensive microeconomic evidence for the role of credit shifts in the US sub-prime crisis and the constraining effect of high household debt levels. Jordà *et al.* (2016) have drawn attention to the increasing role of real estate collateral in bank lending in most advanced countries and in financial crises. The IMF's October 2017 Financial Stability Report (IMF, 2017) provides further evidence, highlighting the critical role of mortgage debt and nonlinear effects, finding more pronounced effects at high debt ratios, and larger effects in countries with open capital accounts and fixed exchange rate regimes.

Beyer *et al.* (2017) note the importance of wealth effects and heterogeneity, including across countries. This is indeed a focus for the ECB's multi-country model, under construction, for the five largest members of the Eurozone. This model belongs to the class of macro-econometric models, newly popular with central banks, which do not impose the rational, representative agent micro of New Keynesian DSGE models and give more scope to empirical evidence. However, most versions of such models impose a net worth constraint on the effect on consumption function of wealth, and ignore shifting credit conditions. The multi-equation personal sector model here estimated for France evaluates whether those assumptions are valid.

Does France resemble the Anglo-Saxon economies where changes in house or financial asset prices translate into changes in consumption, an amplifying mechanism in the financial accelerator, and part of monetary policy transmission? Its institutional background is very different: in particular, home equity withdrawal opportunities are much rarer, the retirement system relies mostly on a pay-as-you-go system and stock-market participation is lower. Current literature reviewed in Online complement C1 generally accepts lower wealth effects in France. However, the macroeconomic estimates of the marginal propensity to consume (MPC) for net worth cover a wide range – from 0.4 cent per additional euro of net worth to 4.6 – largely the result of specification problems such as omitting controls for permanent income (i.e. expectations of income growth) and credit conditions (whose large changes are documented in Online complement C3). On microeconomic data, Arrondel *et al.* (2014) report a MPC for financial wealth which is at the lower end of the range, with 0.5 cent per euro and large disparities between households and types of wealth.

Since household spending, saving and portfolio decisions are related and driven by common shocks and shifts in the economic and demographic environment, it is important to model these decisions jointly in a sub-system of equations when using a macroeconomic approach. In the present article, we follow Aron *et al.* (2012) with a "credit-augmented" permanent income form of the consumption function. This encompasses the textbook permanent income model as a special case but captures shifts in credit availability and balance sheet heterogeneity. As no direct measure of time-varying access to credit is available, we use a latent variable method to measure credit conditions in a six-equation system for France for consumption, housing loans, consumer credit, liquid assets, house prices and permanent income estimated from 1981Q2 to 2016Q4. This can be seen as a translation into macro-time series of Mian and Sufi's (2018) "credit-driven household demand channel".

The outline of the article is as follows. The econometric specification of consumption equation is presented. Then the empirical approach is presented, with the specification of the empirical models finally selected. Conclusions are drawn. An appendix and online complements give respectively details on the data used and further literature background.

Macro theory, the consumption function and the modelling framework

Blanchard (2018) argues that in contrast to dynamic stochastic general equilibrium models, "Partial equilibrium modelling and estimation are essential to understanding the particular mechanisms of relevance to macroeconomics". In particular, Hendry and Muellbauer (2018) criticize the representative agent New Keynesian DSGE models for being insufficiently stochastic – trivializing the role of uncertainty and heterogeneity, insufficiently dynamic – missing key lags in relationships, insufficiently general equilibrium – ignoring important feed-back loops, seen for example in the global financial crisis, and insufficiently Keynesian – missing co-ordination failures in labour and financial markets.

Consumption function

Households actually face idiosyncratic and uninsurable income uncertainty, and uncertainty interacts with credit or liquidity constraints. The asymmetric information revolution in economics in the 1970s for which Akerlof, Spence and Stiglitz shared the Nobel prize explains this economic environment. Research by Deaton (1991, 1992), Carroll (1992, 2000, 2001, 2014), and a new generation of heterogeneous agent models imply that household horizons then tend to be both heterogeneous and shorter – with "hand-to-mouth" behavior even by quite wealthy households (Kaplan *et al*, 2014). Kaplan *et al.* (2018) have incorporated these insights into a DSGE model, though without endogenising housing, and Hedlund *et al.* (2017) into a DSGE model with a frictional housing market. Kaplan and Violante (2018) spell out further implications of heterogeneous agent models, the limitations of existing models and unresolved research questions, for example on asset pricing and labour market income risk. They acknowledge that current versions of the heterogeneous agent New Keynesian model "miss the potentially large wealth effects on consumption for wealthy households that can arise from changes in asset prices", an issue on which the present paper provides empirical evidence. There is also mounting empirical evidence on the cash-flow channel of monetary policy transmission, consistent with heterogeneity and liquidity constraints (La Cava *et al.* (2016) for micro-evidence on Australia, Aron *et al.* (2012) for macro-evidence for the UK).

Contributions to behavioral economics by Thaler and on financial illiteracy (Clark *et al.*, 2017 as an example) reject the hypothesis of a shared rational behavior. Alternative expectations mechanisms, radical uncertainty and structural breaks, such as shifts in credit market architecture in particular, have not, so far, been incorporated in DSGE models useful for central bank policy making. They do however, feature in the quantitative partial equilibrium model of the household sector estimated on aggregate data presented below. To obtain general equilibrium results, this module would have to be inserted into a larger macro-econometric model, including specifications of policy feedback rules.

The simplest textbook permanent income form of the consumption function is as follows, using the log-linear approximation as in Muellbauer and Lattimore (1995):

$$\ln\left(c_t/y_t\right) = \alpha_0 + \ln\left(y_t^p/y_t\right) + \gamma A_{t-1}/y_t \quad (1)$$

where c is consumption, y is non-property income, y^p is permanent non-property income, and A is net worth. The marginal propensity to spend out of net worth is γ.

If real interest rates are variable, standard consumption theory suggests that the real interest rate r_t enters the model with the usual interpretation of inter-temporal substitution and income effects. Extending the model further to include probabilistic income expectations suggests the introduction of a measure of income uncertainty. With income uncertainty, the discount factor, δ, in expected income growth as measured by $\ln\left(y_t^p/y_t\right)$ should incorporate a risk premium, allowing the possibility that households may discount the future more heavily than by the real rate of interest.

Furthermore, different types of assets may imply different marginal propensities to consume. One reason is that owner-occupied housing wealth differs fundamentally from financial assets since a roof over one's head gives shelter (has utility value) as well as having an asset value, see Buiter (2010) and Aron *et al.* (2012). The second reason is that, with credit constraints, housing wealth has a collateral role (see Muellbauer (2007) or Aron *et al.* (2012) for further discussion). A third reason is that illiquid financial assets as well as housing are subject to asset price volatility and/or trading costs or restrictions (Kaplan *et al.,* 2014; Kaplan *et al.,* 2018).

Finally, the consumption to income ratio varies with the incidence of credit constraints, as well as with age, see Fesseau *et al.* (2009) for French evidence for demographic effects on consumption.

The long-run version[1] of the credit-augmented generalized aggregate consumption function is:

$$\ln\left(c_t/y_t\right)=\alpha_{0t}+\alpha_{1t}r_t+\alpha_2 rl_t+\alpha_{3t}E_t\ln\left(y_t^p/y_t\right) \quad (2)$$
$$+\gamma_1 NLA_{t-1}/y_t+\gamma_2 IFA_{t-1}/y_t+\gamma_{3t}HA_{t-1}/y_t$$
$$+\gamma_{4t}\ln\left(hp_{t-1}/y_{t-1}\right)+y_5 demog_t$$

Here *r* is a real interest rate for borrowing and *rl* a real interest rate on liquid assets. Net worth, *A,* is replaced by a tripartite division into liquid assets minus debt[2] *NLA*, illiquid financial assets *IFA*, gross housing wealth *HA*, with different marginal propensities. *hp* is an index of house prices, and *demog* the proportion of adults in the pre-retirement age group on consumption. With numerical indicators such as credit conditions indices (*CCIs*) for the mortgage market (*MCCI*) and for consumer credit loans (*CRCCI)*, it is possible to make each potentially time-varying parameter a linear function of the *CCIs* and to test hypotheses about time variation.

The intercept α_{0t} increases with greater availability of non-housing loans and of mortgages, as the need to save for a down-payment is reduced or as the lengthening of mortgage maturities improves short- to medium-term net cash-flows. The coefficient measuring the sensitivity of down-payment requirements to house prices relative to income, γ_{4t}, should become less negative if the down-payment constraint becomes less binding. However, a relaxation of the debt-service ratio constraint could increase the fraction of households subject to the down-payment constraint. If access to home equity loans increases, the coefficient, γ_{3t}, measuring the marginal propensity to spend out of housing wealth, should increase. Expectations of future income growth, captured in $E_t\ln(y_p/y_t)$ should have a larger effect on consumption when credit constraints ease, while greater income insecurity should have the opposite effect. It is also possible that $\alpha_{1t,}$ the sensitivity of consumption to the real interest rate on borrowing might be affected by credit conditions.

Consumption equation (2) satisfies long-run homogeneity in income and assets: doubling both, doubles consumption. The long run coefficient on *ln y* is set to 1. This means that the income endogeneity issues raised by Hall (1978) are not of concern for the measurement of the long-run income and asset effects.

The modelling philosophy follows an encompassing approach. Bontemps and Mizon (2008), given uncertainty about which of several competing models is correct, recommend constructing an encompassing model, which generates each of the competing models under particular testable parameter restrictions. For example, equation (1) is a special case of equation (2) under a number of restrictions. As presented in the empirical section, the data strongly reject these restrictions.

Modelling framework for household portfolios

Household portfolios are key determinants for consumption. The house price index as well as mortgage and consumer debt and liquid assets are endogenised in the model. They are determined by current and permanent income (with a positive coefficient, +), credit conditions (+ for debt and house prices, - for liquid assets), uncertainty (-), and characteristics of the age composition of population. They are also determined by arbitrage opportunities, represented here by their corresponding interest rates, real or nominal (- for debt and house prices, + for liquid assets) and the evolution of other assets (the impact of which is ambiguous, whether assets are complements or substitutes)[3]. House price and mortgage debt equations also include housing user and transaction costs (-). The modelling framework for the house price index and the mortgage debt are detailed further here, see Online complement C5 for consumer debt and liquid assets equations.

The theory background for the house price equation is an inverted log-linear demand function, where real house prices, *rhp*, are determined by household demand, conditional on the lagged housing stock.

$$\ln rhp_t=h_{0t}+h_{1t}\ln nmr_t+h_{2t}\ln user_t+h_3(\ln\left(y_t/hs_{t-1}\right)$$
$$+h_{4t}E_t\ln\left(y_t^p/y_t\right)+h_5 demog_t+h_6 LA_{t-1}/y_t$$
$$+h_7 IFA_{t-1}/y_t+h_8 spillover_{t-1}+h_9 trans_t \quad (3)$$

Here h_{0t} should increase with mortgage credit conditions. The nominal mortgage rate is *nmr,*

1. *The dynamic version includes partial adjustment, and changes in the unemployment rate – an income uncertainty proxy –, and changes in income and interest rates. Models of this type have been estimated for the UK, US and Japan in Aron* et al. *(2012), Canada in Muellbauer* et al. *(2015), South Africa in Aron and Muellbauer (2013), and Germany in Geiger* et al. *(2016).*
2. *It is possible to disaggregate net worth into four main elements, with a separate coefficient on debt. However, netting debt off liquid assets is supported by the evidence, while netting debt off gross housing wealth, a restriction sometimes found in the literature, is strongly rejected.*
3. *Avouy-Dovi* et al. *(2014) show how financial assets may be complements or substitutes with a model for French households' portfolio detailed in six categories. Liquid assets are substitute for other assets, but not for insurance and pension funds.*

and user cost, measured by interest rates minus expected appreciation, plus a risk premium, is *user*. The parameter h_3 measures minus the inverse of the price elasticity of demand for housing, and is attached to the log ratio of income to the housing stock, which imposes the constraint that the income elasticity of demand for housing is one. The coefficient h_{4t} captures the relative effect of permanent to current income, analogously to a similar term in the consumption function. The remaining terms respectively represent the effects of demography, liquid and illiquid financial assets, spillover effects from other housing markets, transactions costs and income uncertainty.

Mortgage and consumer debt are driven by the purpose of the debt, i.e. house prices and the long-run solution from the consumption function in equation (2) respectively. Higher house prices should increase the demand for mortgages because for a given level of housing demand, higher house prices require greater levels of debt:

$$\begin{aligned}\ln\left(mdebt_t/y_t\right) &= m_{0t} + m_{1t}\ln nmr_t + m_{2t}\ln user_t \quad (4)\\ &+ m_{3t}E_t\ln\left(y_t^p/y_t\right) + m_{4t}\ln\left(hp_{t-1}/y_{t-1}\right) + m_5 demog_t\\ &+ m_{6t}\ln\left(LA_{t-1}/y_t\right) + m_7\ln\left(IFA_{t-1}/y_t\right) + m_9 trans_t\end{aligned}$$

Credit market liberalisation should impact in several ways on these long-run relationships, broadly corresponding to effects described on consumption. A direct, positive effect on debt should result from the different facets of credit liberalisation, which included relaxation of the down-payment and debt-service constraints in the 1980s and longer duration for housing credits in the 2000s, which also reduced debt-service cash-flows. Thus, m_{0t} should increase with *MCCI,* though housing equity loans to existing owners remained marginal in France. Real interest rates may matter more with liberalisation, making m_{2t} more negative for example, while nominal ones perhaps matter less, making m_{1t} less negative. Income expectations may matter more after liberalization, shifting m_{3t}. Higher house prices relative to income should increase demand for mortgages but this might well be more pronounced if liberalisation relaxes the down-payment constraint, shifting m_{4t}. Demography, asset to income ratios and transactions costs are represented in the next four terms in (4). To the extent that bank funding is less constrained by household deposits in a more liberal regime, there may be time variation in m_{6t}.

Empirical findings

Six equations are estimated jointly by maximum likelihood methods for French quarterly data from 1981 to 2016, for consumption, house prices, mortgage loans, consumer credit, and liquid assets[4], permanent income (Box), with credit conditions for both consumer credit and mortgage loans estimated as latent variables[5]. They entail potentially important, highly non-stationary demographic effects. Empirical identification of the latent variables relative to demography is not a trivial exercise. Fortunately, there is institutional and other information on the nature and timing of credit market liberalisation and there are priors on the direction of interest rate and income effects on house prices and household balance sheets. Micro information on holdings of debt and liquid assets by age of household and on household saving rates (hence consumption to income ratios) by age is also used to impose sign restrictions and upper bounds on potential demographic effects.

Estimates for the two credit conditions indices

There are no data to measure credit conditions directly in France before 2003. This article adopts a "latent variable approach", where credit conditions indicators for housing and non-housing loans are proxied by spline functions guided by institutional information on credit market liberalization. Both indices are specified as a linear combination of ogive dummies, which make a smooth transition from zero to one over eight quarters, and lagged inflation rates, relevant for consumer credit. When inflation risk, proxied by the lagged annual inflation rate, is high, lenders are less likely to extend credit for fear of negative returns. The disinflation that really took hold in 1984 would therefore have been likely to ease credit constraints. In all, 13 dummies (resp. 6) are used to describe the shape of the mortgage credit (resp. consumer credit) conditions index *MCCI* (resp. *CRCCI*) shown in Figure I (see also Online complement C2).

Since the stock of consumer credit rises from extremely low levels in 1981, unlike consumption and liquid assets, potentially influenced

4. For the estimations of the consumer credit and liquid assets equations, see Online complement C5.
5. Duca and Muellbauer (2013) name this type of equation system a Latent Interactive Variable Equation System *(LIVES).*

Box – **The permanent income forecasting equation: modelling and estimates**

Following Campbell (1987), expected income growth is defined as a moving average of forward-looking real per capita income over ten years with discount factor δ a measure of permanent income, minus current income.

The expression for the log ratio of permanent to current non-property income per head is

$$\ln\left(y_t^p / y_t\right) = \left(\sum_{s=1}^{k} \delta^{s-1} E_t \ln y_{t+s}\right) \Big/ \left(\sum_{s=1}^{k} \delta^{s-1}\right) - \ln y_t$$

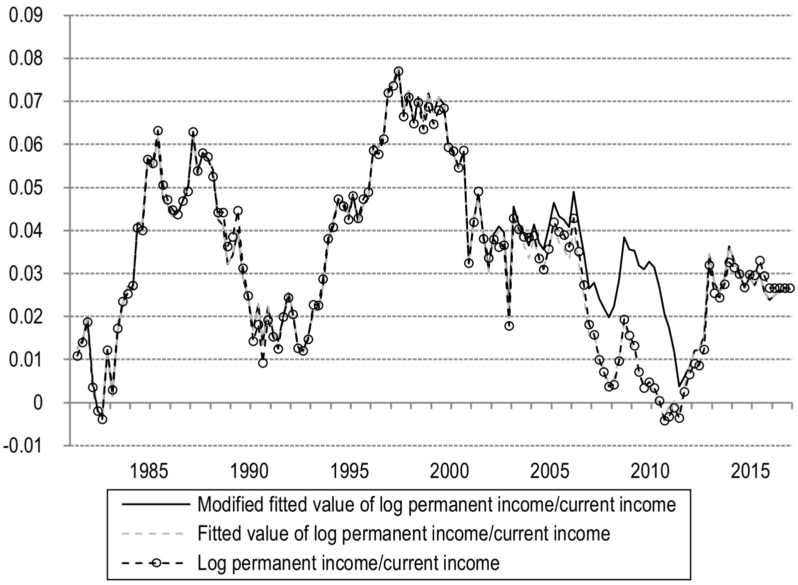
The quarterly discount factor is set at δ = 0.95.

Forecast permanent income follows linear trends, allowing for an unanticipated negative shift after the global financial crisis, economic variables and demography. This approach can be seen as a reduced form representation of the forecast effects of the capital stock and of total factor productivity and of cyclical deviations around capacity on future incomes. The expected signs of coefficients are indicated in parentheses: the economic variables include changes in nominal and levels of real interest rates (-), current real per capita income (-), because of reversion to trend, changes in log real per capita income, possibly indicating some growth momentum (+), household survey expectations of future living standards (+), the unemployment rate (-) (e.g. because it weakens the power of workers in wage negotiations), the log stock market index in real terms (+) (it indicates expectations of productivity growth and is one of the drivers of capital investment which expands future capacity), log real oil prices (-) and the log real exchange rate (-), indicating worsening competitiveness, and finally the ratio of the working age population divided by the total population (+).

The relevant variables were chosen by first carrying out a model selection exercise for data from 1972 to 2016 for forecasting income over 1, 4 and 8-quarter horizons, incorporating a split trend around 2009. This exercise suggested the relevance of longer lags than normally considered in econometric forecasting. Since permanent income is a moving average of future income, it is plausible that moving averages of the drivers would also be relevant and many of the variables enter in that form. The parameter estimates are shown in Table A below and the fit is visualised in Figure A. The long lags shown for many variables are consistent with a slowly evolving capital stock, reacting to economic influences on investment. Because of these long lags, the residuals are highly auto-correlated, though the model does seem to capture reasonably well cyclical fluctuations. Goodness of fit, however, is not necessarily an unmixed blessing since households are bound to make serious forecast errors: rather the aim is to capture what their views might have been, given the kind of information to which households would have ready access. In contrast to the unforecastable financial crisis, the effects of repeated variations in interest rates, equity prices, oil prices, exchange rates and unemployment might have been sensibly evaluated. They could have operated through the medium of professional forecasters, business economists, central banks and organisations such as the IMF and the OECD.

Two alternative methods of dealing with income growth beyond the end of the sample in 2016 were considered. One uses forecasts from Oxfordeconomics.com in which future trend growth is of the order of 1.2%; the other assumes linear trend growth of real per capita income ranging from 0.6% to 1% per annum. The results are robust to alternative assumptions, and 0.8% growth is assumed.

Figure A
Actual values of log ratio of permanent to current income against fitted values and modified fitted values used in the consumption equation



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Box (contd.)

Table A
Estimates for the income growth forecasting model

Dependent Variable = log (permanent income/current income)	1981Q2-2016Q4		1981Q2-2008Q3	
	Coefficient	*t*-ratio	Coefficient	*t*-ratio
Variables				
Constant	1.74	37.3***	1.68	18.7***
Time trend	0.00318	34.1***	0.00299	21.8***
Split trend from 2009Q4, discounted present value	-0.00200	22.3***	-0.00231	-5.4***
Log (real per capita income)	-1.10	-42.4***	-1.02	-39.5***
4-quarter change in log (real per capita income)	0.17	6.0***	0.11	3.2***
Log working age pop./total population	0.59		0.59	
Survey expectations of future conditions	0.0052	3.8***	0.0040	1.1
Real interest rate ma4$_{t-1}$	-0.08		-0.08	
Real interest rate ma4$_{t-5}$	-0.19	-6.3***	-0.18	-7.1***
Real interest rate ma4$_{t-9}$	-0.19	-7.1***	-0.18	-7.9***
4-quarter change in T-bill rate	-0.073	-9.2***	-0.027	-1.6*
4-quarter change in T-bill rate$_{t-4}$	-0.041	-6.7***	-0.016	-1.2
Log real stock market index ma4$_{t-1}$	0.015	7.3***	0.013	5.9***
unemployment rate ma4$_{t-1}$	-0.0034	-5.5***	-0.0020	-2.2**
unemployment rate ma4$_{t-5}$	-0.0022	-4.3***	-0.0014	-3.4***
Log real oil price ma4$_{t-1}$	-0.0071	-5.5***	-0.0044	-2.5**
Log real oil price ma4$_{t-5}$	-0.0059	-4.2***	-0.0058	-3.7***
Log real exchange rate ma4$_{t-1}$	-0.038	-4.5***	-0.032	2.2**
Log real exchange rate ma4$_{t-5}$	-0.033	-3.0***	-0.045	-3.5***
Diagnostics				
Equation standard error	0.00184		0.00161	
DW	0.54		0.42	
R-squared	0.992		0.993	

Note: *t*-ratios are corrected for heteroscedasticity and autocorrelation. Statistical significance at the 10%, 5%, and 1% levels is denoted by *, **, and *** respectively ma4: moving average of order 4.
Sources: Insee; Banque de France; authors' calculations.

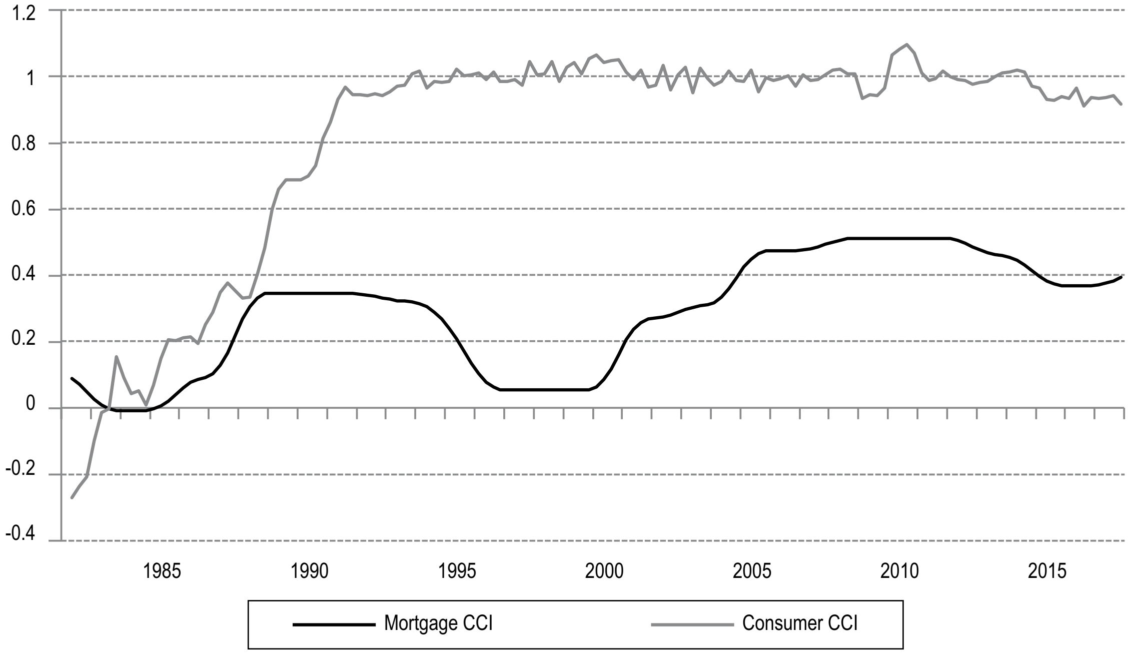
If the downturn in economic growth after the global financial crisis, implying a shift in the trend, had been fully anticipated, then, given the 10-year horizon, already in 2000, household expectations would have been beginning to build in the shift in trend that began at the end of 2009. To fit the data, the permanent income model therefore incorporates the present discounted value of the shift in trend that began at the end of 2009. However, households could not have had this information in real time, so that generated permanent income up to 2009Q3 omits this component of the econometric model. We then assume that households' expectations gradually incorporated the downward revision of trend growth over the next 8 quarters so that from 2011Q4 they have fully adjusted. The effect of the adjustment is that households have increasingly a too optimistic view of permanent income before 2009. This is shown in Figure A, suggesting households over-estimated permanent income by around 3 percent in 2009.

by *CRCCI*, it is implausible to use the same linear form in each equation. Hence while *CRCCI* enters the other equations linearly, in the consumer credit equation it enters as: $ln\left(0.5+CRCCI_t\right)$. For log consumer debt, the marginal effect of *CRCCI* then declines as *CRCCI* rises, while for the other (log) variables, the marginal effect is constant (Figure I).

Though unsecured consumer debt was already rising dramatically before, credit controls were relaxed in 1984, when *MCCI* begins to rise strongly, and further deregulation took place later in the 1980s, when both indices rise. In the early 1990s, in common with many other countries, some French banks were in trouble with bad loans partly due to excess lending to real estate developers in the late 1980s, to households' nominal income deceleration following disinflationary monetary policy, and to the stresses caused by interest rate rises resulting from German unification. There is a close negative correlation from 1991 to 2016 between the lagged ratio of non-performing loans to total loans to the private sector, and our estimated *MCCI* (Figure II). The relation is particularly close when credit conditions tighten in 1991-1996 and 2010-2014.

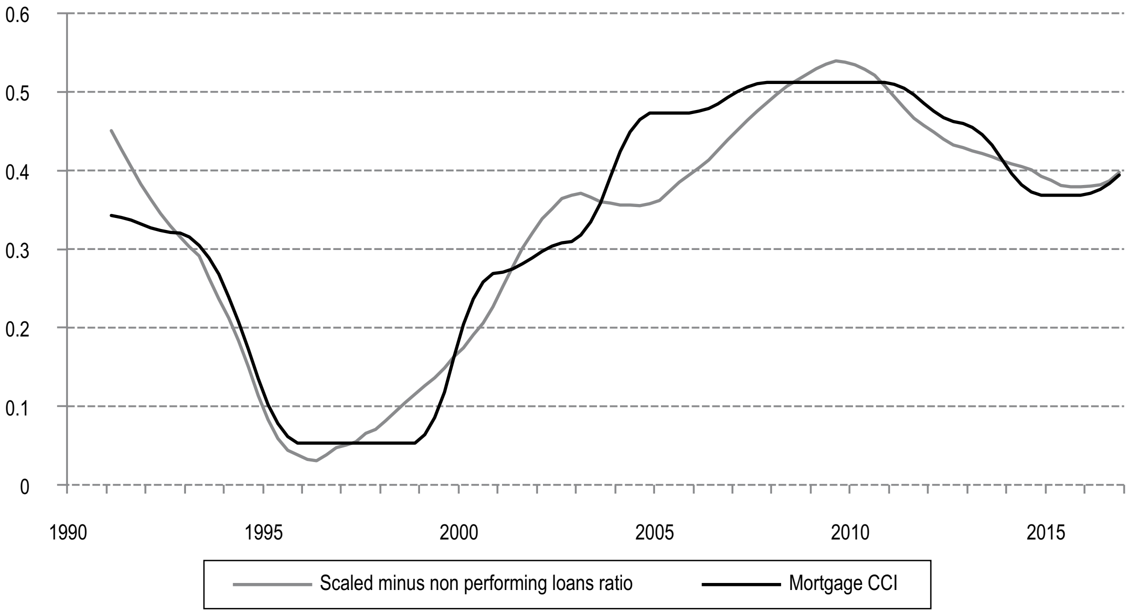
Towards the end of the 1990s, as banks recovered, credit flows improved, competition in credit markets increased with the expected arrival of the common currency and, as discussed in Online complements C3 and C4 conditions on securitisation of loans loosened, while terms of housing loans were extended from an average of 11.8 years in 1989 to 14.3 years in 1999 and 18.4 years in 2009. Given the maximum debt burden of loans allowed by banks to households,

Figure I
Estimated mortgage and consumer credit conditions indices in France



Sources: Insee; authors' calculations (see Online complement C2).

Figure II
Non-performing loan ratio (8-quarter moving average, lagged 2 quarters) and estimated mortgage credit conditions index in France



Sources: Insee; Banque de France; authors' calculations (see Online complement C2).

the level of interest rates and of income, this meant an increase of nearly 20% in the borrowing capacity of households. This shows up as a considerable liberalisation on housing loans before declining once more after 2010 as the bad loans ratio rose. There seems to have been little change in credit availability for consumer credit since about 1990 (Figures I and II).

Consumption

The general form of the consumption equation was set out in equation (2). The estimated speed of adjustment at 0.56 is high, indicating a strong reaction of consumption to the long run determinants (Table 1). The main difference with US and UK estimates comes from effects of house prices and housing wealth.

The real interest rate enters as a weighted average of the real interest rate on unsecured debt and mortgage debt, weighted by the lagged debt to income ratios. It has a strongly significant negative effect. The coefficient on the ratio of permanent to current income is a little over one half, substantially below the "text-book" permanent income hypothesis of one, despite the fact that permanent income, by its construction already embodies a far shorter horizon. The coefficient on net liquid assets is substantially larger than that on illiquid financial wealth, the latter containing a large saving for retirement element[6]. The restriction that the debt coefficient is minus that on liquid assets is easily accepted. The apparently small size of the illiquid financial wealth effect with a marginal propensity to consume (MPC) of 0.022 is partly due to the inclusion of the control for permanent income, which is strongly affected by the stock market[7]. These results are consistent with those based on micro data for France. Using the French Wealth Survey and the Household Budget Survey, Arrondel *et al.* (2014) report a MPC for financial wealth ranging from 0 for the wealthiest owning mostly illiquid assets to 0.11 for the less wealthy owning mostly liquid assets.

Housing wealth/income has a positive effect, but with an MPC (0.013) smaller than that for illiquid financial assets, and with a strong offsetting negative effect from log house prices/income. The two measures are quite correlated, so that their separate coefficients are not very accurately estimated. If the negative house price/income effect is omitted, housing wealth/income becomes insignificant, with a t-ratio below 1 but other coefficients are little affected. This answers the question of whether there is an aggregate housing wealth effect on consumption in France: the simplest interpretation is that there is such an effect for owners, but that it is offset, when housing becomes less affordable, by lower consumption of tenants, including those saving for a housing deposit. Such a hypothesis is confirmed by Arrondel *et al.* (2014), who find a MPC for housing wealth ranging from 0.007 to 0.011 for homeowners on microdata.

An interaction between mortgage credit conditions and log house prices/income proved *negative* and on the margin of significance. This result indicates the importance of distinguishing the down-payment from other constraints on borrowers. Easing only the former would entail a *positive* coefficient on the interaction. Easing only the latter is likely to drive larger fractions of potential first-time buyers to save more for a given down-payment ratio, resulting in a *negative* interaction effect. However, the overall implications for consumption from this more complex specification are almost the same as those discussed below for the 1996 to 2008 period.

Estimating demographic effects on consumption, given the other controls, of which balance sheets are themselves likely to be influenced by demography, potentially runs into a "spurious regression" problem as most demographic variables are integrated of order 2[8]. Cross-section studies tend to find the highest saving rates for households in the pre-retirement age bracket. This suggests using the proportion of adults in this age group, defined as the proportion of those aged 40 to 59 plus 0.4 of those aged 60-64, since the retirement age was 60 over most of our sample. The coefficient on this variable approximately represents minus the difference between the saving rate of this group of adults, about 40% of adults, compared to the remainder of adults. It seems hard to believe that this could be more than 0.4, an upper bound[9]. Between 1981 and 2016, the 3% increase in this proportion would then imply a 1.2% decline in the consumption to income ratio. The freely estimated coefficient is

6. The estimated coefficient is 0.14. However, the ratio to income of net liquid assets has a strong downward trend. Introducing a small trend effect, for example, from increased life expectancy for those aged 60 or more, which should also reduce the consumption to income ratio, it is easy to accept a coefficient of 0.12, close to US and UK estimates. Fortunately, such a modification has little effect on other estimates.
7. This is consistent with Poterba (2000), who argues that so-called wealth effects in consumption functions, excluding controls for expected income, are a mix of genuine wealth effects and expectations.
8. Requiring twice differencing to make them stationary.
9. Cross-section evidence shows more moderate differences in saving rates out of income by age. Such evidence is only a rough guide since gross differences in saving rates by age are attenuated by wealth differences.

within one standard error of -0.4 and we therefore calibrate the coefficient to this value.

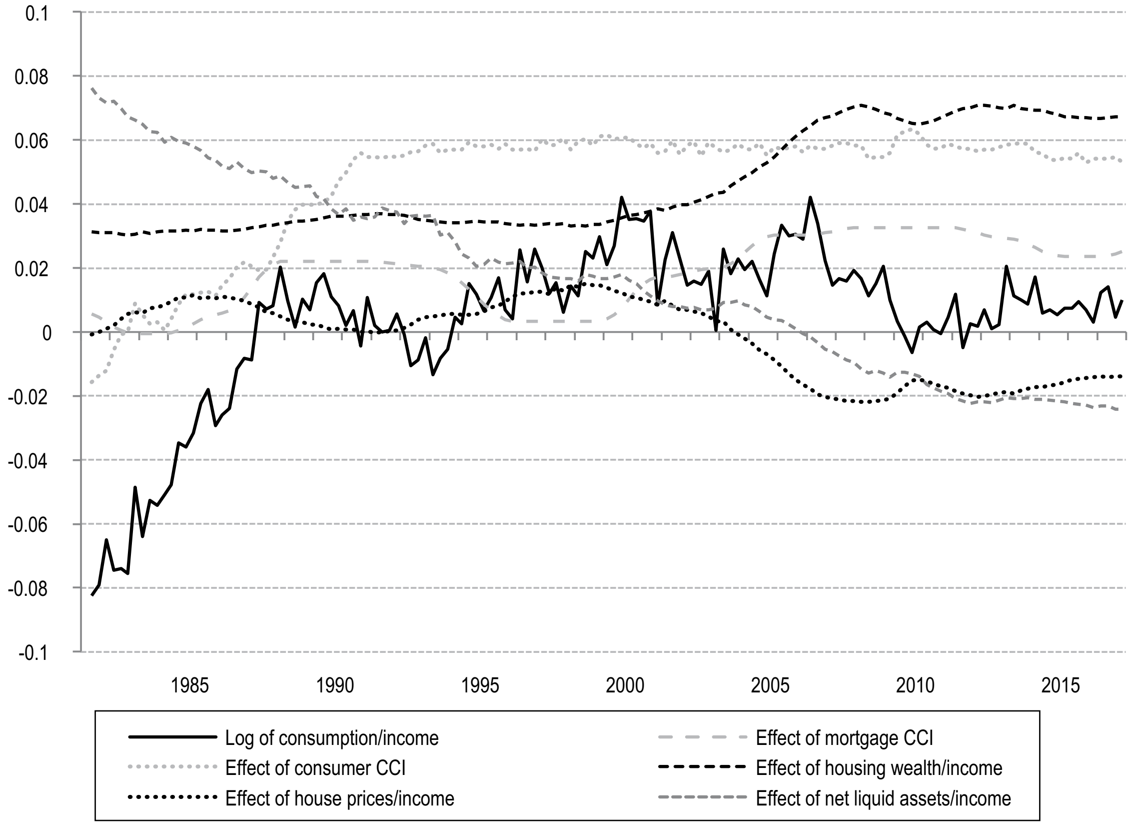
The coefficient on the mortgage credit conditions index is normalised at 1 in the house price equation. When the *MCCI* has an impact of +1% on house prices, then its estimated impact on consumption is +0.06%, everything else being equal. In the consumer loans equation, the term $ln(0.5+CRCCI_t)$ has a coefficient normalised to 1. For high values of *CRCCI*, a rise with a 1% impact on consumer credit implies an impact on consumption of around 0.08%, other things being equal. The quantitative long-run contributions to the log-ratio of consumption to income of the two credit conditions indices are shown in Figure III-A.

From 1983 to 1990 increasing access to consumer credit is estimated to have increased the consumption to income ratio by around 6%, with another 2.5% or so from increased access to mortgages. However, the negative offset from the rise in the overall debt to income ratio, as reflected in the decline in the ratio of liquid assets minus debt, accounted for around 3% over that period.

From the 1996 trough to the 2008 peak in the housing market and mortgage credit availability, the increase in mortgage credit availability accounts for a direct increase in the log consumption to income ratio of about 2.5% and an indirect increase via housing wealth of 3.5%. But this is almost exactly balanced by a 3.5% negative effect from higher house prices relative to income and a 2.5% negative effect of lower net liquid assets relative to income, mainly driven by higher household debt.

The UK and the US also experienced mortgage credit liberalisation and a large rise in housing wealth from 1996 to 2007. Falls in the ratio of liquid assets minus debt to income also occurred in the US and the UK with similar negative effects on consumption to those in France, see Duca and Muellbauer (2013) and Hendry and Muellbauer (2018). But with far smaller down-payment requirements and easy access to home equity withdrawal, the net consumption effects, unlike in France, were large and positive in the US and the UK.

Figure III-A
Long-run effects on log consumption/income in France



Sources: Banque de France; OECD; Insee; authors' calculations.

Figure III-B illustrates the notable contributions of ratios to current income of permanent income and illiquid financial wealth, and of real interest rates, which rose in the 1980s and fell after the mid-1990s. The increasing share of adults in the pre-retirement age-group is reflected in the demographic trend.

The propensity to consume might depend on the type of income. It is accounted for in the form of a weighted average of log conventional household disposable income (HDI) and log non-property income, with weights ω and $1 - \omega$. The estimated weight on log HDI is 0.5. Since HDI contains non-property income, the implied weight on the property component of income is around 0.33 with 0.67 on the non-property component[10].

The short-run dynamics include five economic variables: the quarterly change in log real income enters with a negative coefficient, suggesting that a mix of current and last quarter's income is relevant for consumption. The change over four quarters in the unemployment rate has a significant negative effect, paralleling results for other countries, see Aron *et al.* (2012). Inflation over the two previous years has a negative effect[11]. A measure of the car scrapping scheme subsidy is strongly significant, with a positive effect, offset by a negative effect in the quarter after the subsidy ends[12]. The annual change in the housing transaction tax rate has a significant negative effect on consumption. The specification also included three impulse dummies for outliers[13], which may represent other shocks, e.g. due to major strikes or floods. The results are robust to the exclusion of the impulse dummies though illiquid wealth is a little less significant. Parameter stability tests, for example estimating from 1986Q1 instead of 1981Q2, and estimating to 2008Q3, omitting the global financial crisis, support the reported estimates. The second column reports estimates to 2008Q3[14].

10. If income is measured just by non-property income, all the wealth coefficients rise. This is not surprising since the omitted property income is clearly linked with asset ownership. The negative effect of the log house price to income ratio increases.

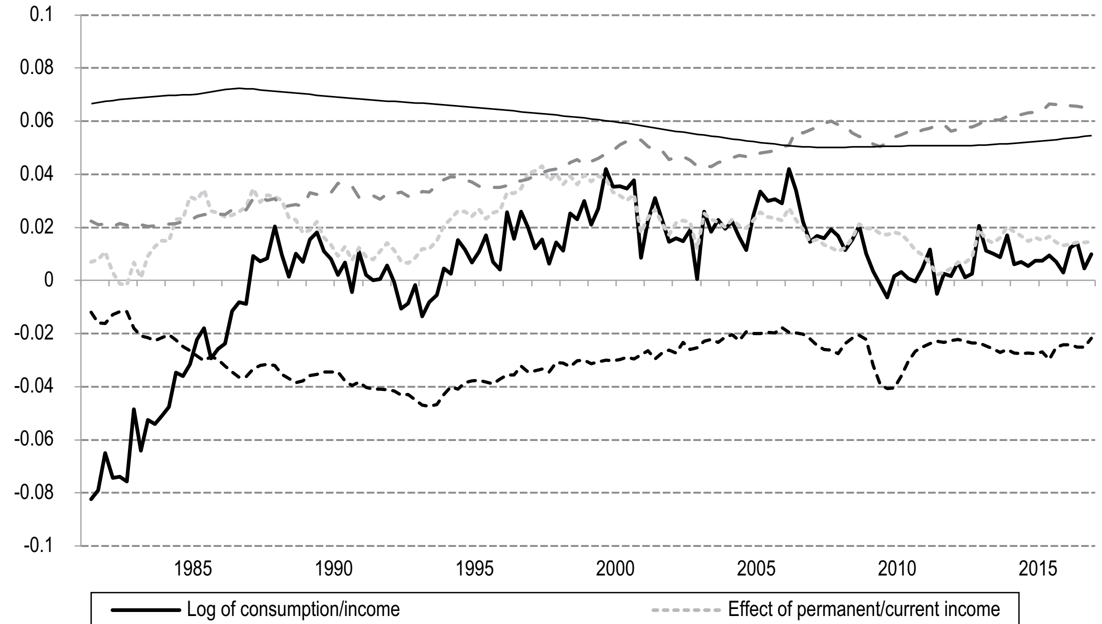
11. It is unlikely that this could be a real balance effect since that is already strongly represented through the net liquid asset/income term. It could be another indicator of uncertainty about real income or indirectly picking up a small role for nominal interest rates, given the strong real interest rate effects in the equation.

12. The scheme operated for parts of the periods 1994-98 and 2009-13 and had the purpose of stimulating the car industry by offering a premium for scrapping of older models when purchasing a new one.

13. For 1984Q4, 1993Q1 and 1995Q2.

14. Since estimation of demographic effects needs long samples, the coefficients on the proportion of adults in the pre-retirement age group in the consumption equation and that on the log working age population in the permanent income equation are set to the full sample values.

Figure III-B
Long-run effects on log consumption/income in France



Sources: Banque de France; Insee; authors' calculations.

The last column of Table 1 shows estimates for the consumption function obtained when the two credit conditions indicators are excluded. The speed of adjustment falls from 0.55 to 0.2 and the R-squared falls from to 0.71 to 0.57. The coefficient on the log house price to income ratio switches from negative to positive, while that on the housing wealth to income ratio switches from positive to negative, though neither is significant. The marginal propensities to spend out of net liquid and illiquid financial assets both rise and are far less well determined. The direction of these biases can all be interpreted in terms of correlations with the omitted

Table 1
Estimates of the long-run solution of the French consumption function

Dependent Variable = $\Delta \ln c_t$	Symbol	1981Q2-2016Q4		1981Q2-2008Q3		1981Q2-2016Q4 Excluding CCIs[(a)]	
		Coefficient	*t*-ratio	Coefficient	*t*-ratio	Coefficient	*t*-ratio
Speed of adjustment	λ	0.56***	11.1	0.63***	10.3	0.20***	5.0
Long-run coefficients for log c/y							
Constant	α_0	0.08*	1.7	0.12**	2.2	-0.11	-0.9
Mortgage credit conditions index: *MCCI*	α_{0c}	0.064***	5.3	0.078***	4.8	0	Fix
Consumer credit CCI: *CRCCI*	α_{00c}	0.058***	5.4	0.066***	4.9	0	Fix
Real interest rate$_t$, weighted by debt/income	α_1	-0.72***	-7.5	-0.65***	-4.8	-1.17***	-4.0
Forecast future income growth: E ln$(yperm/y)_t$	α_3	0.55***	9.9	0.59***	11.3	0.48***	3.1
Net liquid assets$_{t-1}$ / y_t	γ_1	0.14***	4.4	0.13***	4.3	0.18**	2.0
Illiquid financial assets$_{t-1}$ / y_t	γ_2	0.022***	3.3	0.017***	3.4	0.040**	2.3
Housing wealth$_{t-1}$/ income$_{t-1}$	γ_3	0.013**	2.2	0.015***	2.7	-0.013	-0.9
Log house prices$_{t-1}$/ income$_{t-1}$	γ_4	-0.062**	-2.5	-0.081***	-3.1	0.070	1.2
Ratio of pre-retirement age group/adults	γ_5	-0.4	fix	-0.4	fix	-0.4	fix
Weight on *HDI*	ω	0.5	fix	0.5	fix	0.5	fix
Diagnostics							
Equation standard error		0.00324		0.00306		0.0390	
DW		1.93		1.86		1.85	
R-squared		0.705		0.760		0.573	

(a) Excluding the two credit conditions indicators.
Note: Statistical significance at the 10%, 5%, and 1% levels is denoted by *, **, and *** respectively. Maximum likelihood estimation of 6-equation system in TSP (Time Series Processor) 5.1. Equation standard errors are RMSEs of the residuals.
Sources: Banque de France; Insee; OECD; authors' calculations.

Table 2
Estimates of the long-run credit conditions and wealth effects for Germany, UK and US

	Symbol	German estimate 1981:3-2012:4	*t*-ratio	UK estimate 1967:1 – 2005:4	*t*-ratio	US estimate 1971:4 – 2011:1	*t*-ratio
Mortgage credit conditions index: *MCCI*	α_{0c}	0.073	5.8	0.050	3.6	-	-
Consumer credit CCI: *CRCCI*	α_{00c}	0.024	1.0	-	-	0.089	7.7
Net liquid assets$_{t-1}$ / y_t	γ_1	0.09	4.1	0.11	8.0	0.10	7.6
Illiquid financial assets$_{t-1}$ / y_t	γ_2	0.016	2.5	0.022	8.0	0.017	8.6
Housing wealth$_{t-1}$/ income$_{t-1}$	γ_3	0.001	0.1	-	-	-	-
*MCCI**Housing wealth$_{t-1}$/ income$_{t-1}$	γ_{3c}			0.043	10.3	0.055	5.4
log house prices$_{t-1}$/ income$_{t-1}$	γ_4	-0.069	-3.2	-	-	-	-

Notes: German estimate from a special version of the equation in Geiger *et al.* (2016); UK estimate from Aron *et al.* (2012); US estimate from Duca and Muellbauer (2013).
Sources: Cited papers.

credit conditions. Forcing wealth effects to enter in a single net worth to income ratio and omitting the log house price to income ratio fares even worse, with the coefficient on the net worth to income ratio estimated to be negative. No wonder previous estimates of aggregate French consumption functions find unstable wealth effects (Chauvin & Damette, 2011). As argued in Hendry and Muellbauer (2018), the net worth constraint and the omission of shifts in credit conditions correspond to a gross mis-specification, particularly for economies where large shifts have occurred in credit architecture.

Comparable estimates of long-run credit conditions and wealth effects for Germany, the UK and the US, are shown in Table 2. They show no housing wealth or collateral effect in Germany but a comparable negative effect of log house prices/income as in France. Also, the small variation in credit conditions entail smaller effects than in France. In the UK and the US the interaction of mortgage credit conditions and housing wealth/income is crucial, suggesting no housing wealth or collateral effect before mortgage credit liberalisation.

House prices

In the house price equation, the credit conditions indicator for housing loans is identified except for a constant. This effect is normalised at one, at the intercept. The estimated quarterly speed of adjustment is 0.12, similar to that found for Germany in Geiger *et al.* (2016) (Table A2-1). The elasticity of house prices w.r.t. to the nominal mortgage rate is -0.38 (t = -11.5). There is also an interest rate effect buried in the user cost measure, which turns out to interact with mortgage credit conditions. When MCCI is zero, there is no significant user cost effect. This finding is consistent with the large user cost effect found by Duca *et al*. (2011, 2016) for US house prices, given higher levels of leverage there.

The user cost variable is described in Appendix 1. It incorporates large transaction costs which are motivated by weak mobility in France. Together with a time-varying risk premium, this prevents user cost becoming negative after a period of large house price increases. Lagged house price appreciation relative to other countries was also explored but found insignificant.

The effect of income relative to the net housing stock is strongly significant and in line with Meen (2001) "central estimates". Indeed, the log of this measure has a freely estimated coefficient close to 2 and we impose this restriction, implying that the price elasticity of aggregate demand for housing in France is -1/2. It is a little less elastic than UK estimates, see Cameron *et al.* (2006), and substantially less elastic than German estimates, see Geiger *et al.* (2016)[15]. The hypothesis of an equal and opposite coefficient on log income and log housing stock, implying an income elasticity of demand for housing of one, is accepted by data, as is usually the case in this approach[16]. The relative weight of log permanent to current income of 0.52 is close to the 0.55 found in the consumption function.

The last elements in the long run solution are two demographic variables also found relevant in the mortgage equation: the ratio of children to adults and the proportion of adults in the pre-retirement age group. On the one hand, a higher ratio of children to adults suggests a rise in the number of families, increasing housing demand. On the other hand, cross-section data in Arrondel *et al.* (2016) show the highest incidence of mortgages by 10-year age brackets in the 40-49 and 50-59 brackets. To avoid the risk of spuriously large demographic effects, the size of the coefficient for the ratio of children to adults (resp. for the proportion of 40 to 60-64s) is limited to 2 (resp. 3). Those values are within one standard error of the freely estimated coefficient.

Short-term effects include the acceleration of the proportion of those aged 25 to 40 as well as that of unemployment rate over two quarters. Note that those variables are also in the short-term dynamics of mortgage equation, but by considering their change rather than their acceleration.

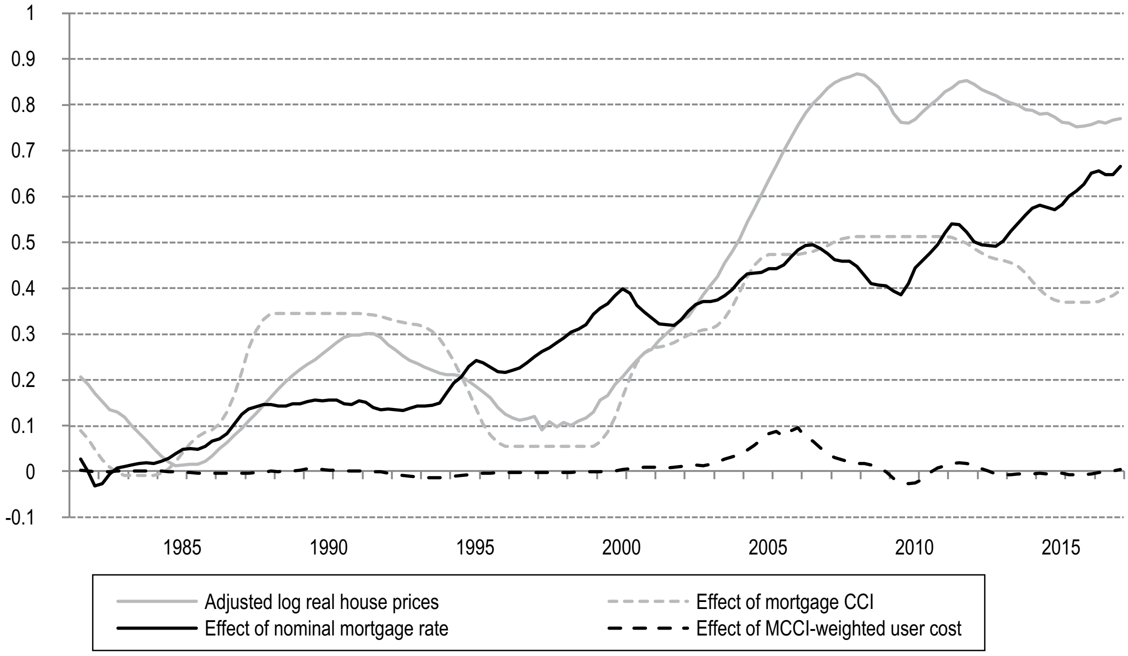
Since persistence in house price appreciation is already incorporated in the user cost, further short-term house price dynamics are checked using lagged acceleration in log nominal housing stock. Short-run dynamics also include the annual change in transactions costs – the level is not significant – and some impulse dummies. These capture the three quarters after the collapse of Lehman Bros.

Figure IV-A shows that the combination of lower nominal interest rates and liberalisation of credit market conditions explains a good deal of the upward trend since 1985 in real house

15. This is probably due to the Paris-dominated structure of the French economy in contrast to the far more decentralised German economy with multiple metropolitan centres, thus offering greater locational substitution possibilities.
16. Note that this model cannot estimate the elasticity of housing supply with respect to prices because the stock of houses is considered as given.

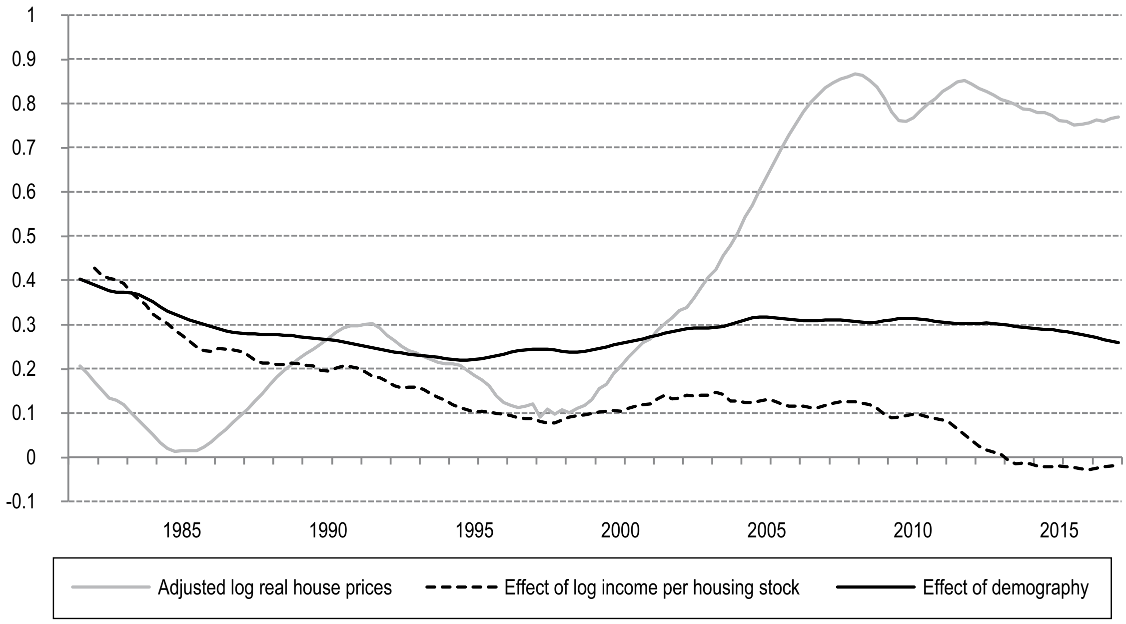
prices, with credit crunches explaining most of the fall from 1990 to 1996 and after 2010. Demography, in the form of the fall in the ratio of children to adults, together with rising housing supply relative to income and population explains the fall in real house prices in the early 1980s, despite falling interest rates (Figure IV-B). Demography explains about half of the rise after 1995, when the increasing share of adults in the pre-retirement age group is more than compensating for the continued, but more moderate, decline in the child/adult ratio.

Figure IV-A
Long-run effects on log real house prices in France



Sources: Banque de France; Insee; OECD; authors' calculations.

Figure IV-B
Long-run effects on log real house prices in France



Sources: Banque de France; Insee; OECD; authors' calculations.

Excluding the *MCCI* term in the house price equation, leads to a collapse in the speed of adjustment from 0.12 to 0.026, and a dramatic worsening in the fit and in autocorrelation of the residuals. Without restrictions, many of the estimated long-run effects would be absurd. To help define a sensible long-run solution, key coefficients are calibrated as shown in the table and demographic effects are generalised by including the proportion of adults aged 25 to 44. The evidence is consistent with that of the studies surveyed in Online complement C1 excluding credit conditions, which reveal extreme fragility of estimated parameters, and in many cases magnitudes of elasticities far from economically plausible values. Even with calibrated demographics and interest rate effects, the freely estimated coefficient on log income per house would rise from a value of 2 to the absurd level of 12 (and a very low price elasticity of demand), while the speed of adjustment falls further.

Mortgage stock

Miles (1992) and Brueckner (1994) discuss the borrowing and saving decisions for housing and portfolio investment motives as well as the consequences of the relaxation of mortgage rationing for the mortgage stock. However, little systematic econometric work exists on household debt, see the reviews in Fernandez-Corugedo and Muellbauer (2006) and in Meen (1990). In France, as in most developed economies, mortgage debt accounts for the major proportion, often 70 to 80 percent of total household debt.

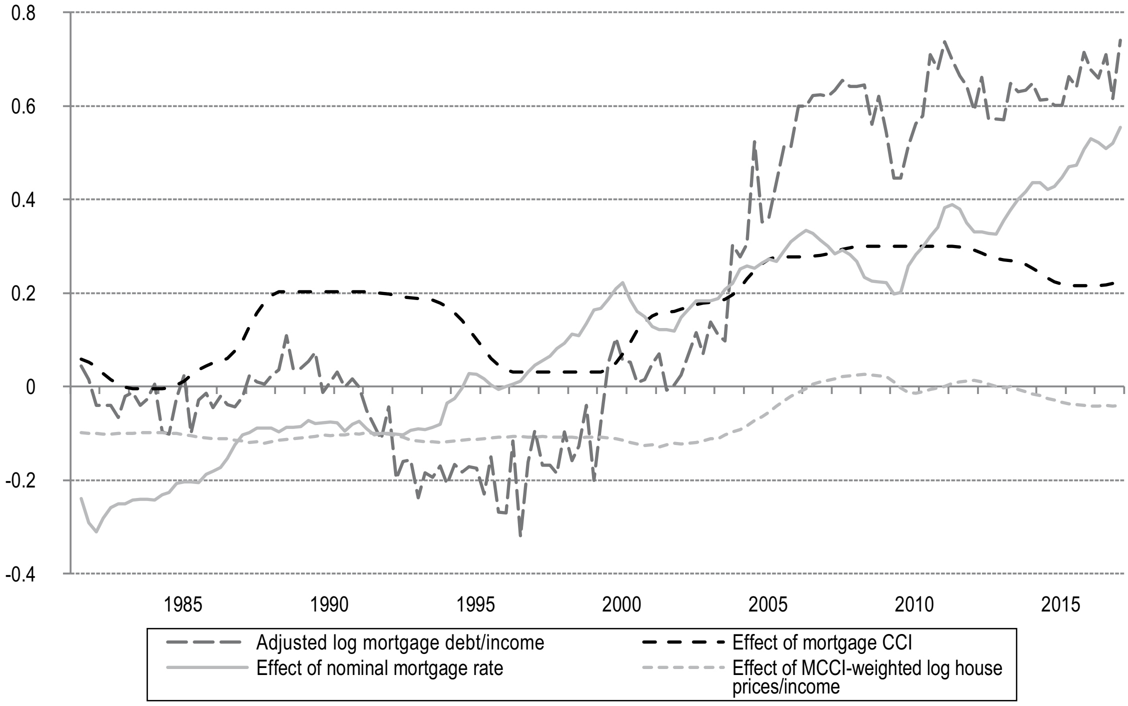
Given the long duration of mortgage contracts, the mortgage stock adjusts quite slowly to the long-run drivers, with a quarterly speed of adjustment of 0.077 (t = 15.8) (see Table A2-2). This is not far from estimates of around 0.065 found for the UK in Fernandez-Corugedo and Muellbauer (2006). In the long-run solution for the mortgage stock equation, the log of the nominal mortgage interest rates has a highly significant coefficient of -0.46 (t = -16.6). Such a strong effect is consistent with banks using the debt service ratio as a key lending criterion (Online complement C4). In the extreme case of every borrower at the maximum allowed by the ceiling on the debt service ratio, the coefficient on the nominal interest rate would be -1. Neither the real interest rate nor a measure of the user cost of housing proved significant, though user cost has an indirect influence via its impact on house prices. Not surprisingly, mortgage credit conditions have a highly significant intercept effect, with a coefficient of 0.59. The effect of the log house price to income ratio varies strongly with mortgage credit conditions, a highly significant interaction effect.

No effects could be detected of liquid or illiquid financial wealth or of permanent income on the stock of mortgages, and an income elasticity of one is accepted. The housing transactions cost has a clear negative effect on the level of mortgages. Demography has important effects, as suggested by recent international evidence on rates of housing investment by Monnet and Wolf (2016) interpreted as demand for housing. The ratio of children to adults and the ratio of adults in the pre-retirement age group (defined as above) both have strong positive effects, somewhat amplified from their role in the house price equation. The effect is calibrated at 1.5 of the effect in the house price equation, an acceptable restriction, below the freely estimated value. In the short-term dynamics, the change (but not the level) in the proportion in the age group 25 to 44 has a highly significant positive effect, t = 12.4. Short run dynamics include a negative effect from the change in the unemployment rate over the two previous quarters, t = -3.2.

Figure V-A and V-B, which decompose part of the long-run solution, show that the loosening of housing loans conditions, the fall in nominal mortgage rates, the interaction of credit liberalisation with house price to income ratios and demography are the key to understanding the rise in the mortgage stock to income ratio. There is a modest positive effect from the decline in transactions cost and a notable effect from demography, in particular from the decline in the child to adult ratio, offset somewhat by the increasing proportion of adults in the pre-retirement age group.

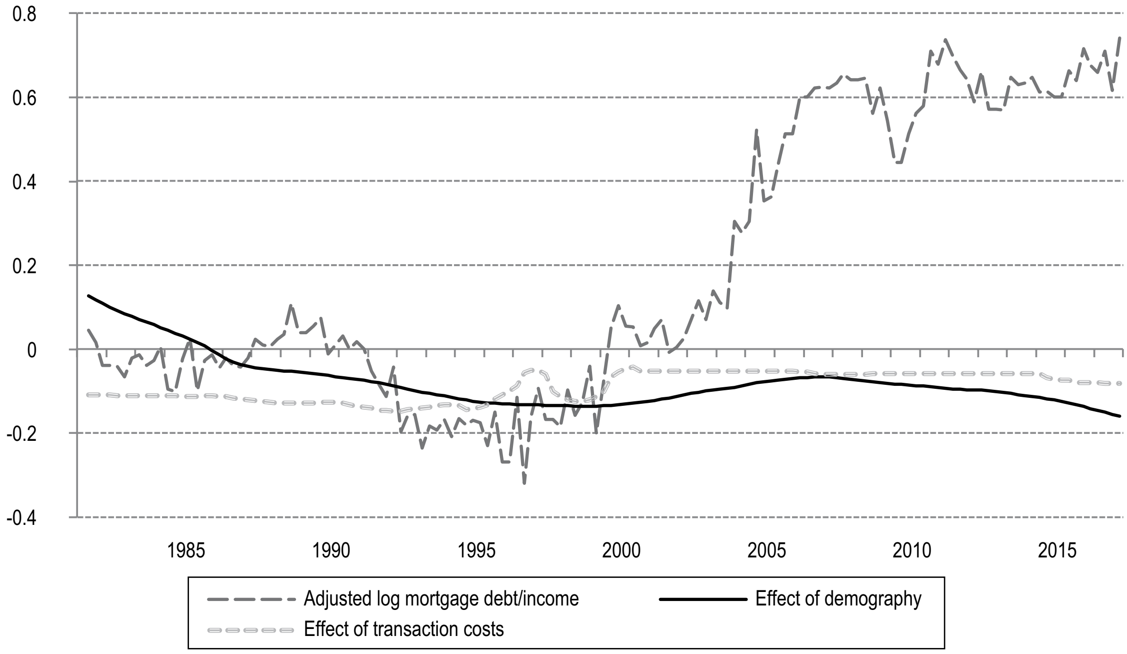
When the mortgage credit conditions index is omitted from the housing loan stock equation, the speed of adjustment falls, but only modestly, and the equation standard error rises. The equation is now dominated by the log ratio of house prices to income, clearly a proxy for the omitted credit conditions effect, though the log of the nominal mortgage rate remains highly significant.

Figure V-A
Long-run effects on log mortgage stock/income in France



Note: Given the slow speed of adjustment, the dependent variable in the figures is ln($debt_{t-1}$ / $income_{t-1}$) + Δln($debt_t$ / π) where π is the speed of adjustment. Without the second term, the visualisation would show a strong lag between the long run drivers and the dependent variable.
Sources: Banque de France; Insee; authors' calculations.

Figure V-B
Long-run effects on log mortgage stock/income in France



Note: Given the slow speed of adjustment, the dependent variable in the figure is ln($debt_{t-1}$ / $income_{t-1}$) + Δln($debt_t$ / π). Without the second term, the visualisation would show a strong lag between the long run drivers and the dependent variable.
Sources: Banque de France; Insee; authors' calculations.

* *
*

The consumption functions of current central bank non-DSGE econometric policy models typically summarise household portfolios in a single net worth measure and neglect shifts in credit conditions. These assumptions greatly restrict the interactions of the household and financial sectors. The empirical evidence of this article for French quarterly data from 1981 to 2016 strongly rejects these assumptions.

Not all co-movements between consumption and wealth are wealth effects. Some result from common factors including shifts in credit conditions, interest rates, income expectations or demographics. These controls are essential to estimate well-identified wealth effects and to illuminate direct and indirect monetary policy transmission on consumption. To distinguish common factors driving consumption and household portfolios from causal relationships, it is necessary to model the main components of household portfolios. This includes modelling house prices, which derive from housing demand, given the housing stock. The model therefore included equations for consumption, house prices, mortgage debt, consumer credit, liquid assets, and permanent income. Controls included credit conditions both for housing and non-housing consumer credit, estimated as latent variables common to multiple equations, interest rates, income expectations and demographics.

Previous macro-econometric models excluding the two credit conditions indicators perform badly, particularly as far as consumption, house prices and consumer credit are concerned. The interpretation of the two latent variables in the system as credit availability indicators is a strong one. Financial liberalization relaxed French mortgage credit conditions from 1984. Subsequent variations are strongly inversely correlated with banks' non-performing loans. Permanent income matters for consumption but, consistent with undiversifiable income uncertainty and liquidity constraints, far less than under the strict permanent income hypothesis. For France, the marginal propensities to consume from financial wealth are comparable to those in the US, the UK and Germany, with a marginal propensity to consume out of liquid assets minus debt far greater than for illiquid financial assets. But, as in Germany, housing wealth or collateral effects in France are much weaker in aggregate, given the absence of home equity loans, than in the US or the UK. ECB (2009) points to this as a major factor in the high levels of heterogeneity across countries in housing wealth or collateral effects on consumption. Arrondel *et al.* (2014) support the evidence for small housing wealth effects for French homeowners, using microdata. Moreover, there is evidence of a negative effect on aggregate consumption of higher house prices. This can be interpreted as follows: with relatively strict financial regulation in France, higher house prices relative to income require younger households to save more if they wish to become homeowners, while other tenants can expect rent rises and so save more also.

During the French house price boom between 1996 and 2008, a small positive housing wealth effect on consumption and looser mortgage credit conditions, were thus offset by the negative effect of higher house prices and higher debt. France is therefore very different from the Anglo-Saxon economies where home equity loans produced large collateral effects of housing wealth on consumption. As a result, despite higher house prices, France did not experience an Anglo-Saxon-style consumption boom in which the financial accelerator via home equity loans proved powerful and destabilising. Another element in the US house price boom was an overshooting of house prices due to extrapolative expectations, likely to have been enhanced by high levels of gearing. The empirical evidence is that overshooting of French house prices due to extrapolative expectations has been on a relatively limited scale, consistent with relatively strict regulations, which limit gearing by French households. This suggests only a small potential risk factor for financial stability from this source.

House prices are quite sensitive to interest rates and, of course, to income and the supply of houses. Moreover, consumption is quite sensitive to interest rates making interest rates and income potential sources of fragility for the French housing and housing loans markets. However, with lower levels of illiquid financial asset holdings in France than in the US or the UK, the financial asset price mechanism for monetary transmission is likely to be weaker. These findings suggest that, incorporated in a larger econometric model, in which different scenarios could be simulated, this household sector model is useful for examining monetary policy issues, including financial stability. ☐

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APPENDIX 1

DATA, DEFINITIONS AND SOURCES

C: Consumption is total consumption excluding financial services at constant prices (source: National accounts, Insee (National Institute of Statistics and Economics)).

Y: Income is a geometric average of disposable non-property income and conventional disposable income of households (source: National accounts, Insee).

LA: Liquid assets include cash (coins and notes), current deposits, liquid saving accounts, short-term debt securities and short-term mutual funds (source: Financial national accounts, Banque de France).

NLA: Liquid assets net of debt (source: Financial national accounts, Banque de France).

IFA: Illiquid financial assets include all financial assets with the exception of liquid assets as defined above (source: Financial national accounts, Banque de France).

HA: Gross housing asset is available as annual data since 1978. It includes housing and land under building (source: National accounts, Insee).

Mdebt: The term "Mortgage debt" has been used in this article in place of housing loans (source: Banque de France). A long time series has been built by Wilhelm (2005). Mortgage loans in the strictly legal sense are a minority in housing loans in France and is not measured as such regularly in France. Most housing loans are indeed guaranteed by a specialized organisation that mutualizes risks on incomes (62% of new loans in 2011 according to the French Supervisory Authority for banks and insurance companies, ACPR). Thus, housing properties are not the guarantee for most loans, but households' income. However when a housing loan is not repaid, households might be obliged to sell their home. Thus the impact on the housing market might not differ from that of a mortgage loan.

Cdebt: Consumer credit extends over any credit card debt, personal loans or overdrafts and loans for the purchase of durable goods other than housing (source: Banque de France)[17].

Hp and *rhp:* House price and real house price (source: OECD): There has been an official house price index for all France, corrected for quality effects, only since 1996 from the notaries data (Gouriéroux & Laferrère, 2009). Before, the only *official* index is a Parisian index since 1980 built by Insee. OECD publishes an index which is based on an annual index constructed by Friggit (2010) based on repeat sales information. Before 1997, actual annual log real house price changes at t-1 are replaced by their fitted values from a regression on growth in mortgage debt, interest rates, inflation and income and the 4-quarter lag of the annual log real house price change.

Rdepr: Returns on liquid assets is measured by a weighted average of real interest rate on regulated saving accounts (source: Banque de France), zero for non-interest bearing deposits (which is the rule in France) and the after tax interest rate on money market funds-such funds for households developed earlier in France than in most other European countries due to fiscal advantages (source: Bernard & Berthet, 2015).

Ncr and *rcr:* nominal/real interest rates on consumer loans. Interest rates on consumer loans are the equally weighted average of rates on overdraft and proper consumer loans measured by the MIR (Monetary Financial Institution Interest Rates) survey harmonized over the euro zone level since 2003 (source: Banque de France). They were backcast by the average of minimum and maximum rates beforehand.

Nmr: Nominal interest rates for mortgage loans adjusted for tax relief on mortgage interests paid. Interest rates on housing loans are those of new loans agreed by banks with fixed rate, according to the survey on the cost of credit (source: Banque de France). Before 1980, they were backcast with information on minimum and maximum rates beforehand. Tax relief is taken from the National accounts for housing (source: Ministry for Housing).

User: The user cost measure is defined as the real after-tax mortgage interest rate minus expected real appreciation plus assumed annualised transactions costs of 4.5%[18] of the value and a lagged time varying risk premium. The time-varying risk premium is defined by the volatility of annual real house price changes in the last four years, with declining weights going back in time: (ad4lrhp + 0.7* ad4lrhp(-4)+ (0.7**2)* ad4lrhp(-8) + (0.7**3)*ad4lrhp(-12))/(1 + 0.7 +(0.7**2) + (0.7**3)) where ad4lrhp is the absolute value of the annual change in log real house prices, instrumented during the pre-1996 period of interpolated annual house price data.

Demog: Demographic data are annual data each 1st January (source: Insee). They were interpolated and lagged accordingly. In the permanent income model, demography affects the ratio of the working age population for all ages, measured as an 8-quarter moving average, to the total population.

H: The housing stock has been recursively computed on the principal of perpetual inventory using data from the housing stock in constant prices (source: National accounts, Insee). The level is set by the value of stock in 2010. Gross fixed capital formation is housing GFC in volume and the deterioration rate is that of national accounts.

θ: Income uncertainty is proxied by the 4-quarter change in the unemployment rate in the consumption equation, and 2-quarter changes in the other equations.

Trans: Transaction costs come from "valeur-immobilier-france" (source: Ministry of Housing).

The impact of car scrapping subsidies is computed following Adda and Cooper (2000) for the first wave and extrapolated according to the link with car registration for the second wave.

17. Like consumption and income, all nominal balance sheet data are deflated by the consumer price deflator and population.
18. For any one transaction, costs, including costs of moving, are much higher. The discounted present value spread out over a few years of ownership could plausibly be of the order of 4.5% per annum. This is consistent with low levels of mobility in France.

ESTIMATES FOR HOUSE PRICES AND MORTGAGE STOCK EQUATIONS

Table A2-1
Estimates of long-run solution for the French house price equation

Dependent Variable = Δ ln hp_t	Symbol	1981Q2-2016Q4		1981Q2-2008Q3		1981Q2-2016Q4 Excluding *MCCI*(a)	
		Coefficient	*t*-ratio	Coefficient	*t*-ratio	Coefficient	*t*-ratio
Speed of adjustment		0.123***	12.6	0.126***	10.3	0.026***	10.8
Long-run coefficients							
Constant	h_0	-5.95***	-51.8	-14.0***	-38.9	-8.8***	-25.9
Mortgage credit conditions index: *MCCI*	h_{0c}	1	fix	1	fix	0	fix
Log nominal mortgage rate	h_1	-0.38***	-12.4	-0.39***	-9.1	-0.38	fix
Log user cost**MCCI*	h_2	-0.07***	-2.8	-0.14*	-1.8	-0.87***(a)	-8.4
Coefficient on risk premium in user cost	h_{2a}	0.63***	12.0	0.72***	10.2	0.96***	16.5
Log (real income/housing stock)	h_3	2	fix	2	fix	2	fix
Log (permanent/current income)	h_4	0.52***	3.8	0.41***	2.7	0.52	fix
Children/adults	h_{5a}	2	fix	2	fix	3	fix
Pre-retirement adults/total adults	h_{5b}	3	fix	3	fix	4	fix
Adults 25-44/total adults		0	fix	0	fix	2.2***	3.2
Diagnostics							
Equation standard error		0.00234		0.00235		0.00482	
DW		1.83		1.72		0.84	
R-squared		0.973		0.969		0.887	

(a) Not interacted with *MCCI*.
Note: Statistical significance at the 10%, 5%, and 1% levels is denoted by *, **, and *** respectively. Maximum likelihood estimation of the 6-equation system in TSP (Time Series Processor) 5.1. Equation standard errors are RMSEs of the residuals.
Sources: Banque de France; Insee; authors' calculations.

Table A2-2
Estimates of the long-run solution for the mortgage stock equation

Dependent Variable = Δ ln $mdebt_t$	Symbol	1981Q2-2016Q4		1981Q2-2008Q3		1981Q2-2016Q4 Excluding *MCCI*(a)	
		Coefficient	*t*-ratio	Coefficient	*t*-ratio	Coefficient	*t*-ratio
Speed of adjustment	π	0.077***	15.8	0.088***	3.3	0.057***	10.8
Long-run coefficients for log (real mdebt/y)							
Constant	m_0	-2.7***	-27.9	-2.9***	-25.5	-7.1***	-4.7
Mortgage credit conditions index: *MCCI*	m_{0c}	0.59***	12.2	0.55***	10.5	0	-
Log nominal mortgage rate	m_1	-0.46***	-16.6	-0.38***	-10.4	-0.59***	-12.3
log(house prices/y)	m_4	0	-	0	-	0.97	14.9
MCCI × log(house prices/y)	m_{4c}	0.70***	5.6	0.86***	5.4	0	-
Composite demographic effect from the house price equation	m_5	1.5	fix	1.5	fix	1.5	fix
Transaction costs	m_9	-2.9***	-4.2	-3.9***	-2.7	-5.1***	-4.4
Diagnostics							
Equation standard error		0.00322		0.00327		0.00374	
DW		2.10		2.21		1.77	
R-squared		0.902		0.906		0.870	

(a) Not interacted with *MCCI*.
Note: Statistical significance at the 10%, 5%, and 1% levels is denoted by *, **, and *** respectively. Maximum likelihood estimation of the 6-equation system in TSP (Time Series Processor) 5.1. Equation standard errors are RMSEs of the residuals.
Sources: Banque de France; Insee; OECD; authors' calculations.