Hiding in Plain Sight: Preferred Habitat Effects in Short-Term Rates*

Edouard Mattille†

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Abstract

This paper uncovers that 30% of overnight interbank lending is driven by banks' usage of securitized "repo" instruments to make uncovered trades in bond markets. I exploit a regulatory reform that shortened the fixed income settlement cycle to identify a class of agents that systematically uses repo to source cash and securities in time for delivery; these institutions instantly shifted their trading to a correspondingly shorter repo maturity to continue rolling over their strategies. I demonstrate that this dynamic distorts both the term structure of interest rates as well as the transmission of the monetary policy rate. This paper thus identifies a preferred habitat effect at the core of interbank funding markets, a notable finding given the ultra-short-term nature of this segment. Finally, I quantify the resulting spillover to the cost of credit in the real economy.

Keywords: Preferred habitat theory, repo markets, expectations hypothesis, term structure of interest rates.

JEL classification: E43, G10, G12.

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† University of Basel, Faculty of Business and Economics, e-mail: edouard.mattille@unibas.ch.

1 Introduction

What drives the behavior of short-term funding rates? Overnight interbank liquidity markets are a cornerstone of the financial system. Since the Global Financial Crisis, such lending is conducted through securitized repurchase agreements: "repo." Repo rates thus represent banks' effective cost of borrowing and thereby impact crucial economic parameters such as deposit and mortgage rates; as such they serve as the initial stage of monetary policy transmission. Furthermore, as the banking sector relies on repo markets for short-term liquidity, ensuring their safety and smooth functioning is essential for financial stability. In this paper, I analyze the pricing and efficiency of repo instruments by examining mispricings at the short end of the yield curve.

This paper shows that a large share of interbank repo trading is driven by banks' use of repos for secondary purposes such as making uncovered trades in bond markets. In doing so, banks distort repo rates away from their fundamental value in the term structure of interest rates as well as from the monetary authority's intended policy rate. In particular, I identify that almost a third of trading volumes are linked to banks' usage of repo instruments to meet their settlement obligations in fixed income markets. Dealer-banks are averse to holding regulatory-burdensome inventories, and instead pursue a strategy whereby they sell bonds they do not own and purchase securities with liquidity they do not have. They thus rely on repo to deliver their commitments, and can further prolong their exposure to effectively speculate on the underlying collateral. Identification is achieved through a quasi-experiment leveraging a regulatory reform which shortened the settlement cycle of bond markets. As this agent class had to adapt to continue rolling over their positions, trading patterns in repo adjusted accordingly: 30% of daily turnover volume instantly changed maturity the day of the reform. I exogenously test for a pricing effect and identify a resulting kink in the yield curve of 5-7 basis points. The analysis suggests that, at the time of reform, these institutions were predominantly using repo for leveraging purposes, which, in addition to the rollover risk caused by this practice, is a concern for financial stability.

This study contributes to our understanding of the term structure of interest rates by causally identifying a preferred habitat effect operating at the heart of interbank repo lending. That is, I identify a set of agents who possess inelastic demand for a specific repo maturity, and whose ensuing price pressure causes a distortion in the yield curve. Through the reform, we observe their price impact as their habitat preference evolves. This is an unexpected finding, as preferred habitat phenomena are typically restricted to long-term maturities (e.g. 15, 30-year bonds; see Greenwood and Vayanos (2010, 2014)) where aversion to interest rate risk limits arbitrage. This study demonstrates that these effects are more pervasive than commonly thought and can exist even in ultra-short, near-identical maturities. While arbitrageurs' risk aversion usually explains their inability to close spreads resulting from agents' inelastic demand, I argue that collateral scarcity and market fragmentation impedes such remedial trading. Using ECB bond purchases under its quantitative easing programs as a proxy, I demonstrate that shocks to the supply of collateral increases yield curve mispricings.

Finally, I consider the impact of this dynamic on the cost of credit in the real economy. Institutions' secondary use of repos generates two distinct effects on the term structure: it induces relative mispricing across maturities (i.e. a preferred habitat effect), while simultaneously elevating the *aggregate* level of the term structure through an expectations hypothesis channel. While a wide literature asserts that repo rates influence real-economy parameters, much less work has been done to actually quantify the impact of repo distortions on bank lending rates. I regress banks' deposit, mortgage, and corporate lending rates on the repo rate while crucially controlling for the ECB policy rate and find a statistically and economically significant pass-through. Mortgage and corporate lending rates are most significantly affected, with a near 1:1 transmission, while deposit rates respond as well, albeit more sluggishly. Overall, the analysis confirms that dealer-banks' usage of repo for speculative purposes has a distortionary effect on banks' lending rates to the real economy.

I proceed in three steps. First, I source data on the European interbank repo

segment by sourcing transaction-level observations from its three major constituent central clearing houses.[1] I document whether these short-term rates deviate from fundamental term structure theory by testing whether they are consistent with the expectations hypothesis (EH). I find that whether repo rates conform to the EH is strongly determined by whether they are part of the *general* or *special* class of repo. A general repo allows the cash borrower to pledge any eligible collateral from a defined basket, while in a special repo, the exact security to be posted is pre-specified by both parties. Interestingly, the EH holds firmly when considering general collateral trades, but breaks down in the more prevalent 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. A monotonic decline consistency with the EH is observed across segments as specialness increases. This dichotomy allows me to isolate the root cause of yield curve mispricings: what is it about the special segment which causes rates to deviate from fundamentals?

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. 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 deliver a specific bond, were unaffected. As these institutions have a habitat preference for the maturity which allows them to continue covering their cash and security positions, they instantly adjusted their preferred maturity in response to the shortening of the fixed-income settlement cycle. I then test whether this shift in habitat resulted in a pricing effect through 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)

[1] Note that the findings of this study apply to repo markets worldwide. However, the European setting imposes itself as Eurozone repo data offer superior granularity and availability relative to U.S. wholesale segments. I discuss the external validity of the study in sec. 9.2.

the tomorrow-next segment was affected, and the spot-next was not. I calculate the EH deviations implied by these tenors when predicting the overnight rate. The results of my novel testing model suggest that agents' trading shift caused a kink in the yield curve: 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 and conduct various robustness checks and placebo tests. 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. The resulting upward movement in both order flow and prices indicates that leveraging was the predominant motive of uncovered trading at the time of the reform.

Third, I analyze the constraints that impede arbitrage activity and allow these spreads to persist. In classic preferred habitat theory, interest rate and duration 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 arbitrage, as unfettered repo trading requires readily-available securities to pledge as collateral. To test this hypothesis, I regress yield curve mispricings on bond purchases conducted by the ECB under the auspices of the Public Sector Purchase Program (PSPP), an unconventional monetary policy measure. When the supply of bonds is reduced, such spreads widen. This is further confirmed through an alternative exercise regressing EH deviations on the specialness of bonds, which again reinforces that the more scarce a specific security, the higher the associated distortion to the term structure. Finally, I conclude the paper by demon-

strating the pass-through of special repo rate deviations from the ECB deposit facility on the cost of credit in the economy. As special repo accounts for up to 70% of inter-bank lending, its rate constitutes banks' effective of cost of borrowing, and as such is reflected in their lending rates.

These findings are significant for three reasons. First, 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)). This study's contribution is to demonstrate the profound influence of preferred habitat phenomena on the term structure by causally identifying their impact in a setting where they are most unlikely to manifest: a deep, liquid market at the ultra-short segment of the yield curve.

Second, the fact that general collateral repos are consistent with the EH confirms that it holds under optimal conditions, which is a critical finding given that its near-universal failure across various asset classes and time periods has called the theory itself into question. It however fails in the special segment, even when consider the same underlying collateral. 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 determinant is the conditions imposed on the choice of collateral. The fact that preferred habitat phenomena partially explain the EH failure in special repos helps explain why risk premia struggle to explain these

mispricings.

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 (Copeland, Martin and Walker (2012), Martin, Skeie, and von Thadden (2014a,b), Mancini, Ranaldo, and Wrampelmeyer (2016), Craig and Ma (2022), Ballensiefen, Ranaldo, and Winterberg (2023), Coen, Coen, and Huser (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 (Nguyen, Tomio, and Vari (2023), Eisenschmidt, Ma, and Zhang, 2024). I further demonstrate and quantify the impact of special repo deviations from the policy rate on bank lending rates.

2 Related literature

This paper uses the EH as a benchmark pricing model of short-term interest rates. Originating in Fisher (1896) and Keynes (1930), the EH is a fundamental theory in financial economics and a precursor of rational expectations: it simply posits that long-term rates are determined by market expectations of future short-term rates. Nevertheless, the empirical studies rejecting the EH are too numerous to list.[2] A

[2] Reviews of this literature can be found in the references of Fama and Bliss (1987), Longstaff (2000), and Della Corte et. al (2008). An exception is provided by Fama and Bliss (1987), who show that the 1-year forward rate has forecasting power for expected returns of 4- to 5-year U.S. Treasury bonds. 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 investigated in foreign exchange (FX) markets through studies of uncovered interest parity (UIP), which tests whether the interest rate differential between two currencies provides an unbiased conditional expectation of the future exchange rate. 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.

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 safe asset securities, they are arguably better measures of the risk-free rate than Treasury bills. Finally, the repos I consider 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.[3] 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

[3] 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.

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 leverage 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) study 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.

The link between repo and bond markets 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.[4]

[4] 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 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

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 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, haircuts, 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. Note that the effects documented in this study are not specific to the EU. This paper (and much of the relevant literature) focuses on EU repo markets due to the quality and availability of such data; U.S. data is only available with much less granularity.[5]

The dataset is created by combining the transactions contained in the three major

a main driver of short-term spreads.

[5] For instance, observations on U.S. tri-party repo trading can be extracted from Securities and Exchange Commission form N-MFP and is available from Crane Data, but this only provides month-end snapshots and further lacks the granularity required for the analyses in this paper.

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 2nd, 2006, to June 30th, 2020. Appendix B plots daily turnover per platform and gives some background on each.

Repo trading is split into two segments, general and special. 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") must 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. In contrast, general repos do not require the borrower to provide a specific bond as collateral but rather make 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. Repo markets have become far more collateral-driven over the last decade (Brand, Ferrante, and Hubert (2019), Schaffner, Ranaldo, and Tsatsaronis (2019)). In Appendix C, one observes that the special segment's share of trading has surged from 65% to 85% in the 2015-2020 period, which coincides with the onset of quantitative easing through the ECB's sovereign bond purchase programs. It is important to note that the *special* rate thus better represents banks' effective cost of borrowing, given that interbank funding markets largely trade on special throughout the sample.

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 cannot know what exact 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.[6]

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. "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 GCP and GCX baskets which are not affiliated with any particular country. Appendix D shows the turnover per country of general and special trading while Appendix E provides summary statistics on the rates contained therein.

4 The term structure of repo rates

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

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

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).[7] 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).[8] 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

[7] 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.

[8] 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.

ON rate of two days later, and (iii) today's SN rate should predict tomorrow's TN rate.[9] Appendix F 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 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.[10] 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.

[9] 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 behavior in repo markets.

[10] 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.

		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

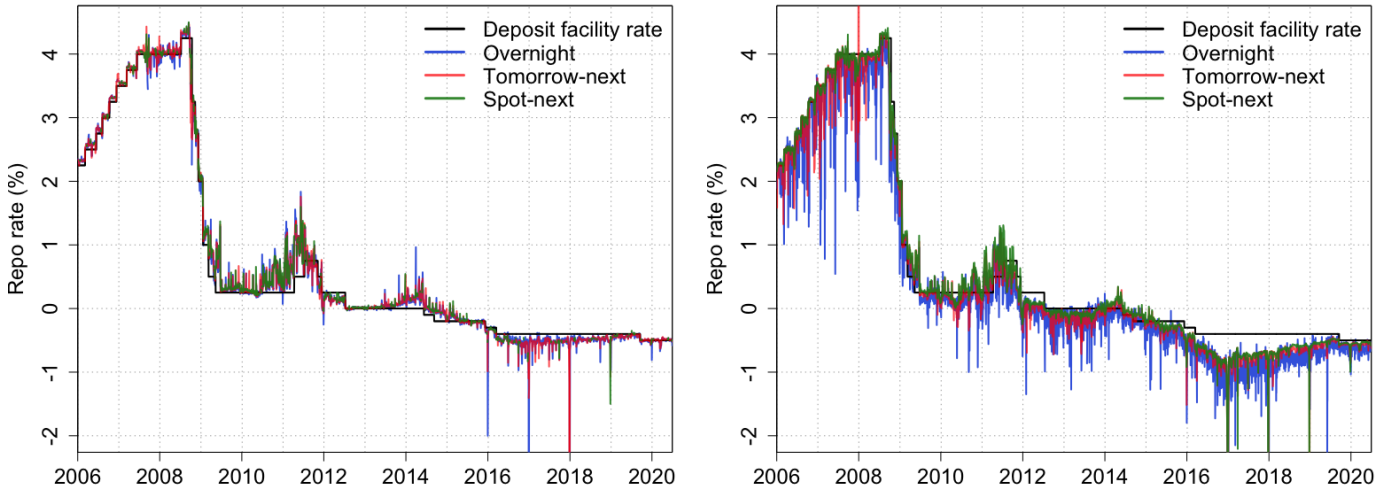
Table 1: The regressions for the GCX and GCP segments are OLS with Newey-West standard errors shown in parentheses. The GC and SC models are pooled OLS with standard errors clustered by basket and ISIN, respectively. Numbers in brackets denote z-scores testing the null of coefficient equality with the 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.

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.[11] 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 considers 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 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. Appendix G goes further into detail by providing country-specific results for both general and 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

[11] 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.



(a) German general collateral (GC) rates **(b)** German special collateral (SC) rates

Fig. 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.

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 test whether preferred habitat effects can explain term structure deviations in repo markets. I leverage a quasi-experiment to identify a habitat of agents using the repo market to deliver on their commitments in the cash (fixed income) market.[12] 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 of the repo market which serves as the "bridge" to the cash market.

[12] 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.

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 standardization 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).[13]

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 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.[14] The ON volumes (not shown here) stay constant.

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.[15] 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

[13] Exceptions were Germany, which was already on a T+2 schedule, and Spanish equities, which migrated during the fourth quarter of 2015. FX 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.

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

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

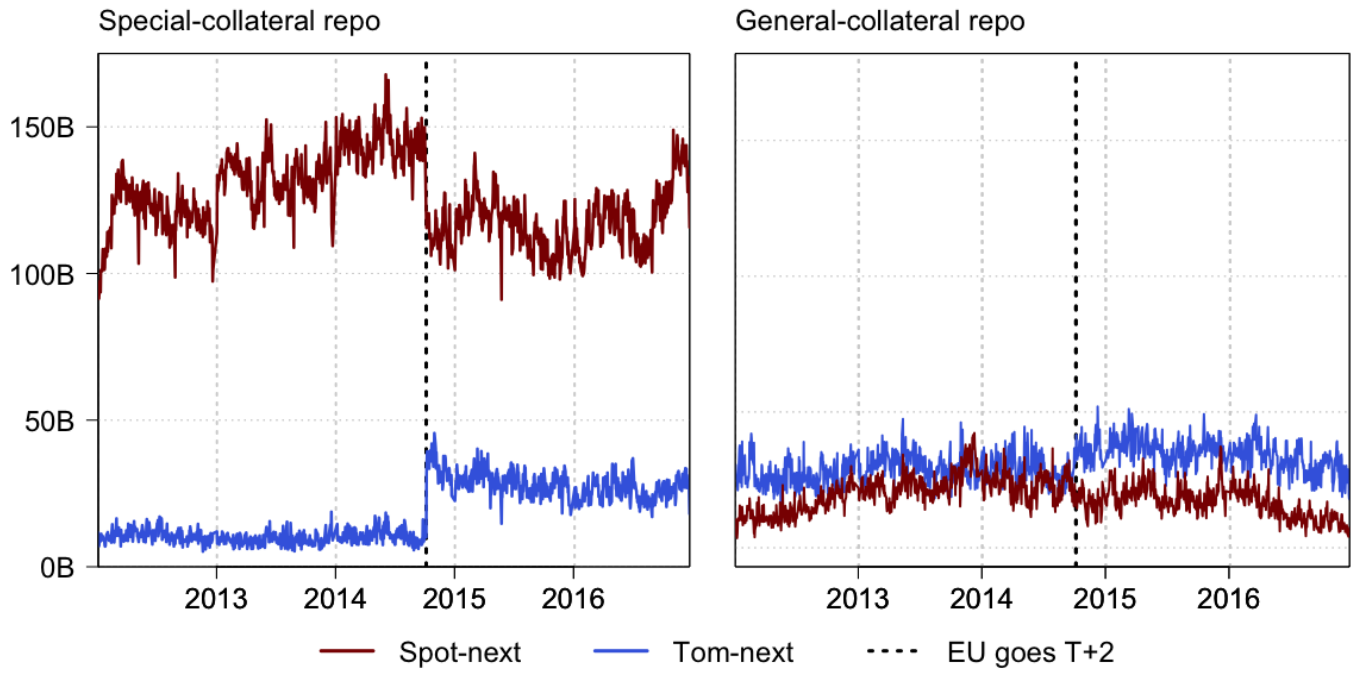


Fig. 2: Daily turnover of special (l.h.s.) and general (r.h.s.) repos. The last week of each calendar year is dropped for visualization purposes.

thus needed to be synced to that settlement cycle. The following section will further delineate the mechanism.

Appendix H provides a formal econometric test of the dynamics shown in Figure (2). That is, I split the data by $\{Segment \text{ x } Country \text{ x } Tenor\}$, 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 H1 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).

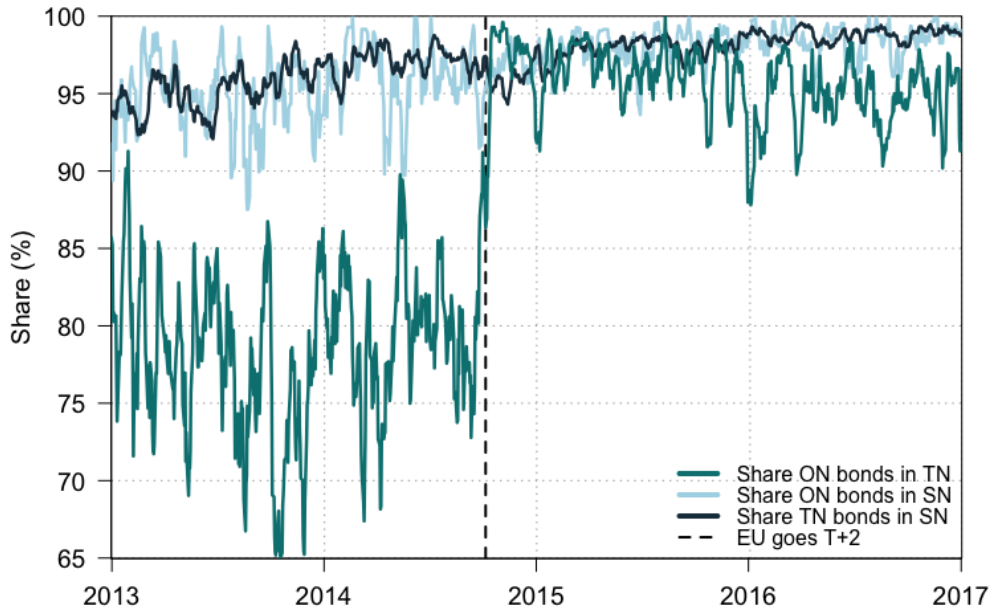


Fig. 3: Share of unique collaterals traded across maturities, rolling weekly averages.

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) depict the movement of a habitat from one maturity to another. Before proceeding to an econometric test of the pricing implications of this change in preferred habitat, this section discusses its institutional causes and drivers.

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 due to agents frequently using 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).

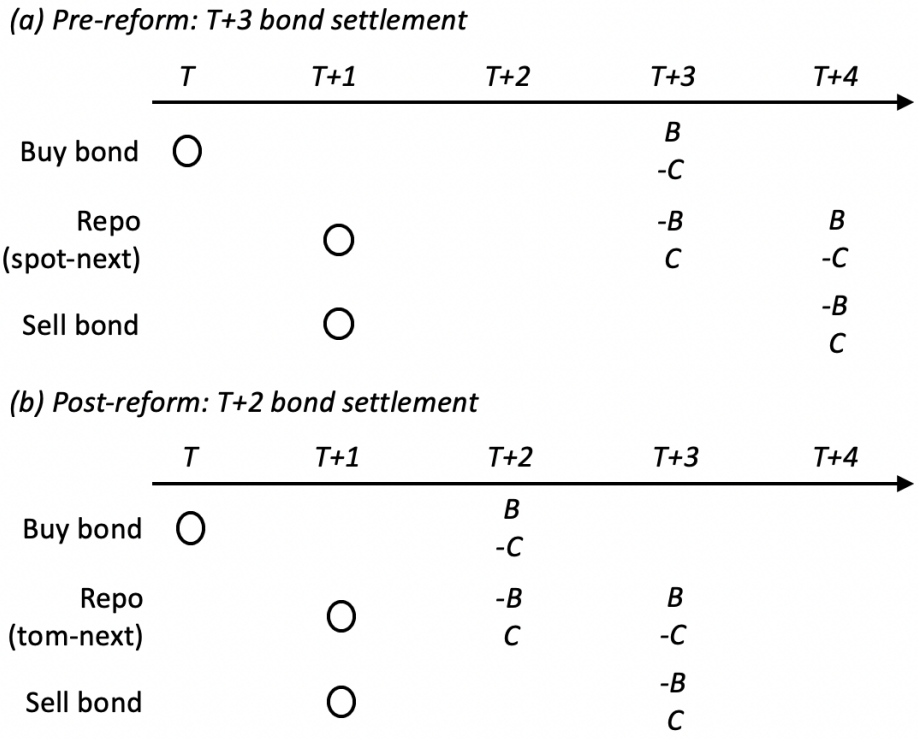


Fig. 4: Financing a cash position (leveraging). Circles represent when a trade is agreed. B and C refers to the delivery of a bond or cash, respectively. The graphic denotes how an agent would finance a cash position before and after the T+2 settlement reform.

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, 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 $\Delta P^B_{T+1,T} - r^{SN}_{T+1}$, or $\Delta P^B_{T+1,T} - r^{TN}_{T+1}$ 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 $-\Delta P^B_{T+1,T} + r^{SN}_{T+1}$, or $-\Delta P^B_{T+1,T} + r^{TN}_{T+1}$ in the post-reform period.

Why do traders wait one day to (reverse) repo away their exposure?[16] 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 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

[16] 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.

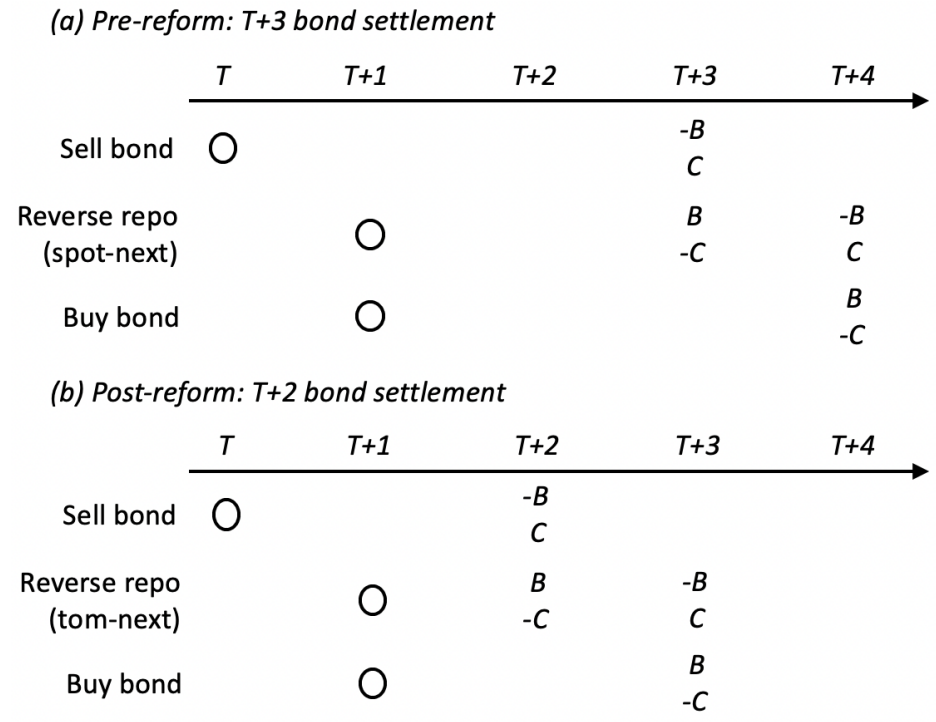


Fig. 5: Covering a securities position (short-selling). Circles represent when a trade is agreed. B and C refers to the delivery of a bond or cash, respectively. The graphic denotes how an agent would cover a securities position before and after the T+2 settlement reform.

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.[17] However, given the dynamics of repo specialness, this would be suboptimal: special repo

[17] Indeed, we see a minor uptick in general activity; see Appendix H.

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 who serve as dealers in fixed income markets, with little to no other agent types. A layman perception of dealer-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. This is likely exacerbated by low levels of dealer inventory; Dick-Nielsen and Rossi (2019) document that aggregate corporate bond inventories have shrunk by 50% since the financial crisis, despite a doubling in the quantity of bonds outstanding. However, while we only observe dealer-banks in our sample, such a strategy could and likely is performed by other institution types as well. The agents under consideration are principally defined by *what* they are doing, rather than by *who* they are. The 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 may also be the case that agents are pursuing these strategies explicitly. Consider 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). 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). Repos are additionally 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). 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.[18] 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 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 term structure

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

[18] 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.

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.[19] The required assumption is relatively weak: it requires 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 verify that this is the case in Appendix I. 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 thus calculate the EH error as the difference between the predictor rate and the target rate for a given collateral type:

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

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

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

and after the T+2 shift.[20] Appendix J provides a graphical schema of the econometric model. The regression now considers a multitude of $\{Segment \text{ x } Country \text{ x } Collateral \text{ x } Tenor\}$ time series. Each EH error stemming from a GC (SC) repo with a specific basket (ISIN) is a unique observation. 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:

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

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

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:

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

I now run various specifications of regression models (9) and (10) 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

[20] Nyborg and Woschitz (2025) show that difference-in-differences models are misspecified for variables with a term structure because of heterogeneity over the maturity spectrum and imperfect matching between treatment and control groups. I avoid the latter issue by achieving a perfect matching in terms of residual maturities; there is an absolute one-for-one overlap between the forward and realized rates. Despite this, studies often neglect studying the term structure of their treatment effect. Here, the regression model is set up to identify the (movement of the) kink in the yield curve resulting from the T+2 reform by studying the treated maturity's behavior relative to the rest of the term structure.

{*Segment* x *Country* x *Collateral* 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. I also run specifications with the data winsorized at the 2.5% and 97.5% level.[21]

The treatment effect implies that the EH performance is negatively impacted across all specifications; the error increases by 5-7 basis points when considering the 6-year proximate sample. The result is weaker when considering the full sample, suggesting that the observed dynamic dissipated over time. Obtaining an estimate of of the *percentage* increase in EH error is challenging, given that the distribution of EH deviations is centred around zero. In Appendix K, I apply an inverse hyperbolic sine to the dependent variable, and find that the results are robust when considered in percentage terms. Furthermore, I approximate the treatment effect as equivalent to 9%-11% of the average future short-rate in the sample.

I perform placebo testing as a final robustness check. In Appendix L, 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 L1 re-runs the models with a placebo date of October 6$^{\text{th}}$, 2012, and Table L2 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. Fur-

[21] The winsorization is carried out separately per {*Segment* x *Tenor*} combination. Results are robust to even stronger winsorizations.

	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	18.34***		16.54***		15.09***		13.45***	
	(1.81)		(1.19)		(1.23)		(0.88)	
TN	0.27		0.08		−0.47		−0.44*	
	(0.36)		(0.34)		(0.32)		(0.26)	
T2	−0.66		−0.76**		−0.65		−0.97***	
	(0.94)		(0.34)		(0.42)		(0.25)	
SC:TN	−9.62***		−7.83***		−5.62***		−4.58***	
	(2.14)		(1.44)		(1.40)		(0.96)	
TN:T2	−0.33	−0.01	−0.12	0.11	0.41	0.54*	0.39	0.49**
	(0.34)	(0.26)	(0.23)	(0.16)	(0.32)	(0.28)	(0.28)	(0.24)
SC:T2	−5.58***	−4.71***	−4.22***	−3.53***	−4.43***	−3.71***	−3.46***	−2.95***
	(1.55)	(1.61)	(1.12)	(1.19)	(1.09)	(1.19)	(0.80)	(0.87)
SC:TN:T2	7.50***	5.96***	5.67***	4.52***	3.74**	2.87*	2.72***	2.35**
	(2.31)	(2.28)	(1.54)	(1.58)	(1.51)	(1.63)	(1.05)	(1.11)
$\xi_{t-1}^{b,n}$	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	0.10	0.01	0.18	0.02	0.08	0.02	0.15	0.02

Table 2: Odd-numbered specifications run the model in eq. (9); evens that of eq. (10). *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*, ω to {*Segment* x *Country* x *Collateral* x *Tenor*}, and τ to *Trade Date*. All observations on the last week of the calendar year were 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.

thermore, 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 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 results of the experiment provides evidence in favor of hypothesis (b): that preferred habitat theory can impact short-term rates. In this section, I study several ramifications of this result. Section 7.1 hypothesizes that collateral scarcity is the constraint preventing an arbitrage of yield curve mispricings. Section 7.2 considers whether risk premia, not preferred habitat effects, drive our results. Section 7.3 shows that the results imply that leveragers dominate the transferred habitat.

7.1 Limits to arbitrage and 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 yield curve mispricings. For example, general repo rates are above special rate, even for the same maturity. One could arbitrage this by borrowing cash in special and lending it in general, but to do so one needs the correct collateral to obtain discount cash in special. Similarly, arbitraging yield curve errors involves borrowing cheaply and lending at a higher rate, but requires having the correct underlying to obtain cheap funding. 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.[22] 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.[23]

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.[24] To

[22] 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.

[23] 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.

[24] 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.

alleviate these concerns, I include a battery of control variables reflecting economic conditions: the LIBOR-OIS spread, the VIX index, and the TED spread.[25] 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 regressions:

$$\xi^n_{i,t} = \beta_1 \cdot \mathsf{PSPP}_{i,t} + \beta_2 \cdot \mathsf{LIBOR\text{-}OIS}_t + \beta_3 \cdot \mathsf{VIX}_t + \beta_4 \cdot \mathsf{TED}_t + \alpha_i + u_{i,t} \tag{12}$$

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 col-

[25] 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.

lateral 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. (**??**). For a repo with underlying bond b and maturity m:

$$\gamma_t^{b,m} := \frac{r_t^{\{b=g\},m} - r_t^{b,m}}{1 + |r_t^{b,m}|}, \qquad g \in \{\text{GCP, GCX}\} \tag{13}$$

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:

$$\xi_{i,t}^n = \beta \cdot \gamma_{i,t}^{b,m} + \omega_i + \tau_t + u_{i,t} \tag{14}$$

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.

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.

	$\xi^n_{i,t}$ (%, 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. (**??**) and (13). ω and τ refer to $\{Segment \text{ x } Country \text{ x } Collateral \text{ x } Tenor\}$ 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.

7.2.1 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 (10), 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.[26]

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 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

[26] 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. (10). *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.

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:

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

$$\gamma_t^{b,m} = \beta_3' \cdot D_{t,b,m}^{TN} \cdot D_{t,b,m}^{T2} + \beta_4' \cdot \gamma_{t-1}^{b,m} + \beta_5' \cdot r_t^{GCP,m} + \omega_b + \tau_t \, 9i + u_t^{b,m} \tag{16}$$

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 M1 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).[27]

Why did leveraging dominate short-selling as a strategy at the time of the reform? When interest rates are negative, an investor is paid to borrow cash, and penalized for lending it. Considering the expected payoffs of the two strategies makes it clear why leveraging would be dominant when interest rates are negative:

$$E_T\left[\Delta P^B_{T+1,T} - r^{TN}_{T+1}\right] > E_T\left[-\Delta P^B_{T+1,T} + r^{TN}_{T+1}\right], \quad \forall\, r^{TN}_{T+1} < 0 \tag{17}$$

This natural asymmetry explains the relative popularity of leveraging; with interest rates now above zero, it is likely that this dynamic has inversed. In an environment of negative rates, safe assets, and convenience yields, agents are incentivized to pursue leveraging, as cheap cash borrowing in repo allows investors to achieve higher rates of leverage. Those financial intermediaries which hold quality assets can take advantage of their status to obtain cheap liquidity.[28] 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.

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

[27] 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.

[28] 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.

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 leveraging in this market).

8 Effects on the real economy

How much do distortions to the (special) repo rate actually impact real economic parameters? In this section, I test how deviations from the policy rate spill over to deposit, mortgage, and corporate lending rates. The previous sections have focused on the term structure of interest rates, and how dealer-banks' change in trading patterns post-reform consisted of a shift in habitat preference from one maturity to another. Here, though, we ask ourselves how these banks' activity affects repo markets in *aggregate*. That is, agents' borrowing/lending pressure also shifts the term structure as a whole through an expectations hypothesis channel (see sec. 4). While I have identified how preferred habitat effects disparately impact the rates of maturities relative to one another, agents' pressure on the tom-next rate assuredly transmits to spot-next and overnight maturities, and thus pushes the overall repo rate away from the rate ostensibly desired by the central bank. As special repo borrowing represents up to 70% of daily turnover, and secured borrowing is the dominant funding source in the post-2008 interbank environment (De Fiore, Hoerova, Rogers, and Uhlig, 2018), distortions to such rates alter banks' effective cost of borrowing, and thus may impact real economy rates. While a wide literature has documented repo distortions, and warned of disturbances to the pass-through of monetary policy, little has been done to quantify the effects of such frictions.[29]

I test how deviations in special repo rates away from the ECB policy rate transmit to the rates of the real economy. I source data on country-specific deposit, mortgage,

[29] Ballensiefen et. al (2023) document that the pass-through from EONIA to non-financial corporate borrowing rates, typically strong under normal conditions, diminishes substantially when repo rates become more dispersed.

and corporate borrowing rates at monthly frequency. I test this transmission channel by expanding a model proposed by Messer and Niepmann (2023) which itself is based on the literature on exchange rate pass-through (Burstein and Gopinath, 2014). As I am interested in seeing whether movements in the special repo rate impact real-economy lending independent of policy rate movements, I estimate:

$$\Delta r^{d}_{c,t} \;=\; \alpha_c \;+\; \sum_{k=0}^{K} \beta^k \cdot \Delta r^{\mathsf{ECB}}_{t-k} \;+\; \sum_{k=0}^{K} \gamma^k \cdot \Delta \left(r^{\mathsf{SC}}_{c,t-k} - r^{\mathsf{ECB}}_{t-k} \right) \;+\; \Gamma \cdot \mathbf{X}_{c,t} \;+\; \epsilon_{c,t} \quad (18)$$

where $r^{d}_{c,t}$ will alternate between deposit, mortgage, and corporate lending rates per country c, α are country fixed effects, r^{ECB} is the ECB policy rate[30], $r^{\mathsf{SC}} - r^{\mathsf{ECB}}$ represents special repo rate deviations away from the policy rate, and $\mathbf{X}$ is a vector of controls. In particular, I control for the country-specific inflation rate and the level of bank deposit liabilities to control for deposit demand. I furthermore use the LIBOR-OIS spread to control for tensions in financial markets. I estimate the model in both levels and differences. I also add lagged values in addition to the contemporaneous rate, as deposits are slow-moving. I include $K = 3$ lags as Messer and Niepmann (2023) document that most of the pass-through occurs within the first three months.

Our results are strongly robust to considering different amounts of lags (e.g. 6 or 12 months), but they are strongest when considering the cumulative 3-month lag. They indicate an economically and statistically significant transmission to lending rates. The result is strongest for mortgage and corporate lending rates, where a one basis point increase translates to a 0.5 to 1 basis point effect. On the other hand, deposit rates are more sluggish; a one basis point increase translates only to a 0.2 point effect.

9 Policy implications and external validity

9.1 Implications for policymakers

Several conclusions impose themselves from a policymaking perspective. First of all, repo rates - which affect critical parameters in the global economy such as deposit and

[30] From the beginning of our sample until Oct. 8, 2008, the policy rate was effectively the minimum bid rate on variable tenders for main refinancing operations. Following that date, it is instead the deposit facility rate, i.e. the rate at which banks may make overnight deposits in the Eurosystem.

	Deposit rates				Mortgage rates				Corporate lending rates			
	Levels		Differences		Levels		Differences		Levels		Differences	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Panel A: Contemporaneous effects												
r_t^{ECB}	0.16**		0.15**		0.01		0.26***		0.61***		0.78***	
	(0.06)		(0.04)		(0.08)		(0.05)		(0.07)		(0.04)	
$r_t^{\mathsf{SC}} - r_t^{\mathsf{ECB}}$	0.21**		0.03		1.15***		0.24		0.88***		0.31**	
	(0.07)		(0.01)		(0.24)		(0.13)		(0.14)		(0.07)	
$\mathsf{Inflation}_t$	−0.02		0.001		0.08		0.03		0.03		0.01	
	(0.02)		(0.002)		(0.05)		(0.03)		(0.03)		(0.01)	
$\mathsf{Deposit\ Liabilities}_t$	−0.59*		−0.08		−4.44***		0.17		−1.09		0.10	
	(0.26)		(0.20)		(0.53)		(0.39)		(0.54)		(0.21)	
$\mathsf{LIBOR\text{-}OIS}_t$	0.31**		0.08**		1.41***		0.02		0.82***		0.35***	
	(0.08)		(0.02)		(0.30)		(0.09)		(0.15)		(0.04)	
Panel B: Lagged effects												
$\sum_{k=0}^{K=3} r_{t-k}^{\mathsf{ECB}}$		0.17***		0.18***		−0.03		0.26***		0.61***		0.84***
		(0.06)		(0.05)		(0.09)		(0.05)		(0.08)		(0.05)
$\sum_{k=0}^{K=3} \left(r_{t-k}^{\mathsf{SC}} - r_{t-k}^{\mathsf{ECB}}\right)$		0.20***		0.05***		0.97***		0.46***		0.91***		0.64***
		(0.07)		(0.02)		(0.36)		(0.09)		(0.21)		(0.07)
$\sum_{k=0}^{K=3} \mathsf{Inflation}_{t-k}$		−0.01		0.00		0.09*		0.05**		0.04		0.01
		(0.02)		(0.01)		(0.05)		(0.03)		(0.04)		(0.02)
$\sum_{k=0}^{K=3} \mathsf{Deposit\ Liabilities}_{t-k}$		−0.57**		0.26**		−4.56***		1.58		−1.08*		−0.44
		(0.26)		(0.11)		(0.51)		(1.60)		(0.60)		(0.46)
$\sum_{k=0}^{K=3} \mathsf{LIBOR\text{-}OIS}_{t-k}$		0.30***		0.03		1.94***		0.16***		1.02***		0.29***
		(0.09)		(0.03)		(0.40)		(0.04)		(0.27)		(0.06)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country clustering	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	786	774	781	769	786	774	781	769	795	780	790	775
Adj. R^2	0.84	0.84	0.37	0.44	0.77	0.79	0.03	0.04	0.91	0.92	0.47	0.49

Table 6: Regression of deposit, mortgage, and corporate lending rates on the ECB policy rate (r_t^{ECB}), deviations from policy of the special repo rate $r_t^{\mathsf{SC}} - r_t^{\mathsf{ECB}}$, $\mathsf{Inflation}_t$, the quantity of $\mathsf{Deposit\ Liabilities}_t$, and LIBOR-OIS. Panel A considers only contemporaneous effects, while Panel B also includes $K = 3$ lags and calculates the cumulative effect and corresponding joint significance level. Observations are monthly for Germany, Italy, Spain, the Netherlands, and Belgium and span January 31st, 2006 to June 30th, 2020.

mortgage rates - deviate away from fundamentals due to banking institutions' behavior. In our case, banks' usage of repo for speculative activities results in pricing distortions. It would thus be beneficial for the pass-through of monetary policy that such pricing effects are minimized. Solutions could include ensuring that bonds purchased under unconventional monetary policy are released back into the repo system at fair market prices under the SLF. While such a relaxation of pricing conditions was implemented in November 2020, it was only partial. Furthermore, the euro area's fragmented nature could be minimized by encouraging the usage of general collateral repo or the usage of supranational bonds as repo collateral.

Banks' reliance on repo to deliver on settlement obligations further causes roll-over risk: disturbances in repo markets would spill over to the cash segment in times of financial distress. Interestingly, while regulation prohibits the practice of naked short-selling, market-makers are exempt, and this study demonstrates that heavy usage is being made of this exemption. Furthermore, while naked short-selling is banned for non-dealer participants, the inverse operation of buying bonds without having the underlying liquidity is permitted. These activities provide market participants room to manoeuvre; for instance, dealers can more easily manage inventory with these practices. However, careful monitoring of the extent of such market practices and the roll-over risk they present would help minimize the risk of spillover effects during times of financial turmoil. This paper identified that around 30% of the interdealer repo segment is devoted to such activity; the customer segment is likely heavily involved as well. A deeper understanding of the quantities and risk involved through active monitoring would inform whether further action is required.

9.2 External validity

While we identify the dynamics of this paper in European repo markets, they are universal to money markets worldwide (which have all largely moved to securitized standards). While the European market is perhaps unique in that it combines bond issuances from multiple sovereigns, repo specialness is not unique to the Eurozone.

Repo specialness was first documented by Duffie (1996) in the *U.S.* context, where short-selling pressure concentrated on on-the-run issues. U.S. repos are often backed by heterogeneous collateral: U.S. Treasuries, mortgage-backed securities, and agency debt. The leveraging dynamics in this paper have also been observed in money markets abroad; most notably, we discussed how funds in the U.S. used repo to leverage their arbitrage strategies in sec. 7.3. Finally, collateral scarcity is a key ingredient to short-term habitat effects. Such scarcity naturally arises when bonds are bought up by institutional investors such as pension funds, or due to quantitative easing programs, which are universal. However, these are not the only potential drivers. For example, an ICMA (2024) report documents that the Australian repo market is under pressure caused by the Australian government's very low debt/GDP ratio. Low debt issuance means a scarcity of securities suitable to serve as collateral, and the report notes that the issue is exacerbated by the prevalence of buy-and-hold investors.

10 Conclusion

This study has shown that a large share of interbank repo trading is driven by banks' use of repos for secondary purposes such as making uncovered trades in bond markets. In doing so, banks distort repo rates away from their fundamental value in the term structure of interest rates as well as from the monetary authority's intended policy rate. Using a reform to the settlement cycle of fixed income markets, I exogenously tested for a pricing effect and identified a resulting kink in the yield curve of 5-7 basis points. This suggests that dealer-banks commonly use repo to undertake leveraging operations. I rationalize the presence of a preferred habitat effect in ultra-short, near-identical rates by demonstrating that market fragmentation and collateral scarcity are an impediment to free arbitrage. This paper thus reveals an increased pervasiveness of habitat phenomena, meaning that the yield curve is less efficiently priced than previously thought. Finally, as institutions' borrowing/lending pressures move the term structure as a whole through an expectations hypothesis channel, their activity distorts the pass-through of monetary policy. I quantify a sizeable impact of special

repo rate distortions to the real cost of credit in the form of bank deposit, mortgage, and corporate lending rates. Beyond the implications for our understanding of drivers of short-term interest rates, this study highlights the second-order effects of the post-2008 shift to securitized funding markets.

Appendix A: A repo transaction explained

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%.

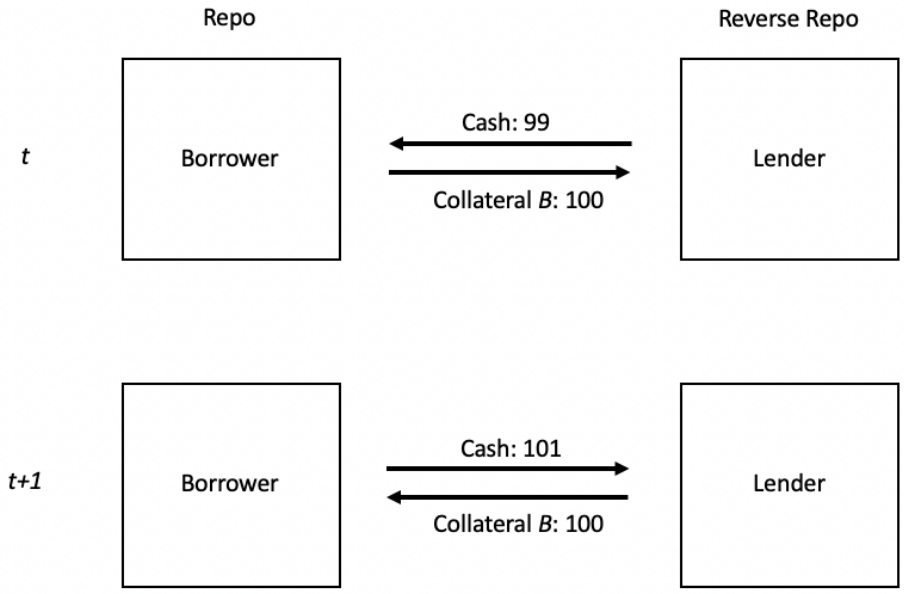


Fig. A1: Example of a repo transaction

Appendix B: Repo trading per platform

The repo trading data originates from the three major CCPs in Europe: BrokerTec, Eurex, and MTS Repo. These collectively represent 70% of the interbank CCP segment which forms the "nucleus" of European repo trading. BrokerTec is the largest platform by daily turnover, and is mostly used to trade special repos, Eurex, the smallest, focuses on general pooling baskets (GCP/GCX), and MTS covers Italian repo. The below figure plots daily turnover per platform. Note that MTS data is available only since 2010.

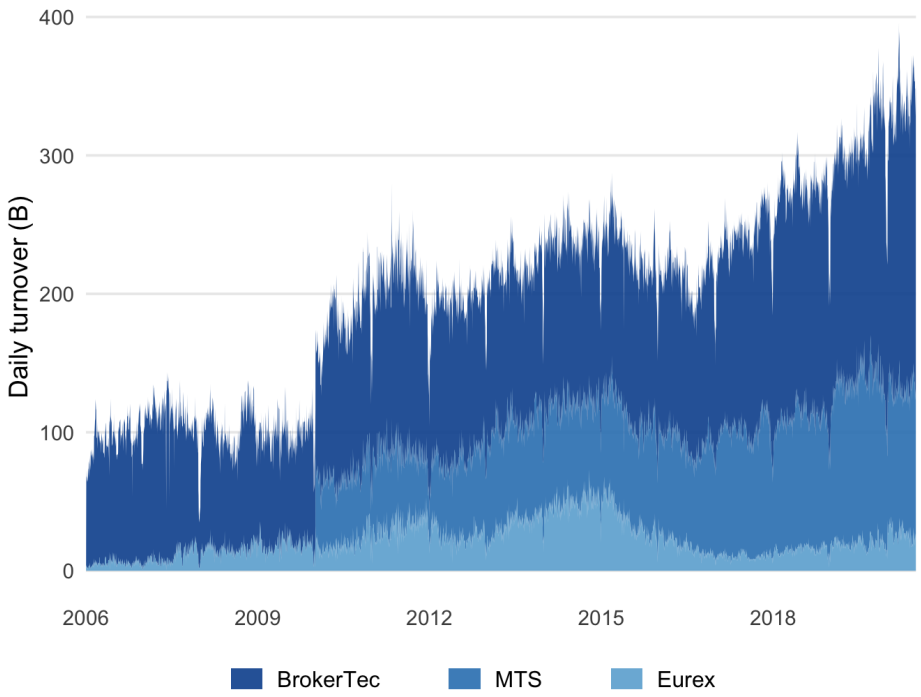
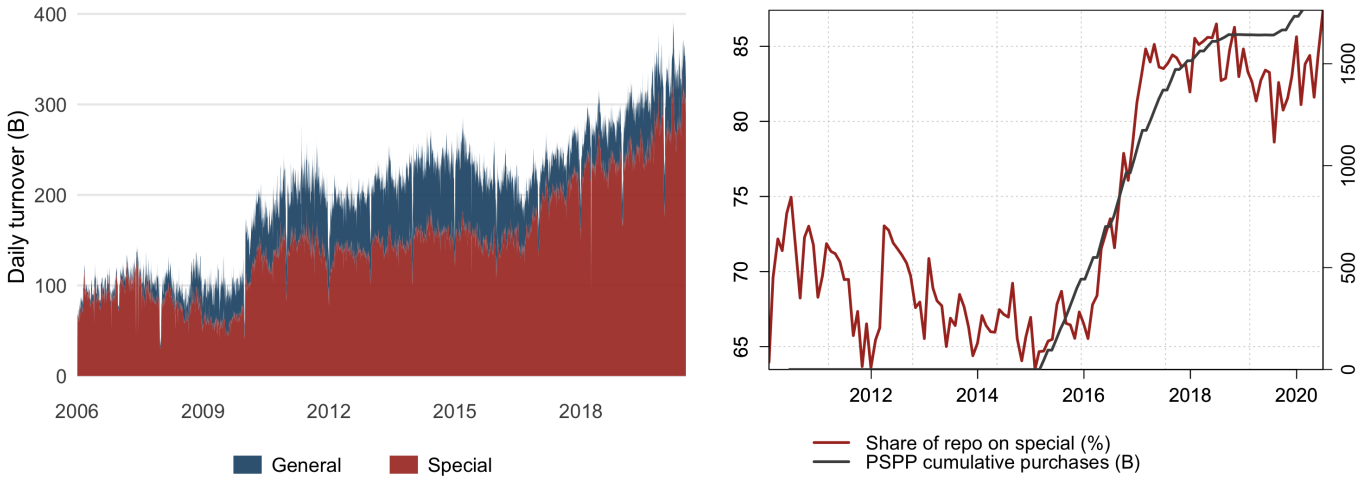


Fig. B1: Daily turnover per repo platform

Note that the T+2 settlement reform's impact was not limited to a specific platform; the shift in turnover we observe in Fig. (2) repeats for both BrokerTec and MTS. As the T+2 shock mostly affected specials, it does not appear however in Eurex, which makes sense given only unaffected GCP/GCX repos are traded there. For more on these platforms, see Schaffner et. al (2019).

Appendix C: Repo trading per segment

Panel (a) of the below figure plots the total daily turnover for general and special repo segments. Note that the trading of specials increased in 2010 due to the entry of the MTS platform in the dataset. In panel (b), I consider special repos as a share of total repo turnover and plot that against purchases of sovereign bonds under the auspices of the PSPP program. Note that I start the sample in 2010 so as to avoid a confounding bias from MTS' entry. One observes that special trading became more prominent as the central bank purchased bonds as part of unconventional monetary policy.



(a) Turnover per segment (B) **(b)** Special share vs. PSPP takeup

Fig. C1: Panel (a) plots daily turnover (B) for general and special repo segments. Panel (b) compares special repos as a share of total repo trading (%) with sovereign bond purchases under the PSPP (B).

Appendix D: Repo trading per country

The below figure plots repo trading per country for special and general repo segments. "EU" includes GCP and GCX baskets. Note that special French repos are under-represented as we drop repos with floating rates; as we do not have data on the quoted rate, these bias the analysis. Values are averages of daily turnover starting from 2010 (when MTS entered the dataset).

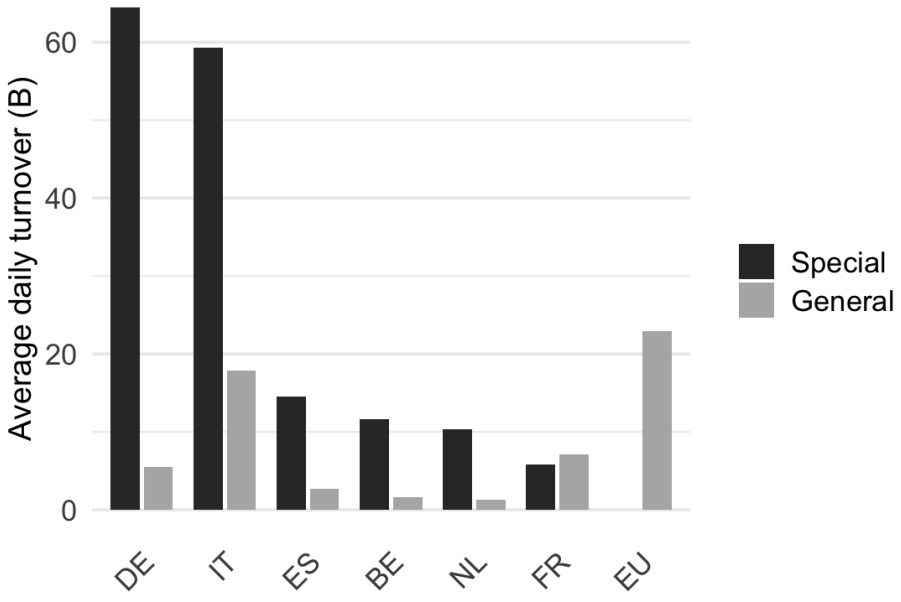


Fig. D1: Average daily turnover per country, 2010-2020.

Appendix E: Descriptive statistics

	DE	FR	BE	NL	ES	IT	GCP	GCX
Panel A: GC Repo Rates								
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		

Appendix F: Understanding repo tenors

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.

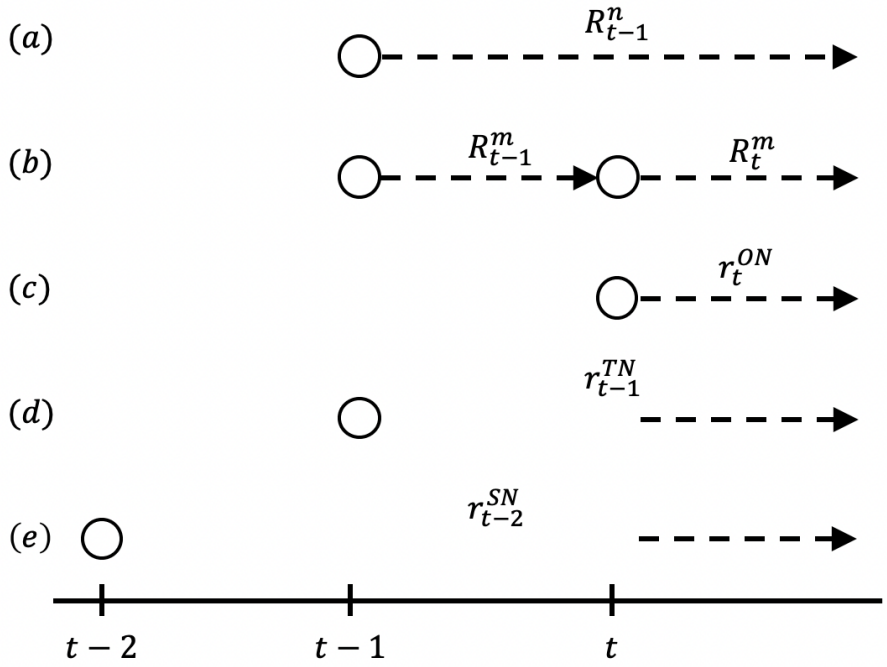


Fig. F1: Visualization of various maturity types

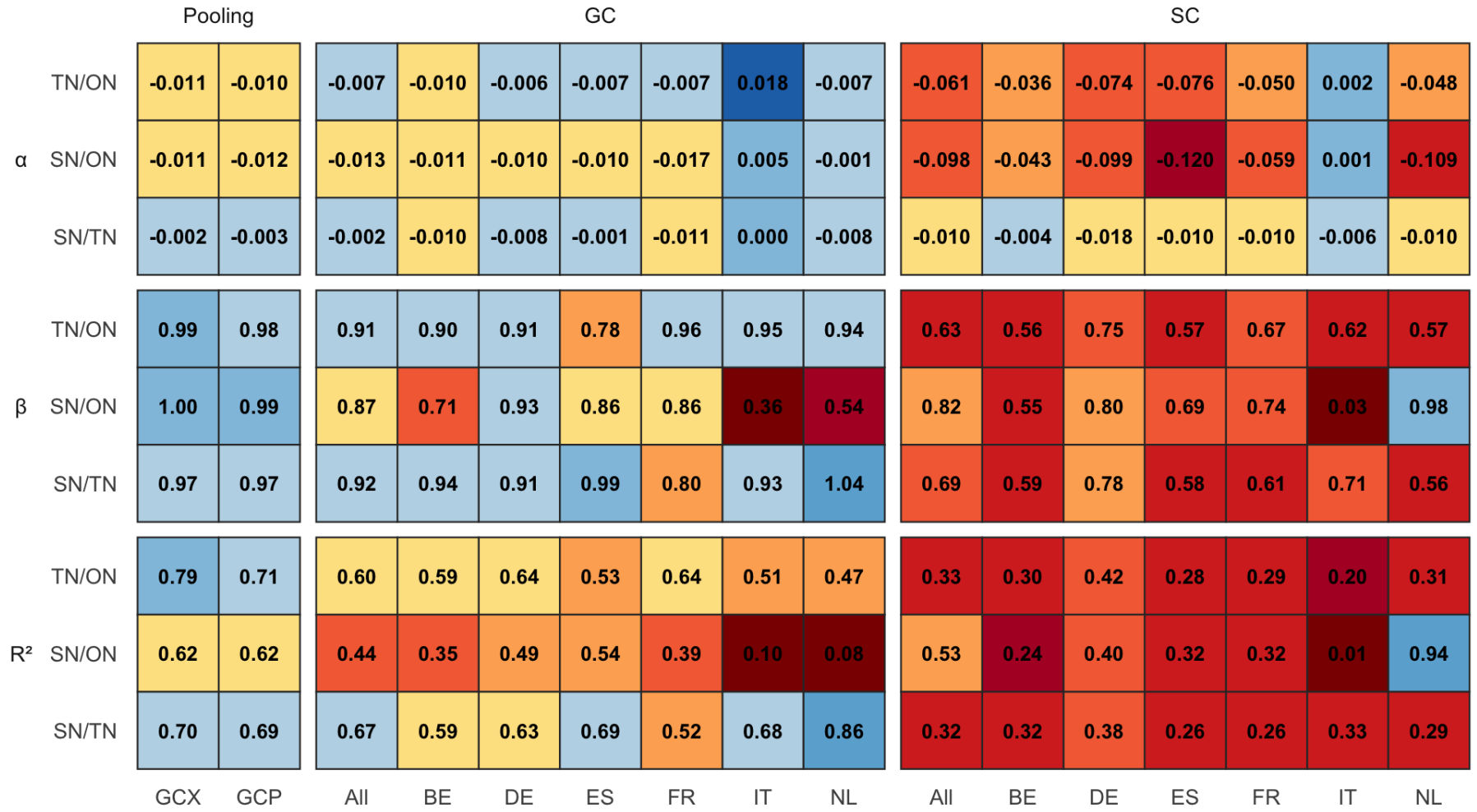


Fig. G1: α, β, and R^2 values from EH regressions on various segments. Blue (red) colors denote values which are close to (far from) those stipulated by the strong form of the EH (i.e. $\alpha = 0, \beta = 1$) and an R^2 of one. Regressions are run separately for (i) GCX and GCP pooling baskets, (ii) GC country-specific baskets, and (iii) ISIN-specific special repos, per country, as in Table 1. "All" refers to panel regressions over all countries.

Appendix H: Triple-differences estimation of volume shift

I validate the hypothesis formed in section 5.1 and confirm that a significant trading volume shift occurred from spot-next to tom-next 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 c, and 3 maturities n, I consider 34 different time series.[31] I consider:

$$V_t^{c,n} = \beta_1 \cdot D_{t,c,n}^{SC} + \beta_2 \cdot D_{t,c,n}^{TN} + \beta_3 \cdot D_{t,c,n}^{SC} \cdot D_{t,c,n}^{TN} + \delta_0 \cdot D_{t,c,n}^{T+2} + \delta_1 \cdot D_{t,c,n}^{T+2} \cdot D_{t,c,n}^{SC} + \delta_2 \cdot D_{t,c,n}^{T+2} \cdot D_{t,c,n}^{TN} + \delta_3 \cdot D_{t,c,n}^{T+2} \cdot D_{t,c,n}^{SC} \cdot D_{t,c,n}^{TN} + \alpha_c + u_{t,c,n} \tag{19}$$

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:

$$V_{t,b,n} = \delta_1' \cdot D_{t,b,n}^{T+2} \cdot D_{t,b,n}^{SC} + \delta_2' \cdot D_{t,b,n}^{T+2} \cdot D_{t,b,n}^{TN} + \delta_3' \cdot D_{t,b,n}^{T+2} \cdot D_{t,b,n}^{SC} \cdot D_{t,b,n}^{TN} + \lambda_{b,n} + \tau + u_t \tag{20}$$

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. I also consider a simple regression over all countries combined to get a total volume estimate. Finally, I also consider all specifications in logged volumes to obtain percentage effects.

Table (H1) shows results. The DDD estimator is economically and statistically significant across all specifications. The logged-volume regressions suggest that the T+2

[31] 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)	(5)	(6)
SC	14.65**		102.80***	0.65		1.31***
	(6.32)		(1.39)	(0.95)		(0.02)
TN	0.29		−9.66***	0.51**		−0.29***
	(1.65)		(0.86)	(0.20)		(0.02)
T2	−0.52		−5.67***	−0.02		−0.17***
	(0.44)		(0.94)	(0.10)		(0.06)
SC · TN	−15.57**		−121.48***	−0.71		−2.35***
	(6.80)		(1.50)	(0.98)		(0.03)
TN · T2	1.46**	1.44**	12.96***	0.25	0.23	0.39***
	(0.63)	(0.62)	(1.03)	(0.17)	(0.17)	(0.03)
SC · T2	−2.36*	−2.17	−18.16***	0.09	0.13	−0.02
	(1.31)	(1.29)	(1.69)	(0.18)	(0.18)	(0.05)
SC · TN · T2	5.35***	5.18**	30.51***	0.66**	0.62**	0.87***
	(2.06)	(2.05)	(1.94)	(0.29)	(0.29)	(0.05)
Fixed effects	α	$\lambda + \tau$	Constant	α	$\lambda + \tau$	Constant
Clustering	λ	$\lambda + \tau$	NW	λ	$\lambda + \tau$	NW
Obs.	16,686	16,686	2,040	16,686	16,686	2,040
R^2	0.26	0.19	0.98	0.06	0.06	0.98

Table H1: All specifications other than (2) and (4) run the model in eq. (19); (2) and (4) considers that of eq. (20). Specifications (3) and (6) combine all countries. *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.

switch caused an 85%-93%[32] 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.

[32] 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.

Appendix I: Parallel trends verification

To confirm the causal impact of the T+2 reform, I first formally evaluate the parallel trends assumption in a dynamic specification of the treatment effect spanning 15 weeks before and after the reform:

$$V_t^{c,n} = \sum_{j=-15}^{15} \beta_j \cdot \mathsf{SC} \cdot \mathsf{TN} \cdot \mathsf{Post}_{t+j} + \alpha_c + u_{t,c,n} \tag{21}$$

where Post_t is unity for the week of the reform. Results are presented in Fig. (I1).

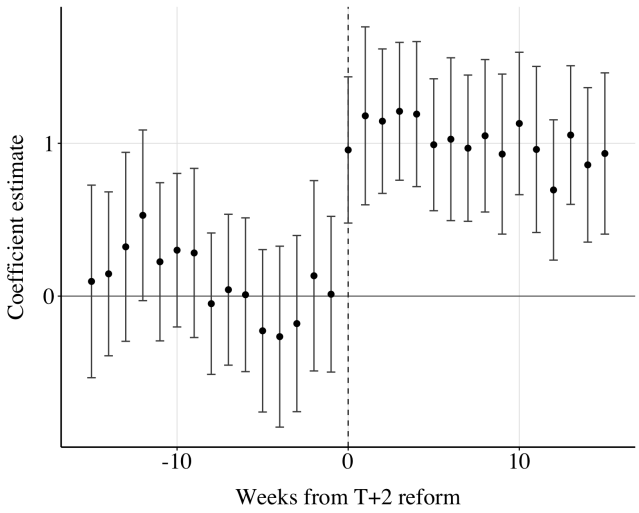


Fig. I1: Dynamic parallel trends verification for trading volumes

The triple-differences model relies on the assumption that the relative EH deviations 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.

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

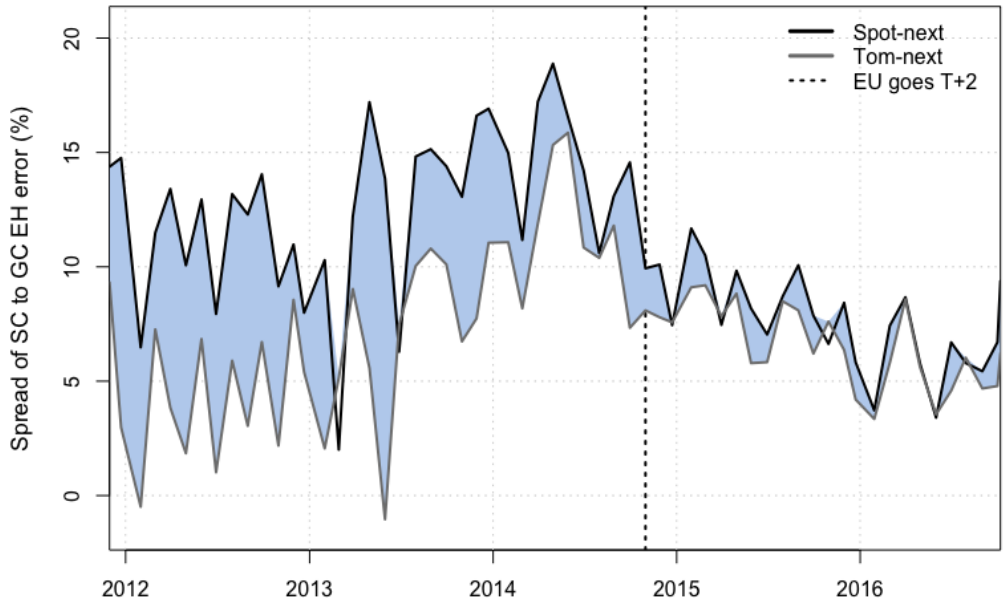


Fig. I2: Spread of percentage EH error between SC and GC segments, for spot-next and tom-next maturities

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.

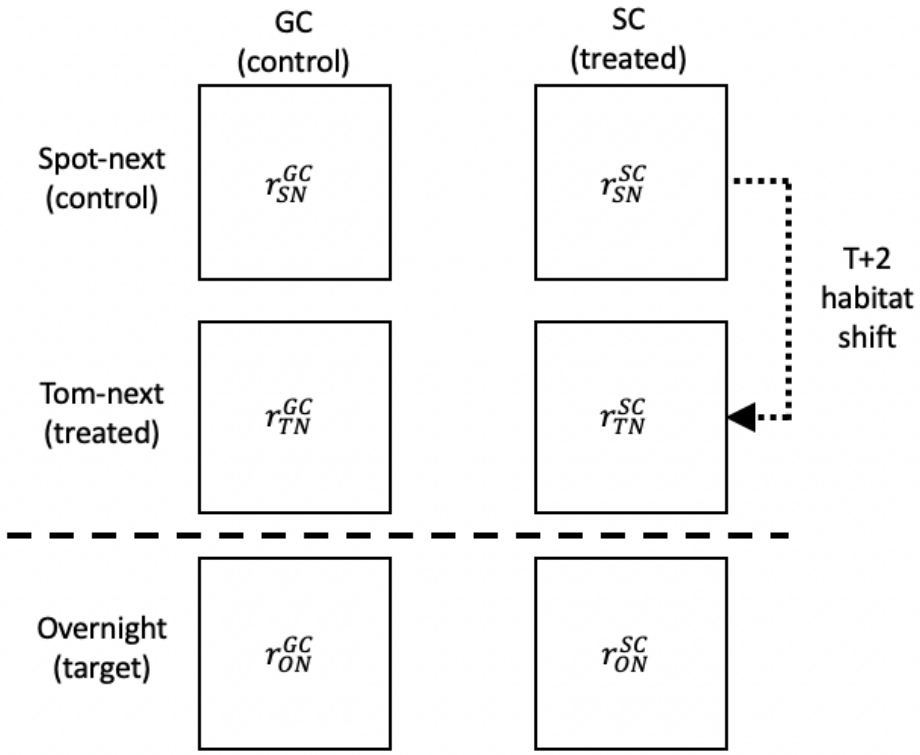


Fig. J1: Empirical model schema

Appendix K: Triple-differences with percentage treatment effect

Accurately measuring the treatment effect resulting from our triple-differences in *percentage* units is more involved due to the outcome variable being distributed tightly around zero. To first measure the *percentage increase in EH deviation* resulting from the T+2 shift (which has thus been far reported in basis points), I apply an inverse hyperbolic sine transformation. First, I divide EH errors by their sample mean:

$$\widehat{\xi}_t^{\,b,n} := \frac{\xi_t^{\,b,n}}{\bar{\xi}_t^{\,b,n}}$$

resulting in variable $\widehat{\xi}_t^{\,b,n}$ centred around 1, which is desirable for taking an inverse hyperbolic sine. This transformation is similar to the logarithmic transformation but has the advantage of being well-defined for zero and negative values.

$$\widetilde{\xi}_t^{\,b,n} := \text{arcsinh}\ \ \widehat{\xi}_t^{\,b,n} = \log\left(\widehat{\xi}_t^{\,b,n} + \sqrt{1 + (\widehat{\xi}_t^{\,b,n})^2}\right)$$

For large enough x, we have $\text{arcsinh}(x) \approx \log(2x)$ and coefficients may be interpreted as a percentage change as in the log case. Table K1 re-runs our triple-differences model on $\widetilde{\xi}_t^{\,b,n,\%}$ and we obtain a treatment effect of 16%-19% (after one applies the necessary $100 \cdot \left(e^{\beta} - 1\right)$ adjustment). Note that, while a useful approximation, the resulting coefficient is not unit-invariant (Chen and Roth, 2024). However, this exercise is nonetheless valuable in that it confirms the results hold in percentage terms.

The above expresses the treatment effect as a percentage increase in EH deviation. However, one may be interested in the treatment effect as a *percentage of the underlying future short-rate*, i.e. the forecast error as a percentage of the target rate. This is further complex as the interest rate is often at zero, which is undefined. A simple work-around solution is to re-scale the EH deviation as:

$$\xi_t^{b,n,\%} := \frac{r_t^{b,n} - r_{t+n-m}^{b,m}}{1 + |r_{t+n-m}^{b,m}|} \cdot 100$$

While this "adjusted percentage approximation" method gives reasonable, tractable results, it is an admittedly arbitrary adjustment and likely underestimates the "true" effect. Alternatively, the symmetric mean absolute percentage error ("SMAPE") is another solution used in empirical work (see Davis and Haltiwanger, 1992):

$$\xi_t^{b,n,\%} := \frac{r_t^{b,n} - r_{t+n-m}^{b,m}}{(|r_t^{b,n}| + |r_{t+n-m}^{b,m}|)/2} \cdot 100$$

and results in a variable bounded between +/- 200. While not arbitrary, it nonetheless produces very high estimates when interest rates are close to zero.

In Table K2, I run the usual regression model on the four iterations of the proximate sample, for both percentage approximations. The adjusted percentage approximation, prone to under-estimation, indicates a treatment effect of 3%-4% of the future short-term rate, while the SMAPE, prone to over-estimation, implies an increase of ∼14%. While this provides a perhaps too-broad range of values, these regressions confirm that results are robust when considering the EH deviation as a percentage of the future short-rate (and thus importantly confirms that our results are not driven by quirks in changes in the near-zero level of the underlying interest rates).

Now that I have confirmed the robustness of the result in percentage terms, I can simply calculate the percentage coefficient as the absolute coefficient derived in eq. (10), times the mean absolute future short-term rate in the sample. This gives us a final result of 9%-11%, which is within the range provided by the more formal exercise.

	Expectations hypothesis error: $\widetilde{xi}_t^{b,n}$, inverse hyperbolic sine							
	Proximate sample				Full sample			
	Raw		Winsorized		Raw		Winsorized	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
SC	0.92***		0.85***		0.01***		0.01***	
	(0.05)		(0.04)		(0.001)		(0.001)	
TN	−0.02		−0.03**		−0.0004		−0.0004*	
	(0.01)		(0.01)		(0.0003)		(0.0002)	
T2	0.04		0.02		−0.0004		−0.001***	
	(0.03)		(0.02)		(0.0004)		(0.0002)	
SC:TN	−0.33***		−0.29***		−0.01***		−0.004***	
	(0.07)		(0.06)		(0.001)		(0.001)	
TN:T2	−0.01	0.003	−0.002	0.01	0.0004	0.001*	0.0004	0.0005**
	(0.03)	(0.02)	(0.02)	(0.02)	(0.0003)	(0.0003)	(0.0003)	(0.0002)
SC:T2	−0.06	−0.04	−0.05	−0.02	−0.004***	−0.003***	−0.003***	−0.003***
	(0.06)	(0.06)	(0.05)	(0.05)	(0.001)	(0.001)	(0.001)	(0.001)
SC:TN:T2	0.24***	0.17**	0.21***	0.15**	0.003**	0.003*	0.003***	0.002**
	(0.09)	(0.08)	(0.08)	(0.08)	(0.001)	(0.002)	(0.001)	(0.001)
$\xi_{t-1}^{b,n}$	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	0.16	0.01	0.19	0.01	0.09	0.02	0.15	0.02

Table K1: Odd-numbered specifications run the model in eq. (9); evens that of eq. (10). *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*, ω to {*Segment* x *Country* x *Collateral* x *Tenor*}, and τ to *Trade Date*. All observations on the last week of the calendar year were 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: $\xi_t^{b,n,\%}$, percentage of future rate							
	Adjusted percentage approx.				SMAPE			
	Raw		Winsorized		Raw		Winsorized	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
SC	11.5***		11.1***		67.3***		71.3***	
	(0.7)		(0.6)		(4.0)		(3.5)	
TN	−0.1		−0.1		−3.6		−3.5*	
	(0.1)		(0.2)		(2.2)		(1.8)	
T2	1.1***		0.3		2.2		2.6	
	(0.3)		(0.2)		(2.4)		(2.0)	
SC:TN	−5.1***		−4.8***		−17.8***		−16.9***	
	(1.0)		(0.8)		(5.5)		(4.8)	
TN:T2	−0.04	0.1	−0.002	0.1	2.2	2.0	1.9	1.7
	(0.2)	(0.2)	(0.2)	(0.1)	(2.4)	(2.5)	(2.0)	(1.9)
SC:T2	−3.6***	−3.6***	−3.7***	−3.4***	−39.3***	−45.4***	−42.9***	−51.0***
	(0.8)	(0.8)	(0.6)	(0.7)	(4.1)	(5.0)	(3.7)	(4.3)
SC:TN:T2	4.0***	3.4***	3.6***	3.0***	14.6**	14.2**	14.0***	14.3**
	(1.2)	(1.2)	(0.9)	(1.0)	(5.8)	(6.4)	(5.2)	(5.6)
$\xi_{t-1}^{b,n}$	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	22,971	22,971	22,971	22,971
R^2	0.14	0.03	0.20	0.02	0.17	0.05	0.28	0.09

Table K2: Odd-numbered specifications run the model in eq. (9); evens that of eq. (10). *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*. All observations on the last week of the calendar year were 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	13.42***		13.84***		13.27***		11.93***	
	(1.66)		(1.33)		(1.29)		(0.93)	
TN	−0.74		−0.69		−1.34***		−1.08***	
	(0.51)		(0.47)		(0.37)		(0.30)	
T2′	−1.41		−0.84**		−1.17**		−1.29***	
	(0.92)		(0.34)		(0.55)		(0.33)	
SC:TN	−6.08***		−5.35***		−4.79***		−3.81***	
	(1.80)		(1.29)		(1.50)		(0.96)	
TN:T2′	1.51***	1.26***	1.30***	1.00**	1.46***	1.39***	1.14***	1.08***
	(0.35)	(0.45)	(0.35)	(0.42)	(0.35)	(0.41)	(0.31)	(0.39)
SC:T2′	2.12	2.16	1.50	1.71	−1.59	−0.07	−1.26*	−0.03
	(1.33)	(1.83)	(1.01)	(1.40)	(1.12)	(1.39)	(0.73)	(0.92)
SC:TN:T2′	1.91	1.10	1.40	0.33	2.22	1.67	1.45	1.04
	(2.00)	(2.32)	(1.37)	(1.68)	(1.57)	(1.81)	(0.97)	(1.15)
$\xi_{t-1}^{b,n}$	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.	18,964	18,964	18,964	18,964	38,237	38,237	38,237	38,237
R^2	0.08	0.01	0.15	0.01	0.08	0.01	0.15	0.02

Table L1: 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. (10). *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*. All observations on the last week of the calendar year were 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, 2016							
	Proximate sample				Full sample			
	Raw		Winsorized		Raw		Winsorized	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
SC	12.15***		11.11***		13.13***		11.93***	
	(0.74)		(0.59)		(0.91)		(0.68)	
TN	0.19		0.002		−0.36		−0.32	
	(0.32)		(0.26)		(0.35)		(0.29)	
T2″	−0.72		−1.02***		−0.37		−0.60**	
	(0.82)		(0.33)		(0.39)		(0.30)	
SC:TN	−2.36***		−2.14***		−3.70***		−3.15***	
	(0.79)		(0.68)		(0.87)		(0.66)	
TN:T2″	−0.24	0.17	−0.06	0.25	0.33	0.40	0.29	0.33
	(0.33)	(0.33)	(0.31)	(0.27)	(0.36)	(0.30)	(0.35)	(0.29)
SC:T2″	−0.75	0.31	−0.25	0.65	−2.78***	−0.88	−2.18***	−0.63
	(0.87)	(0.88)	(0.75)	(0.75)	(0.88)	(0.86)	(0.73)	(0.73)
SC:TN:T2″	0.13	−0.22	−0.04	−0.56	1.75	0.60	1.22	0.34
	(1.24)	(1.11)	(1.05)	(0.99)	(1.22)	(1.11)	(0.99)	(0.95)
$\xi_{t-1}^{b,n}$	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	23,375	23,375	38,237	38,237	38,237	38,237
R^2	0.11	0.01	0.17	0.02	0.08	0.01	0.15	0.02

Table L2: 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. (10). *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*. All observations on the last week of the calendar year were 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			
	$\gamma_t^{\{b=GCP\},m}$		$\gamma_t^{\{b=GCX\},m}$		$\gamma_t^{\{b=GCP\},m}$		$\gamma_t^{\{b=GCX\},m}$	
	(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 M1: 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), *T*2 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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