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Macroprudential mortgage lending measures

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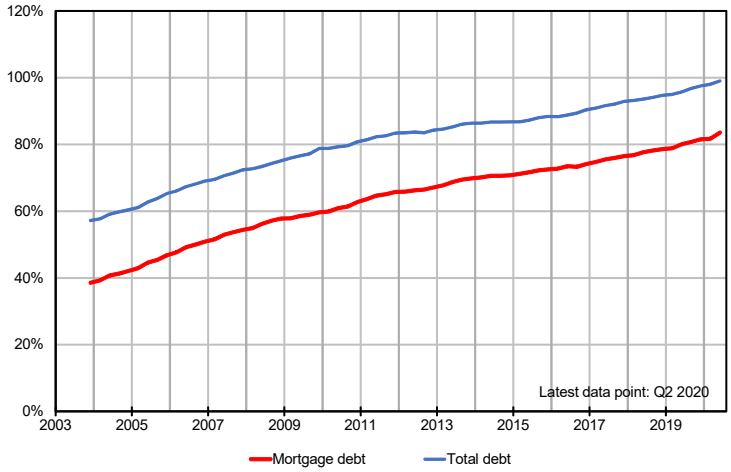
- Out-of-control mortgage lending is a source of considerable risk to financial stability. The subprime lending crisis in the United States spurred the expansion of so-called macroprudential policies, which aim to reduce financial risk for the financial system as a whole.
- In France, mortgages account for 50% of bank loans held by non-financial agents and total outstanding mortgage debt exceeds one year's total disposable household income. A combination of runaway mortgage growth and deteriorating loan quality poses significant risk to financial stability.
- To ensure these loans remain solid, adequately risk-assessed assets, macroprudential authorities can impose lending restrictions, for example on the ratio of debt service to income (DSTI), the ratio of debt to income (DTI), the maturity of the loan or the size of the down payment.
- In December 2019, France's High Council for Financial Stability (HCSF) recommended a maximum loan maturity of 25 years and a DSTI limit of 33% (later revised to 35% in January 2021) for a majority of mortgages. The HCSF's recommendation is to become binding in the summer of 2021.
- Using a property market model, we analysed the economic impact of two types of macroprudential measures: the first, limits on both DSTI ratio and loan maturity, and the second, a DTI cap. Both succeed in reducing the overall debt level, but the effect of the combined limitation is less pronounced, since it allows some households to extend maturity in order to circumvent the cap on DSTI ratio. The measure directly targeting DTI ratio has a stronger impact on prices and transactions and generates more significant distributive effects.

Mortgage debt and total debt of French households, as a % of gross disposable income



Source: Banque de France and INSEE.

1. Lending conditions and financial stability

The 2008 financial crisis was a reminder of the significant role mortgage lending plays in financial systems, triggering a burst of research on its relationship to financial instability. Two main approaches – macroeconomic and microeconomic – have been used to analyse the issue. The advantage of the macroeconomic approach is the ability to conduct cross-country studies, thanks to empirical data with rich enough detail but at a sufficiently aggregate level to be available in numerous countries. The downside is that this kind of analysis cannot pinpoint, at a country-specific level, the exact mechanism through which mortgage lending practices may destabilise the financial system. The microeconomic approach, on the other hand, allows for a more detailed examination of the explanatory factors of mortgage borrower default risk and its consequences for banks' balance sheets.

1.1 Macroeconomic approach: the empirical significance of aggregate debt

The macroeconomic approach looks at the aggregate explanatory factors behind financial crises. Over the past decade, numerous studies have attempted to demonstrate the relationships that exist between rising lending volumes, rising property prices and financial instability. A central finding in the literature is the substantial role played by credit in triggering crises. As Schularick and Taylor[1] put it, financial crises are "credit booms gone bust". Yet since the 1980s, the growth of mortgages on banks' balance sheets has significantly outpaced non-mortgage lending growth,[2] and credit cycles have been largely driven by mortgage lending trends.

In the United States, rising household debt helped inflate the property bubble that burst in 2007.[3] In wealthy economies, "real estate credit has become a more important predictor of impeding financial fragility" and "recessions are more severe if they are preceded by lending booms".[4] According to this research, traditional prudential policy measures, centred on increased capital requirements for banks, can help mitigate the consequences of a financial crisis but cannot prevent one.[5]

The conclusion drawn is that controlling overall mortgage lending activity is key to reducing the risk of a future financial crisis.

1.2 Microeconomic approach: DSTI or DTI a better predictor of default risk?

The relationship between mortgage debt levels and financial stability can be examined in closer detail by studying the relationship between mortgage lending conditions and households' probability of default (see Box 1 and Table 1).

Box 1: Example mortgage lending conditions for the purchase of a main residence

In this example, there is a property for sale valued at €330,000 and a buyer with an annual household income of €45,000, net of social contributions but before income tax. The purchase is to be financed by a €230,000 mortgage and a €100,000 down payment, which gives a LTV ratio of 70% (with the down payment representing 30%). For a 20-year mortgage at a rate of 1.4%, monthly payments would be €1,100,[a] representing a DSTI ratio of 29.3% and a DTI ratio of 5.1 years (€230,000 mortgage divided by an annual pre-tax income of €45,000). For a 25-year mortgage at a rate of 1.8%, monthly payments would be €953, for a DSTI ratio of 25.4%.

a. The DSTI ratio is calculated based on the total cost of borrowing, which includes all borrower-borne costs that are a condition of credit approval, such as insurance premiums.

(1) Schularick M. and A. M. Taylor (2012), "Credit Booms Gone Bust", *American Economic Review*.
(2) Jordà Ò., Schularick M. and A. M. Taylor (2016), "The Great Mortgaging: Housing Finance, Crises and Business Cycles" *Economic Policy*.
(3) Mian A. and A. Sufi (2015), House of Debt, University of Chicago Press.
(4) Jordà Ò., Schularick M. and A. M. Taylor (2016), "The Great Mortgaging: Housing Finance, Crises and Business Cycles," *Economic Policy*.
(5) *Ibid*.

There are two criteria that are particularly important (see Table 1): the DSTI ratio, which measures the financial burden of a borrower's debt against their income, and the DTI ratio, which measures the amount of a borrower's debt against their income. In France in 2019, according to the Prudential Supervisory and Resolution Authority (ACPR), the average DSTI ratio at origination was 30.3%, the average DTI ratio 5.4 years and the average maturity 20.5 years.

Table 1: Lending indicators and their definitions

Indicator	Definition
Loan-to-value (LTV) ratio	Loan amount/Property value
Debt-service-to-income (DSTI) ratio[a]	Monthly payment/Monthly income
Debt-to-income (DTI) ratio	Amount of borrowed debt/Annual income

a. For variable-rate loans, the DSTI ratio at origination is defined in the same way: the ratio of the monthly payment amount at origination to monthly income at origination. However, because it is less informative in these cases, macroprudential regulations include stress tests to ensure resiliency to rate fluctuations over the term of the loan..

The risk of default over the lifetime of the loan – in other words, the likelihood that the borrower will fail to make payments during the term of the mortgage – can be minimised by manipulating lending conditions. One may make two assumptions: either the rate of default will increase in proportion to the DSTI ratio (e.g. a 1% higher DSTI ratio will result in a 1% increase in the rate of default), or the rate of default will increase more than proportionally to the DSTI ratio (e.g. a 1% higher DSTI ratio will result in a 2% increase in the rate of default above a certain level). If first hypothesis is relevant, then it is better to target the DTI ratio, which indirectly accounts for loan maturity (the longer the term, the more opportunity to default). If the second is more relevant, it is better to focus on the DSTI ratio to reduce the risk of default (see Box 2). It is also possible to target the loss the bank would suffer in the event of default, essentially the difference between the remaining principal balance and the value of the property – particularly if the property serves as collateral for the loan. This is where the macroeconomic feedback effects of housing prices famously come into play, as seen in the subprime mortgage crisis. Increased lending drives up house prices, which in turn raises the value of the collateral held by the banks and encourages them to lend more, continuing on until the bubble bursts. In this case, regulators can impose LTV ratio limits to prevent this kind of feedback loop from starting.

The feedback effect appears to be less of an issue in France, where nearly 60% of new loans are secured by *cautionnement* (guarantee). Since the property does not serve as collateral, the risk is distributed. And unlike in the United States, where the value of the property itself constitutes the collateral securing the loan, in France more importance is attached to the borrower's overall resources. As a result, house prices have less of an influence on lending practices.

Box 2: Lending conditions and default risk

Let's assume that the probability of default at a given time t, ***Pd(t)***, is expressed as a function of the DSTI ratio using the following formula, where g is an increasing function:

$$Pd(t) = g(DSTI(t))$$

Also assuming that the DSTI ratio at origination ($DSTI_0$) is a reasonable approximation of the DSTI ratio and that the probability of default is constant over the loan term, a loan's probability of default, over its repayment term, T_0 can be expressed as:

$$Pd(t) = 1 - (1 - g(DSTI_0))^{T_0}$$

So, by Taylor expansion, if $g(DSTI_0)$) is a small number:

$$Pd = g(DSTI_0) \times T_0$$

It can therefore be demonstrated that, if the immediate risk of default is increasing over-proportionally to the *DSTI* ratio, then *DSTI* ratio is a very good indicator of default risk

As for *DTI* ratio at origination DTI_0, it can be expressed as follows in a low interest-rate environment:

$$DTI_0 = DSTI_0 \cdot T_0$$

Comparing these equations shows that if the immediate probability of default is increasing proportionally to the DSTI ratio, then DTI ratio can also be a good indicator of default risk when borrowing rates are low.

2. Borrower-based macro-prudential measures used in Europe

2.1 Inventory of the various measures

There are five main categories of borrower-based measures available to macroprudential authorities: LTV ratio, DSTI ratio, DTI ratio, loan maturity at origination and amortisation schedule (for example, banning bullet loans, where the borrower pays interest but does not pay down the principal during the term of the loan or until after a certain period).

Such measures can either take the form of strict limits, applying to all new loans across the board, or come with some degree of flexibility, allowing banks to exempt a proportion of their lending book. That is the situation in the United Kingdom, for example, where in 2014 the Financial Policy Committee introduced a cap, limiting the flow of new mortgages that could be granted at loan-to-income ratios above 4.5 to 15%.

Table 2: Borrower-based measures in effect in the European Economic Area[a]

Measure	Number of countries where the measure is binding	Number of countries where the measure is non-binding
LTV Ratio	14	6
DSTI ratio	7	4
DTI ratio	3	2
Loan maturity	3	3
Loan amortisation schedule	3	2
Other (solvency stress test)	10	5

a. The European Economic Area includes the 28 EU Member States, Norway, Lichtenstein and Iceland.

Source: European Systemic Risk Board, DG Trésor and Banque de France, September 2020.

2.2 Literature review on the effects of these measures

To study the effects of these measures, we can compare the trajectories of countries where they have been introduced with the trajectories of those where they have not. This comparison reveals that borrower-based measures, like LTV limits, are associated with lower aggregate debt.[6] However, in addition to the difficulty of drawing causal inferences from macroeconomic data, mainly due to omitted variable bias and selection bias, this method does not account for differences between countries' housing finance models. Every country has its own set of institutions (loan guarantee systems, borrower selection criteria, prevalence of fixed or variable rates, social security systems, etc.) that affect the resilience of its housing finance model, which suggests that there is considerable heterogeneity in the effects of macroprudential measures aimed at the housing market.[7] These differences factor heavily into a country's macroprudential policy decisions.

(6) See for example: Stijn C., Swati Ghosh R. and R. Mihet, "Macro-Prudential Policies to Mitigate Financial System Vulnerabilities", *IMF Working Paper*; Kuttner K.N. and I. Shim (2016), "Can Non-Interest Rate Policies Stabilize Housing Markets? Evidence from a Panel of 57 Economies", *Journal of Financial Stability*; Zohair A. *et al.* (2019), "Digging Deeper – Evidence on the Effects of Macroprudential Policies from a New Database", *IMF Working Paper*.

(7) Although some empirical studies have focused on country-specific experiences (e.g. Hong Kong, Israel, Ireland, South Korea), to our knowledge there has not been a country-specific study on the introduction of a combination of DSTI/maturity limits, or on the effect of a DTI cap alone.

A recent complementary approach uses theoretical models calibrated with aggregate or individual data to compare the effectiveness of different policy tools. It shows that monetary policy tightening appears to be less effective than reducing the tax deductibility of mortgage interest or imposing LTV limits on mortgages.[8] The undesirable effects of these measures on growth and inflation can also be quantified, and they are less pronounced than the effects of monetary tightening.[9] But the downside of this approach is that it uses the simplified assumption of the "representative agent", which is ill-suited for analysing borrower-based measures designed to regulate extreme behaviour (excessively long maturities, unsustainable DSTI ratios, minimal down payments) without affecting the rest of the distribution.

Heterogeneous agent models factor in this kind of diversity in population characteristics and lending conditions. They also more accurately depict borrower-based measures, particularly those that do not affect the entire population. A model from the Bank of England, for example, demonstrates how introducing a loan-to-income limit, prospectively affecting only around 35% of new loans, can reduce the amplitude of house price cycles.[10]

3. Findings from a DG Trésor simulation model

To assess the impacts of different macroprudential measures in France, an agent-based model was designed to reproduce property purchase and lending transactions. It uses a heterogeneous population of agents, representative of the French population.

3.1 Model calibration

To replicate the dynamics of the household mortgage lending situation in France as closely as possible, the model uses a population that is representative of the French population: the one captured in the household wealth survey conducted by the National Institute of Statistics and Economic Studies (INSEE).[11] The characteristics of the households in the model making purchasing, selling, borrowing and other decisions correspond to those of the households polled in 2010.

The model is calibrated[12] in such a way as to reproduce both the 2010 situation in 2010 and the 2018 situation in 2018 (the main difference, apart from wage and population numbers, being different interest rates).

These calibrations allow for a realistic reproduction of the situation in 2010 and 2018 in terms of prices, transactions, aggregate debt levels and lending conditions (DSTI and DTI ratios, loan maturity at origination).

To ensure the model's mechanisms are realistic, it is put through various stress tests (positive shocks on interest rates, rent prices or construction). The impacts are as expected and elasticity values are close to their empirical estimations.

(8) Alpanda S. and S. Zubairy (2014), "Addressing Household Indebtedness: Monetary, Fiscal and Macroprudential Policy?", *European Economic Review.* The deductibility of mortgage interest is a tax provision under which the amount of interest payments made during the year can be subtracted from the taxpayer's base taxable income.

(9) The above authors use a model calibrated with US data to show that a 100-basis-point tightening in the policy rate would do less to limit new loans but would have a more negative impact on inflation and growth than lowering the LTV limit by 5 percentage points.

(10) Rafa B., Doyne Farmer J., Hinterschweiger M., Low K., Tang D. and A. Uluc (2016), "Macroprudential Policy in an Agent-Based Model of the UK Housing Market", *Bank of England Working Paper*.

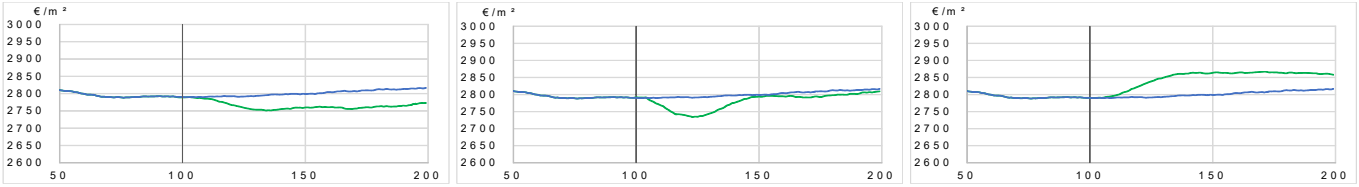
(11) INSEE, 2010 Household Wealth Survey. "Sources et Méthodes", 2010, www.insee.fr/en/metadonnees/source/serie/s1005.

(12) The parameters of the model, which are not easy to find estimates for in the literature, have been adjusted so that the variables of interest (price level, transaction frequency and aggregate debt level for 2010 and 2018, as well as distribution of lending conditions in 2018) are as close as possible to their targets. We calibrated the construction growth rate, home ownership costs, the time horizon over which households form expectations about price changes, the spread of these expectations, the pace of moves, the sensitivity of sellers to property market tension and to historical price growth, negotiating range, the parameters of the utility function to determine households' DSTI preferences, and the rate at which new households are formed.

As shown in Chart 1: (i) a +100bps shock on the 20-year mortgage rate leads to a 2.5% permanent price drop; (ii) a 1% housing stock increase leads to a 2% price level decrease;[13] (iii) a 5% permanent increase in rent price level[14] leads to a 4% house price level increase. These effects are consistent with the literature.[15]

Chart 1: Price effects (in €/m²) of different shocks to the lending and property marketsr

(a) Positive rate shock (+100bps) **(b) Temporary construction shock (+1%)** **(c) Positive rent shock (+5%)**



Source: DG Trésor calculations

How to read this chart: These charts present the simulated effects on prices of three shocks to the lending and property markets. In each chart, the blue curve represents the counterfactual and the green curve represents the price trajectory following a shock that occurs at the 100th interval (after 8 years and 4 months, indicated by the vertical black line). At the 100th interval, the model is an accurate representation of the 2018 property market, and these charts show the differences in trajectory caused by the introduction of a shock. In the absence of a shock, the model continues on with the original situation. Each curve represents the average of 100 simulations generated by the model. The vertical axis is the price in euros per square metre, calculated using the average transaction price over the previous 12 months. The horizontal axis is the number of simulation intervals, each corresponding to one month.

Box 3: Model overview[a]

Agent-based modelling (ABM) was first developed in the 1970s for use in complexity theories in physics. The principle behind ABM is to study complex phenomena arising from interactions between numerous heterogeneous agents with simple rules of action. Adopted by economists in the 1980s, ABM has been used to study the housing market, where it is usually combined with matching methods (adopted from labour economics), which examine the consequences of friction between buyers and sellers in a market with imperfect information. ABM has been used to study the emergence of the Washington DC property bubble in the 2000s.[b]

The model presented here is based on a population of 14,440 households, representative of the French population, including both tenants and owners. During each interval,[c] some tenants decide

endogenously to attempt to purchase a home,[d] and property is put up for sale on a random basis, either because the owners are looking to purchase something new or because they have died. A number of new builds are also put on the market.

Buyers determine their spending limit based on the value of their financial assets, their borrowing capacity and, for existing owners purchasing another property, a conservative portion of their asking price.[e]

a. See Bauer A., Berthet L. and N. Krakovitch (2021), "Borrower Measures and Households Indebtedness", *DG Trésor working paper*, publication pending.
b. Geanakoplos *et al.* (2012), "Getting at Systemic Risk via an Agent-Based Model of the Housing Market", American Economic Review, 102 (3): 53-58.
c. In the model, an interval is equal to one month.
d. Age-related heterogeneity of purchasing behaviours is modelled indirectly: the income growth rate is based on agents' age.
e. Owners' wealth is determined based on their financial assets and 90% of their asking price. It is a conservative estimate of the value of their property assets, allowing for potential downward price adjustments during the matching process.

(13) Which corresponds to estimates found in the empirical literature, for example: Friggit J. (2015), "L'élasticité du prix des logements par rapport à leur nombre", CGEDD memo. The rental market is not modelled here, since there is not an absolute quantity of housing units, and therefore no supply/demand relationship that would determine a natural price.
(14) The model only deals with the main residence market; buy-to-let investment is not modelled. Rental prices are therefore exogenous.
(15) In the 2018 IMF working paper "Interest Rate Elasticity of Residential Housing Prices", Plamen I., Cihak M. and A. Shanghavi estimate the elasticity of housing prices to interest rates to be -3, and in a 2015 CGEDD memo entitled "L'élasticité du prix des logements par rapport à leur nombre", J. Friggit estimates the elasticity of housing prices to the rate of new construction to be between -1.5 and -2.

Sellers determine their asking price based on the quality and surface area of the property, the average market price, historical price trends and market tension, which depends on the ratio between the number of buyers and sellers.

Buyers and sellers are then matched, in the presence of matching frictions, based on spending limit and asking price. If a sale is not made, buyers may raise their offer and sellers may lower their price during the next interval. If a sale is made, buyers in need of a mortgage go to a bank and choose the best combination of DSTI ratio and loan maturity to borrow the amount they need. All household characteristics are then updated (status, wealth, income, debt, etc.) and another interval begins.

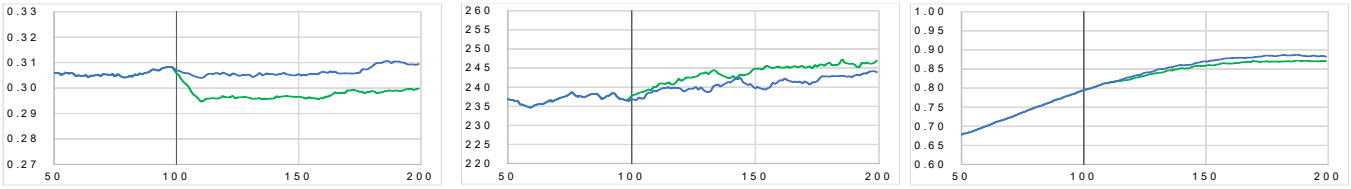
3.2 A comparison of two borrower-based measures

We examined the effect of a DSTI limit of 33%[16] combined with a maturity limit of 25 years. The model predicted a significant decline in average DSTI ratio at origination, which fell from 31% to 29% after both measures were introduced simultaneously (see Chart 2). Loan maturity at origination also increased by approximately 10 months. This carryover effect can be explained by the assumption that, after the measures were introduced, borrowers continued to seek loans for amounts as close as possible to what they had been seeking previously, and they were able to lower their DSTI ratio by extending the term of the mortgage.[17] The aggregate debt level is lower than it would be without the measures in place, but the impact is limited by the carryover effect between DSTI ratio and loan maturity.

Next we examined the effect of a cap on DTI ratio at origination, set at 5.8 years of income, in order to, *ex-ante*, target the same percentage of new loans (roughly 35%) as the combination of measures modelled above. Chart 3 shows that although this measure had a marked effect on DSTI ratio at origination, it was not accompanied by an increase in loan maturity at origination. After the measure was introduced, the DSTI ratio fell by 2 percentage points and the average loan maturity at origination decreased by roughly 10 months, therefore producing a more significant reduction in aggregate debt level.

Chart 2: Effect of a combination of limits on DSTI ratio (33%) and loan maturity (25 years)

(a) Effect on DSTI ratio at origination **(b)) Effect on loan maturity at origination** **(c) Effect on aggregate debt[a]**



Source: DG Trésor calculations.

How to read this chart: From left to right: (a) DSTI ratio; (b) average loan maturity at origination over the previous 12 months; and (c) aggregate debt, defined as the 12-month sum of borrowers' mortgage debts over the sum of their annual incomes. The blue curve represents the counter-factual (trajectory without any loan limits).

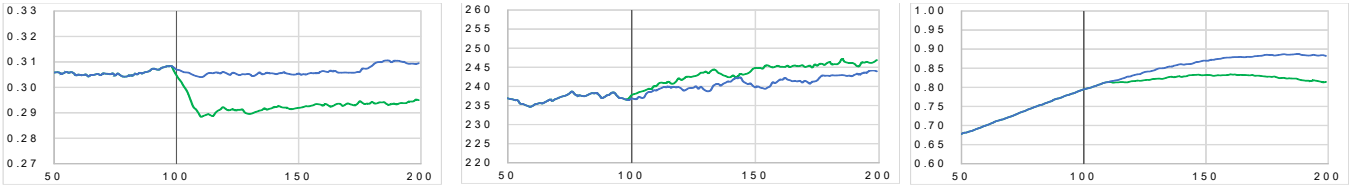
a. The agents in the model have an initial level of wealth corresponding to 2010 figures, but from the outset the financing conditions are those from 2018, which generates a debt accumulation trend. Because the financing conditions do not change, the aggregate level of indebtedness stabilises in the counterfactual (blue curve) once households achieve 2018 levels of wealth.

(16) See the HCSF recommendation of 20 December 2019. Qualitative results appear to be similar with the 35% limit (HCSF decision of 17 December 2020). The model does not incorporate the recommendation's margin of flexibility.

(17) The 33% DSTI limit has a stronger impact than the 25-year mortgage maturity limit. According to the HCSF's 2020 annual report (in French), the proportion of mortgages longer than 25 years was 2% in 2019, while the proportion with a DSTI ratio above 33% was more than 20%.

Chart 3: Effect of a DTI ratio cap (5.8 years of income)

(a) Effect on DSTI ratio at origination **(b) Effect on loan maturity at origination** **(c) Effect on aggregate debt**



Source: DG Trésor calculations.
How to read this chart: See note under Chart 2.

The decrease in aggregate debt level is largely due to a decrease in average individual debt, the result of borrowers making larger down payments. The DTI cap therefore has more of a direct impact on reducing the average debt load than a combination of measures targeting DSTI ratio and loan maturity and also has a stronger influence on housing prices and transactions. However, it also has stronger distributive effects and results in a degree of selection effect among buyers, to the detriment of lower income categories.

In December 2019, France's High Council for Financial Stability (HCSF)[18] published a recommendation, endorsing a standard practice, that lenders apply a debt service criterion of no more than one-third of a borrower's income (33% in December 2019, later increased to 35% in January 2021) and limit mortgages to 25 years. It is an attempt to curb the loosening of lending conditions observed since 2015 and, ultimately, to limit households' risk of default while preserving borrowing capacity to the extent possible.

Per the HCSF's recommendation, a portion (15% in December 2019, increased to 20% in January 2021) of new loans each quarter can deviate from the recommended DSTI and maturity limits. Loans granted as part of this "flexibility" allowance are to be closely monitored in terms of DTI ratio to ensure that their risk profile remains appropriately managed.

(18) DG Trésor acts as secretariat to the HCSF jointly with the *Banque de France*. The analysis and conclusions of this publication are not those of the HCSF.

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