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The Dynamics of Ample Reserves

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Abstract

How monetary policy is implemented can have significant implications for the dynamics of the central bank's balance sheet. If liquid deposits increase the demand for reserves (Lopez-Salido and Vissing-Jorgensen 2025), then the "ample" level of reserves needed to close the spread between the policy rate and interest on reserves is itself a function of liquid deposits. The supply of reserves will continue to normalize *after* first reaching ample levels and *until* liquid deposits return to trend as well. Furthermore, if the supply of reserves encourages deposit creation (Acharya et al. 2024), then a feedback loop arises that can amplify the persistence of elevated deposits and even lead to explosive dynamics. An off-the-shelf calibration exercise finds that even modest amounts of intrinsic deposit persistence could trigger explosive dynamics. Attenuating the response of ample reserves to deposits removes the risk of instability at a modest cost in terms of rate deviations. Simulations with stable roots show that reserves first reach ample earlier and at a higher level than expected by the demand of reserves alone. However, the supply of reserves *may* decrease further thereafter, at least relative to trend, as liquid deposits remain elevated in the transition period.

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Very well then I contradict myself,
(I am large, I contain multitudes.)

Walt Whitman, *Song of Myself*, 1892.

1 Introduction

The Federal Reserve's balance sheet plays a critical role across multiple policy dimensions. Reserves and lending facilities anchor monetary policy implementation and underpin the broader U.S. liquidity and regulatory frameworks. On the asset side, the primary role of the Fed's security holdings is to back up the aforementioned liabilities—plus currency in circulation. The asset side can also provide monetary accommodation via quantitative easing (QE) when the policy rate hits its effective lower bound.

Fulfilling these roles requires a minimum scale, ultimately set by the demand for the Fed's liabilities. In 2006, the balance sheet operated smoothly at roughly 5 percent of nominal GDP (NGDP). When the FOMC concluded its second stint of quantitative tightening (QT) in December 2025, the Fed's balance sheet exceeded 20 percent of NGDP. There is thus a clear drift in size, with reserves accounting for more than two-thirds of the historical change from 2006 to 2025.

Currently, the FOMC instructs the Open Market Desk at the Federal Reserve Bank of New York "to maintain ample reserves," which is being implemented via the Reserve Management Purchases (RMPs) program.[1] The driver of the Fed's balance sheet is thus the level of reserves deemed ample and will remain so until further FOMC instruction.

In this short policy paper, I define "ample" as the level of reserves at which the effective federal funds rate (EFFR) equals the interest on reserves (IOR), or a preset spread between them. This definition is not unique, but it is fully compatible with the FOMC's January 2019 statement that put "ample" into the lexicon, describing "*a regime in which an ample supply of reserves ensures that control over the level of the federal funds rate and other short-term interest rates is exercised primarily through the setting of the Federal Reserve's administered rates, and in which active management of the supply of reserves is not required.*" The definition I use is closest to Dallas Fed President Logan's view that ample reserves are ultimately a property of rates or, more precisely, spreads: "*Banks neither face an opportunity cost for holding reserves nor receive a subsidy for doing so,*" (Logan 2026).

With this definition at hand, I show that maintaining ample reserves can also have significant implications for the dynamics of the central bank's balance sheet.[2] First, if

[1] Implementation Note issued April 29, 2026, FOMC. See also FRB NY Desk's FAQ document.

[2] In addition to the well-understood, if poorly quantified, implications for the central bank's balance sheet.

the demand for reserves shifts with liquid deposits, as argued by Lopez-Salido and Vissing-Jorgensen (2025), then the level of ample reserves will also shift with deposits. The immediate implication is that when reserves first meet ample, that is, when the spread between policy and administered rates is first closed, the system may not yet be normalized: If deposits are still elevated relative to an unspecified trend, ample reserves will continue to decline, at least relative to trend, as deposits themselves normalize.

Second, if the supply of reserves encourages deposit creation, as documented in Acharya et al. (2024), then a feedback loop arises given by the elasticity of ample reserves to deposits times the deposit creation coefficient. The major concern is that the feedback loop magnifies the intrinsic persistence of deposits and, if strong enough, it would lead to explosive dynamics, with ample reserves growing without bound, taking the Fed's balance sheet along for the ride, at least until either the implementation policy or the transmission forces change.

These possibilities are formalized in a basic model that simply couples the main specifications from Lopez-Salido and Vissing-Jorgensen (2025) and Acharya et al. (2024).[3] The supply of reserves, ample reserves, and deposits are modelled as log-deviations from their unspecified trends. Similarly, I view the model's equations to be sufficient to establish the local, but not the global, properties of the system.

Ample reserves and their associated elasticity to deposits are given by inverting the demand for reserves at a zero EFFR–IOR spread. The stability condition is simple enough to state: The strength of the feedback loop plus the intrinsic persistence of deposits must be less than one. In other words, the coupling between ample reserves and deposits will introduce persistence in the dynamics of both variables, and if the feedback is strong enough, it can lead to explosive dynamics.[4]

An off-the-shelf calibration exercise finds that the feedback loop is substantial, driven by a very high elasticity of ample reserves to deposits. Without a clear path to identify the underlying trends, I leave the intrinsic persistence of deposits as the "known unknown" in the stability condition. At the point estimates from the aforementioned papers, modest amounts of intrinsic deposit persistence would be enough to push the system into instability.

I conduct some simple explorations of the implied dynamics under the QE-QT-RMP playbook, under a parametrization with stable roots.[5] I show that there is further normalization to go after the supply of reserves first meets ample. At that time, deposits are still

[3]I take the claims advanced in these papers as given, without further evidence for or against any of them.

[4]The reader may immediately wonder whether the only distinction that liquid deposits enjoy in my analysis is that they have been previously documented, and other factors (like, perhaps, payments) could follow a similar logic. The reader is immediately correct.

[5]The model allows for the supply of reserves to follow an exogenously given path as long as it remains above ample reserves on all previous dates. As a result, the timing when the supply of reserves first meets ample is endogenous.

elevated relative to trend, and thus, everything else the same, it takes more reserves than under trend deposits to implement the same spread. In other words, ample reserves themselves fully normalize only as deposits do. If we had forecast ample reserves without accounting for the role of deposits, we would have been surprised to encounter ample reserves sooner than expected, and at a larger amount than expected.

Fortunately, the Desk can simply attenuate the response of ample reserves to deposits, allowing some policy rate deviations, but drastically reducing the persistence of the system and hence the risk of explosive dynamics. For the QE-QT-RMP playbook, attenuated ample reserves plot a lower path for the Fed's balance sheet, with a longer QT phase and lower deposits. Attenuation is also a very robust approach, something that has not been lost on policymakers.[6]

I found it useful to state explicitly what my analysis does not do. First, it does not provide evidence for or against the claims advanced in the papers by Lopez-Salido and Vissing-Jorgensen (2025) and Acharya et al. (2024).[7] Second, it is purposefully silent about the *levels* of reserves and deposits, focusing instead on their dynamics given by log-deviations from unspecified trends.[8]

2 Model

The model is designed to isolate the effects between ample reserves and liquid deposits and be able to assess, locally, whether the dynamics are stable or explosive. It is not a full model of the banking system, the Fed's balance sheet, or, god forbid, both.

The model is based on two equations:

- A log-linear **demand for reserves** with an explicit role for liquid deposits, from Lopez-Salido and Vissing-Jorgensen (2025). I obtain an equation for **ample reserves** by inverting the demand for reserves at a zero EFFR–IOR spread.

- A **deposit creation** equation, from Acharya et al. (2024), capturing how banks shift to liquid deposits in response to abundant reserves. The equation also includes intrinsic persistence in deposits, but no asymmetry to capture the "ratchet" effect documented in the aforementioned paper.

[6]"We can't and shouldn't eliminate all fluctuations in market rates," (Logan 2026).

[7]At the time of this writing, there has been at best only a handful of periods to corroborate the evolution of ample reserves as defined here. Looking forward, the future joint evolution of ample reserves will inform such definition and, in turn, evolve our thinking regarding how reserves and other factors relate to each other.

[8]Perhaps a better understanding of the dynamics can then be useful in recovering such trends.

An unusual feature of the model is that the supply of reserves is allowed to follow an exogenous path as long as it remains above ample reserves. The model can then capture the QE/QT episodes as unrelated to deposit dynamics, with the transition to ample reserves as an endogenous event. A formal equilibrium definition is given at the end of this section.

2.1 Environment

Time is discrete and infinite $t = 1, 2, \ldots$. Initial conditions are dated at $t = 0$ and taken as given. The model is deterministic and written in terms of log-deviations from an unspecified trend. The variables of interest are the supply of reserves, m_t, ample reserves, m_t^a, and deposits, d_t; as well as the EFFR–IOR spread, s_t.

2.2 Ample reserves

The demand for reserves, from Lopez-Salido and Vissing-Jorgensen (2025), is

$$s_t = \phi_m \, m_t + \phi_d \, d_t, \tag{1}$$

where ϕ_m, ϕ_d are the demand coefficients for reserves and deposits, respectively. I expect the demand to be downward sloping in reserves, so $\phi_m < 0$. Anticipating that deposits shift the demand for reserves upward, I go ahead and assume $\phi_d \geq 0$ to avoid the possibility of negative roots in the stability condition later on.

An important simplification from equation (9) in Lopez-Salido and Vissing-Jorgensen (2025) is that I have omitted the non-linear floor given by the ON RRP rate.[9] The simplification is innocuous for the purpose of stability, as discussed in Lopez-Salido and Vissing-Jorgensen (2025). Once reserves are ample, the ON RRP facility is not binding. That said, it is still possible that the ON RRP rate spread to the IOR remains relevant.[10] Relatedly, the demand form (1) does not satisfy the "global" properties argued for in Lagos and Navarro (2026).

Are there structural foundations for this demand model? Lopez-Salido and Vissing-Jorgensen (2025) derive their specification with a theory of the banks' transaction costs, which brings a convenience yield on reserves that drives the spread between rates and the IOR.[11] Briefly, banks incur no transaction costs if they meet deposit outflows with reserves. However, if they must meet those outflows by reducing holdings of bonds, the bank incurs

[9] This feature is critical for estimation and is included in the robustness exercises in the online Appendix.
[10] See Armenter and Lester (2017) and Clouse and Schulhofer-Wohl (2018).
[11] Lopez-Salido and Vissing-Jorgensen (2025), Appendix 1.

transaction costs.[12]

To obtain the equation for ample reserves, I simply invert the demand for reserves at a zero spread $s_t = 0$, as in Vissing-Jorgensen (2026). Note this requires the demand to be *strictly* downward sloping in reserves. The resulting equation for ample reserves is

$$m_t^a = \frac{\phi_d}{-\phi_m} d_t. \tag{2}$$

The elasticity of ample reserves to deposits, $-\phi_d/\phi_m$, will determine by how much the Desk needs to adjust ample reserves in response to deviations in deposits from trend, and will prove to be the main impetus behind the feedback loop.

2.3 Deposit creation

The second key equation stems from Acharya et al. (2024). Among others, they document that "during the QE episodes, commercial banks expand their balance sheets, issuing demand deposits."[13] Deploying cross-section bank data, Acharya et al. (2024) claim a causal effect from the supply of reserves to deposit creation (to be more precise, liquid deposits and demandable claims more broadly). Adapted from their Section 3 on aggregate evidence, I write the response of deposits to changes in reserves as an equilibrium law of motion for deposits:

$$d_t = \gamma_m m_t + \rho_d d_{t-1}, \tag{3}$$

with $\gamma_m \geq 0$ the deposit creation coefficient and $0 \leq \rho_d < 1$ introducing intrinsic persistence in deposits, but by assumption deposits are stable in the absence of any feedback through the supply of reserves.

I should also immediately note that the aggregate evidence is not the basis of the causal claim in Acharya et al. (2024)—their analysis relies instead on bank-level panel data and an instrumental variable strategy. This generates a missing intercept problem. While I can proceed with the analytical results, the issue returns in full force in the next section when I attempt an off-the-shelf calibration. Stronger structural foundations would be desirable, but in their absence, I approach equation (3) as a reduced-form relationship that is at least

[12] This is unlikely to be the only structural foundation for deposits to shift the demand for reserves. After all, the Fed provides liquidity to banks, which are in the business of providing liquidity to their customers. It does not seem far-fetched to think that an increase in the "downstream" demand for liquidity will bring some increase in the demand for reserves.

[13] In a list that is not ever expected to be complete on how banks responded to QE and QT episodes: McCauley and McGuire (2014) for a look across borders, Kandrac and Schlusche (2021) for a focus on lending decisions, Ennis and Wolman (2015) on how the large excess reserves were ultimately distributed across depository institutions, ...

locally invariant.

2.4 Stability

Assume the supply of reserves is given by their ample level, $m_t = m_t^a$. Coupling the ample reserves equation (2) with the deposit creation equation (3), I obtain a simple one-dimensional system in deposits:

$$d_t = \left(1 - \gamma_m \frac{\phi_d}{-\phi_m}\right)^{-1} \rho_d d_{t-1}. \tag{4}$$

The stability condition is almost embarrassingly simple: The strength of the feedback loop, given by the product of the elasticity of ample reserves to deposits and the deposit creation coefficient, plus the intrinsic persistence of deposits, must be less than one:

$$\gamma_m \frac{\phi_d}{-\phi_m} + \rho_d < 1. \tag{5}$$

Note it is possible to have an unstable system even if deposits have no intrinsic persistence, $\rho_d = 0$, but in that case the system jumps to steady state as the only finite solution.

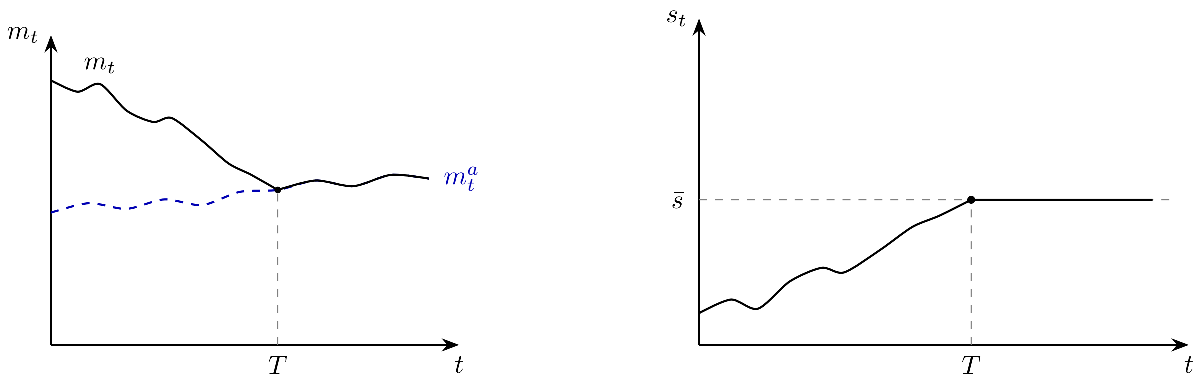
What does it mean if the system is unstable? The Desk will provide reserves as needed to close the EFFR–IOR spread. If deposits are elevated relative to trend, the level of ample reserves is higher than it would be otherwise, and as the Desk matches the needed amount, further deposits are created. Obviously this feedback cannot go unchecked forever and confines the model to a strict local approximation. Is there a level of reserves at which no further deposit creation occurs or, alternatively, banks become satiated despite elevated deposits? Or would instead the ample reserves approach be revisited? Let us not speculate: If unstable, all the model says is that at least one of these things must happen to prevent ample reserves from growing out of control and taking the Fed's balance sheet for a ride.

2.5 Equilibrium

I close this section with an overdue formal definition of equilibrium. As previously discussed, I want to accommodate exogenous paths for the supply of reserves, as long as they are above ample reserves, and an endogenous transition to the ample regime.

A sequence $\{m_t, d_t\}$ is an **ample-consistent** equilibrium, given an initial condition d_0, if for all t:

- deposit creation follows (3);
- the supply of reserves is abundant or ample, $m_t \geq m_t^a$, with m_t^a given by (2);



(a) Supply and ample reserves

(b) Spread EFFR–IOR

Figure 1: **Transition to ample reserves.** Panel (a): the supply of reserves m_t follows an exogenous, abundant path and meets the ample level m_t^a at the endogenous date T, tracking it thereafter. Panel (b): the spread (EFFR–IOR) is negative while reserves are abundant and closes to zero from T onward. Drawn for a stable system.

- ample reserves are absorbing: if $m_k = m_k^a$ for some $k < t$, then $m_t = m_t^a$.

The supply of reserves may follow an exogenous path—a QE or QT program—while strictly abundant, $m_t > m_t^a$; the transition to the ample regime occurs at the first date T with $m_T = m_T^a$, after which reserves track ample reserves.

Figure 1 illustrates the transition to ample reserves, assuming $d_t = 0$. Until time T, the supply of reserves follows an exogenous path—as long as it stays above ample reserves, which are also shown over time. The EFFR–IOR spread is negative, as the supply of reserves is abundant. At endogenous time T, the supply of reserves meets ample, and the spread closes to zero. From then on, the supply of reserves is given by ample reserves, depicted here for a stable system.

2.6 Three caveats

1. At best, equations (1) and (3) are local approximations of an underlying non-linear system. Lyapunov conditions for stability are still valid in a neighborhood of the steady state (or, in our case, near the trend), but the system is unlikely to have robust global properties.

2. While empirical evidence clearly points to deposits, other factors may also shift the demand for reserves. If, in turn, those factors are also affected by the supply of reserves, then they may also contribute to the feedback loop. For example, Ferris, Rose, and Tase (2025) discuss how reserves and payments interact, with significant effects on

spreads. My analysis can easily be extended to multiple factors, but the relationship among those factors can shape dynamics by themselves.[14]

3. There is no corroborating evidence for ample reserves (2). Simply put, at the time of this writing there is at most a handful of periods when one could reasonably claim that the supply of reserves was ample—and managed to remain so.

3 Off-the-shelf calibration

I now conveniently return to Lopez-Salido and Vissing-Jorgensen (2025) and Acharya et al. (2024) for an off-the-shelf calibration. The point estimates for parameters γ_m, ϕ_d, and ϕ_m are sufficient to pin down the strength of the feedback loop. I also discuss the robustness and comparative statics of the feedback loop.

The first decision is the frequency of the model. Lopez-Salido and Vissing-Jorgensen (2025) use monthly data, but I find it completely implausible that the feedback loop deposits-reserves-deposits operates at such high frequency. Instead, the preferred frequency is quarterly, which also has the advantage of smoothing out some of the volatility in the data. There is no going around the fact that this is a judgment call at this stage, which effectively confines the intrinsic persistence of deposits to its role as known unknown.

With the point estimates at hand, I can now compute the critical value of the intrinsic persistence of deposits, ρ_d, for stability. I find that the system is unstable for any $\rho_d > 0.7$ at the preferred quarterly frequency. That is, the critical value of ρ_d for stability implies a half-life of about two quarters—a modest amount.

I close this section with a set of simple exercises to show how the model can be used to simulate the transition to ample reserves and the dynamics thereafter. For these exercises, I choose a stable parametrization, with $\rho_d = 0.6$.

3.1 Point Estimates

Starting with the demand for reserves, Lopez-Salido and Vissing-Jorgensen (2025)'s preferred estimates are $\phi_m = -21.5$ and $\phi_d = 30.0$.[15] The specification is remarkably capable of tracking the spread for the full estimation period 2009-2025.

The resulting elasticity of ample reserves to deposits, $-\phi_d/\phi_m$, is about 1.4. That is, the demand for reserves is more sensitive to deposits than to reserves themselves, which already

[14] Even if the factors are independent of each other, the correct approach would be to model all factors jointly.

[15] That is, a 10% increase in reserves would lower the spread EFFR–IOR by a bit more than 2 basis points.

puts the onus on the Desk to respond more than one-to-one to changes in deposits if it wants to keep the spread EFFR–IOR at zero. In other words, ample reserves *exacerbate* the effects of the deposit creation channel.

Fortunately, the point estimates for the deposit creation channel are quite modest. Acharya et al. (2024) find $\gamma_m = 0.2$ in their panel estimation using instrumental variables. In their view, the deposit creation channel is driven by banks offering more liquidity to their customers, showing, for example, that time deposits actually decrease with the supply of reserves. However, due to their use of time fixed effects, I have a "missing intercept" problem in that general equilibrium effects are not captured by the coefficient. I take comfort that aggregate OLS returns comparable estimates over the paper's favorite window, 2009-2021, and remains significant extending the sample through 2025, across several lag structures. The caveat is that prior to 2019, the contemporaneous relationship is weaker in the aggregate data—though Acharya et al. (2024) extensively report that their panel estimates are robust across sample periods.

The resulting strength of the feedback loop, $\gamma_m \cdot -\phi_d/\phi_m$, is around 0.3 at the preferred quarterly frequency. The amount of feedback is quite substantial, but far from pushing the system to instability on its own.

3.2 Robustness

It is immediately apparent that small changes in the parameters can push the system to instability. In addition to the obvious, like an increase in deposit persistence, small changes in the demand coefficients can have a large effect on the feedback loop. For example, the feedback loop strengthens sharply if the demand for reserves meets ample where it is flatter: a slope of $\phi_m = -10$ brings the feedback loop to 0.6—halfway to instability before any deposit persistence is added.

I conducted a host of robustness checks, focused on the coefficients for the demand for reserves and trend specification.[16] Below I report the key findings, which frankly suggest that either further structure for low-frequency movements or a wider set of factors, in addition to deposits, are needed for the model to return consistent results.

- **Demand for reserves - Coefficients.** Exploring a wide range of log-linear specifications, I find that the coefficient for reserves in the demand function, $-\phi_m$, is quite robust around the point estimate—or even larger, suggesting less feedback. However, the coefficient for deposits, ϕ_d, is substantially more sensitive—and, unfortunately, on the upside. I found no specifications with a significant coefficient for deposits below

[16] All details are in the online appendix.

the mid-20s, while short-run specifications—distributed lags and long differences—produced significant coefficients as high as 85.

- **Ample Reserves - Elasticity.** The key summary statistic for the feedback loop is the elasticity of ample reserves to deposits, $-\phi_d/\phi_m$. Fortunately, most specifications return elasticities around 1.4, though a handful approach 2—driven by those estimations that return large coefficients for deposits.

- **Deposit creation channel.** The point estimate is robust across samples that span the 2020–21 expansion—both Acharya et al. (2024)'s 2009–2021 window and the full 2009–2025 sample. It is fragile only to *excluding* that episode: in samples ending in 2019 the coefficient falls by several-fold and the demandable-deposit response loses significance.

The comparative statics are mostly straightforward: the higher the effect of reserves on deposit creation, the stronger the feedback loop, and the more likely the system is to be unstable.

The comparative statics from the ample reserves equation are a touch more subtle. As one would expect, the more sensitive fed funds rates are to deposits, the stronger the feedback loop. But the important statistic is the ratio of the demand coefficients for deposits and reserves. That is inversely proportional, and particularly sensitive, to the slope of the demand for reserves, ϕ_m. This implies that if ample reserves are met where the demand for reserves is almost flat, that is, close to the abundant regime, the feedback loop will be very strong, and the system more likely to be unstable. Conversely, if ample reserves are met closer to scarce reserves, the slope of the demand for reserves may be steeper, and the feedback loop much weaker, making the system more likely to be stable.[17]

3.3 QE, QT, and RMP

Focusing on a parametrization with stable roots, I present a simple exercise to illustrate the model's implications over a cycle of QE, QT, and RMPs "maintaining ample reserves." The main result of interest is that when the supply of reserves meets ample, the system is not yet at its balanced growth path, as deposits are still above trend. As a result, reserves continue to normalize, albeit at a slow pace, as deposits gradually return to trend. RMPs will then undershoot those needed to keep up with the trend for some time.

Parameters are set at their point estimates, and the known unknown is arbitrarily set at $\rho_d = 0.6$, close but safely below the critical value for stability. Initial conditions are set at

[17] To be clear, the coefficients are fixed by equation (1) at each parametrization explored.

the trend, $d_0 = m_0 = 0$. The supply of reserves then follows a QE program, increasing the supply of reserves by 20% over 2 years in identical quarterly increments. Then a QT program follows, decreasing the supply of reserves at exactly half the pace of the QE program. As described in the equilibrium definition, the supply of reserves will follow the exogenous path as long as it has remained above ample reserves. Afterward, the supply of reserves will track ample reserves.

Figure 2 shows the results, in the top panel for log deviations from trend and in the bottom panel in levels, that is, log change since date $t = 0$.[18] The vertical dotted line marks the end of the QE program and start of the QT program, T_{qt}, set exogenously. The next vertical line, dashed, marks the endogenous time, T_a, when ample reserves are first met. Three lines are shown: the supply of reserves, m_t, the level of ample reserves, m_t^a, and deposits, d_t. By design, the supply of reserves is above ample reserves until T_a, after which it tracks ample reserves.

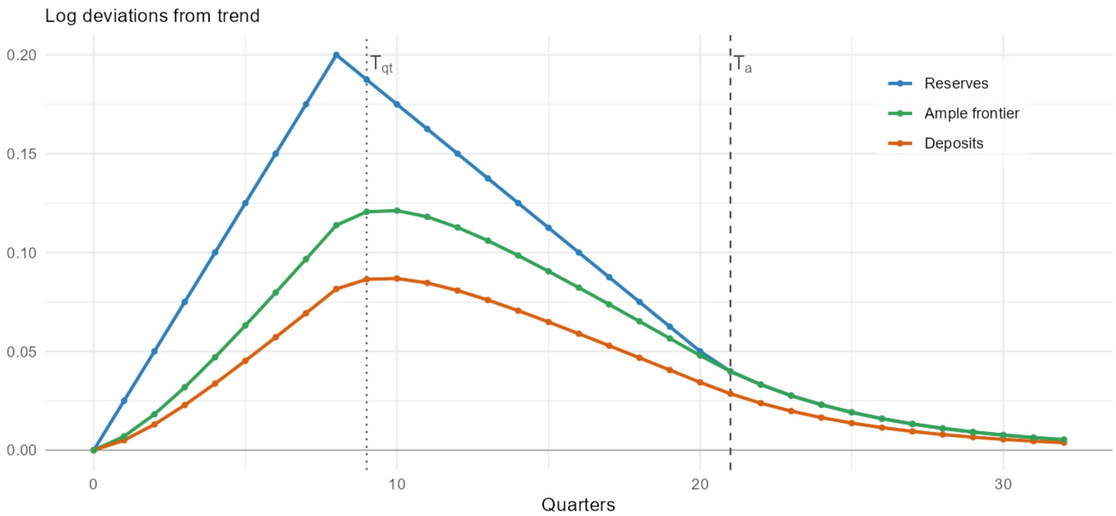
Starting with the top panel, and reading from left to right as time passes, the fast increase in reserves during the QE program pulls deposits up. In our exercise, QE brings a 20% increase in reserves, which translates into a peak of about 8% increase in deposits, right around the start of QT, T_{qt}. The reader may be surprised about the magnitude of the increase in deposits, given the modest deposit creation coefficient, $\gamma_m = 0.2$. Obviously, this is not due to the feedback loop: until T_a, the supply of reserves is not given by ample reserves and thus does not respond to deposits. Instead, it is the intrinsic persistence of deposits: At any given date t, we can write deposits as a function of the path of the supply of reserves to date,

$$d_t = \gamma_m \, m_t + \gamma_m \, \rho_d \, m_{t-1} + \gamma_m \, \rho_d^2 \, m_{t-2} + \cdots + \gamma_m \, \rho_d^{t-1} \, m_1.$$

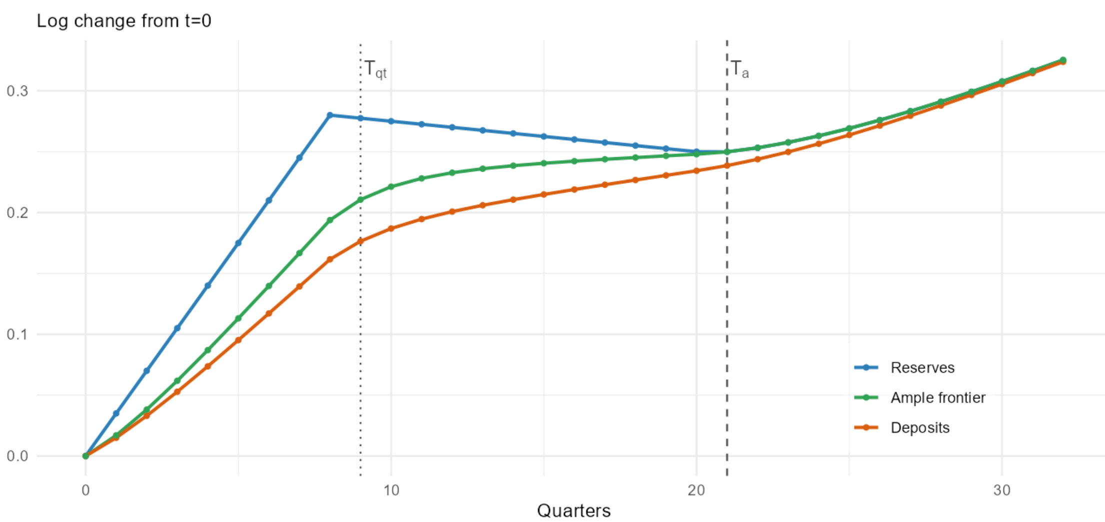
For example, if the Desk were to maintain a constant supply of reserves $m > 0$, deposits would eventually converge to $\gamma_m \, m/(1 - \rho_d)$, which at $\rho_d = 0.6$ is about 2.5 times $\gamma_m \, m$. Indeed, the length and pace of the QE program matter for the peak increase in deposits. In our exercise, the QE program lasts 8 quarters. Had the same 20% increase in reserves been compressed into 4 quarters, we would get a peak increase in deposits of about 6%, while if it had been stretched to 12 quarters, we would get a peak increase in deposits of about 9%. Projections ignoring deposits would struggle to find a stable specification for the path of ample reserves.

As deposits increase, everything else the same, the amount of reserves needed to close the spread increases: the level of ample reserves m_t^a shifts up—actually, (2) tells us exactly how much. As reserves start to decrease, both deposits and ample reserves start to normalize,

[18] For the latter, a simple linear trend of 4% growth was used.



(a) Deviations from trend



(b) Levels

Figure 2: **QE, QT, and RMP exercise.** The vertical lines mark the transition from QE to QT, T_{qt}, and the transition to ample reserves, T_a. Levels are constructed with a log-linear trend $0.01t$ for illustrative purposes. See main text for parameter choices.

albeit slowly due to the persistence of deposits. This means that the supply of reserves will meet ample *before* deposits, and thus ample reserves, have returned to trend.

Crucially, hitting ample reserves is not the same as being "back on trend." As long as deposits remain elevated, so does the level of ample reserves: from (2), closing the spread at T_a requires more reserves than the trend, steady-state level. An observer who forecast ample reserves from steady-state conditions—or who ignored the role of deposits altogether—would thus be surprised on two counts: the spread closes *sooner*, and at a *higher* level of reserves, than expected. Full normalization includes normal deposits.

At T_a, reserves relative to trend still have about 4 percentage points to go before they are back on trend. That is, the Fed's balance sheet will continue to shrink, at least relative to trend, for some time after the transition to ample reserves. The dynamics here are much clearer in terms of levels, in the bottom panel. Reserves resume growth after T_a, as the Desk starts the RMP program. However, the purchases needed to maintain ample, that is, to keep the spread at zero, are less than implied by trend growth.

Finally, a passing observation is that even simple dynamics can flip the sign of the correlation between changes in reserves and deposits. As shown in the bottom panel of Figure 2, during the QT program, reserves are decreasing while deposits are still increasing. The reason is that the deviation in reserves is closing faster than the deviation in deposits (top panel). Adding a trend can then confound the sign of the correlation in raw changes.[19]

4 Attenuation

Fortunately, there is a simple and straightforward solution to the risk of instability: attenuate the response of ample reserves to deposits. It does re-introduce some rate volatility, but attenuation can extend the QT program with small and temporary positive spreads. Moreover, attenuation should be easy to communicate as it is a well-known tool in control theory and has a long history in monetary policy.[20]

Consider the **attenuated ample reserves**, transforming (2) with an attenuation factor $\alpha \geq 0$:

$$\hat{m}_t = \frac{1}{1+\alpha}\,\frac{\phi_d}{-\phi_m}\,d_t. \tag{6}$$

For arbitrarily large α, the supply of reserves effectively becomes insensitive to deposits, and the system is stable for any $\rho_d < 1$. But since attenuated reserves deviate from the ample

[19]Because the added trend is for illustrative purposes only, the flipped sign is a possibility rather than a prediction. That said, I cannot help notice that the sign switch may appear as an asymmetric response in the data, which could be misinterpreted if one were not aware of the underlying dynamics.

[20]For example, see Goodfriend (1991).

level, the spread will no longer be pinned at zero:

$$s_t = \frac{\alpha}{1+\alpha}\,\phi_d\,d_t.$$

As expected, $\alpha = 0$ ensures no volatility in spreads. As α increases, the spread absorbs some of the deviation in deposits, which then no longer feeds into the feedback loop. Without shocks, the volatility of the system is bounded above as α grows large—the spread will always be bounded by $|\phi_d\,d_t|$.

In sum, the feedback loop weakens to $\gamma_m \frac{1}{1+\alpha} \frac{\phi_d}{-\phi_m}$, so the binding-regime persistence

$$\rho_{\text{eff}}(\alpha) = \frac{\rho_d}{1 - \gamma_m \frac{1}{1+\alpha} \frac{\phi_d}{-\phi_m}}$$

declines from its $\alpha = 0$ value back toward the intrinsic ρ_d. In other words, turning up attenuation buys lower persistence—and hence stability—at the cost of a more responsive, more volatile spread.

Because attenuation reduces the strength of the feedback loop, it reshapes the dynamics of the Fed's balance sheet. Figure 3 shows the transition to ample reserves under attenuation, with $\alpha = 1$, that is, halving the response of ample reserves to deposits; and with $\alpha = 0$, that is, the baseline case without attenuation.[21]

The left panel in Figure 3 shows the dynamics of reserves and deposits. For the first four quarters, the supply of reserves is driven by the exogenous path of the QT program. As shown in the right panel, the spread is then zero at $t = 5$, which is the defining characteristic of the unattenuated ample reserves regime. Reserves and deposits continue to decline, albeit more slowly, due to the dynamics discussed in the previous section.

For attenuated reserves, there is still a way to go. The spread is allowed to turn positive while the supply of reserves continues to fall for a couple more quarters. It then tracks the attenuated ample reserves—slowing down but continuing the normalization a bit further. Note that the spread normalizes back to zero as deposits return to trend: at the time of the transition, attenuated ample reserves look like targeting a positive spread, but in the long run attenuation has no impact. This is in contrast with actually targeting a positive spread, say of one or two basis points, which would change the long run value of the spread but would not taper down the feedback loop.

[21] Parameters are set as in the previous Section, and initial conditions are arbitrarily set $m_0 = .1, d_0 = .05$ for illustrative purposes.

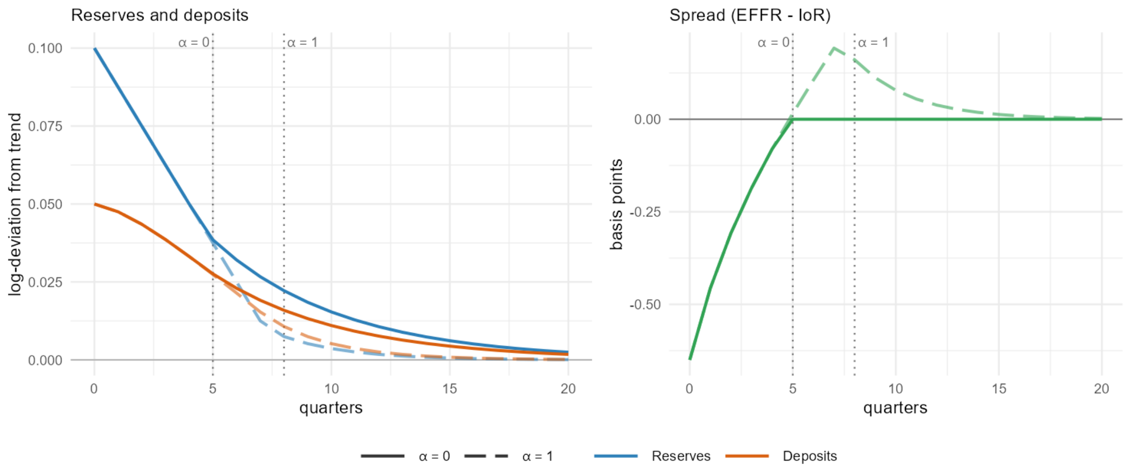


Figure 3: **Transition dynamics under attenuation.** Left: reserves and deposits. Right: the spread. Each panel compares no attenuation ($\alpha = 0$) with $\alpha = 1$. See main text for parameters.

5 Conclusions

The main point of this policy paper is to highlight that the dynamics of ample reserves may bring a surprise or two to the path of the Fed's balance sheet. By coupling the equations in Lopez-Salido and Vissing-Jorgensen (2025) and Acharya et al. (2024), and the associated supporting empirical evidence, I view the theoretical possibilities as both plausible and potentially impactful, as well as not fully scoped by the present work: Liquid deposits may not be the only factor driving the dynamics of ample reserves.

It is, though, the final result regarding attenuation that deserves further attention here. Without any long-run implications, attenuation wards off instability effectively by allowing small deviations in spread. It is also a remarkably simple solution that can be easily implemented and communicated. Moreover, were the premises leading to this paper's main results to be wrong, attenuation would be mostly innocuous.

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