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Die Hochschule im Dialog:
Inflation-induced Liquidity Constraints in Real Estate Financing

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Inflation-induced Liquidity Constraints in Real Estate Financing

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Abstract:

Despite the "interest rate turnaround" initiated by the ECB in the second half of 2022 as a late reaction to the clearly underestimated persistence of high inflation rates in the euro area, real interest rates are by no means to be regarded as restrictive, neither in the ex post nor in the ex ante view. However, banks have been quite quick to adopt stricter lending guidelines, and demand in housing construction and mortgage lending has plummeted. Against this background, the paper discusses the importance of cash flow effects in annuity loans and in particular analyses the so-called front-loading effect. Accordingly, even if inflation rates are fully anticipated and real market and lending interest rates remain unchanged, higher nominal rates lead to strong additional financial burdens in the first phases of the typically mortgages with long maturities. Such liquidity effects can severely reduce the ability or willingness to pay of private investors in the household sector. This is particularly true for long-run loans in the form of a percentage annuity, as an additional maturity shortening effect occurs here. These types of fixed term loans are quite popular in Germany.

Looking ahead, there is also a real risk to the stock of housing loans if there is a refinancing of the large stock of cheap housing loans, a risk that also has implications for macroeconomic and financial stability.

JEL Classification: G21, G51, E59

Keywords: ECB, monetary policy, liquidity effects of interest rate policy, front loading effects, housing finance, mortgage

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Kurzfassung:

Trotz der von der EZB eingeleiteten „Zinswende“ in der zweiten Jahreshälfte 2022 als späte Reaktion auf die deutlich unterschätzte Persistenz hoher Inflationsraten im Euroraum sind die Realzinsen sowohl in der ex post Betrachtung als auch in der ex ante Betrachtung keineswegs als restriktiv einzuschätzen. Die Banken haben allerdings recht rasch strengere Vergaberichtlinien beschlossen, und die Nachfrage im Wohnungsbau und bei den Hypothekarkrediten ist stark eingebrochen.

Der Beitrag thematisiert vor diesem Hintergrund die Bedeutung von Zahlungsstromeffekten bei Annuitätenkrediten und analysiert hier vor allem den sog. front-loading Effekt. Danach führen höhere Nominalzinsen selbst bei vollständig antizipierten Inflationsraten und unveränderten Realzinsen zu starken finanziellen Zusatzbelastungen in den ersten Phasen der typischerweise langen Kreditlaufzeit. Derartige Liquiditätseffekte können die Zahlungsfähigkeit bzw. die Zahlungsbereitschaft der privaten Investoren empfindlich verringern. Dies gilt vor allem bei Darlehen in Form der Prozentannuität, da hier zusätzlich ein Laufzeitenverkürzungseffekt auftritt. Solche Darlehen sind in Deutschland recht populär.

Mit Blick auf die Zukunft besteht auch eine reale Gefahr für den Bestand an Wohnungsbaukrediten, wenn es zu einer Refinanzierung des großen Bestands an günstigen Wohnungsbaukrediten kommt, ein Risiko, das auch Auswirkungen auf die makroökonomische und finanzielle Stabilität hat.

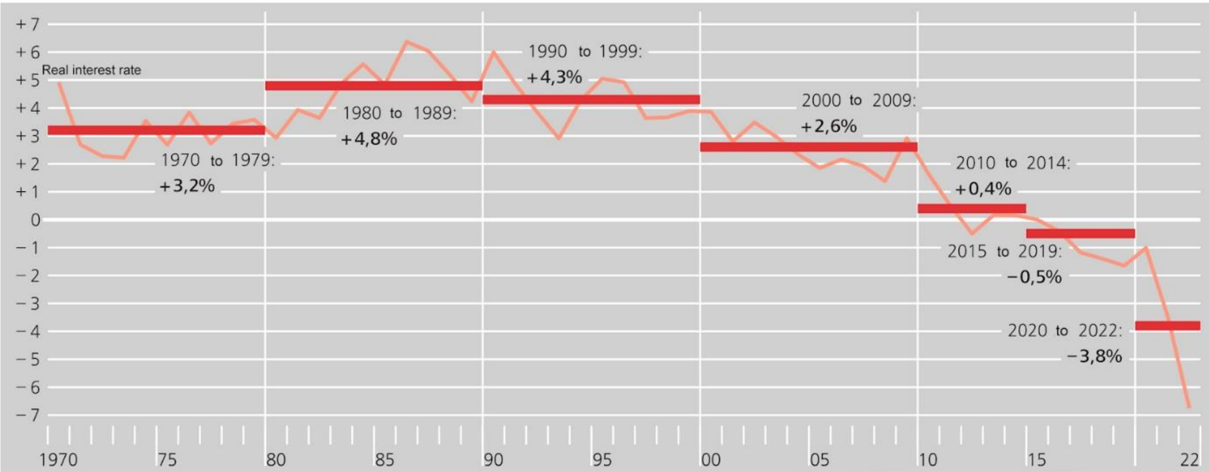
Contents

I. ECB policy rates reversal in the deep trough

With the ECB's "interest rate turnaround" initiated in the second half of 2022, following a long period of ultra-loose monetary policy, **nominal interest rates and yields** in the markets of public bonds and asset backed securities of banks (mortgage backed securities in particular) in the longer maturities have also risen. These developments primarily reflect high inflation rates and elevated inflation expectations. In line with this, interest rates in banks' business for new housing loans with initial fixed interest rates of more than ten years have risen at a rapid pace from around 1.3% to 3.5% within the year 2022.[4]

Real interest rates in Germany, annual and long-term averages

in %



Real interest rate = capital market rates of long-term public bonds minus consumer price inflation (annual basis)
Data source: Deutsche Bundesbank

However, the rise in inflation rates went far beyond the increase in key market interest rates that followed them. As a result, **realized (ex post) real interest rates** for German government securities with a remaining term of 10 years - an asset class that has an important benchmark function on the German and European capital markets - even reached

[4] See also Feld, L. P. et al. (2023); Frühjahrsgutachten Immobilienwirtschaft 2023 des Rates der Immobilienweisen.

new lows, resulting in a veritable loss of substance of -3.8% on an annual average between 2020 and 2022.

According to Bundesbank calculations, the corresponding **expected (ex ante) real interest rates** remained negative throughout 2022 (December value: -0.7%), despite an increase since spring 2022. A restrictive effect of the change in monetary policy cannot yet be derived from the real interest rate levels on the capital market; rather, it merely shows that the degree of monetary expansion is no longer as high as before.

In its press release of Jan. 31, 2023, however, the Bundesbank drew attention to the following finding from its **bank lending survey**: "*The German banks surveyed as part of the Bank Lending Survey (BLS) applied stricter lending guidelines to corporate loans, private housing loans, and consumer and other loans in the fourth quarter of 2022. Across all lending segments, banks primarily justified the tightening by what they perceived as an increase in credit risk.*"

II. Cash flow effects of interest rate shocks

What impact do higher nominal interest rates and historically low or negative real interest rates have on aggregate demand? In general, the **interest rate sensitivity of residential construction** is comparatively high. This impact channel is examined in more detail below. It turns out that in the current interest rate phase, it is not the classic real interest rate channel that is likely to play a major role, but above all the often-overlooked **liquidity channel**. This is particularly true in the case of Germany, where **long-term debt financing via mortgage loans** is widespread and banks' credit standards prescribe income related burden limits in most cases.

Interest rate effects on bullet bonds differ clearly from interest rate effects on annuity loans.[5] A distinction must be made between market value effects and cash flow effects.[6] While in the case of the former, valuation-related duration and convexity effects on interest debt have received much attention in the more recent financial literature in terms of their present value or terminal value effects, **cash flow effects on annuity loans** have been overlooked or forgotten in many cases[7].

The older literature however has already produced important results with explicit reference to monetary policy and macroeconomics.[8] In addition to the question of the fixed-interest period (*floating rate versus fixed rate*),[9] a phenomenon termed ***front- loading*** has received much attention. Based on pioneering work of Tucker[10], Lessard and Modigliani[11] for instance analysed the adverse effects of inflation on the demand for housing due to the distortion of the time pattern of real mortgage payments.[12]

According to this phenomenon, even if real interest rates remain unchanged or inflation is fully anticipated, higher nominal interest rates in fact lead to a **redistribution of repayment flows over time** at the expense of the initial years of a loan term. This results in an **inflation-induced *cash flow* constraint** (*adverse cash flow effect*), not to be confused with an effective asset restriction (*adverse present value effect*). Front loading played an important role in mortgage defaults during the subprime crisis in the U.S.A. in 2007/8, as

[5] In the following, the focus is on characteristics typical of the type of loan. We therefore abstract from other factors such as borrower-related or credit institution-dependent factors. Similarly, the impact of liquidity restrictions on consumer loans on private savings formation is not discussed here.
[6] Cf. Franke and Hax (2009), pp. 637-642.
[7] An exception is, for example, the treatment of this topic in Hartmann-Wendels et al. (2010), p. 562 ff.
[8] See Greenwald (2016) and Garriga et al. (2013) for details.
[9] Cf. e.g. Bank of England (1994).
[10] See the classic reference in Tucker (1975).
[11] See Lessard/Modigliani (1975).
[12] In the case of Germany, a report of the Expert Commission on Housing Policy (Expertenkommission zur Wohnungspolitik,1994) followed the same line of argument.

borrowers found it difficult to make their monthly mortgage payments once the period of low introductory interest rates had expired.

In this context, the higher the debt financing share of the real estate purchase for a given fully anticipated nominal interest rate shock[13], the greater the increase in the fiscal burden, measured in terms of the share of interest and principal payments in disposable income. In addition, the maturity plays an important role. It should be noted that the increase in burden in the early years (i.e. the ***front-loading effect***) is counterbalanced by a corresponding relief in the later years of the loan term as nominal income rises over time. In the case of a quite common percentage annuity, an increase in interest rates shortens the term of the loan.

III. Conceptual framework: an annuity model

In the following, we use a standard annuity model to analyse the **partial analytic interest rate effects** on a bank-financed annuity loan for private house purchases - which is widely used in private real estate financing - by means of a scenario analysis at different high and differently anticipated inflation rates.

The formula for the annuity (A) of a mortgage (D_0) at the nominal interest rate (i) and a term of n years is given by

(1) $$A = anf D_0$$

with the annuity factor:

(2) $$anf(i,n) = \frac{i}{1-(1+i)^{-n}}$$

The annuity factor increases ceteris paribus (c.p.) as the interest rate increases, and it decreases with maturity. For long maturities, it converges against the interest rate: $anf \approx i$.

[13] To keep things simple, we abstract from inflation-induced risk premia.

Of course, for various reasons, the nominal mortgage rate (i) and the inflation rate (π) are not independent. In the following, we assume that the central bank's monetary policy responds to changes in the inflation rate and acts with the anticipated rate $\alpha\,(\geq 0)$ on the mortgage rate: $di = \alpha\, d\pi$. The **inflation-induced change in the annuity factor** is thus:

(2') $$danf = \frac{danf}{di}\,\alpha\, d\pi$$

The response of the annuity factor to a change in the nominal interest rate is:

(2'') $$\frac{danf}{di} = \frac{anf}{i}\left[1 - \frac{n\ anf}{(1+i)^{n+1}}\right]$$

For very long durations, the expression converges to 1.

Further, we assume that nominal disposable income (Y) of the household sector grows at the rate of inflation:[14]

(3) $$Y(t) = Y_0(1+\pi)^t$$

The combined financial burden of current interest and principal payments expressed in relation to disposable income, the burden ratio (BQ), in year t (=1...n) is:

(4) $$BQ(t) = \frac{A}{Y(t)} = anf\ \frac{d_0}{(1+\pi)^t}$$

Therein $d_0 \equiv D_0/Y_0$ denotes the credit ratio at the beginning of the credit period; D_0 is the amount of the bank loan taken out, consisting of the purchase price (including ancillary costs) for the building and the land, less the financial funds invested and the amount of own work performed.

[14] In the current context, disposable income is to be understood as an approximation. In a liquidity analysis, it would be more appropriate to use income adjusted for taxes and transfers as a starting point, but not to deduct imputed depreciation and interest expenses from it, as is required by the system of national accounts. Cf. Drehmann et al. (2015).

The differential effect of inflation with respect to the time-dependent burden ratio results from:

(4') $$dBQ(t) = BQ(t)\left[\frac{danf}{di}\,\frac{\alpha}{anf} - \frac{t}{1+\pi}\right]d\pi, \quad t = 1,2,\dots,n$$

For mortgage loans in the form of the popular **percentage annuity** (with a final payment, if applicable), not only the interest rate (i) but also the repayment rate (τ) for the first payment in percent of the agreed loan amount (D) is fixed in advance, so that the annuity with

(5) $$A = (i + \tau)D_0$$

is given and the time of maturity (n) becomes an endogenous variable:

(6) $$n = \frac{ln\left(\frac{i+\tau}{\tau}\right)}{ln(1+i)}$$

Since $dn/di < 0$, a higher nominal interest rate also c.p. shortens the maturity in the inflation scenario, and the front-loading effect is amplified.

IV. Alternative shock scenarios

a) Annuity effects with exogenous maturity

Depending on the model specification and the choice of parameters, the financial burden derived from the reference model can be calculated according to equation (4). It becomes obvious that the time-dependent burden ratio over the term of the mortgage reacts to a change in the inflation rate (π) and to a change in the monetary policy reaction of the nominal interest rate to the inflation rate (compensation parameter α). It is assumed throughout that - regardless of the strength of the reaction on the capital market - nominal disposable income grows in line with the given inflation rate (assuming a complete pass-through in the wage rates).

The **basic characteristics of the burden ratio** in the case of inflation can be inferred from the following illustration. The maximum of the higher total payments is right at the beginning of the credit period and declines continuously thereafter, following a **convex time path.** The "critical point in time" (breakeven point) is the period in which the change in the burden switches from positive to negative values compared to the scenario of price stability (base scenario).

Four scenarios are considered. The impact of inflation to the mortgage interest rate takes place according to the formula: $i = 0.01 + \alpha\,\pi$. The loan term is set at n=20 years, and for the credit ratio we assume d_0 = 4.[15] In the base scenario I there is price stability (π = 0). In scenarios II, inflation prevails at a rate of π = 4% p.a. and α = 0% (IIa), α = 50% (IIb), and α = 100% (IIc), respectively. Thus, the nominal interest rate in the four scenarios is i = [0.01, 0.01, 0.03, 0.05], respectively.

[15] The cost of building or purchasing a new owner-occupied residential property is determined by a variety of factors and cost blocks. In addition to the location and size of the property, these include above all the size of the living space and the type of interior fittings. Regional differences also play a major role here. The values for the parameters used as a basis for the model calculations are average values with a wide range and are therefore of indicative nature.

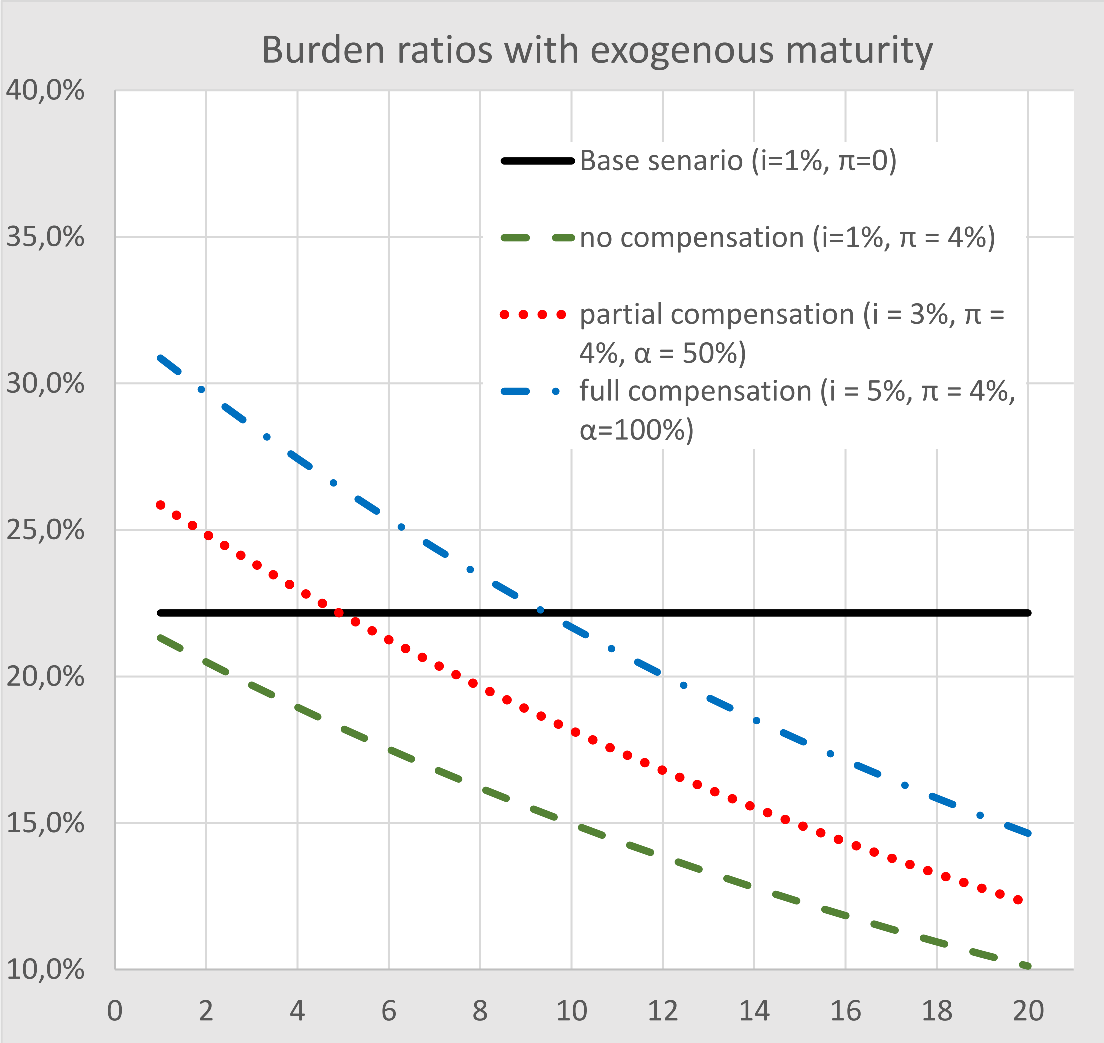


Table 1 shows the burden ratios in t=1 and t=20 as well as on average over the entire time span of the credit contract.

Table 1: Annuity mortgage repayment

Scenario	Basis	no comp.	partial comp.	full comp.
	I	**IIa**	**IIb**	**IIc**
Inflation (π)	0%	4%	4%	4%
Comp. param. (α)		0%	50%	100%
t=1	22.2%	21.3%	25.9%	30.9%
t=20	22.2%	10.1%	12.3%	14.6%
on ∅	**22.2%**	**15.1%**	**18.3%**	**21.8%**

In **scenario I** (no inflation), the burden ratio is constant at 22.2% over the entire term. In the three variants of scenario II, the inflation rate is assumed at π = 4%.

In **scenario IIa,** no compensation for the loss of purchasing power of money in the nominal interest rate takes place (α = 0). Accordingly, the burden ratio as a function of (inflation-indexed) nominal income falls from 21.3% at the beginning of the term to 10.1% at the end.

In **scenario IIb,** partial compensation takes place (α = 50%). As a result, the burden ratio at the beginning increases from 22.2 to 25.9% (*front loading*) at the beginning of the term, and at the end it has fallen to 12.3%.

In **scenario IIc,** a complete transfer of inflation to the interest rate takes place (α = 100%). The burden ratio at the beginning jumps from 22.2% to 30.9%. At the end of the term, it is down to 14.6%.

The average burden ratio is naturally lowest in scenario IIa (4% inflation, no impact on interest rates), at around 15%. For mortgage borrowers, this purely hypothetical case of a permanently high inflation rate, which (e.g. in the case of a "successfully" accommodative monetary policy) is not transmitted to nominal interest rates, but to nominal income, is unquestionably the most favourable financial scenario. If we consider the case of partial compensation of inflation in interest rates, which is much more likely to be encountered in practice, the burden ratio falls over time compared with the baseline calculation without inflation, but it is significantly higher in the first years.

The explanatory power of the **liquidity channel** for the current slump in private housing construction can be regarded as significant and relevant.[16] The liquidity restriction may easily become binding for two

[16] An effective liquidity restriction can take various forms. Either the desire to purchase real estate is abandoned or at least postponed, or - although this is less likely to be the case - another, less expensive property (smaller residential and land area, less elaborate construction) comes into consideration.

reasons: either because the credit institutions consider the credit risks to be too high in the case the borrower's stress ratios have been exceeded, or because the borrower himself considers the expected restrictions on the household's standard of living over a number of years to be too drastic. Even historically low real interest rates do not change this. The liquidity effect dominates in many cases.

b) Annuity effects with endogenous maturity

The liquidity effect in the case of a percentage annuity also affects the maturity of the loan, unlike the loan type or model class discussed in section IV.a). This **maturity shortening effect** has a large impact in terms of an additional burden. The quantitative results for this type of loan, with otherwise unchanged transmission rates (α) of inflation to the loan rate for the three scenarios and an initial repayment rate (τ) of around 4.5%[17] are shown in the following chart. It should be noted that in the case of percentage annuity, there is usually still a residual debt to be repaid at the end of the term, which has been neglected in the chart and in the table to ensure better comparability with the calculations for an exogenously predetermined term.

[17] The initial amortization percentage would be chosen so that the maturities for the base calculation are the same in both variants (exogenous versus endogenous maturity).

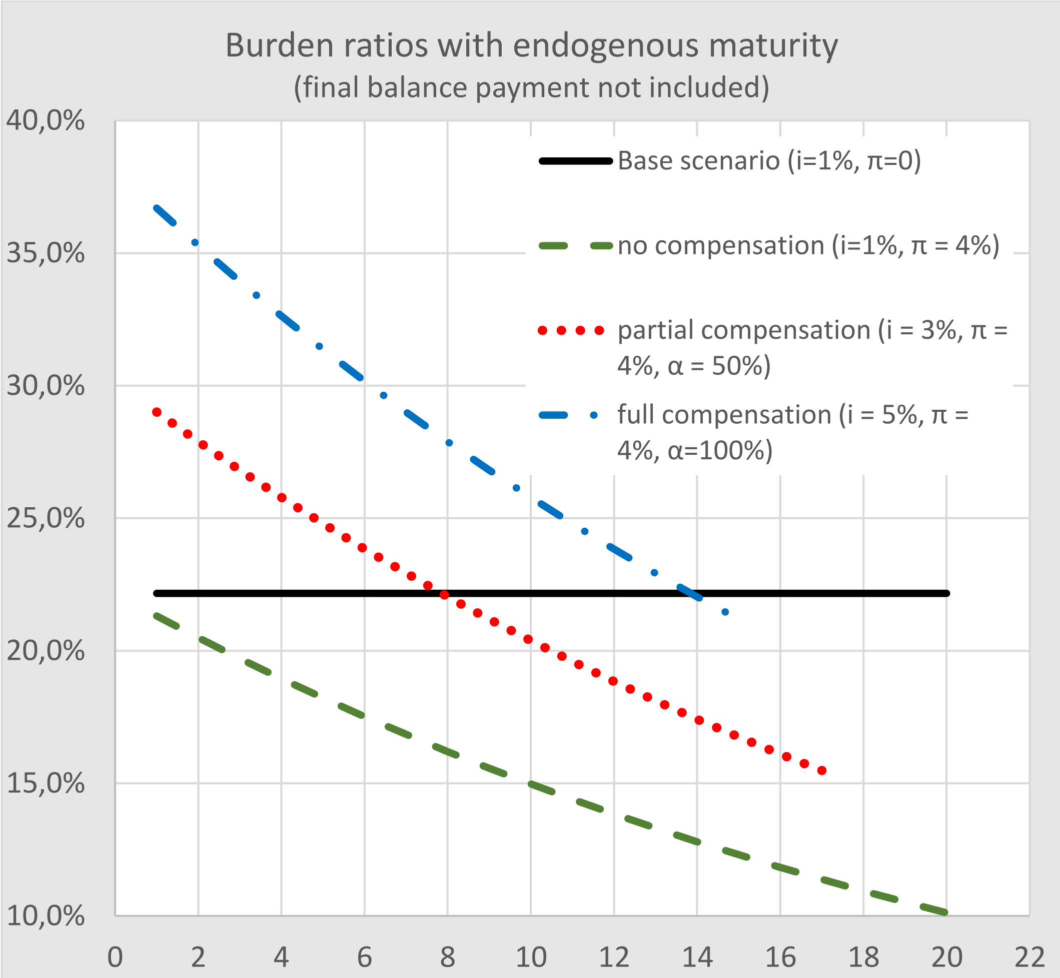


Table 2 also shows the burden ratios at the beginning and end of the - now endogenous - terms.[18]

Table 2: Percentage mortgage repayment

Scenario	Basis	no comp.	partial comp.	full comp.
	I	**IIa**	**IIb**	**IIc**
Inflation (π)	0%	4%	4%	4%
Comp. param. (α)		0%	50%	100%
t=1	22,2%	21,3%	29,0%	36,7%
t=20	22,2%	10,1%	-	-
t=17	-	-	15,5%	-
t=15	-	-	-	21,2%

[18] The average burden ratios are not comparable due to the different maturities.

Let us again consider the different scenarios of inflation compensation in the interest rate. Without taking inflation into account in the interest rate, both types of loans react identically. However, if there is a nominal interest rate increase, the initial burden ratio rises much more sharply, by roughly 3 percentage points in scenario IIb and even by almost 6 percentage points in scenario IIc (see Table 1 and 2). This is, of course, related to the afore-mentioned maturity shortening effect. If the inflation rate is fully compensated in the interest rate, the borrower will hardly benefit from lower burden ratios compared with the baseline calculation. Even the shorter term is of no help here, because most households cannot cope with burden ratios of between 30 and 40%, so that the (desired) financing needs to be abandoned.

c) Caveat

As useful and important as the distinction between liquidity and wealth effects of monetary policy is from an analytical point of view, it is often difficult to make the right assessment in concrete cases. The reason is the need of estimating future, and thus in principle **uncertain, cash flows** over a long period of time. Thus, their expected present value becomes the central variable. In the case of an annuity-financed house purchase, the associated **risk costs** arise from the fact that the expected present value of the cash flow stream not only corresponds to the agreed annuity and the annuity present value factor, but both are also inextricably multiplicatively linked to the cumulative survival probability (the default risk or credit quality risk) over the entire term of the. From the perspective of the lending bank, an interest-related increase in the burden ratio, as shown here, also generally reduces the **expected present value** of the total recoveries from the lending business if the burden ratios increase over longer periods. In addition, it is not only the **expected loss** that increases, but also the **unexpected loss**, i.e. the proper risk variable that burdens equity and requires a "true" risk premium in addition to the earnings-reducing cost component in the form of the standard risk costs.[19] Since both, default and risk premiums rise as a result of liquidity-related increases in stress ratios, the **degree of effective restriction** increases even more sharply than shown in the stress scenarios.

It should also be stressed that significant **welfare losses** are involved with inflation-induced liquidity effects. This does not only hold for theoretical considerations. There is "real money", that is at stake. Croushore[20] estimated the benefits in the absence of liquidity effects for housing demand to be worth between 0.06 and 0.12 % of GDP. These are permanent annual gains, that can be realized year per year by reducing the inflation rate by two percentage points.[21]

V. Restrictive liquidity effects meet cost push factors

In the current situation, the liquidity effects described above are exacerbated by a **sharp cost surge** which has hit residential construction in the German construction sector hard. For example, the **prices of construction materials for new residential buildings** in 2022 alone rose by an average of around 16% year-on-year; in many key cost areas, the increase was much higher.

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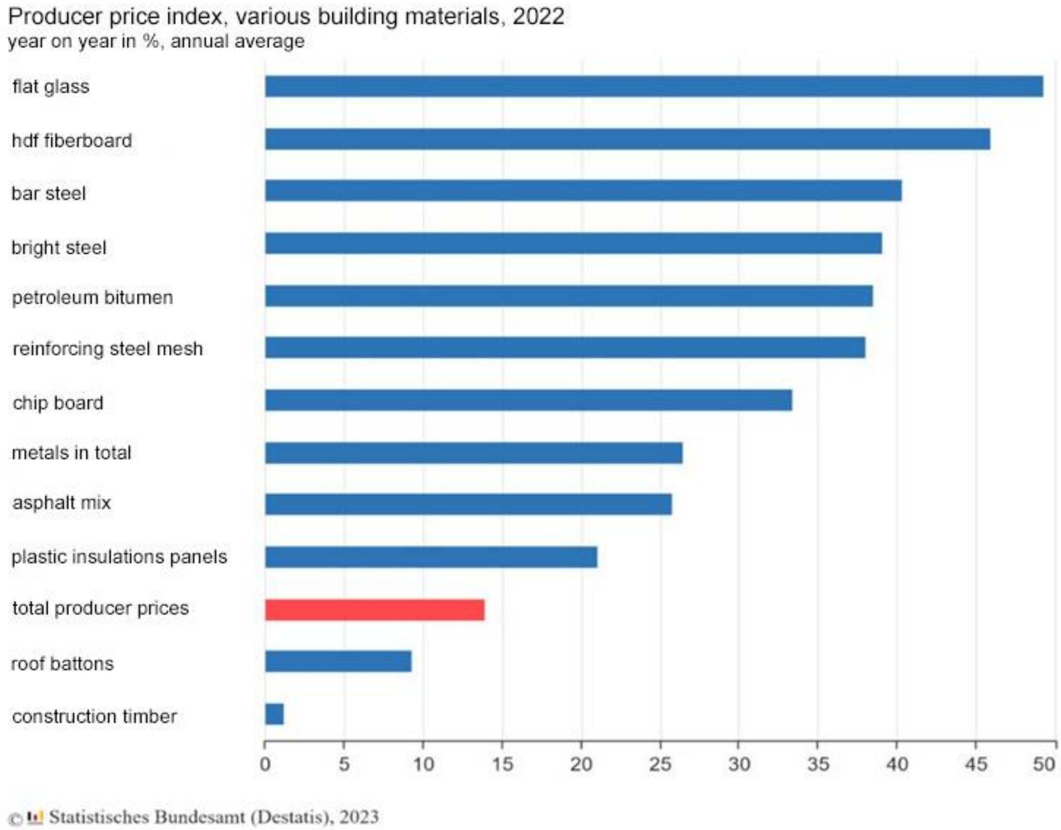
[19] In this context, it is crucial that default probabilities play a central role in quantifying both expected and unexpected loss. While the relative expected loss increases linearly with the probability of default for a given loss severity, the unexpected loss reacts much more strongly. On the concepts of expected and unexpected loss, see in detail Oehler/Unser (2002), esp. p. 270 et seq., and Ong, Michael K. (1999).

[20] See Croushore (1992).

[21] For a full discussion of the costs and benefits of inflation see esp. Feldstein ed. (1999).



Added to this are persistently high price increases for construction sites.[22] Given the investor's own funds, this has led to a sharp increase in the need for borrowed funds, so that the actual slump in residential construction, measured in terms of the number of building permits and the volume of new orders in the construction sector, is likely to find an additional explanation from this side as well.

VI. Growing risks of follow-up financing

The liquidity effects of front-loading shown here relate to the current demand for new housing. However, in the case of short-term fixed interest rates or flexible lending rates, as is common in Spain or the UK, for example, changes in the market interest rate can also quickly lead

[22] Cf. Höhlich, H.; Hofer, Th. (2022).

to higher charges for already existing borrowers, depending on the loan vintage.[23] This **stock effect** reduces current demand for consumer goods (especially durables), increases the risk of private insolvency and has a dampening effect on the real economy.

After a very long period of extremely low nominal interest rates, similar effects to those seen in variable-rate mortgage financing also occur in the case of long loan terms. This is because here the average interest rate of the outstanding portfolio of mortgage loans adjusts - the longer the more - to the prevailing low market interest rates and therefore “vintage effects” cannot work. This **risk of follow-up financing** is also likely to become increasingly effective in Germany in the current interest rate phase.

The **ultra-loose interest rate policy pursued by the ECB from 2014 to 2021** at the latest[24] was marked above all by large scale long-term refinancing operations for banks (TLTROs I-III) and increasingly massive bond-buying programs (especially public securities). This was followed by a belated and therefore comparatively quite **strong policy rate reaction in the course of 2022 and in 2023** due to the inflation dynamics already evident beforehand.

This policy reaction function has not only led to an **allocation-distorting, highly overheated real estate market** in Germany during the last ten years, but have also made a decisive contribution to an **abrupt slump in demand for housing** in more recent times[25] .

Thus, according to calculations by the Bundesbank, the **overvaluations on the German real estate markets** have been maintained in the annual figure for 2022 and continue to be classified as extremely high, which points to considerable **potential for a setback** or a longer correction phase.

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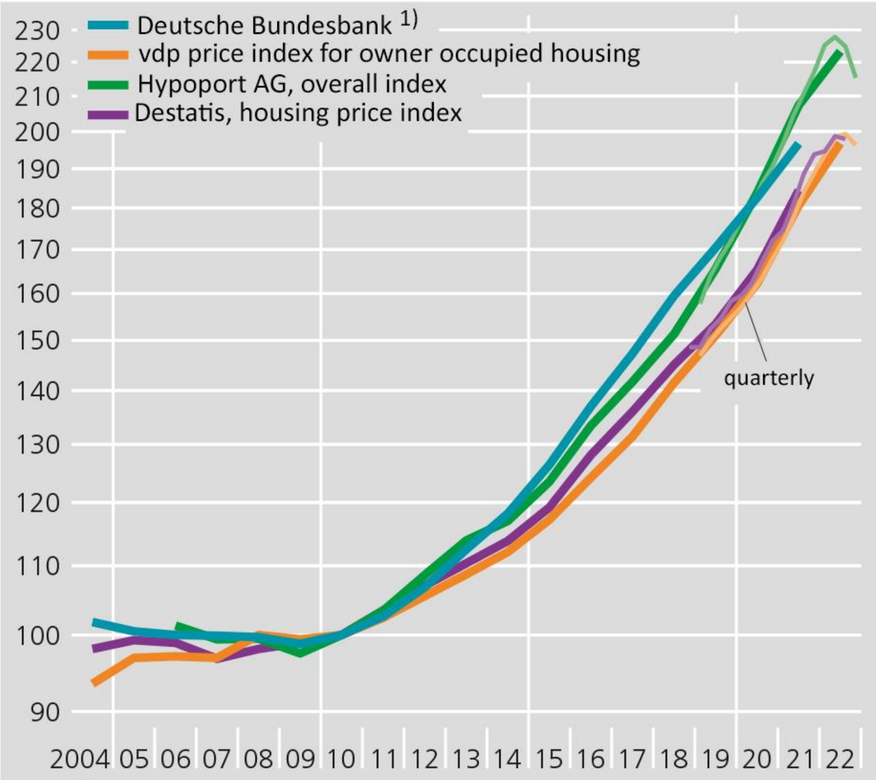
[23] Cf. Bank of England (1994).

[24] Hannoun, H. et al: Memorandum on the ECB`s Monetary Policy, 04 October 2019.

[25] Critical questions o regarding financial stability also have to be asked here. Cf. e.g. Schularick, M. (2023).

This applies regardless of which price indicators for residential real estate are used (see chart).



1 Transaction-weighted. Own calculations on the basis of price data of the Bulwiengesa AG.

Deutsche Bundesbank

"*According to both the purchase price-to-income ratio and estimation results for the long-term relationship between housing prices, income, and interest rates, residential real estate prices were 20% to 30% higher than the benchmark*".[26]

It goes without saying that both the collateral value and derived therefrom the mortgage lending limit have been revised downwards amid a period of persisting inflation, increasing nominal long-term

[26] Cf. Deutsche Bundesbank, Monthly Report, February 2023, p. 60.

lending rates and related liquidity constraints and adverse cost push factors in the construction industry.

As to the stock of mortgage loans, Eichenbaum et al. (2018) also show unpleasant implications for monetary policy. As they point out, the potential for expansionary monetary policy effectiveness is likely to be reduced substantially after a long period of low interest rates, because the **refinancing channel** can no longer generate the desired effect.

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