

Submission to the Senate Select Committee on Australia's Productivity

Governing Credit Efficiency:  
A Structural Framework Linking Housing Affordability, Productivity, and  
Fiscal Capacity

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## Executive Summary

Housing affordability, national productivity, and fiscal capacity are often treated as separate policy issues. This submission shows they are linked through a single structural mechanism: the efficiency of long-term credit. The rate-term product ( $rT$ ) captures the cumulative cost of borrowing over time and provides a measurable basis for understanding how credit affects economic outcomes.

When housing loans are extended at long duration and high cumulative interest, a large share of household income is pre-committed to servicing debt. This increases borrowing capacity faster than wages and is capitalised directly into land values. The result is persistent housing unaffordability, slower equity formation, reduced household resilience, and a long-run diversion of national income away from consumption, productive investment, and public purpose.

In contrast, economies with lower and more efficient  $rT$  settings produce stable housing affordability anchored to incomes rather than speculative expectations. Households build equity more rapidly, total lifetime interest transfers fall, and credit is more available for enterprise, infrastructure, and innovation. These effects strengthen productivity and expand fiscal capacity without requiring subsidies or disruptive intervention.

The framework distinguishes three credit regimes: governed, ungoverned, and out-of-control. In governed systems, efficiency metrics are measured, reported, and used to align credit flows with broader economic and social objectives. Interest rates ( $r$ ) continue to stabilise the macroeconomy, while loan term ( $T$ ) and other prudential tools shape the long-run structure of credit. In ungoverned regimes, these levers are not coordinated, and credit tends to flow toward housing by default. In out-of-control regimes, speculative dynamics dominate, amplifying inequality and systemic risk.

Transition to a more efficient credit structure can be gradual and non-disruptive. Lower  $rT$  settings apply to new lending only, while existing loans amortise under current terms. Over time, average efficiency rises, house prices stabilise relative to income, and the share of national income allocated to productive activity increases.

Governing credit efficiency does not suppress markets. It aligns private incentives with public objectives and restores the conditions under which households can form stable plans, businesses can invest, and governments can govern with confidence. Because the structure of credit shapes the structure of the economy, managing credit efficiency is a foundational requirement for long-run affordability, productivity, and social cohesion.

## Introduction

This submission responds to the Terms of Reference of the Senate Select Committee on Australia’s Productivity by presenting a structural framework that links housing affordability, productivity performance, capital allocation, and fiscal capacity through the efficiency of long-term household credit.

The accompanying report, *Governing Credit Efficiency*, provides the mathematical, empirical, and policy foundations for this framework. This submission summarises the key mechanisms and maps them directly to the Committee’s Terms of Reference.

## Mapping the Terms of Reference to the Credit Efficiency Framework

This section maps the Senate Select Committee on Australia’s Productivity Terms of Reference (TOR) to the structural mechanisms and findings presented in *Governing Credit Efficiency*. Each TOR category is addressed directly through the lens of the rate–term product ( $rT$ ), which the paper identifies as the missing structural variable linking housing, investment, productivity, and fiscal capacity.

### 1. Challenges in Measuring Productivity

**TOR Focus:** Historical performance, measurement limitations, non-market sector gaps, and international comparison.

**Paper Contribution:** The paper introduces the rate–term product ( $rT$ ) as a measurable, cross-country comparable structural variable that explains productivity outcomes through credit allocation.

“The rate–term product ( $rT$ ) captures the cumulative cost of borrowing over time and provides a measurable basis for understanding how credit affects economic outcomes.”

This addresses:

- missing structural variables in productivity measurement,
- the link between credit structure and productivity stagnation,
- international comparability of credit efficiency,
- why productivity slowed despite stable labour and capital inputs.

## 2. Australia’s Global Competitiveness

**TOR Focus:** Causes of declining productivity relative to OECD peers; lessons from high-performing countries.

**Paper Contribution:** High  $rT$  settings divert national income into long-horizon interest payments, reducing capital available for productive investment and weakening competitiveness.

“A large share of household income is pre-committed to servicing debt... diverting national income away from consumption, productive investment, and public purpose.”

The paper’s international comparisons show that countries with low  $rT$  (e.g., Japan, Germany) maintain stronger productivity and competitiveness.

## 3. Industry Contributions to Productivity

**TOR Focus:** Market and non-market sector performance; measurement challenges.

**Paper Contribution:** High  $rT$  suppresses both household consumption and business investment, reducing productivity across market and non-market sectors.

“The result is persistent housing unaffordability, slower equity formation, reduced household resilience, and a long-run diversion of national income away from productive investment.”

This provides a macro-structural explanation for:

- weak productivity across industries,
- negative productivity in non-market sectors,
- capital shortages in care, health, and education.

## 4. Regulatory Burdens Limiting Productivity

**TOR Focus:** Regulatory constraints on productivity and investment.

**Paper Contribution:** The paper identifies the ungoverned structure of credit—not planning regulation—as the dominant regulatory distortion affecting productivity.

“In ungoverned regimes, these levers are not coordinated, and credit tends to flow toward housing by default.”

This reframes the issue as a coordination failure between monetary, prudential, and strategic credit settings.

## 5. Investment and Productivity

**TOR Focus:** Capital flows, foreign investment, and barriers to productive investment.

**Paper Contribution:** High  $rT$  crowds out enterprise investment and inflates land values, reducing Australia’s attractiveness for productive capital.

“Credit is more available for enterprise, infrastructure, and innovation under lower  $rT$  settings.”

This directly addresses:

- weak capital deepening,
- low business investment,
- distortions from foreign investment in housing.

## 6. Tax System and Productivity

**TOR Focus:** How taxes distort investment and productivity.

**Paper Contribution:** The paper shows that the largest fiscal distortion is not tax policy but the interest burden created by high  $rT$ .

“These effects strengthen productivity and expand fiscal capacity without requiring subsidies or disruptive intervention.”

Lower  $rT$  increases disposable income, taxable activity, and fiscal resilience.

## 7. Freight, Supply Chains, and Infrastructure

**TOR Focus:** Infrastructure investment and supply chain resilience.

**Paper Contribution:** High  $rT$  reduces both public and private capacity to invest in infrastructure, weakening supply chain resilience.

“A long-run diversion of national income away from... infrastructure and innovation.”

## 8. Productivity in Regional Australia

**TOR Focus:** Regional development, labour mobility, and investment.

**Paper Contribution:** High  $rT$  inflates metropolitan land values, suppressing regional investment and limiting household mobility.

“Stable housing affordability anchored to incomes... restores the conditions under which households can form stable plans.”

## 9. Competition Policy

**TOR Focus:** Competition, innovation, and market dynamism.

**Paper Contribution:** High  $rT$  reduces business formation and competition by crowding out enterprise credit.

“Credit is more available for enterprise... under lower  $rT$  settings.”

## 10. Labour Market Dynamism

**TOR Focus:** Skills, mobility, and structural barriers to labour productivity.

**Paper Contribution:** High  $rT$  suppresses household mobility, risk-taking, and skill investment.

“Households build equity more rapidly... restoring the conditions under which households can form stable plans.”

This links credit structure to:

- labour mobility,
- wage growth,
- skill formation,
- household resilience.

## Recommendations

Based on the structural mechanisms outlined above, the following recommendations are proposed:

1. Establish national credit efficiency metrics, including the rate–term product ( $rT$ ), and report them regularly.
2. Align prudential settings (loan term, LTI, DSR) with long-run productivity and affordability objectives.
3. Introduce a coordinated credit governance framework spanning Treasury, the RBA, APRA, and a new strategic credit authority.
4. Set long-run affordability targets by aligning income deciles with housing quartiles.

5. Gradually transition to lower  $rT$  settings for new lending only, avoiding disruption to existing borrowers.
6. Reallocate credit toward productive enterprise by reducing the share absorbed by speculative housing.
7. Strengthen fiscal capacity by reducing long-horizon interest extraction from household income.

## **Appendix A: Governing Credit Efficiency (Full Report)**

# Governing Credit Efficiency: Aligning Housing Affordability, Productivity, and Fiscal Capacity

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## Abstract

Housing affordability, household leverage, and national productivity are closely linked through the structure of mortgage credit. In many advanced economies, declining interest rates and progressively longer loan terms have increased borrowing capacity and raised house prices relative to income. These dynamics have shifted a growing share of household resources toward long-horizon interest payments, reduced equity formation, and limited the availability of credit for productive investment.

This paper introduces a formal efficiency measure for amortising credit based on the rate-term product  $rT$ , which describes the distribution of repayment flows between interest and principal over the life of a loan. Expressed using continuous compounding, this formulation enables direct comparison of credit structures across countries, time periods, and policy settings. The  $rT$  product provides a tractable lever for analysing affordability, leverage, and systemic exposure, and forms the basis for a unified framework linking monetary, prudential, housing, and fiscal policy.

The paper shows that stabilising or reducing the  $rT$  product can increase the efficiency of credit, accelerate equity accumulation, and moderate the capitalisation of repayment capacity into housing prices. Coordinated adjustment of interest rates, loan terms, and capacity constraints can therefore support both financial stability and the reallocation of lending toward productive investment.

The conceptual framework is demonstrated using representative lending conditions in a range of advanced economies. The findings provide a basis for integrating efficiency considerations into credit regulation and for designing policy interventions aligned with long-run affordability, productivity, and fiscal resilience.

## Key Messages

- **Credit efficiency is measurable.** The rate–term product ( $rT$ ) provides a clear, quantifiable expression of how much income is transferred as interest over time. This enables efficiency to be assessed, compared, and governed.
- **Efficiency is a structural policy variable.** When  $rT$  is allowed to drift, housing affordability, business investment, and fiscal capacity become unstable. When  $rT$  is governed, the structure of credit supports productive economic activity and sustainable home ownership.
- **Housing affordability becomes a design choice.** By aligning credit duration with income capacity, governments can set long-run affordability targets (e.g., aligning income deciles  $D_1$ – $D_{10}$  with housing quartiles  $Q_1$ – $Q_4$ ). Affordability is no longer an emergent market outcome, but a deliberate, transparent policy objective.
- **Productive sectors regain access to capital.** Lower and more efficient  $rT$  settings reduce the share of total credit absorbed by speculative housing. Capital real-locates toward enterprise investment, infrastructure, and innovation, raising long-run productivity and wages.
- **Transition does not require retrospective contract changes.** Efficiency governance applies to new lending flows. Existing borrowers amortise naturally, reducing adjustment risk and avoiding disruptive price shocks.
- **A governed efficiency regime strengthens fiscal capacity.** Reduced household interest burdens increase disposable income and taxable activity. Governments can invest more reliably in public goods without relying on higher debt or austerity.
- **Stakeholder interests are aligned, not opposed.** Households gain stability and agency; lenders gain lower loss volatility; businesses gain access to capital; governments gain fiscal resilience. Efficiency governance supports system-wide cooperation rather than zero-sum competition.

## Executive Summary

Housing affordability, national productivity, and fiscal capacity are often treated as separate policy challenges. This report demonstrates that they are structurally linked through the time structure of credit. The rate–term product ( $rT$ ) expresses the cumulative cost of credit over a loan’s duration and therefore determines how much of household income becomes equity and how much becomes interest.

When  $rT$  is high, households commit decades of future labour to debt service. Borrowing capacity is capitalised into land values, house prices diverge from incomes, and credit is absorbed by speculative housing rather than productive enterprise. This dynamic reduces household resilience, suppresses business investment, and increases demand for fiscal support.

When  $rT$  is governed and average efficiency rises, repayment horizons shorten, equity forms earlier, and a greater share of household income circulates in the real economy. Housing affordability stabilises at levels consistent with incomes, firms face reduced competition for credit, and fiscal capacity expands as less income is transferred into long-horizon interest payments.

This report distinguishes three credit system states: governed, ungoverned, and out of control. In a governed system, efficiency metrics are measured, reported, and aligned with national objectives for affordability, productivity, and fiscal stability. Monetary policy continues to manage interest rates ( $r$ ) for macroeconomic stability, while prudential and strategic regulators calibrate loan term ( $T$ ) to maintain long-run credit efficiency. The rate–term product becomes a coordinated instrument rather than a residual outcome.

The transition to a higher-efficiency regime is gradual and non-disruptive. Adjustments apply to new lending only, allowing existing loans to amortise naturally. Price stabilisation occurs through reduced speculative pressure rather than correction. Wealth formation shifts from leverage-driven appreciation to productivity-driven income and enterprise.

Governed credit efficiency does not restrict markets. It aligns private incentives with public outcomes. By managing  $rT$ , governments can restore stable housing access, strengthen productive capacity, and build fiscal resilience without relying on subsidies, tax increases, or supply shocks.

The structure of credit determines the structure of the economy. Governing credit efficiency is therefore a foundational requirement for long-run economic stability and social cohesion.

## 1 Credit Expansion and Policy Context

Over the past half-century, housing finance has shifted from a marginal component of national financial systems to a dominant macroeconomic force. This section provides a structured overview of that evolution in three parts. First, we trace the long-term expansion of mortgage credit from single-digit shares of GDP to levels approaching or exceeding total annual output in several advanced economies. Second, we examine how the Global Financial Crisis (GFC) exposed the consequences of allowing such credit booms to unfold under weak or misaligned prudential frameworks. Finally, we highlight recent Asian experiences — notably in China and Korea — where targeted macroprudential tools have been deployed to preempt speculative credit cycles and reallocate financing before housing markets destabilise the broader financial system.

Together, these developments illustrate how mortgage credit has moved from the periphery to the centre of macro-financial management, with profound implications for housing affordability, financial stability, and monetary transmission. They also provide the historical and policy backdrop for the structural mechanisms analysed in later sections of this paper.

### 1.1 From Marginal to Macroeconomic: The Long-Term Rise of Mortgage Credit

Over the last half-century, mortgage credit has shifted from a marginal financial activity to a central macroeconomic force. In many advanced economies in the 1950s and 1960s,

outstanding mortgage credit amounted to less than 10% of GDP. Housing finance operated largely through regulated savings institutions and tightly controlled credit channels. Mortgage markets were segmented and often rationed, and housing price dynamics were primarily local and supply-driven [16, 15].

From the 1970s onwards, consolidation, financial liberalisation, securitisation, and the deepening of capital markets triggered a sustained expansion of mortgage credit relative to GDP. By the early 2000s, mortgage credit-to-GDP ratios had reached 60–100% in many advanced economies [3]. This secular drift transformed housing credit from a peripheral activity into a dominant macro-financial variable.

Despite this dramatic expansion, borrower-based prudential limits such as Loan-to-Income (LTI) or Debt-Service Ratio (DSR) caps remained rare or non-binding. Monetary policy frameworks were not designed to address housing price dynamics, and prudential regulators focused primarily on the solvency of individual banks rather than aggregate credit cycles.

This institutional configuration set the stage for the Global Financial Crisis (GFC): a regime in which housing credit volumes had become systemically large, but policy tools remained anchored in a bygone era of low credit-to-GDP ratios and bank-centric oversight.

## 1.2 When Prudential Limits Became Policy-Relevant: Timeline and Evidence

The Global Financial Crisis (GFC) of 2007–2009 was preceded by a prolonged period of easy credit, rapid house price appreciation, and limited prudential constraints on mortgage lending, especially in the United States. Lax underwriting standards, high leverage, and widespread use of adjustable-rate and subprime products fuelled speculative housing booms [12, 7]. Crucially, during this period there were no binding national caps on Loan-to-Income (LTI), Debt-to-Income (DTI), or Debt-Service Ratios (DSR), and supervisory frameworks focused narrowly on bank solvency rather than system-wide credit dynamics.

Some jurisdictions introduced targeted prudential measures even before the GFC. For example, Turkey imposed a 15-year maximum mortgage term in 2007, while Korea had already experimented with LTV and DTI caps in the early 2000s [1, 3]. These were exceptions: most advanced economies lacked binding borrower-based tools prior to the crisis.

The crisis revealed how unconstrained credit expansion, combined with falling interest rates and weak borrower affordability checks, could amplify speculative dynamics and destabilize financial systems. In response, from 2010 onwards, regulators around the world began to introduce a range of explicit prudential instruments—LTI caps, DSR/DSTI limits, serviceability buffers, and term caps—often designed in consultation with the banking sector. These measures were initially calibrated primarily to strengthen bank resilience to shocks, rather than to manage housing affordability or speculative price pressures [3, 1].

A brief timeline illustrates this regulatory shift:

- **Pre-GFC (early 2000s):** Few binding borrower-based measures in advanced economies. Early adopters include Korea (LTV/DTI caps) and Turkey (term caps in 2007).
- **GFC (2007–2009):** US housing bubble bursts; subprime mortgage defaults trigger global financial crisis. Lack of LTI/DSR limits plays a central role [12, 7].

- **Post-GFC (2010–):** Gradual global rollout of borrower-based prudential tools, e.g., Hong Kong (2010), Singapore (2013), Australia (2014–), UK (2014–2017). IMF and BIS document widespread diffusion during the 2010s [11, 13, 6, 2, 3].
- **Pandemic tightening (2020–):** With household credit-to-GDP ratios at record levels, and monetary easing pushing rates to historic lows, these prudential caps became binding for the first time in many jurisdictions, shaping credit allocation and affordability [5, 4].

Initially, these measures had little direct impact on affordability. They were set at levels that ensured bank solvency under stress but were too loose to constrain credit growth in normal times. Over the 2010s, however, sustained credit expansion and lower interest rates brought these limits closer to binding levels. The pandemic-era cycle marked the first period in which these ratios significantly affected affordability and credit growth. This decade-long lag between policy introduction and effectiveness reflects their original purpose: to protect banks, not to moderate house price dynamics.

### 1.3 Asian Anti-Speculation Measures and Credit Reallocation

Following the Global Financial Crisis, several Asian economies moved earlier and more aggressively than their Western counterparts to deploy targeted macroprudential measures to contain speculative housing cycles before they became systemic. Rather than waiting for credit expansion to translate into banking crises, these jurisdictions acted to reshape the composition of credit and damp speculative demand in housing markets.

**China: The “Three Red Lines” and Developer Deleveraging** In 2020, China introduced the so-called “three red lines” policy — a set of balance-sheet thresholds for property developers covering (i) liability-to-asset ratios, (ii) net gearing ratios, and (iii) cash-to-short-term-debt ratios [9]. Developers breaching these thresholds faced binding restrictions on new borrowing.

This policy effectively targeted the *supply-side* of speculative credit cycles by constraining highly leveraged developers rather than households. At the same time, authorities imposed regionally differentiated Loan-to-Value (LTV) and Debt-Service-to-Income (DSTI) caps on households in overheated markets, alongside controls on second-home purchases.

Rather than collapsing aggregate credit, these measures redirected financing towards infrastructure and productive sectors, supporting overall credit growth while slowing house price inflation [8]. The Chinese approach represents a macroprudential attempt to rebalance credit flows away from housing, addressing speculative pressures without triggering systemic banking stress.

**Korea: Regional Caps and DSTI Tightening (2022–2025)** Korea has a long history of employing borrower-based instruments to manage housing credit, including differentiated LTV and Debt-to-Income (DTI) caps by region and borrower profile since the early 2000s [10]. In 2022, in response to renewed speculative pressures, the Korean authorities introduced

region-specific tightening in “speculative zones,” combining lower LTV limits with enhanced DSTI caps.

The most recent tightening round, implemented in July 2025, further reinforced this framework. Key elements included:

- **Lower DSTI caps** for high-income borrowers in overheated regions, tightening qualification for larger loans;
- **Cumulative DSTI** rules that aggregate obligations across multiple properties, closing loopholes used by investors;
- **Shorter maximum maturities** for high-LTV loans in speculative districts.

These measures were explicitly justified in macro-financial terms: to pre-empt speculative credit booms and reallocate credit flows toward business investment. Data from 2023–2025 indicate that while total credit growth remained robust, housing credit slowed markedly, and speculative price appreciation moderated [14].

**Structural Contrast** These Asian experiences stand in sharp contrast to the pre-GFC United States, where rapidly falling interest rates interacted with DSR-style lending to amplify speculative housing price cycles. In China and Korea, by contrast, policy actively rebalanced credit flows away from housing speculation toward productive investment in business and infrastructure.

Rather than focusing solely on bank solvency after the fact, these measures intervene directly in the structural transmission from interest rates to housing prices. Importantly, credit was *reallocated*, not suppressed: overall lending volumes were maintained, but housing ceased to be the dominant sink for new credit creation.

These cases provide a practical policy counterpoint to the structural mechanisms developed in the subsequent sections of this paper, demonstrating how macroprudential tools can reshape credit dynamics before housing markets destabilise the broader financial system.

## 2 Policy Instruments

This section discusses how policy instruments, that can be both a measure and control, influence credit and differ in their design, frequency of application, and institutional oversight. Governments set overall policy and may set access limits. Central banks set the baseline cost of credit through interest rates  $r$  and prudential regulators manage the robustness of the banking through a range of measures including LTV, LTI, DSR, principal caps, and term limits.

Table 1 summarises the main policy instruments within this structural framework, indicating their institutional operators, primary policy targets, and key structural parameters or effects. The table highlights how conventional tools, centred on monetary and prudential objectives relate.

Table 1: Summary of Policy Instruments in Structural Context.

<b>Instrument</b>	<b>Primary Operator</b>	<b>Primary Target</b>	<b>Key Structural Parameters / Effects</b>
Interest Rate ( $r$ )	Central Bank	Macroeconomic stability, inflation	Sets baseline cost of credit; broadly influences consumption, investment, asset valuations, and exchange rates; affects relative cost of domestic vs. foreign borrowing.
Deposit / LTV	Lenders & Prudential	Loss allocation, borrower equity	Determines borrower contribution relative to property value; influences leverage, default risk, and timing of market entry.
Loan-to-Income (LTI)	Prudential	Borrower solvency, leverage	Caps loan relative to income ( $P/Y$ ); limits maximum borrowing and pre-commitment of income.
Debt-Service Ratio (DSR)	Prudential	Borrower cashflow capacity	Limits proportion of income devoted to debt ( $c/Y$ ); links repayments to income and interacts with $r$ and $T$ .
Principal Limits ( $P_{\max}$ )	Prudential / Macroprudential	Concentration risk	Absolute ceiling on loan size; constrains exposure to high-value segments and moderates speculative activity.
Access Limits	Policy / Regulators	Demand management, market participation	Restricts who may acquire property ( $V$ ); shapes market eligibility and reinforces prudential controls.
Loan Term ( $T$ )	Prudential	Maturity risk, repayment structure	Balances repayment stress, principal, and leverage; influences credit allocation, cost of capital, and speculative risk.

Taken together, these instruments form an integrated framework linking monetary policy and prudential regulation. The following subsections examine each tool in turn, outlining its primary function, operational mechanism, and secondary effects.

## 2.1 Interest Rates ( $r$ ) — Monetary Policy

Interest rates are set by independent central banks to achieve national macroeconomic objectives, typically centred on maintaining price stability and managing aggregate demand. Adjustments to  $r$  influence the cost of credit, intertemporal consumption and investment decisions, exchange rates, and broader financial conditions across the economy.

*Primary purpose:* Regulate the pace of economic activity and inflation. Lowering  $r$  reduces the cost of borrowing and encourages investment and consumption, stimulating demand. Raising  $r$  increases borrowing costs, restraining demand and dampening inflationary pressures. This mechanism operates at the level of the entire economy, not any specific sector.

*Secondary impacts:* Because credit conditions affect multiple sectors, persistent changes in  $r$  can influence the structure of credit allocation and relative asset valuations. Extended periods of low interest rates can encourage leverage and shift capital flows toward more interest-sensitive sectors, while higher rates can tighten financial conditions broadly and raise the cost of refinancing.

Figure 1 illustrates the sensitivity of loan principal and repayment composition to changes in the interest rate ( $r = 2.5, 5, 10, 20\%$ ). With annual repayment capacity normalised to unity ( $c = 1$ ), total repayments over the life of the loan equal the term ( $R = T = 30$ ), allowing both principal ( $P$ ) and interest ( $I = R - P$ ) to be expressed directly in time-equivalent units. The difference  $I = T - P$  thus represents the number of repayment years effectively lost to interest.

As interest rates rise, the attainable principal for a given repayment capacity declines sharply, compressing affordability and accelerating equity accumulation. Conversely, lower interest rates increase the principal that can be sustained—but at the cost of a slower transition to ownership, as a larger share of repayments services interest. The asymptotic limit at  $P = 1/r$  marks the boundary of sustainable lending; beyond this point, all repayments are consumed by interest, corresponding to an interest-only loan.

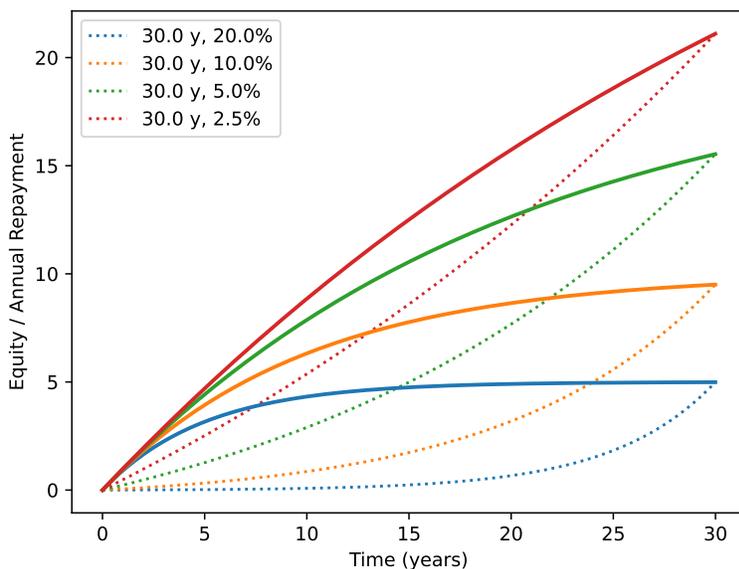


Figure 1: Sensitivity of equity accumulation to **interest rates** expressed relative to annual payments. The *dotted* lines show the trajectories of equity accumulation for the interest rates and loan terms indicated in the legend. The *solid* lines represent the envelope of end points generated by reducing  $T$  from the legend-specified endpoints.

## 2.2 Minimum Deposit / Loan-to-Value ( $D/LTV$ ) — Prudential Tool

Deposit requirements and Loan-to-Value ( $LTV$ ) limits are set by lending institutions, often guided by prudential authorities, to allocate downside risk between borrower and lender. The net principal financed is

$$P_{\text{net}} = V - D = LTV \cdot V,$$

where  $V$  is the property value.

*Primary purpose:* Reduces lender exposure by shifting potential losses from falling property values or borrower default to the borrower. Higher deposits / lower  $LTV$ s decrease the lender's risk of loss.

*Secondary impacts:* Influences household saving behaviour and timing of market entry. Higher deposits or lower  $LTV$ s may delay first-time buyers entering the market, while lower deposits / higher  $LTV$ s increase leverage, overall credit growth, and systemic exposure. Mortgage insurance or government underwriting can partially transfer this risk to third parties.

The effect of this measure can be conceptualised by extending Figure 1 and related figures, incorporating the accumulation of savings required to meet deposit or  $LTV$  constraints. The pre-loan phase would appear as a horizontal extension to the left of the loan's commencement (effectively negative time)—representing the period spent saving before credit activation. This would extend the maximum slope at the origin (1:1) until the absolute value of the deposit is reached, as determined by the  $LVR = P/(P + D)$ . This visualisation encodes deposit accumulation as a structural offset: a pre-loan equity buffer that delays entry, shapes ownership trajectory, and positions  $D/LTV$  not merely as a leverage constraint but as a temporal and liquidity filter on credit participation.

## 2.3 Loan-to-Income ( $LTI$ ) — Prudential Tool

The Loan-to-Income ratio is set by prudential authorities to cap the maximum loan relative to a borrower's annual income:

$$LTI \equiv \frac{P}{Y}.$$

*Primary purpose:* Protect lenders by limiting the total exposure to individual borrowers.  $LTI$  caps ensure loans remain manageable relative to income, safeguarding bank balance sheets.

*Secondary purpose:* As a measure of how much income can be pre-committed to housing debt, it provides an indication of household leverage relative to income. Higher prices and less affordable housing is associated with higher  $LTI$ s and, conversely, more affordable housing is associated with lower  $LTI$ s. While  $LTI$  have historically been used as a control to protect banks, lowering the  $LTI$  limit could potentially be used to decrease leverage and thus increase affordability, if the transitional dynamics could be appropriately managed.

While loan value directly maps as  $P$  in Figure 1 and related figures, income is more difficult to encode.  $LTI$  operates as a primitive filter—assuming that repayment capacity is fully covered by income, without accounting for its internal composition. In practice, income

must also support household essentials, collective essentials (e.g., taxation), forced savings (e.g., superannuation), and discretionary spending/savings/buffer. These components are structurally relevant but not visible in LTI. Their role is explored in the next section on DSR, which reframes income not as a scalar, but as a compositional constraint on repayment capacity.

## 2.4 Debt-Service Ratio (DSR) — Prudential Tool

The Debt-Service Ratio caps the proportion of a borrower's income that can be committed to debt repayments:

$$\text{DSR} \equiv \frac{c}{Y}, \quad (1)$$

The relationship between LTI and DSR is anchored in the principal-to-capacity ratio:

$$\frac{\text{LTI}}{\text{DSR}} = \frac{P}{c} = \frac{1 - e^{-rT}}{r}.$$

*Primary purpose:* Protect lenders by ensuring borrowers do not over-commit income to debt, limiting default risk and maintaining financial system robustness.

*Secondary purpose:* A indication of excess household capacity for other private (essentials, discretion, consumption etc.) or public purposes (taxation). To be effective as an affordability measure, the rate will need to set significantly lower than that required to protect banks and adjust with rates. In this regard, LTI is a more stable measure, but DSR provides the opportunity to adjust affordability settings in the background of changing interest rates.

The effect of this measure can be conceptualised by extending Figure 1 and related figures, interpreting annual mortgage payments (represented by an even slope in the top graph and a horizontal line at 1 in the bottom graph) within the broader context of repayment burdens. Total income may be decomposed into household essentials, collective essentials (e.g., taxation), forced savings (e.g., superannuation), and discretionary spending/savings/buffer. These components would fan radially above the 1:1 repayment slope in the figure visually encoding the structural tension between repayment obligations and income allocation.

## 2.5 Principal Limits ( $P_{\max}$ ) — Prudential / Macroprudential Tool

Principal caps may be set by prudential or macroprudential authorities to place an absolute ceiling on loan size, independent of borrower income or property value. These limits can be uniform or differentiated by region, property type, or borrower category.

*Primary purpose:* Contain lender exposure to high-value loans, mitigating concentration risk and protecting financial institutions from correlated losses in the upper tail of the market. Principal caps also reduce systemic vulnerability associated with large, clustered exposures in premium segments.

*Secondary impacts:* By constraining the maximum amount that can be borrowed, principal caps can dampen speculative activity and moderate price escalation at the upper end of housing markets, where price movements often set benchmarks for the broader market. They may also limit investor concentration in prime locations. Direct affordability effects are typically limited unless the caps are calibrated relative to income or local price levels.

Significantly reduced principal limits can stratify the market into a clearer property ladder, lowering aggregate credit costs and curbing speculative price growth.

While principal ( $P$ ) is structurally encoded in Figure 1 and related figures, it is scaled relative to repayments rather than expressed in absolute terms. Caution is advised when interpreting these figures for absolute principal limits.

## 2.6 Access Limits — Policy / Regulatory Tool

Access restrictions are set by housing authorities, prudential regulators, or governments to determine who may obtain mortgage credit or acquire property. Common instruments include residency or citizenship requirements, owner-occupancy rules, and caps on the number of mortgaged properties per borrower.

*Primary purpose:* Manage demand by controlling speculative, non-resident, or investor participation, ensuring that credit allocation aligns with national housing and financial stability objectives. These measures are particularly important when high leverage limits (e.g., LTI, P, DSR caps) are in place, as they prevent external buyers from circumventing domestic prudential constraints. **To do (??)**

*Secondary impacts:* Redirects credit toward eligible borrowers, typically owner-occupiers, supporting affordability and moderating price growth. Distributional consequences can be significant, particularly if restrictions segment markets or exclude certain groups. Effective enforcement is critical to avoid circumvention through legal or financial loopholes. In open economies, aggressive measures may be required to shield domestic markets from external speculative pressures, preserving the intended effects of prudential limits like LTI caps.

Access limits operate upstream of the repayment figures presented in this document. Functionally, households excluded from ownership are diverted into the rental market, where payments continue but equity does not accumulate. From a structural perspective, this resembles an interest-only loan with infinite term—where repayments flow not to the bank, but to the property owner.

This section focuses on policies that directly exclude market participation. However, whether households are excluded by policy or affordability, the mechanism and outcome are the same. The graphs encode repayment dynamics conditional on credit access; they remain silent on the structural exclusions imposed by insufficient income, deposit, or credit history. For households unable to meet these entry thresholds, repayment capacity is effectively zero, and the ownership trajectory is inaccessible. In such cases, the repayment graph does not bend or flatten—it vanishes.

## 2.7 Maximum Loan Term ( $T$ ) — Prudential Tool

Loan term limits may be established by prudential authorities to cap the duration over which debt can be amortised. This including restricting availability of interest only loans. While commonly expressed in years, Term is more accurately understood as a mechanism of *temporal leverage*—redistributing repayment obligations across time and shaping both borrower behaviour and systemic exposure.

## Primary purpose

Reduce temporal leverage by limiting the horizon over which credit risk and repayment exposure remain outstanding.

## Secondary impacts

- **Increases periodic repayments ( $c$ ):** Shorter permitted terms compress amortisation, raising the periodic repayment required for a given principal.
- **Decreases total repayments ( $R$ ):** Reducing term length lowers cumulative interest payments over the life of the loan.
- **Releases lifetime earnings:** Reduced long-term debt service obligations free household and business income for other uses—consumption, savings, investment, and taxation—strengthening both private and public balance sheets.
- **Decreases maximum principal ( $P$ ):** For a fixed repayment capacity, shorter terms reduce the maximum principal that can be financed, moderating leverage.
- **Stabilises housing affordability:** Shorter permitted terms reduce the demand-side capacity that capitalises future repayment streams into prices, thereby mitigating speculative amplification. Significant tightening of term lengths can constrain access for lower-income borrowers in the short term. Observed affordability depends on policy credibility, market expectations, and complementary measures (e.g., maximum loan size, occupancy requirements, and supply-side adjustments). This dynamic underscores the need for a nuanced framework to balance housing access across income levels.
- **Enhances housing affordability:** Over time, shorter permitted terms accelerate equity accumulation, reduce speculative price amplification, and limit excessive borrowing. As households build ownership faster and credit is redirected toward productive investment rather than leveraged speculation, the effective cost of housing declines and structural affordability improves.
- **Rebalances the wealth effect:** Under shorter lending horizons, wealth accumulation arises from genuine debt reduction rather than speculative asset revaluation, enhancing financial wellbeing without dependence on volatile house price gains. This shift enhances financial wellbeing and reduces dependence on speculative capital gains to sustain consumption or perceived prosperity.
- **Enables withdrawal of distortionary affordability interventions:** By structurally limiting the horizon of credit expansion, shorter permitted terms reduce speculative pressure and restore equilibrium between income and asset values. As affordability improves through disciplined credit dynamics rather than subsidised demand, governments can progressively withdraw distortionary policy supports—such as first-home grants, tax incentives, or relaxed macroprudential thresholds—that previously

inflated prices and fiscal exposure. This transition realigns housing policy with long-term fiscal sustainability and genuine affordability grounded in earned income.

- **Strengthens fiscal capacity for equitable access:** Lower aggregate debt service and higher productivity under shorter credit horizons expand public revenues and private savings. This enhanced fiscal space enables durable support for lower-income households, facilitating inclusive housing access and ownership without reintroducing leverage-driven instability.
- **Rebalances credit allocation:** Constraining term lengths reduces speculative housing demand and redirects credit toward productive or socially beneficial investment.
- **Increases national productivity:** By freeing credit capacity for business, infrastructure, and enterprise, shorter lending horizons support productive capital formation and output growth.
- **Improves bank stability and capital efficiency:** Shorter permitted terms accelerate borrower equity accumulation, reducing cumulative default risk and enhancing loan performance. Banks may face slightly higher periodic repayments for borrowers in the short term, but over time, expected and unexpected loss exposures decline, balance-sheet resilience improves, and capital efficiency rises. Reduced long-term exposure also frees capacity for redeployment toward productive sectors, supporting profitability and alignment with national economic objectives.
- **Moderates asset inflation:** Structural constraints on borrowing reduce long-term speculative amplification in housing and other asset markets.
- **Moderates speculative pressure and risk of collapse:** By constraining the leverage cycle, shorter terms limit the build-up of speculative excess in housing and other asset markets. This reduces the amplitude of boom–bust dynamics, lowering the probability and severity of price corrections and associated balance-sheet stress. In effect, the measure acts as a counter-cyclical stabiliser—preventing systemic fragility from accumulating during prolonged expansions.
- **Strengthens financial stability:** Reduced exposure duration lowers cumulative default risk and enhances balance-sheet resilience, improving systemic stability.
- **Improves intergenerational equity:** Prevents excessive debt burdens from being passed to future cohorts and supports sustainable access to credit and ownership. Mechanistically, longer terms (beyond roughly 25 years) embed intergenerational wealth transfer by enabling present borrowers to capitalise future income streams into higher asset prices, whereas shorter terms constrain valuations to contemporary earning capacity.
- **Summary effect:** Reducing maximum loan term serves as a structural lever that simultaneously moderates speculative demand, enhances long-term affordability, strengthens banking system resilience, and channels credit toward productive investment.

Figure 2 visually encodes many of the secondary impacts listed above, illustrating how Term modulates repayment slope, interest exposure, and ownership accumulation. The figure shows the sensitivity of loan principal and repayment composition to variations in loan term, holding the interest rate constant at 5%. Dotted curves illustrate repayment trajectories for specific terms ( $T = 10, 20, 30, 40$  years), each terminating on the same principal trajectory defined by the solid reference curve. The green curves (30 years at 5%) are consistent across Figures 1,2,5 and 6, providing a stable baseline for comparison.

This presentation highlights how Term governs the temporal distribution of repayment obligations. Longer terms reduce short-term affordability but increase cumulative interest exposure. Shorter terms accelerate ownership but require higher periodic payments.

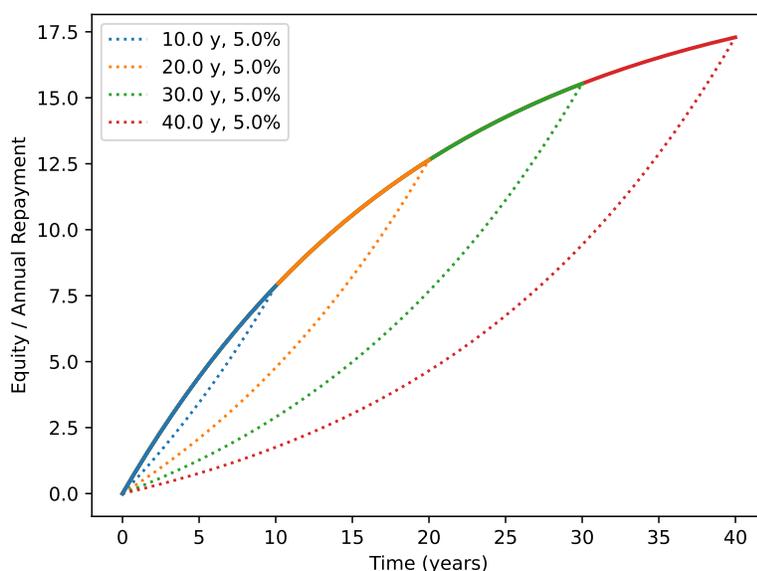


Figure 2: Sensitivity of equity accumulation to **loan term** expressed relative to annual payments. The *dotted* lines show the trajectories of equity accumulation for the interest rates and loan terms indicated in the legend. The *solid* lines represent the envelope of end points generated by reducing  $T$  from the legend-specified endpoints, which approaches asymptotic limit of  $1/r$  as Term increases.

## 2.8 Summary of Measures

The mapping of credit instruments and controls reveals that each operates on distinct components. The interest rate  $r$  governs the price of credit and mediates cost differentials between domestic and foreign capital. Deposit requirements and loan-to-value ratios ( $D/LTV$ ) allocate downside risk between borrower and lender, defining the degree of fiscal leverage within the system. Loan term  $T$  introduces temporal leverage, balancing short- and long-term repayment costs and shaping how credit is distributed across time and sectors. Income-based measures—annual repayment capacity  $c$ , household income  $Y$ , loan-to-income (LTI), and

debt-service ratio (DSR)—anchor repayment capacity to real cashflows, linking affordability to income rather than asset appreciation.

Building on this structural mapping, the following section examines the underlying repayment mechanics in more detail. We distinguish between discrete and continuous formulations of credit obligations, highlighting how repayment timing, interest accrual, and amortisation profiles interact with instrument settings such as  $r$ ,  $T$ , and LTI/DSR.

### 3 Structural Mechanism of Credit

This section considers both the discrete and continuous forms of mortgage compounding — using the discrete form on the LHS and the continuous form on the RHS — and demonstrates how the continuous approximation exposes the underlying structural mechanisms linking affordability, prices, costs, interest rates, and loan term. While the mathematics is classical, this formulation makes the symmetry between interest rates and loan terms transparent, allowing repayment burdens, borrowing capacity, credit efficiency and the cost of capital to be understood and managed using simple, policy-relevant relationships. However, its policy implications are not: when expressed in continuous form, the structure reveals a one-to-one mapping between loan term, rate, and credit efficiency—providing a transparent basis for credit regulation.

#### Repayment Structure

Periodic and annual repayments,  $c$  and  $P$ , respectively, provide a common baseline to consider mortgages and other forms of credit.

$$R_{\text{total}}^{\text{discrete}} = \frac{c}{n} \cdot nT = R_{\text{total}}^{\text{continuous}} = c \cdot T \quad (2)$$

where  $c$  is annual payment,  $n$  is number of payments per year and  $T$  is number of years. Total repayment for both discrete (LHS) and continuous (RHS) forms are identical. Figure 5a shows  $R$  increasing with  $T$  for the trivial case of  $c = 1$ , thus  $R = T$ .

#### Principal

The financed principal  $P$  can be written using the standard discrete amortising formula:

$$P_{\text{discrete}} = \frac{c}{r} n \left[ 1 - \left( 1 + \frac{r}{n} \right)^{-nT} \right] \approx P_{\text{continuous}} = \frac{c}{r} (1 - e^{-rT}). \quad (3)$$

The discrete form (LHS) gives the exact principal for a given repayment capacity  $c$ , rate  $r$ , number of annual repayments  $n$ , and Term  $T$ . While widely used, the discrete form is often *opaque* for policy analysis: it combines interest rate, term, number of payments and Term in a non-linear fashion, making the interaction between monetary policy, repayment capacity, and housing prices difficult to interpret. On the other hand, the continuous form (RHS) approximation<sup>1</sup> can simplify analysis. Figure 5b shows  $P$  across  $T$  and  $r$ . Note how

<sup>1</sup>This approximation is extremely accurate: for a 30-year mortgage at 5% with daily compounding, it differs from the exact discrete calculation by only 0.003%, or about 3 cents per \$1,000 of principal.

leverage increases exponentially with increasing  $T$  and decreasing  $r$ . For a 30-year mortgage at 5%, the total principal that can be borrowed is about 15.5 times annual payment times annual repayment capacity and reduces to 12.6 and 7.9 times, for a  $T$  of 20 and 10 years, respectively.

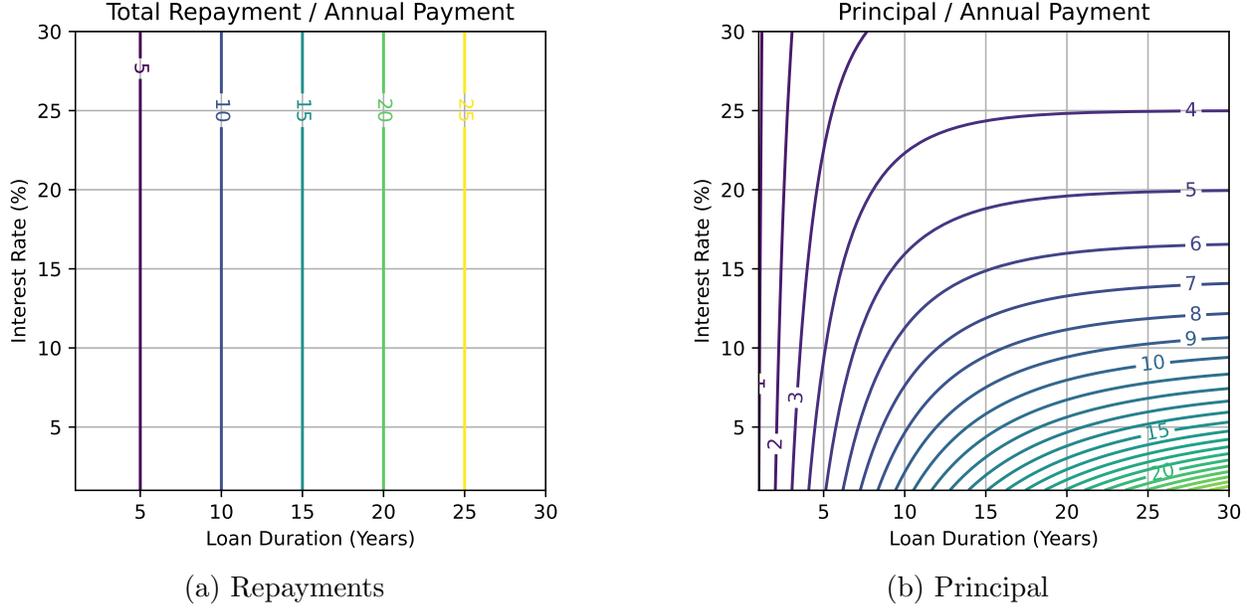


Figure 3: Repayments and repayable principal as multiples of annual repayment over rates and terms indicated.

## Equity

As repayments are made, equity is built up by the repayment of outstanding principal:

$$E(t) = P - P_{\text{remaining}}(t). \quad (4)$$

The build-up of equity is entirely determined by the total principal and the elapsed fraction of the term, making it straightforward to interpret repayment dynamics and policy effects. The equity accumulation mirrors the reduction in principal as the term is shortened, as Figures 1 and 2 illustrate. Equations 3 and 4 can be rearranged to give the following analytical forms:

$$E_{\text{discrete}}(t) = \frac{c}{r} n \frac{(1 + \frac{r}{n})^{nt} - 1}{(1 + \frac{r}{n})^{nT}} \approx E_{\text{continuous}}(t) = \frac{c}{r} \frac{e^{rt} - 1}{e^{rT}} \quad (5)$$

where  $t \in [0, T]$  is the elapsed time.

The discrete form (LHS) gives the exact equity build-up, while the continuous approximation (RHS) provides a smooth, analytically tractable representation that supports analysis.

## Interest

As repayments are made, interest accrues on the outstanding principal. The total interest paid at time  $t$  is the difference between cumulative repayments and equity:

$$I(t) = R(t) - E(t), \quad (6)$$

where  $R(t)$  is the cumulative repayments up to time  $t$ .

Using the discrete and continuous amortisation formulas, the interest build-up can be written analytically as:

$$I_{\text{discrete}}(t) = \sum_{k=1}^{nt} c - E_{\text{discrete}}(t) \approx I_{\text{continuous}}(t) = ct - E_{\text{continuous}}(t), \quad (7)$$

where the sum in the discrete form runs over the  $nt$  payments made up to time  $t$ , and  $ct$  in the continuous approximation represents the total repayments up to time  $t$ .

The discrete form gives the exact interest accrued, while the continuous approximation provides a smooth, analytically tractable representation. Interest accumulation is fastest at the start of the loan, when the outstanding principal is Largest, and slows as equity builds, reflecting the decreasing interest component of each payment over time.

## Credit Efficiency

The efficiency of credit, like other dynamic systems, can be defined as the ratio of outputs to inputs ( $\varepsilon = \text{output} / \text{input}$ ). For a loan, the output is the *equity* that builds up, and the input is the *cumulative repayments*. Thus, the *accumulated efficiency* of credit at time  $t$  is the ratio of equity accumulated to cumulative repayments:

$$\bar{\varepsilon}(t) = \frac{E(t)}{R(t)}, \quad t \in [0, T]. \quad (8)$$

Using the amortisation formulas for equity and repayments, substituting 5 and 2 into 8 gives:

$$\bar{\varepsilon}_{\text{discrete}}(t) = \frac{1}{rt} \frac{(1 + \frac{r}{n})^{nt} - 1}{(1 + \frac{r}{n})^{nT}} \approx \bar{\varepsilon}_{\text{continuous}}(t) = \frac{1}{rt} \frac{e^{rt} - 1}{e^{rT}}. \quad (9)$$

These expressions depend only on the interest rate  $r$ , the loan term  $T$ , and— for the discrete form (left-hand side)—the number of compounding periods  $n$  per year. While the discrete form remains opaque, the continuous approximation greatly simplifies analysis and reveals a hidden symmetry in  $r$  and  $T$ : from a credit efficiency perspective, only the rate-Term product  $rT$  matters. An incremental increase in  $r$  can be offset by an equivalent proportional decrease in  $T$ , and vice versa, demonstrating the structural substitutability between rate and term. Given this, the continuous form is adopted for further analysis.

The *instantaneous efficiency* of credit measures how effectively each infinitesimal repayment at time  $t$  contributes to equity:

$$\varepsilon(t) = \frac{E'(t)}{R'(t)}. \quad (10)$$

For linear repayment accumulation,  $R(t) = ct$  with constant rate  $c > 0$ , differentiation gives:

$$E'(t) = c[\bar{\varepsilon}(t) + t\bar{\varepsilon}'(t)], \quad (11)$$

and dividing by  $R'(t) = c$  yields

$$\varepsilon(t) = \bar{\varepsilon}(t) + t\bar{\varepsilon}'(t), \quad t \in [0, T]. \quad (12)$$

Substituting the continuous form of  $\bar{\varepsilon}(t)$  from 9 and differentiating gives:

$$\varepsilon(t) = e^{-r(T-t)} = \frac{e^{rt}}{e^{rT}}. \quad (13)$$

At the start of the loan, instantaneous and accumulated efficiencies coincide, so using 13:

$$\varepsilon_0 = \bar{\varepsilon}_0 = e^{-rT}. \quad (14)$$

At the end of the loan, instantaneous efficiency approaches unity as final repayments are almost entirely principal, however the accumulated efficiency depends on the initial efficiency:

$$\varepsilon_T = 1, \quad \bar{\varepsilon}_T = \frac{1 - \bar{\varepsilon}_0}{rT}. \quad (15)$$

At high  $rT$  values, initial efficiency becomes negligible and term efficiency approaches  $\bar{\varepsilon}_T \approx 1/(rT)$ . In this regime, almost all repayments are initially interest, so the annual repayment  $c$  approaches the nominal interest on the principal,  $c \rightarrow r$ . Consequently, total repayments  $R = cT \sim rT$ , recovering the simple linear scaling of the cost multiplier  $\bar{\varepsilon}_T^{-1} \approx rT$ , independent of the detailed amortisation schedule.

### Cost of Credit

The inverse of credit efficiency provides a measure of the inefficiency or *cost of credit*:

$$\varepsilon^{-1} = \frac{R}{E} = 1 + \frac{I}{E} \quad \Rightarrow \quad \text{repayments per unit equity (1-}\times\text{)}$$

This dimensionless multiplier expresses the repayments required per unit of equity accumulated. Conceptually, the cost of credit reflects the systemic “friction” of borrowing: it quantifies how much repayment effort is dissipated as interest rather than converted into ownership. The accumulated and instantaneous cost of capital and boundary conditions can be determined from the reciprival of equations 9, 13, 14 and 15.

### Rate–Term Product

As efficiency and cost of capital of the credit system can be fully determined from the  $rT$ , the inverse relationship can be expressed from the initial and term efficiencies using the natural logarithm and nonlinear Lambert  $W$  function, respectfully:

$$rT(\varepsilon_0) = -\ln(\varepsilon_0), \quad \varepsilon_0 \in [0, 1]$$

and

$$rT(\bar{\varepsilon}_T) = \frac{1}{\bar{\varepsilon}_T} + W_0\left(-\frac{e^{-1/\bar{\varepsilon}_T}}{\bar{\varepsilon}_T}\right), \quad \bar{\varepsilon}_T \in [0, 1]. \quad (16)$$

where:

- $\varepsilon_0$  is initial efficiency—either instantaneous or accumulated.
- $\bar{\varepsilon}_T$  is accumulated term efficiency and
- $W_0(\cdot)$  denotes the principal branch of the Lambert  $W$  function, which solves  $z = W(z)e^{W(z)}$ .

### Examples of Efficiency, Cost of Capital and rate–Term product

Table 2 presents the corresponding credit efficiency and cost-of-credit values for a range of  $rT$ , with implied annual rates for notional terms of 10, 20 and 30 years. The bold cells highlight key thresholds in the credit efficiency–cost relationship. The first four rows illustrate how specific  $rT$  values can be chosen to target initial or term efficiencies of 10%, 50% and 75%. The final three rows show that at very high  $rT$  values the cost of credit ( $\bar{\varepsilon}_T^{-1}$ ) asymptotically approaches  $rT$  from above. These thresholds, also marked on Figure 4, provide intuitive landmarks for interpreting how rapidly borrowing credit efficiency deteriorates as rate or term increase.

$rT$	$\varepsilon_0, \bar{\varepsilon}_0$	$\bar{\varepsilon}_T$	$\varepsilon_0^{-1}, \bar{\varepsilon}_0^{-1}$	$\bar{\varepsilon}_T^{-1}$	r (T=10)	r (T=20)	r (T=30)
0.61	54.6%	<b>75.0%</b>	1.8×	1.3×	6.1%	3.0%	2.0%
0.69	<b>50.0%</b>	72.1%	<b>2.0×</b>	1.4×	6.9%	3.5%	2.3%
1.59	20.3%	<b>50.0%</b>	4.9×	<b>2.0×</b>	15.9%	8.0%	5.3%
2.30	<b>10.0%</b>	39.1%	<b>10.0×</b>	2.6×	23.0%	11.5%	7.7%
<b>3.00</b>	5.0%	31.7%	20.1×	3.2×	30.0%	15.0%	10.0%
4.00	1.8%	24.5%	54.6×	4.1×	40.0%	20.0%	13.3%
5.00	0.7%	19.9%	148.4×	5.0×	50.0%	25.0%	16.7%

Table 2: Initial and term efficiencies and cost of capital for amortising loans at selected  $rT$  levels. Implied annual rates are the solutions to  $rT$  for the stated term  $T$ .

Let us consider  $rT = 1.59$  (equivalent to a 30-year loan at approximately 5.3%<sup>2</sup>) in detail to draw out the policy implications. The  $rT = 1.59$  row was chosen to achieve an *accumulated* efficiency target of 50% (and hence an accumulated cost of credit  $\bar{\varepsilon}_T^{-1} = 2\times$ ) via equation 16. Under these assumptions, if the loan is repaid on schedule, half of total repayments over the 30-year term are interest and half are principal.

This average cost of credit applies across the entire household budget during the loan term. For every dollar, peso, or pound of income that flows through the household—earned, taxed, saved, spent, or wasted—the bank receives the same amount again in interest over the duration of the loan. Whether it is a tax payment, a grocery bill, a school fee, or a new pair of shoes, any money not directed toward reducing principal ultimately sustains the interest burden for longer. From a household perspective, the loan quietly doubles the monetary cost of everything: every outflow carries an unseen twin, a matching amount of lifetime interest. It is not that the bank takes half of each paycheck directly, but rather that the cost of credit

<sup>2</sup>This notional rate is illustrative; actual effective rates depend on prevailing central bank policy, lending margins, inflation expectations, opportunity costs, and the realised loan period.

spreads invisibly across every transaction—on average, half of all economic effort over the loan term goes simply to holding the debt in place.

Yet the burden is not uniform over time. At the beginning of the loan, due to compounding over the full term, the effective leverage is far greater: for  $rT = 1.59$ , the residual multiplier  $\varepsilon^{-1}(0) = e^{rT} \approx 4.9$ .

Thus, every dollar, peso, or pound of household expenditure near the beginning of the loan ultimately drives about five times that amount in total repayments by the time the loan is fully settled. The spare room, the nicer car, the new curtains, the housewarming party—all effectively cost five times their sticker price over the life of the loan. Even large unavoidable costs are magnified: an upfront 5% stamp duty on acquisition implies, in nominal total repayments, an effective burden of about  $5 \times 5\% = 25\%$  of the property value by the time the loan is repaid.

Conversely, the same mechanism works in reverse. Every dollar *not* spent, every discount negotiated, and every unnecessary expense avoided near the beginning of the loan has a magnified long-term benefit. A dollar saved at purchase is not merely a dollar kept—it compounds through the entire credit structure, reducing total repayments by roughly five dollars over the life of the loan. Bargaining the price down, skipping a luxury upgrade, or delaying non-essential renovations therefore delivers a multi-fold gain in eventual equity. Credit amplifies both waste and prudence: the same exponential that punishes excess also rewards restraint. Yet while the mathematical effects are symmetrical, the risks are not—overstretching early can jeopardize financial stability, whereas restraint only strengthens it.

Figure 4 visualises these relationships over the loan term for different  $rT$  levels. The top and bottom rows show credit efficiency and cost of credit, respectively, while the left and centre columns show instantaneous and accumulated values. These four graphs depict the profiles of each measure over the term of the loan for the rate-Term products indicated in the legend. Note that all measures start at the same initial value, but instantaneous values reach 1 (or 100%) at the end of the loan, whereas accumulated values converge to the average over the term. These boundary points are shown in the right-hand column across rate-Term products, with the underlying equations indicated in the legend and markers corresponding to bold values from Table 2.

Plotting both credit efficiency and its inverse (the cost of credit) allows both extremes to be considered simultaneously. Values that appear compressed in the credit efficiency view are expanded in the cost-of-credit view: for example, a reduction in credit efficiency from 10% to 5% corresponds to an increase in the cost of credit from roughly  $10\times$  to  $20\times$ . Regardless of the measure, the curves vary smoothly, change monotonically, and exhibit saturation effects and asymptotic behaviour at high  $rT$ .

Beyond the mathematics, these curves reveal the real-world implications for households. Small differences in early-term credit efficiency translate into disproportionately large differences in lifetime repayments: a minor reduction in credit efficiency due to a higher rate or longer term can dramatically increase the cost of credit, amplifying the financial burden of every dollar spent. Conversely, any early saving—whether from negotiating a lower purchase price, avoiding unnecessary upgrades, or deferring non-essential expenses—compounds over the loan term, effectively reducing total repayments by multiple times the initial outlay. By visualising both instantaneous and accumulated measures alongside their inverses, the figure

illustrates how credit amplifies both waste and prudence, highlighting the critical importance of early-term decisions for long-term household financial outcomes.

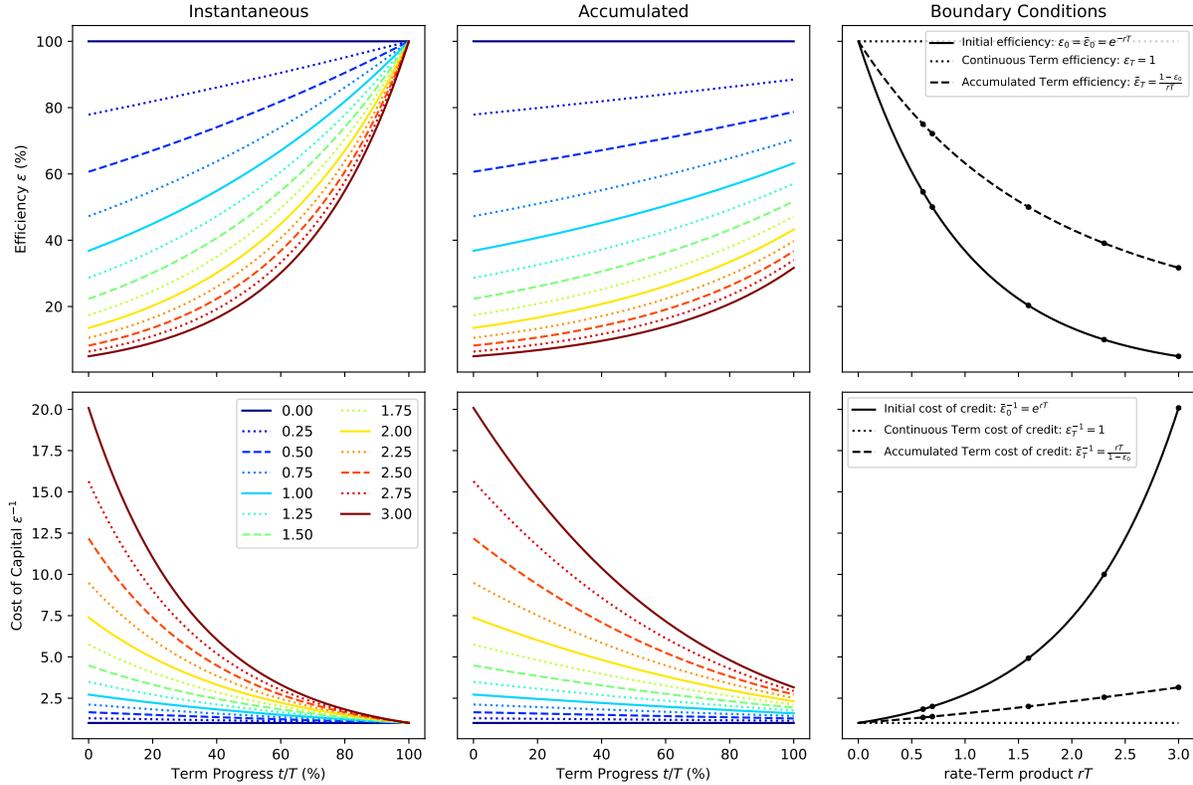


Figure 4: Instantaneous and Accumulated Efficiency and Cost of Capital over Term for indicated  $rT$  and boundary conditions.

### Principal, Housing Prices, and Affordability Under Coordinated Credit Conditions

A key implication of the amortisation identity

$$P = \frac{c}{r} (1 - e^{-rT})$$

is that, when the credit system maintains a stable rate-term product  $rT$ , the efficiency factor  $(1 - e^{-rT})$  becomes effectively constant. In this regime,

$$P \propto \frac{c}{r}, \quad \text{and therefore} \quad V \propto P \propto \frac{c}{r},$$

where  $V$  denotes the price that households can bid for housing. This proportionality creates a direct transmission channel from policy choices to housing prices and, ultimately, to affordability. To keep housing prices stable when interest rates move, four distinct policy levers must operate in a coherent sequence:

1. **Monetary policy (the interest rate  $r$ ).** Changes in the policy rate adjust the macroeconomic stance but also directly alter the capacity of households to capitalise future repayments into present housing prices. Because  $P \propto 1/r$  under stable efficiency, movements in  $r$  require compensation elsewhere in the system to avoid house-price volatility.
2. **Credit efficiency targets (the rate–term product  $rT$ ).** Since  $r$  and  $T$  enter only through their product, policymakers can offset rate movements by adjusting term (i.e. temporal leverage) to maintain a stable credit efficiency and cost of credit. Stability in  $rT$  prevents the amortisation structure itself from amplifying interest-rate cycles.
3. **Repayment-capacity standards (the allowable repayment flow  $c$ ).** Lending guidelines—such as debt-service-to-income caps, buffer rates, or income stress tests—control the stream of repayments that can be pledged. Because  $P \propto c$ , tightening or loosening these standards moves housing prices proportionally.
4. **Fiscal leverage standards (loan-to-value and equity requirements).** LTV constraints determine the size of the deposit needed to access credit and therefore calibrate the effective leverage in the housing market. These rules shape the distributional and financial-stability consequences of price movements.

Taken together, these four levers determine the level and stability of housing prices and the affordability of borrowing. When all components adjust in a coordinated manner, the principal that households can obtain—and hence the prices they can bid—remains stable even as interest rates change. However, any gap in this chain of adjustments causes mechanically amplified movements in  $P$  and  $V$ , generating housing-price volatility, accelerating price levels during easing cycles, and producing affordability pressures during tightening cycles.

In short, monetary policy alone cannot stabilise housing outcomes. Price stability in the housing market requires an explicit credit-efficiency target (stable  $rT$ ), supported by repayment-capacity and fiscal-leverage standards that move in concert with the policy rate. Without this coordination, interest-rate cycles propagate directly into house prices, household balance sheets, and the cost of living.

## Policy Implications

The structural relationships outlined above reveal two key transmission channels for policy:

- $rT$  determines *credit efficiency* and *cost of capital*. Any combination of  $r$  and  $T$  yielding the same  $rT$  produces identical repayment profiles over the term, allowing regulators to manage credit conditions through interest rates and loan terms.
- The ratio  $c/r$  determines *borrowing capacity* and thus property price potential.

Coordinated policy across these levers enables governments, central banks, and prudential regulators to target affordability and credit conditions transparently: central banks set  $r$  for macroeconomic purposes, regulators can adjust  $T$  to manage the cost of capital, and fiscal or housing policy can shape  $c$  through income, subsidies, or caps. Once  $rT$  is stabilised,

property prices respond primarily to changes in  $c/r$ , making the transmission mechanism from credit to housing prices explicit.

The next section builds on the prior section by considering how credit efficiency measures and cost of capital can be used to assess credit how rate-Term can be used to balance national productivity and housing affordability.

## 4 Efficiency and Cost of Credit Measures

The efficiency of credit  $\varepsilon$  and its inverse, the cost of credit  $\varepsilon^{-1}$ , quantify the structural efficiency of loan repayment.

These dimensionless ratios provide two complementary perspectives:  $\varepsilon$  indicates the fraction of total loan repayments that actually build principal (ownership), while  $\varepsilon^{-1}$  expresses how many units of repayment are required per unit of principal. By making the relationship between repayments and ownership explicit,  $\varepsilon$  and  $\varepsilon^{-1}$  serve as intuitive measures of credit efficiency.

### Primary purpose

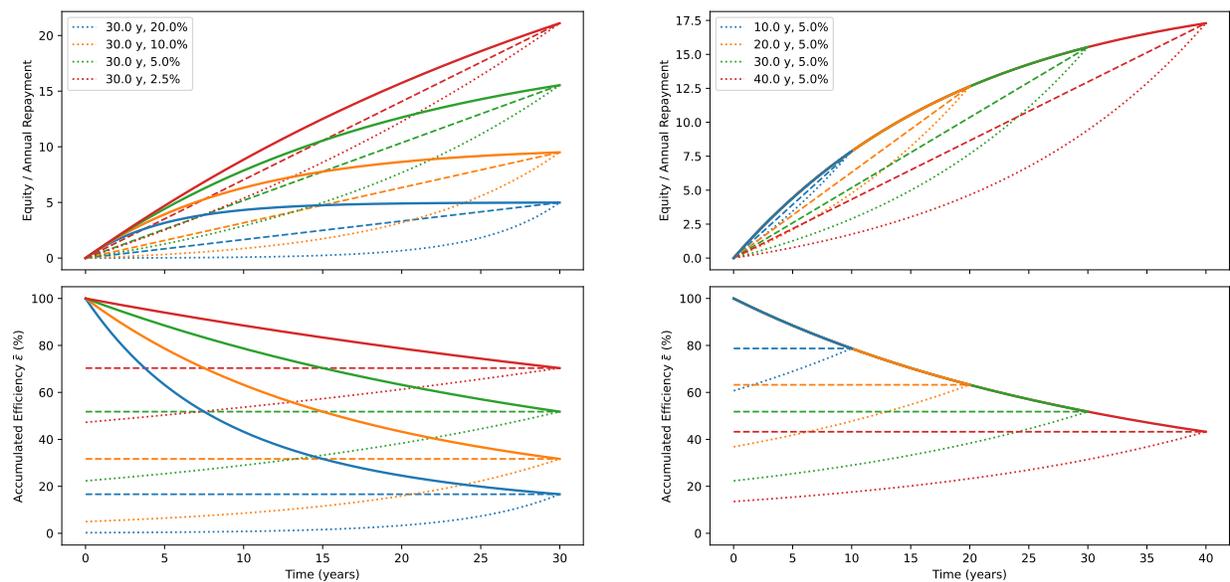
To provide transparent, structural measures of credit efficiency that can be interpreted by borrowers, analysts, and policymakers alike.

### Secondary impacts

- **Transparency of Credit Efficiency:**  $\varepsilon$  shows how much of each repayment contributes to principal rather than interest, revealing loans that are structurally inefficient.
- **Household Affordability Awareness:** By quantifying the share of repayments going to the lender versus equity,  $\varepsilon$  provides a clear, intuitive measure of true credit efficiency and effective cost of credit.
- **Illustrating Interest Burden:**  $\varepsilon$  and  $\varepsilon^{-1}$  make it immediately apparent when interest dominates repayments, showing the structural cost of borrowing independent of market price appreciation.
- **Decision-Making Guidance:** Borrowers can use  $\varepsilon^{-1}$  to judge how efficiently their repayments convert into ownership and how many times over additional features, rooms or other early costs are paid for in interest over the life of the loan, is it twice, three time, perhaps four or five times?
- **Equity Accumulation Visibility:**  $\varepsilon$  highlights the rate at which principal accumulates over time, offering a straightforward metric of ownership progression.
- **Credit Efficiency Assessment:**  $\varepsilon$  directly measures the fraction of repayments consumed by interest, providing a structural efficiency metric across different loan terms and rates.

- **Affordability Benchmarking:**  $\varepsilon$  and  $\varepsilon^{-1}$  provide a standardised metric for comparing loans across interest rates, terms, or repayment capacities.
- **Portfolio and Market Diagnostics:** Aggregated  $\varepsilon$  values can reveal systemic exposure to high-cost credit, over-leveraging, or front-loaded interest structures across segments or regions.
- **Credit Risk Monitoring:** Low  $\varepsilon$  can flag loans that are effectively interest-only or otherwise high-risk, providing early warning signals for potential default.
- **Policy and Strategic Communication:**  $\varepsilon$  and  $\varepsilon^{-1}$  provide intuitive, transparent measures that policymakers can use to communicate the efficiency and cost of credit to the public, supporting informed decision-making and regulatory messaging.

These measures are illustrated by the dashed lines in Figure 5 where each unique combination of interest rate ( $r$ ) and loan term ( $T$ ) produces a distinct repayment signature—defined by the corresponding  $\varepsilon$  and  $\varepsilon^{-1}$ . These ratios vary with the loan’s principal ( $P$ ) and total repayments ( $R$ ), allowing direct comparison of credit efficiency and equity accumulation across regimes. As shown in the figures, longer terms flatten the repayment slope and delay equity build-up, while higher rates compress borrowing power.  $\varepsilon$  and  $\varepsilon^{-1}$  distill these dynamics into structural ratios, making credit efficiency legible across policy settings.



(a) Varying interest rates.

(b) Varying loan terms.

Figure 5: Sensitivity of **equity accumulation** (top - leaf shape) and **credit efficiency** (bottom - beak profile) to **interest rates** and **loan term**, with equity expressed relative to annual payments. The *dotted* lines show the trajectories for the interest rates and loan terms indicated in the legend. The *solid* lines represent the envelope of end points generated by reducing  $T$  from the legend-specified endpoints. The *dashed* lines represent the overall credit efficiency of the loan  $\bar{\varepsilon}$ .

## National Credit Efficiency and Macroeconomic Drag

Having defined the structural efficiency of credit through the  $\varepsilon$  and its inverse, the cost of credit  $\varepsilon^{-1}$ , these measures can now be aggregated across an economy to assess national credit efficiency. At the macro level, the aggregate stock of housing credit ( $P_{\text{national}}$ ) and prevailing average loan characteristics (interest rate  $r$ , term  $T$ ) together define a nation's systemic credit efficiency and the associated macroeconomic drag imposed by interest costs.

**Accumulated Efficiency** The accumulated efficiency of a nation's housing credit system can be approximated as:

$$\bar{\varepsilon}_{\text{national}} \approx \frac{1 - e^{-rT}}{rT}, \quad (17)$$

where  $r$  is the average mortgage rate and  $T$  the average term. This dimensionless measure captures the fraction of total repayments that contributes to ownership versus interest over the life of the loans.

The efficiency of the credit system can be estimated from the distribution of rates and terms via 17. In many advanced economies, this accumulated efficiency is currently around 50%.

**Macroeconomic Interpretation** At the national level, the total interest burden on housing can be estimated from the total credit exposure  $P$  (often expressed as a fraction of GDP) and prevailing mortgage rates:

$$I = rP, \quad \text{typically expressed as a \% of GDP.}$$

In several advanced economies, household mortgage debt approaches 100% of GDP, with typical loan terms around 30 years, nominal rates of 5–6%, and accumulated efficiency of roughly 50%. At these levels, about 5–6% of national income is annually diverted to interest payments, and a similar share toward principal repayment. Collectively, approximately 10% of GDP is absorbed by a sector that, while generating some productive activity, mainly redistributes wealth rather than creating net new output—a leveraged, largely self-determining segment of the economy.

This demonstrates how individual credit efficiency scales across the nation: low efficiency combined with long-term, high-leverage credit creates a persistent macroeconomic drag, linking household debt conditions directly to systemic fiscal and economic exposure.

### Structural Implications

- **National Efficiency Benchmarking:**  $\varepsilon$  provides a unified measure to compare the structural efficiency of housing credit systems across countries and over time.
- **Financial Friction Quantification:**  $1 - \varepsilon$  quantifies the share of repayments dissipated as financial cost, representing a measurable economic drag.
- **Policy Leverage:** Reducing  $rT$  (via lower rates or shorter terms) directly improves  $\varepsilon$ , lifting credit efficiency and freeing GDP for productive use.

- **Systemic Productivity Link:** Each percentage point improvement in national  $\varepsilon$  translates into a proportional release of credit flow from interest cost into equity accumulation and consumption.
- **Macroprudential Insight:** Economies with high household debt-to-GDP and low  $\varepsilon$  ratios are structurally exposed to greater macro drag, lower consumption multipliers, and higher financial fragility.

**Summary** The efficiency of national housing credit is not a matter of price or preference but of structure. By reframing credit conditions in terms of  $\varepsilon$  and  $rT$ , policymakers can measure, compare, and optimise national housing finance systems in the same way that engineers evaluate energy efficiency — identifying where systemic waste can be reduced to improve total economic performance.

## Cross-country Illustration

Table 3 summarises key mortgage parameters and derived structural metrics for selected advanced economies, with columns scaled to national GDP to illustrate the implied macroeconomic exposure.

Country	$r$	$T$	$P/\text{GDP}$	$rT$	$\bar{\varepsilon}_T$	$\bar{\varepsilon}_T^{-1}$	$\varepsilon_0^{-1}$	$I/\text{GDP}$	$E/\text{GDP}$	$c/\text{GDP}$
Australia	6.27%	30	112.7%	1.88	45.1%	2.22×	6.6×	7.1%	1.3%	8.3%
United States	6.90%	30	68.3%	2.07	42.2%	2.37×	7.9×	4.7%	0.7%	5.4%
South Korea	4.12%	30	89.5%	1.24	57.4%	1.74×	3.4×	3.7%	1.5%	5.2%
United Kingdom	5.00%	25	75.9%	1.25	57.1%	1.75×	3.5×	3.8%	1.5%	5.3%
Germany	3.68%	20	49.4%	0.74	70.8%	1.41×	2.1×	1.8%	1.7%	3.5%
Japan	1.50%	30	64.4%	0.45	80.5%	1.24×	1.6×	1.0%	1.7%	2.7%

Table 3: Cross-country comparison of housing credit efficiency and macroeconomic exposure.  $rT$  links rate and term into a single measure of affordability and credit efficiency. Credit stock, interest cost, and total repayment effort are expressed as shares of national GDP.

**Interpretation.** The table highlights two interacting sources of inefficiency: (1) the *structural inefficiency of credit*, captured by ( $rT$ ) and credit efficiency ( $\varepsilon$ ); and (2) the *macroeconomic amplification* of these inefficiencies through the scale of mortgage credit relative to GDP.

Countries such as Japan and Germany combine low  $rT$  values with moderate credit stocks, yielding high credit efficiency and limited macroeconomic drag. By contrast, Australia and the United States exhibit both high  $rT$  values and large credit exposures relative to GDP, producing a dual compounding effect in which household-level inefficiency scales up to a national-level burden.

Managing  $rT$ —particularly through *term policy*—thus provides a structural lever for improving credit productivity and limiting the proportion of national income absorbed by

housing-related debt service. Such measures represent the practical domain of social intervention: restraining systemic credit expansion, rebalancing repayment structures, and restoring alignment between financial flows and productive output.

The following section examines  $rT$  as a measure—linking monetary and prudential policy within a single framework for credit control.

## 5 Rate–Term Product ( $rT$ ) — Strategic Structural Lever

The dimensionless product of the interest rate and loan term,  $rT$ , captures the inherent symmetry between  $r$  and  $T$  in determining the cost of credit:

$$R = P \frac{rT}{1 - e^{-rT}} \Rightarrow \varepsilon \text{ and } \varepsilon^{-1} \text{ are functions of } rT.$$

This symmetry implies that rate and term are structurally interchangeable in shaping credit efficiency. Although currently unregulated,  $rT$  effectively isolates the structural cost of new loans from short-term monetary policy, providing a high-level lever for guiding credit allocation and affordability.

### Primary Purpose

The primary function of  $rT$  is to serve as a single, dimensionless lever for managing the structural cost, duration, and risk of credit. By constraining or calibrating  $rT$  across loan segments, policymakers can directly align affordability, leverage, and equity formation with long-term economic and social objectives—without distorting monetary or prudential mandates.

### Regulatory Architecture — Complementary Roles

Effective management of the  $rT$  relies on coordination across four complementary policy domains, each with distinct responsibilities:

- **Fiscal Authority (Government):** Sets overarching social and economic objectives to ensure a functional, purposeful society. Through taxation, public investment, transfers, and regulatory oversight, fiscal policy supports social cohesion, resilience, productivity and other high level objectives. Governments shape the broad framework within which credit and financial policy operate, without prescribing operational details.
- **Monetary Regulator (Central Bank):** Manages liquidity, exchange-rate stability, and inflation. Focuses on short- to medium-term macroeconomic equilibrium, using interest-rate policy to maintain price and currency stability.
- **Prudential Regulator (Financial Stability Authority):** Safeguards institutional soundness, capital adequacy, and systemic resilience. Implements capital buffers and lending standards to constrain credit risk, without directly setting structural affordability or loan-term limits.

- **Strategic Regulator (Credit Allocation Commission):** Aligns long-term national priorities—productivity, housing affordability, credit efficiency, intergenerational equity—with differentiated  $rT$  settings. Operates orthogonally to monetary and prudential regulators, managing the *structure* of credit rather than its *volume* or *risk*, linking credit creation to social and economic outcomes.

This architecture ensures that fiscal objectives provide the guiding mandate, monetary and prudential regulators maintain stability and resilience, and the strategic regulator shapes credit structure to achieve long-term social and economic goals.

### Structural and Policy Impacts of $rT$ Control

By setting and enforcing segmental  $rT$  targets—translated into permissible loan terms or product designs—a Strategic Regulator can channel new lending toward a desired credit efficiency frontier. Acting on the *flow* of credit rather than the stock,  $rT$  control provides a durable mechanism for structural transformation, cohort by cohort.

- **Macro–Micro Signalling:** Establishes a visible, credible commitment to manage the structural cost of credit, aligning expectations and behaviour with long-term affordability and productivity.
- **Structural Steering Capacity:** Provides a programmable lever to realign the efficiency of newly originated credit across an interest-rate cycle.
- **Cyclical Efficiency Realignment:** Enables regulators to progressively improve credit efficiency over full interest-rate cycles by adjusting loan terms as rates fall—lowering  $T$  to maintain or reduce  $rT$  and lift structural efficiency. This grants regulators durable structural power to shape affordability trajectories across cycles.
- **Decoupling from Monetary Cycles:** Stabilises credit conditions independently of short-term rate volatility, enhancing policy precision.
- **Integrated Policy Coordination:** Aligns monetary, fiscal, and prudential instruments within a unified structural framework.
- **Systemic Risk Containment:** Constrains the leverage–duration frontier before excessive exposure accumulates.
- **Temporal Resilience:** Calibrates repayment horizons and rollover cycles to maintain balance across economic generations.
- **Social and Political Stability:** Aligns credit structures with productive contribution, reinforcing fairness, legitimacy, and intergenerational equity.

## Structural Dynamics of the Rate–Term Product

Figure 6 illustrates how  $rT$  governs both equity accumulation and the structural efficiency  $\varepsilon$  of repayments.

Along each dashed  $rT$  line, the scale-invariant leaf shapes and beak profiles (top and bottom graphs, respectively) show that the distribution of repayments between equity and interest is determined by  $rT$  rather than the absolute rate or term. Critically, the  $rT$  value sets both the **efficiency of the initial payment**  $\varepsilon_0$ —visible as the  $y$ -intercept in the bottom graph—and the **accumulated efficiency**  $\bar{\varepsilon}_T$ —represented by the slope and endpoint of the dashed line. By imposing a minimum  $rT$ , regulators set a structural floor on credit efficiency, constraining both initial equity contribution and total interest burden.

Comparing across  $rT$  levels highlights the systemic impact of credit conditions: lower  $rT$  (0.5) accelerates equity accumulation and reduces total repayment burden, typical  $rT$  (1.5) reflects current lending practices, and high  $rT$  (4.5) illustrates extreme, potentially unsustainable combinations (e.g., 30 years at 15% or 15 years at 30%). The figure demonstrates how adjusting terms and rates to manage  $rT$  can strategically shape affordability, equity formation, and systemic risk.

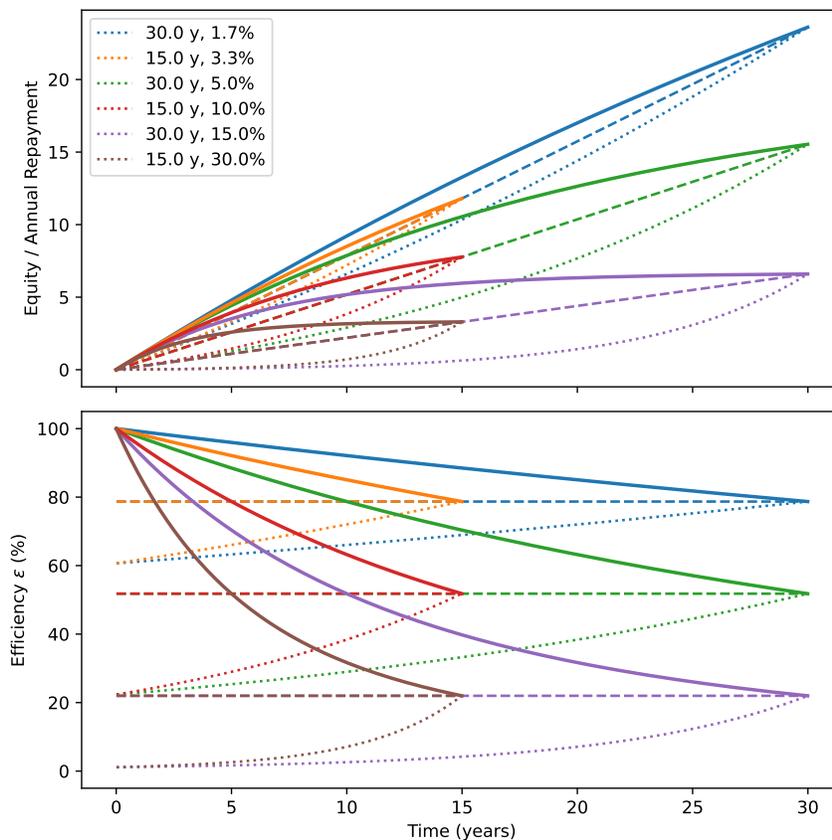


Figure 6: Sensitivity of equity accumulation (top — leaf-shaped) and repayment composition (bottom — beak-profile) to the **rate-term product** ( $rT$ ), with equity expressed relative to annual payments. The *dotted* and *dashed* lines show, respectively, the trajectories of equity accumulation and overall credit efficiency for the interest rates and loan terms indicated in the legend. The *solid* lines represent the envelope of end points generated by reducing  $T$  from the legend-specified endpoints. The  $y$ -intercept in the bottom panel reflects the efficiency of the first repayment  $\varepsilon_0$ , while the dashed line captures accumulated efficiency  $\bar{\varepsilon}_T$ —both structurally governed by  $rT$ .

Figure 7 demonstrates the dynamic behaviour of  $rT$  over a full monetary cycle under real-world conditions, using Bank of England policy rates and observed UK mortgage terms. The top row shows how interest-rate movements determine the baseline price of credit, while  $rT$  reflects the structural conditions under which that credit is extended. The bottom row shows the resulting implications for borrowing capacity, allowable loan term, and credit efficiency. By holding a minimum credit efficiency condition ( $\bar{\varepsilon}_T$ ) constant, the coloured curves illustrate how adjustments to  $rT$  act as a structural counterweight to interest-rate movements. When rates rise, maintaining credit efficiency requires shorter terms and reduced principal capacity; when rates fall, the same condition limits excessive leverage. This coordinated behaviour reveals  $rT$  as an independent policy axis: one that does not replace monetary policy, but modulates its transmission into asset prices and systemic exposure.

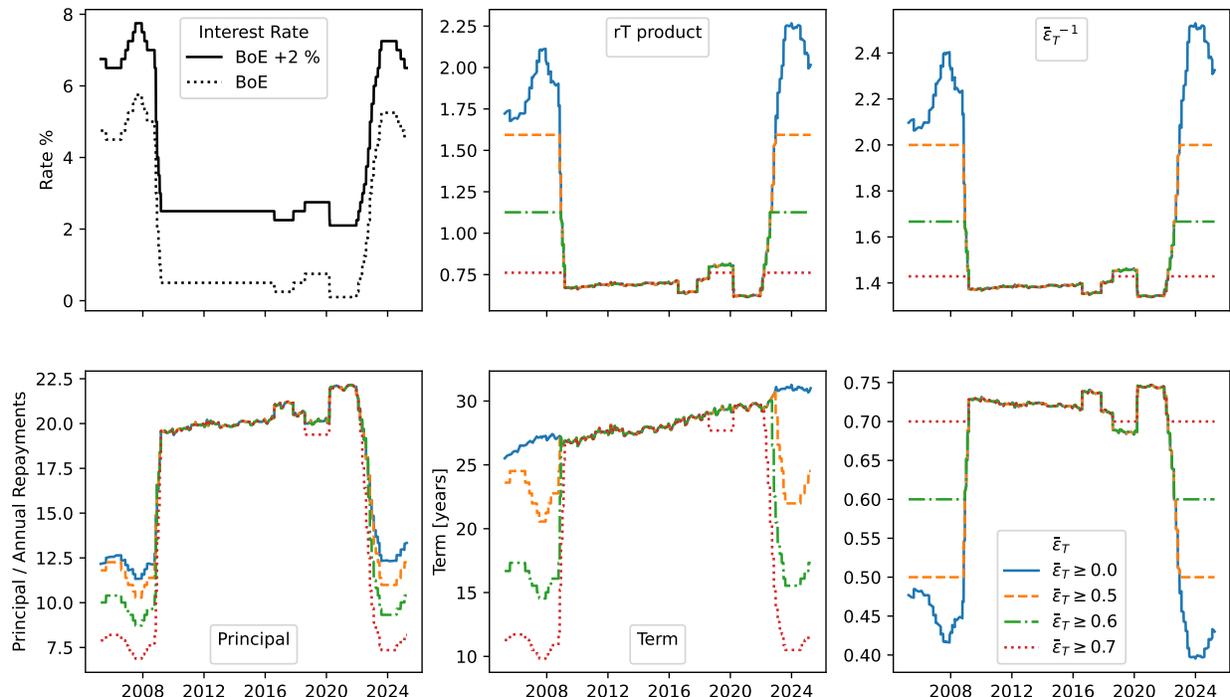


Figure 7: Composite illustration of monetary, structural, and borrowing-capacity measures under  $(rT)$  framework across a full interest-rate cycle (2005–2025). Panels show: (top row) the Bank of England policy rate (plus 2% lending margin), the resulting  $rT$ , and the accumulated cost of credit; and (bottom row) the corresponding principal capacity, allowable loan term, and accumulated efficiency. Coloured curves indicate alternative minimum credit efficiency settings ( $\bar{\varepsilon}_T \ge \{0, 0.5, 0.6, 0.7\}$ ).

At the structural level, the proposed *credit efficiency metrics*— $\varepsilon$  and its inverse  $\varepsilon^{-1}$ —quantify the underlying efficiency of the credit system. The *control lever*  $rT$  provides the mechanism to actively steer that efficiency. By managing the composite  $rT$  rather than rate or term in isolation, governments and regulators can stabilise the effective cost of capital, decouple affordability from short-term interest fluctuations, and align credit structures with long-term productivity, equity, and social objectives.

The following section explores how policy settings—through targeted  $rT$  calibration—can reshape credit efficiency, affordability, and macro-financial balance.

## 6 Credit Efficiency-Based Policy Measures and Controls

Once credit efficiency can be measured and expressed through  $rT$ , it becomes possible to treat credit efficiency as a policy variable rather than an emergent consequence of market conditions. The objective is not to restrict lending or suppress economically rational prices, but to ensure that the temporal structure of borrowing aligns with long-run income capacity, productive investment, and social priorities.

In this framing, the efficiency of credit becomes a transmission channel linking household balance sheets, credit allocation, national productivity, and fiscal stability. Systematic adjustment of  $rT$ —primarily through the term dimension—provides a mechanism to stabilise borrowing capacity across the rate cycle, reduce speculative price amplification, and lower the long-horizon drag associated with low-credit efficiency debt structures.

## 6.1 System States and Credit Allocation Outcomes

Policy Pillar	Governed (Active Efficiency Control)	Ungoverned (Emerging Controls)	Out of Control (Reactive Oversight)
Fiscal Authority	Sets objectives for productivity, affordability, and social cohesion; aligns taxation and budget with economic capacity	Provides general fiscal guidance without structural alignment; reactive measures to address affordability; partial erosion of productivity and fiscal capacity	Reactive or absent oversight; credit trends disconnected from structural objectives; social housing pressures escalate; fiscal capacity collapses
Monetary Regulator	Controls interest rates to maintain macro stability; integrates policy with credit efficiency targets to avoid speculative amplification	Focuses on inflation/price stability; interest rates may inadvertently amplify credit cycles and speculative flows	Short-term rate policy dominates; systemic leverage largely ignored; speculative credit flows unchecked
Prudential Regulator	Adjusts Term, LTV, DSR, and capacity rules in line with efficiency targets; monitors sectoral exposures proactively	Maintains standard capital and liquidity buffers; sectoral imbalances may grow; metrics reported but not systematically linked to structural objectives	Reactive enforcement; systemic leverage and correlated risks unmanaged; retrospective tightening increases volatility
Strategic Regulator	Actively sets differentiated credit efficiency targets across sectors in accordance with national objectives and monetary policy, ensuring affordability, credit efficiency, and equity	Partial management; credit efficiency metrics reported; active control introduced but not consistently applied or fully aligned with national objectives	Not established; no structural oversight of credit allocation or distribution; credit system operates without systemic guidance
<b>Impact Summary</b>	Stable affordability, sustainable productivity, systemic resilience	Moderate instability; uneven affordability; limited credit efficiency gains	Speculative boom-bust cycles; fiscal strain; high systemic risk

Table 4: Comparison of governance across the four policy pillars under three characteristic credit efficiency regimes: Governed, Ungoverned, and Out of Control. The final row summarises the aggregate impact on social, economic, and systemic outcomes.

Taken together, Tables 4 and 5 illustrate how the efficiency of credit allocation functions as a structural determinant of economic and social outcomes. The first table focuses on the institutional configuration of policy authority: how fiscal, monetary, prudential, and strategic regulators interact to shape the rate–term structure of credit. The second table traces the consequences of those institutional settings through the real economy by examining how credit is ultimately distributed across infrastructure, productive enterprise, housing, households, and the fiscal system.

In the *governed* regime, credit efficiency is treated as a managed policy variable rather than a passive outcome of market dynamics. The temporal structure of borrowing is aligned with national objectives, such as sustainable housing affordability, productive investment, fiscal resilience, and social mobility. Under this regime, credit flows reinforce rather than

Policy Pillar	Governed (Active Efficiency Control)	Ungoverned (Emerging Controls)	Out of Control (Reactive Oversight)
Infrastructure (Enabling Investment)	Stable, predictable financing; credit available for strategic national projects; long-term returns optimised	Uneven funding; some projects delayed or scaled back; financing subject to market volatility	Severely constrained; projects postponed or cancelled; infrastructure backlog grows; social and economic development impaired
Business (Productive Output)	Substantial allocation; credit directed to investment, innovation, and working capital; supports national output; enables globally competitive industries	Moderate allocation; significant diversion to housing; productive investment constrained; domestic focus	Limited allocation; capital crowded out by housing debt; productivity stagnates; underinvestment threatens future growth
Housing Market (Unproductive Activity)	Moderate share of total credit; efficiently amortising; rents and ownership stabilise at affordable levels without uncompetitive wage inflation	High share of credit; mostly inefficient; significantly speculative; unsustainable household leverage; unaffordable without intervention	Dominant share of credit; speculative boom/bust cycles; unaffordability attracts national attention; unsustainable household debt; compounding systemic risks
Household Capacity (Essentials, Consumption, Investment)	Stable and predictable; households can meet essential needs, consume sustainably, and invest in productive activities; work for pleasure	Moderately constrained; essential consumption maintained, but discretionary spending and investment partly crowded out; work to live	Severely constrained; high debt service limits consumption and investment; household financial resilience impaired; economic migration; work to survive
Fiscal Capacity (Taxation / Public Investment)	Robust and predictable; tax receipts and transfers aligned with economic activity; sustainable public programs; capacity to support external priorities	Moderate strain; fiscal resources partly absorbed by speculative credit-driven inflation; programs constrained; debt required for crisis management	Severe strain; credit-fuelled asset inflation erodes real tax capacity; public spending squeezed; social programs underfunded; persistent deficits
Aggregate Impact	Balanced, resilient economy; stable asset prices; long-term productivity growth; manageable household debt	Partial instability; rising inequality; credit inefficiency; moderate systemic risk	Crisis-prone economy; boom-bust cycles; low productivity; high household debt; fiscal instability

Table 5: Illustrative allocation of credit, investment, and fiscal capacity across major economic domains under three credit efficiency regimes: Governed, Ungoverned, and Out of Control.

undermine economic stability: households accumulate equity faster, productive sectors gain access to capital, infrastructure investment proceeds predictably, and monetary policy operates without amplifying housing cycles.

By contrast, the *ungoverned* regime resembles current conditions in many developed economies. Here, credit markets function without explicit constraints on duration or credit efficiency. While institutions remain nominally intact, policy levers operate in isolation rather than coordination. Housing absorbs a disproportionate share of total credit, business investment is partially crowded out, and fiscal capacity is gradually eroded as tax revenues struggle to keep pace with debt-driven asset inflation. The system remains functional, but

increasingly fragile.

In the *out of control* regime, the reinforcing loop between credit expansion and asset prices overwhelms the stabilising capacity of both households and the state. Housing leverage dominates the financial system, business investment stagnates, infrastructure renewal stalls, and fiscal systems are forced into structural deficit. This condition is historically associated with financial crises, forced deleveraging, and political instability.

These regimes are not ideological alternatives but structural equilibria. Economies with ungoverned and out-of-control credit dynamics tend to converge toward volatility, stagnation, and widening inequality, while economies that manage the efficiency of credit allocation tend to sustain productive investment, affordability, and institutional resilience. The tables therefore highlight a simple but foundational principle:

*The structure of credit determines the structure of the economy.*

Accordingly, the policy objective is not to suppress lending, inhibit housing markets, or distort price formation. Rather, the aim is to *govern the temporal efficiency of credit* so that borrowing supports long-run income capacity, productive investment, and social stability. A governed regime aligns private financial incentives with public economic objectives. It does so not by eliminating market forces, but by ensuring that intertemporal leverage remains consistent with the capacity of households and the state to bear it.

In this regard, the governed economy is not a departure from market logic—it is the condition under which markets remain functional, productive, and socially coherent.

## 6.2 Strategic Governance: The Desired End State

The preceding analysis outlined three levels of credit efficiency governance; this section describes what governance *enables*. Rather than treating affordability, productivity, and fiscal capacity as separate policy issues, an credit efficiency-based framework shows them to be linked expressions of the same underlying mechanism: the structure of long-term credit.

The desired end state is not defined by any specific level of house prices, wages, or taxation. It is defined by a different *shape* of the economy. In a governed credit efficiency regime, households, businesses, and public institutions have greater agency and stability because the long-term structure of credit supports real economic activity rather than amplifying speculative cycles. Housing markets reflect fundamentals of income, location, and quality. Wealth is formed through production and contribution, not through rising leverage.

### 6.2.1 Collective Choice and Social Cohesion

Credit efficiency governance is not automatic; it requires deliberate collective choice. The costs of the current regime—strained budgets, long commutes, delayed household formation, reduced mobility, and widening intergenerational divides—are often experienced privately, and therefore mistaken for individual misfortune rather than structural design.

Once it is recognised that these pressures arise from a credit system that channels competition into land values rather than productive output, the core question becomes normative rather than technical:

*Do we want a society in which stable housing and a meaningful life are widely attainable, or one in which access depends primarily on accumulated advantage?*

A governed regime corresponds to the former. It supports:

- households living near work and community
- families with time and stability rather than chronic financial pressure
- mobility driven by opportunity rather than displacement
- intergenerational continuity rather than divergence

In such a system, housing prices reflect what can be sustainably paid from income under efficient credit terms. Housing returns to its role as a social and economic foundation rather than a vehicle for extractive wealth transfer.

### 6.2.2 Household Agency and Financial Freedom

In the current regime, long-duration lending at high cumulative interest requires households to pledge decades of future income in advance. This raises prices, reduces resilience, constrains occupational choice, and often forces work to serve debt rather than capability or contribution.

When credit efficiency is measured, reported, and governed, this dynamic changes. Lower  $rT$  settings and shorter effective repayment horizons:

- accelerate equity formation
- reduce lifetime interest expenditure
- increase the share of income available for living rather than servicing debt

The result is increased *agency*: individuals gain real discretion over how they use their time, where they live, and how they engage in work and community. Housing becomes a stable platform for life choices rather than a binding constraint that determines them.

### 6.2.3 Housing Affordability as a Deliberate Policy Outcome

Under an credit efficiency-governed framework, housing affordability becomes a controllable, long-run policy variable rather than a market by-product. The focus shifts from *What will the market produce?* to *What affordability level supports social and economic objectives?*

This can be operationalised by linking:

- income distribution (deciles  $D_1$ – $D_{10}$ ) to
- housing cost distribution (price quartiles  $Q_1$ – $Q_4$ ).

For example, essential workers ( $D_3$ – $D_5$ ) may be targeted to access stable housing in  $Q_2$ – $Q_3$  within reasonable commute. The gap between current conditions and this alignment guides both the *pace* and *approach* of adjustment. Affordability becomes a design parameter rather than a residual outcome.

### 6.2.4 Economic Output and Productive Capacity

As less income is transferred as interest over long horizons, real economic capacity expands. Households consume, invest, and educate; firms gain access to capital for productive purposes; infrastructure can be financed in line with national development priorities.

Wealth formation shifts:

- from speculative appreciation based on leverage,
- to durable productivity based on wages, output, and enterprise.

Society does not become poorer—wealth becomes *real*.

### 6.2.5 Fiscal Capacity and Shared Prosperity

Lower household interest burdens increase taxable activity and reduce the need for reactive fiscal support. Governments gain the capacity to invest consistently in shared public goods:

- health and care systems
- education and skills formation
- strategic and connective infrastructure
- environmental resilience and climate adaptation
- research, innovation, and industry development

A society with stable housing, stronger household balance sheets, and productive credit allocation is more resilient internally and more capable of constructive engagement externally.

### 6.2.6 Summary

The governed end state is not defined by constraint. It is defined by:

- greater household agency
- stable and attainable housing
- productive rather than speculative wealth formation
- stronger fiscal foundations
- a society able to plan confidently and act generously

The following sections show how  $rT$  calibration enables this transition and how the adjustment path can be implemented gradually while maintaining the interests of all major stakeholders.

### 6.3 From Affordability Targets to System-Level Benefits

Once affordability is treated as a long-run strategic objective rather than a market by-product, the role of credit policy shifts from passive accommodation to structural design. The credit efficiency-based framework does not attempt to set prices directly; instead, it shapes the *conditions under which prices form*, by determining how much credit can be extended over what period of time. This aligns borrowing capacity with incomes and real productivity, rather than with speculative expectations.

Under a governed credit efficiency regime, the level of affordability becomes a choice variable. Jurisdictions can articulate explicit target alignments between income deciles ( $D_1$ – $D_{10}$ ) and housing price quartiles ( $Q_1$ – $Q_4$ ). The gap between the desired steady state and current conditions then informs the required *pace and approach* of adjustment through  $rT$  policy. In this way, affordability policy becomes transparent, evidence-based, and democratically visible: society defines the housing distribution it intends to deliver, and the credit system is calibrated to achieve it over time.

Crucially, the implications extend beyond affordability alone. When the temporal structure of credit is governed efficiently, four broader system-level domains benefit simultaneously:

1. Household balance sheets stabilise and wealth formation becomes faster and more broadly distributed.
2. Financial stability improves as correlated exposure to long-duration mortgage risk declines.
3. Productive sectors regain access to capital previously crowded out by speculative housing credit.
4. Fiscal capacity strengthens as interest-transfer leakage reduces and taxable economic activity expands.

These are not secondary effects — they are the systemic mechanisms through which affordability, productivity, and social stability reinforce one another. The following section formalises these linkages by examining the *strategic outcomes* of  $rT$  calibration and the dynamics of the transition path toward a governed high-credit efficiency steady state.

### 6.4 Strategic Outcomes of $rT$ Calibration

Calibrating  $rT$  provides policymakers with a structural lever that operates at the level of credit design itself. Unlike short-cycle interest rate adjustments, which influence demand indirectly and often unevenly,  $rT$  calibration shapes the *time structure of repayment*. This determines how quickly borrowers build equity, how much of each repayment is transferred as interest, and how strongly borrowing capacity feeds into asset prices.

By adjusting  $rT$ , the credit system can be aligned with desired long-run affordability, productivity, and financial stability outcomes. Lower and more efficient  $rT$  settings accelerate equity formation and reduce speculative amplification in housing markets, while simultaneously improving the resilience of household and bank balance sheets. In parallel, shorter,

more efficient credit structures free capital for productive investment, increasing output and employment without requiring higher leverage or fiscal expansion.

The strategic effects of  $rT$  calibration therefore unfold across four interconnected domains:

- **Affordability and Household Balance Sheets**
  - Moderates price escalation and stabilises borrowing capacity.
  - Accelerates equity accumulation and reduces long-run interest burden.
  - Lowers probability of negative equity and improves financial resilience.
- **Financial Stability and Prudential Outcomes**
  - Shortens exposure duration and reduces correlated default risk.
  - Increases risk-adjusted returns through lower loss volatility.
  - Anchors prudential controls (LTV, DSR, LTI) to a stable structural base.
- **Credit Allocation and Productivity**
  - Redirects lending from speculative housing to enterprise and infrastructure.
  - Raises total factor productivity and employment through investment-led growth.
  - Strengthens national output by reducing unproductive capital extraction.
- **Fiscal and Macroeconomic Capacity**
  - Reduces long-term household interest transfers to the financial sector.
  - Expands taxable economic activity and fiscal headroom.
  - Enhances monetary transmission and stabilises the credit cycle.

## 6.5 Dynamic Transition and Structural Rebalancing

The transition toward a lower average  $rT$  regime should be conceived as a continuous structural rebalancing process rather than a discrete policy shock.

Because  $rT$  embeds both cost and duration, gradual adjustment allows credit conditions to converge toward equilibrium without destabilising existing portfolios or borrower expectations.

In the early phase, reductions in permissible  $rT$  values primarily affect new lending flows rather than outstanding stock as the transition applies only to new credit issuance. Existing contracts amortise naturally and no retrospective changes are required. This ensures that existing loan contracts amortise naturally, while marginal credit creation shifts incrementally toward shorter, more efficient structures. As new credit issuance aligns with reduced temporal leverage, the aggregate composition of system-wide exposure progressively contracts in duration and volatility.

Over the medium term, as shorter-term credit becomes the norm, equity accumulation accelerates and speculative pressure in housing markets declines. The rate of principal recovery

within each loan increases, strengthening household and bank balance sheets simultaneously. Liquidity turnover increases as shorter credit cycles return principal more quickly, expanding the supply of lendable funds without increasing leverage.

Once equilibrium between asset prices, incomes, and repayment capacities is re-established,  $rT$  settings can stabilise around a steady-state value consistent with long-run productivity growth and sustainable affordability. At this point, credit allocation operates as a balanced system: household borrowing no longer competes destructively with enterprise credit, and financial intermediation once again supports real economic output rather than speculative inflation.

In this sense, the dynamic management of  $rT$  functions as a structural thermostat for the credit economy—lowering temporal leverage when systemic imbalances emerge, and maintaining equilibrium between affordability, risk, and productivity once stability is restored.

## 6.6 Stakeholder Roles and Expected Outcomes

The objective of efficiency-based credit reform is not to reduce lending or suppress market prices, but to ensure that the time structure of repayment aligns with long-run income capacity, productive investment, and social stability. Each stakeholder maintains their core function within the credit system. The changes arise in *incentives* and *balance sheet dynamics*, not in the availability of credit itself. Table 6 summarises these effects in terms of what each group values and how those interests are preserved or strengthened.

Importantly, transitioning to a governed credit efficiency regime does not eliminate market choice or reduce the role of private lenders. It reshapes incentives so that core interests are preserved while systemic risk is reduced.

This table illustrates that a structurally lower  $rT$  regime does not undermine the fundamental interests of any stakeholder. Instead, it aligns incentives, reduces systemic risk, and redirects credit toward productive uses while enhancing access, profitability, and social stability. By clarifying how fears translate into manageable adjustments, the framework demonstrates that credit efficiency-based policy can achieve durable financial, social, and economic outcomes without disruptive shocks.

### Aggregate Assessment

A coherent reduction in average  $rT$  across the lending system reallocates financial capacity from speculative asset growth to productive investment. The result is a more stable financial core, enhanced housing affordability, and higher long-run national productivity. Although short-term credit expansion slows, system-wide risk declines and the credit efficiency of each borrowed dollar increases. In aggregate, lenders become safer, households more resilient, and economies more balanced—delivering higher welfare per unit of leverage.

## 6.7 Implementation Pathways

The governance of credit efficiency operates across multiple scales, each with distinct responsibilities and levers. Global institutions set expectations for equitable development,

Stakeholder	Core Interests	Common Concern	Outcome Under Lower Average $rT$
<b>Households</b>	Secure housing, manageable repayments, wealth accumulation.	Fear of being priced out or forced into rent indefinitely.	Housing remains attainable, equity accumulates faster, repayment risk falls, and price growth stabilises around income—not speculative momentum.
<b>Lenders (Banks)</b>	Stable margins, reliable repayment flows, manageable default risk.	Fear that shorter terms reduce profit or loan demand.	Expected losses fall faster than interest income; risk-adjusted returns improve; balance sheets become more stable; lending volumes remain healthy but less volatile.
<b>Businesses and Firms</b>	Access to affordable investment credit; predictable capital conditions.	Fear of being crowded out by housing credit cycles.	Credit is rebalanced toward productive sectors; long-term investment becomes easier to finance; wage and output growth strengthen.
<b>Developers and Builders</b>	Predictable demand and financeable project pipelines.	Fear that moderated borrowing will collapse prices and reduce sales.	Market shifts to stable, income-anchored demand; construction cycles smooth; viability increases due to lower financing costs and reduced land speculation pressure.
<b>Government and Fiscal Authorities</b>	Economic stability, tax base resilience, social cohesion.	Fear of political consequences from altering housing incentives.	Fiscal space increases as interest transfer leakage declines; housing access improves over time; systemic risk falls; policy becomes preventative rather than reactive.

Table 6: Key stakeholder interests, perceived risks, and realised outcomes under a lower average  $rT$  regime.

sustainability, and credit access, providing overarching principles that guide societal priorities. Super-national entities contextualise these expectations, coordinating policies that affect cross-border flows, regional stability, and shared economic interests. At the national level, authorities establish minimum credit efficiency standards, define glide paths for achieving long-term objectives, and set other key targets such as fiscal capacity and affordability thresholds. Sub-national jurisdictions adapt and implement these standards, tailoring measures to regional conditions and priorities. Ultimately, local governments carry the responsibility for maintaining community cohesion, ensuring that housing supply, demand, and tenure structures align with both societal and local objectives. This multi-level framework recognises that while credit efficiency governance is a structural and systemic pursuit, the outcomes are realised at the community level, where households live, work, and invest.

- **Global:** sets expectations for equitable development, sustainability, and fair credit access; establishes overarching norms and principles to guide policy at lower levels.
- **Super-national:** provides external context by coordinating cross-border fiscal, eco-

conomic, and security policies; ensures regional stability and alignment with global standards (e.g., EU, OECD, IMF, WTO).

- **National:** defines minimum credit efficiency standards and glide paths; establishes macroeconomic, fiscal, and housing targets; provides metrics and enforcement mechanisms for consistent policy application.
- **Sub-national:** implements region-specific measures within national standards; tailors term-based interventions, lending constraints, and tenure incentives to local conditions and priorities.
- **Local:** ultimately responsible for local cohesion; manages housing supply, approvals, property taxes, and community programs to ensure D/Q alignment and that housing outcomes meet societal and local needs.

### Roles, Levers, and Local Calibration

Operationalising efficiency governance requires clear roles, available levers, and careful calibration to jurisdictional conditions. Loan term ( $T$ ) adjustments complement interest rate ( $r$ ) settings and can be applied at any level. Examples of levers include:

- Communication and guidance to shape borrower and lender expectations.
- Maximum or minimum term limits for new lending.
- Taxes or incentives tied to mortgage transfers or speculative ownership.
- Rate adjustments linked to loan type, borrower profile, or social objectives (e.g., first-home buyers, essential workers).

Authorities may tune interventions to achieve strategic objectives that reflect community or regional priorities. For instance, a city may encourage affordable housing to attract younger households, supporting intergenerational stability and broader economic vitality. Costs and trade-offs can be aggregated across jurisdictions to maintain fiscal sustainability, ensuring credit efficiency-based measures reinforce rather than undermine broader objectives.

This structure ensures that credit efficiency is governed intentionally across all scales, providing flexibility for local adaptation while maintaining coherence with overarching societal, economic, and fiscal goals. It also allows for gradual, transparent adjustment of the  $rT$  to support household agency, productive investment, and long-term social cohesion.

With roles, levers, and calibration defined across all levels of governance, the system is positioned to translate credit efficiency objectives into actionable policies; the following recommendations outline practical steps to operationalise this framework and achieve the desired high-credit efficiency, socially coherent end state.

## 7 Recommendations

1. **Recognise the systemic linkages:** Affordability, productivity, and fiscal capacity are interdependent outcomes of credit efficiency. Acknowledge that ungoverned credit dynamics amplify housing stress, reduce productive investment, and constrain fiscal flexibility.
2. **Introduce efficiency metrics:** Develop and standardise measures such as rate-Term product, credit efficiency and cost of credit. Metrics are essential to diagnose structural inefficiencies and enable governance.
3. **Enhance household and societal agency:** Policies should aim to reduce long-term debt burdens and accelerate equity formation, giving households greater freedom in life, work, and consumption decisions.
4. **Adopt a coordinated, multi-pillar framework:** Align national objectives, monetary policy, prudential term/capacity limits, and fiscal policy. Coordination ensures that interventions reinforce each other rather than create unintended distortions.
5. **Set explicit affordability and productivity targets:** Define acceptable repayment burdens, housing price distributions, and sectoral credit allocation objectives. Targets should be evidence-based, measurable, and reviewed periodically.
6. **Calibrate monetary policy strategically:** Interest rate policy should focus on macroeconomic stability and productive investment, avoiding unintended amplification of speculative asset prices.
7. **Adjust loan term and capacity limits prudently:** Prudential authorities should use term ( $T$ ) and borrowing capacity ( $c$ ) tools to guide affordability, maintain financial resilience, and ensure productive credit flows are not crowded out.
8. **Operationalise multi-level governance:** Implement levers consistently across global, super-national, national, sub-national, and local levels to ensure cohesion between over-arching objectives and local housing outcomes.
9. **Monitor, report, and adapt dynamically:** Continuous observation of credit flows, housing prices, household balance sheets, and sectoral allocations is essential to fine-tune policies and maintain alignment with targets.
10. **Communicate objectives and expectations:** Clear messaging to lenders, borrowers, and the public is critical to align behaviours with credit efficiency targets and build confidence in the governance framework.

## 8 Conclusion

Housing affordability, financial stability, and macroeconomic independence are tightly linked through mortgage credit structures. By recognising the structural role of repayment capacity,

loan terms, and interest rates, policymakers can implement coordinated interventions that enhance housing affordability, productivity and fiscal capacity.

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## A Comparative Statics of Continuous-Form Principal

For analytical transparency, this appendix uses the continuous-form principal

$$P(r, c, T) = \frac{c}{r} (1 - e^{-rT}),$$

which closely approximates the exact discrete-form calculation. The discrete form is algebraically more cumbersome: derivatives with respect to interest rate or term are opaque and offer little additional insight for policy analysis. By contrast, the continuous form exposes the structural role of the product  $rT$  and makes the scaling of principal with repayment capacity  $c$  and interest rate  $r$  immediately apparent.

**General partial derivatives.** The derivatives with respect to each variable are

$$\begin{aligned} \frac{\partial P}{\partial c} &= \frac{1 - e^{-rT}}{r}, \\ \frac{\partial P}{\partial r} &= \frac{c}{r} \left[ T e^{-rT} - \frac{1 - e^{-rT}}{r} \right] \\ \frac{\partial P}{\partial T} &= c e^{-rT}. \end{aligned}$$

Even in this simple continuous form, the derivative with respect to  $r$  is cumbersome and obscures the intuitive proportionality to  $c/r$ .

**Partial derivatives under policy-stabilised  $rT$ .** If  $rT$  is held constant by policy (i.e.,  $x := rT$  fixed), the principal simplifies to

$$P = \frac{c}{r} (1 - e^{-x}) = k \frac{c}{r}, \quad k = 1 - e^{-x}.$$

The partial derivatives become transparent:

$$\begin{aligned} \left. \frac{\partial P}{\partial c} \right|_x &= \frac{k}{r} \propto \frac{1}{r}, \\ \left. \frac{\partial P}{\partial r} \right|_x &= -k \frac{c}{r^2} \propto -\frac{c}{r^2}, \\ \left. \frac{\partial P}{\partial T} \right|_x &= 0. \end{aligned}$$

With  $rT$  stabilised, the messy exponential dependence disappears from the derivatives. Principal now scales linearly with repayment capacity  $c$  and inversely with interest rate  $r$ , making the policy levers fully transparent.