Addressing interest rate risk when banking on deposits: A simple framework

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Abstract

This note discusses the prudential regulatory treatment of interest rate risk in the banking book in the context of a simple model of a bank involved in maturity transformation and exposed to interest rate risk. The analysis acknowledges that the intermediation margins earned on deposits contribute to banks' profitability but also that deposits are flighty and, hence, those margins may evaporate and not be ready to cover interest rate losses if depositors run away. If the deposit franchise is small or can easily evaporate because of a run, then the capital necessary to keep the bank supersolvent in adverse interest rate scenarios coincides with the capital that would be needed to absorb the (unrealized) marked-to-market losses in the banking book. However, if the franchise value of deposits is not negligible and does not fully evaporate due to runs, then the capital needed for the bank to remain supersolvent is much lower (and can even be zero). The simple model is used to discuss the policy trade-offs associated with other elements of the prudential framework, including the extent of coverage of the deposit insurance system (which can add resilience by making deposits less flighty in a run) and liquidity requirements (which can reduce losses realized in adverse interest rate scenarios but at the cost of reducing the average gains from maturity transformation).

JEL Classification: G01, G21, G28

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1 Introduction

This note discusses the prudential regulatory treatment of interest rate risk in the banking book in the context of a simple model of a bank involved in maturity transformation and, hence, exposed to interest rate risk. The model combines the standard representation of maturity transformation and the implied bank run risk of the literature in the tradition of Diamond and Dybvig (1983), with the observation, most notably and recently in Dreschler et al. (2021, 2023), that deposits are a source of rents (or franchise value) and the relatively low sensitivity of their rates to market rates (together with an effective duration higher than their contractual duration) constitutes a natural source of hedging for banks. The analysis acknowledges that the intermediation margins earned on deposits contribute to banks' profitability but also that deposits are flighty and, hence, those margins may evaporate and not be ready to cover interest rate losses if depositors run away. The analysis captures that the realization of interest rate risk in the banking book can act as trigger of deposit runs, as witnessed in the demises of Silicon Valley Bank (March 10, 2023), Signature Bank of New York (March 12, 2023), and First Republic Bank (May 1, 2023) in the US.

The analysis addresses the prudential regulatory treatment of interest rate risk in the banking book from the perspective of preserving the solvency of the banks, while taking into account not only the franchise value of deposit funding but also the fragility associated with the possibility of runs. In this sense, the analysis incorporates the observations made in Dreschler et al. (2021, 2023) into a model in the tradition of Diamond and Dybvig (1983), Rochet and Vives (2004), and Goldstein and Pauzner (2005), among others. The focus on the implications of regulation for banks' solvency and vulnerability to runs is reminiscent of Vives (2014). However, for the time being and to keep things simple, the model presented in this note abstracts from incomplete information and thus the endogenous determination of the probability of a bank run. Instead it characterizes the set of regulatory choices that could make banks "supersolvent" and, hence, free from the risk of runs, as well as the set of choices for which banks are "fundamentally solvent but fragile," in the sense that they can remain solvent in the absence of a run but can become insolvent if a (rational self-fulfilling) panic occurs.

The analysis reveals that if the deposit franchise is small or can easily evaporate because of a run, then the capital necessary to keep the bank supersolvent in adverse interest rate scenarios (more specifically, when interest rates unexpectedly rise) coincides with the capital that would be needed to absorb the (unrealized) marked-to-market losses in its banking book. However, if the franchise value of deposits is not negligible and does not fully evaporate due to runs (e.g. because there is a base of insured deposits or other type of safety net interventions that help to keep them "sticky" during potential runs), then the capital needed to make the bank remain supersolvent in those scenarios is lower than the latent marked-to-market asset side losses. Intuitively, this happens because there are latent unrealized liability side intermediation margins that can also contribute to absorb the asset side losses.

We assume that ex ante capital regulation aims to make banks resilient to sufficient adverse realizations of interest rate risk. We show that the minimum equity buffers required for banks to remain solvent when interest rates unexpectedly spike are decreasing in the importance and stability of the deposit franchise. A valuable and stable deposit franchise reduces the ex ante capital buffer needed to guarantee that banks remain supersolvent in the scenario with higher interest rates as well as the (lower) capital buffer that would make it just fundamentally solvent.

A valuable deposit franchise, even if it fully evaporates in a future crisis, reduces the ex ante capital that guarantees either supersolvency or fundamental solvency since it provides margin income until a crisis starts. If the franchise fully evaporates in adverse scenarios, then the capital that a bank would need to have in those scenarios to preserve its solvency coincides with that required to absorb the latent market-to-market losses of its assets. However, if the franchise does not fully evaporate, solvency can be guaranteed with less capital. So, in general, marking assets to market and forcing banks to have the equity capital that would make them contemporaneously able to absorb the implied losses would be harsher than necessary to preserve supersolvency.

If the system can guarantee the stability of a greater fraction of deposits during crises (e.g. by extending the fraction of them covered by deposit insurance), the minimal ex ante and ex post capital that warrants supersolvency also declines. In practical terms this means that authorities interested in making their banks supersolvent when confronting interest rate risk in the banking book face a trade-off between requiring banks to issue a larger proportion of loss absorbing liabilities and extending the coverage of the safety net on their deposits (or short term liabilities more generally). The optimal resolution of such a trade-off would depend on cost-benefit considerations that should include aspects not explicitly captured in the current analysis such as the implications of expanded deposit insurance coverage for banks' risk shifting (or other instances of moral hazard) and the distortions to competition in the markets for deposits (and related money market securities). However, its seems reasonable to conjecture that, other things equal, relying on deposit insurance coverage would make more sense the larger are the intermediation margins associated with deposits and the larger is the ex ante cost of raising loss absorbing liabilities (e.g. because of lack of capacity to accumulate capital internally and frictions in primary equity markets, or because of agency problems between managers and the holders of loss aborbing liabilities).

The analysis can be extended to consider the role of liquidity requirements, namely, requirements imposing that a minimal fraction of bank assets are safe and of short maturity, so that their value is unaffected by unexpected changes in interest rates. The discussion on liquidity requirements would be trivial in the absence of a positive expected term premium in the relevant bank assets (e.g. long-term bank loans) since in this case a bank fully invested in short-term assets could then appropriate the intermediation margin on deposits without incurring any interest rate risk. However, if a term premium exits, as it is the case in most realistic circumstances, imposing liquidity requirements comes at the cost of reducing the expected interest rate income that banks can generate. This is per se a source of erosion of their profitability and, dynamically, of their capacity to accumulate loss absorbing capacity. Thus, while liquidity requirements can reduce the interest rate related losses suffered by a bank in adverse interest rate scenarios, their imposition does not come without costs. Specifically, it is unclear whether liquidity requirements are superior to capital requirements as an ex ante prudential measure directed to guarantee banks' solvency in face of interest rate risk. The comparison may yield different outcomes for different banks and in different environments. Our analysis suggests that liquidity (capital) requirements will tend to be superior when the expected term premium earned on long term assets is small (large) and the excess social cost of demanding banks to be funded with equity or equivalent loss absorbing liabilities is large (small).

Altogether, this analysis suggests that a simple, one-size-fits-all solution to the prudential regulation of interest rate risk in the banking book does not exist. The preferred prudential measure as well as its detailed calibration will generally depend on the value of each bank's deposit franchise, the stickiness of the corresponding deposits, the marginal cost of increasing the bank's loss absorbing liabilities, and the term premium that can be earned by investing in long term assets financed with short term liabilities.

A potential approach to the problem that would offer the flexibility to cope with these heterogeneous across banks and variable over time determinants of the best prudential treatment would be to allow banks to choose their preferred combination of capital, liquidity and safety-net coverage tools (e.g. by relying more or less on insured deposits for their funding) provided that they demonstrate their capacity to resist sufficiently adverse interest rate scenarios under their equilibrium choices. This solution points to a framework broadly consistent with treating interest rate risk in the banking book within Pillar II of the current microprudential framework, requiring banks to regularly prove their capacity to pass suitably designed interest-rate-variability stress tests. If a bank's capacity to withstand adverse interest rate scenarios is regarded insufficient by the supervisor, the supervisor should require the bank to immediately plan to cover of the protection shortfall with additional capital (a mandatory buffer) and should subsequently apply, if relevant, corrective actions (e.g. in terms of distributions) similar to those already envisaged in under current regulations when a buffer requirement is not met (e.g. under the maximum distributable amount –MDA– approach of Basel III).

2 A simple benchmark model

Consider a three date economy with time indexed by $t = 0, 1, 2$ and universal risk neutrality. At $t = 0$ and $t = 1$, there is a short-term risk-free asset that pays an interest rate r_t at $t+1$. The interest rate r_0 is known at $t = 0$ and, hence, from the perspective of that date, is deterministic, while the interest rate r_1 realizes at $t = 1$ and, from the ex ante perspective, is a random variable with support in the interval $[r_l, r_h]$, with $r_l < r_h$.

A bank of asset size normalized to one is created at $t = 0$. The bank holds a long-term asset that pays interest income c_0 at $t = 1$ and principal and interest $1 + c_1$ at $t = 2$. In terms of interpretation this asset can be a treasury bond with maturity at $t = 2$ and coupons c_{t-1} at each date $t = 1, 2$ or a portfolio of identical loans without credit risk that repay their principal at $t = 2$ and pay a loan rate c_{t-1} at each date $t = 1, 2$. For the time being, c_0 and c_1 are regarded as exogenous, with $c_0 > r_0$ (most typically, $c_0 > r_0$) and $r_l < c_1 < r_h$.[1]

The bank finances its assets with combinations of short term deposit funding, short term market funding, and equity.[2] A crucial difference between deposit funding and market funding is that the latter requires an expected gross return equivalent to that of the risk free asset between dates t and $t+1$, that is, $1 + r_t$, while deposits, by virtue of liquidity services provided by the bank to their holders under non-perfectly competitive conditions, imply repayments (inclusive of any intermediation cost incurred by the bank) equal to $1 + \alpha + \beta r_t$, where $\alpha > 0$ and $\beta \in [0, 1]$. Under this formulation, having $1 + \alpha + \beta r_t < 1 + r_t$, that is, $(1-\beta)r_t > \alpha$, implies that deposit funding is cheaper than market funding and, hence, makes the bank's deposit franchise a source of value.[3] Finally, if needed to assess the ex ante value

[1] This assumption on c is compatible with endogenzing c as the long term rate at which, if the long-term asset were tradeable (e.g. a treasury bond), the risk neutral investors would be indifferent between investing in the long-term asset or in the sequence of short-term assets.

[2] From the eyes of this simple model, "equity" could include forms of long-term, loss absorbing funding other than common equity such as Tier 1 or 2 capital instruments or even senior non-preferred long-term debt.

[3] The emprical work in Deschler et al. (2021) suggests that the "deposit beta" parameter, β. is well

of bank to its shareholders, we assume that one unit of initial equity has a shadow value (or cost) of $1+\rho$ at $t=0$ where $\rho \geq 0$ accounts for any frictions (scarcity of owners' wealth, adverse selection, agency costs or tax distortions) that make equity funding privately (and perhaps socially) disadvantageous to the bank.

To simplify the analysis, we describe the initial capital structure of the bank as made up of (i) an exogenous given base d_0 of customer deposits, (ii) a regulatorily required amount of equity funding e_0, and (iii) a residually determined amount of short-term market funding $b_0 = 1 - d_0 - e_0$.[4] Since the asset size is normalized to one, d_0 and e_0 can be interpreted as the bank's initial deposit-to-asset ratio and capital ratio, respectively.

When arriving to $t=1$ the new short term rate r_1 realizes and the bank experiences a run-off rate ψ on its deposits so that $d_1 = (1-\psi)d_0$, where ψ is a random variable with support in the interval $[0, \psi_h]$, where ψ_h represents deposit withdrawals in some worst case scenario. We think of ψ and ψ_h as affected by both fundamental liquidity shocks and possible self-fulfilling prophecies regarding depositors' trust in the solvency of their banks. So ψ and, specifically, ψ_h can be influenced by institutions such as deposit insurance as well as, perhaps, the degree of sophistication and digitalization of the depositors.

After collecting the interest c_0 from its long term assets and observing the realization of ψ, the bank issues new short term funding b_1 to accommodate its net refinancing needs. To streamline the analysis, we assume that at $t=1$ issuing new equity funding is not possible and the bank abstains from paying any dividends. Then its uses and sources of funds equality (or budget constraint) at $t=1$ is as follows:

$$(1+\alpha+\beta r_0)d_0 + (1+r_0)b_0 = c_0 + (1-\psi)d_0 + b_1, \tag{1}$$

where the left hand side (LHS) contains the repayments implied by the pre-existing liabilities and the right hand side (RHS) contains interest income from the bank assets, rolled-over deposits and the new amount of short term debt.

Finally, with the liability structure inherited from date $t=1$, the net worth of the bank at $t=2$ can be written as follows:

$$n_2 = (1+c_1) - (1+\alpha+\beta r_1)(1-\psi)d_0 - (1+r_1)b_1, \tag{2}$$

below 1, while α can be positive due to the presence of sizeable intermediation costs. For a recent empirical reassessment of deposit betas, see Koont et al. (2023) .

[4] For the time being, we assume $b_0 \geq 0$ but given the assumption that market funding pays on expectation the short term market rate, $b_0 < 0$ might also be interpreted as the bank lending (rather than borrowing) at the market rate r_1 between $t=0$ and $t=1$. This consideration may be relevant when considering the effects of imposing a liquidity requirement at $t=0$.

where first term is the terminal value of the long-term assets, the second are the repayment obligations from the deposits outstanding from $t = 1$, and the third are the repayment obligations from the short-term market funding raised at $t = 1$

3 Interim book equity that ensures solvency at $t = 2$

The condition for the bank to be solvent at $t = 2$ is to have $n_2 \geq 0$. At $t = 1$, the bank's book value of equity (and regulatory capital) under the amortized cost measurement of its asset value is

$$e_1 = 1 - d_1 - b_1 = 1 - (1 - \psi)d_0 - b_1,$$

from where we can write the market funding raised at $t = 1$ as a function of d_0, ψ, and e_1:

$$b_1 = 1 - (1 - \psi)d_0 - e_1.$$

Using this expression to substituting for b_1 in (2), we obtain

$$\begin{aligned} n_2 &= 1 + c_1 - (1 + \alpha + \beta r_1)(1 - \psi)d_0 - (1 + r_1)[1 - (1 - \psi)d_0 - e_1] \\ &= (1 + r_1)e_1 + [(1 + c_1) - (1 + r_1)] + [(1 - \beta)r_1 - \alpha](1 - \psi)d_0. \end{aligned} \tag{3}$$

Thus having $n_2 \geq 0$ requires

$$e_1 \geq \frac{r_1 - c_1}{1 + r_1} - \frac{[(1 - \beta)r_1 - \alpha](1 - \psi)d_0}{1 + r_1}, \tag{4}$$

whose RHS contains, by construction, as a function of parameters and the run-off rate ψ, the minimum capital ratio at $t = 1$ compatible with the bank being solvent a $t = 2$.

To explain the terms that appear in the RHS of (4) notice that the marked-to-market value of the bank assets at $t = 1$ is

$$q_1 = \frac{1 + c_1}{1 + r_1},$$

so, relative to a book value of 1, the marked-to-market asset-side losses of the bank at $t = 1$ are

$$\text{MTM asset losses} = 1 - q_1 = 1 - \frac{1 + c_1}{1 + r_1} = \frac{r_1 - c_1}{1 + r_1}. \tag{5}$$

So the first term in the RHS of (4) accounts for these losses. The second term is the negative of residual value of the deposit franchise at $t = 1$ (after the deposit withdrawals implied by ψ in that date). , that is, the present value of the intermediation margin, , that will be earned at $t = 2$ per each unit of retained deposits. This second term enters with a negative sign because the prospect of the intermediation margins that will be earned on deposits between dates $t = 1$ and $t = 2$ (amounting $(1 - \beta)r_1 - \alpha$ per unit of retained deposits) reduce the book equity that the bank must have at $t = 1$ to ensure its solvency at $t = 2$.

The fact that interim book equity that ensures the solvency of the bank at $t = 2$ is contingent on the realization of r_1 and ψ implies that both interest rate risk and deposit run-off risk are, from an ex ante perspective, relevant sources of vulnerability.

4 Initial book equity that ensures solvency at $t = 2$

The condition in (4) refers to the bank's book equity at $t = 1$, e_1. However, given that the bank cannot raise new equity at $t = 1$, our formulation implies that the amount of equity with which the bank arrives at $t = 1$ depends on choices made at $t = 0$ and the factors affecting the evolution of the bank between $t = 0$ and $t = 1$. Taking this endogeneity into account, allows us to re-express the solvency condition in terms of the bank's capital structure at $t = 0$, the realizations of r_1 and ψ, and other parameters.

In (1), we can solve for b_1 and use the initial balance sheet of the bank to substitute for $b_0 = 1 - d_0 - e_0$, obtaining

$$\begin{aligned} b_1 &= (1 + \alpha + \beta r_0)d_0 + (1 + r_0)b_0 - c_0 - (1 - \psi)d_0 \\ &= (1 + \alpha + \beta r_0)d_0 + (1 + r_0)(1 - d_0 - e_0) - c_0 - (1 - \psi)d_0 \\ &= (1 + r_0)(1 - e_0) - c_0 - [(1 - \beta)r_0 - \alpha]d_0 - (1 - \psi)d_0, \end{aligned} \tag{6}$$

which shows that the market funding that the bank needs at $t = 1$, b_1, depends positively on initial leverage $(1 - e_0)$, and negatively on asset returns earned in the first period (c_0), the intermediation margin earned in the first period $([(1 - \beta)r_0 - \alpha]d_0)$, and the deposit funding retained at $t = 1$ $((1 - \psi)d_0)$.

Using (6) to substitute for b_1 in (2), we can express

$$\begin{aligned} n_2 &= (1+c_1)-(1+\alpha+\beta r_1)(1-\psi)d_0-(1+r_1)(1+r_0)(1-e_0) \\ &\quad +(1+r_1)c_0+(1+r_1)[(1-\beta)r_0-\alpha]d_0+(1+r_1)(1-\psi)d_0 \\ &= [(1+c_1)+(1+r_1)c_0-(1+r_1)(1+r_0)]+(1+r_1)(1+r_0)e_0 \\ &\quad +(1+r_1)[(1-\beta)r_0-\alpha]d_0+[(1-\beta)r_1-\alpha](1-\psi)d_0 \\ &= [(c_1-r_1)+(1+r_1)(c_0-r_0)]+(1+r_1)(1+r_0)e_0 \\ &\quad +(1+r_1)[(1-\beta)r_0-\alpha]d_0+[(1-\beta)r_1-\alpha](1-\psi)d_0, \end{aligned} \tag{7}$$

where the first term in the last expression of the RHS is the capitalized intermediation margin that would be earned if the long term asset were funded exclusively with market debt, the second term is the net worth resulting from the equity funding used in the first period, the third term is the capitalized value of the deposit margin earned on first period deposits, and the fourth term is the deposit margin earned on second period deposits.

Equation (7) allows us to find out the minimal capital ratio (or initial book equity) e_0 necessary to guarantee the solvency of the bank at $t=2$ under given realizations of r_1 and ψ. Indeed, having $n_2 \geq 0$ requires

$$e_0 \geq \frac{[(r_1-c_1)-(1+r_1)(c_0-r_0)]-\{(1+r_1)[(1-\beta)r_0-\alpha]+[(1-\beta)r_1-\alpha](1-\psi)\}d_0}{(1+r_1)(1+r_0)}$$

or

$$e_0 \geq e(r_1,\psi) \equiv \frac{(r_1-c_1)-(1+r_1)(c_0-r_0)}{(1+r_1)(1+r_0)}-\left(\frac{(1-\beta)r_0-\alpha}{1+r_0}+\frac{[(1-\beta)r_1-\alpha](1-\psi)}{(1+r_1)(1+r_0)}\right)d_0, \tag{8}$$

where the first term in the RHS represents, if positive (negative), the present value of the hypothetical intertemporal losses (gains) from having financed the long term asset from $t=0$ to $t=2$ with a sequence of market funding at rates r_0 and r_1 at $t=0$ and $t=1$, respectively. The second term subtracts from those losses the present value of the intertemporal margins earned from financing part of the long term asset with deposits d_0 and $(1-\psi)d_0$ at dates $t=0$ and $t=1$, respectively.

In general, whether a particular initial capital ratio e_0 ensures solvency at $t=2$ depends on parameters and the realization of the random variables r_1 and ψ. The impact of parameters and these random variables on $e(r_1,\psi)$ is shown in the form of signs below the relevant argument of a function F abstractly representing $e(r_1,\psi)$ in the following equation:

$$e(r_1,\psi) = F(\underset{?}{r_1},\underset{+}{\psi};\underset{-}{c_0},\underset{-}{c_1},\underset{?}{r_0},\underset{+}{\alpha},\underset{+}{\beta},\underset{-}{d_0}). \tag{9}$$

Hence, most arguments have a non-ambiguously signed impact on $e(r_1, \psi)$ and the only exceptions are, remarkably, the short term market rates r_0 and r_1. Other things equal, when any of these rates are higher, the present values of future gains or losses decline, possibly contributing to the ambiguity. On top of that, higher market rates imply (i) lower profitability from the financing the long term asset at market rates (that is, a negative impact on the first term of $e(r_1, \psi)$), and (ii), for $\beta < 1$, higher profitability from financing part of the long term asset with deposits.

The following expressions provide details on the derivatives of $e(r_1, \psi)$ with respect to r_0 and r_1 after expressing it as

$$e(r_1, \psi) = A - Bd_0, \tag{10}$$

with

$$A \equiv \frac{(r_1 - c_1) - (1 + r_1)(c_0 - r_0)}{(1 + r_1)(1 + r_0)} = \frac{(r_1 - c_1)}{(1 + r_1)(1 + r_0)} - \frac{c_0 - r_0}{1 + r_0} \tag{11}$$

and

$$B \equiv \frac{(1 - \beta)r_0 - \alpha}{1 + r_0} + \frac{[(1 - \beta)r_1 - \alpha](1 - \psi)}{(1 + r_1)(1 + r_0)}. \tag{12}$$

We have

$$\begin{aligned} \frac{\partial A}{\partial r_0} &= -\frac{(r_1 - c_1)}{(1 + r_1)(1 + r_0)^2} - \frac{-1 - r_0 - c_0 + r_0}{(1 + r_0)^2} \\ &= -\frac{(r_1 - c_1)}{(1 + r_1)(1 + r_0)^2} + \frac{1 + c_0}{(1 + r_0)^2} \\ &= \frac{1 + c_1 + c_0(1 + r_1)}{(1 + r_1)(1 + r_0)^2} > 0 \end{aligned} \tag{13}$$

unless c_0 and/or c_1 are negative (and extremely large in absolute value). And

$$\frac{\partial A}{\partial r_1} = \frac{1 + c_1}{(1 + r_1)^2(1 + r_0)} > 0. \tag{14}$$

This confirms common wisdom on the negative effects of market interest rates (r_0 and r_1) on the profitability of holding long-term assets with fixed coupons. This term pushes in making the capital ratio required for the bank to be solvent at $t = 2$ increasing in r_0 and r_1.

On the other hand, we have

$$\begin{aligned} \frac{\partial B}{\partial r_0} &= \frac{(1 - \beta) + \alpha}{(1 + r_0)^2} - \frac{[(1 - \beta)r_1 - \alpha](1 - \psi)}{(1 + r_1)(1 + r_0)^2} \\ &= \frac{(1 - \beta) + \alpha + (1 - \beta)r_1 + \alpha r_1 - (1 - \beta)r_1 + \alpha + [(1 - \beta)r_1 - \alpha]\psi}{(1 + r_1)(1 + r_0)^2} \\ &= \frac{(1 - \beta) + \alpha(2 + r_1 - \psi) + (1 - \beta)r_1\psi}{(1 + r_1)(1 + r_0)^2} > 0, \end{aligned} \tag{15}$$

and

$$\begin{aligned}\frac{\partial B}{\partial r_1} &= \frac{[(1-\beta)(1+r_1)-(1-\beta)r_1+\alpha](1-\psi)}{(1+r_1)^2(1+r_0)} \\ &= \frac{[(1-\beta)+\alpha](1-\psi)}{(1+r_1)^2(1+r_0)} > 0, \end{aligned} \tag{16}$$

whose signs confirm that higher values of r_0 or r_1 imply a higher value of the deposit franchise, reducing for any given d_0, the initial capital required to the bank remain solvent at $t = 2$.

The final impact of r_0 and r_1 on the capital needed for the bank to be solvent ultimately depends on the importance of the effects captured in A (asset-side losses) relative to those captured in B (franchise value gains). With respect to the latter, it is immediate to see that their final impact on e_0 is (i) proportional to d_0, and (ii) the profitability-enhancing effects of r_1 are also proportional to $1-\psi$, that is, the capacity of the bank to retain its deposits between $t = 1$ and $t = 2$. Since in our setup banks have no assets paying market rates, the net effect of the opposite-sign effects coming through A and B should be unambiguously negative (since the bank's funding costs are definitely not decreasing in r_0 and r_1). Yet, the ambiguity may reappear if the bank has assets with returns linked to short terms rates, as those might imply increases in intermediation margins on the asset side as well, contributing to further offset what through B can only be a partial offsetting of the effects experienced through A.

5 A stress-testing approach to required capital

The analysis in the previous section shows that the capital needed for a bank funded with deposits to remain solvent when facing interest rate risk (potential rises in r_1) and run-off risk (potential rises in ψ) is not necessarily (although it will be typically) increasing in r_1, while it is generally increasing in ψ. The impact of r_1 on solvency ultimately depends on the importance of the deposit franchise and might turn from negative to positive if the bank has a large deposit base (its deposit to asset ratio d_0 is high), deposit interest rates are not very sensitive to market rates (β is low), and the bank manages to retain a large fraction of its deposits in adverse circumstances (ψ is low). The interaction between interest rate risk and run-off risk is crucial. If a rise in r_1 is combined with fears that lead to an abnormally high withdrawal of bank deposits (potentially up to the upper limit ψ_h determined by deposit insurance or some other credible backstop), the capital ratio needed for the bank to remain solvent is higher than in the case the bank could retain all its deposits ($\psi = 0$).

Building on terminology from the literature on bank panics we can identify $e(r_1, 0)$ as the minimum capital ratio for which the bank is *fundamentally solvent* (that is, solvent provided that it retains all its deposits at $t = 1$) and $e(r_1, \psi_h)$ as the minimum capital ratio for which the bank is *supersolvent* (that is, able to withstand even the highest conceivable withdrawals ψ_h) when the interest rate prevailing at $t = 1$ is r_1. A supersolvent bank should be immune to rational self-fulfilling runs and, if by any other reason, it were subject to withdrawals within the range $[0, \psi_h]$, it would be able to absorb the implied losses; thus its name. In contrast a bank that is fundamentally solvent but not supersolvent (that is, has its capital ratio in the interval $(e(r_1, 0), e(r_1, \psi_h)))$ would be vulnerable to rational runs based on self-fulfilling insolvency fears. Finally, of course, a bank that is not fundamentally solvent under r_1 (that is, has its initial capital ratio below $e(r_h, 0)$) would suffer a rational run for sure if the interest rate at $t = 1$ is r_1.

Based on (8), we have:

$$e(r_1, \psi_h) - e(r_1, 0) = \frac{[(1-\beta)r_1-\alpha]}{(1 + r_1)(1 + r_0)} \psi_h d_0,$$

which shows that the extra capital buffer needed to guarantee supersolvency (rather than just fundamental solvency) is equal to the discounted value of the interest rate margins $((1-\beta)r_1-\alpha)$ associated with the runable deposits of the bank $(\psi_h d_0)$. Institutions such as deposit insurance together with other aspects affecting the runability of deposits (demographic characteristics of the depositors base, digitalization, social net works) can thus have an influence on the amount of capital needed to guarantee resilience to runs, engendering possible policy trade-offs.

More generally, the ratio $e(r_1, \psi_h)$ necessary to guarantee supersolvency can show great variation across banks, driven by variation in features related to the jurisdictions in which they operate (e.g. the credibility of their deposit insurance systems), market structure and competition (affecting deposit margins and their sensitivity to market interest rates), and business models (e.g. with greater or lower reliance on retail versus wholesale or household versus corporate deposits). All this points to the difficulty of adopting a simple one-size-fits-all approach to the prudential treatment of interest rate risk in the banking book and points to more individually-calibrated requirements based on suitably designed stress-test approaches as the best alternative to align the required loss absorption capacity of the bank with the size of the potential losses.

Numerical examples To gauge the quantitative importance of the deposit franchise effects captured in our formula for $e(r_1, \psi)$, we are going to evaluate such a formula across several numerical examples. The numbers emerging from this exercise must be taken with a grain of salt since the time structure of a three date model is typically quite unsuitable for calibration, as since banks in the real world operate over longer horizons. More specifically, assuming one period in the model (the distance between to consecutive dates) corresponds to one calendar year, the model might help quantity the effects associated with the financing of long-term assets with a maturity of two years but would fail to capture effects due to investing in assets with longer maturities which might give rise to higher capital losses upon a sufficiently persistent rise in interest rates.

To partly account for this, one "short-cut" solution that preserves the three-date structure of the model is to assume asymmetry in the length of the calendar time between dates and to adjust the interest rates and intermediation margins accruing between dates to the assumed length of the periods. In this sense, the numerical examples in this subsection will assume that the period between $t = 0$ and $t = 1$ corresponds to one calendar year, while the period between $t = 1$ and $t = 2$ corresponds to $T \geq 1$ calendar years, where T can be interpreted as the relevant *residual maturity* of the long-term assets of the bank at the time the uncertainty about the interest rate r_1 prevailing after $t = 1$ and the run-off rate ψ experienced by the bank at $t = 1$ realize.

To avoid adding further complications to the formula in (8), we will simply multiply by T the interest rates, returns, and intermediation margins accruing between $t = 1$ and $t = 2$ so that parameters such as α, c_1, or r_1 can still be measured in "per year" terms. The resulting generalized expression for $e(r_1, \psi; T)$ is:

$$e(r_1, \psi; T) \equiv \frac{T(r_1 - c_1) - (1 + Tr_1)(c_0 - r_0)}{(1 + Tr_1)(1 + r_0)} - \left(\frac{(1-\beta)r_0 - \alpha}{1 + r_0} + \frac{T[(1-\beta)r_1 - \alpha](1-\psi)}{(1 + Tr_1)(1 + r_0)} \right) d_0. \quad (17)$$

In the numerical examples below we evaluate, in the adverse interest rate scenario with $r_1 = r_h$, the naïve mark-to-market requirement $e(r_h, 1)_{|d_0=0}$, the pessimistic full-run-off requirement $e(r_h, 1)$, the supersolvency requirement $e(r_h, \psi_h)$, and the optimistic fundamental solvency requirement $e(r_h, 0)$ for three illustrative values of the residual maturity parameter, $T = 1, 5, 10$. Each example introduces some variation in parameters with respect to first example and the changed parameters appear in **bold**.

Table 1
Baseline example. Zero lower bound initial scenario

Parameters

r_0	r_l	r_h	c_0	c_1	α	β	d_0	ψ_h
0.00	0.00	0.03	0.01	0.01	0.01	0.40	0.70	0.30

Results under $r_1 = r_h$ (adverse scenario)

T	$e(r_h,1)_{\mid d_0=0}$	$e(r_h,1)$	$e(r_h,\psi_h)$	$e(r_h,0)$
1	0.009	0.013	0.007	0.004
5	0.077	0.080	0.053	0.041
10	0.144	0.147	0.098	0.077

Results under $r_1 = r_l$ (benign scenario)

T	$e(r_l,1)_{\mid d_0=0}$	$e(r_l,1)$	$e(r_l,\psi_h)$	$e(r_l,0)$
1	-0.020	-0.017	-0.014	-0.013
5	-0.060	-0.057	-0.044	-0.039
10	-0.110	-0.107	-0.082	-0.072

Table 2
Positive initial rates scenario

Parameters

r_0	r_l	r_h	c_0	c_1	α	β	d_0	ψ_h
0.02	0.00	**0.05**	**0.03**	**0.03**	0.01	0.40	0.70	0.30

Results

T	$e(r_h,1)_{\mid d_0=0}$	$e(r_h,1)$	$e(r_h,\psi_h)$	$e(r_h,0)$
1	0.009	0.004	-0.007	-0.012
5	0.069	0.064	0.016	-0.005
10	0.121	0.116	0.036	0.002

Differences with respect to baseline

T	$e(r_h,1)_{\mid d_0=0}$	$e(r_h,1)$	$e(r_h,\psi_h)$	$e(r_h,0)$
1	-0.001	-0.009	-0.014	-0.016
5	-0.008	-0.017	-0.037	-0.046
10	-0.023	-0-031	-0.062	-0.076

Table 3
Narrower maturity transformation gains (lower long-term asset yields)

Parameters

r_0	r_l	r_h	c_0	c_1	α	β	d_0	ψ_h
0.00	0.00	0.03	**0.005**	**0.005**	0.01	0.40	0.70	0.30

Results

T	$e(r_h,1)_{\vert d_0=0}$	$e(r_h,1)$	$e(r_h,\psi_h)$	$e(r_h,0)$
1	0.019	0.023	0.017	0.014
5	0.104	0.107	0.080	0.068
10	0.187	0.191	0.142	0.121

Differences with respect to baseline

T	$e(r_h,1)_{\vert d_0=0}$	$e(r_h,1)$	$e(r_h,\psi_h)$	$e(r_h,0)$
1	0.001	0.001	0.001	0.001
5	0.027	0.027	0.027	0.027
10	0.043	0.043	0.043	0.043

Table 4
Narrower intermediation margins (higher deposit betas)

Parameters

r_0	r_l	r_h	c_0	c_1	α	β	d_0	ψ_h
0.00	0.00	0.03	0.01	0.01	0.01	**0.60**	0.70	0.30

Results

T	$e(r_h,1)_{\vert d_0=0}$	$e(r_h,1)$	$e(r_h,\psi_h)$	$e(r_h,0)$
1	0.009	0.013	0.010	0.008
5	0.077	0.080	0.066	0.059
10	0.144	0.147	0.121	0.110

Differences with respect to baseline

T	$e(r_h,1)_{\vert d_0=0}$	$e(r_h,1)$	$e(r_h,\psi_h)$	$e(r_h,0)$
1	0.000	0.000	0.003	0.004
5	0.000	0.000	0.013	0.018
10	0.000	0.000	0.023	0.032

6 Liquidity requirements

In this section we sketch how the analysis in prior sections can be extended to consider the role of liquidity requirements, namely, requirements imposing that a minimal fraction of bank assets are safe and of short maturity, so that their value is unaffected by unexpected changes in interest rates.

The discussion on liquidity requirements would be trivial in the absence of an positive expected term premium in the long-term assets in which the bank may invest (e.g. long-term government bonds or bank loans) since in this case a bank fully invested in short-term assets could then appropriate the intermediation margin on deposits without incurring any interest rate risk. If a term premium exits, liquidity requirements come at the cost of reducing the interest rate income generated by the bank, which on expectation should be positive when the bank invests in those assets and, hence, per se, on average, a source of value and loss absorbing capacity. Yet, such requirements can reduce the interest rate related losses in adverse interest rate scenarios and hence be potentially useful in making banks both super-solvent and fundamentally solvent (but fragile) in those scenarios.

If the bank in our baseline model operates at $t = 0$ with a positive amount of short-term market funding, $b_0 > 0$, the marginal effects of a liquidity requirement on solvency are (to a first approximation) equivalent to reducing b_0 and, in parallel, the investment in the long term asset by Δ. Adding these variations, equation (2) becomes

$$n_2 = (1 - \Delta)(1 + c_1) - (1 + \alpha + \beta r_1)(1 - \psi)d_0 - (1 + r_1)b_1, \tag{18}$$

and equation (1) becomes

$$(1 + \alpha + \beta r_0)d_0 + (1 + r_0)(1 - \Delta - d_0 - e_0) = (1 - \Delta)c_0 + (1 - \psi)d_0 + b_1, \tag{19}$$

implying

$$b_1 = (1 + \alpha + \beta r_0)d_0 + (1 + r_0)(1 - \Delta - d_0 - e_0) - (1 - \Delta)c_0 - (1 - \psi)d_0, \tag{20}$$

As a result, we have

$$
\begin{aligned}
n_2 &= (1-\Delta)(1+c_1)-(1+\alpha+\beta r_1)(1-\psi)d_0-(1+r_1)(1+r_0)(1-\Delta-e_0) \\
&\quad +(1+r_1)[(1-\beta)r_0-\alpha]d_0+(1+r_1)c_0+(1+r_1)(1-\psi)d_0 \\
&= [(1+c_1)+(1+r_1)c_0-(1+r_1)(1+r_0)](1-\Delta)+(1+r_1)(1+r_0)e_0 \\
&\quad +(1+r_1)[(1-\beta)r_0-\alpha]d_0+[(1-\beta)r_1-\alpha](1-\psi)d_0 \\
&= [(c_1-r_1)+(1+r_1)(c_0-r_0)](1-\Delta)+(1+r_1)(1+r_0)e_0 \\
&\quad +(1+r_1)[(1-\beta)r_0-\alpha]d_0+[(1-\beta)r_1-\alpha](1-\psi)d_0, \qquad (21)
\end{aligned}
$$

implying

$$e(r_1,\psi;\Delta)\equiv\frac{(r_1-c_1)-(1+r_1)(c_0-r_0)}{(1+r_1)(1+r_0)}(1-\Delta)-\left(\frac{(1-\beta)r_0-\alpha}{1+r_0}+\frac{[(1-\beta)r_1-\alpha](1-\psi)}{(1+r_1)(1+r_0)}\right)d_0. \qquad (22)$$

Thus, assuming that in adverse interest rate scenarios,the first term in (22) is positive (because of asset side losses implied by a rise in r_1), increasing the liquidity requirement Δ at $t=0$ is a way to reduce the size of those future losses and the implied loss absorption needs. More generally, for given adverse scenarios (r_1,ψ), this equation provides a linear frontier of choices of $e(r_1,\psi)$ and Δ that guarantee the solvency of the bank in those scenarios. Out of the points in this frontier, the most efficient would be the least costly in terms of the sum of (i) the wasted expected maturity transformation gains, which could be measured by averaging those gains across all scenarios (benign and adverse),

$$\text{Lost MT gains}=E\left[\frac{(c_1-r_1)+(1+r_1)(c_0-r_0)}{(1+r_1)(1+r_0)}\right]\Delta, \qquad (23)$$

and the social costs of requiring banks to operate with greater initial equity, $e(r_1,\psi)\rho^S$, where ρ^S is the excess social cost of each unit of extra equity funding required to banks (which might include economic losses from any induced reduction in credit or investment). In the polar case in which the expected maturity transformation gains in (23) were not positive, setting $\Delta=1$ would be optimal. While in the alternative polar scenario with $\rho^S=0$ guaranteeing supersolvency by simply relying on a sufficiently high capital requirement would be optimal.

In less polar scenarios, it is generally unclear whether liquidity requirements are superior to capital requirements as an ex ante prudential measure or vice versa. We can reasonably conjecture that liquidity (capital) requirements will tend to be superior (to the other alternative) if the expected term premium earned on long term assets is small (large) while the excess cost of requiring banks to be funded with more equity capital is large (small).

7 Policy trade-offs

Building on the baseline numerical example in Table 1 above, this section considers variations in policy-related parameters such as the maximum run-off rate ψ_h (which can be associated with the degree of coverage of the deposit base d_0 with deposit insurance) and, based on the extended formulas in (22) and (23), the liquidity requirement Δ.

Table 5
Extending insurance to an additional 10% of deposits

Parameters

r_0	r_l	r_h	c_0	c_1	α	β	d_0	ψ_h
0.00	0.00	0.03	0.01	0.01	0.01	0.40	0.70	**0.20**

Results

T	$e(r_h,1)_{\lvert d_0=0}$	$e(r_h,1)$	$e(r_h,\psi_h)$	$e(r_h,0)$
1	0.009	0.013	0.006	0.004
5	0.077	0.080	0.049	0.041
10	0.144	0.147	0.091	0.077

Differences with respect to baseline

T	$e(r_h,1)_{\lvert d_0=0}$	$e(r_h,1)$	$e(r_h,\psi_h)$	$e(r_h,0)$
1	0.000	0.000	-0.001	0.000
5	0.000	0.000	-0.004	0.000
10	0.000	0.000	-0.007	0.000

Table 6
Removing deposit insurance ($\psi_h = 1$)

Parameters

r_0	r_l	r_h	c_0	c_1	α	β	d_0	ψ_h
0.00	0.00	0.03	0.01	0.01	0.01	0.40	0.70	**1.00**

Results

T	$e(r_h,1)_{\lvert d_0=0}$	$e(r_h,1)$	$e(r_h,\psi_h)$	$e(r_h,0)$
1	0.009	0.013	0.013	0.004
5	0.077	0.080	0.080	0.041
10	0.144	0.147	0.147	0.077

Differences with respect to baseline

T	$e(r_h,1)_{\lvert d_0=0}$	$e(r_h,1)$	$e(r_h,\psi_h)$	$e(r_h,0)$
1	0.000	0.000	0.006	0.000
5	0.000	0.000	0.028	0.000
10	0.000	0.000	0.049	0.000

The following table describes the implications of introducing a liquidity requirement Δ. For purely illustrative purposes, the requirements is fixed at the level $\Delta=\psi_h d_0$ which would, mechanically, allow to accommodate the maximum level of deposit withdrawals at $t=1$ without having to issue additional short-term market debt. To compute the lost intermediation margins according to (23), it is assumed that the high interest rate scenario ($r_1=r_h$) occurs with probability 20%, while with the remaining probability of 80% the interest rate remains at it lowest level ($r_1=r_l$). Lost intermediation gains are compared to the saved equity funding costs assuming a social excess cost of equity funding (ρ^S) equal to 10%. With these parameters, the net gains from the introduction of the liquidity requirement are negative: the loss of expected asset returns implied the requirements significantly exceeds the saved social costs of having to impose a lower minimum capital requirement, $e(r_h, \psi_h)$, to guarantee supersolvency in the adverse interest rate scenario.

Table 7
Introducing a liquidity requirement ($\Delta = 0.21$)

Parameters

r_0	r_l	r_h	c_0	c_1	α	β	d_0	ψ_h	Δ
0.00	0.00	0.03	0.01	0.01	0.01	0.40	0.70	0.30	**0.21**

Results

T	$e(r_h,1)_{\vert d_0=0}$	$e(r_h,1)$	$e(r_h,\psi_h)$	$e(r_h,0)$
1	0.007	0.011	0.005	0.002
5	0.061	0.064	0.037	0.025
10	0.114	0.117	0.068	0.047

Differences with respect to baseline

T	$e(r_h,1)_{\vert d_0=0}$	$e(r_h,1)$	$e(r_h,\psi_h)$	$e(r_h,0)$
1	-0.002	-0.002	-0.002	-0.002
5	-0.016	-0.016	-0.016	-0.016
10	-0.030	-0.030	-0.030	-0.030

Cost-benefit analysis (with pr(r_h)=1–pr(r_l)=0.2, ρ^S=0.1)

T	Lost MT gains	Saved cost of e_0	Net gain
1	0.0030	0.0002	-0.0028
5	0.0068	0.0016	-0.0052
10	0.0124	0.0030	-0.0094

8 Conclusions

As anticipated in the Introduction and part of the discussions above, authorities interested in making their banks supersolvent (that is not just fundamentally solvent but also resilient to solvency problems resulting from self-fulfilling runs) face several policy trade-offs regarding the treatment of interest rate risk in the banking book.

One of the trade-offs is between requiring banks to be funded with a larger proportion of loss absorbing liabilities (e.g. equity capital) and extending the coverage of the safety net on their deposits (or short term liabilities more generally). The optimal resolution of this trade-off will typically depend on cost-benefit considerations that should include aspects not explicitly captured in the current analysis such as the implications of expanded deposit insurance coverage for banks' risk shifting (or other instances of moral hazard) and the distortions to competition caused by insurance in the markets for deposits (and related money market securities). However, its seems reasonable to conjecture that, other things equal, relying on deposit insurance coverage would make more sense the larger the intermediation margins associated with deposits and the larger the ex ante cost of raising loss absorbing liabilities (e.g. because of the anticipation of larger agency problems between bank managers and the holders of these liabilities).

Another trade-off is between requiring banks to issue a larger proportion of loss absorbing liabilities or reducing the exposure to interest rate risk by imposing higher liquidity requirements. The corresponding discussion above suggests that liquidity (capital) requirements will tend to be superior (to the other alternative) if the expected term premium which will on average be earned on long term assets is small (large) while the excess cost of requiring banks to be funded with more equity capital is large (small).

The analysis contained in this note also suggests that a simple, one-size-fits-all solution to the prudential regulation of interest rate risk in the banking book does not exist, since the capital requirement that would make banks supersolvent in adverse interest rate scenarios would generally depend on the size of their deposit bases, the size of the intermediation margins and their sensitivity to market interest rates (the so-called deposit betas), and the stickiness (or runability) of these deposits. Some numerical example provided above suggest that the quantitative implications of these considerations (that is, their translation into the size of the capital buffers needed to guarantee supersolvency) are not trivial.

In this context a microprudential stress-test approach would have the advantage of aligning the loss absorption capacity required to each bank with the size of the potential losses that it might suffer in adverse interest rate and deposit run-off rate scenarios. This approach seems broadly consistent with treating interest rate risk in the banking book within Pillar II of the current microprudential framework. Broadly speaking, and within the bounds implied by other elements of the existing prudential framework, banks would be free to choose their preferred combination of capital, liquidity and safety-net coverage tools (e.g. by adopting a business model that implies relying to a larger or lower extent on insured deposits for their funding), provided that they demonstrate their capacity to resist sufficiently adverse interest rate and deposit run-off rate scenarios under their equilibrium choices. If the supervisor regarded such a capacity insufficient, it should require the bank to immediately plan to cover of the protection shortfall with additional capital (a mandatory buffer) and subsequently apply, if relevant, the corrective actions (e.g. in terms of distributions) similar to those already envisaged in under current regulations when a buffer requirement is not met (e.g. under the MDA approach of Basel III).

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NON-TECHNICAL SUMMARY

The role played by losses related to interest rate risk in the banking book in the runs and subsequent failures of Silicon Valley Bank (March 10, 2023), Signature Bank of New York (March 12, 2023), and First Republic Bank (May 1, 2023) in the US in early 2023 has brought the discussion on the regulatory treatment of this risk to the top of the agenda of bank regulators and supervisors.

Exposure to interest rate risk is a direct implication of banks' involvement in maturity transformation as well as the fact that, even for assets and liabilities of a similar maturity structure, the effective yields that they pay or oblige to pay may not react with equal size or time path to changes in reference interest rates. For example, if a bank has a portfolio of ten year loans, the increase in the returns of those loans when reference interest rates increase will be very different if the loans pay a frequently revised floating rate than if they pay a fixed rate up to termination or up to a relatively distant revision date. Similarly, on the liability side, even if the bank relies heavily on short term debt, the situation is very different is such a debt are mainly deposits with interest rates that tend to react little or only very gradually to increases in interest rates (and thus tend to remain significantly lower than market rates when interest rates increase) than if the debt is commercial paper or certificates of deposit placed in a highly competitive market whose rates track reference rates much more closely.

On top of the sensitivity to market interest rates of the cash flows associated with the assets and liabilities that appear in a bank's balance sheet at a given point in time, banks may have exposures to interest rate derivatives that imply offsetting or augmenting changes in their cash flows when interest rates vary. Those exposures and their implications for the overall sensitivity to interest rates of banks' cash flow streams are not easily to gauge in standard accounting reports.

To make things more complicated, interest rate risk is a dynamic object. Its importance (or the importance of the potential gains and losses that it may generate) may evolve over time in response to numerous factors, including the persistence of the changes in the interest rates, internal management decisions (affecting the conditions of the contracts signed in the new interest rate scenarios or banks' hedging strategies), market wide factors (e.g. affecting banks' incentives to compete for deposits), or other aspects not entirely under the control of the bank, such as the loss of part or all of the deposit base perhaps partly, but not exclusively, because of fears that interest rate risk might put depositors' money at risk.

In an influential paper Dreschler et al. (2021) argue, based on evidence for US banks over a long time period, that the presence of a deposit franchise allows banks to effectively hedge against the impact of fluctuations in interest rates on the rest of their balance sheet. They understand by "deposit franchise" banks' capacity to finance a part of their activities with deposits that pay interest rates which are lower and react significantly less than one-by-one with reference market rates. In their analysis the so-called “deposit betas” measure the sensitivity of deposit rates to market rates in way similar to how the betas of the famous Capital Asset Pricing Model represent the partial correlation between the returns of a specific asset and the returns of the market portfolio. Quite intuitively, when deposit betas are lower than one, the intermediation margins earned on deposits (that is, the differences between market rates and deposit rates) contributing to offset potential declines in the intermediation margins earned on bank assets (that is, differences between the rates paid by those assets and market rates). The lower deposit betas, the stronger these hedging effects.

Dreschler et al. (2021) find that the estimated beta of interest rate expense (0.34) is very similar to the estimated interest rate income beta (0.35), implying that banks implicitly hedge the interest rate risk of their assets with the offsetting interest rate risk of their liabilities. This hedge takes place in spite of the maturity mismatch between aggregate bank assets (with estimated average maturity of 3.7 years) and aggregate bank liabilities (0.3 years), The study also finds that, although interest rate sensitivities of assets and liabilities differ across banks, they are strongly correlated in the cross-section, which suggest that banks tend to adopt business models under which their interest rate risk is largely “naturally” hedged by matching the interest rate sensitivities of their assets and liabilities.

Of course, these finding refer to a specific time period and apply to a typical bank in the reference sample. This is compatible with individual banks or business models failing to be effectively hedged against interest rate risk, as the bank failures witnessed in the US in early 2023 clearly illustrate. Those failures also identified that the franchise and hedging value of deposit funding is vulnerable to runs or, more generally, to any force that leads depositors to withdraw their funds or suddenly require banks to pay much higher rates for them to be willing to maintain or roll over their positions (such as the emergence of competing investment products, including better remunerated deposits at other banks or alternatives as such money market funds offering better yields).

When run-off risk realizes, the affected banks face the need to replace the flying deposit funding with more expensive funding sources or to significantly increase the remuneration of their deposits to stop or slow down the outflows. Having to find alternative sources of funding (including, in extreme cases, emergency funding from the lender of last resort) is likely to be the unavoidable outcome in the case of fully fledged runs, since it is improbable that deposit withdrawals mainly motivated by fears about the solvency of the bank can be offset by simply remunerating deposits at a higher rate. Instead, if deposit outflows are in principle only motivated by the presence of more attractive investment alternatives, rising deposit rates may still help reduce or even reverse the outflows. In both situations, however, the implication is that the funding of the bank becomes more expensive (and perhaps more difficult) than if value and hedging properties of the deposit franchise were assessed as if banks' deposit bases were invariant to interest rates and immune to panics.

From this perspective, interest rate risk and deposits' run-off risk may be more tightly connected than commonly thought (at least prior to the panics seen in early 2023 in the US). In the milder cases, rises in the reference interest rate may lead banks to lose some of their deposits unless they are willing to remunerate them at higher rates, with the net effect (both if the deposits are allowed to go and replaced by more expensive funding sources or if their fly is avoided by rising deposit rates) of a rise in banks' funding cost. In more severe cases, especially when the rise in the interest rate causes sufficiently large declines in the value of bank assets (e.g. if a bank holds unhedged positions in a long-term debt securities that pay fixed interest rates), the rise in interest rates may act as the trigger of a deposit run. These observations took Dreschler et al. (2023) to extend the analysis in Dreschler et al. (2021) to the case in which banks may not be able to retain their deposit funding or the relatively low (and less sensitive to reference interest rates) remuneration of their deposits when interest rates rise.

The analysis of banks' exposure to interest rate risk taking into account the hedging value but also the fragility of their deposit funding implies putting together the insights in Dreschler et al. (2021) with those of the literature on bank runs, including Diamond and Dybvig (1983), Rochet and Vives (2004), and Goldstein and Pauzner (2005), among others.

In this spirit, this paper discusses the prudential regulatory treatment of interest rate risk in the banking book in the context of a simple model that combines the standard representation of maturity transformation and the implied bank run risk of the literature in the tradition of Diamond and Dybvig (1983) with the observation that deposits are a source of rents (franchise value) and the relatively low sensitivity of their rates to market rates constitutes a natural source of hedging against interest rate risk. The analysis acknowledges that the intermediation margins earned on deposits contribute to banks' profitability but also that deposits are flighty and, hence, those margins may evaporate and not be ready to cover interest rate losses if depositors run away.

The analysis addresses the prudential regulatory treatment of interest rate risk in the banking book from the perspective of preserving the solvency of the banks and, specifically, that a bank that is fundamentally solvent but is financed with flighty deposits may turn insolvent due to the value destroying logic of self-fulfilling bank runs. The focus of the analysis on the implications of regulation for banks' solvency and vulnerability to runs is reminiscent of Vives (2014). However, the note abstracts, for simplicity, from incomplete information (and thus the endogenous determination of the probability of a bank run).

Instead it characterizes the set of regulatory choices that could make banks "supersolvent," that is, solvent even under the hypothetical realization of full run. The analysis allows to compare the set of regulatory choices under which banks are fundamentally solvent but "fragile" (that is, vulnerable to rational self-fulfilling runs) in some adverse interest rate scenario with those that would make them supersolvent (immune to rational self-fulfilling runs) the sense that they can remain solvent in the absence of a run but can become insolvent if a (rational) panic occurs.

The analysis reveals that if the deposit franchise is small or can easily evaporate because of a run, then the capital necessary to keep the bank supersolvent when interest rates unexpectedly rise coincides with the capital that would be needed to absorb the (potential) marked-to-market losses in its banking book. However, if the franchise value of deposits is not negligible and does not fully evaporate due to runs (e.g. because there is a base of insured deposits or other type of safety net interventions that help to keep deposits are the bank during potential runs), then the capital needed for the bank to remain supersolvent in those scenarios is lower than the latent marked-to-market asset side losses. Intuitively, this happens because simultaneously there are unrealized liability side intermediation margins (potentially widened by the rise in interest rates) that can also contribute to absorb the asset side losses.

In this context, the minimum equity buffers required for banks to remain solvent or supersolvent when interest rates unexpectedly spike are decreasing in the importance and stability of the deposit franchise. In fact, from an ex ante perspective, a valuable deposit franchise, even if it were expected to evaporate in sufficiently adverse future scenarios, reduces the capital that guarantees either supersolvency or fundamental solvency since it is a source of interest margin income (and hence an internal source of loss absorbing capacity) until a crisis starts. This argument adds to the previous one about situations where the deposit franchise value is partly or fully preserved in a crisis to conclude that, in general, marking the assets in the banking book to market and, thus, forcing banks to have the equity capital that would make them contemporaneously able to absorb the latent losses implied by fluctuations in interest rates would be harsher than necessary for a typical bank to preserve its supersolvency.

If the system can guarantee the stability of a greater fraction of deposits during crises (e.g. by extending the fraction of them covered by deposit insurance), the minimal capital that ensures that a bank is supersolvent declines. This means that authorities interested in preserving financial stability when confronting interest rate risk in the banking book face a trade-off between requiring more capital to banks and extending the coverage of the safety net on their deposits (or short term liabilities more generally). The optimal resolution of such a trade-off would depend on cost-benefit considerations that should include aspects such as the implications of expanded guarantees on banks' risk shifting temptations (or other instances of moral hazard) and the distortions to competition in the markets for deposits (and related money market securities). Its seems reasonable to conjecture that, other things equal, relying on deposit insurance coverage would make more sense the larger the intermediation margins associated with deposits and the larger the cost of increasing banks' capitalization (e.g., because of lack of capacity to achieve it internally and frictions in primary equity markets, or because of agency problems between managers and outside equity-holders).

Liquidity requirements are other policy tool whose role is worth considering in this context. By imposing that a minimal fraction of bank assets (or of some suitably defined measure of flighty liabilities, like in the case of the Liquidity Coverage Ratio requirement of Basel III), a liquidity requirement provides at first instance a buffer with which to accommodate potential deposit outflows without having to sell longer term or less liquid assets. Additionally, in the presence of interest rate risk and to the extent that the assets qualifying as "safe and liquid" in the requirement are of sufficiently short term maturities, a liquidity requirement also warrants that a minimal fraction of bank assets are no or very little affected by unexpected changes in interest rates. Due to these two good properties, the discussion on the financial stability value of imposing liquidity requirements would be trivial if they did not imply offsetting or neutralizing an essential element of banks' business model (and economic function): maturity transformation. The value of maturity transformation reflects into the typical presence of positive term premia that banks can earn by investing in long term assets such as long-term loans or bonds while funding them with the roll-over of shorter term liabilities. If there were no positive term premia, banks could earned the same intermediation margin on deposits by simply investing in short term assets (being something close to what the literature knows as "narrow banks") and, thus, without undertaking much interest rate risk on their asset side. However, if a term premium exits as it is the case in most realistic circumstances, imposing liquidity requirements comes at the cost of reducing the expected interest rate income that banks can generate. This is per se a source of erosion of their profitability and, dynamically, of their capacity to accumulate loss absorbing capacity. Thus, while liquidity requirements can reduce the interest rate related losses suffered by a bank in adverse interest rate scenarios, their imposition does not come without costs. Specifically, it is unclear whether liquidity requirements are superior to capital requirements as an ex ante prudential measure directed to guarantee banks' solvency in face of interest rate risk. The comparison may yield different outcomes for different banks and in different environments. Liquidity (capital) requirements will tend to be superior when the expected term premium earned on long term assets is small (large) and the excess social cost of demanding banks to be funded with equity or equivalent loss absorbing liabilities is large (small).

Altogether, this analysis suggests that a simple, one-size-fits-all solution to the prudential regulation of interest rate risk in the banking book does not exist. The preferred prudential measure as well as its detailed calibration will generally depend on the value of each bank's deposit franchise, the stickiness of the corresponding deposits, the marginal cost of increasing the bank's loss absorbing liabilities, and the term premium that can be earned by investing in long term assets financed with short term liabilities.

A potential approach to the problem that would offer the flexibility to cope with these heterogeneous across banks and variable over time determinants of the best prudential treatment would be to allow banks to choose their preferred combination of capital, liquidity and safety-net coverage tools (e.g. by relying more or less on insured deposits for their funding) provided that they demonstrate their capacity to resist sufficiently adverse interest rate scenarios under their equilibrium choices. This solution points to a framework broadly consistent with treating interest rate risk in the banking book within Pillar II of the current microprudential framework, requiring banks to regularly prove their capacity to pass suitably designed interest-rate-variability stress tests. If a bank's capacity to withstand adverse interest rate scenarios is regarded insufficient by the supervisor, the supervisor should require the bank to immediately plan to cover of the protection shortfall with additional capital (a mandatory buffer) and should subsequently apply, if relevant, corrective actions (e.g. in terms of distributions) similar to those already envisaged in under current regulations when a buffer requirement is not met (e.g. under the maximum distributable amount approach of Basel III).