Hiding in plain sight: preferred habitat effects in short-term rates*

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Abstract

This paper investigates the failure of the expectations hypothesis (EH) in an ideal yet critical setting: repurchase (repo) agreements, the short-term funding market underlying interbank lending. I exploit a regulatory reform which shortened the settlement cycle of *bond* markets to identify a preferred habitat of agents using repo to fund their fixed income positions. Trading patterns adjust accordingly in repo as agents' habitat preference changes. A triple-differences identification strategy demonstrates that this shock deteriorated the EH performance of the treated maturity, implying that preferred habitat effects can distort pricing even in optimal conditions. I argue that collateral scarcity and fragmentation act as a limit to arbitrage. My results further highlight a concerning usage of repo to finance leveraged positions.

Keywords: Expectations hypothesis, preferred habitats, repo markets, term structure of interest rates.

JEL classification: E43, G10, G12.

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Originating in Fisher (1896) and Keynes (1930), the expectations hypothesis (EH) is a fundamental theory in financial economics and a precursor of rational expectations. It provides a basic framework of the term structure of interest rates by positing that long-term rates are determined by the market's current expectations of future short-term rates. Despite its foundational nature and simple intuition, the EH has been consistently empirically rejected across many asset classes and time periods. A notable and important exception, however, is found in repurchase (repo) markets, where the evidence is inconclusive. Repo rates are an idealized setting in which to test the EH, as inter alia they are the ultra-short-term segment of the yield curve, minimizing interest rate uncertainty. The repo market is, incidentally, a crucial juncture in the financial system, as it is the primary source of banks' overnight funding and liquidity needs, and further serves as the transmission mechanism of monetary policy. This paper seeks to determine the source of the EH failure by studying its performance in repo, and further considers what deviations from the EH mean for the stability and well-functioning of this crucial market.

While the EH failure is usually explained through risk premia, the main innovation of this paper is to causally identify a preferred habitat effect operating at the heart of interbank repo lending. This is a significant finding in that such effects are associated with long-term maturities (e.g. 15, 30-year bonds; see Greenwood and Vayanos (2010, 2014)); this study demonstrates that habitat effects are more pervasive than commonly thought and can exist even in ultra-short, one-day maturities. Identification is achieved through a quasi-experiment leveraging a regulatory reform which shortened the settlement cycle of *bond* markets. Many institutions routinely rely on repo to deliver their settlement obligations in fixed income markets, and thus trading patterns in repo adjusted accordingly: 30% of daily trading volume instantly changed maturity the day of the reform. I thus observe agents change habitat preference and am able to exogenously test for a pricing effect, the presence of which confirms a preferred habitat dynamic. While interest rate risk is usually used to explain arbitrageurs' inability to close the spreads resulting from agents' inelastic demand, I argue that collateral scarcity and market fragmentation impedes such remedial trading. My analysis further suggests that agents use repo to take on leverage, raising additional financial stability concerns.

I proceed in three steps. First, I clarify whether and when the EH holds in repo rates. I demonstrate that the EH actually holds when considering general collateral trades, but breaks down in the "special" segment. That is, those repos which require pledging a *specific* underlying bond as collateral clearly fail the EH test, even when considering repos with the *same* underlying collateral. On the other hand, the EH cannot be rejected in those repo segments which do not demand a designated security as collateral (i.e., generals, where any bond from a list of approved collateral can be pledged). A monotonic decline in EH performance is observed across segments as specialness increases. This dichotomy allows me to isolate the root cause of the EH rejection: what is it about the special segment which causes it to fail?

Second, I identify a preferred habitat effect stemming from agents who use the repo market to deliver on their commitments in the cash (fixed income) market. These banks often pursue a strategy whereby they frequently sell bonds they do not own, or purchase bonds with liquidity they do not have; they thus turn to the repo market to make up for such shortfalls. As a quasi-experimental set-up I leverage a regulatory reform in 2014 whereby the European transaction settlement standards of *bond* markets were shortened to T+2 (as opposed to the usual T+3 timeline). Trading volumes in special repos adapted accordingly: a large shift in daily turnover occurred from the spot-next to the (shorter) tomorrow-next segment (general repos, which cannot be used to target a specific bond, were unaffected). As these agents have a habitat preference for the maturity which allows them to continue covering their cash and security positions, they had to migrate to the corresponding maturity when the fixed income settlement cycle shortened.

I then test whether this shift in habitat resulted in a pricing effect. I implement a difference-in-difference-in-differences model leveraging the fact that (i) only special repos were affected by the settlement change (and generals were not), and (ii) the tomorrow-next segment was affected, and the spot-next was not. I calculate the EH errors implied by these tenors when predicting the overnight rate. The results of my novel testing model suggest that deviations from the EH increased in the treated segment after this change: the EH error increased by 5-7 basis points across all collaterals. That is, the tomorrow-next tenor received an influx of trades which bid the repo rate up relative to the target overnight rate, as well as to untreated repos. This is powerful evidence of a preferred habitat dynamic. I consider alternative explanations for this effect and run various robustness checks. First, a similar triple-differences approach on order flow shows that buying pressure indeed similarly increased in the treated group. This strengthens the notion that it was participants' activity, not some other risk premium, which directly affected pricing. I demonstrate that rates moved in the opposite direction than predicted by alternative explanations, such as liquidity or specialness premia.

Finally, I consider what constraint stops arbitrageurs from closing the spreads resulting from such a habitat shift. In classic preferred habitat theory, interest rate risk caused by holding assets and liabilities of drastically different maturity profiles disincentivizes risk-averse arbitrageurs from trading prices back to their fundamental value. Such an explanation is inapplicable here, given that the rates under consideration only differ by a day in settlement time. Instead, I propose that collateral scarcity and fragmentation in repo markets stop potential arbitrageurs from fulfilling their role, as doing so requires the underlying security to be readily available. To test this hypothesis, I consider deviations from the EH and regress them on bond purchases conducted by the ECB under the auspices of the Public Sector Purchase Program (PSPP), an unconventional monetary policy measure. Indeed, when the supply of bonds is reduced, EH deviations widen. This is further confirmed through an alternative exercise regressing EH deviations on the specialness of bonds, which again reinforces that the more in-demand and sought-after a specific security, the higher the associated EH deviation.

The results of my experiment further indicate that leveraging is a widespread strategy in repo trading. If an agent repos a bond in order to cover a cash outlay, this represents leveraging in economic terms; the inverse operation is a short-sale. Given a positive price impact, leveragers' repo trades bid up the rate, whereas short-selling bids it down. I rationalize this through the presence of specialness convenience yields which decrease the cost of cash borrowing in repo, thus incentivizing leveraging. Agents use the valuable, safe asset collateral on their books to obtain cheap funding with which they can pay for bond purchases. They can even use the borrowed to cash purchase further bonds, allowing for further repo cash borrowing, and so forth. Such a strategy allows for infinite leverage in theory and has previously caused financial turmoil in practice, and as such constitutes a source of financial risk.

These findings are significant for three reasons. First, the results obtained in the idealized setting of general collateral repos show that the EH can indeed hold in optimal conditions, and is not just a theoretical construct. Interestingly, however, it fails in the special segment, even when I consider the same underlying collateral in the tests. In doing so, I contribute to the literature testing the EH in short-term rates (Longstaff (2000), Buraschi and Menini (2001), Della Corte, Sarno, and Thornton (2008)). While these papers have reached varying conclusions as to the EH performance, I point out that the fundamental aspect to consider is the conditions imposed on the choice of collateral.

Second, I contribute to preferred habitat theory by demonstrating that such inefficiencies are more pervasive than previously thought. The extant literature has considered preferred habitat effects driven by shocks to pension fund demand or unconventional monetary policy, but these are major shocks impacting long-term maturities spanning to 15 to 30 year horizons. While preferred habitat theory originated in the writings of Culbertson (1957) and Modigliani and Sutch (1966), it has only recently entered the mainstream academic literature, which seeks to understand its implications for the term structure and financial markets more broadly (Vayanos and Vila (2021), Gourinchas, Ray, and Vayanos (2022), Greenwood, Hanson, Stein, and Sunderam (2023), Klingler and Sundaresan (2023), Jappelli, Pelizzon, and Subrahmanyam (2023), Cavaleri (2023), Jansen, Li, and Schmid (2024)).

Finally, I show that arbitrage of the resulting spreads is constrained by collateral scarcity, and that the specialness of safe asset securities encourages a high degree of leveraging. I thus contribute to the literature on convenience yields (Krishnamurthy and Vissing-Jorgensen (2012)), of which repo specialness is a manifestation (Duffie (1996), Corradin and Maddaloni (2020), Arrata, Nguyen, Rahmouni-Rousseau, and Vari (2020)). Finally, my findings concerning this practice contribute to work documenting the microstructure of repo markets (Mancini, Ranaldo, and Wrampelmeyer (2016), Craig and Ma (2022), Ballensiefen, Ranaldo, and Winterberg (2023)), and highlight two vulnerabilities for policy-makers to consider: the usage of repo to leverage positions (Huh and Infante (2022), Huber (2023)), and the potential for fragmentation to distort market functioning and the pass-through of monetary policy (Eisenschmidt, Ma, and Zhang, 2024).

2 Related literature

The empirical studies rejecting the EH are too numerous to list.[1] A notable exception lies within repo markets, which the literature has argued are an ideal testing ground for the EH. This is primarily due to the ultra-short-term tenor of repo rates, which minimizes interest rate uncertainty; Cox, Ingersoll, and Ross (1981) show that the EH is a no-arbitrage condition in the absence of such uncertainty. Furthermore, as repo rates represent the cost of capital for holding riskless securities, they are arguably better measures of the short-term riskless term structure than Treasury

[1] Reviews of this literature can be found in the references of Fama and Bliss (1987), Longstaff (2000), as well as Della Corte et. al (2008). An exception is provided by Fama and Bliss (1987), who confirm earlier findings that forward rate forecasts of short-term interest rate changes fare poorly, but show that the 1-year forward rate has forecasting power for expected returns of 4- to 5-year U.S. Treasury bonds, which they attribute to the mean-reverting tendency of the 1-year rate. Campbell and Shiller (1991) find that for any combination of maturities between 1 month and 10 years in the U.S. term structure, high yield spreads forecast a rise in short-term interest rates and a declining yield of said bond, which is inconsistent with the EH. The EH has also been studied in foreign exchange (FX) markets by testing whether interest rate differentials between two currencies provide an unbiased conditional expectation of the future exchange rate. This is in essence a test of uncovered interest parity (UIP), and given the popularity of carry trades exploiting UIP's failure, it is unsurprising to hear that this iteration of the EH is strongly rejected; see Bekaert and Hodrick (2001) for a list of references.

bill rates. Finally, the repos under consideration are traded in an interbank market on anonymous, transparent, and liquid platforms cleared by central counterparties (Mancini et. al, 2016), which allows for the stark reduction of counterparty credit risk.

Accordingly, the literature has interested itself with whether the EH holds in the ideal conditions presented by this segment. Longstaff (2000) studies general collateral repos backed by U.S. Treasuries and finds that overnight, weekly, and monthly repo rates are unbiased estimates of the average overnight rate for the period from 1991 to 1999. Thus, the author cannot reject the EH and further finds no evidence for the existence of term premia, even up to weekly and monthly maturities. This finding is challenged and somewhat contradicted by Della Corte et. al (2008) who study the same data for the time period 1991 to 2005. They reject the EH statistically, and attribute their discrepancy to the lengthier data sample and their usage of more recent and powerful VAR methods.[2] However, they show that the EH is *economically* insignificant by considering the returns from a mean-variance portfolio framework. Buraschi and Menini (2001) find that long-term special repo spreads poorly forecast future convenience yields, and strongly reject the EH in repo rates; they explain this rejection with the presence of a time-varying risk premium due to the conditional volatility of the special repo spread. Ranaldo and Rupprecht (2019) study the temporal and cross-sectional variation in the forward premium of repo rates and argue that the EH cannot be rejected when funding liquidity is low.

This paper argues that the link between bond and repo markets results in there being a preferred habitat (see Modigliani and Sutch (1966); Vayanos and Vila (2021)) for traders who exploit the connection between these two markets to either lever-

[2] Indeed, the econometric methodologies used to test the EH have also advanced. Previously, tests suffered from poor finite sample properties, size distortions, and power problems. The foremost issue, as identified by Campbell and Shiller (1991), is the overlapping-errors problem. Consider testing the EH by using a long-term rate with n periods to forecast a short-term rate of m periods. In such a case, one only has an entirely independent observation of the forecast power every n periods. If one is testing an n of say 1 year, but only has 10 years of data, then the problem becomes particularly acute. The best-in-class methodology is now the vector autoregression (VAR) framework developed by Bekaert and Hodrick (2001). The VAR makes for a powerful test of overlapping equations by applying orthogonality conditions based on the assumption of rational expectations.

age or short-sell their bond trades. Greenwood and Vayanos (2010) use the 2004 UK pension fund reform as a demand shock for bonds with maturities of over 15 years. Greenwood and Vayanos (2014) studies a supply shock in the form of quantitative easing purchase programs on the yield curve. Klingler and Sundaresan (2023) demonstrate that the decline in swap rates below U.S. Treasuries rates during the 2008-2015 period can be attributed to the demand from U.S. pension funds for long-dated interest-rate swaps. Jappelli et. al (2023) provide a general equilibrium model where arbitrageurs seek to short-sell bonds trading on special and thus apply downward pressure on special repo rates.

This paper focuses heavily on the link between the repo market and the bond market itself, a topic which has been studied by Ballensiefen (2023), who shows why on-the-run bonds are more likely to be delivered than cheapest-to-post securities. The connection between bond and repo markets leads to a phenomenon termed "specialness," whereby the rate on repos collateralized by a desirable, difficult-to-obtain security will be decreased. This paper thus relates to the literature on convenience yields and collateral scarcity, as these underly the dynamics we observe.[3] This paper focuses in particular on how participants use repo to enter leveraged bond positions, a topic described by Huber (2023) in the context of the U.S. market. Huh and Infante (2022) model how dealers use repo to intermediate order flow in the cash

[3] In other words, specialness is a premium paid by a lender in order to obtain a specific collateral. Duffie (1996) shows that a bond traded with a specialness premium in the repo markets should be trading at a price premium in the cash market. This is confirmed empirically by Jordan and Jordan (1997), who find evidence that the overnight specialness premium in repo markets is reflected in cash markets. This specialness is a manifestation of a "convenience yield," which can be defined as a non-pecuniary return in the form of liquidity and/or by virtue of being a safe asset (Gorton, 2017). The presence of such convenience yields has been empirically demonstrated by Krishnamurthy and Vissing-Jorgensen (2012) for U.S. Treasuries, in particular by showing that their supply (i.e. availability) is positively related to their yield. Nagel (2016) finds that the liquidity premia of near-money assets such as Treasury bills reflect the opportunity cost of holding money, which is largely determined by the interest rate level. Jiang, Lustig, Van Nieuwerburgh, and Xiaolan (2021) highlight the importance of bond convenience yields in the Eurozone by showing that they explain a larger fraction of bond yields than default spreads, thus having large ramifications for the management of sovereign debt. Arrata et. al (2020) show how central bank bond purchases under the auspices of unconventional monetary policy cause asset scarcity, exerting downward pressure on repo rates. Ballensiefen and Ranaldo (2022) provide the first asset pricing analysis of repos, and show that a carry factor accounting for the heterogeneity in convenience yields and changes in safety / liquidity premiums is necessary for pricing these assets. d'Avernas and Vandeweyer (2024) describe how the scarcity of Treasury bills is a main driver of short-term spreads.

market, and how this impacts the repo rate.

3 Background and data

A repo contract is a short-term funding arrangement backed by collateral, usually a government debt security. The cash lender purchases the bond from the cash borrower, who pledges to repurchase it at maturity. The lender of the cash (borrower of the bond) is performing a reverse repo. The repo rate is an interest calculated based on the cash amounts being exchanged at the near and far legs of the transaction. Appendix A goes into further detail as to the mechanics of a repo transaction.

I focus on the European interbank repo market, which is an ideal setting due to several appealing features. First, its ultra-short term tenors minimize interest rate uncertainty and risk premia, as risk aversion increases with an investment's time horizon. Second, these rates are the main funding rate for investors' bond positions along the entire yield curve. Third, being a central counterparty (CCP) based market mitigates various concerns commonly encountered in over-the-counter (OTC) markets such as counterparty risk, bargaining power, and unobservable bilateral banking relationships. Fourth, the overnight rate in particular is the rate through which monetary policy is implemented, and repo markets are naturally deep and liquid. Finally, the data allows for a granular breakdown among several critical dimensions which I will leverage in the analysis.

The dataset is created by combining the transactions contained in the three major CCP-based European electronic trading platforms: BrokerTec, Eurex Repo, and MTS Repo. CCP-based repo has been estimated to account for more than 70% of the European interbank repo market (Mancini et. al, 2016). The data sample extends from January 2$^{\text{nd}}$, 2006, to June 30$^{\text{th}}$, 2020. The data can be broadly split into two segments. As mentioned, special repos are those trades where a specific collateral has to be delivered as part of the repo transaction. A specific bond ISIN ("International Securities Identification Number") has to be agreed upfront in the terms of the transaction as the collateral. Our dataset specifies which ISIN served as the collateral in each of our repo transactions. We can thus also divide these repos into the country of origin of the underlying collateral. In contrast, general repos do not require the borrower to provide a specific bond as collateral but rather makes reference to a basket of eligible bonds. As the lender cannot know which bond he will receive, these repos do not trade on special. Hence the general (GC) repo segment is usually funding/cash-driven, whereas the special (SC) segment is principally concerned with sourcing collateral. The literature has observed that repo markets have become far more collateral-driven over the last decade, see Brand, Ferrante, and Hubert (2019) and Schaffner, Ranaldo, and Tsatsaronis (2019).

The basket which a GC repo refers to can vary in the characteristics of the eligible bonds. In particular, many baskets only allow collateral from a specific country (e.g. a basket can only allow certain German Treasuries). Country-specific baskets are special to a certain extent given that they impose conditions on collateral eligibility, but maintain the characteristic that the cash lender does not know what collateral he will receive. I differentiate a further kind of repo: those which are backed by collateral from the GC Pooling ECB (GCP) and GC Pooling EXTended (GCX) baskets. The former contains 3'000 securities eligible for open market operations at the ECB with minimum AA- credit ratings; the latter expands that to 14'000 securities with at least BBB- ratings (also eligible at the ECB). These baskets are interesting in that they have the broadest eligibility requirements in the data (the GCX even more so than the GCP). I thus define my measure of repo specialness as the difference between the repo rate in question and the rate of the GCP repo with same maturity and trade date.[4]

This study considers three maturities: overnight (ON), tomorrow-next (TN), and spot-next (SN); these tenors account for 94.5% of the data in our sample. An overnight repo, as the name suggests, is agreed on date t, cash and bond exchange hands that night, and the transaction is reversed the next day, $t + 1$. A tomorrow-next repo agreed today actually sees the exchange of collateral and cash at 11 a.m.

[4] I principally use the GCP basket as it has fewer missing values in the time series. The GCX basket provides a useful robustness check.

"tomorrow," and is closed out at $t+2$. Finally, a spot-next trade is similarly a one-day maturity, but settlement of the two legs occurs at $t+2$ and $t+3$ respectively.

I filter the data to ensure consistency. I remove all repos which were pre-arranged (as they may have a different economic substance). Only repos in euro currency are considered, and repos with floating rates are dropped (due to uncertainty in calculating an appropriate rate). Furthermore, I only consider overnight repos which settle before 11 a.m. as tom-next and spot-next repos settle at that time. I only consider repos (whether GC or SC) whose collaterals originate from the following six countries: Germany, France, Italy, Spain, Belgium, and the Netherlands. Additionally, I consider the GCP and GCX baskets which are not affiliated with any particular country. Appendix B provides summary statistics on the data.

4 The expectations hypothesis in repo markets

Consider again the example of forecasting a short-term m-period rate with a longer-term n-period rate. The EH states that the current n-period rate is a conditional expectation of the current and expected future m-period rates $n-m$ periods into the future. In a setting with continuously compounded interest rates R, the relationship is:

$$R_t^n = \frac{m}{n} \sum_{i=0}^{(n-m)/m} E_t\left[R_{t+m\cdot i}^m\right] + C, \qquad \frac{n}{m} \in \mathbb{Z} \tag{1}$$

The constant C reflects a term premium which must stay constant throughout time t, but may vary for different maturities n and m. However, in the strong form of the EH, C must also equal zero.

The EH is a test of whether the forward premium s_t (or term spread, in case of bonds) is an unbiased predictor of expected future simple interest rates r_{t+1}. Consider the case of $m=1$ and $n=2$ in eq. (1), which renders:

$$R_t^2 = \frac{1}{2}\left(R_t^1 + E_t\left[R_{t+1}^1\right]\right) + C \tag{2}$$

There are no two-period repos in the data, but one can be formed by combining e.g. an ON and a TN repo, given that $R_t^2 = \frac{1}{2}(r_t^{TN} + r_t^{ON})$. Converting to repo rates

($R_t^1 = r_t^{ON}$), one obtains:

$$r_t^{TN} = E_t\left[r_{t+1}^{ON}\right] + c, \qquad c = 2 \cdot C \tag{3}$$

which can be tested in a regression framework as follows:

$$\Delta r_{t+1} = \alpha + \beta_1 \cdot s_t + u_{t+1} \tag{4}$$

In this setting, $\Delta r_{t+1} = r_{t+1}^{ON} - r_t^{ON}$ and $s_t = r_t^{TN} - r_t^{ON}$. Testing the EH in differenced form is desirable as interest rates typically display a high degree of persistence, and differencing reduces the possibility of spurious results (Anderson et. al, 1997).[5] If the EH holds, then $\beta_1 = 1$, and $-\alpha$ represents the term premium c (which is zero in the pure form of the EH).[6] Given the three one-period rates in the sample, there are three restrictions one can potentially test: (i) the TN rate should be an unbiased predictor of the next-day ON rate, as shown above, (ii) the SN rate should similarly predict the ON rate of two days later, and (iii) today's SN rate should predict tomorrow's TN rate.[7] Appendix C clarifies the structure of these repo tenors as well as the classical term structures used in equation (1) above.

I now compare the performance of the EH across the various segments I have defined. Table (1) presents the results of running a regression model as defined in equation (4) on the various repo rates in the data. I run the regression for four different segments (1) the GCX basket, (2) the GCP basket, (3) all GC repos, and (4) all SC repos. Note that the four segments are listed in decreasing order of "specialness." That is, GCX repos allow for the widest array of acceptable collateral, the GCP is a bit more restrictive, GC baskets only allow collateral from a certain

[5] The EH in differences states that the term spread between long-term and short-term interest rates provides the conditional expectation of future changes in the short-term rate.

[6] In the traditional theory of the term structure of interest rates, term premia represent a risk premium that risk-averse investors demand for holding long-term bonds. Cohen, Hördahl, and Xia (2018) provide a review of the theory and estimation methodology of bond term premia. Investors earn this premium because the short-term return earned from holding a long-term bond is risky, but it is certain if a bond is maturing over that same horizon.

[7] It is trivial to derive similar conditions for the aforementioned cases (ii) and (iii), although one then observes different term premia. Many of the empirical problems concerning the EH stem from the fact that one observes multiple combinations of maturities of length n forecasting multiple iterations of the same rate m. This leads then to the aforementioned methodological issues concerning overlapping-errors and so forth. I avoid such issues by eschewing simultaneous joint estimation of multiple predictor maturities. Given that, I will use plain regression analyses in the style of (4) to present some heuristics about the EH's behaviour in repo markets.

country, and SC repos require a specific bond (ISIN) as collateral. Note that I take care to match the predictor and target rates such that they have the exact same collateral requirements, and the GC and SC models are thus panel regressions across countries and ISINs respectively.[8] I run these regressions for each of the three cases (i.e. the different combinations of TN/SN rates predicting ON/TN rates).

Several conclusions emerge. I fail to reject the weak form of the EH for the GCX and GCP baskets. Indeed, the β coefficient is impressively close to 1. This demonstrates that for repo segments where specialness is not a factor, the EH cannot be rejected. A panel regression of country-specific GC baskets sees a statistical rejection of the EH, but the coefficient values range from 0.87 to 0.92. This is in marked contrast with the SC segment, where the EH is decisively rejected and β coefficients are as low as 0.633.[9] For such short-term tenors, this is a substantive rejection of the EH. To compare, Shiller, Campbell, and Schoenholtz (1983) perform the same exercise with 6-month and 3-month rates and obtain a coefficient of 0.285. Fama (1984) uses the 1-month rate to obtain a β of 0.46. Campbell and Shiller (1991) re-run these analyses and obtain values of 0.348 and 0.54.

The performance of the EH as measured by the beta coefficient monotonically decreases as one consider less special to more special segments. A similar dynamic can be observed when considering the constant α: in the GC segments the term premium is around 1 basis point; this increases to as much as 6 and 10 points in the SC segments. These figures are substantially bigger than those reported by

[8] The GCX and GCP segments can be estimated with ordinary least squares (OLS) as they each represent individual time series. Regarding specials, we observe repo transactions with various ISINs as collateral. Previous studies have derived a single special rate (e.g. by taking a volume-weighted average over all bonds) and tested the EH using these rates. However, doing so inserts a bias; calculating averages over different compositions of bonds inserts noise into the estimation of the coefficient. Counter-intuitively, this noise biases the OLS estimate to *zero*, making it more likely to reject the null hypothesis that $\beta = 1$. It is thus crucial to match the data such that for each observation, one compares a forward premium and a target rate (Δr_{t+1}) which are derived on the basis of the exact same ISIN (or basket, in the case of the GCs). Thus, for the GC and SC segments, I run a pooled OLS model as follows: $\Delta r^b_{t+1} = \alpha + \beta_1 \cdot s^b_t + u_{t+1}$. I calculate rates as daily volume-weighted averages across baskets and ISINs, respectively, and cluster the standard errors along those dimensions. Alternatively, one could run a fixed effects panel regression model. This would allow for ISIN-specific (basket-specific) term premia for the SC (GC) repos. Instead, by running pooled OLS with an intercept, I impose a common term premium for each segment.

[9] The β value is higher in the SC SN/ON segment, but this is paired with a very high term premium of 10 basis points.

		GCX	GCP	GC	SC
Case (i): TN/ON	α	-0.011***	-0.010***	-0.007***	-0.061***
		(0.001)	(0.001)	(0.001)	(0.003)
		[17.55]	[18.22]	[18.40]	-
	β	0.993	0.976	0.909***	0.633***
		(0.034)	(0.033)	(0.026)	(0.022)
		[8.852]	[8.563]	[8.037]	-
	R^2	0.791	0.708	0.600	0.328
	Obs.	2'605	3'629	12'593	21'315
Case (ii): SN/ON	α	-0.011***	-0.012***	-0.013***	-0.098***
		(0.002)	(0.002)	(0.002)	(0.009)
		[9.236]	[9.143]	[8.913]	-
	β	0.996	0.991	0.868**	0.823**
		(0.037)	(0.036)	(0.063)	(0.076)
		[2.047]	[1.997]	[0.453]	-
	R^2	0.621	0.619	0.438	0.528
	Obs.	2'256	2'729	3'403	20'703
Case (iii): SN/TN	α	-0.002	-0.003***	-0.002*	-0.010***
		(0.001)	(0.001)	(0.001)	(0.001)
		[7.191]	[5.664]	[6.321]	-
	β	0.970	0.965	0.924***	0.686***
		(0.030)	(0.025)	(0.015)	(0.024)
		[7.333]	[8.020]	[8.393]	-
	R^2	0.697	0.694	0.668	0.325
	Obs.	2'219	2'686	18'957	682'116

Table 1: The regressions for the GCX and GCP segments are OLS with Newey-West standard errors shown in parentheses. The GC and SC models are pooled OLS with standard errors clustered by basket and ISIN, respectively. Numbers in brackets denote z-scores testing the null of coefficient equality with the corresponding SC value. Superscripts $***$, $**$, and $*$ indicate significance at the 1%, 5%, and 10% levels, testing the null hypothesis of $\alpha = 0$ and $\beta = 1$. GCX and GCP basket rates are daily averages across transactions; GC and SC segment rates are daily volume-weighted averages across baskets and ISINs. Data span January 2, 2006, to June 30, 2020, excluding the last week of each year.

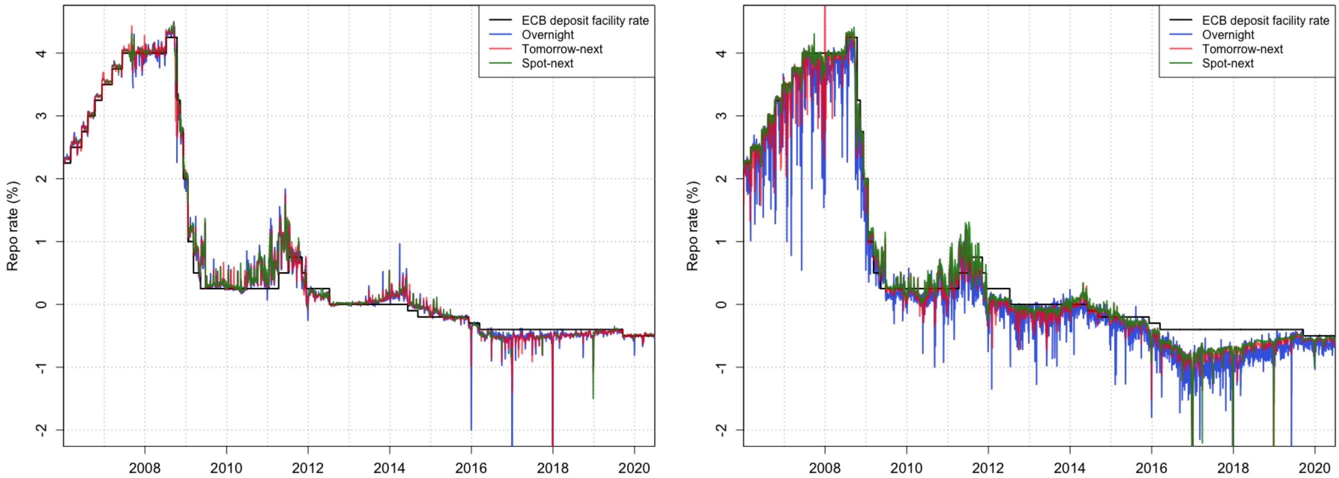
Longstaff (2000), who reports a 0.56 basis point term premium for the 1-week general repo relative to overnight. Bracketed values denote the z-score from a coefficient equality test relative to the corresponding SC value; virtually all null hypotheses are decisively rejected. Finally, the R^2s of the regression models starkly decrease as one moves from general to more special segments.

The discrepancy between special and general repos' EH performance is clear and can be observed visually. Figure (1) plots volume-weighted average GC and SC rates for repos collateralized by German bonds; each maturity (ON, TN, SN) is plotted separately. In panel (b), the special maturities are juxtaposed to each other, and this dynamic holds true over the whole sample. To the contrary, the GC rates of panel (a) directly overlap and are clearly on the same level throughout the sample. One may further observe the classic dichotomy between special and non-special rates, whereby the former rates trade at a discount. This is essentially a clear visualisation of a time series where the EH holds, and one where it does not. The question is then to understand what factor causes such a dramatic difference in EH performance. As I observe relatively minimal EH deviations in the GC segment, my results indicate that EH deviations in repo markets are related to participants' desire to obtain a specific collateral, as opposed to needing liquidity.

5 Experiment: shortening the settlement cycle

5.1 Dynamics of the T+2 shift

This section seeks to explain the EH failure by identifying an instance of a preferred habitat effect impacting repo rates. I leverage a quasi-experiment to identify a habitat consisting of agents who use the repo market to deliver on their commitments in the cash (fixed income) market. Many of the dealer-banks I observe pursue a strategy whereby they frequently sell bonds they do not own, or purchase bonds with liquidity they do not have; they turn to the repo market to make up for such shortfalls. These agents thus have inelastic demand for a specific maturity/segment



(a) German general collateral (GC) rates

(b) German special collateral (SC) rates

Figure 1: Panels (a) and (b) plot three maturities of German general and special collateral repo rates, respectively. Rates are calculated as the daily volume-weighted average across transactions.

of the repo market which serves as the "bridge" to the cash market.[10]

My identification strategy takes advantage of a regulatory reform which changed the settlement time of fixed income markets. The settlement cycle refers to the time settlement takes for the transaction of financial instruments including equities, bonds, and so forth. The standardisation and shortening of the settlement cycle alleviates counterparty risk and decreases clearing capital requirements as well as reducing pro-cyclical margin and liquidity demands. Crucially, the European Union used to have a T+3 settlement standard until it moved to T+2 settlement on October 6$^{\text{th}}$, 2014 (ICMA, 2014; PricewaterhouseCoopers LLP, 2015).[11]

Notably, even though the regulatory reform only impacted *bond* markets, major, corresponding shifts occurred in *repo* markets. The l.h.s. of Figure (2) plots the evolution of tom-next and spot-next special volumes and pinpoints the time when Europe transitioned its settlement cycle. TN daily trading volumes increase dramatically from 10B to as much as 40B. The SN segment experiences a corresponding

[10] The fixed income market (or bond market) is frequently referred to as the cash market when comparing it to the repo market. The cash market can further be split into the primary and secondary segments, depending on whether the bond sold is newly issued or not.

[11] Exceptions were Germany, which was already on a T+2 schedule, and Spanish equities, which migrated during the fourth quarter of 2015. Foreign exchange settlement was already T+2. The U.S. used T+3 settlement since 1995, switched to T+2 on September 5$^{\text{th}}$, 2017, and updated to T+1 on May 28$^{\text{th}}$, 2024.

drop in absolute value, from 150B to 120B, although it recovers around two years later. Both of these shifts occurred precisely on the date of the reform.[12] The ON volumes (not shown here) stay constant.

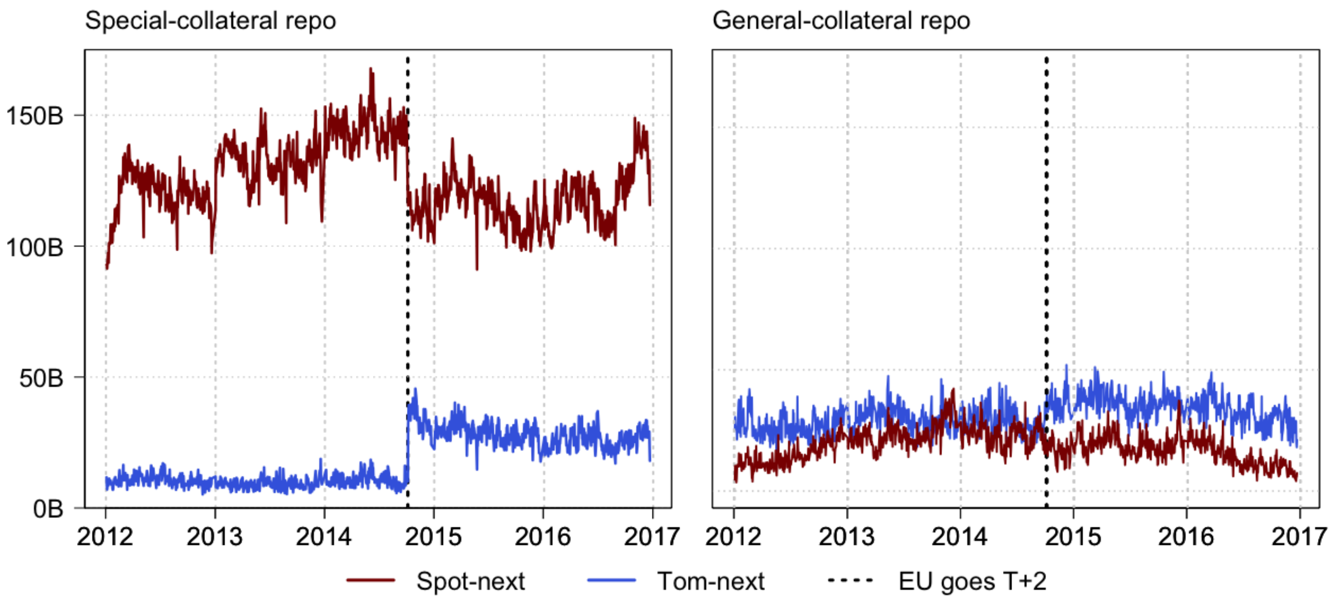


Figure 2: Daily turnover of special (l.h.s.) and general (r.h.s.) repos. The last week of each calendar year is dropped for visualization purposes.

These dynamics are a first indication of a link between the repo and cash markets. A further piece of evidence is provided by considering the corresponding effects in the cash-driven segment; general repo is plotted in the r.h.s. of Fig (2). The T+2 change does not perceptibly impact the GC market.[13] This highlights the role of the special spot-next (and subsequently, tom-next) segment as the bridge between repo and cash markets. The fact that only specials were affected indicates that the affected repos were collateral-driven. The fact that they adapted to the settlement time of the cash market indicates that they were used in conjunction with fixed income trades, and thus needed to be synced to that settlement cycle. The following section will further delineate the mechanism.

Appendix D provides a formal econometric test of the dynamics shown in Figure

[12] Interestingly, German repos also show these dynamics, even though German bonds were apparently already transitioned to T+2. This suggests that many German bonds trade in foreign markets.

[13] A formal econometric test shows *some* movement in the GC segment, but not all specifications achieve statistical significance (see Appendix D). Ultimately, as the visual evidence in Fig. (2) makes clear, GC dynamics were far more muted.

(2). That is, I split the data by $\{Segment$ x $Country$ x $Tenor\}$, and test whether a volume shift from SN to TN indeed occurred for special repos only. The econometric model used will be introduced in depth in section 6.2. Table (D1) shows results, which are economically and statistically significant across all specifications. The T+2 switch caused an 85-93% increase in the treated segments' volume. This confirms the visual evidence and emphasizes there was a migration of a preferred habitat from the special spot-next segment to the special tomorrow-next segment, whereas other sectors were unaffected.

Finally, one observes a shift as to *which* bonds were traded in what segment. I calculate the number of unique ISINs on a given day which traded e.g. in both the TN and ON segment. I define the "share of m-tenor bonds in n" as follows: $\frac{\{B_t^m\} \bigcap \{B_t^n\}}{\{B_t^m\}} \cdot 100$ where $\{B_t^m\}$ is the set of unique ISINs traded on a given day t for a given maturity m. I derive this for our three cases: TN/ON, SN/ON, and SN/TN. Rolling weekly averages of the three resulting time series are plotted in Figure (3).

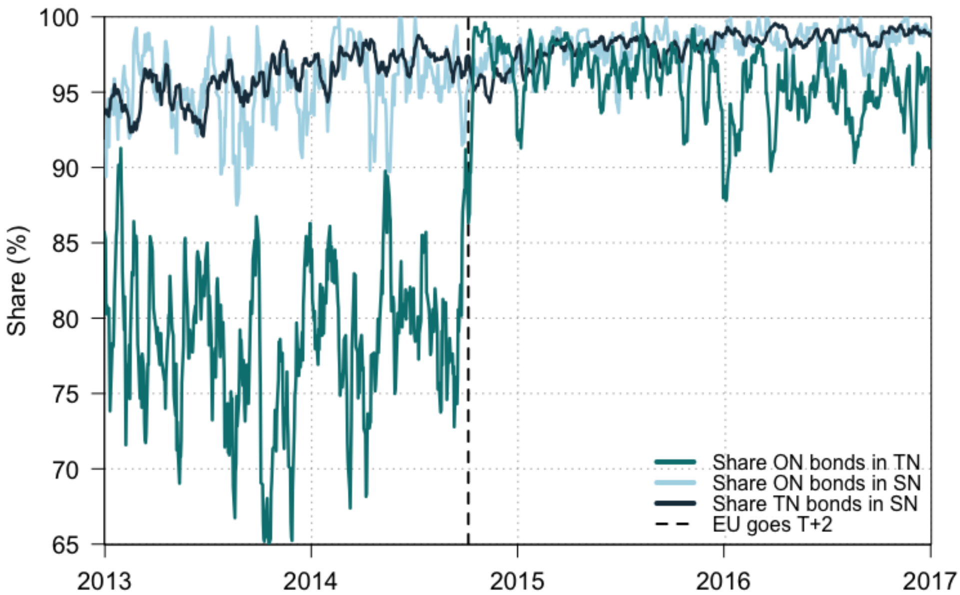


Figure 3: Share of unique collaterals traded across maturities, rolling weekly averages.

Before the reform, around 78% of ON bonds also appeared in the TN segment; post-reform, this increased to 96%. This is unsurprising, given that the TN segment became far larger. Interestingly, the spot-next segment did not see major declines in its collateral commonality, despite seeing a 30% reduction in daily turnover. The share of ON (TN) bonds also appearing in the SN segment increased from 95% to 98% (96% to 98%). Thus the only real impact of the reform in terms of collaterals traded is that the tom-next maturity saw greater commonality with the overnight rate, which is in large part a reflection of its 300% surge in daily turnover.

5.2 Inspecting the mechanism

The dynamics in Figure (2) represent the movement of a habitat from one segment to another. Before proceeding to an econometric test of whether this change in preferred habitat had a pricing effect, this section discusses the causes and drivers of this phenomenon.

Figure (2) demonstrates that a share of repo transactions were timed to sync exactly with the delivery of bonds in the cash market. This is because agents frequently use repo to provide them with the liquidity and/or securities obligations they must deliver in the fixed income market. Figure (4) provides an example of this dynamic. Consider an agent buying and selling bonds throughout the day (T) before the implementation of the T+2 settlement reform. At the end of the day, they calculate their position and observe that they will purchase a certain bond on a net basis. They will now receive the bond B in three days ($T+3$) and will have a cash outflow $-C$ at that time (see the top row of the figure).

Suppose that the agent does not have the cash on hand needed to pay for the bond's purchase. The next morning, the agent can resolve this by entering a repo, pledging that same bond as collateral. Given that they are now in period $T+1$ and need to deliver the cash at $T+3$, the spot-next maturity imposes itself. The funding issue is then resolved. If the agent closes the position by selling the bond at the same time they agree the repo ($T+1$), they do not ever need pay for the bond; the bond sale will cancel out the far leg of the repo at time $T+4$ (refer to Fig. 4). While we are demonstrating a one-period example, the process could be continued. If the agent desires to hold the bond for longer, or purchases even more of the bond,

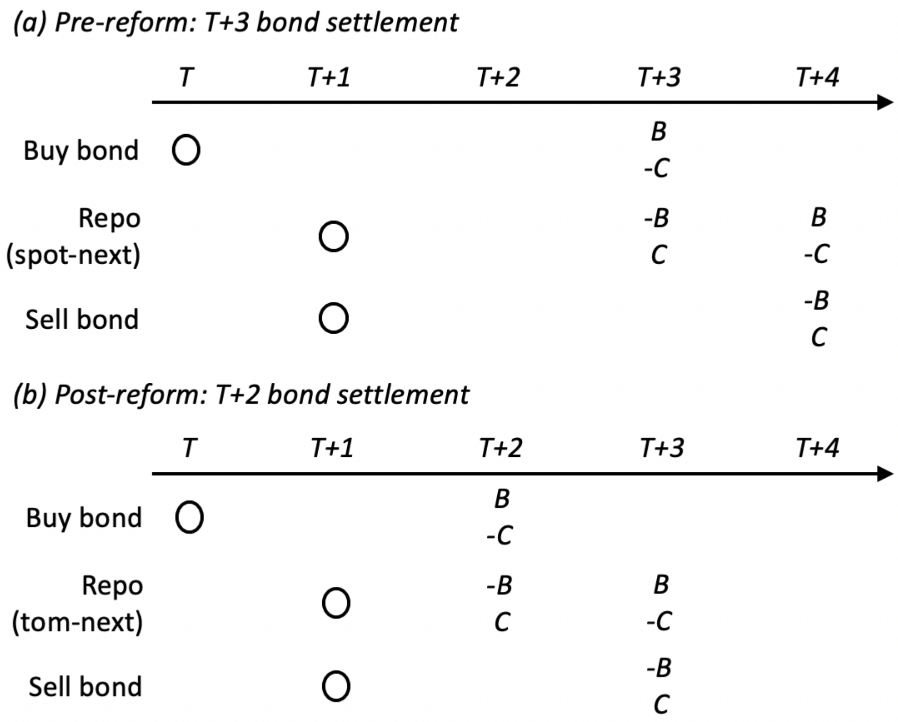


Figure 4: Financing a cash position (leveraging). Circles represent when a trade is agreed. B and C refers to the delivery of a bond or cash, respectively. The graphic denotes how an agent would finance a cash position before and after the T+2 settlement reform.

he can perform another repo at time $T+2$ to roll over the trade. Again, the agent need not ever purchase the bond, and can continue holding it until its eventual sale.

The bottom half of Fig. (4) should make it clear why participants shifted to the tomorrow-next maturity after the $T+2$ reform. Previous to the reform, a spot-next repo was necessitated to provide cash funding for a bond purchased at time T; after the reform, tom-next became the "bridge" to the cash market. I will explain why doing so in the special segment (as opposed to the general) is preferable later in this section.

Fig. (4) demonstrates the financing of a cash position. Economically, this is equivalent to *leveraging*. The agent has taken a position on a bond with a self-financing strategy. The resulting profits are of the order $\Delta P^B_{T+4,T+3} - r^{SN}_{T+1}$, or $\Delta P^B_{T+3,T+2} - r^{TN}_{T+1}$ in the post-reform period (recall that repo rates have been negative since 2012, thus the rate component is actually positive). The inverse operation is also possible of course: participants can cover an outgoing securities position. If an agent has committed to sell a bond at time $T+3$, they can perform a *reverse* repo; everything remains the same, but as a mirror image of Fig. (4). Figure (5) shows these dynamics for completeness. Such a process is correspondingly equivalent to short-selling; profits are of the order $-\Delta P^{B}_{T+4,T+3} + r^{SN}_{T+1}$, or $-\Delta P^{B}_{T+3,T+2} + r^{TN}_{T+1}$ in the post-reform period.

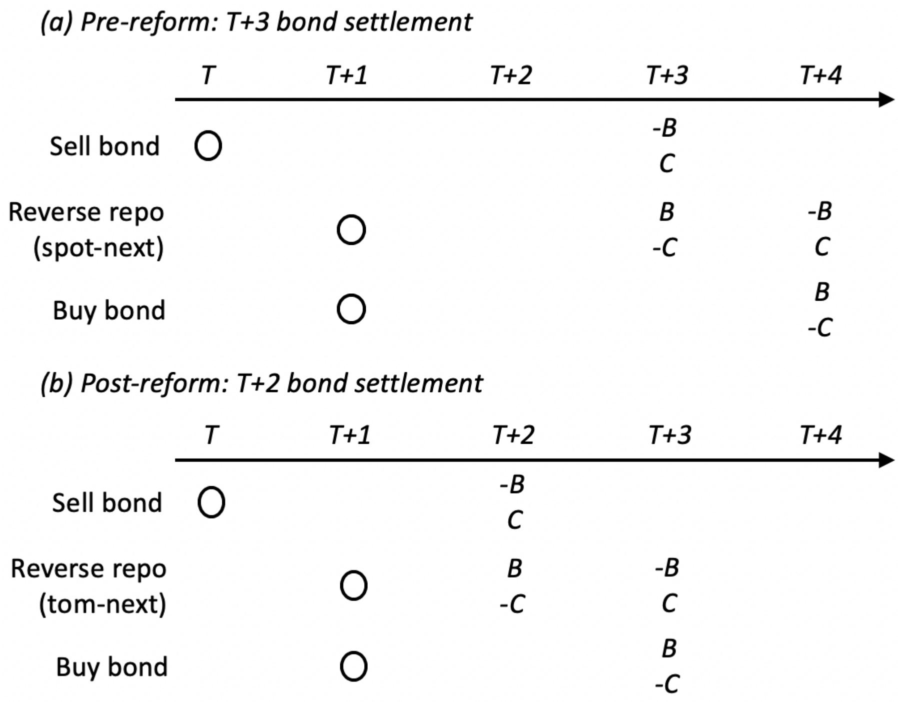


Figure 5: Covering a securities position (short-selling). Circles represent when a trade is agreed. B and C refers to the delivery of a bond or cash, respectively. The graphic denotes how an agent would cover a securities position before and after the T+2 settlement reform.

Why do traders wait one day to (reverse) repo away their exposure?[14] The answer has much to do with the schedule of the market. Interviews with traders indicate that participants only know their net position once it is calculated at the end of the day. Liquidity is at its lowest then, and finding a specific bond may be difficult and/or costly. They instead wait for the next day's more liquid morning hours to net the previous day's imbalance (on intraday patterns, see e.g. Dufour, Marra, and

[14] For example, an actor could at time T instigate a repo with a near leg at $T+3$ and a far leg at $T+4$; such a maturity is called "corporate-next" (CN). While I observe a significant shift from SN to TN maturities in the data, there is no corresponding shift from CN to SN. ON, TN, and SN maturities comprise 94.5% of repos; that the CN tenor sees very little relative daily turnover may be part of the answer.

Sangiorgi, 2019). Indeed, in anticipation of the settlement reform, the International Capital Market Association (ICMA, 2014) as well as the European Repo Council and the International Securities Lending Association, predicted that after the shift, repos would "most likely move to $T+1$ [i.e. a tom-next maturity]. This is because the cash positions that need to be financed and the securities positions that need to be covered in the SFT [securities financing transaction] markets are only known after close of business on the cash market transaction date (T)." Interestingly, a similar dynamic is observed in FX swap markets; Kloks, Mattille, and Ranaldo (2023) document that a bank's net currency exposures will be calculated at end-of-day and swapped into domestic currency the next morning, which is why a surge in tom-next FX swap turnover is observed at 8 a.m. London time.

Why do agents use the special segment, as opposed to the general, for such operations? In the case of covering a securities position, the answer is obvious: the agent must provide the specific bond in the cash market. Agreeing a general reverse repo provides no guarantee that the correct ISIN will be retrieved. In the opposite case, financing a cash outlay, the agent could potentially use the general segment.[15] However, given the dynamics of repo specialness, this would be suboptimal: special repo offers far more attractive rates, and safe asset bonds are in high demand (and were equally so in 2014). Recall Figure (1); as special repo rates are negative, an agent would be paid to borrow the missing cash if he uses a special repo.

What kind of agents pursue this strategy? The interbank segment I observe naturally consists of the major European banks (with little to no other agent types). A layman perception of banks' trading may assume that they have cash and bond inventories to call upon to net out imbalances. This is not the case. In reality, cash/bond shortages occur on a daily basis, and are netted out in repo. While we only observe banks in our sample, such a strategy could and likely is performed by other institution types as well. However, the agents under consideration are principally defined by *what* they are doing, rather than by *who* they are. The

[15] Indeed, we see a minor uptick in general activity; see Appendix D.

habitat preference is held by those agents which sync their repo trading to that of fixed income markets, as they source cash/collateral from repo to meet their commitments in the cash market.

I have made the point that the mechanisms demonstrated in Figures (4) and (5) are at least economically equivalent to leveraging and short-selling, respectively. However, it also may be the case that agents are not just covering their commitments in cash markets, but pursuing these strategies explicitly. Consider for example the leveraging example. If an agent has spare cash at hand after conducting the repo at time $T+1$, they could use such cash to purchase more of the bond, which they could then use in a further repo, and so forth. Such a strategy could in theory be used to implement infinite leverage (ICMA, 2019). In reality, credit and regulatory capital constraints such as the Basel III leverage ratio imposes a constraint on such activity (see Ranaldo, Schaffner, and Vasios (2021) for the regulatory cost of repo). Repos are further often used by cash market participants to finance long bond positions or to initiate a short sale, by borrowing liquidity or the underlying asset respectively (Corradin and Maddaloni, 2020). Repo transactions are often used by institutional investors to fund leveraged investment strategies on a cost-efficient basis. For example, pension fund managers who need to borrow to fund purchases of government bonds to hedge the long-term exposure of their liabilities to interest rate and inflation risks, use repo as a source of leverage (ICMA, 2019). Short-selling can also be used for reasons other than speculation on the price of the bond itself. For example, it allows market-makers to continuously quote prices for securities that they do not hold in inventory.[16] Note that the presence of these dynamics does not necessarily mean that the agent is placing a speculative bet on the performance of the bond. It may be that the investor is hedging their position otherwise, e.g. through interest rate swaps or by selling futures on the bond. In such a case, the

[16] If an investor buys one of these securities, the market-maker can be sure of being able to deliver, because they know they can borrow it if they are unable or unwilling to immediately buy that security from someone else in the market. Furthermore, short-selling enables dealers in the secondary market to hedge the interest rate risk on their inventory as well as any temporary long positions accumulated through buying.

transactions would serve just to finance the bond purchase.

A final comment should be made on the feasibility of short-selling. Collateral re-use is allowed in European repo, therefore selling a collateral obtained through a repo does not cause an issue. However, "locate rule" regulations do state that parties should first ensure that they can obtain a security (through reverse repo) before selling it. The short-sale of a security without first borrowing it is termed naked or uncovered short-selling. In the EU, such activity has been banned by the "Regulation on Short Selling and Credit Default Swaps" which came into force in March 2012 (European Commission, 2012). However, the ban does not apply to market-makers or banks involved in the issuance of government bonds (ICMA, 2019). As these are the prevalent agents in my data, short-selling is indeed a plausible motive in the trading patterns we observe.

6 Impact of the reform on the EH performance

The regulatory reform described in the previous section allows for a test of whether preferred habitat effects are present in short-term tenors. This section ascertains whether the observed shift in habitat had any impact on the EH performance, i.e. on pricing.

6.1 Conditions and hypotheses

I first consider the conditions required for a pricing effect to occur, and draw up potential hypotheses. Should one expect the EH performance of the treated segment to improve or deteriorate? Why? When considering whether the habitat shift in question will affect prices, the following three conditions must be met.

Condition 1: Agents' trades must have non-zero price impact, i.e. order flow must be able to move prices.

Consider a simplified framework whereby agents place orders T, which are either to borrow cash (B) or lend it (L). This would entail initiating a repo or reverse repo contract, respectively. The sum total of agents' cash borrowing/lending over an interval $[t, t-1]$ is the order flow $X_{t,t-1}$. A regression of the price, in this case the repo rate $r_{t,t+1}$, on order flow yields the Kyle (1985) lambda.

$$X_{t,t-1} = \sum_{k=t-1}^{t} \mathbb{1}[\mathrm{T_k} = \mathrm{B}] \; - \; \mathbb{1}[\mathrm{T_k} = \mathrm{L}], \tag{5}$$

$$\Delta r_{t,t-1} = \lambda \cdot X_{t,t-1} + u_{t,t-1} \tag{6}$$

If agents in the repo market were to have zero price impact, there would naturally be no pricing effect despite the shift in habitat. Buying or selling pressure could not impact the pricing dynamic even if order flow were lop-sided. If the Kyle lambda in eq. (6) is zero and markets are perfectly liquid and efficient, one would observe no effect. This is unlikely to be the case, but is not entirely theoretical either (for example, a market where prices are pinned down by a no-arbitrage principle should see relatively little to no price impact).

Condition 2: Repo buying and selling pressure do not cancel out.

Condition 1 points out that if $\lambda = 0$ in eq. (6) then order flow cannot impact the price. Similarly, if order flow itself $X_{t,t-1} = 0$, then we can expect no price change. For that not to occur, we must have

$$\sum_{k=t-1}^{t} \mathbb{1}[\mathrm{T_k} = \mathrm{B}] \neq \sum_{\mathrm{k=t-1}}^{\mathrm{t}} \mathbb{1}[\mathrm{T_k} = \mathrm{L}] \tag{7}$$

Naturally, if the buying and selling pressure of repo contracts cancels out, then no net pricing effect would be observable, even if agents have a positive price impact. There are two types of agents who changed habitat at the T+2 transition date: those who were financing cash outlays, and those who were covering their bond positions. For simplicity, I refer to these as leveragers and short-sellers respectively. Leveraging requires borrowing cash, hence initiating a repo transaction (B), while short-selling necessitates a reverse repo (L). Thus, Condition 2 states that no pricing effect will be observed if the share of leveragers equals the share of short-sellers in the transferred habitat.

If short-sellers dominate, one would expect the EH to improve in the treated segment. Short-sellers perform reverse repos and thus bid down the rate of the segment they trade in. Thus, if short-selling is the dominant motive, one should expect the special TN rate to decrease post-reform relative to the SN; given that the forward premium consistently over-shoots target (as shown in Table (1)), this would improve the EH performance. On the other hand, if leveragers (who bid up the rate through their outright repo trades) dominate, then the TN rate would increase relative to the SN, and the EH performance would worsen. Of course, there is no guarantee that there is a dominant group at all, in which circumstance there would be no change in the EH performance.

Condition 3: The spread caused by the transition of the preferred habitat is not arbitraged away.

This condition is at the core of preferred habitat theory. Even if Conditions 1 and 2 hold, agents outside of the shifted habitat could enter the market and arbitrage any resulting spread. In Vayanos and Vila (2021) risk-averse arbitrageurs are unable to take on the interest rate / duration risk required to fully arbitrage long-term maturity mismatches. This particular reason is unlikely to hold, given that the maturities under consideration are all one-day. Thus Condition 3 stipulates that some other impediment to arbitrageurs' activity is required for there to be a pricing effect.

Conditions 1-3 must all hold for there to be an impact on the EH performance. Conversely, if I observe a directional pricing impact, I can surmise that all three have been fulfilled. I summarize the potential hypotheses below. Note that in the case the EH performance remains constant, it would be impossible to ascertain whether it is hypothesis (c) or (d) which has been validated.

(a) The EH performance improves, because short-sellers dominate the transferred preferred habitat (all conditions hold).

(b) The EH performance deteriorates, because leveragers dominate the transferred preferred habitat (all conditions hold).

(c) The EH performance stays constant, because the effects of short-selling and leveraging cancel each other out (condition 2 is not met).

(d) The EH performance stays constant because the preferred habitat theory has no effect, for example because there is no price impact, or because arbitrageurs can step in (either condition 1 or 3 is not met).

6.2 Difference-in-difference-in-differences estimation

I now proceed to testing the performance of the EH before and after the T+2 change. Figures (2) indicates several routes to a difference-in-differences analysis. The l.h.s. panel suggests that comparing the relative EH performance in GC and SC rates before and after the T+2 change would satisfy the parallel trends assumption. The treatment group would be the EH performance of TN special rates, and they would be compared to the unaffected TN general results. However, this leaves open the possibility that GC and SC rates may have evolved differently for reasons other than the 2014 T+2 change. To remove this possibility, one would need another control group to observe the relative GC and SC performance in a setting where they are both unaffected by the treatment. The SN segment can precisely play this role. One could consider a difference-in-differences analysis comparing the special TN and SN performance before and after the T+2 change, but this equivalently opens up the possibility that other factors than the treatment could impact the relative performance of TN and SN maturities.

This motivates the usage of the difference-in-difference-in-differences (DDD) estimator, which combines the two difference-in-differences set-ups into one econometric specification. The DDD model is a strictly superior approach as it does not require either of the aforementioned parallel trends assumptions.[17] The required assumption is relatively weak: it requires that the relative EH performance of special repos

[17] See Wooldridge (2010) and Olden and Møen (2022) for a discussion of the conditions necessary for the usage of the DDD estimator.

w.r.t. general repos in the spot-next maturity does not trend differently from the relative EH performance of special repos w.r.t. general repos in the tom-next maturity, outside of the T+2 shock; I verify that this is the case in Appendix E. A potential objection may be that the control group should not be affected by the shock itself, and clearly the switch to T+2 affected all repos (as the change actually occurred in the bond market). However, we are not interested in the T+2 change itself, but rather the surge in volume, and the habitat contained therein, and this effect clearly manifested itself only in the special tom-next segment.

The empirical strategy requires measuring of the EH performance at any given point in time, i.e. an estimate for each given day in our sample. Equation (4) decomposes the EH failure into a time-constant and time-varying risk-premia, but as it requires a full time series it is unsuitable. Furthermore, the underlying collateral b (be it a basket in the general case, or an ISIN in the SC special segment) must be identical for both the predictor and target rate. I resolve this by simply calculating the EH error as the difference between the predictor rate and the target rate for a given collateral type. A further challenge is posed by the need to standardize the EH error as a share of the underlying rate. The rates in the sample vary widely from e.g. below -2% to over 4% (see Fig. (1)). As taking a percentage of a zero percent interest rate is impossible, I re-scale the rates by taking their absolute value and adding 1. Thus, the EH error is defined as:

$$\xi_t^{b,n} := \frac{r_t^{b,n} - r_{t+n-m}^{b,m}}{1 + |r_{t+n-m}^{b,m}|} \tag{8}$$

where n is the predictor rate and m is the target rate (which is always the ON rate). To summarise, the identification set-up essentially compares the relative abilities of the TN and SN rates to predict the ON rate in the general vs. special segments, before and after the T+2 shift. Appendix F provides a graphical schema of the econometric model. The regression now considers a multitude of $\{Segment$ x $Country$ x $Collateral$ x $Tenor\}$ time series. Each EH error stemming from a GC (SC) repo with a specific basket (ISIN) is a unique observation. Note that when considering a DDD model with various time periods and segments, a full set of corresponding dummies can be added to eq. (9); see Wooldridge (2010). These fixed effects render all but three interaction variables redundant through perfect multicollinearity. I consider both versions of the model:

$$\xi_t^{b,n} = \beta_1 \cdot D_{t,b,n}^{SC} + \beta_2 \cdot D_{t,b,n}^{TN} + \beta_3 \cdot D_{t,b,n}^{SC} \cdot D_{t,b,n}^{TN} + \delta_0 \cdot D_{t,b,n}^{T+2} + \delta_1 \cdot D_{t,b,n}^{T+2} \cdot D_{t,b,n}^{SC}$$
$$+ \delta_2 \cdot D_{t,b,n}^{T+2} \cdot D_{t,b,n}^{TN} + \delta_3 \cdot D_{t,b,n}^{T+2} \cdot D_{t,b,n}^{SC} \cdot D_{t,b,n}^{TN} + \beta \cdot \mathbf{X} + \alpha_j + u_t^{b,n} \quad (9)$$

$$\xi_t^{b,n} = \delta_1' \cdot D_{t,b,n}^{T+2} \cdot D_{t,b,n}^{SC} + \delta_2' \cdot D_{t,b,n}^{T+2} \cdot D_{t,b,n}^{TN} + \delta_3' \cdot D_{t,b,n}^{T+2} \cdot D_{t,b,n}^{SC} \cdot D_{t,b,n}^{TN} + \beta' \cdot \mathbf{X}$$
$$+ \omega_b + \tau_t + u_t^{b,n} \quad (10)$$

where $\mathbf{X}$ is a set of control variables and ω are $\{Segment \text{ x } Country \text{ x } Collateral \text{ x } Tenor\}$ fixed effects. Controls are the current level of the overnight rate on the date the forecast repo is traded (i.e. to control for the level of the interest rate) and the lagged EH error for that particular grouping. These controls will have little to no bearing on the regression coefficients. The coefficient of interest is $\hat{\delta}_3$, which has the interpretation:

$$\hat{\delta}_3 = \left\{ \left(\hat{\xi}_{\text{SC, TN, T+2}} - \hat{\xi}_{\text{SC, TN, T+3}} \right) - \left(\hat{\xi}_{\text{SC, SN, T+2}} - \hat{\xi}_{\text{SC, SN, T+3}} \right) \right\}$$
$$- \left\{ \left(\hat{\xi}_{\text{GC, TN, T+2}} - \hat{\xi}_{\text{GC, TN, T+3}} \right) - \left(\hat{\xi}_{\text{GC, SN, T+2}} - \hat{\xi}_{\text{GC, SN, T+3}} \right) \right\} \quad (11)$$

I now run various specifications of regression models (9) and (11) in table (2). I run the model first on data from the 6-year period around the T+2 implementation (the "proximate" sample), as well as on the full sample. Given the length of the sample (15 years' worth of data), I expect the treatment effect to attenuate with time. On the other hand, considering the full sample provides more statistical power. I include only $\{Segment \text{ x } Country \text{ x } Collateral \text{ x } Tenor\}$ series which appeared before and after the T+2 switch. For all specifications, I drop all observations which occur during the final week of each calendar year, as well as any observations where $|\xi_t^{b,n}| > 100$. I also run specifications with the data winsorized at the 2.5% and 97.5% level.[18]

[18] The winsorization is carried out separately per $\{Segment \text{ x } Tenor\}$ combination. Results are

The treatment effect implies that the EH performance is negatively impacted across all specifications; the error increases by 3-4% when considering the 6-year proximate sample. The result is weaker when considering the full sample, suggesting that the observed dynamic dissipated over time. Note that the coefficients are underestimated due to the operation conducted in eq. (8). When re-running the analysis on the unscaled EH error (i.e. the numerator of eq. (8)), I obtain an effect size of 5-7 basis points (see Appendix G).

I perform placebo testing as a final robustness check. In Appendix H, I re-run the models of Table (2) on placebo dates for the T+2 treatment effect. That is, I repeat the exact same exercise, but see how results evolve when I assume a date two years prior, and two years after, the actual T+2 implementation date of October 6$^{\text{th}}$, 2014. When considering the proximate, 6-year samples, I now take the 3 years before and after the respective placebo dates. Therefore Table (H1) re-runs the models with a placebo date of October 6$^{\text{th}}$, 2012, and Table (H2) does the same for a date of October 6$^{\text{th}}$, 2016. None of the DDD estimators from the combined 16 placebo test specifications achieve statistical significance. The economic magnitudes are small and occasionally incorrectly signed. Note that when running these placebo tests many of the observations are actually correctly labelled, outside of the 2 years around the placebo date. Thus, these placebo tests confirm that the T+2 shift which occurred on October 6$^{\text{th}}$, 2014 indeed had a causal impact on the performance of the EH in short-term rates.

These findings show that preferred habitat theory can have an effect in habitats with the same maturity, but which differ only in settlement times by one day. Furthermore, I have shown this effect in a heavily traded, deep, and liquid market. The results indicate that preferred habitat effects are more powerful and pervasive than previously believed. Comparing the proximate and full sample results in Table (2) suggests that the spread did attenuate over time. Overall, though, the evidence presented here suggests that the ON, TN, and SN rates each operate - to a certain

robust to even stronger winsorizations.

	Expectations hypothesis error: $\xi_t^{b,n}$							
	Proximate sample				Full sample			
	Raw		Winsorized		Raw		Winsorized	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
SC	11.507***		11.150***		8.168***		8.842***	
	(0.717)		(0.622)		(0.589)		(0.443)	
TN	−0.094		−0.117		−0.536***		−0.416***	
	(0.134)		(0.153)		(0.125)		(0.125)	
T2	1.060***		0.284		−0.466*		−0.922***	
	(0.343)		(0.212)		(0.253)		(0.148)	
SC:TN	−5.063***		−4.775***		−2.792***		−2.571***	
	(1.045)		(0.833)		(0.767)		(0.518)	
TN:T2	−0.040	0.088	−0.002	0.136	0.412**	0.328*	0.319*	0.326*
	(0.215)	(0.175)	(0.158)	(0.121)	(0.192)	(0.185)	(0.173)	(0.174)
SC:T2	−3.646***	−3.621***	−3.652***	−3.392***	−2.604***	−3.616***	−2.791***	−3.085***
	(0.751)	(0.827)	(0.646)	(0.707)	(0.577)	(0.663)	(0.443)	(0.491)
SC:TN:T2	3.993***	3.385***	3.620***	2.984***	1.857**	1.815**	1.524**	1.429**
	(1.158)	(1.159)	(0.925)	(0.961)	(0.836)	(0.890)	(0.604)	(0.650)
$\xi_{t-1}^{b,n}$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
r_t^m	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	α	$\omega+\tau$	α	$\omega+\tau$	α	$\omega+\tau$	α	$\omega+\tau$
Clustering	ω	$\omega+\tau$	ω	$\omega+\tau$	ω	$\omega+\tau$	ω	$\omega+\tau$
Obs.	23,005	23,005	23,005	23,005	38,224	38,224	38,224	38,224
R^2	0.140	0.027	0.195	0.020	0.112	0.029	0.158	0.021

Table 2: Odd-numbered specifications run the model in eq. (9); evens that of eq. (11). *SC* denotes whether the repo is collateralized by a special, TN denotes whether the repo is tomorrow-next (as opposed to SN or ON), $T2$ equals 1 if the repo occurred after the shift to T+2 settlement. α refers to *Country*, ω to {*Segment* x *Country* x *Collateral* x *Tenor*}, and τ to *Trade Date*. For all specifications, all observations during the last week of the calendar year as well as all where $|\xi_t^{b,n}| > 100\%$ are dropped. I further remove all ω combinations which did not trade both before and after the T+2 switch. Winsorized data is adapted at the 2.5% and 97.5% levels per {*Segment* x *Tenor*} combination. The within-model R^2 is reported.

extent - as their own habitat. This is remarkable given that they each have the exact same tenor (from leg to leg) but differ only in their settlement times.

7 Interpreting the results

The worsening of the EH performance in the treated segment provides evidence in favor of hypothesis (b): that preferred habitat theory can impact short-term rates. In this section, I study two ramifications of this result. Section 7.1 hypothesizes that collateral scarcity is the constraint preventing an arbitrage of EH deviations. In section 7.2 I show that the result of our analysis implies that leveragers dominate the transferred habitat.

7.1 Collateral scarcity

It is difficult to suggest that arbitrageurs' risk aversion blocks them from closing these spreads. Interest rate risk is often viewed as constraining arbitrageurs' activity (Vayanos and Vila, 2021), but this is unlikely to be the case here given the near-identical and ultra-short term nature of the respective segments. Instead, the likely culprit is an inability to access the safe asset bonds required to arbitrage away deviations from the EH. To specifically arbitrage the spreads opened by the T+2 reform, agents should be performing spot-next special-collateral reverse repos, but doing so requires having the requisite safe asset collateral in the first place. Safe asset scarcity caused by unconventional monetary policy, for example, reduces the potential for arbitrage operations. Furthermore, pension funds are large institutional investors who hold major shares of the outstanding pool of long-term dated bonds (Greenwood and Vayanos (2010), Greenwood and Vissing-Jorgensen (2018), Klingler and Sundaresan (2019)), and are unlikely to perform such sophisticated activity.

I provide evidence that deviations from the EH worsen when collateral is scarce by considering (i) the effects of unconventional monetary policy on bond supply and (ii) the EH performance in relation to repo specialness. For the former, I use bond purchases by the ECB's Public Sector Purchase Program (PSPP) as shocks to the supply of bond collateral. As part of unconventional monetary policy, the ECB conducted net purchases of public sector securities under the PSPP between March 2015 and June 2022.[19] Naturally, the ECB's purchases reduces the amount of available bonds in the financial system, contributing to collateral scarcity. For instance, Arrata et. al (2020) estimate that PSPP purchases of 1% of a bond outstanding is associated with a 0.78 basis point decline of its repo rate. While bonds purchased under the PSPP are made available for lending through dedicated securities lending facilities (SLF), these are intended as a backstop for when collateral is scarce. Greppmair and Jank (2022) document the restrictions imposed on participants wishing to use SLFs, and describe that borrowing volume nearly doubled when these securities' pricing conditions were ameliorated in November 2020.[20]

I thus use PSPP purchases as quasi-exogenous shocks on the supply of bonds. I hypothesize that deviations from the EH intensify with PSPP bond purchases. There is a plausible reverse causality channel to consider: if EH deviations reflect a sign of economic malaise, it may be that the ECB increases bond purchases in response.[21] To alleviate these concerns, I include a battery of control variables reflecting economic conditions: the LIBOR-OIS spread, the VIX index, and the TED spread.[22] As PSPP purchases were allocated between the bonds of various member states on a monthly basis, I run a panel regression aligning the country-specific average EH error with the monthly purchased quantity. I thus run the

[19] From January to October 2019, the Eurosystem only reinvested the principal payments from maturing securities held in the PSPP portfolio. The Eurosystem comprises the European Central Bank and the national central banks of member states whose currency is the euro.

[20] Before (after) November 2020, the ECB allowed "eligible counterparties to borrow securities against cash as collateral at a rate equal to the rate of the deposit facility minus 30 (20) basis points or the prevailing market repo rate... whichever [was] lower." See Greppmair and Jank (2022) and ECB (2021) for the original text.

[21] The PSPP and asset purchases programs (APPs) more broadly were devised to assist in the ECB's goal to reduce persistently weak inflation in a zero-interest rate environment. As such, APPs' "size and duration were linked to achieving a sustained adjustment in the path of inflation towards price stability," see ECB (2019). A structured forward guidance was adopted which implied both a fixed, monthly recurring component as well as a state-dependent component linked to the price stability objective.

[22] The LIBOR-OIS spread is a key measure of interbank counterparty risk, as it compares two otherwise comparable interest rates, differing in that overnight index swaps (OIS) do not involve the exchange of principal. I use EURIBOR and euro OIS rates for a euro-area specific measure. The VIX is the Chicago Board of Exchange's volatility index. The TED spread is the difference between interbank lending rates and U.S. Treasury bills.

regressions:

$$\xi^n_{i,t} = \beta_1 \cdot PSPP_{i,t} + \beta_2 \cdot LIBOR\text{-}OIS_t + \beta_3 \cdot VIX_t + \beta_4 \cdot TED_t + \alpha_i + u_{i,t} \quad (12)$$

Table (3) presents results. The first (last) three columns consider EH deviations from TN (SN) rates predicting the ON rate. We measure EH deviations in basis points, as a percentage, and as a winsorized percentage. Economic and statistical significance is achieved for all specifications, showing that deviations from the EH are stronger when collateral is made scarce by quantitative easing programs.

	Expectations hypothesis error, $\xi^n_{i,t}$					
	TN (bps)	TN (%)	TN (%,W)	SN (bps)	SN (%)	SN (%,W)
	(1)	(2)	(3)	(4)	(5)	(6)
PSPP	0.371**	0.187**	0.193**	0.451**	0.218**	0.225**
	(0.137)	(0.068)	(0.067)	(0.152)	(0.082)	(0.078)
LIBOR-OIS	Y	Y	Y	Y	Y	Y
VIX	Y	Y	Y	Y	Y	Y
TED	Y	Y	Y	Y	Y	Y
Fixed effects	α	α	α	α	α	α
Clustering	α	α	α	α	α	α
Obs.	293	293	293	293	293	293
R^2	0.102	0.097	0.113	0.092	0.074	0.090

Table 3: The table shows the results of regressions of the EH error, $\xi^n_{i,t}$, on purchases conducted under the PSPP. Specifications are monthly panel regressions with country fixed effects and clustering. The first (last) three columns consider EH deviations from TN (SN) rates predicting the ON rate. I measure EH deviations in basis points, as a percentage, and as a winsorized percentage. The within-model R^2 is reported.

I conduct a second analysis showing the relationship between EH errors and collateral scarcity by leveraging repo specialness. As a bond is made more scarce in the cash market, it commands a premium for borrowing it through repo; that is, the cash borrowing rate of a repo backed by a prized collateral is decreased. I measure specialness as a spread to either the GCP or GCX rate, and further scale it as in eq. (8). For a repo with underlying bond b and maturity m:

$$\gamma^{b,m}_t := \frac{r^{\{b=g\},m}_t - r^{b,m}_t}{1 + |r^{b,m}_t|}, \qquad g \in \{\text{GCP, GCX}\} \quad (13)$$

As specialness is a proxy for collateral scarcity, I test whether EH deviations worsen with increased specialness. I regress EH deviations on a measure of specialness based on the overnight rate (i.e. $m = \text{ON}$ in eq. (14)) on a per-collateral basis as follows:

$$\xi^n_{i,t} = \beta \cdot \gamma^{b,m}_{i,t} + \omega_i + \tau_t + u_{i,t} \tag{14}$$

Table (4) shows results; their statistical and economic significance confirm the intuition. The positive relationship between specialness and EH deviations increased during the era of zero interest rate policy (ZIRP), which is defined as any time when the GCP/GCX rate was below zero. Then, a 1% increase in specialness resulted in a 11% increase in the EH error. Taken as our whole, the analyses confirm the intuition that collateral scarcity is the reason why arbitrageurs cannot erase EH deviations.

	$\xi^n_{i,t}$ (%, W)			
	Full sample		Sub-ZIRP	
	GCP	GCX	GCP	GCX
	(1)	(2)	(3)	(4)
$\gamma^{b,m}_{i,t}$	3.734***	4.292***	10.994***	10.975***
	(1.267)	(1.257)	(1.804)	(1.889)
Fixed effects	$\omega + \tau$	$\omega + \tau$	$\omega + \tau$	$\omega + \tau$
Clustering	$\omega + \tau$	$\omega + \tau$	$\omega + \tau$	$\omega + \tau$
Obs.	15,838	15,012	10,957	10,698
R^2	0.001	0.002	0.011	0.011

Table 4: The table shows the results of regressions of the EH error, $\xi^n_{i,t}$, on repo specialness $\gamma^{b,m}_{i,t}$. The EH errors are derived from spot-next and tom-next maturities; specialness from the overnight rate. Variables are measured as percentages according to eq. (8) and (13). ω and τ refer to $\{$*Segment* x *Country* x *Collateral* x *Tenor*$\}$ and *Trade Date* fixed effects/clustering, respectively. Specifications alternatively consider GCP and GCX rates in the calculation of the specialness premium. The first two columns consider the full sample; the latter two consider observations only when the GCP (GCX) rate was below zero. The within-model R^2 is reported.

7.2 Could risk premia explain the pricing effect?

This paper has causally identified a preferred habitat effect: I have observed a set of agents as they change habitat preference, and seen prices react as a result. However, it may yet be the case that risk premia, and not the movement of traders, drove these pricing effects. In this section, I consider the notion that perhaps it was not the shift in traders' activity which impacted prices, but rather an alteration in risk premia caused by the T+2 reform.

7.2.1 Order flow dynamics

I argue against these potential confounders by studying how order flow was impacted by the reform. If term premia drove the pricing result, order flow need not coincide with the direction of the pricing effect. Conversely, if the agents which shifted habitat are responsible, one would expect their order flow to be bidding up the price. Thus, I test to see whether order flow coincided with the pricing movement.

The fact that the treatment repo rate increased as a result of the T+2 shift suggests that leveragers outnumbered short-sellers in the transferred habitat. The reasoning is that leveraging requires repo borrowing, which bids up the repo rate, resulting in higher EH errors relative to the ON rate. Thus, if the transferred agents mostly consisted of cash borrowers, we would expect order flow to go in the direction of borrowing repos more aggressively (as opposed to reverse repos).

For each transaction in the data, I am able to identify whether the transaction was initiated by the cash borrower or the cash lender. I thus measure order flow ϕ per maturity and collateral as the share of volume in which the initiator (or "aggressor") borrowed cash. I run models as in equations (9) and (11), with this measure of order flow aggressiveness as the dependent variable. I run the specifications once on the raw shares and once on logarithmic values (to get a percentage change). As before, I include the lagged dependent variable as well as the level of the interest rate being traded as controls.[23]

Results in Table (5) show a statistically and economically significant increase in order flow aggressiveness in the treatment group after the T+2 switch. Note that given that the dependent variable in the "raw" specification is bounded by (0,1) it is a linear probability model. In any case, the regression results confirm that order

[23] A larger number of observations are reported in this specification as I previously could only use observations for which both a predictor and target rates with the same collateral were available.

	Order flow aggressiveness $\phi_t^{b,n}$							
	Proximate sample				Full sample			
	Raw		Logarithmic		Raw		Logarithmic	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
SC	-0.039^{*}		-0.210^{***}		-0.037^{*}		-0.233^{***}	
	(0.022)		(0.052)		(0.019)		(0.067)	
TN	0.038^{**}		-0.042		0.030^{**}		-0.056	
	(0.017)		(0.049)		(0.012)		(0.056)	
T2	0.014		0.036		0.044^{**}		0.045	
	(0.017)		(0.042)		(0.019)		(0.040)	
SC:TN	-0.082^{***}		-0.250^{***}		-0.099^{***}		-0.363^{***}	
	(0.029)		(0.069)		(0.027)		(0.117)	
TN:T2	-0.034	-0.037	-0.109	-0.125	-0.022	-0.025	-0.032	-0.050
	(0.029)	(0.031)	(0.075)	(0.080)	(0.028)	(0.030)	(0.061)	(0.068)
SC:T2	-0.023	-0.027	-0.124^{**}	-0.143^{**}	-0.044^{**}	-0.046^{**}	-0.096	-0.115
	(0.019)	(0.021)	(0.050)	(0.054)	(0.021)	(0.022)	(0.065)	(0.071)
SC:TN:T2	0.068^{**}	0.074^{*}	0.244^{**}	0.267^{**}	0.082^{**}	0.087^{**}	0.320^{***}	0.357^{***}
	(0.034)	(0.036)	(0.099)	(0.105)	(0.037)	(0.039)	(0.096)	(0.106)
$\phi_{t-1}^{b,n}$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
r_t^m	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	α	$\omega+\tau$	α	$\omega+\tau$	α	$\omega+\tau$	α	$\omega+\tau$
Clustering	ω	$\omega+\tau$	ω	$\omega+\tau$	ω	$\omega+\tau$	ω	$\omega+\tau$
Obs.	49,885	49,885	49,885	49,885	106,370	106,370	106,370	106,370
R^2	0.121	0.061	0.104	0.025	0.123	0.059	0.145	0.042

Table 5: Odd-numbered specifications run the model in eq. (9); evens that of eq. (11). *SC* denotes whether the repo is collateralized by a special, TN denotes whether the repo is tomorrow-next (as opposed to SN or ON), $T2$ equals 1 if the repo occurred after the shift to T+2 settlement. α refers to *Country*, ω to {*Segment* x *Country* x *Collateral* x *Tenor*}, and τ to *Trade Date*. For all specifications, I drop all observations on the last week of the calendar year. The within-model R^2 is reported.

flow into repos (reverse repos) increased (decreased), which is consistent with the notion that leveragers dominated this preferred habitat. I also similarly run placebo tests based on the proximate sample (not shown here) and confirm that only the T+2 switch is capable of rendering this result.

Thus, I observe that the treated tenor's increase in repo rate coincides with additional buying pressure into cash borrowing. While this does not remove the possibility of term premia effects, it reinforces the idea that prices were impacted by an influx of cash borrowing demand, and that the shifted agents' order flow pressure directly affected prices, rather than prices automatically adjusting due to risk premia. In the next sections, I consider the main candidates for potentially confounding premia.

7.2.2 Specialness premium

A potential confounder is that the shortened settlement time would have created additional risk and stress in repo markets, which is then reflected in prices. For example, ICMA (2014) predicted that the reform would "narrow the window within which the repo market has to fund most cash transactions from three to two days... [t]his will mean more frequent resort to credit lines and more urgent securities borrowing, which may be reflected in increased fails and specialness." In other words, an increased pressure to deliver collaterals on time could result in a premium related to how in-demand the security is, i.e. specialness.

However, this is contrary to the observed dynamic: a by-product of the mechanism at hand is that repo specialness *decreased* in the treatment group following this switch. This may seem counter-intuitive at first, given that leveragers are essentially betting on an increase in value of safe asset collateral. However, by bidding up the repo rate, leveragers are mechanically decreasing specialness in the repo market. To formalize this I run a simple difference-in-differences model on special repos as follows:

$$\gamma_t^{b,m} = \beta_1 \cdot D_{t,b,m}^{TN} + \beta_2 \cdot D_{t,b,m}^{T2} + \beta_3 \cdot D_{t,b,m}^{TN} \cdot D_{t,b,m}^{T2} + \beta_4 \cdot \gamma_{t-1}^{b,m} + \beta_5 \cdot r_t^{GCP,m} + b + u_t^{b,m} \tag{15}$$

$$\gamma_t^{b,m} = \beta_3' \cdot D_{t,b,m}^{TN} \cdot D_{t,b,m}^{T2} + \beta_4' \cdot \gamma_{t-1}^{b,m} + \beta_5' \cdot r_t^{GCP,m} + \omega_b + \tau_t + u_t^{b,m} \tag{16}$$

where b are collateral fixed effects. I run the model twice, once basing the specialness variables on the GCP rate (as shown) and once based on the GCX.

Table (I1) in Appendix I shows results; they point to a consistently significant decrease in repo specialness of around 1.5% (2%) when considering specialness relative to the GCP (GCX) basket. By leveraging their bets on special bonds in fixed income markets, leveragers decrease the specialness of those bonds in repo markets. Naturally, one presumes that the securities these leveragers buy in bond markets increase in price due to their bidding, while their repo activity decreases their value as collateral. In short, the results point to order flow, not a risk premium, as driving the pricing effect.

7.2.3 Liquidity risk premium

The T+2 reform dramatically increased the turnover of the special tom-next segment from 10B to 40B. It stands to reason its liquidity conditions increased dramatically as a result. Lenders typically demand a higher interest rate to compensate for the risk of illiquidity (see e.g. Bechtel, Ranaldo, and Wrampelmeyer (2023)), and a more liquid market reduces such liquidity risk. Thus, one could feasibly expect the influx of trading volume to *decrease* the treated segment's rate. However, the results of our analysis shows that the tomorrow-next tenor *increased* relative to the control groups; a more liquid (or at least, more traded) tom-next tenor saw an increase in its repo rate. Thus, the repo rate moved contrary to the direction hypothesized by a liquidity risk premium.

7.2.4 Haircuts

Another potential explanation for the pricing effect could be through haircuts. As is made clear in Appendix A, the repo rate is linked to the haircut charged on the collateral's value. Perhaps the increase in price in the treated segment is a reflection of higher haircuts being charged due to increased uncertainty, especially w.r.t. those agents who are borrowing cash to pay off purchases they have already made. This hypothesis is non-viable due to the fact that I am considering repos which are traded on CCPs. Trading through CCPs is performed anonymously (dispelling concerns about market power and/or price discrimination), and haircuts are furthermore set by the CCP, not by repo traders (Mancini et. al, 2016). Thus the structure of this market segment dispels this possible alternative explanation.

To conclude, then, the most salient term premia explanations can safely be rejected, as prices moved in a direction counter to their prediction. Furthermore, prices did not automatically adjust to the settlement time shift; instead, order flow coincided with the shift in pricing.

7.3 Leveraging in repo

The pricing and order flow movements highlight the prevalence of leveraging in repo at the time of the reform. It may be that this activity is restricted to agents simply raising cash to meet obligations in fixed income markets. But it is also plausible that a more explicit form of leveraging is also at play: in theory, an agent can buy a security with its own funds and repo out that security to raise more liquidity, which could be used to buy another bond, which could be repoed out for yet more funds, and so on, ad infinitum (ICMA, 2019). There is precedent for this practice in repo markets. Schrimpf, Shin, and Sushko (2020) explore how the Covid-19 crisis resulted in a forced sell-off of U.S. Treasury securities by investors who had attempted to exploit small yield differences through the use of repo leverage. They further argue that these investors could achieve high levels of leverage because the collateral value of Treasury securities is normally very high: "For instance, if an investor can borrow

\$99 by pledging \$100 worth of Treasuries, the investor need have only \$1 of own funds to hold Treasuries worth \$100, achieving 100-fold leverage." At the time of writing, the potential for high levels of leverage in repo still attracts attention and concern from central banks and regulators; see for example Barth, Kahn, and Mann (2023).[24]

In an environment of negative interest rates, safe assets, and convenience yields, agents are incentivized to pursue leveraging. Cheap cash borrowing in repo allows investors to achieve high rates of leverage. Second, those financial intermediaries which hold quality assets can take advantage of their status to obtain cheap liquidity.[25] Furthermore, in the era of zero or negative interest rates which started in 2012, an investor receives *more* cash than the value of the collateral they provide (see Figure (1)). Leveraging is further advantaged w.r.t. its counterpart short-selling. As specialness decreases the repo rate and short-selling requires a reverse repo, the agent is lending cash at a suboptimal rate when shorting. In particular, borrowing special bonds is particularly cumbersome in the safe asset environment. Leveraging, on the other hand, means the agent could take advantage of a security they own, while borrowing at cheap special rates. The profitability of leveraging and short-selling is $\Delta P^B_{T+3,T+2} - r^{TN}_{T+1}$ and $-\Delta P^B_{T+3,T+2} + r^{TN}_{T+1}$ respectively; given negative interest rates, the former is advantageous w.r.t. the latter. Naturally, with interest rates now above zero, it is likely that this dynamic has inversed.

Note that these results are remarkable in that they imply an economically significant change in the EH performance (around 5% of target) based the difference between two counter-acting exogenous shocks. That is, it is the *difference* between the share of leveraged trades and short-sale trades which is causing this 5% shift. The average treatment effect is not the effect of a shift in e.g. just leveragers or short-sellers, but the effect caused by the delta between the two. This speaks favorably to the strength of the results (or alternatively, to the strong dominance of

[24] Buraschi and Menini (2001) provide an older example in Orange County, California which, in an attempt to earn high non-tax income, took positions worth \$20 billion using just \$7.5 billion of assets by financing itself in repo. After a rise in interest rates, it declared bankruptcy in 1994.

[25] Note that while legal ownership of the collateral changes hands during a repo agreement, the benefits of such collateral (e.g. any coupon payments due during the term of the repo) accrue (somewhat counter-intuitively) to the collateral's original owner, i.e. the cash-borrower.

leveraging in this market).

8 Conclusion

Repo markets are an ideal laboratory to test the expectations hypothesis. While results on this critical question have thus far been mixed, this study clarifies that the major distinguishing factor in the validity of the EH in repo is whether one considers general or special collateral segments. I find that the EH fails in special repos, despite only considering repo combinations with the same underlying ISIN.

The results have demonstrated the existence of a preferred habitat connecting the repo segment to fixed income markets. Leveraging a quasi-exogenous experiment in the reform of settlement times in bond markets, I showed that a large portion of the repo market is used to fund positions in the cash market. When this segment transferred to the tomorrow-next maturity along with the new shortened settlement time, the tom-next maturity increased on average and thus its performance in EH tests declined relative to special spot-next trades. The general collateral segment provided an opportune second control group, allowing a powerful and robust difference-in-difference-in-differences identification strategy. I further argued that the pricing shift was due to order flow moving prices, and discussed why alternative explanations based on risk premia cannot explain the observed dynamics.

Three noteworthy results stand out. First, the EH can indeed hold in the ideal setting of general collateral, and is thus not just a theoretical construct. Second, preferred habitat effects are more powerful and pervasive than previously thought. The tom-next and spot-next maturities which were affected here have the same maturity and differ only in settlement time by one day. This is a far cry from preferred habitat theories which have analysed differences in tenors with years' distance from each other on the yield curve. Collateral scarcity and fragmentation - i.e. microstructural frictions - replace interest rate risk as the constraint stopping arbitrageurs' remedial trading. Finally, repo markets are used to finance unfunded cash/securities outlays and to take on leveraged positions. This suggests that the convenience yields of safe assets allow for cheap repo funding, which may encourage such behaviour. My findings thus contribute to the literature on the expectations hypothesis and preferred habitat phenomena, while also shedding light on a potential financial vulnerability.

The cash borrower performs a repo, while the cash lender (bond borrower) is conducting a reverse repo. Legal ownership of the collateral changes hands, but the benefits of such collateral (e.g. any coupon payments due during the term of the repo) accrue to the collateral's original owner, i.e. the cash-borrower. In the example below, the repo rate is calculated as (101-99)/99 = 2%. The cash lender is likely to apply a haircut to the loaned amount. In this case the haircut is 1-99/100 = 1%.

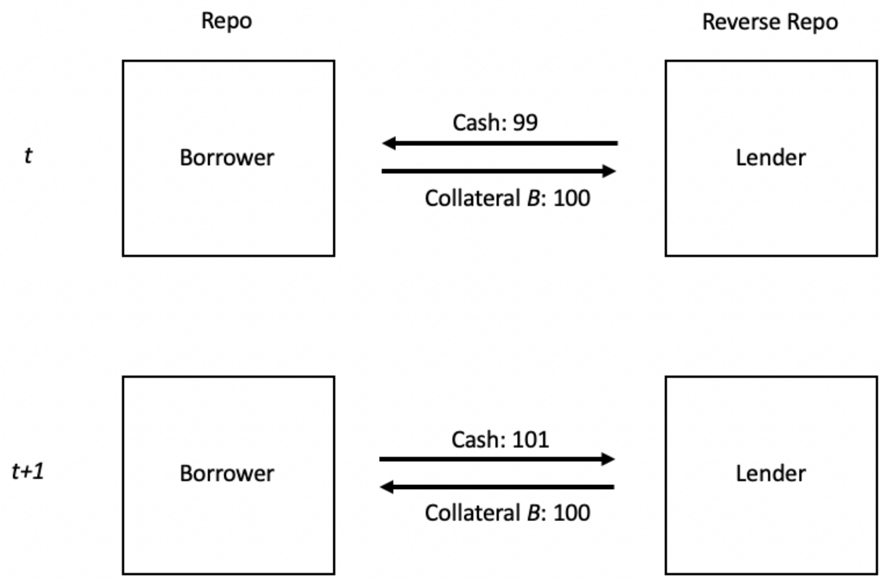


Figure A1: Example of a repo transaction

Panel A: GC Repo Rates								
	DE	FR	BE	NL	ES	IT	GCP	GCX
Overnight								
Mean	0.576	0.190	0.476	0.320	-0.021	-0.127	0.728	0.017
Std Dev	1.455	1.013	1.357	1.252	0.574	0.581	1.511	0.504
Min	-8.000	-7.222	-3.093	-3.635	-1.805	-0.490	-1.011	-0.944
Max	4.488	4.439	4.650	4.400	4.350	4.100	5.117	2.975
Obs	3'421	3'125	3'111	2'641	2'328	269	3'679	2'797
Tomorrow-next								
Mean	0.686	0.118	0.694	0.472	0.060	0.032	0.706	−0.002
Std Dev	1.522	0.868	1.486	1.336	0.715	0.537	1.494	0.491
Min	−4.009	-3.339	-3.459	-3.452	-1.618	-0.727	-1.583	−0.549
Max	4.480	4.410	4.500	4.530	4.060	4.070	4.955	3.050
Obs	3'702	3'036	3'431	3'247	2'521	2'723	3'575	2'665
Spot-next								
Mean	0.715	-0.027	0.343	0.082	-0.022	0.032	0.283	−0.042
Std Dev	1.379	0.542	0.913	0.940	0.450	0.526	1.041	0.435
Min	-4.177	-4.012	-4.000	-3.868	-1.263	-0.656	-1.353	-0.550
Max	4.500	4.385	4.460	4.330	3.550	3.310	4.488	2.900
Obs	1'554	1'624	417	379	1'496	2'736	2'697	2'303

Panel B: SC Repo Rates						
	DE	FR	BE	NL	ES	IT
Overnight						
Mean	0.376	0.151	0.328	0.049	−0.062	0.228
Std Dev	1.506	1.191	1.394	1.174	1.078	1.288
Min	-7.706	-5.000	-6.732	-8.025	-6.499	-5.010
Max	4.297	4.310	4.350	4.401	4.300	4.360
Obs	3'650	698	3'332	2'884	3'124	929
Tomorrow-next						
Mean	0.523	0.559	0.609	0.588	0.599	0.343
Std Dev	1.539	1.508	1.530	1.537	1.511	1.193
Min	-7.663	-4.336	-7.059	-8.468	-1.515	-1.236
Max	7.624	4.310	4.347	4.388	4.402	4.390
Obs	3'707	1'871	3'706	3'706	3'707	3'287
Spot-next						
Mean	0.588	0.802	0.656	0.632	0.645	0.677
Std Dev.	1.553	1.578	1.529	1.536	1.503	1.490
Min	-5.481	-2.250	-4.749	-4.974	-1.014	-0.960
Max	4.410	4.313	4.432	4.405	4.410	4.450
Obs	3'707	1'951	3'707	3'707	3'707	3'685

The below graphic displays a stylised depiction of various tenors. Circles represent when the trade is agreed (and hence, the time at which the expectation governing the rate was formed). Dotted lines represent when the loan / repo was active (i.e. when interest was being paid). (a) shows a multi-period compound interest rate in the style of equation (1), where $n = 2$. (b) does the same for two short-term rates where $m = 1$. (c)-(e) show the dynamics of ON, TN, and SN repos respectively, and align them so that a test of the EH could be made for the time period at time t.

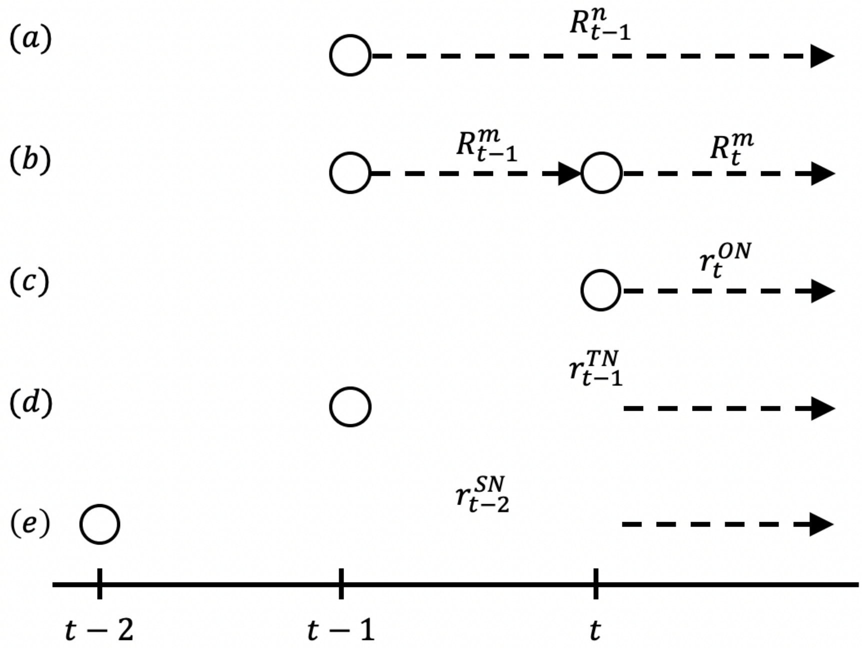


Figure C1: Visualization of various maturity types

I validate the hypothesis formed in section 5.1 and confirm that a significant trading volume shift occurred from spot-next to tom-next occurred for special repos. I run a DDD model using traded volume V as the dependent variable; this is essentially a formal econometric validation of the dynamic we observe in Fig. (2). I split the trading volume data into several time series according to $\{Segment \text{ x } Country \text{ x } Tenor\}$. For example, I consider the trading volume of special French repos in the overnight tenor, to make a time series denoted $\{SC \text{ x } FR \text{ x } ON\}$. Given that there are 2 segments, 8 countries, and 3 maturities, I consider 34 different time series.[26] I consider:

$$V_t \; = \; \beta_1 \cdot D_t^{SC} \; + \; \beta_2 \cdot D_t^{TN} \; + \; \beta_3 \cdot D_t^{SC} \cdot D_t^{TN} \; + \; \delta_0 \cdot D_t^{T+2} \; + \; \delta_1 \cdot D_t^{T+2} \cdot D_t^{SC}$$
$$+ \; \delta_2 \cdot D_t^{T+2} \cdot D_t^{TN} \; + \; \delta_3 \cdot D_t^{T+2} \cdot D_t^{SC} \cdot D_t^{TN} \; + \; \alpha \; + \; u_t \tag{17}$$

where D denotes a dummy variable, SC denotes whether the repo is collateralized by a special, TN denotes whether the repo is tomorrow-next (as opposed to SN or ON), $T+2$ equals 1 if the repo occurred after the shift to T+2 settlement, and α here represents country fixed effects. $\hat{\delta}_t$ then is the DDD estimator, giving a causal estimate of the impact of the settlement change on trading volumes. I further consider a specification with a comprehensive set of fixed effects:

$$V_t \; = \; \delta_1' \cdot D_t^{T+2} \cdot D_t^{SC} \; + \; \delta_2' \cdot D_t^{T+2} \cdot D_t^{TN} \; + \; \delta_3' \cdot D_t^{T+2} \cdot D_t^{SC} \cdot D_t^{TN} \; + \; \lambda \; + \; \tau + \; u_t \tag{18}$$

where I use $'$ to distinguish our coefficients from the full specification, λ refers to $\{Segment \text{ x } Country \text{ x } Tenor\}$ fixed effects, and τ refers to time fixed effects. To isolate the effect of the treatment, I run the two models on data extending one year before, to one year after, the date of the T+2 switch. Finally, I also consider these two specifications in logged volumes, in order to get a consistent percentage change in trading volume across segments.

Table (D1) shows results. The DDD estimator is economically and statistically significant across all specifications. The logged-volume regressions suggest that the

[26] Given that I treat GCP and GCX as "countries", and that I remove 8 time series for insufficient data, the calculation is $(2 \cdot 8 \cdot 3) - (2 \cdot 3) - 8 = 34$.

	Volume (B)		Volume (logs)	
	(1)	(2)	(3)	(4)
SC	14.645**		0.655	
	(6.323)		(0.950)	
TN	0.293		0.509**	
	(1.650)		(0.198)	
T2	−0.524		−0.017	
	(0.441)		(0.100)	
SC · TN	−15.571**		−0.707	
	(6.803)		(0.978)	
TN · T2	1.462**	1.443**	0.248	0.234
	(0.632)	(0.625)	(0.169)	(0.168)
SC · T2	−2.356*	−2.174	0.086	0.128
	(1.310)	(1.289)	(0.179)	(0.178)
SC · TN · T2	5.346***	5.183**	0.658**	0.617**
	(2.064)	(2.053)	(0.290)	(0.289)
Fixed effects	α	$\lambda + \tau$	α	$\lambda + \tau$
Clustering	λ	$\lambda + \tau$	λ	$\lambda + \tau$
Obs.	16’686	16’686	16’686	16’686
R^2	0.261	0.190	0.058	0.059

Table D1: Specifications (1) and (3) run the model in eq. (17); (2) and (4) that of eq. (18). SC denotes whether the repo is collateralized by a special, TN denotes whether the repo is tomorrow-next (as opposed to SN or ON), $T + 2$ equals 1 if the repo occurred after the shift to T+2 settlement. α refers to *Country*, λ to $\{$*Segment* x *Country* x *Tenor*$\}$, and τ to *Trade Date*. The within-model R^2 is reported.

T+2 switch caused an 85%-93%[27] increase in trading volume (while high, Figure (2) saw TN volumes surge from below 10 to 40 billion). This confirms the results presented by the graphical evidence and emphasizes there was a migration of a preferred habitat from the special spot-next segment to the special tomorrow-next segment, whereas other sectors were relatively unaffected. Note that the coefficient on "TN · T2" implies that there was some volume movement in the general segment as well; however significance is not achieved for all specifications, and the dynamic is relatively muted, as can also be confirmed visually.

[27] As the model is in log-linear form, a unit increase in the regressor causes a $100 \cdot \left(e^{\delta} - 1\right)$ percent increase in the dependent variable.

The triple-differences model relies on the assumption that the relative EH performance of special repos w.r.t. general repos in the spot-next maturity does not trend differently from the relative EH performance of special repos w.r.t. general repos in the tom-next maturity, outside of the T+2 shock. I confirm this visually by taking the mean percentage EH error of (i) spot-next generals, (ii) spot-next specials, (iii) tom-next generals, and (iv) tom-next specials. I then compute the spread between the EH performance of special repos w.r.t. general repos in spot-next and tom-next by subtracting (i) from (ii) and (iii) from (iv). The below figure plots weekly averages of the result.

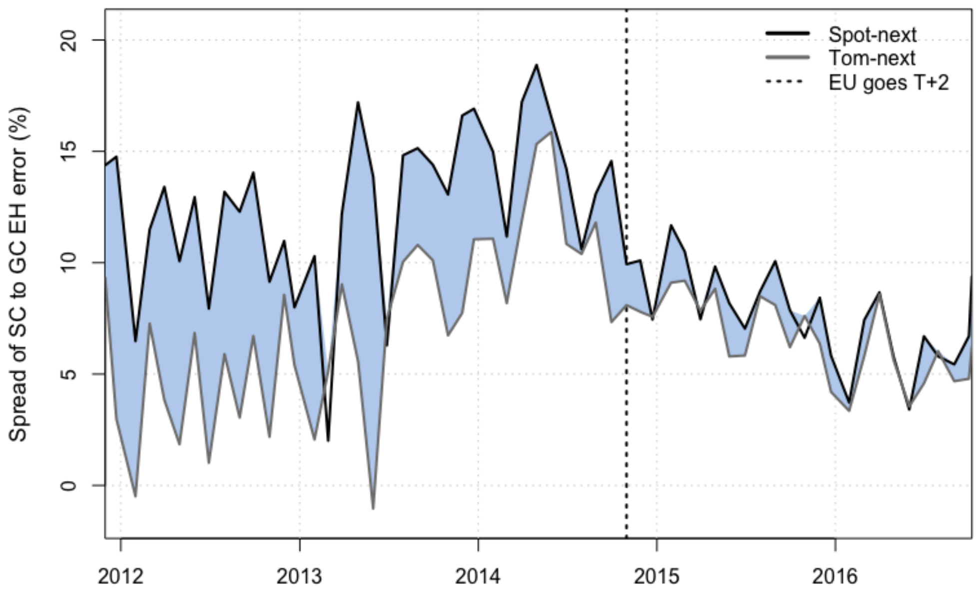


Figure E1: Spread of percentage EH error between SC and GC segments, for spot-next and tom-next maturities

I observe that the spread between the SC and GC error is greater in the spot-next maturity than in the tom-next, and, importantly, the two are constantly co-moving. After the T+2 shift, as the special tom-next percentage EH error worsened, the tom-next time series in the plot moves closer to the spot-next series. The area between the two time series is shaded blue for an easier comparison.

The below figure helps visualize the different tenors and segments used in the empirical model. General-collateral repos were unaffected by the shift, as was the spot-next segment. Thus spot-next special repos are the only pure treatment group. I use overnight rates as the target. Two difference-in-difference models are available: one comparing general and special tom-next repos, and one comparing special spot-next and tom-next repos. The difference-in-difference-in-differences model combines both into one econometric specification. It is a strictly better model as it requires a far weaker parallel trends assumption.

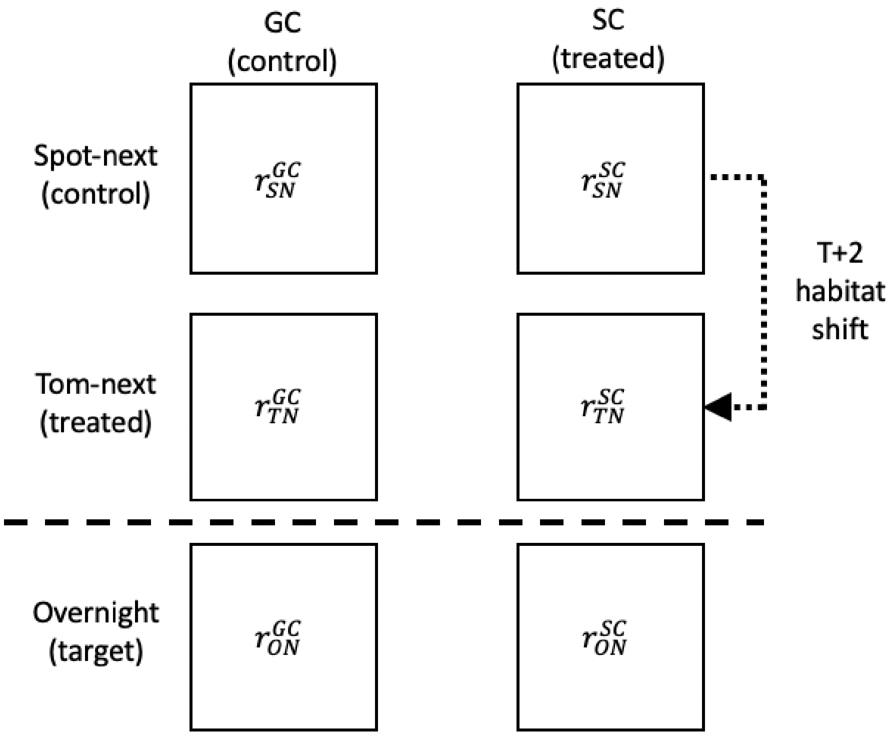


Figure F1: Empirical model schema

	Expectations hypothesis error: $\xi_t^{b,n}$ (bps)							
	Proximate sample				Full sample			
	Raw		Winsorized		Raw		Winsorized	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
SC	0.183***		0.165***		0.151***		0.135***	
	(0.018)		(0.012)		(0.012)		(0.009)	
TN	0.003		0.001		−0.005		−0.004*	
	(0.004)		(0.003)		(0.003)		(0.003)	
T2	−0.007		−0.008**		−0.006		−0.010***	
	(0.009)		(0.003)		(0.004)		(0.003)	
SC:TN	−0.096***		−0.078***		−0.056***		−0.046***	
	(0.021)		(0.014)		(0.014)		(0.010)	
TN:T2	−0.003	−0.0001	−0.001	0.001	0.004	0.005*	0.004	0.005**
	(0.003)	(0.003)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.002)
SC:T2	−0.056***	−0.047***	−0.042***	−0.035***	−0.044***	−0.037***	−0.035***	−0.029***
	(0.015)	(0.016)	(0.011)	(0.012)	(0.011)	(0.012)	(0.008)	(0.009)
SC:TN:T2	0.075***	0.060***	0.057***	0.045***	0.037**	0.029*	0.027***	0.023**
	(0.023)	(0.023)	(0.015)	(0.016)	(0.015)	(0.016)	(0.011)	(0.011)
$\xi_{t-1}^{b,n}$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
r_t^m	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	α	$\omega+\tau$	α	$\omega+\tau$	α	$\omega+\tau$	α	$\omega+\tau$
Clustering	ω	$\omega+\tau$	ω	$\omega+\tau$	ω	$\omega+\tau$	ω	$\omega+\tau$
Obs.	23,005	23,005	23,005	23,005	38,237	38,237	38,237	38,237
R^2	0.096	0.0135	0.176	0.016	0.084	0.015	0.152	0.021

Table G1: Odd-numbered specifications run the model in eq. (9); evens that of eq. (11). *SC* denotes whether the repo is collateralized by a special, TN denotes whether the repo is tomorrow-next (as opposed to SN or ON), $T2$ equals 1 if the repo occurred after the shift to T+2 settlement. α refers to *Country*, ω to {*Segment* x *Country* x *Collateral* x *Tenor*}, and τ to *Trade Date*. For all specifications, all observations during the last week of the calendar year as well as all where $|\xi_t^{b,n}| > 100\%$ are dropped. I further remove all ω combinations which did not trade both before and after the T+2 switch. Winsorized data is adapted at the 2.5% and 97.5% levels per {*Segment* x *Tenor*} combination. The within-model R^2 is reported.

	Expectations hypothesis error: $\xi_t^{b,n}$ on placebo date of October 6th, 2012							
	Proximate sample				Full sample			
	Raw		Winsorized		Raw		Winsorized	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
SC	9.269^{***}		9.497^{***}		6.943^{***}		7.391^{***}	
	(0.939)		(0.737)		(0.723)		(0.499)	
TN	-0.762^{***}		-0.584^{**}		-1.088^{***}		-0.757^{***}	
	(0.269)		(0.250)		(0.227)		(0.175)	
T2′	0.873^{***}		0.207		−0.465		-0.749^{***}	
	(0.315)		(0.194)		(0.368)		(0.210)	
SC:TN	-2.857^{***}		-3.197^{***}		-1.906^{**}		-2.182^{***}	
	(1.079)		(0.807)		(0.909)		(0.566)	
TN:T2′	0.985^{***}	0.763^{***}	0.773^{***}	0.566^{*}	1.048^{***}	0.707^{***}	0.711^{***}	0.514^{*}
	(0.176)	(0.263)	(0.184)	(0.291)	(0.265)	(0.251)	(0.191)	(0.275)
SC:T2′	1.075	0.710	0.355	0.270	−0.714	−0.977	-1.297^{***}	-1.095^{*}
	(0.814)	(1.060)	(0.614)	(0.877)	(0.688)	(0.811)	(0.435)	(0.571)
SC:TN:T2′	0.397	−0.070	0.813	0.243	0.515	0.664	0.822	0.843
	(1.150)	(1.333)	(0.891)	(1.087)	(0.962)	(1.041)	(0.611)	(0.738)
$\xi_{t-1}^{b,n}$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
r_t^m	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	α	$\omega+\tau$	α	$\omega+\tau$	α	$\omega+\tau$	α	$\omega+\tau$
Clustering	ω	$\omega+\tau$	ω	$\omega+\tau$	ω	$\omega+\tau$	ω	$\omega+\tau$
Obs.	18,958	18,958	18,865	18,865	38,224	38,224	38,224	38,224
R^2	0.137	0.032	0.177	0.014	0.109	0.026	0.156	0.019

Table H1: I assume a placebo date of October 6, 2012 for the T+2 switch, resulting in variable $T2'$. Odd-numbered specifications run the model in eq. (9); evens that of eq. (11). SC denotes whether the repo is collateralised by a special, TN denotes whether the repo is tomorrow-next (as opposed to SN or ON), $T2'$ equals 1 if the repo occurred after the shift to the false T+2 settlement date. α refers to *Country*, ω to {*Segment* x *Country* x *Collateral* x *Tenor*}, and τ to *Trade Date*. For all specifications, all observations on the last week of the calendar year as well as all where $|\xi_t^{b,n}| > 100\%$ are dropped. I further remove all ω combinations which did not trade both before and after the T+2 switch. Winsorized data is adapted at the 2.5% and 97.5% levels per {*Segment* x *Tenor*} combination. The within-model R^2 is reported.

	Expectations hypothesis error: $\xi_t^{b,n}$ on placebo date of October 6^{th}, 2016							
	Proximate sample				Full sample			
	Raw		Winsorized		Raw		Winsorized	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
SC	7.758***		6.934***		7.309***		7.508***	
	(0.389)		(0.328)		(0.407)		(0.330)	
TN	−0.065		−0.125		−0.419***		−0.294**	
	(0.131)		(0.120)		(0.126)		(0.125)	
T2″	−0.027		−0.443**		−0.427*		−0.662***	
	(0.254)		(0.190)		(0.236)		(0.185)	
SC:TN	−1.383***		−1.273***		−1.828***		−1.912***	
	(0.468)		(0.411)		(0.471)		(0.372)	
TN:T2″	0.028	0.232	0.075	0.257	0.359*	0.307	0.258	0.277
	(0.168)	(0.230)	(0.178)	(0.185)	(0.217)	(0.212)	(0.216)	(0.194)
SC:T2″	−1.666***	−1.262***	−1.276***	−0.933**	−2.291***	−1.910***	−2.385***	−1.897***
	(0.463)	(0.485)	(0.418)	(0.426)	(0.451)	(0.489)	(0.404)	(0.420)
SC:TN:T2″	0.272	0.004	0.182	−0.138	0.843	0.504	0.872	0.479
	(0.654)	(0.628)	(0.585)	(0.563)	(0.635)	(0.634)	(0.554)	(0.560)
$\xi_{t-1}^{b,n}$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
r_t^m	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	α	$\omega+\tau$	α	$\omega+\tau$	α	$\omega+\tau$	α	$\omega+\tau$
Clustering	ω	$\omega+\tau$	ω	$\omega+\tau$	ω	$\omega+\tau$	ω	$\omega+\tau$
Obs.	23,375	23,375	23,107	23,107	38,224	38,224	38,224	38,224
R^2	0.147	0.015	0.182	0.022	0.113	0.027	0.164	0.021

Table H2: I assume a placebo date of October 6, 2016 for the T+2 switch, resulting in variable $T2''$. Odd-numbered specifications run the model in eq. (9); evens that of eq. (11). *SC* denotes whether the repo is collateralized by a special, *TN* denotes whether the repo is tomorrow-next (as opposed to SN or ON), $T2''$ equals 1 if the repo occurred after the shift to the false T+2 settlement. α refers to *Country*, ω to {*Segment* x *Country* x *Collateral* x *Tenor*}, and τ to *Trade Date*. For all specifications, all observations on the last week of the calendar year as well as all where $|\xi_t^{b,n}| > 100\%$ are dropped. I further remove all ω combinations which did not trade both before and after the T+2 switch. Winsorized data is adapted at the 2.5% and 97.5% levels per {*Segment* x *Tenor*} combination. The within-model R^2 is reported.

	Repo specialness $\gamma_t^{b,m}$							
	Proximate sample				Full sample			
	$\gamma_t^{\{\text{b=GCP}\},m}$		$\gamma_t^{\{\text{b=GCX}\},m}$		$\gamma_t^{\{\text{b=GCP}\},m}$		$\gamma_t^{\{\text{b=GCX}\},m}$	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
T2	-2.412^{***}		-4.159^{**}		-1.938^{***}		-2.985^{***}	
	(0.818)		(1.758)		(0.310)		(0.935)	
TN	2.011^{***}		2.723^{***}		1.455^{***}		2.383^{***}	
	(0.408)		(0.596)		(0.299)		(0.516)	
T2:TN	-1.541^{**}	-1.437^{**}	-2.357^{***}	-1.840^{**}	-1.004^{**}	-1.355^{**}	-2.022^{***}	-1.919^{**}
	(0.623)	(0.709)	(0.914)	(0.923)	(0.447)	(0.582)	(0.735)	(0.856)
$\gamma_{t-1}^{b,n}$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
$r_t^{GCP,m}$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	b	$\omega + \tau$	b	$\omega + \tau$	b	$\omega + \tau$	b	$\omega + \tau$
Clustering	ω	$\omega + \tau$	ω	$\omega + \tau$	ω	$\omega + \tau$	ω	$\omega + \tau$
Obs.	42,064	42,064	41,386	41,386	67,151	67,151	59,757	59,757
R^2	0.570	0.535	0.492	0.473	0.556	0.518	0.484	0.460

Table I1: Odd-numbered specifications run the model in eq. (15); evens that of eq. (16). TN denotes whether the repo is tomorrow-next (as opposed to SN or ON), $T2$ equals 1 if the repo occurred after the shift to T+2 settlement. b refers to *Collateral*, ω to $\{Segment$ x $Country$ x $Collateral$ x $Tenor\}$, and τ to *Trade Date*. For all specifications, all observations on the last week of the calendar year are dropped. I further remove all ω combinations which did not trade both before and after the T+2 switch. The within-model R^2 is reported.

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