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

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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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1 Introduction

Interbank liquidity markets are a crucial juncture of the financial system. The short-term lending rates prevailing therein serve as the anchor of the yield curve: dynamics in these markets propagate throughout the term structure. Since the Global Financial Crisis, interbank lending has been conducted through secured repurchase agreements: "repo." As these repo rates represent banks' effective cost of borrowing, they impact key economic parameters such as deposit and mortgage rates, and as such serve as the first stage of monetary policy transmission. Finally, as the banking sector relies on repo markets for short-term liquidity, ensuring their safety and smooth functioning is essential for financial stability.

This study demonstrates that a major share of interbank repo trading is driven by banks' usage of the instrument to make uncovered trades in bond markets. Dealer-banks are averse to holding fixed income inventory, and instead regularly sell bonds they do not own and purchase securities with liquidity they do not have. They instead rely on repo to deliver on their commitments to their counterparties, and can further prolong their exposure to 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 dealer-banks had to adapt to continue rolling over their positions, their trading in repo adjusted accordingly: 30% of daily turnover instantly changed maturity the day of the reform, allowing banks to make delivery in time for settlement. I test for a pricing effect and identify a resulting kink in the yield curve of 5-7 basis points.

The consequence of these agents' uncovered trading activity is to distort repo rates away from (i) their fundamental value in the term structure of interest rates as well as from (ii) the monetary authority's intended policy rate. With respect to the former, this paper is notable in that it causally identifies - and explains - the presence of a preferred habitat effect in the ultra-short-term segment of the term structure, when such phenomena should in theory be restricted to long-term horizons. With respect to the latter, I show that uncovered trading pressures impact the repo rate in *aggregate*, and thus alters banks' effective cost of funding away from the intended policy rate. As a result, the cost of credit in the real economy - e.g. deposit and mortgage lending rates - is partially determined by the level of banks' uncovered trading activity. From a policy-making perspective, the study highlights several vulnerabilities and unintended consequences of the shift to securitized lending.

I proceed in four steps. First, I build a comprehensive panel on repo rates by sourcing transaction-level observations from the three major clearing houses constituting the European interbank repo segment.[1] I assess pricing efficiency by testing whether repo rates are consistent with the expectations hypothesis (EH), perhaps the most fundamental theory of the term structure. I find that whether repo rates conform to the EH is determined by whether they are part of the *general* or *special* class of repo. A general repo allows the cash borrower to choose any eligible collateral from a pre-defined basket, while in a special transaction, the exact security to be posted is pre-agreed by the parties. The EH holds - even in its strongest form - 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.

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.[2] 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

[1] The European setting imposes itself as Eurozone repo data offer best-in-class granularity and availability relative to U.S. wholesale segments. I explain the external validity of the study for global money markets in sec. 8.2.

[2] Both spot-next and tom-next are one-day maturities, with the difference that a spot-next (tom-next) trade has its first leg two days (one day) after agreement. Thus shifting from the former to the latter was necessary for banks to continue to make the settlement deadline post-reform.

adjusted their preferred maturity in response to the shortening of the fixed-income settlement cycle. I then test for a resulting pricing effect through a difference-in-difference-in-differences framework leveraging the fact that (i) only special repos were affected by the settlement change (and generals were not), and (ii) the tomorrow-next segment was affected, and the spot-next was not. I calculate the EH deviations implied by these tenors when predicting the overnight rate. The results imply that agents' habitat preference causes a kink in the yield curve: the EH error increased by 5-7 basis points in treated repos. 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: 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. 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, reinforcing that the more scarce a specific security, the higher the associated distortion to the term structure. I further show that this relationship is not explained by specialness and/or unconventional monetary policy effects.

Finally, I consider the impact of this dynamic on the cost of credit in the real economy. Dealer-banks' behavior in repo 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. Conventional monetary policy sees the central bank influence economic parameters by determining banks' effective cost of short-term funding, often represented by a benchmark unsecured rate such as €STR. However, as interbank funding shifted to a secured standard in the wake of the Great Financial Crisis, it is repo rates which represent banks' effective cost of funding. Furthermore, given that special trades represent 70%-80% of total repo turnover, it is special, not general, rates which are determinant. I regress banks' deposit, mortgage, and corporate lending rates on the special repo rate and find a statistically and economically significant pass-through, despite crucially controlling for the ECB policy rate and other macro factors. Mortgage and corporate lending rates are most significantly affected, while deposit rates respond as well, albeit more sluggishly. The implication is that, to the extent the repo rate is distorted by the dynamics studied herein, real economic parameters such as deposit and mortgage rates are partially a function of banks' uncovered trading activity.

This paper contributes to our understanding of term structure dynamics by causally identifying a preferred habitat effect in ultra-short, nearly-identical maturities. Such effects have been viewed as intrinsically long-term phenomena, affecting maturities at the e.g. 15- to 30-year horizon (Greenwood and Vayanos, 2010, 2014). Our findings paint a considerably less efficient and noisier picture of the term structure, with market segmentation generating pricing distortions even in the most liquid and shortest-term segments. This study thus offers a novel perspective on a long-standing puzzle: the difficulty of empirically identifying time-varying risk premia that can account for the term structure's deviations from the expectations hypothesis. While a large literature has sought to explain these deviations through time-varying risk premia, the fundamental economic sources of such premia remain difficult to identify. Our findings suggest why: instead of cleanly reflecting the fair pricing of compensation of risk, term structure dynamics may instead be distorted by pricing effects arising from heterogeneous maturity preferences and constrained arbitrage.

A second contribution is an explanation why preferred habitat effects can occur even in the most ideal of settings: a deep, liquid market at the ultra-short segment of the yield curve. Theory implies that preferred habitat effects are intrinsically long-term phenomena, as duration/interest rate risk is the key constraint stopping risk-averse arbitrageurs from correcting mispricings. However, duration risk is not a viable explanation in such short-term maturities; I instead provide evidence that collateral scarcity and market fragmentation impede such remedial trading. More generally, the study demonstrates that preferred habitat effects can arise from the interaction of microstructural frictions and maturity-specific demand shocks independent of duration risk, suggesting that conventional long-term preferred habitats are one case of a more general phenomenon.

A further contribution is to clarify whether and why the expectations hypothesis fails in short-term rates. The EH is often studied in repo as these markets are an ideal testing ground due to their depth, liquidity, and safety. However, researchers have reached varying conclusions as to its performance; this study clarifies this tension by showing that the fundamental determinant is the conditions imposed on the choice of collateral, i.e. the dichotomy between special and general repos. The fact that preferred habitat phenomena partially explain the EH failure in special repos helps explain why risk premia struggle to explain these mispricings. On the other hand, the strong form of the EH holds in the general repo segment, which is significant given its pervasive empirical rejection across asset classes and time periods.

Finally, the paper contributes to our understanding of the secondary effects of the post-2008 shift to secured money markets. While safer and more efficient interbank lending is desirable, this study shows that the change is not without downsides. Several conclusions emerge. First, banks now routinely make use of repo to make delivery in bond markets; this practice gives rise to a spillover risk - disruptions in repo segments may lead to defaults in bond markets. That this happens daily in ultra-short maturities results in further rollover risk. Then, we have shown that collateral scarcity and market fragmentation impede free arbitrage, highlighting that collateralized money markets require a liquid supply of eligible collateral (in addition to cash liquidity) to remain efficient. Finally, the paper shows that agents' trading activity can shift aggregate short rates away from the monetary policy target; the repo price is a function not only of special convenience yields but also collateral-specific demand shocks. There is thus a tradeoff between financial stability - through the securitisation of interbank lending - and the accurate transmission of monetary policy.

The paper finally provides important insights for policy-makers as to the secondary effects of shortened settlement cycles. Future reforms have been planned to further shorten the settlement cycle, with the goal of staving off counterparty risk and increasing efficiency. Distributed ledger technology (DLT) allows for the implementation of atomic or instant settlement using blockchain, and multiple global initiatives are investigating this possibility. However, this paper shows that banks rely on secured lending as a substitute for maintaining an on-balance-sheet inventory, which ties up capital and is costly from a regulatory perspective. The enforcement of instantaneous settlement would make such a practice infeasible. This may be desirable in terms of reducing spillover/rollover risk, but it comes at the risk of counterintuitively *increasing* illiquidity in bond markets, as dealer-banks are likely to pass on the cost of holding such securities on-balance-sheet to their customers. Policy-makers thus need to consider that reducing the settlement cycle schedule is, in some sense, equivalent to tightening the constraint on banks' balance sheets, with the usual consequences that have been documented in the literature.

Related literature: This paper contributes to preferred habitat theory (Culbertson, 1957; Modigliani and Sutch, 1966) by demonstrating that interest rate risk is not a necessary condition for such effects. A wide literature documents their implications for financial markets and monetary policy (Greenwood and Vissing-Jorgensen, 2018; Vayanos and Vila, 2021; Greenwood et al., 2023; Klingler and Sundaresan, 2023; Jappelli, Pelizzon, and Subrahmanyam, 2023; Cavaleri, 2023; Jansen, Li, and Schmid, 2024; Gourinchas, Ray, and Vayanos, 2025; Chen, 2025), all of which refer to arbitrageurs' aversion to interest rate risk. We show an example where arbitrage is constrained due to microstructural effects, i.e. the securitization of funding markets and collateral scarcity.

The paper also contributes to studies of the EH failure in the term structure as documented in Cox, Ingersoll, and Ross (1981), Fama (1984), Fama and Bliss (1987), Campbell and Shiller (1991), Bekaert and Hodrick (2001) and, for repo markets, in Longstaff (2000), Buraschi and Menini (2001), Della Corte, Sarno, and Thornton (2008), and Ranaldo and Rupprecht (2019) by explaining under what conditions it holds at the short end of the yield curve. It further relates to the literature identifying time-varying risk premia in the term structure (Evans, 1998; Dai and Singleton, 2002; Cochrane and Piazzesi, 2005; Ludvigson and Ng, 2009; Cieslak and Povala, 2015; Bauer and Chernov, 2024) by highlighting that such estimation is rendered more difficult by the pervasiveness of preferred habitat effects.

The paper is also related to the study of convenience yields which manifest as specialness in repo (Duffie, 1996; Jordan and Jordan, 1997; Krishnamurthy and Vissing-Jorgensen, 2012; Nagel, 2016; Gorton, 2017; Ballensiefen and Ranaldo, 2022; d'Avernas and Vandeweyer, 2024). However, instead of arguing that specialness reflects a convenience yield, we show that it can be the result of bidding pressure from dealers in a market with limited supply. My findings contribute to our understanding of the microstructure of secured wholesale markets (Copeland, Martin and Walker, 2012; Martin, Skeie, and von Thadden, 2014a,b; Mancini, Ranaldo, and Wrampelmeyer, 2016; Corradin and Maddaloni, 2020; Arrata et al., 2020; Craig and Ma, 2022; Ballensiefen, Ranaldo, and Winterberg, 2023; Ballensiefen, 2023; Coen, Coen, and Huser, 2026; De Fiore et al., 2026) and highlight several vulnerabilities for policy-makers to consider: the usage of repo to leverage positions (Huh and Infante, 2022; Huber, 2023), 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), and rollover/spillover risk. That flows can materially affect rates even at the short end of the term structure is consistent with the growing literature on inelastic financial markets (Koijen and Yogo, 2019; Gabaix and Koijen, 2020). Finally, the paper contributes to the nascent field studying settlement risk and cross-border payments (Du, Huang, and Scharfstein, 2026; Lee, Ranaldo, and Tsuruga, 2026).

2 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.[3]

The dataset is created by combining the transactions contained in the three major CCP-based European electronic trading platforms: BrokerTec, Eurex Repo, and MTS Repo. CCP-based repo has been estimated to account for more than 70% of the European interbank repo market (Mancini et al., 2016). The data sample extends from January 2$^{\text{nd}}$, 2006, to June 30$^{\text{th}}$, 2020. 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

[3] 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.

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.[4]

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

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

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.

3 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 future. In a setting with continuously compounded interest rates R, the relationship is:

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

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

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

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

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

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

which can be tested in a regression framework as follows:

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

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

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

[6] 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.

[7] 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

combinations of TN/SN rates predicting ON/TN rates).

Several conclusions emerge. I fail to reject the weak form of the EH for the GCX and GCP baskets. Indeed, the β coefficient is impressively close to 1. This demonstrates that for repo segments where specialness is not a factor, the EH cannot be rejected. A panel regression of country-specific GC baskets sees a statistical rejection of the EH, but the coefficient values range from 0.87 to 0.92. This is in marked contrast with the SC segment, where the EH is decisively rejected and β coefficients are as low as 0.633.[8] 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.

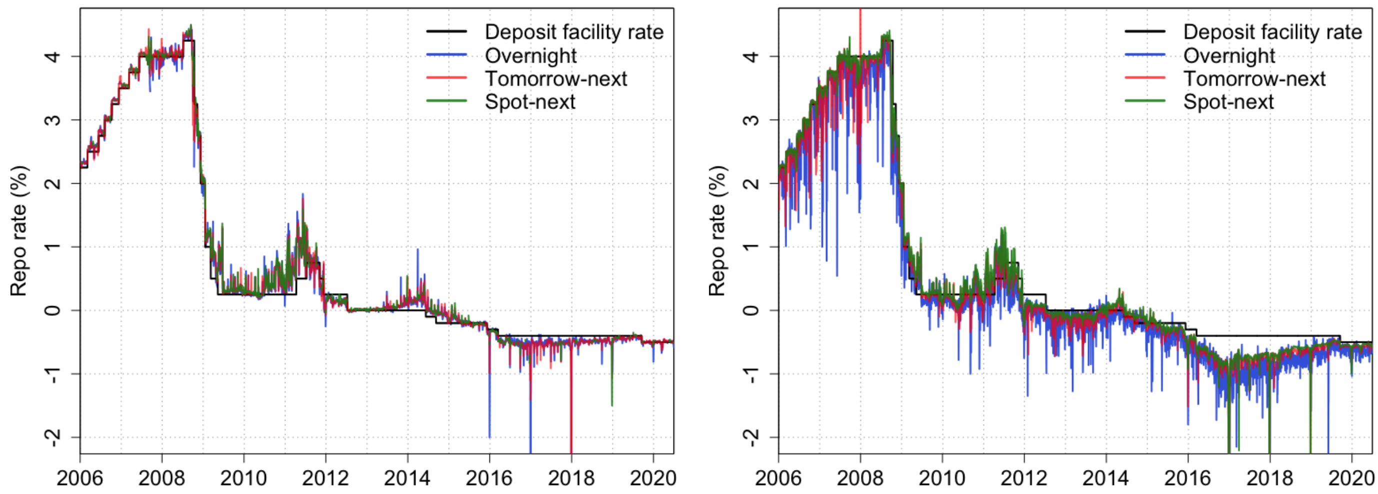
The discrepancy between special and general repos' EH performance is clear and

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.

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

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

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



(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.

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

4 Experiment: shortening the settlement cycle

4.1 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.[9] 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.

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).[10]

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.[11] 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

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[9] 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.

[10] 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.

[11] 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.

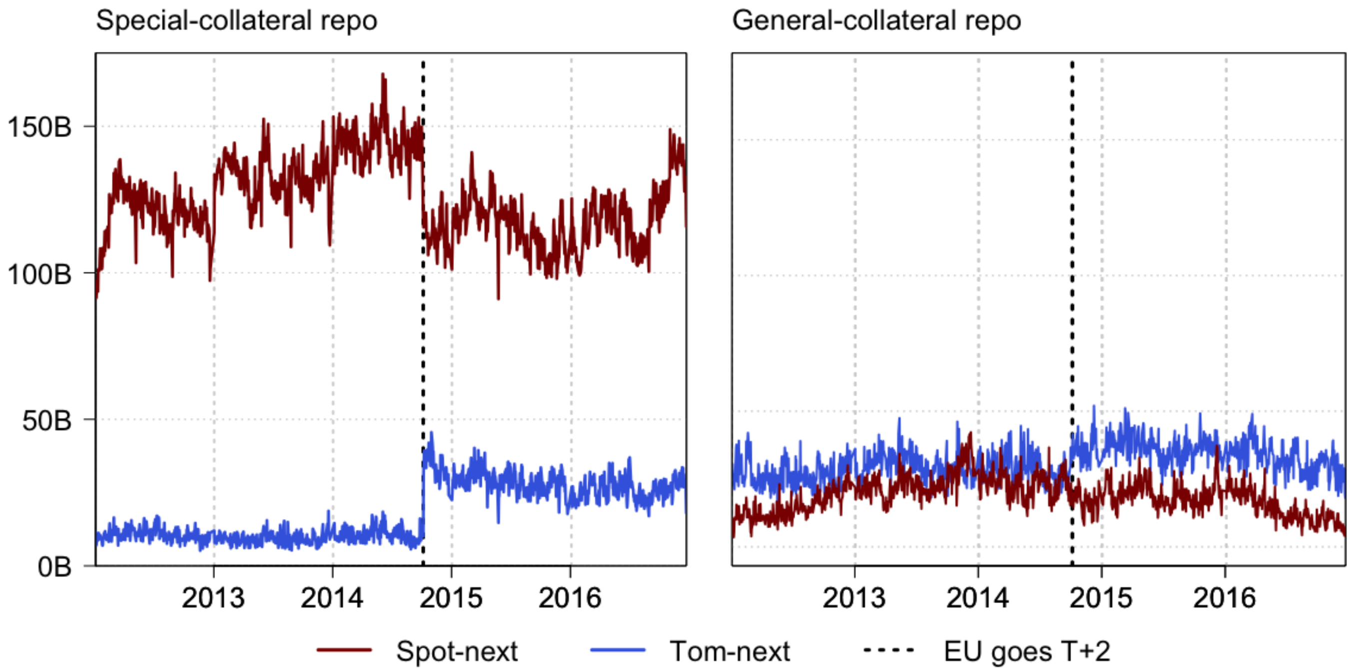


Fig. 2: Daily turnover of special (l.h.s.) and general (r.h.s.) repos. The last week of each calendar year is dropped for visualization purposes.

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.[12] This highlights the role of the special spot-next (and subsequently, tom-next) segment as the bridge between repo and cash markets. The fact that only specials were affected indicates that the affected repos were collateral-driven. The fact that they adapted to the settlement time of the cash market indicates that they were used in conjunction with fixed income trades, and thus needed to be synced to that settlement cycle. The following section will further delineate the mechanism.

Appendix H provides a formal econometric test of the dynamics shown in Figure (2). That is, I split the data by $\{Segment$ x $Country$ x $Tenor\}$, and test whether a volume shift from SN to TN indeed occurred for special repos only. The econometric model used will be introduced in depth in section 5.2. 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

[12] 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.

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).

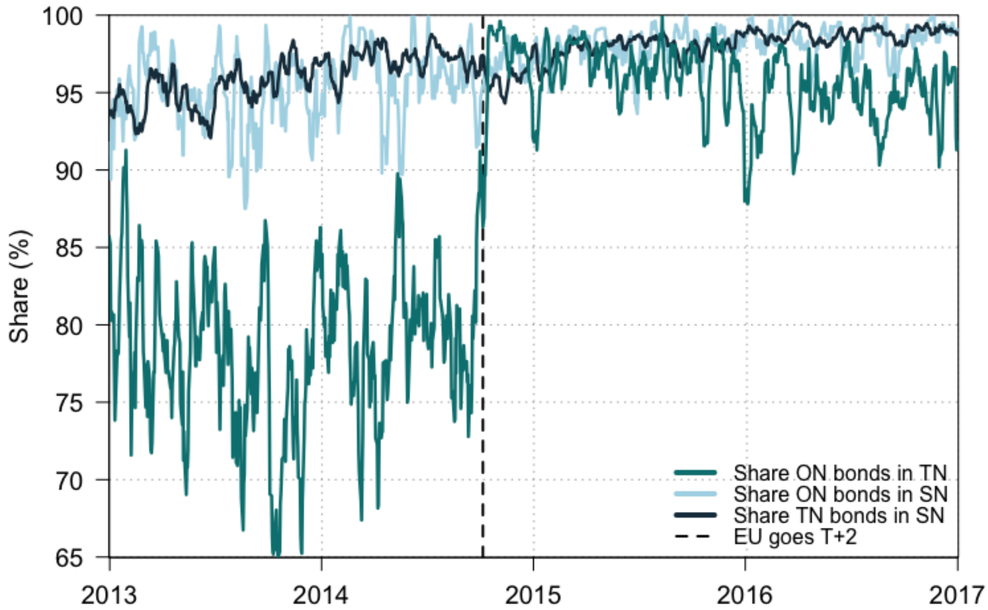


Fig. 3: Share of unique collaterals traded across maturities, rolling weekly averages.

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.

4.2 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).

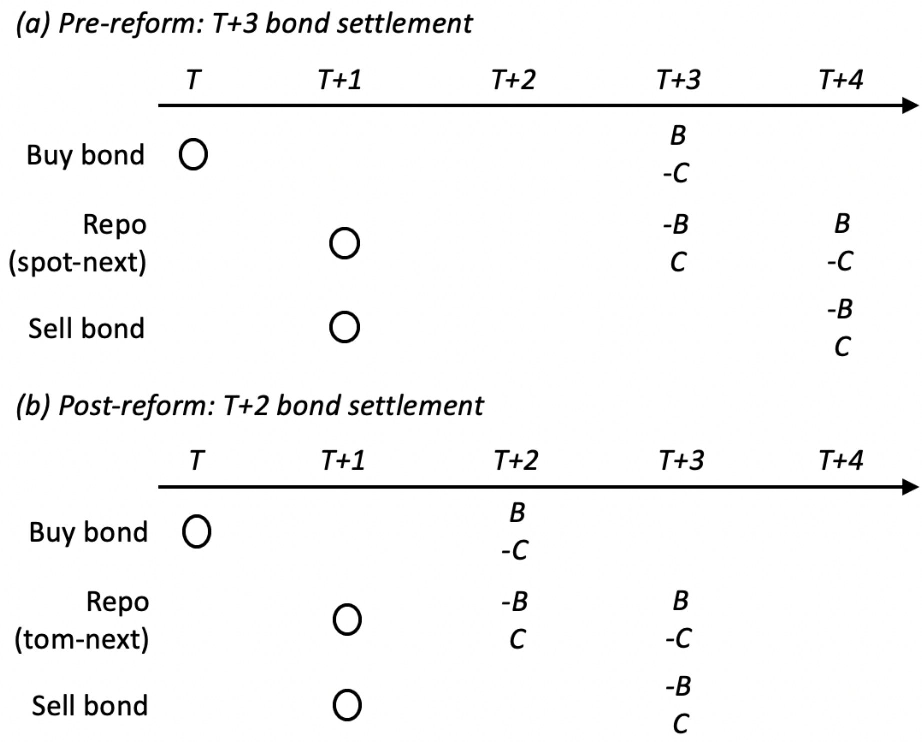


Fig. 4: Financing a cash position (leveraging). Circles represent when a trade is agreed. B and C refers to the delivery of a bond or cash, respectively. The graphic denotes how an agent would finance a cash position before and after the T+2 settlement reform.

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?[13] The answer

[13] 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.

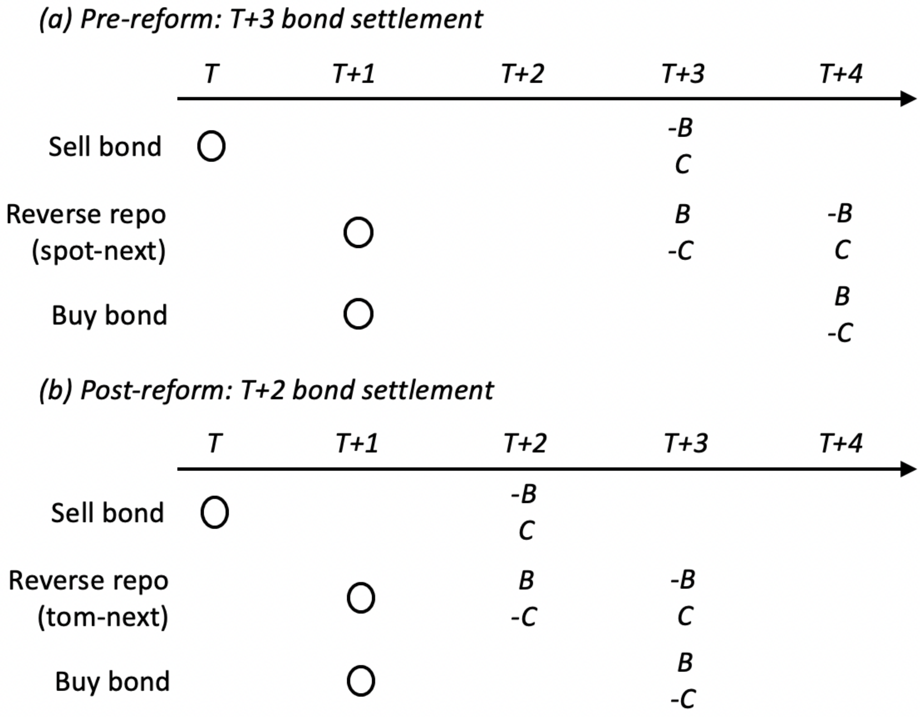


Fig. 5: Covering a securities position (short-selling). Circles represent when a trade is agreed. B and C refers to the delivery of a bond or cash, respectively. The graphic denotes how an agent would cover a securities position before and after the T+2 settlement reform.

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 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.[14] However, given the dynamics of repo specialness, this would be suboptimal: special repo offers far more attractive rates, and safe asset bonds are in high demand (and were equally so in 2014). Recall Figure (1); as special repo rates are negative, an agent would be paid to borrow the missing cash if he uses a special repo.

What kind of agents pursue this strategy? The interbank segment I observe naturally consists of the major European banks 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

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

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.[15] 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 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

[15] 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.

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.

Finally, while the underlying dynamic of dealer short-selling is present in other markets, the 2014 European settlement cycle reform is particularly well-suited for its identification. For one, EU repo markets offer unparalleled and necessary granularity, in particular by distinguishing between ON/TN/SN repo maturities. Second, although the U.S. twice shortened its settlement cycle in recent years (to T+2 in 2017 and T+1 in 2024), U.S. government securities have long operated on a T+1 settlement cycle. Therefore, while similar dynamics are very likely present in U.S. Treasury markets, this institutional feature precludes identification. On the other hand, U.S. corporate bonds did transition during these reforms, though they are primarily borrowed through dedicated securities lending markets rather than repo money markets. In line with the predictions of this paper, Goyal, Nozawa, and Qiu (2025) study corporate bond lending through the U.S. T+2 reform and document evidence of a similar dynamic, concluding that dealers are the primary short-sellers in such markets.

5 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 whether the observed shift in habitat had any impact on the EH performance, i.e. on pricing.

5.1 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.

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

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

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:

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

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).

5.2 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.[16] 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 and after the T+2 shift.[17] 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

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

[17] 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.

(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:

$$\begin{aligned}
\xi_t^{b,n} \;&=\; \beta_1 \cdot D_{t,b,n}^{SC} \;+\; \beta_2 \cdot D_{t,b,n}^{TN} \;+\; \beta_3 \cdot D_{t,b,n}^{SC} \cdot D_{t,b,n}^{TN} \;+\; \delta_0 \cdot D_{t,b,n}^{T+2} \;+\; \delta_1 \cdot D_{t,b,n}^{T+2} \cdot D_{t,b,n}^{SC} \\
&\quad +\; \delta_2 \cdot D_{t,b,n}^{T+2} \cdot D_{t,b,n}^{TN} \;+\; \delta_3 \cdot D_{t,b,n}^{T+2} \cdot D_{t,b,n}^{SC} \cdot D_{t,b,n}^{TN} \;+\; \beta \cdot \mathbf{X} \;+\; \alpha_j \;+\; u_t^{b,n} \qquad (9) \\
\xi_t^{b,n} \;&=\; \delta_1' \cdot D_{t,b,n}^{T+2} \cdot D_{t,b,n}^{SC} \;+\; \delta_2' \cdot D_{t,b,n}^{T+2} \cdot D_{t,b,n}^{TN} \;+\; \delta_3' \cdot D_{t,b,n}^{T+2} \cdot D_{t,b,n}^{SC} \cdot D_{t,b,n}^{TN} \;+\; \beta' \cdot \mathbf{X} \\
&\quad +\; \omega_b \;+\; \tau_t \;+\; u_t^{b,n} \qquad (10)
\end{aligned}$$

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 $\{Segment \text{ x } Country \text{ x } Collateral \text{ x } Tenor\}$ series which appeared before and after the T+2 switch. For all specifications, I drop all observations which occur during the final week of each calendar year. I also run specifications with the data winsorized at the 2.5% and 97.5% level.[18]

The treatment effect implies that the EH performance is negatively impacted across

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

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. Furthermore, I have shown this effect in a heavily traded, deep, and liquid market. The results indicate that preferred habitat effects are more powerful and pervasive than previously believed. Comparing the proximate and full sample results in Table (2) suggests that the spread did attenuate over time. Overall, though, the evidence presented here suggests that the ON, TN, and SN rates each operate - to a certain extent - as their own habitat. This is remarkable given that they each have the exact same

	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.

tenor (from leg to leg) but differ only in their settlement times.

5.3 Robustness checks and other considerations

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. The ensuing sections consider a host of alternative explanations.

5.3.1 Order flow dynamics

I argue against these potential confounders by studying how order flow was impacted by the reform. If a change in risk 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.[19]

Results in Table M1 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.

5.3.2 Specialness premium

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

However, this is contrary to the observed dynamic: a by-product of the mechanism at hand is that repo specialness *decreased* in the treatment group following this switch. This may seem counter-intuitive at first, given that leveragers are essentially betting

[19] 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.

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:

$$\gamma_t^{b,m} = \beta_1 \cdot D_{t,b,m}^{TN} + \beta_2 \cdot D_{t,b,m}^{T2} + \beta_3 \cdot D_{t,b,m}^{TN} \cdot D_{t,b,m}^{T2} + \beta_4 \cdot \gamma_{t-1}^{b,m} + \beta_5 \cdot r_t^{GCP,m} + b + u_t^{b,m} \quad (12)$$

$$\gamma_t^{b,m} = \beta_3' \cdot D_{t,b,m}^{TN} \cdot D_{t,b,m}^{T2} + \beta_4' \cdot \gamma_{t-1}^{b,m} + \beta_5' \cdot r_t^{GCP,m} + \omega_b + \tau_t \, 9i + u_t^{b,m} \quad (13)$$

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 N1 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.

5.3.3 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.

5.3.4 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.

5.4 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).[20]

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:

$$E_T\left[\Delta P^B_{T+1,T} - r^{TN}_{T+1}\right] > E_T\left[-\Delta P^B_{T+1,T} + r^{TN}_{T+1}\right], \quad \forall\ r^{TN}_{T+1} < 0 \tag{14}$$

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.[21] 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 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).

[20] 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.

[21] 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.

6 Arbitrage constraints in short-term rates

6.1 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 canonically viewed as the constraint on term structure arbitrage (Vayanos and Vila, 2021), but 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 usually higher than the 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. Two major reasons drive the potential for safe asset scarcity during the period under review. The first is unconventional monetary policy, as central bank purchases of government debt sucks "collateral liquidity" out of the repo system, thus reducing the scope for arbitrage operations. Second, 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. These issues are further compounded by the intrinsic fragmented nature of the European repo market. While it may appear deep, liquid, and unified at first glance, the usage of bond-specific special repo coupled with the heterogeneity in European bonds - spanning many countries and ISINs - means the market rather resembles a constellation of sub-segments trading w.r.t. to different reference rates.

In this section, I seek to demonstrate that it is constraints to arbitrageurs' access to collateral which causes yield curve mispricings. 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 (2026) 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 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

[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 (2026) 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.

[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.

monthly purchased quantity.[26] I thus run the regressions:

$$\xi^n_{i,t} = \beta_1 \cdot \mathsf{PSPP}_{i,t} + \beta_2 \cdot \mathsf{LIBOR\text{-}OIS}_t + \beta_3 \cdot \mathsf{VIX}_t + \beta_4 \cdot \mathsf{TED}_t + \alpha_i + u_{i,t} \tag{15}$$

where α_i are Country x Tenor fixed effects. Panel A of Table (3) presents results. Economic and statistical significance is achieved for all specifications, and shows that deviations from the EH are stronger during periods when the ECB is purchasing higher amounts of securities, consistent with the notion that no-arbitrage breaks down when collateral is made scarce, in this instance by quantitative easing programs. Column (1) measures EH deviations in basis points, and shows that a 10 billion euro increase in PSPP purchases leads to an 8 bps increase in EH error (during the sample, PSPP purchases averaged 36 bn EUR per month across all countries). Column (2) expresses PSPP purchases as a share of total government debt held by the European banking sector; when the ECB purchases 1% of such debt, the EH error increases by 2.3% of the target overnight rate. The final specification in logs shows that a 1% increase in PSPP purchases increases the EH deviations by 0.42%. In the final three specifications, I collapse the panel structure and average across all countries to obtain a single time series; the result maintain their significance. Panel B considers the same regression models but with specialness added as a covariate; I will discuss this specification later. Overall, these results are noteworthy in that we have averaged EH errors to obtain a monthly value; such temporal aggregation dampens variability, setting a higher bar for significance.

The results in Table 3 provide evidence that a shock to the supply of collateral, here in the form of quantitative easing purchases, results in larger yield curve mispricings, which I argue stem from a reduced ability for arbitrageurs to obtain the collateral required to smoothly operate in the market. However, unconventional monetary policy is just one factor dictating the supply of government securities. A reduction in government borrowing, for example, reduces the availability of eligible collateral for securitized lending; if lending turnover volumes are unaffected, then one would expect

[26] That is, I first calculate average daily ISIN/tenor-specific EH errors, and then take monthly averages per country and tenor. The two tenors are spot-next and tom-next rates, with the overnight serving as the target.

	Expectations hypothesis error: $\xi^n_{i,t}$					
	Panel regression			Single time series		
	bps	%	logs	bps	%	logs
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Purchases						
Purchases	0.82***	2.25***	0.42***	0.24***	3.84***	0.79***
	(0.20)	(0.32)	(0.06)	(0.06)	(1.36)	(0.20)
LIBOR–OIS	Yes	Yes	Yes	Yes	Yes	Yes
VIX	Yes	Yes	Yes	Yes	Yes	Yes
TED	Yes	Yes	Yes	Yes	Yes	Yes
Constant	No	No	No	Yes	Yes	Yes
Country x Term FE	Yes	Yes	Yes	No	No	No
Observations	536	536	536	64	64	64
Adj. R^2	0.46	0.34	0.25	0.61	0.35	0.38
Panel B: Purchases and GCP Specialness						
Purchases	0.46**	0.62***	0.26***	0.09**	0.61	0.41**
	(0.16)	(0.14)	(0.05)	(0.04)	(0.79)	(0.19)
Specialness$_{t-1}$ ($\gamma^{b,m}_{i,t-1}$)	0.27***	0.80***	0.46***	0.40***	1.18***	0.83**
	(0.02)	(0.13)	(0.05)	(0.07)	(0.25)	(0.39)
LIBOR–OIS	Yes	Yes	Yes	Yes	Yes	Yes
VIX	Yes	Yes	Yes	Yes	Yes	Yes
TED	Yes	Yes	Yes	Yes	Yes	Yes
Constant	No	No	No	Yes	Yes	Yes
Country x Term FE	Yes	Yes	Yes	No	No	No
Observations	471	471	471	63	63	63
Adj. R^2	0.54	0.44	0.51	0.79	0.62	0.45

Table 3: The table shows the results of regressions of the absolute EH error, $\xi^n_{i,t}$, on purchases conducted under the PSPP. In columns (1) to (3), the dependent variable is derived by first calculating average daily ISIN/tenor-specific EH errors, and then take monthly averages per country and tenor. The two tenors are spot-next and tom-next rates, with the overnight serving as the target. I apply country-tenor fixed effects and likewise cluster the standard errors. The EH error is expressed first in basis points, then as a percentage of the target rate as in eq. (24), and finally in logarithms. Purchases refers to ECB purchases under the PSPP program. They are denoted in billions in specification (1) and (4), as a percent of Securities Held Outstanding in columns (2) and (5), and finally in logarithms in (5) and (6). Specifications (4)-(6) collapse the panel structure into a single, averaged time series; Newey-West standard errors are applied. Specialness$_{t-1}$ is the prior month's average overnight specialness w.r.t. to the GCP rate and is likewise calculated as the dependent variable. The sample spans March 2015 to June 2020.

frictions to similarly arise. A further test of this hypothesis would be to consider whether there is a relationship between the *amount of bonds held by the banking sector* and term structure mispricings in repo. I thus source data from the ECB's Securities Holdings Statistics by Sector data on European government debt held by monetary financial institutions (excluding central banks) of the various Eurozone countries. I apply a similar estimation set-up as in Table 3. As many latent factors can determine the volume of debt securities held by the banking sector, I leverage year-month fixed effects for the panel models, and a set of year dummies for the single time series.

Table 4 shows results. In general, they document a negative relationship between the amount of securities owned by the banking sector, yield curve mispricings. Specifically, column (1) show that a decrease of 100 bn euro in securities outstanding results in an increase in EH error of 8 basis points. For comparison, euro area financial institutions jointly held an average of 1,664 bn euro of securities during the period under study. Specification (2) tells that a decrease of 100B in securities outstanding, there is an increase of 8 percentage point of EH error w.r.t. the target overnight rate. Panel B repeats the exercise by adding specialness as a covariate; I will discuss these results later. Overall, the results suggest that the less government bonds are in circulation, the greater the yield mispricings, which I attribute to a lack of collateral access impeding free arbitrage.

To provide further evidence for the hypothesis that collateral scarcity impinges on arbitrage activity, I conduct a second analysis studying the relationship between EH errors and 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 as below. For a repo with underlying bond b and maturity m:

$$\gamma_t^{b,m} := \frac{r_t^{\{b=g\},m} - r_t^{b,m}}{1 + |r_t^{b,m}|}, \qquad g \in \{\text{GCP, GCX}\} \tag{16}$$

As specialness is a proxy for collateral scarcity, I test whether EH deviations worsen

	Expectations hypothesis error: $\xi^n_{i,t}$					
	Panel regression			Single time series		
	bps	%	logs	bps	%	logs
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Securities Held						
Securities Held	-0.08^{**}	-0.09^{*}	0.004	-0.002^{**}	-0.002^{**}	-0.001^{*}
	(0.03)	(0.04)	(0.01)	(0.001)	(0.001)	(0.0004)
Country x Term FE	Yes	Yes	Yes	No	No	No
Year-Month FE	Yes	Yes	Yes	No	No	No
Constant	No	No	No	Yes	Yes	Yes
Year dummies	No	No	No	Yes	Yes	Yes
Observations	544	544	544	65	65	65
Adj. R^2	0.45	0.37	0.30	0.70	0.67	0.50
Panel B: Securities Held and GCP Specialness						
Securities Held	-0.13^{***}	-0.18^{***}	-0.01^{***}	-0.002^{*}	-0.002^{**}	-0.001^{*}
	(0.01)	(0.03)	(0.002)	(0.001)	(0.001)	(0.0003)
Specialness$_{t-1}$	0.05	0.10	0.09	1.44	-1.31	0.68^{**}
	(0.04)	(0.08)	(0.07)	(1.20)	(1.39)	(0.31)
Country x Term FE	Yes	Yes	Yes	No	No	No
Year-Month FE	Yes	Yes	Yes	No	No	No
Constant	No	No	No	Yes	Yes	Yes
Year dummies	No	No	No	Yes	Yes	Yes
Observations	475	475	475	64	64	64
Adj. R^2	0.46	0.43	0.66	0.69	0.69	0.51

Table 4: The table shows the results of regressions of the EH error, $\xi^n_{i,t}$, on the amount of European government securities held by euro area monetary financial institutions. In columns (1) to (3), the dependent variable is derived by first calculating average daily ISIN/tenor-specific EH errors, and then take monthly averages per country and tenor. The two tenors are spot-next and tom-next rates, with the overnight serving as the target. I apply country-tenor and year-month fixed effects and cluster by country-tenor. The EH error is expressed first in basis points, then as a percentage of the target rate as in eq. (24), and finally in absolute logarithms. Securities held are denominated in billions of euros in all specifications. Specifications (4)-(6) collapse the panel structure into a single, averaged time series; Newey-West standard errors are applied. Specialness$_{t-1}$ is the prior month's average overnight specialness w.r.t. to the GCP rate and is likewise calculated as the dependent variable. The sample spans March 2015 to June 2020.

with increased specialness. I regress EH deviations on a measure of specialness based on the overnight rate (i.e. $m = \text{ON}$ in eq. (17) on a per-collateral basis as follows:

$$\xi^n_{i,t} = \beta \cdot \gamma^{b,m}_{i,t} + \omega_i + \tau_t + u_{i,t} \tag{17}$$

This specification has an advantage relative to the previous exercise in that one can test the hypothesis at ISIN-level and at daily frequency. Table (5) shows results; their statistical and economic significance confirm the intuition. A basis point increase specialness results in an increased EH error of 0.24 bps, alternatively, a percentage point increase results in a 0.17% increase as a share of the target overnight rate. The positive relationship between specialness and EH deviations persists during the era of zero interest rate policy (ZIRP), which is defined as any time when the GCP/GCX rate was below zero. Taken as our whole, the analysis provides support for the intuition that collateral scarcity is the reason why arbitrageurs cannot erase EH deviations.

	Expectations hypothesis error ($\xi^n_{i,t}$)					
	Full sample				Sub-ZIRP	
	GCP (bps) (1)	GCX (bps) (2)	GCP (%) (3)	GCX (%) (4)	GCP (bps) (5)	GCX (bps) (6)
Specialness ($\gamma^{b,m}_{i,t}$)	0.24***	0.24***	0.17***	0.18***	0.20***	0.19***
	(0.02)	(0.02)	(0.01)	(0.01)	(0.02)	(0.02)
ISIN-Tenor FE	Yes	Yes	Yes	Yes	Yes	Yes
Trade Date FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	15,845	15,015	15,838	15,012	10,957	10,698
Adj. R^2	0.36	0.34	0.35	0.35	0.24	0.24

Table 5: The table reports regressions of the absolute EH error, $\xi^n_{i,t}$, on repo specialness, $\gamma^{b,m}_{i,t}$. EH errors are constructed from spot-next and tom-next maturities, while specialness is measured using the overnight repo rate. Variables are in basis points, except for columns (3) and (4) where they are expressed in percentage terms as defined in eq. (16). Specifications alternatively use GCP and GCX rates in the construction of the specialness premium. Columns (1)-(4) use the full sample, whereas columns (5)-(6) restrict the sample to observations with negative GCP (GCX) rates to study dynamics in the sub-zero interest rate environment. All specifications include ISIN-tenor and trade-date fixed effects. Standard errors are clustered by ISIN-tenor.

6.2 A specialness premium vs. a constraint on arbitrage

The preceding analyses provide evidence that a shortage of available collateral prevents arbitrageurs from trading prices back to fundamental value, giving rise to preferred-habitat effects in short-term rates. Studying shocks to the supply of collateral (as well as the amount of securities outstanding held by banks and the specialness variable) shows that collateral scarcity is tightly linked to such deviations from the EH. However, a potent alternative explanation requires examination. Collateral scarcity may result in EH deviations not because of a constraining effect on arbitrageurs, but because rates price in an immediacy premium. When a security is scarce, agents may be willing (or rather obliged) to pay a premium for immediate delivery of the repo collateral, and the overnight rate will shift lower relative to the tom-next and spot-next maturities, widening EH mispricings. Note that such an immediacy premium does not imply a breakdown of no-arbitrage: if the bond in question is scarce across all agents due to exogenous, economy-wide factors, then the premium is simply a reflection of fundamental value, and no profitable remedial trading is feasible. A no-arbitrage breakdown occurs, however, when the security is potentially available, but withheld from otherwise willing arbitrageurs (due to e.g. central bank purchases or inelastic institutional ownership by pension funds). The arbitrage trade in this case would be to lend the bond in the overnight segment, thereby bidding up its price relative to the longer-term forward rates. If arbitrageurs cannot source said security however, this trade cannot be executed, and the resulting no-arbitrage failure manifests as EH violations.

I seek to distinguish between these two channels by asking whether shocks to the supply of collateral can influence EH deviations holding constant the influence of general bond scarcity. To do that, I reconsider the analyses performed in Tables 3 and 4, but this time control for the lagged level of specialness. That is, I am interested in testing whether a decreased of supply of collateral, independent of scarcity, deteriorates the EH performance. In Panel B of Table 3, we see that specialness indeed positively correlates with EH deviations. However, the economic and statistical significance of

PSPP purchases on yield curve mispricings persists.[27] Panel B of Table 4 performs the same exercise and renders the same conclusion: even when holding the level of specialness constant, a reduced bond supply widens EH deviations. This gives strong credence to the idea that such mispricings arise not because of an immediacy premium, in which case specialness would solely explain EH deviations, instead the availability of collateral stops the arbitrage required for these rates to converge.

Finally, the model reported in Table 5 directly regresses EH errors on the specialness variable itself. Such a specification cannot distinguish between the immediacy premium and arbitrage constraint hypotheses. Instead, I re-run the regression on specialness tertiles; that is, I divide the data into low, medium, and high specialness, and see if the relationship found over the whole sample holds in these sub-segments. The idea is that, an immediacy premium should only hold during periods of high specialness, while the arbitrage constraint hypothesis should see a relationship, even if weakened, even during periods of low specialness: a reduction in arbitrageurs' access to collateral will impede remedial trading, even if the collateral is not that particularly prized.

Table 6 shows results. Columns (1)-(6) split the sample into the aforementioned tertiles, and consider the variables once in basis points and then in percentages. Columns (7) to (8) consider the case where the EH deviation is negative, that is, the forward rate underpredicts the future short rate, suggesting immediacy is a lesser concern. The relationship between specialness and EH deviations remains strong across all segments. It is attenuated in the lowest tertile, where a percentage point increase in specialness raises the EH error by 8 basis points, versus 22-27 bps in the upper two tertiles, but remains significant. As a priced immediacy premium reflects demand pressure that is largely absent when collateral is not scarce, one would expect the relationship to break down in the least-special tertile; instead, the significant slope there is consistent with an access friction that affects all collateral regardless of specialness. Estimates are un-

[27] While specification (5) loses statistical significance, this is in large part due to the variable being defined as a share of securities outstanding, which has its own effect as one observes in the next analysis.

	Expectations hypothesis error ($\xi^n_{i,t}$)							
	Basis points			Percentages (%)			bps	%
Specialness tertile	1^{st}	2^{nd}	3^{rd}	1^{st}	2^{nd}	3^{rd}	$\xi^n_{i,t} < 0$	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Specialness ($\gamma^{b,m}_{i,t}$)	0.08^{**}	0.27^{***}	0.22^{***}	0.07^{**}	0.19^{***}	0.14^{***}	0.22^{***}	0.21^{***}
	(0.04)	(0.05)	(0.04)	(0.03)	(0.04)	(0.03)	(0.02)	(0.03)
ISIN-Tenor FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Trade Date FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,229	5,421	5,229	5,228	5,386	5,224	3,261	3,261
Adj. R^2	0.50	0.24	0.29	0.51	0.33	0.25	0.57	0.54

Table 6: The table reports regressions of the absolute EH error ($\xi^n_{i,t}$) on repo specialness ($\gamma^{b,m}_{i,t}$) for various segments of the data. EH errors are constructed from spot-next and tom-next maturities, while specialness is measured using the overnight repo rate. Variables are in basis points, except for columns (4)-(6) and (8) where they are expressed in percentage terms as defined in eq. (16). The GCP rate is used for the construction of the specialness premium. Columns (1)-(6) are each based on a given tertile of the specialness variable (in percentages); the first (third) tertile contains ISIN-tenor observations with the lowest (highest) specialness premium. Columns (7) and (8) consider a subsample of the data were the EH deviation is negative, i.e. where the forward rate is lower than the future short realization. All specifications include ISIN-tenor and trade-date fixed effects. Standard errors are clustered by ISIN-tenor.

changed from the base specification in Table 5 when one considers instances where the forward rate is below the short rate in columns (7) to (8). While immediacy depresses the overnight rate and thus results in positive EH deviations, specialness continues to explain deviations in the negative-error subsample, where such a premium is not in effect. Overall, these results give further credence to the notion that collateral scarcity in and of itself which causes yield curve mispricings, not a priced-in premium for immediacy, which we would expect to dissipate for instances when specialness is lower. On the other hand, if arbitrageur access to a security is the constraining factor, we expect an increase in collateral scarcity to affect the yield curve in all instances.

7 Effects on the real economy

How much do distortions to the (special) repo rate distort the transmission of monetary policy and impact real economic parameters? In the previous section, we have considered the impact of agents' usage of repo for secondary purposes on the term structure of interest rates, considering how rates of various maturities evolve relative to one another. This dynamic, however, also affects repo markets in *aggregate*. That is, agents' order flow pressure also shifts the term structure as a whole though an expectations hypothesis channel; the results of 3 imply that repo rates are highly interconnected. Thus, while we have identified how preferred habitat effects disparately impact repo tenors, demand shocks to e.g. the tom-next rate assuredly transmits to neighboring spot-next and overnight maturities, and thus pushes the overall repo rate away from that ostensibly desired by the central bank in its implementation of monetary policy. As the "special" segment represents up to 70% of daily repo turnover, and secured borrowing is the dominant funding source in the post-2008 interbank environment (De Fiore et al., 2026), distortions to such rates alter banks' effective cost of borrowing, and thus impacts 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.[28]

I study 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). To test 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 various bank lending rates per country c, α are country fixed effects, r^{ECB} is the ECB policy rate[29], $r^{\mathsf{SC}} - r^{\mathsf{ECB}}$ represents special repo rate deviations away from the policy rate, and $\mathbf{X}$ is a vector of controls. For $r^{d}_{c,t}$, I source data from the ECB on country-specific deposit, adjustable mortgage, and corporate borrowing rates at monthly frequency. For deposits, I consider deposit liabilities vis-a-

[28] 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.

[29] 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.

vis euro area households reported by monetary financial institutions (excluding central banks). For mortgages, I consider the rate on newly-issued adjustable mortgages with an interest rate fixation period of up to one year. Finally, for corporate lending, I consider rate on newly-issued variable-rate loans to corporations with principal over 1 million EUR and an interest rate fixation period of up to one year.[30] I estimate the model in both levels and differences. I also add lagged values in addition to the contemporaneous rate, as real economy rates are slow-moving. I include $K = 4$ lags as this has the highest explanatory power; the results are robust to considering different amounts of cumulative lags (e.g. 6 or 12 months).

The above specification could be impacted by endogeneity in the form of confounding factors which jointly affect lending rates and repo convenience yields. I will consider such concerns in the ensuing discussion of results. As a first step to mitigate such issues, I include a battery of control variables. In particular, I control for the country-specific inflation rate and the level of bank deposit liabilities to control for deposit demand. The LIBOR-OIS spread is included to control for tensions in financial markets. Most importantly, one needs to consider the impact of quantitative easing, which increases repo specialness but impacts the real cost of credit through so-called unconventional means. I thus include the cumulative (contemporaneous) amount of bonds purchased under the PSPP program in level (differenced) specifications.

The results of Table 7 show an economically and statistically significant transmission from the policy to lending rates. Consider the contemporaneous specifications of Panel A. Transmission is strongest for corporate lending, where 78-95% of a basis point increase is transmitted, and weakest for deposits (15-17% pass-through), with mortgage rates falling between these values. Crucially, special deviations from policy achieve statistical significance in 4 out of 6 specifications, with slightly less economic significance (up to 57% in corporate lending). However, the influence of specialness

[30] Deposit rates are expected to react directly to short-term money market rates. Mortgages and corporate lending terms should be driven by the long-term component of the term structure, which is in turn guided by the central bank through short-term rates. One could indeed use such long-term lending rates in the below analysis (by considering newly-issued stock) as a reduced-form exercise, and indeed the results are robust to such a specification. However, I use adjustable mortgage and variable corporate lending rates to allow these to adjust directly to short-term movements.

	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}	0.17***		0.15***		0.55***		0.63***		0.78***		0.95***	
	(0.01)		(0.01)		(0.05)		(0.07)		(0.03)		(0.04)	
$r_t^{\mathsf{SC}} - r_t^{\mathsf{ECB}}$	0.13**		0.03		0.35*		0.12		0.57***		0.38**	
	(0.05)		(0.02)		(0.20)		(0.11)		(0.13)		(0.14)	
$\mathsf{Inflation}_t$	−0.02		0.001		0.06		−0.01		0.04		0.01	
	(0.01)		(0.002)		(0.04)		(0.01)		(0.03)		(0.01)	
$\mathsf{Deposit\ Liabilities}_t$	−0.29*		−0.08		−0.54		0.77**		0.88***		0.62*	
	(0.15)		(0.11)		(0.45)		(0.27)		(0.27)		(0.34)	
$\mathsf{LIBOR\text{-}OIS}_t$	0.26***		0.08**		0.93***		0.31***		0.42***		0.40***	
	(0.03)		(0.03)		(0.11)		(0.09)		(0.07)		(0.09)	
$\mathsf{PSPP}_t^{\mathsf{cum}}$	−0.001***				−0.002***				−0.002***			
	(0.0002)				(0.001)				(0.0003)			
PSPP_t			−0.0001				−0.001				−0.001	
			(0.0003)				(0.001)				(0.001)	
Panel B: Lagged effects												
$\sum_{k=0}^{K=4} r_{t-k}^{\mathsf{ECB}}$		0.18***		0.19***		0.55***		0.64***		0.78***		0.98***
		(0.01)		(0.01)		(0.04)		(0.05)		(0.03)		(0.04)
$\sum_{k=0}^{K=4} \left(r_{t-k}^{\mathsf{SC}} - r_{t-k}^{\mathsf{ECB}}\right)$		0.11*		0.06*		0.46**		0.54***		0.64***		0.84***
		(0.06)		(0.03)		(0.16)		(0.09)		(0.15)		(0.10)
$\sum_{k=0}^{K=4} \mathsf{Inflation}_{t-k}$		−0.01		0.002		0.09*		0.03		0.06*		−0.01
		(0.01)		(0.003)		(0.04)		(0.02)		(0.03)		(0.02)
$\sum_{k=0}^{K=4} \mathsf{Deposit\ Liabilities}_{t-k}$		−0.30**		0.04		−0.60		1.31		0.85***		−0.30
		(0.14)		(0.19)		(0.42)		(0.89)		(0.28)		(0.65)
$\sum_{k=0}^{K=4} \mathsf{LIBOR\text{-}OIS}_{t-k}$		0.23***		0.07***		1.03***		0.54***		0.45***		0.48***
		(0.07)		(0.02)		(0.20)		(0.11)		(0.15)		(0.10)
$\mathsf{PSPP}_t^{\mathsf{cum}}$		−0.001***				−0.001**				−0.002***		
		(0.0002)				(0.0005)				(0.0003)		
$\sum_{k=0}^{K=4} \mathsf{PSPP}_{t-k}$				−0.0001				−0.0003				−0.001
				(0.0003)				(0.001)				(0.001)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	786	770	781	765	786	770	781	765	795	775	790	770
Adj. R^2	0.85	0.86	0.37	0.46	0.92	0.93	0.39	0.49	0.94	0.95	0.47	0.50

Table 7: Regression of deposit, adjustable mortgage, and variable 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 $\mathsf{Deposit\ Liabilities}_t$, LIBOR-OIS, and PSPP flows and stock. Panel A considers only contemporaneous effects, while Panel B also includes $K = 4$ lags and calculates the cumulative effect and corresponding joint significance level. Standard errors are Driscoll and Kraay (1998). Data is monthly for Germany, Italy, Spain, the Netherlands, and Belgium and span January 31st, 2006 to June 30th, 2020.

grows once we also consider the cumulative impact of the previous 4 months' lagged values in Panel B. Significance is achieved across all specifications and ranges up to 84%. The special rate's impact is not far off the policy rate; its coefficient is on average 71% of that of the policy. Corporate lending and adjustable mortgage rates respond most quickly; deposits are again more sluggish in their response.

The above analysis merits discussion. First, above exercise is not intended to provide a causal identification of the pass-through from special deviations to the real cost of credit. There may be confounders which similarly affect both specialness yields and the cost of credit. To mitigate such concerns, I have ran a panel regression with country fixed effects and controlled at a country level for probable confounders, not least of which quantitative easing purchases. A fully exogenous analysis would require one to study a shock which solely impacted specialness rates but left other variables - credit rates, other facets of monetary policy - unaffected.

Nevertheless, there are convincing reasons for us to believe in the transmission of special rates to bank lending. Most fundamentally, this is how monetary policy is expected to work, as stated by the ECB itself: "The change in the official interest rates affects directly money-market interest rates and, indirectly, lending and deposit rates, which are set by banks to their customers."[31] Given that secured borrowing displaced unsecured means post-2008, and given that the special segment dominates such repo trading, the special repo rate is now effectively the money market rate considered above. This concern has been brought up by both academics and policymakers.[32] The importance of special repo rates for monetary policy is not novel. The contribution of this paper is instead to highlight that these precise rates are being distorted by banks' usage of repo for secondary purposes, namely, inventory management and speculation. That this activity can then be reflected in real economic rates such as deposits and mortgages is notable unintended consequence of the switch to secured funding.

[31] See `https://www.ecb.europa.eu/mopo/intro/transmission/html/index.en.html`.

[32] See, among others, Arrata et al. (2020), Ballensiefen et al. (2023), Nguyen et al. (2023), and Eisenschmidt et al. (2024). The first of these sources quotes then-ECB executive board member Benoît Coeuré: "there is a risk that, under the current framework, some short-term market rates would not respond fully to changes in our key interest rates or, even if they would, that a continued dispersion of short-term rates would adversely impact the transmission of our monetary policy stance."

Returning to the issue of exogeneity, one could study bank-level lending rates, and link them to individual banks' specific fixed income portfolios: institutions with bonds trading on special in their balance sheets should be able to offer preferable lending terms to customers. This is studied and confirmed in Tischer (2022), who studies data from the German security register to show that banks with lower funding costs driven by their ex ante security holdings expanded their credit supply. Crucially, this holds true only for those banks which are active in the repo market. These results corroborate the broader aggregate relationship between specialness deviations from policy and banking lending rates documented in Table 7.

Finally, the greatest challenge to the above analysis is the role of unconventional monetary policy. Quantitative easing decreases both the cost of credit and special repo rates. However, I am only interested in the direct effect of special repo on real economic conditions. I have already mitigated against this by including PSPP purchases into the specifications. A more definitive robustness check is to segment the data to the pre-quantitative easing period. In Table O1, I restrict the sample to 2006 through mid-2014, thereby excluding the period following the introduction of negative interest rates and the PSPP program; this further entails that both PSPP variables drop from the specifications. This set-up guarantees that quantitative easing cannot be a driver of the relationship. The economic importance of specialness remains largely unchanged and statistical significance is achieved on 5 of the 6 lagged specifications.

8 Policy implications and external validity

8.1 Implications for policymakers

From a policy perspective, the major takeaway is that banks' effective cost of funding is being distorted by agents' usage of secured funding markets for secondary purposes, with the result that real economic parameters such as deposit rates are being in part decided by dealer-banks' inventory management / speculation activities. It would be beneficial for the pass-through of monetary policy that such pricing effects are minimized. The general deviation of special rates from policy has long been noticed and commented, and yet they persist. These deviations may have been welcome during periods of loose monetary policy, as they helped drive interest rates below the zero lower bound. However, it is generally unsound for such a sensitive parameter to be dictated by dealers' fixed income strategies.

While the ECB officially targets "short-term money market rates," the benchmark rate is €STR (formerly EONIA), which is unsecured. This is sensible given that it allows for a clean and unified measurement of money market rates, which would otherwise be infeasible given the heterogeneity in special repo rates. It however ignores the fact that banks' funding comes from secured markets, with the distortions they entail.

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; bonds are still only re-released at non-market rates. While remedying this would likely improve liquidity and reduce the impact of distorting demand pressures, it does not fully resolve the core issue of banks' reliance on repo to deliver settlement obligations. This further causes roll-over risk: disturbances in repo are likely to spill over into the cash market in times of distress. A deeper understanding of the quantities and risk involved through active monitoring would inform whether and what policy response is required. 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.

Interestingly, while regulation prohibits the practice of naked short-selling, market-makers are exempt, and this study demonstrates that heavy usage is made of this exemption. Furthermore, while naked short-selling is banned for non-dealers, the inverse operation, leveraging, is permitted. Note that these activities provide agents room to manoeuvre; for instance, dealers rely on repo to avoid holding their bond inventory fully on-balance sheet. However, this tendency is in and of itself an unintended consequence of banking regulation; holding fixed income securities is suboptimal given balance sheet space and capital requirements.

Curbing this practice would likely not be without consequences. If sourcing securities in repo allows banks to avoid the regulatory burden of holding inventory, ceasing this dynamic would likely see them charge a premium in the cash market, thus negatively impacting bond liquidity and price efficiency. It may further see bond intermediation to shift into the hands of non-bank financial institutions, who are not likewise regulated.

Banks who use repo to substitute for holding a bond inventory may find themselves needing to adapt even in the absence of any regulatory action. There is a global shift towards shorter settlement cycles, and the U.S. Securities Exchange Commission has already garnered comments on an eventual shift to T+0 settlement.[33] More importantly, the advent of distributed ledger technologies (DLT) has led institutions to consider the tokenization of financial assets, which would pave the way for *atomistic* settlement.[34] Were such initiatives to result in instantaneous settlement processes, banks would be obliged to keep bond inventories on hand, as there would be no time to find the sold security in repo markets.[35] This would fundamentally change banks' dealership model and impact market liquidity.

8.2 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.

[33] It concluded that while shortening the settlement cycle beyond T+1 would prove more beneficial than the shift to T+1, the impediments are also far greater and thus such a shift will require more time. SEC (2023) lists such impediments as regarding "multi-lateral netting, institutional trade processing, securities lending practices, money settlement systems, mutual fund and ETF processing, transaction funding requirements, and corporate action processing."

[34] Project Agorá is a BIS-proposed initiative focused on the tokenization of wholesale cross-border payments. Elsewhere, the SEC has allowed the Depository Trust and Clearing Corporation (DTCC) to move U.S. Treasury securities and collateral management onto blockchain.

[35] Du (2026) argues that instantaneous settlement is unlikely to be adopted, as agents prefer to wait a certain period to instead allow for simultaneous settlement, i.e. settling the net of a period's flows as opposed to each of its gross transactions. Nevertheless, as the settlement cycle shortens, banks may find it increasingly challenging to reliably borrow securities in time at reasonable rates.

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. 5.4. 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.

9 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.

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%.

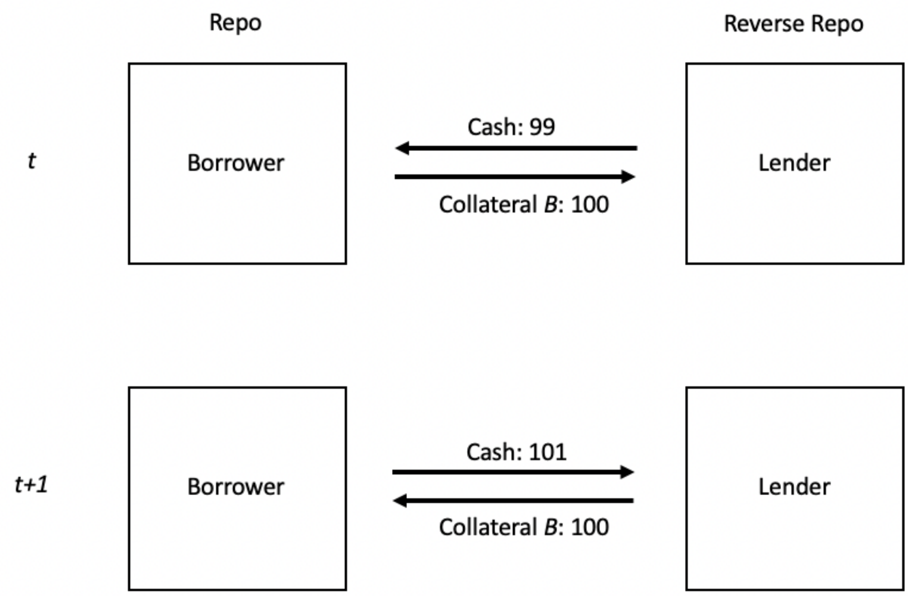


Fig. A1: Example of a repo transaction

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.

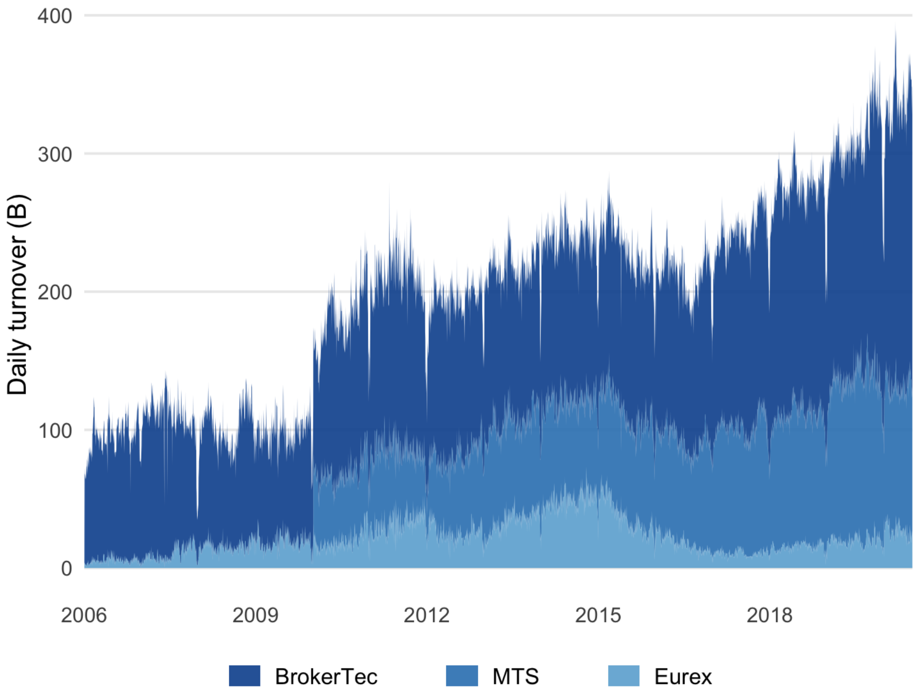
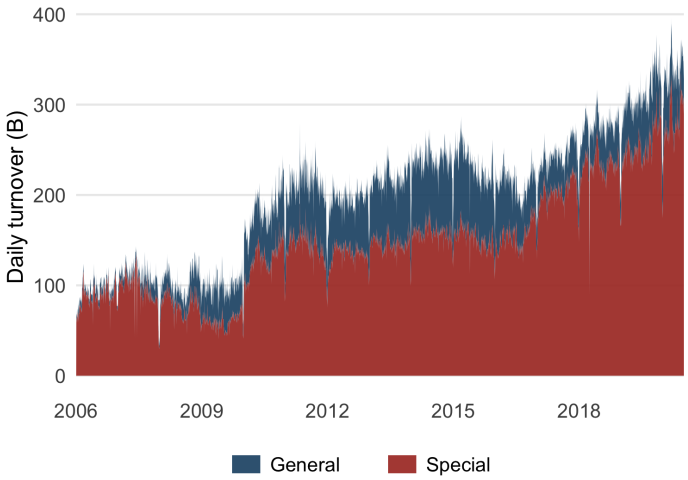


Fig. B1: Daily turnover per repo platform

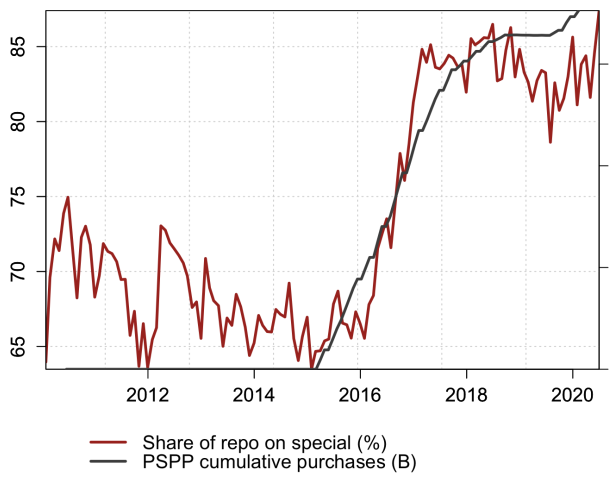
Note that the T+2 settlement reform's impact was not limited to a specific platform; the shift in turnover we observe in Fig. (2) repeats for both BrokerTec and MTS. As the T+2 shock mostly affected specials, it does not appear however in Eurex, which makes sense given only unaffected GCP/GCX repos are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

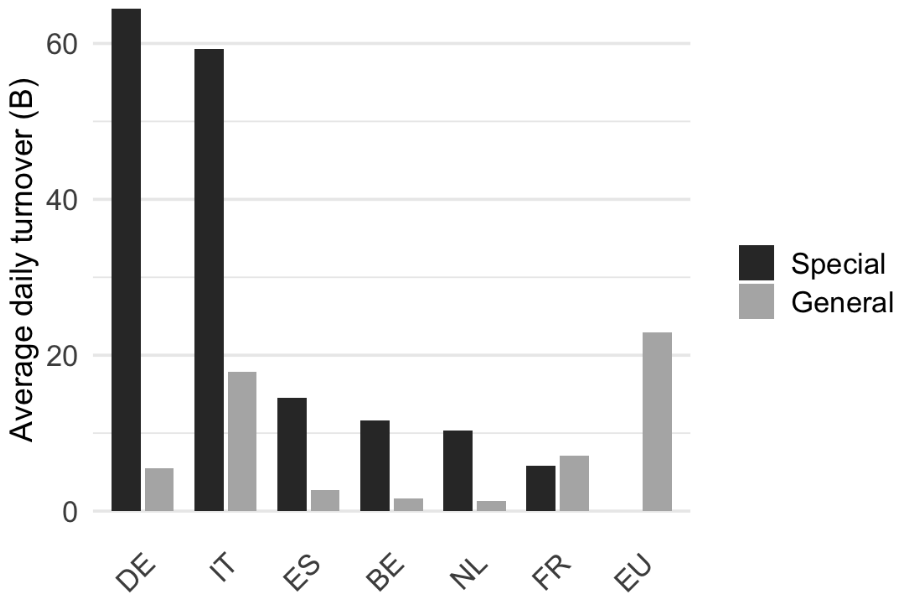


Fig. D1: Average daily turnover per country, 2010-2020.

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

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

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

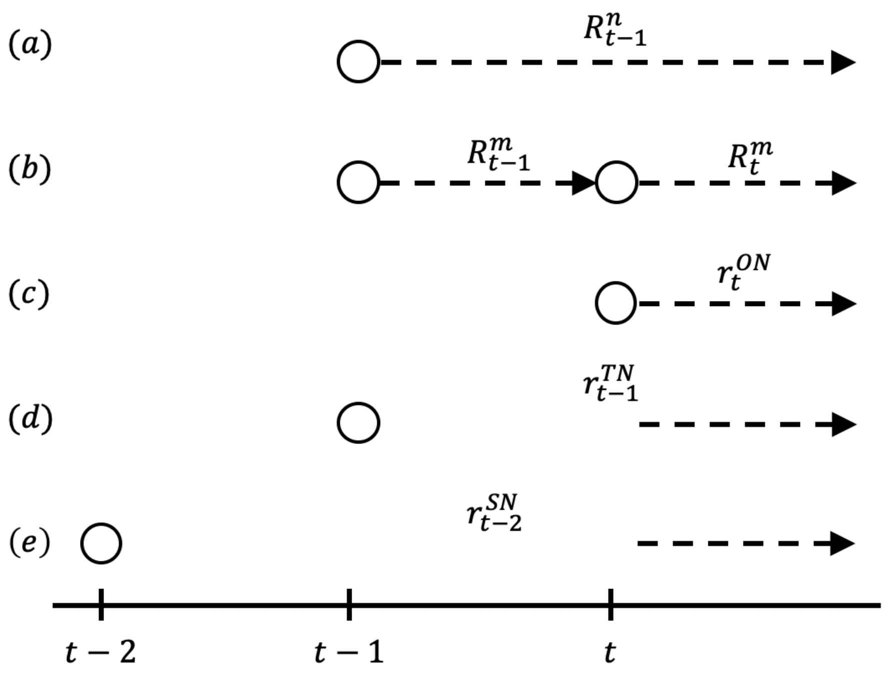


Fig. F1: Visualization of various maturity types

		Pooling		GC							SC						
		GCX	GCP	All	BE	DE	ES	FR	IT	NL	All	BE	DE	ES	FR	IT	NL
α	TN/ON	-0.011	-0.010	-0.007	-0.010	-0.006	-0.007	-0.007	0.018	-0.007	-0.061	-0.036	-0.074	-0.076	-0.050	0.002	-0.048
α	SN/ON	-0.011	-0.012	-0.013	-0.011	-0.010	-0.010	-0.017	0.005	-0.001	-0.098	-0.043	-0.099	-0.120	-0.059	0.001	-0.109
α	SN/TN	-0.002	-0.003	-0.002	-0.010	-0.008	-0.001	-0.011	0.000	-0.008	-0.010	-0.004	-0.018	-0.010	-0.010	-0.006	-0.010
β	TN/ON	0.99	0.98	0.91	0.90	0.91	0.78	0.96	0.95	0.94	0.63	0.56	0.75	0.57	0.67	0.62	0.57
β	SN/ON	1.00	0.99	0.87	0.71	0.93	0.86	0.86	0.36	0.54	0.82	0.55	0.80	0.69	0.74	0.03	0.98
β	SN/TN	0.97	0.97	0.92	0.94	0.91	0.99	0.80	0.93	1.04	0.69	0.59	0.78	0.58	0.61	0.71	0.56
R²	TN/ON	0.79	0.71	0.60	0.59	0.64	0.53	0.64	0.51	0.47	0.33	0.30	0.42	0.28	0.29	0.20	0.31
R²	SN/ON	0.62	0.62	0.44	0.35	0.49	0.54	0.39	0.10	0.08	0.53	0.24	0.40	0.32	0.32	0.01	0.94
R²	SN/TN	0.70	0.69	0.67	0.59	0.63	0.69	0.52	0.68	0.86	0.32	0.32	0.38	0.26	0.26	0.33	0.29

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.

I validate the hypothesis formed in section 4.1 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.[36] I consider:

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

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

[36] 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%[37] 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.

[37] 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.

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).

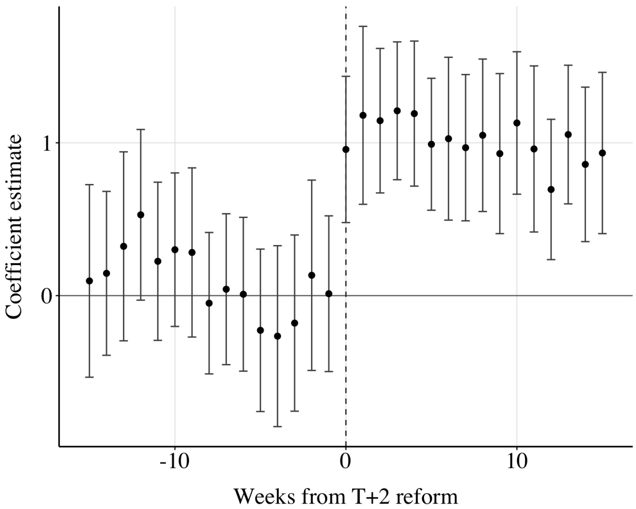


Fig. I1: Dynamic parallel trends verification for trading volumes

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

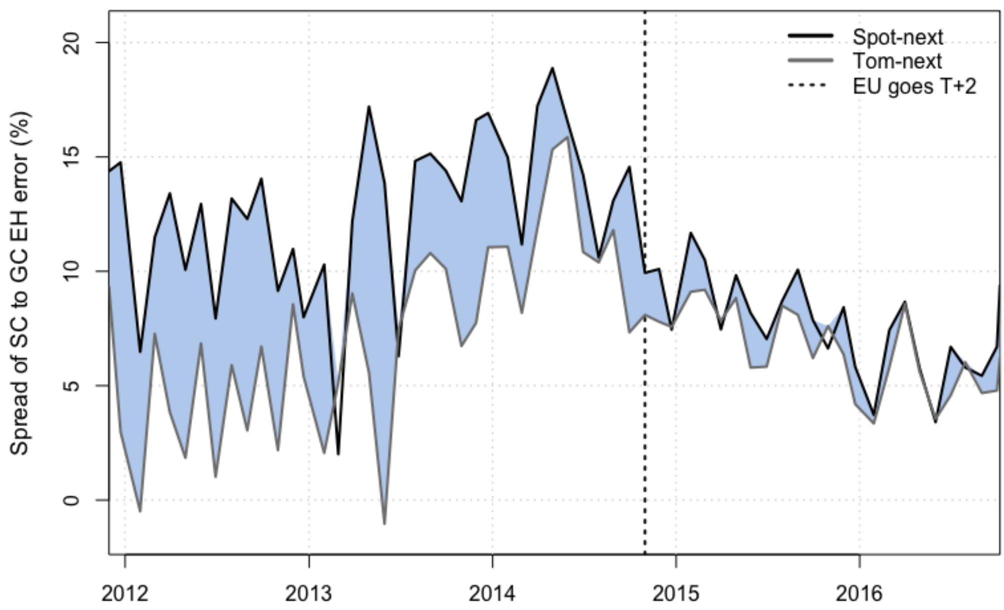


Fig. I2: Spread of percentage EH error between SC and GC segments, for spot-next and tom-next maturities

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.

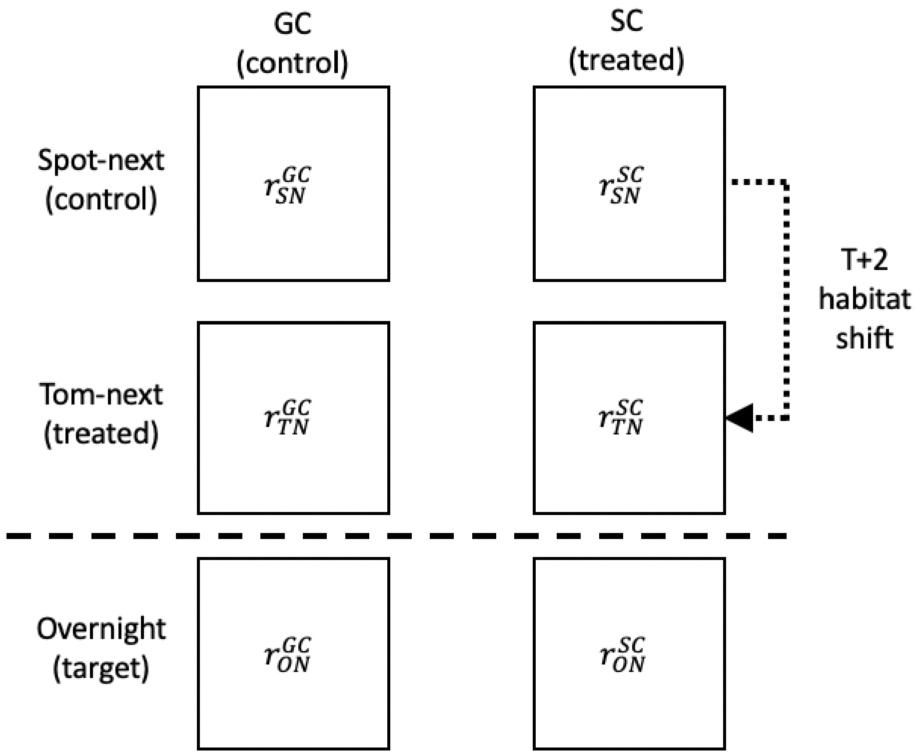


Fig. J1: Empirical model schema

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:

$$\widehat{\xi}_t^{\,b,n} := \frac{\xi_t^{\,b,n}}{\overline{\xi}_t^{\,b,n}} \tag{22}$$

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.

$$\widetilde{\xi}_t^{\,b,n} := \operatorname{arcsinh}\ \widehat{\xi}_t^{\,b,n} = \log\left(\widehat{\xi}_t^{\,b,n} + \sqrt{1 + (\widehat{\xi}_t^{\,b,n})^2}\right) \tag{23}$$

For large enough x, we have $\operatorname{arcsinh}(x) \approx \log(2x)$ 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:

$$\xi_t^{b,n,\%} := \frac{r_t^{b,n} - r_{t+n-m}^{b,m}}{1 + |r_{t+n-m}^{b,m}|} \cdot 100 \tag{24}$$

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):

$$\xi_t^{b,n,\%} := \frac{r_t^{b,n} - r_{t+n-m}^{b,m}}{(|r_t^{b,n}| + |r_{t+n-m}^{b,m}|)/2} \cdot 100 \tag{25}$$

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), $T2$ 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: $\xi_t^{b,n,\%}$, 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.

	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 M1: 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*. For all specifications, I drop all observations on the last week of the calendar year. The within-model R^2 is reported.

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

Table N1: Odd-numbered specifications run the model in eq. (12); evens that of eq. (13). TN denotes whether the repo is tomorrow-next (as opposed to SN or ON), $T2$ equals 1 if the repo occurred after the shift to T+2 settlement. b refers to *Collateral*, ω to $\{$*Segment* x *Country* x *Collateral* x *Tenor*$\}$, and τ to *Trade Date*. For all specifications, all observations on the last week of the calendar year are dropped. I further remove all ω combinations which did not trade both before and after the T+2 switch. The within-model R^2 is reported.

	Deposit rates				Adjustable 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}	0.19***		0.15***		0.60***		0.62***		0.82***		0.97***	
	(0.01)		(0.01)		(0.03)		(0.07)		(0.03)		(0.04)	
$r_t^{\mathsf{SC}} - r_t^{\mathsf{ECB}}$	0.09		0.03		−0.05		0.13		0.46**		0.47***	
	(0.07)		(0.02)		(0.19)		(0.12)		(0.16)		(0.14)	
$\mathsf{Inflation}_t$	−0.02		0.002		0.04		−0.003		0.02		0.02*	
	(0.01)		(0.004)		(0.02)		(0.01)		(0.03)		(0.01)	
$\mathsf{Deposit\ Liabilities}_t$	−0.09		−0.08		0.79**		0.69**		1.68***		0.59*	
	(0.15)		(0.12)		(0.30)		(0.30)		(0.27)		(0.32)	
$\mathsf{LIBOR\text{-}OIS}_t$	0.25***		0.08**		0.64***		0.33**		0.30***		0.43***	
	(0.04)		(0.03)		(0.10)		(0.11)		(0.05)		(0.08)	
Panel B: Lagged effects												
$\sum_{k=0}^{K=4} r_{t-k}^{\mathsf{ECB}}$		0.20***		0.19***		0.62***		0.64***		0.83***		0.98***
		(0.01)		(0.01)		(0.03)		(0.05)		(0.03)		(0.04)
$\sum_{k=0}^{K=4} \left(r_{t-k}^{\mathsf{SC}} - r_{t-k}^{\mathsf{ECB}}\right)$		0.10*		0.06*		0.15		0.58***		0.67***		0.87***
		(0.05)		(0.03)		(0.16)		(0.09)		(0.17)		(0.10)
$\sum_{k=0}^{K=4} \mathsf{Inflation}_{t-k}$		−0.004		0.003		0.10**		0.03		0.05		−0.01
		(0.01)		(0.01)		(0.03)		(0.03)		(0.04)		(0.03)
$\sum_{k=0}^{K=4} \mathsf{Deposit\ Liabilities}_{t-k}$		−0.06		0.10		0.77**		0.74		1.72***		−1.26**
		(0.16)		(0.24)		(0.33)		(0.99)		(0.31)		(0.52)
$\sum_{k=0}^{K=4} \mathsf{LIBOR\text{-}OIS}_{t-k}$		0.17**		0.07***		0.50***		0.55***		0.22*		0.48***
		(0.06)		(0.02)		(0.09)		(0.12)		(0.11)		(0.11)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	481	465	476	460	481	465	476	460	481	465	476	460
Adj. R^2	0.83	0.83	0.40	0.49	0.89	0.91	0.47	0.58	0.94	0.94	0.45	0.49

Table O1: Regression of deposit, adjustable mortgage, and variable 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 for the pre-quantitative easing period. Panel A considers only contemporaneous effects, while Panel B also includes $K = 4$ lags and calculates the cumulative effect and corresponding joint significance level. Standard errors are Driscoll and Kraay (1998). Data is monthly for Germany, Italy, Spain, the Netherlands, and Belgium. Unlike Table 7 the data span January 31st, 2006 to June 30th, 2014; that is, before sub-zero interest rates and unconventional monetary policy.

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