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A Tale of Two Tightenings*

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Both the magnitude and the pace of monetary policy tightening in the euro area during 2022-23 were historically large and fast. Yet, the real economy proved to be resilient. In this paper, we analyze the pass-through of the ECB's changes in the policy rate to mortgage rates in Finland during the post-pandemic period of 2022-23, when the policy liftoff began at the negative interest rate territory, using the normal tightening cycle in 2006-08 as control. We use monthly data and three different empirical methodologies: event studies, high-frequency identification, and exposure-measure regressions. Our evidence suggests that the post-pandemic monetary policy transmission was significantly less effective than during the control period, implying that for the same amount of tightening in financial conditions, a bigger increase in the policy rate is needed. The loss in monetary transmission during the negative interest rate policy is also playing out when monetary policy changes course. Thus, while monetary policy remains effective in the negative interest rate territory, it creates headwind for policy normalization down the road.

JEL codes: E42, E58, E52, G21.
Keywords: Monetary Policy, Mortgage Rates, Monetary Policy Normalization, Finland.

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1 Introduction

Towards the end of the COVID-19 pandemic, the reopening of economies around the world led to a surge in inflation in both the United States and the European Union amid the imbalances between supply and demand. To combat inflation, both the Federal Reserve and the European Central Bank tightened monetary policy rapidly. The degree of monetary tightening and the pace of monetary tightening are unprecedented (see, for example, Kwan and Liu, 2023). While inflation has been receding gradually, the economy proves to be rather resilient with the unemployment rate barely climbing and consumer spending robust. Housing prices also stay high.

At the same time, rising interest rates stress banks' investment portfolio severely, resulting in sizable mark to-market losses in many banks. Silicon Valley Bank in the United States eventually failed after it was unable to withstand the run by depositors. It quickly spilled over to Europe and led to the demise of Credit Sussie in Switzerland. The banking system looked vulnerable in many advanced economies amid sharply higher interest rates that depressed the economic value of long-term assets on banks' book.

Moreover, the COVID-19 pandemic accelerated the trend towards remote work, raising office vacancy rate in many metropolitan areas and depressing commercial real estate prices. In both the US and the euro area, a large fraction of commercial real estate debts was held by banks. Thus, banks were not only squeezed by interest rate risk, but also they faced challenges in managing credit risk stemming from their commercial real estate exposure.

Further complicating the transmission of monetary policy in the post-pandemic world was the low, and in some economies, negative policy rates that were set by various central banks during the pandemic. The literature on negative interest rates suggests that the monetary transmission to bank loan rates could be hindered when the policy rate turned negative. Kwan et al. (2025), thereafter KUV, found that the policy transmission in Finland lost about 40 percent effectiveness during the negative policy rate period. Therefore, it is unclear how the tightening of monetary policy starting from a negative interest rate territory might work.

Without much guidance from either experience or research on policy liftoff from the negative interest rate territory, the transmission of monetary policy in the post-pandemic world is uncertain. Moreover, the heterogeneity of banks' exposure to interest rate risk and credit risk at the onset of the policy liftoff, and hence banks' willingness to extend credit, further makes the transmission more unpredictable. In this paper, we study the transmission of monetary policy to the mortgage rates in Finland during the 2022-23 tightening cycle when the liftoff took place at negative interest rate territory, using the "normal" tightening cycle in 2006-08 as control period.

Focusing on a single loan product, mortgages, for a single euro-zone country, Finland, has a number of empirical advantages. First, we examine the actual transmission most directly from the policy rate to a bank loan rate. This is distinct from the policy transmission literature that focuses on other outcome variables, such as aggregate lending or stock prices. Second, mortgages are more homogeneous to Finnish households than they would be to the whole euro zone, so that the mortgage rates that we study are more directly comparable over time and across banks. Third, all Finnish banks are supervised and regulated by the same authority so that mortgage loan pricing is expected to be more uniform. Fourth, we can exploit the granular data collected by the Finnish banking regulator under uniform reporting requirements. Finally, being a small country among the nineteen economies in the euro zone, Finland's GDP is just about 2 percent of the euro zone's GDP. Thus, the monetary policy of the European Central Bank (ECB) is unlikely to respond directly to Finnish economic developments alone, mitigating concerns about the endogenity of the policy rate.

Our findings suggest that in the post-pandemic tightening cycle, for a given amount of policy tightening, the transmission from the policy rate to Finnish mortgage rates is significantly less than that of the 2006-08 tightening cycle. This is consistent with the prediction by some theoretical papers on negative interest rates such as Ulate (2021a) and Ulate (2021b) which posit that bank loan rates are compressed by the zero lower bound. Together with the findings in KUV, the efficiency loss in monetary transmission in the negative policy rate territory appears to be roughly symmetric in both policy easing and policy tightening. The results imply that to slow aggregate demand by tightening monetary policy, policy makers need to do more when lifting off from the negative interest rate territory than during the normal tightening cycle. Another way to say this is that despite the large increases in policy rate, the tightening of financial conditions when lifting off from a negative territory is significantly less than when lifting off from a positive territory. This can explain the resiliency of the real economy given the unprecedented pace and magnitude of monetary tightening during the post-pandemic tightening cycle.

Results of the cross-sectional heterogeneity in the transmission of monetary policy in the post-pandemic world confirm the headwind of the post-pandemic tightening was consistent with the negative interest rate policy at the time of policy liftoff. In these analysis, we exploit the cross-sectional differences in banks' deposit-to-asset ratio to examine the heterogeneity in transmission. During the negative interest rate policy, bank deposit rate was constrained by the zero lower bound whereas the rates on market-based funding followed the policy rate into the negative territory. KUV found that banks relied more on deposit funding transmitted less of the policy rate changes to mortgage rate when the policy rate was below zero. In our cross-section results, we also found significant drag in transmission of the tightening by banks that had higher deposit-to-asset ratio. These results support the notion that the tightening headwind faced by policy makers during the post-pandemic tightening cycle was due to the negative interest rate policy in effect at the onset of policy tightening.

The rest of the paper is organized as follow: Section 2 briefly describes the Finnish economy and banking system as well as the data used. In Section 3, we examine the extent to which changes in the policy rate were transmitted to newly-originated mortgage rates in Finland during the pre-pandemic tightening in 2006-08 and the post-pandemic tightening in 2022-23 using event studies. To identify the causal effects of monetary policy, Section 4 employs a high-frequency identification strategy to examine policy transmission. To further explore the changes in monetary policy transmission across differentially exposed banks, Section 5 exploits banks' cross-sectional differences in funding sources to test the effect of negative interest rate at liftoff on policy transmission. Finally, Section 6 concludes.

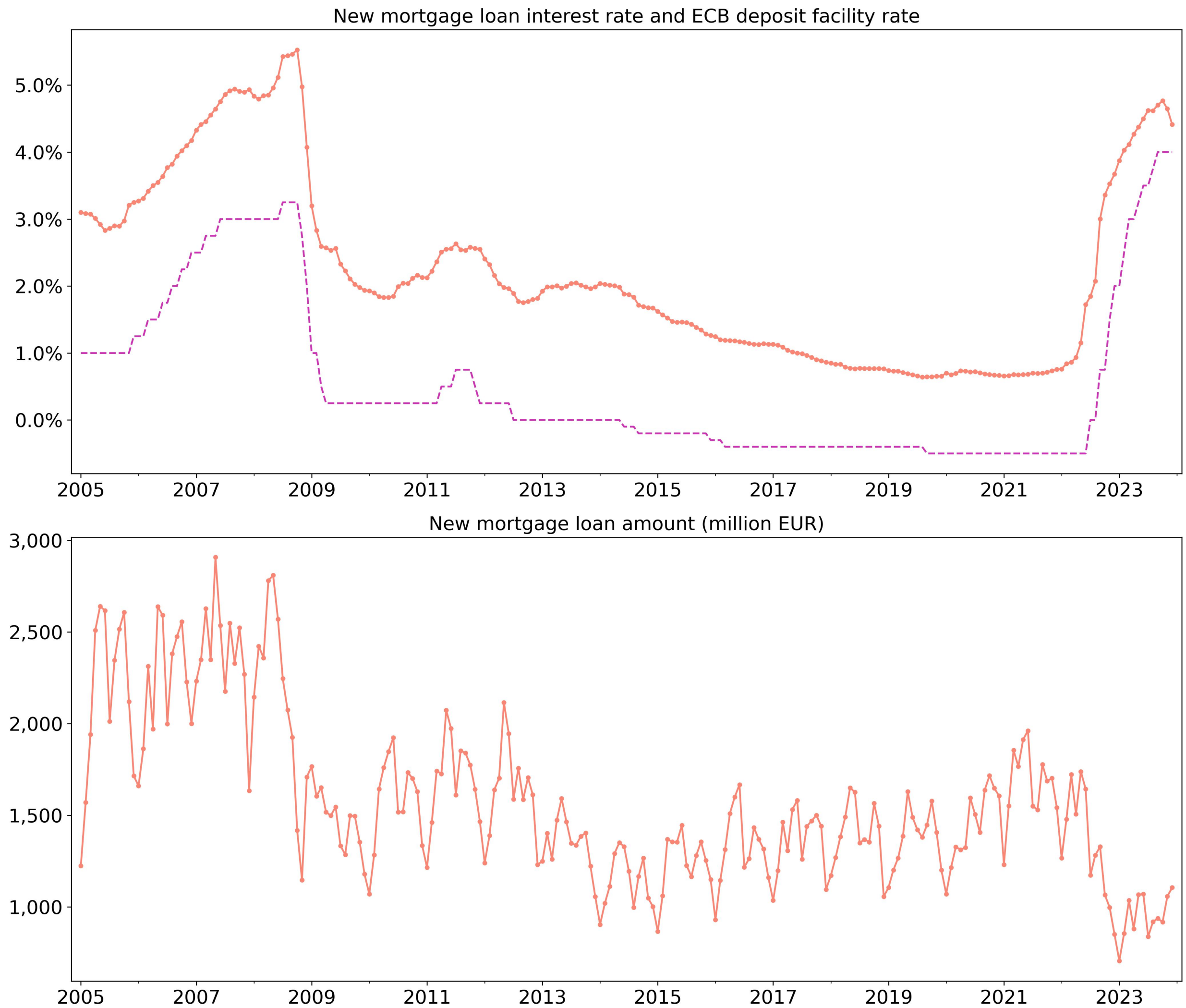
Figure 1: Deposit facility rate and market rates

Notes: Notes: Figure displays ECB's deposit facility rate (DFR) with 6-month Euribor rate as well as 2 and 10 year Finnish government bond yields. Data is at daily frequency between 2005-01-01 and 2023-12-31. Source: Bloomberg and authors' calculations.

2 Background about Finland and Summary Statistics

Finland is a small open economy which has been part of the European Union since 1995 and of the euro area since its establishment in 1999. In 2019, Finnish GDP was 242 billion euros (269 billion USD), which was about 2 percent of the euro area's GDP. The banking sector in Finland is dominated by a handful of large banking organizations. Monetary conditions in Finland are set by the monetary policy of the ECB. The ECB's main policy instrument is the Deposit Facility Rate (DFR), which is the interest rate banks receive for their deposits held at the ECB. In June 2014, the ECB lowered the DFR to negative territory. Figure 1 shows the DFR, along with the 6 month Euribor, as well as the 2- and 10-year Finnish government bond yields. Historically, short-term euro area rates, as well as government bond yields, have followed the DFR somewhat closely. During the Negative Interest Rate Policy (NIRP) period, when the DFR was negative, short-term rates converged with the DFR, whereas the 2-year government yield turned even more negative than the DFR. Before the beginning of the current tightening cycle in 2022, market interest rates started to move up, likely in response to euro area inflation data and ECB's forward guidance. When the ECB tightening was in full swing, both the 6-month rate and the 2-year rate rose in lockstep with the policy rate. At the peak of this tightening cycle, the 10-year rate was well below the policy rate. Note that an inverted yield curve

Figure 2: Interest rates and amounts of new mortgage loans



Notes: The frequency of the data is monthly. 'New mortgage loan' refers to true new mortgage loan contracts. The top panel displays the volume-weighted average mortgage rate over the sample banks (orange solid line) as well as the ECB deposit facility rate (purple dashed line). The bottom panel displays the total amount of new mortgages over the sample banks. Source: Bank of Finland and authors' calculations.

has been a reliable indicator of a recession.

Figure 2 displays new mortgage loan amounts in the bottom panel with the corresponding average interest rate (aggregated over bank groups) in the top panel. The DFR is also included in the top panel of the figure for comparison. We can see that interest rates on new mortgage loans have fallen in tandem with the DFR during policy easing. KUV (2023) documented that Finnish mortgage rates fell during the negative policy rate period, but by an amount less than the change in the policy rate. We can also see that mortgage rates rose with the policy rate during the 2022 to 2023 tightening cycle. The bottom panel shows that the amount of new mortgage loans plummeted following the

2008-09 Great Financial Crisis, and has not yet returned to the pre-crisis level. During the negative interest rate period, new mortgage originations have been trending up, consistent with the stimulative effects of monetary policy. However, mortgage originations fell precipitously during 2022 to 2023 as mortgage rates rose sharply amid rapid policy tightening.

For our analysis, we employ a monthly panel dataset with information on the balance sheets of Finnish credit institutions from 2022 to 2023 (post-pandemic tightening cycle), and from 2006 to 2008 (control tightening cycle) at the bank group level. The dataset contains amounts and interest rates on new mortgage loans to Finnish residents originated by eight bank groups. Together, the eight bank groups in the sample account for 90 percent of all new mortgage origination in Finland as of January 2022. We also collect data on each sample bank-group's balance sheet ratios to measure their exposure to negative interest rate. Our main data source is the "Balance Sheet Items and Interest Rate Statistics of Finnish Monetary Financial Institutions" dataset compiled by Bank of Finland. We complement this with bank-group level balance-sheet information from S&P's Capital IQ Pro database. "New mortgage loans" refers to euro-denominated newly-issued mortgage loan contracts (in contrast to new draw-downs). Bank-group specific interest rates on new mortgages are the volume-weighted average of contractually agreed total interest rates. Table 1 provides descriptive statistics of key variables for the tightening period from December 2005 to October 2008, the control sample. Table 2 provides descriptive statistics for the post-pandemic tightening period, from July 2022 to December 2023.

Table 1: Descriptive statistics for monthly panel data, control period

	Mean	SD	Obs.	Min.	5p	25p	50p	75p	95p	Max.
MR	449	68	280	-	332	393	467	497	551	-
$\Delta MR_{t-1,t}$	7	13	280	-51	-8	1	6	11	26	88
$\Delta MR_{t-1,t+1}$	12	20	280	-68	-21	3	14	22	39	84
MA	284	316	280	-	8	46	113	358	901	-
DFR	251	67	35	125	125	200	275	300	325	325
$\Delta DFR_{t-1,t}$	6	11	35	0	0	0	0	12	25	25
DAR	47%	22%	8	22%	26%	31%	41%	63%	79%	83%

Notes: This table presents descriptive statistics for the monthly panel data. The sample spans from December 2005 to October 2008. The variables are the new mortgage loans interest rate in levels (MR, in basis points) as well as one-month and two-month changes, the amount of new mortgage loans (MA, in million EUR), the level and the one-month change in the deposit facility rate (DFR, in basis points), as well as bank-group specific deposit-to-asset ratios (DAR). The left panel displays the mean, standard deviation, and the number of observations for each variable. The right panel displays the minimum and maximum values as well as selected percentiles for the variable's distribution. The statistics for mortgage loans are calculated over time and bank groups, whereas the statistics for the DFR are calculated over time. For the deposit-to-asset ratio we first pick the 2013 year-end (December) values and the statistics are then calculated from these values. There are 8 bank groups in the sample. The minimum and maximum values of new mortgage amounts and interest rate levels are omitted for confidentiality. Source: S&P Capital IQ Pro, Bank of Finland, and authors' calculations.

Table 2: Descriptive statistics for monthly panel data, post-pandemic tightening period

	Mean	SD	Obs.	Min.	5p	25p	50p	75p	95p	Max.
MR	386	94	144	-	189	336	420	457	482	-
$\Delta MR_{t-1,t}$	15	24	144	-54	-18	4	12	25	58	110
$\Delta MR_{t-1,t+1}$	30	40	144	-63	-33	11	26	46	121	143
MA	126	160	144	-	10	16	47	159	474	-
DFR	253	141	18	0	0	175	300	362	400	400
$\Delta DFR_{t-1,t}$	25	27	18	0	0	0	25	50	75	75
DAR	47%	22%	8	22%	26%	31%	41%	63%	79%	83%

Notes: This table presents descriptive statistics for the monthly panel data. The sample spans from July 2022 to December 2023. For other details, see Table 1. Source: S&P Capital IQ Pro, Bank of Finland, and authors' calculations.

In terms of the composition of bank loans, the share of mortgages as a percent of total outstanding bank loans in Finland at the end of 2022 was roughly 42% (about 103 billion euros), which is in line with the average in the Euro Area. Finnish banks typically hold mortgage loans on their balance sheets (that is, little securitization takes place). Furthermore, banks may acquire market-based funding by issuing bonds collateralized by pools of mortgage loans, or so-called covered bonds. Covered bonds, which have high credit ratings, have been a source of relatively inexpensive funding for Finnish banks. Yet, deposits from the public are still the single-most important funding source (Putkuri, 2020). The fact that Finnish banks mostly keep mortgages on their balance sheets makes our setting different from that in the United States, where many banks use the "originate-to-distribute" model so they do not keep mortgages on their balance sheet. Moreover, banks in other European countries, particularly the Nordic countries (including Sweden) have business models that are much closer to the Finnish one than to the U.S. one.

In terms of the rate-fixing structure of mortgages in Finland, the vast majority of Finnish mortgages have a semi-variable rate with a fixing period of one year or less. It is worth noting that the share of mortgages with a rate-fixing term of one year or less is greater in Finland (which has a sample average of 97% between 2010 and 2020) than in other countries where the pass-through to mortgage rates has been studied (73% in Sweden and 53% in Italy).

3 Mortgage-Rate Betas

In this section, we investigate the extent to which changes in the policy rate pass onto the rates on newly originated mortgages. We will denote this pass-through of the policy rate to the mortgage rate as the "mortgage-rate beta". This concept is similar to the deposit-rate beta in Drechsler et al. (2017) and Drechsler et al. (2021), but for a product on the asset side of the bank balance sheet (mortgages) instead of one on the liability side. To assess the mortgage-rate beta, including the possibility of lags in transmission and differences between normal and negative territory, we specify the following panel regression with bank fixed effects:

$$\Delta y_{b,t} = \alpha_b + \sum_{k=0}^{K} \beta_k \Delta i_{t-k} + Post_t \cdot \sum_{k=0}^{K} \mu_k \Delta i_{t-k} + \varepsilon_{b,t}. \tag{1}$$

In equation (1), b is a given bank, t is the time period, Δ is the difference operator, $y_{b,t}$ is the interest rate on new mortgages charged by bank b at time t, α_b is a bank fixed effect, i_t is the policy rate (DFR) in period t, $Post_t$ is a dummy variable equal to one if t is from the post-pandemic monetary tightening period of July 2022 to December 2023 (the control sample is from December 2005 to October 2008), $\varepsilon_{b,t}$ is an error term for bank b at time t, and K indicates the maximum number of lags in transmission being considered in the regression.

The second term in equation (1) measures how much of the change in the policy rate was transmitted to the mortgage rate on average across bank groups, both contemporaneously and with lags, during the two monetary tightening cycle of 2006-08 and 2022-23. If banks changed their mortgage rates by exactly the same amount as the change in the policy rate instantly and permanently, the contemporaneous coefficient, β_0, would be equal to one and all lagged coefficients would be equal to zero. When some of the transmission takes place with a lag, the coefficient β_0 is less than one, and the lagged coefficient β_k measures how much of the mortgage rate change in month t is a result of the change in the policy rate in month $t-k$. The sum $\sum_{k=0}^{K} \beta_k$ measures the total transmission of the policy rate to the mortgage rate over $K+1$ months (the cumulative mortgage-rate beta during monetary tightening).

The third term in equation (1) measures the additional transmission of the policy rate to mortgage rates during the post-pandemic tightening cycle, on average across bank groups. If there was no change in the transmission of the policy rate to the mortgage rate during the post-pandemic tightening cycle, all the μ coefficients would be zero. The sum of the μ coefficients ($\sum_{k=0}^{K} \mu_k$) measures the total change in transmission during the post-pandemic tightening cycle, and the sum of all the β and μ coefficients ($\sum_{k=0}^{K} \beta_k + \sum_{k=0}^{K} \mu_k$) measures the total transmission during the post-pandemic tightening cycle (the cumulative mortgage-rate beta in the post-pandemic tightening cycle).

The estimates from the regression in equation (1) with K = 3 are shown in Table 3. The top panel provides estimates of the β coefficients measuring the transmission of the policy rate to mortgage rates during the two tightening cycles. These estimates provide evidence that the change in the policy rate by the ECB was transmitted to Finnish banks' mortgage rates, both contemporaneously and with lags. At 38 percent, the contemporaneous transmission of the policy rate to the mortgage rate is significantly positive but economically incomplete. A relatively large amount of the transmission, estimated at 25 percent, took place at lag 1, which also is statistically significant. The last column of the top panel in Table 3 shows the sum of β's, which measures the total transmission of the policy rate to the mortgage rate over four months, estimated to be 83 percent. The result suggests a large fraction of the change in the ECB's policy rate was eventually transmitted to Finnish banks' mortgage rates when the ECB tightened monetary policy.

The middle panel of Table 3 displays the additional transmission during the post-

Table 3: Results from correlation analysis

β_0	β_1	β_2	β_3	$\sum_{k=0}^{3} \beta_k$
0.384***	0.252***	0.069	0.124	0.829***
(0.083)	(0.071)	(0.054)	(0.067)	(0.065)
μ_0	μ_1	μ_2	μ_3	$\sum_{k=0}^{3} \mu_k$
0.056	0.079	0.067	−0.390***	−0.187***
(0.113)	(0.078)	(0.068)	(0.049)	(0.049)
$\beta_0 + \mu_0$	$\beta_1 + \mu_1$	$\beta_2 + \mu_2$	$\beta_3 + \mu_3$	$\sum_{k=0}^{3} \beta_k + \mu_k$
0.440***	0.331***	0.136**	−0.266***	0.641***
(0.040)	(0.036)	(0.045)	(0.032)	(0.032)
Number of observations			424	
Adjusted R^2			0.28	

Notes: This table presents selected coefficients and standard errors (in brackets) estimated from the regression in equation 1 with K = 3 and the dependent variable being the one-month difference in the rate on new mortgage loans in percentage points. The change in the policy rate is also measured in percentage points. The pre-sample period is December 2005 to October 2008 and the post-sample period is July 2022 to December 2023. Standard errors are clustered at the bank-group level. Asterisks denote statistical significance: *=10%, **=5%, ***=1%.

pandemic tightening cycle from January 2022 to December 2023. During this period, the policy transmission is found to be significantly smaller at lag 3, as evidenced by the significantly negative μ_3 coefficient. The last column in the middle panel displays the sum of the μ's, which is significantly negative at -19 percent. This suggests that the effectiveness of monetary policy decreased significantly during the post-pandemic tightening when the policy rate was lifted from the negative territory.

The bottom panel of Table 3 shows that in the post-pandemic period, the total transmission of the policy rate to the mortgage rate over four months was 64 percent, which remained statistically significant but was smaller than the control period. The findings indicate that the total pass-through from the policy rate to the mortgage rate was reduced by 33 percent during the post-pandemic tightening when the policy rate was negative at the time of the liftoff. This evidence suggests that monetary policy had to work much harder through the interest rate channel to lift the mortgage rate up after the pandemic than during the normal tightening cycle when the policy rate was above zero at the tome of liftoff.

4 High Frequency Identification

To identify the causal effects of monetary policy more precisely, in this section, we employ a high frequency identification strategy to examine the transmission of policy rate to mortgage rates during the two tightening cycles. Using high-frequency data allows the econometrician to identify monetary surprises from short event-windows surrounding monetary policy announcements. The idea is to take the difference between several measures of yields before the monetary policy announcement and those same measures after the announcement has occurred. If the window around the monetary policy announcement is short enough, the change in asset prices is likely driven solely by the new information embedded in the announcement. This method arguably provides a "clean" measure of unexpected monetary policy shocks, to the extent that the expected component of the monetary policy announcement has already been incorporated into the pre-announcement asset prices in an efficient market.

To operationalize this identification scheme in our particular context, we need data on asset prices around monetary policy announcements. We follow Altavilla et al. (2019), utilizing their Euro Area Monetary Policy event study Database (EA-MPD; Altavilla et al., 2019).[1] This dataset contains, among other things, what the authors call the changes in the "Monetary Event Window". These are changes between the median quote of a given asset price in the ten-minute window before the ECB's press release of its monetary policy decision (from 13:25 CET to 13:35 CET) and the median quote for that same asset price in the ten-minute window after the ECB's press conference that accompanies its monetary policy decision (from 15:40 CET to 15:50 CET).

The derivation of our monetary policy surprises follows a procedure similar to the one described in Gurkaynak et al. (2005) in the case of the United States. First, we select seven bond yields from EA-MPD data (the same ones as in Altavilla et al., 2019) that describe the euro area's yield curve from 1 month to 10 years. Next, we extract the first two principal components of the (normalized) bond yield series. We rotate the resulting components such that the first component, S^T, captures the "target" factor (corresponding to the surprise change in the short-term policy rate) and the second component, S^P, captures the "path" factor (corresponding to expected future changes in policy rates which are independent from changes in the current policy rate).

The rotated factors do not naturally have an interpretable direction or scale. We rescale the factors such that S^T moves the first asset price (the one month Overnight Index Swap, OIS, yield) by exactly 1 unit. This way we can interpret a shock to the target factor (S^T) as if it were a one percent shock to the short-term rate. Further, the re-scaling is such that it forces S^T and S^P to have the same effect on the one-year yield (12 month OIS yield). This allows us to interpret S^P as a longer run (path) factor that moves the one-year yield as much (and in the same direction) as S^T. Finally, to use the shocks in regressions, we aggregate the shock series to monthly frequency by summing the shocks from all the monetary policy decisions taking place during the same month.

After identifying the monetary policy shocks using high frequency data, we test the causal effects of monetary policy on mortgage rates by running the following regression:

$$y_{b,t+1} - y_{b,t-1} = \alpha_b + \gamma \, \text{Post}_t + \beta^T \, S_t^T + \beta^P \, S_t^P + \mu^T \, S_t^T \, \text{Post}_t + \mu^P \, S_t^P \, \text{Post}_t + \epsilon_{b,t}, \quad (2)$$

[1] The data version used in this paper is from November 20th, 2023. The most up-to-date dataset is available at https://www.ecb.europa.eu/pub/pdf/annex/Dataset_EA-MPD.xlsx

where $y_{t,b}$ is the interest rate on new mortgages for bank group b at time t, α_b are bank fixed-effects, S_t^i is the i identified monetary policy shock at time t (S^T being the target shock and S^P the path shock), and $Post_t$ is the dummy indicating whether t is in the post-pandemic tightening cycle. The control sample is from December 2005 to July 2008 and post-pandemic sample is from July 2022 to September 2023.

The results from the regression in equation (2) are shown in Table 4. We gather several important lessons. First, a surprise tightening in monetary policy, as measured by an increase in the target factor S^T, leads to a statistically significant increase in the mortgage rate before the pandemic, as evidenced by the significantly positive β^T. Second, the difference between the pre-pandemic transmission and the post-pandemic transmission, μ^T for S^T is significantly negative, meaning that the transmission of target shocks to mortgages rates weakened significantly during the post-pandemic tightening period. As a result, the post-pandemic monetary transmission of the target shock, $\beta^T + \mu^T$, while remain positive and statistically significant, is smaller in magnitude. These evidence confirms that the monetary policy shock of the target policy rate on the mortgage rate during the post-pandemic tightening cycle, while remaining positive and statistically significant, was significantly smaller than that during the control period when the liftoff took place at a positive interest rate territory.

Third, for the path factor, S^P, the coefficient of the monetary path shock during the control period is indistinguishable from zero, which is not surprising. By construction, the monetary path shock is orthogonal to the monetary target shock. The monetary path is communicated by the ECB in its forward guidance and balance sheet policy, both of which were absence before the global financial crisis. It was only after the policy rate was approaching zero after the global financial crisis that the ECB expanded its tools to include asset purchases and forward guidance in formulating monetary policy. The coefficient of the path shock during the post-pandemic tightening is positive and statistically significant. This indicates that the effect of shocks to the expected future path of monetary policy was transmitted to Finnish mortgages rates. Thus, while the monetary target shock lost potency during the post-pandemic period, the monetary path shock picked up some slack.

From the point estimates in Table 4, the effect of the post-pandemic monetary target shock on mortgage rates was less than one-third of the pre-pandemic effect. How much the loss in the target shock transmission was made up by the effect of the path shock is not straightforward. Nevertheless, the evidence suggests that the post-pandemic transmission of monetary policy was both qualitatively and quantitatively different than the transmission during the normal tightening cycle. In the post-pandemic tightening when the liftoff was at the negative territory coupled with the strong desire of policy makers to tighten policy expeditiously, the finding that the monetary policy path shock played an important role in the transmission of policy is noteworthy.

Table 4: Results from high-frequency analysis

	Two shocks
Target Shock (S^T)	
S^T pre (β^T)	7.43***
	(0.71)
S^T post ($\beta^T + \mu^T$)	2.14**
	(0.69)
S^T difference (μ^T)	−5.29***
	(0.91)
Path Shock (S^P)	
S^P pre (β^P)	0.05
	(0.19)
S^P post ($\beta^P + \mu^P$)	4.50***
	(0.55)
S^P difference (μ^P)	4.45***
	(0.49)
Obs.	376
Adj. R2	0.26

Notes: The table presents the coefficients and standard errors (in brackets) estimated from the regression in equation 2 with the dependent variable being the two-month difference (from $t-1$ to $t+1$) in the mortgage rate in basis points. The two independent variables are the monetary policy shocks derived using the extraction method described in the main text. Standard errors are clustered at the bank-group level. Asterisks denote statistical significance: *=10%, **=5%, ***=1%.

5 Heterogenity in Transmission

To delve deeper into the effect of the negative policy rate at the time of liftoff on monetary transmission, our third empirical method uses banks' exposure to negative interest rates to identify the effects of negative rates on more-exposed banks' vis-a-vis less-exposed banks' transmission of policy in the two tightening cycle. While this identification scheme is common in the negative rate literature (see, for example, Heider et al., 2019; Bittner et al., 2022), it requires taking a stance on what constitutes being "more exposed" to negative rates. Here, as the measure of exposure, we use the deposit-to-asset ratio which is the most commonly used exposure measure as described in Balloch et al. (2022) and used in KUV (2025). Banks with higher deposit-to-asset ratios are assumed to be more exposed to negative rates, because they obtain a higher share of their funding from deposits, for which the interest rate is likely to be floored at 0 percent. When the policy rate is in positive territory, and the rates on different sources of funding co-move strongly, the degree of exposure to deposit funding is not expected to affect the pass-through. By contrast, when the policy rate is in negative territory, the rates on non-deposit funding respond more strongly to changes in the policy rate (see Figure 1) than deposit rates. Consequently, banks relying more on deposit funding (indicated by a higher DAR), ceteris paribus, are expected to pass through less of the change in the policy rate to mortgage rates during the negative interest rate policy. Because more exposed banks (with higher DAR) passed through less of the policy rate change to mortgage rates during monetary easing, these banks are expected to also pass through less of the policy tightening to mortgage rates.

To test whether banks with more exposure to deposit funding pass through less of the tightening in monetary policy to their mortgage rates during the post-pandemic tightening cycle, we run the following regression:

$$\Delta y_{b,t} = \alpha_b + \gamma_t + \sum_{k=0}^{3} \beta_k \cdot DAR_b \cdot \Delta i_{t-k} + \sum_{k=0}^{3} \mu_k \cdot Post_t \cdot DAR_b \cdot \Delta i_t + \epsilon_{b,t}, \tag{3}$$

where $\Delta y_{b,t}$ is the change in the rate on new mortgage loans issued by bank b between time $t-1$ and t, α_b denotes a set of bank fixed effects, γ_t denotes a set of time fixed effects, and DAR_b is the average deposit-to-asset ratio of bank b in December 2013. $Post_t$ continues to be the dummy for the post-pandemic period. The control sample and post-pandemic tightening sample are the same as in relation to regression in equation (1).

In equation (3), the coefficient β measures how much more-exposed banks increase their mortgage rates after a hike in the policy rate compared to less-exposed banks when the policy rate was positive at the start of the tightening cycle. With three lags, policy transmission is allowed to take place over a total of four months. The sum of the coefficients $(\beta + \mu)$ measures this same relative difference during the post-pandemic tightening cycle. Therefore, the coefficient μ measures how much the transmission of more-exposed banks is hindered in the post-pandemic tightening cycle compared to the normal tightening cycle. If more-exposed banks indeed passed through less tightening to their mortgage rates, the coefficients μ are expected to be negative.

The results of estimating equation (3) by OLS are presented in Table 5. The β coefficients, as well as the sum of β, are not significantly different from zero, indicating that when the policy rate was positive at the time of tightening, banks with a higher DAR do not exhibit a differential pass-through of monetary policy to mortgage rates compared to banks with a lower DAR. With regard to the μ coefficients, while the individual μ is insignificant, the sum of the μ coefficients is negative and significant at the the 10 percent confidence level. The findings indicate that banks with a higher DAR pass through a smaller fraction of monetary policy changes to mortgage rates when the policy rate is negative at the time of liftoff compared to banks with a lower DAR.

Banks with a higher DAR rely more heavily on deposits for their funding. In negative territory, the deposit rate essentially stops co-moving with the policy rate, while interest rates on other sources of funding continue to co-move with the policy rate. Therefore, banks with a higher DAR face a smaller reduction in their funding costs compared to banks with a lower DAR when the ECB cuts the DFR in negative territory. As a consequence, banks with a higher DAR did not cut their mortgage rates by as much as banks with a lower DAR. When the ECB tightened policy after the pandemic, banks with a higher DAR compensated for their relatively higher mortgage rates compared to low-DAR banks by passing through less of the tightening in the policy rate to the mortgage rate, ceteris paribus.

Table 5: Results from exposure measure analysis

Change in the mortgage rate (bps)				
β_0	β_1	β_2	β_3	$\sum_{k=0}^{3} \beta_k$
-0.236	0.182	0.181	0.006	0.134
(0.281)	(0.291)	(0.182)	(0.297)	(0.199)
μ_0	μ_1	μ_2	μ_3	$\sum_{k=0}^{3} \mu_k$
0.181	0.013	-0.360	-0.138	-0.304^{*}
(0.417)	(0.312)	(0.258)	(0.231)	(0.159)
$\beta_0 + \mu_0$	$\beta_1 + \mu_1$	$\beta_2 + \mu_2$	$\beta_3 + \mu_3$	$\sum_{k=0}^{3} \beta_k + \mu_k$
-0.055	0.195	-0.179	-0.131	-0.169
(0.182)	(0.197)	(0.191)	(0.150)	(0.100)
Number of observations			424	
Adjusted R^2			0.64	

Notes: This table presents selected coefficients and standard errors (in brackets) estimated from regression equation 3 with the dependent variable being the one-month difference in the mortgage rate in basis points. The change in the policy rate is also measured in basis points and the deposit-to-asset ratio is measured as a number between 0 and 1. Standard errors are clustered at the bank-group level. Asterisks denote statistical significance: *=10%, **=5%, ***=1%.

6 Conclusions

Both the magnitude and the pace of monetary policy tightening in the euro area during 2022-23 were historically large and fast. Yet, the real economy proved to be resilient so far, without falling into recession that was feared a priori. In this paper, we analyze the pass-through of the ECB's changes in the deposit facility rate to mortgage rates in Finland during the post-pandemic period of 2022-23, when the liftoff was from the negative interest rate territory, using the normal tightening cycle in 2006-08 as control.

We employ three empirical strategies to study the monetary policy pass through in Finland. First, mortgage beta regression results show that, in the control period, a large fraction of the tightening in the ECB's policy rate was transmitted to Finnish banks' mortgage rates both contemporaneously and with lags, up to 83 percent over four months. However, during the post-pandemic tightening cycle, the total pass-through was reduced significantly, by about one-third. The total pass-through from the policy rate to the mortgage rate was estimated to be 64 percent during the post-pandemic tightening cycle, less bang for the buck when tightening financial conditions was urgently needed to arrest surging inflation.

Our second empirical strategy pins down the causal effects of monetary policy more precisely. In this strategy, we first identify monetary policy shocks over a short window around monetary policy announcements, providing estimates of the monetary policy shock's target factor and the future policy rate path factor. These monetary policy shocks are then used to explain the changes in the mortgage rate. Our results show that a surprise tightening in monetary policy leads to a statistically significant increase in the mortgage rate, both during the post-pandemic tightening cycle and during the control period. In particular, while the effect of the monetary policy target surprise was significant in both tightening episodes, it was diminished significantly during the post-pandemic tightening cycle when the liftoff took place at the negative interest rate territory.

In addition, we found the surprises in the lifting of the monetary policy path led to statistically significant increase in the mortgage rate during the post-pandemic period, but not during the control period. To the extent that monetary policy tools that aim at the path of future monetary policy were not used before the global financial crisis, the absence of the path effects on mortgage rates during the control period seems reasonable. Nevertheless, whether the path shock is able to make up for the less potent target shock during the post-pandemic period is an interesting question for future research.

To further pin down the effect of the liftoff at negative interest rate on policy transmission, our third empirical strategy exploits differences in Finnish banks' reliance on deposits as a funding source to identify the differential effects of negative policy rates among more- versus less-exposed banks. To the extent that bank deposit rates are likely constrained by the zero lower bound while market-based funding rates are not, banks relying more on deposit funding are expected to have a smaller pass-through to mortgage rates during the negative policy rate period. By the same token, more-exposed banks are expected to pass through less monetary tightening to their mortgage rates when monetary policy changes course. Our results show that during the control period when the policy rate was positive, banks with a higher DAR did not exhibit any differences in the pass-through of monetary policy to mortgage rates compared to banks with a lower DAR. However, during the post-pandemic tightening when the liftoff was at negative territory, banks relying more on deposit funding passed through a smaller fraction of monetary policy changes to mortgage rates than banks with a lower DAR.

Taken together, the results in this paper show that the effectiveness of monetary policy during the post-pandemic tightening cycle has diminished, when tighter financial conditions were urgently needed to combat inflation. The loss in monetary potency was likely due to the liftoff taking place at negative interest rate territory, suggesting that negative interest rate led to a drag in policy transmission in both monetary easing and monetary tightening. Thus, while negative interest rate is a viable policy tool to stimulate demand without being constrained by the zero lower bound, it also creates headwind down the road for future policy normalization.

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